Manals Committee

West Virginia Department of Transportation

Division of Highways

2022 Construction Manual

INTRODUCTION

The 2022 Construction Manual has been prepared to inform and assist construction inspection personnel within the West Virginia Division of Highways (WVDOH); to provide timely completion of projects to a high standard, on a uniform basis throughout the state. The manual provides guidance on the application of construction specifications and inspection practices for the administration of construction projects, field inspection, preparation of project records, checking quantities, and finalization.

As the on-site representatives of the WVDOH, the construction personnel are authorized to observe all work being performed to ensure compliance with the contract. The construction personnel record their observations and inspections to document that the work performed meets the contract requirements. This documentation is later used to verify that work paid for by the Department was performed and acceptable. The documentation may also be used to defend the Department in a dispute or claim. Written documents are valuable resources in a claim, to establish what was done and when, to demonstrate that the contractor was given proper instructions, and to demonstrate that Department testing was properly performed. The Construction Manual gives guidance to the construction personnel as to what information is important to document based on the Department's experience. Proper documentation thereby helps ensure quality work and minimizes the Department's responsibility in a claim.

This manual is not a contract document, and its content is not legally binding upon any WVDOH contract. It does not pertain to Design-Build projects, please consult Alternative Project Delivery Manual for guidance on these projects. The Construction Manual includes references throughout to certain sections of the Specifications to relate certain inspection activities to an applicable Specification.

Contract Administration and Technical Support Division encourages and requests that they be advised when errors or alternative construction methods are founds. Approved changes, additions, or deletions will be issued as the need arises.

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101.1-DIVISION OF HIGHWAYS

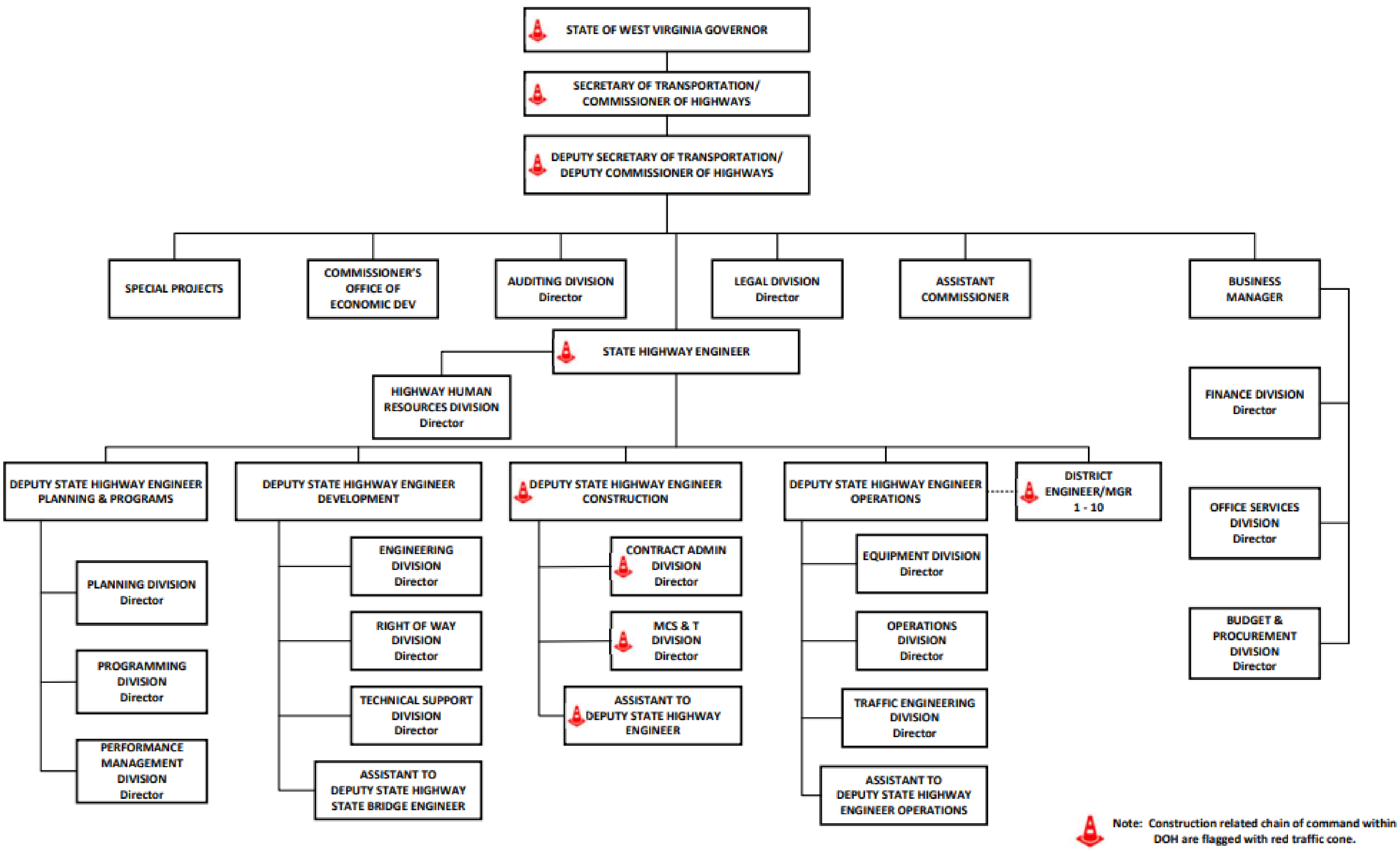
The West Virginia Division of Highways (DOH) is organized to plan, design, construct, and maintain an adequate system of safe public roadway facilities capable of meeting the traffic needs of the State. The DOH also performs many other functions such as highway research, traffic regulation, right-of-way acquisition, outdoor advertising contiguous to state roads, roadside development, safety, and dissemination of highway information. The organization chart of DOH can be obtained from the Division's webpage.

The primary contacts for construction related issues are within the Contract Administration Division. Below is the chain of command within DOH as it pertains to construction:

1. Secretary of Transportation. The Division of Highways is organized under the supervision of the Secretary of Transportation who is appointed by the Governor.
2. Deputy Secretary of Transportation/Commissioner of Highways. Provides general supervision over the state road program and the construction, reconstruction, repair and maintenance of state roads and highways.
3. State Highway Engineer. Oversees the functions of Chief Engineer of Planning and Programming-Deputy State Highway Engineer; Chief Engineer of Construction-Deputy State Highway Engineer, Chief Engineer of Development-Deputy State Highway Engineer; Chief Engineer of Operations-Deputy State Highway Engineer, and District Engineer/Manager.
4. Chief Engineer of Construction-Deputy State Highway Engineer. Oversees the functions of Contract Administration Division, and Materials Control, Soils and Testing Division.
5. Contract Administration Division. Is charged with the responsibility of administering highway construction by contract from award until the project completion and the contractor is paid in full, including checking the verification of final estimates. See next subsection for additional detail.

See Figure 101A for organizational chart of DOH. For additional information on the DOH and other Divisions, visit the DOH Internet Website.

101.1.1-Contract Administration Division The Contract Administration Division is responsible for administering all DOH highway construction projects. The organization of the Contract Administration Division can be obtained from its webpage. The Director of the Contract Administration Division reports to the Chief Engineer of Construction-Deputy State Highway Engineer. Contract Administration is organized in a manner that divides the Division into three groups: Contractor Prequalification & Contract Processing; Logistics & Technology; and Construction. The responsibilities of the Sections within the Contract Administration Division are as follows:



WEST VIRGINIA DIVISION OF HIGHWAYS ORGANIZATION

Figure 101A

1. Contractor Prequalification and Contract Processing. Contractor Prequalification and Contract Processing oversees the following:
   a. Contractor Prequalification/Financial Section. The Contractor Prequalification/ Financial Section is responsible for the prequalification of bidders. The Section also obtains financial information and experience records.
   b. Contract Development Section. The Contract Development Unit is responsible for processing contract documents, coordinating with project manager, and obtaining project approval.
   c. Contract Procurement Section. The Contract Procurement Unit is responsible for advertising all highway contracts, distributing bid documents, managing the Electronic Bidding System (EBXS), updating the DOH Internet Website relative to contractual information, and coordinating work related to the execution of contracts, contract bonds, and insurance certificates.
2. Logistics and Technology Section. The Logistics and Technology Section oversee the following:
   a. Contract Analytics: Conducts bid analysis of construction contracts let for bidding to determine whether contract should be awarded or rejected based on bids.
   b. Integrated Construction Technologies. Support software and administer accounts for AASHTOWare,
   c. Project Control Unit. The Project Control Unit establish project authorities and initiate start dates of each contract. The unit also establishes and monitors the finalization policies and procedures administered at the District and project levels. The Unit also oversees Contractor performance for progress and final payments.
   d. Contract Management Coordinator. The Contract Management Coordinators, coordinate change order and estimates with district personnel of their respective districts.
3. Construction Section. The Construction Section oversee the following:
   a. Consultant Services & Field Inspection Unit. Responsible for the establishment of all consultant inspection agreements. The unit also oversees statewide field inspection & engineering support staff.
   b. Regional Construction Engineers. The Regional Construction Engineers oversee the highway construction operations of their respective Districts. The District Construction Engineers of the ten DOH Districts coordinate with the Central Office through their respective Regional Construction Engineer. The Regional Construction Engineers are responsible for the review, coordination, and approval of engineering practices, procedures, and contract modifications related to field activities.

101.1.2-Materials Control, Soils and Testing Division The Materials Control, Soils and Testing (MCS&T) Division is responsible for administering all activities related to materials control, soils and testing for DOH highway construction projects. The organization of the MCS&T Division can be obtained from its webpage. The Director of the MCS&T Division reports to the Chief Engineer of Construction-Deputy State Highway Engineer. The responsibilities of the MCS&T

Division are as follows:

1. Technical Support Group. The Technical Support Group provides a variety of services for the Materials Control, Soils and Testing Division that do not intuitively fall in another group in the Division's organization chart. These services include, but not limited to: overseeing the Division's materials inspector and technician certification programs; complying with the Nuclear Regulatory Commission requirements with respect to the Division's storing, handling, and operation of its nuclear density gauges; administering the consultant inspection, review, and sampling contracts; processing new material for approval and use; maintaining the Division's web page; overseeing the Division's laboratory accreditation; and processing District reports, such as, DMIRs and ST-1s.
2. Aggregate and Soils Group. The Aggregate and Soils Section maintains the DOH Approved Material Source/Product List, performs aggregate and soil testing required at the Division level, reviews District laboratories for conformance to minimum requirements, and reviews District and Contractor testing procedures and documentation.
3. Metals Group. The Metals Section is responsible for the quality assurance testing of metal materials used in highway and bridge projects. This Section inspects structural steel, reinforcing steel, lighting structures, guardrail, fasteners, and signing materials at the fabrication site and ensures that all field welders are qualified to weld in accordance with specifications.
4. Environmental and Coatings Group. The Environmental and Coatings Section consists of three subgroups: Coatings Subgroup, Chemical Laboratory Subgroup, and Environmental Site Investigation Subgroup. The primary function of the Coatings Subgroup is to conduct chemical and physical testing on paint samples, review quality control plans, and handle coatings issues. The Chemical Laboratory Subgroup primarily conducts chemical analysis on metals, various types of cement, fly ash, slag, and chloride samples. The Environmental Site Investigation Subgroup is responsible for conducting environmental site investigations at the DOH maintenance facilities to determine the extent of contamination at the sites.
5. Asphalt Group. The Asphalt Section establishes procedures for mix design and testing of asphalt concrete. This Section reviews field and laboratory testing procedures for asphalt concrete and monitors mix designs and material components.
6. Cement and Concrete Group. The Cement and Concrete Section establishes procedures for mix design and testing of Portland cement concrete and maintains test records of PCC sources for the DOH Approved Material Source/Product Listing. This Section reviews all PCC mix designs incorporated in projects and administers the DOH Certification Program related to PCC technology.
7. Subsurface Investigation Group. The Subsurface Investigation and Support Services Section is responsible for exploring and providing geotechnical, roadway, bridge, and environmental information necessary for the development, construction, maintenance, and operations of DOH.
8. Pavements Group. The Pavement Group severs as a technical resource to the Districts and other Divisions in all matters related to pavement. The groups focus is on Design,

Construction, and Preservation of pavements in an effort to have our pavements last longer, which is achieved through education, research, quality control, and innovation.

9. Materials Control Group. This section generates Materials to the Site Manager contract. Maintain the test requirements as new materials are add to the projects. They ensure all materials incorporated into construction projects have met DOH specifications, Plans and Quality Control Plans submitted by the contractor for projects all over the State.
10. Traffic Certification Group. Responsible for traffic certificate and related functions within the Division.
11. Equipment Group. The Equipment Group is responsible for maintaining a reliable fleet of equipment used to conduct the work by both MCS&T Division and our neighbors, the Sign Shop. This involves providing direct equipment maintenance service, minor and major repairs as well as the responsibility for coordinating the purchase of all parts and supplies.
12. Payroll, Personnel, Purchasing, and Training Group. Responsible for human resources and related functions within the Division

101.1.3-DOH Districts The State is divided into ten DOH Districts. Each District has jurisdiction over their respective counties as follows:

District 1 – Boone, Clay, Kanawha, Mason, and Putnam Counties.
District 2 – Cabell, Lincoln, Logan, Mingo, and Wayne Counties.
District 3 – Calhoun, Jackson, Pleasant, Ritchie, Roane, Wirt, and Wood Counties.
District 4 – Doddridge, Harrison, Marion, Monongalia, Preston, and Taylor Counties.
District 5 – Berkeley, Grant, Hampshire, Hardy, Jefferson, Mineral, and Morgan Counties.
District 6 – Brooke, Hancock, Marshall, Ohio, Tyler, and Wetzel Counties.
District 7 – Barbour, Braxton, Gilmer, Lewis, Upshur, and Webster Counties.
District 8 – Pendleton, Pocahontas, Randolph, and Tucker Counties.
District 9 – Fayette, Greenbrier, Monroe, Nicholas, and Summers Counties.
District 10 – McDowell, Mercer, Raleigh, and Wyoming Counties.

The District Engineer is responsible for all operations within the District and will utilize, as needed, the services provided by the DOH Central Office Divisions. The organization of each DOH District varies somewhat because of its size, workload, and local conditions. Each District is generally organized into two primary groups – construction and maintenance operations.

101.1.3.1-District Maintenance Operations The District Maintenance Engineer is responsible for District maintenance personnel, equipment, equipment shop, sign shop, building and grounds, and any use of District forces.

101.1.3.2-District Construction Operations The following discusses the responsibilities of key District construction personnel:

1. District Construction Engineer. The District Construction Engineer is directly responsible for all aspects of District construction including project progress and priorities, personnel assignments, personnel and public safety, project surveys, utility coordination, project inspection and reviews, project records, and materials control

operations. The Construction Engineer will periodically visit projects to verify progress and check that construction is being performed in accordance with State Law, DOH policies, and the contract specifications. As needed, the District Construction Engineer also will report to the District Engineer the findings and recommendations of any special studies needed to resolve problems.

2. District Materials Supervisor. The District Materials Supervisor directs all materials control operations within the District. The Supervisor is responsible for ensuring that all District projects follow DOH materials policies and procedures for quality control and assurance. The duties of the District Materials Supervisor include:
   a. Becoming knowledgeable on DOH specifications and certification procedures for all materials used within the District;
   b. Maintaining liaison with the Contract Administration Division-Project Control Unit and the Materials Control, Soils and Testing Division;
   c. Maintaining a close working relationship with all Project Engineers/ Supervisors within the District;
   d. Supervising commercial asphalt and concrete plant inspections;
   e. Supervising mobile laboratories within the District;
   f. Assisting District personnel when materials are an issue on District maintenance and construction projects; and
   g. Providing recommendations to the District Construction Engineer on any materials that do not comply with DOH specifications.

101.1.3.3-Project Organization The organization and scheduling of DOH and Contractor personnel and equipment will depend on the type, scope, and schedule of the project. The District will staff projects sufficiently and satisfactory to perform the work; Figure 101B provides typical project staffing guidelines. To accommodate DOH personnel on large projects, a physical building or trailer may be needed for use as a field office; however, small jobs may only necessitate the use of a truck for monitoring and inspection purposes.

	PROJECT TYPE				
PERSONNEL TYPE	Large Grade, Drain and Pave ≥ $25 Million	Small Grade, Drain and Pave $8 Million to $25 Million	Major Structure ≥ $7 Million	Small Structure or Miscellaneous Improvements	Resurfacing
Project Engineer/ Supervisor	1	1	1	1	—
Project Inspector	5 [Note 1]	3 [Note 1]	2	1	2
TOTAL PERSONNEL	6+	4+	3	2	2

Note 1: Additional Project Inspectors may be required for structures, work which is highly technical in nature, when Contractor is working double shift, etc.

Typical Personnel Requirements for Normal Daily Operations of a Project
Figure 101B

District Project Engineers/Supervisors and Project Inspectors are the primary DOH representatives in charge of monitoring, inspecting, and accepting/rejecting the Contractor's work and the materials delivered to the project site. The Project Engineer/Supervisor's primary point-of-contact with the Contractor is the Contractor's Project Superintendent. The following describes the roles and responsibilities of key personnel at the project level:

1. Project Engineer/Supervisor. A Project Engineer/Supervisor within the District will be assigned to the project. A Project Engineer/Supervisor may be responsible for simultaneously supervising several District projects. In Districts that have many ongoing projects or complex construction activities, a District Area Engineer/ Supervisor may be assigned to supervise a group of Project Engineers/Supervisors. The Project Engineer/Supervisor oversees all aspects of a project including personnel, construction and materials inspection, progress monitoring, and reviewing and approving documentation (e.g., Daily Work Repots, AASHTOWare Project). The Project Engineer/Supervisor accepts or rejects contract items and materials based on the requirements of the plans and specifications. Other DOH District personnel (e.g., Project Inspectors, survey crews) will be assigned, as needed, to assist the Project Engineer/Supervisor. The Project Engineer/Supervisor maintains close contact with the DOH Project Inspectors and the Contractor's Project Superintendent. The Project Engineer/Supervisor also will have frequent contact with adjacent property owners, municipal officials, utility representatives, and the traveling public.
2. Project Inspectors. The Project Inspector is responsible for monitoring, inspecting, and documenting daily that construction practices and material quality meet the requirements of the plans and specifications. A Project Inspector typically may be responsible for multiple activities and ensuring that the Contractor produces a product in compliance with the plans and specifications.
3. Contractor's Project Superintendent. The Contractor's Project Superintendent is the Contractor's authorized representative who is responsible for the quality of work and materials incorporated into the project. The Project Superintendent is the Contractor's primary point-of-contact with DOH construction activities and directs all Contractor and subcontractor personnel during project construction (e.g., equipment superintendent, foremen, laborers, equipment operators).

101.1.4-DOH Web Sites To better serve its customers, the DOH provides significant information on the DOH Web Site.

The Contract Administration web site makes available to the public, consultants, and contactors, including the following information:

1. Notices of projects scheduled for letting;
2. Information on consultants, prequalification, requests for professional services, and the consultant selection process;

3. Information on prequalified contractors, project schedules and locations, current and archived contract lettings, electronic bidding system, contract awards, and average unit bid prices; and
4. Information on the status of ongoing construction projects.

The Technical Support Division webpage list the Publications and manuals for the WVDOH, including Standard Details, Standard Specifications, and Supplemental Specifications.

101.2-FEDERAL HIGHWAY ADMINISTRATION

101.2.1-General The Federal Highway Administration (FHWA) administers the Federal-aid program that funds eligible highway improvements nationwide. Their basic responsibility is to ensure that the WVDOT comply with all applicable Federal laws, policies and procedures in their expenditure of Federal funds and to ensure that the WVDOT meet the applicable engineering, legal, and administrative requirements for their Federally funded highway projects.

FHWA maintains a Division Office within each State, and the West Virginia Division Office is the primary point of contact for WVDOT. The Division Administrator is delegated wide authority for administration of the program in accordance with policies established by the headquarters office of the Federal Highway Administration.

The FHWA West Virginia Division Office uses an Area Engineer organization to fulfill its responsibilities within the State. Each Area Engineer is responsible for all Federal-aid highway activities within his/her area for both project plan development and construction activities. In addition, the West Virginia Division Office has designated "specialists" in specific highway functional areas (e.g., construction, environment, bridges, road design, financial affairs). See FHWA West Virginia Division Office website for additional information.

101.2.2-FHWA/West Virginia Relationship

101.2.2.1-Stewardship and Oversight Agreement In accordance with Federal Requirements, the WVDOT and FHWA have adopted a Stewardship and Oversight Agreement. The agreement can be obtained from FHWA/WVDOT Web Page. Its basic purpose is to define the operational relationship between WVDOT and FHWA by documenting the basic standards and procedures for use in the Federal-aid highway program. This applies to planning, design, construction, and maintenance.

101.2.2.2-Project Types WVDOH will place each proposed Federal-aid project in one of the following categories:

1. NHS Non-Exempt. Those projects on the National Highway System (NHS) for which the WVDOH is not exempt from project- level FHWA review and oversight.

2. NHS Exempt. Those projects on the NHS for which the WVDOH is exempt from project-level FHWA review and oversight. On exempt projects, WVDOH is responsible for ensuring that all applicable policies, standards, and regulations are met.
3. Non-NHS Exempt. The WVDOH is exempt from project-level FHWA review and oversight on all projects not on the NHS, except traffic surveillance and control projects exceeding $1,000,000. On exempt projects, WVDOH is responsible for ensuring that all applicable policies, standards, and regulations are met.
4. Concurrence. For certain projects on the NHS, the WVDOH may propose that the FHWA provide project-level oversight by concurrence. These projects are administered as NHS non-exempt projects.

In the absence of significant changes in the project scope, the project type designation in project plan development will be retained for the construction phase of the project.

101.2.2.3-FHWA Role in Construction FHWA will fulfill its responsibilities as an oversight agency in one of two basic approaches:

1. Project-Level. On non-exempt NHS and concurrence projects, FHWA will be involved in the approval of all major construction activities. These include contract award, change orders, time extensions, changes to the plans, specifications and estimates, and periodic field inspections.
2. Continuous Process Improvement Studies. FHWA and WVDOH will mutually establish teams to periodically review and evaluate specific major construction activities. This will typically involve selected in-depth field inspections on active construction projects as part of the process review. Continuous Process Improvement Studies will typically be limited to the NHS.

101.2.3-FHWA Relationships The relationship between FHWA and WVDOH does not directly involve the Contractor. FHWA representatives inspect the project to review the Department's procedures, which require the project to be constructed according to the commitments in the Stewardship Agreement. The FHWA's representative is reviewing the State's performance and not the Contractor's. FHWA has neither the responsibility nor authority to interact directly with the Contractor relative to ensuring compliance with the plans and specifications.

All Department employees are urged to cooperate with the FHWA during all phases of the Contract. Construction personnel must be courteous to FHWA representatives whenever they conduct their reviews. FHWA personnel have been delegated to review construction activities relating to progress, quality, contractor's payrolls, etc. They may also take field measurements, review test procedures and results, or investigate requested contract changes. Comments made by the FHWA representatives should be noted in the Daily Work Reports (DWR), and issues that require action by the Department should be referred to the Construction Engineer. All correspondence to FHWA shall be submitted through the Central Office for proper signature.

101.3-PERSONNEL RESPONSIBILITIES

101.3.1-General DOH project personnel have the responsibility of promoting good working relationships with each other. Each Project Inspector is expected to follow the instructions of the Project Engineer/Supervisor. Each Project Engineer/Supervisor will demonstrate conduct that earns the full support and cooperation of the Project Inspectors. It is important to keep each other fully informed on daily project activities including progress, problems, and resolutions, needed plan or schedule modifications, and upcoming schedules. All these items should be noted on the DWR and attachments. Both Project Engineers/ Supervisors and Project Inspectors must fully understand their respective responsibilities and authority. They are representatives of the DOH and the District Construction Engineer on the project. Project Engineers/Supervisors and Project Inspectors are responsible for verifying Contractor performance and compliance with applicable specifications and contract requirements.

101.3.2-Project Engineer/Supervisor The Project Engineer/Supervisor may be responsible for inspecting on or a group of highway projects. The Engineer/Supervisor will supervise personnel, assign tasks, and provide technical advice to Project Inspectors. The Project Engineer/Supervisor will apply a broad knowledge of field-testing and inspection techniques to ensure that the quality of workmanship and materials conform to the plans and specifications and that the construction meets the terms of the Contract. The Project Engineer/Supervisor holds frequent discussions with Project Inspectors and the Contractor’s Project Superintendent to resolve problems in the field requiring interpretation of the plans and specifications. The discussions and any subsequent decisions are to be noted on the DWR. The Project Engineer/Supervisor serves as liaison between the field and the District Office to keep the Construction Engineer apprised of progress and problem resolution. Supervision is received from the District Construction Engineer through periodic discussions and reviews. Example responsibilities of the Project Engineer/Supervisor include:

1. Determining inspection needs and assigning Project Inspectors to ensure adequate inspection;
2. Instructing Project Inspectors on inspection techniques and field testing methods;
3. Interpreting contractual requirements for Project Inspectors and the Contractor’s Project Superintendent;
4. Investigating property owner complaints arising from conflicts between construction and right-of-way agreements;
5. Preparing and/or checking and approving Inspector’s DWR and all attachments and documentation. The Project Engineer/Supervisor should ensure the timely entry of applicable data into AASHTOWARE Project (AWP) and timely uploading of materials data;
6. Preparing Supervisor’s Diaries or DWRS for project documentation and for entry of applicable data into AWP;
7. Utilizing AWP to administer the Contract, manage the project, prepare correspondence, change order, and generate reports and other documentation relative to the project;
8. Verifying progress and final estimates and discussing any discrepancies with the Project Inspectors;
9. Maintaining a perspective overview regarding Federal, State, and local laws regulating construction procedures, safety practices, and working conditions;

10. Inspecting work in progress to check that methods, materials, and equipment conform to the contract specifications; and
11. Supervising the training of Project Inspectors, evaluating performance, and recommending promotions and transfers.
12. Reviewing the daily performance of Project Inspectors and advising them as necessary;
13. Answering questions from Project Inspectors and the Contractor's Project Superintendent/Foremen;
14. Review and monitors the materials data process; and
15. Supervising training of Project Inspectors assigned to the project.

101.3.3-Project Inspector The Project Inspector inspects construction under the supervision of a Project Engineer/Supervisor. Assignments depend on the scope or complexity of the project. The work is distinguished from a trainee by the requirements of relatively independent decisions, actions, and relationships with the Contractor's Project Superintendent/Foremen and the public. Providing assistance in training and supervision of trainees are requirements of the work. Example responsibilities of the Project Inspector include:

1. Inspecting assigned phases of work on a project and making official contact with the Contractor's Project Superintendent/ Foremen to ensure conformance with the contract plans and specifications;
2. Frequently checking and noting on the DWR line, grade, and dimensions of roadways and structures and advising the Contractor's Project Superintendent/Foremen of any discrepancies;
3. Checking construction operations where specific methods are dictated and specifying corrective action for any variances;
4. Ascertaining that traffic signs are erected and maintained for the safety and convenience of the traveling public;
5. Preparing DWR and Attachments for project documentation into the AASHTOWARE Project;
6. Checking materials delivered to the project to ascertain that they are DOH approved and delivered with the appropriate shipping documents, confirming laboratory number, performing routine material field sampling and testing as required, and shipping any required samples to the District Materials Supervisor or MCS&T Division laboratories for materials verification;
7. Preparing or checking progress reports including physical progress and percent of total work completed;
8. Maintaining accurate project records;
9. Performing other duties as assigned by the Project Engineer/Supervisor; and
10. Review contractor/subcontractor's certified payrolls.

101.4-PERSONNEL TRAINING AND CERTIFICATION

101.4.1-DOH Technician Training / Certification The DOH certifies Project Inspectors and other technicians through an examination process administered under the auspices of the West Virginia Transportation Engineering Technician Board (WV TRET Board). Training for a variety of inspection policies and procedures are offered to employees of the DOH. Certification can be obtained only through this process.

101.4.2-DOH Materials Sampling/Testing In accordance with the DOH Quality Control/Quality Assurance Program and FHWA requirements that persons performing materials sampling or testing activities for the DOH or the Contractor be certified under the Division's testing program, the WVDOH Technical and Inspector Certification Program administers written examinations and/or practical examinations to certify that technicians and inspectors employed by either the DOH or Contractor are competent in the materials sampling and testing fields for which they apply. The DOH Certification Program covers eight technical areas: Aggregate Technician, Aggregate Sampling Inspector, Portland Cement Concrete Inspector, Portland Cement Concrete Technician, Asphalt Preservation Technician, Asphalt Plant Technician, Asphalt Field and Compaction Technician, and Soil and Aggregate Compaction Inspector. Upon passing the examination, the Board issues a letter and certificate. Certification remains in effect for a period as regulated by the Board. The Contractor is responsible for providing the certified personnel necessary for administering the Contractor's Quality Control Plan during the project. Contact MCS&T to verify whether an individual is certified. See Division 700 for additional information on the DOH Materials Sampling/Testing Certification.

101.5-EQUIPMENT AND VEHICLES

The following sections provide information on the use of State-owned equipment by DOH personnel.

101.5.1-Engineering & Materials Equipment Engineering instruments and laboratory equipment are delicate precision tools. Reliable results can only be obtained if these tools are used properly, and improper handling can result in damage and costly repairs. The Materials Control, Soils and Testing Division will furnish materials sampling and testing equipment for field and laboratory work.

101.5.2-Vehicular Equipment State Vehicles are to be utilized per current state and DOH requirements/policies.

101.6-CONTRACT SPECIFICATIONS

101.6.1-Order of Precedence The term "specifications" is a general term that applies to all directions, provisions, and requirements pertaining to performance of the work by the Contractor. The Standard Specifications is a DOH document that provides those specifications for use in DOH construction contracts. The Supplemental Specifications contain additions and revisions to the Standard Specifications. A Special Provision is an addition and/or revision to the Supplemental Specifications or Standard Specifications covering conditions that are peculiar to an individual project and are included in the proposal as needed on a project-by-project basis. The Standard Specifications, Supplemental Specifications, Special Provisions, plans, and all supplementary documents are essential parts of the Contract and requirements occurring in one are as binding as though occurring in all. These documents are intended to be complementary and provide for a complete work. Use the following order of precedence to resolve any discrepancies:

1. Calculated dimensions will govern over scaled dimensions;
2. Supplemental specifications will govern over standard specifications,
3. Plans will govern over supplemental specifications and standard specifications; and
4. Special provisions will govern over plans, supplemental specifications and standard specifications;

101.6.2-Context of Responsibilities The contract specifications will refer to specific parties and individuals. It is important to note the distinction between these references to ascertain the context of responsibilities while administering the Contract. Use the following guidelines:

1. Engineer. The Engineer refers to the DOH State Highway Engineer, or authorized representative, limited by the scope of duties assigned.
2. Contractor. The Contractor is the individual, firm or corporation, party of the second part to the Contract, acting directly through their agents, Employees, or Subcontractors.
3. Subcontractor. A Subcontractor is an individual, firm, or corporation to whom the Contractor sublets part of the Contract.
4. Employee. An Employee is any person working on the project who is under the direction of the Contractor or any Subcontractor.

101.6.3-Availability The Standard Specifications Roads and Bridges and Supplemental Specifications are available for viewing, download, and/or printing from DOH Specifications webpage. Annual issues of the Supplemental Specifications will be published each January and new edition of the Standard Specifications will be published as determined by Technical Support Division. Hard copies of these documents, if available, may be purchased by contractors, subcontractors, and suppliers from the Technical Support Division. Hard copies will be provided to DOH employees in Districts and Central Office, if available, by the Division's Specification Engineer.

101.7-MATERIALS PROCEDURES (MPs)

DOH MPs typically are referenced by the contract specifications and are maintained by the Materials Control, Soils and Testing Division (MCS&T). MPs define standard methods and guidelines for inspecting, sampling, testing, evaluating, and documenting activities relative to the quality assurance program for materials, products, and processes. Each Material Procedure is identified by the letters "MP" followed by seven numeric digits (i.e., MP XXX.XX.XX). See MCS&T webpage for list of current MPs.

SECTION 102
BIDDING REQUIREMENTS AND CONDITIONS

Section 102 of the Specifications presents the requirements under which a prospective bidder may bid on an advertised construction contract. Also see the WVDOH Contract Award Manual; a copy of the publication can be obtained from Contract Administration webpage.

SECTION 103
AWARD AND EXECUTION OF CONTRACT

103.1-GENERAL

Upon receiving bids, DOH must follow certain procedures to evaluate bids and award and execute the Contract. See Section 103 of the Specifications and the Contract Award Manual for additional information.

103.1.1-Distribution of Executed Contract The executed Contract will accompany all original project documents and certificates. Contract Administration Division will process the executed Contract and place it in the Project file on ProjectWise.

103.3-PRE-CONSTRUCTION ACTIVITIES

103.3.1-Preconstruction Conference The DOH requires that a Preconstruction Conference be held for all State and Federal-aid projects.

The Preconstruction Conference is called by DOH to discuss any real or anticipated construction issues and to assure that the affected parties are fully informed of key aspects of the project. The Conference will be held after Contract award and prior to construction. Attendees will include representatives from DOH, the Contractor, and other affected parties. The District Office will provide any additional information for the Conference.

103.3.1.1-Purpose The Preconstruction Conference will:

1. Plan for the DOH administration and inspection of contract items;
2. Discuss the scope and resolution of any real or anticipated construction problems;
3. Clarify the Contractor's understanding of project features and details;
4. Discuss the nature and status of agreements (e.g., utilities, property owners) and how they affect construction operations;
5. Schedule an effective sequence of operations for construction;
6. Coordinate the activity schedules of other agencies involved in the project; and
7. Introduce DOH personnel (e.g., Project Engineer/Supervisor, Project Inspectors) assigned to the project.
8. Contractor personnel.
9. Contractor QC plans/proposed source of materials

103.3.1.2-Arrangement and Scheduling After receiving the Notice of Award from the Contract Administration Division, the District Construction Engineer will coordinate with the Project Engineer/Supervisor, Contract Administration Division, and the Contractor to arrange a suitable date for the Preconstruction Conference. If utility coordination is significant, a preliminary meeting to resolve the major utility issues should be held before the Conference.

As needed, the District Construction Engineer will schedule such a meeting with the affected utility companies, District Construction Engineer, District Utilities Supervisor, Project Engineer/Supervisor, Railroad/Utilities Unit of the Right-of-Way Division, and the Contract Administration Division. See Section 105.2 of this manual for additional information on utilities. All attendees should be notified as far in advance of the scheduled Conference date as practical. The District Construction Engineer, or designee, will transmit correspondence containing the date, time, and location of the Conference to attendees.

103.3.1.3-Attendees In general, key representatives of the parties directly involved in any construction phase should attend the Preconstruction Conference. The District Construction Engineer will approve the final list of attendees, which may include:

1. DOH personnel from the Central Office including:
   a. Regional Construction Engineer, Contract Administration Division;
   b. Division Representative, Materials Control, Soils, and Testing Division;
   c. Traffic Engineer, Traffic Engineering Division;
   d. Project Design Engineer, Engineering Division;
   e. Environmental Engineer, Technical Support Division;
   f. Utilities Supervisor, Right-of-Way Division;
   g. Civil Rights Compliance Specialist, Civil Rights Compliance Division;
   h. Planning Division (for associated grant projects)
   i. Project Right-of-Way Agent, Right-of-Way Division; and
2. DOH personnel from the District Office including:
   a. Construction Engineer;
   b. Right-of-Way Agent;
   c. Encroachment/Hauling Permits Supervisor;
   d. Design Engineer;
   e. Bridge Engineer;
   f. Traffic Engineer;
   g. Materials Supervisor;
   h. Construction Office Manager;
   i. Safety Officer;
   j. Utility Supervisor;
   k. Area Engineer/Supervisor;
   l. Project Engineer/Supervisor;
   m. Project Inspectors; and
   n. Secretary to record minutes.
3. Contractor's management representative (e.g., Owner, Vice President);
4. Contractor's Project Superintendent;
5. Appropriate FHWA representatives;
6. Representatives from affected utility and railroad companies;
7. Representatives from the consulting engineer firm; and
8. Representatives from other concerned Federal, State, and local agencies including:
   a. US Coast Guard;
   b. US Army Corps of Engineers;

c. US Forest Service;
d. WV Department of Natural Resources;
e. WV Department of Environmental Protection;
f. Public Lands Corporation; and
g. Municipalities.

103.3.1.4-Facilitation The District Construction Engineer, or designee, will Chair the Conference and ensure that the minutes are accurately recorded. The Chair will announce the meeting agenda and ask each attendee to state their name and organization. Each attendee will sign the Conference Attendance Sheet. When facilitating the Conference, consider the following key topics, roles, and responsibilities:

1. Right-of-Way. The District Right-of-Way Agent will discuss the status of the project right-of-way.
2. Railroads/Utilities. The District Utilities Supervisor will discuss how the project will affect railroad and/or utility facilities. Representatives from affected companies should be queried as to how needed relocations and adjustments will affect construction progress.
3. Civil Rights Compliance. If unable to attend the Conference, Civil Rights Compliance Division will forward to the District Construction Engineer an informational packet outlining the civil rights and labor compliance regulations for Federal-aid projects. The District Construction Engineer will discuss the Contractor's responsibilities for compliance (e.g., notices to be posted, subcontracting requirements). Ensure that the Contractor has the Labor Compliance Guidelines and instruct the Contractor to thoroughly examine and comply with these regulations.
4. On-the-Job Training. If OJT is specified in the Contract, DOH requires the Contractor to submit a Training Proposal to the OJT Program Manager within the Civil Rights Compliance Division three (3) business days prior to the Conference designating the number of trainees and a Training Program for each selected work classification. The Civil Rights Compliance Division may approve the Training Proposal prior to the Conference if the Contractor uses Training Programs already approved by the Secretary of Labor. However, if the Contractor proposes to develop its own Training Programs, the DOH and FHWA must first approve the Training Programs before they are used on the project. The OJT Program Manager will emphasize that it is the Contractor's responsibility to identify work classifications of trainees on payrolls submitted to the Project Engineer/Supervisor. See Section 107.3.2 for additional information.
5. Materials Control. Desirably, the Contractor will submit the Proposed Source of Materials (Form PC-454) to the District Materials Supervisor before the Preconstruction Conference; otherwise, the Contractor must submit it at the Conference. See Section 702.2 for additional information. The District Materials Supervisor will discuss materials control issues and answer related questions posed by attendees. During the Conference, emphasize to the Contractor the need to have all material approved by the DOH prior to use.

6. Project Safety. The District Safety Supervisor will discuss the safety policies and procedures in the Contract and emphasize the importance of project safety.
7. Project Construction. The Project Engineer/Supervisor is responsible for thoroughly examining the details of the Contract, Plans, Specifications, Special Provisions, Agreements, and the Project Site before the Conference. The Project Engineer/Supervisor will discuss the specific phases of project construction, indicate acceptable locations for a Project Field Office (e.g., trailer), and emphasize to the Contractor's Project Superintendent the importance of promptly notifying Project Inspectors of arrival and departure times of all project labor, materials, and equipment. Other issues should be presented and discussed as needed.
8. Control of Work. The District Construction Engineer will discuss topics regarding the control of work including inspection procedures and requirements for materials and construction quality assurance; quantity measurements and documentation; laboratory numbers; Supervisor's and Inspector's DWR; preparation of estimates for payment; and progress.
9. Other Issues. As needed, other Central Office and/or District Office personnel will discuss topics in their fields of expertise (e.g., drainage, foundations, soils, aggregates, paving, structures, maintenance of traffic).
10. Contractor Submitted Documents. The Contractor will present the following at the Preconstruction Conference:
    a. An executed Proposed Source of Materials (Form PC-454);
    b. Any executed Subcontracting Requests (Form 403);
    c. A letter to the District Construction Engineer requesting approval of the following key Contractor personnel:
        i. Professional Engineer/Professional Surveyor who will supervise the pay item – Construction Layout Stakes, including West Virginia PE/PS Registration Number, professional registration status;
        ii. Project Superintendent, including resume;
        iii. Names of the representative(s) authorized to sign project documents;
        iv. Name and authority of the EEO officer; and
        v. Name(s) of the Labor Compliance and DBE Liaison Officer(s) designated to administer Labor Compliance and DBE matters;
    d. Method and schedule proposed for mitigating erosion and sedimentation;
    e. Storm Water Pollution Prevention Plan (SWPPP);
    f. On-the-Job Training Proposal and Training Programs;
    g. Quality Control Plan detailing the type and frequency of material sampling and testing as governed by the contract specifications; and the project schedule prepared in accordance with the contract specifications.
11. Minutes of Conference. The District Construction Engineer will ensure that accurate minutes of the Conference are recorded. As early as practical after the Conference, the District Construction Engineer will proofread the typed minutes and prepare the Preconstruction Conference Report. The Report is critical because it may become evidentiary evidence in resolving future claims or disputes. The Report will include a transcript of the minutes and a summary of the agreements, decisions,

commitments, and actions required on outstanding issues. The District Construction Engineer will distribute a copy of the Report to the:

a. Contractor;
b. Applicable Division personnel, such as District Engineer; Project Engineer/Supervisor, etc.
c. as necessary, other attendees and/or the representatives of other organizations that attended the Conference.
d. File in ProjectWise.

<u>103.3.2-Pre-Survey of Work Zone</u> The safe and efficient movement of traffic through a construction area is achieved through careful planning. The District Construction Engineer, District Traffic Engineer, and the Project Engineer/Supervisor should carefully examine the Contract Plans and Specifications for Maintenance of Traffic (MOT) provisions. On large and complex projects, the MOT Plan typically will show the type and location of all traffic control devices for the various stages of construction including any needed crossovers and detours. If an MOT Plan is not included in the Contract Plans (i.e., for smaller, less complex projects), traffic control will be implemented in accordance with the DOH Manual on Temporary Traffic Control for Streets and Highways. As part of this planning process, the District may conduct a preliminary survey of the work zone to:

1. Evaluate the overall MOT Plan relative to accommodation and control of traffic during construction;
2. Evaluate the structural strength of the existing pavement relative to its ability to carry additional traffic loads;
3. Evaluate the conditions of drainage structures within the work zone; and
4. Check for any evidence of bridge deterioration.

Based on the findings, the review team will forward recommendations to the Traffic Engineering Division and Contract Administration Division regarding any desired adjustments to the proposed construction sequence or revisions to the MOT Plan.

<u>103.4-PROJECT INSURANCE</u>

<u>103.4.1-Insurance Requirements</u> The Contractor is required to have public liability and property damage insurance. Other types of insurance may be necessary for special circumstances or conditions. If a Project Field Office is provided, the Contractor must maintain an insurance policy to protect its contents. Protective Liability Insurance is required on all projects that encroach Turnpike and/or railroad right-of-way. Before the Commissioner executes the Contract and Contract Bond, the Contract Procurement Unit will verify that the insurance requirements of the Contract are met (e.g., types, monetary limits) and that a West Virginia Resident Agent has countersigned the appropriate documents (e.g., Certificate(s) of Insurance). A copy of the processed Certificate(s) of Insurance is to be saved in the Project Files. See Section 103 of the Specifications for additional information.

103.4.2-Monitoring Insurance Requirements Typically, an insurance company will issue a policy for a one-year period with a provision for renewal. The Project Engineer/Supervisor will ensure that the Contractor renews all required policies throughout the life of the project.

Check the Insurance expiration date in AASHTOWare Project monthly to ensure that renewal Certificates are received two weeks prior to their date of expiration. If a renewal Certificate is not received in this timeframe, contact the Contractor by phone and document the telephone contact in a letter to the Contractor. Place copy of the letter in ProjectWise in the Project File.

SECTION 104
SCOPE OF WORK

Section 104 of the Specifications presents the requirements, conditions, and other incidentals related to the Contract's scope of work (e.g., Contract changes, maintenance of traffic). The following Section presents specific DOH procedures and additional clarifying information.

104.1-CONTRACT CHANGES AND INCIDENTALS

104.1.1-Contract Intent and Partnering The Contract is intended to provide all necessary instructions and details for project construction. Misunderstandings do arise, and the decision of the Commissioner will be final. However, District and field personnel should make every effort to resolve the issues in the field. The DOH and the Contractor are each party to the Contract and each control how their respective resources are used to complete the project successfully. Obviously, project success depends on how well these parties work together. Partnering focuses on working together. Its aim is to develop a proactive effort and spirit of trust, respect, and cooperation among all stakeholders. Partnering is a process for developing a spirit of teamwork and cooperation through shared goals, open communications, problem identification and resolution, conflict mitigation procedures, and the monitoring of team performance. DOH favors the informal use of this philosophy in all its construction projects; however, the DOH and the Contractor may agree on some projects to facilitate a formal partnering process through a Partnering Agreement between the DOH and the Contractor. Partnering roles and responsibilities are established, meeting facilitators are selected, and project workshops are frequently held to continually monitor and identify issues to resolve any potential conflicts.

104.1.2-Changes in Plans, Quantities, and Work DOH reserves the right to alter the Contract plans, plan quantities, and the character of the work as necessary during the project. DOH may issue a Supplemental Agreement or an LME Force Account Work Order, as appropriate, to permit the Contractor to fulfill the new requirements under the provisions for extra work in the contract specifications. Changes in plans, plan quantities, and contract time due to differing site conditions, authorized suspension of work, or significant changes in the character of the work will be paid in accordance with the contract specifications.

104.1.2.1-Added Work When extra work is encountered on the project, the Division will request that the Contractor submit a price to perform the additional work. One of the following methods shall be agreed upon prior to any extra work being performed.

1. The Contractor will submit a price for extra work that is able to be compared to Average Bid Prices.
   a. If the price is within the average, it may be accepted without further documentation.
   b. If the price appears high or is above the Average Unit Bid Price, the Division may

attempt to negotiate with the Contractor a price that is acceptable to both parties. If approved, no further action will be required.

c. If a negotiated price cannot be achieved, then the Contractor will be required to submit a justification as to why the price is higher than the Average Unit Bid Price. If the Division and Contractor agree on the justification, no further action is required.

d. If the price cannot be agreed upon, then the Division and Contractor shall enter into a Force Account to cover the Added Work. See AASHTOWare manual for further instructions.

2. The Contractor will submit a price for extra work that is not able to be compared to the Average Unit Bid Prices.
   a. The Department will accept this price with concurrence of the Area Engineer/ Supervisor and Construction Engineer based upon their prior experience, under similar situations. No further documentation is required.
   b. If the Area Engineer/Supervisor and Construction Engineer believe this price is too high, the Division may attempt to negotiate with the Contractor a price that is acceptable to both parties. If approved, no further action will be required.
   c. If a negotiated price agreement cannot be reached; the Contractor will be required to submit a detailed cost breakdown. The Area Engineer and Construction Engineer will review this detailed cost breakdown. If approved, no further action will be required.
   d. If the price cannot be agreed on, the Contractor and Division shall enter into a Force Account to cover the Added Work. See AASHTOWare manual for further instructions.

The Justification in the Change Order will explain how the Department and Contractor agreed to the pricing based upon one of the methods listed above. There will also be a statement that this price was agreed upon by the Department and Contractor prior to any work being performed. Coordination and approval from District Engineer/Manager must also be received. Once an agreement has been made between the District and Contractor, the Regional Construction Engineer will be notified by email. If at any time the Area Engineer/Supervisor and Construction Engineer do not feel comfortable accepting the price, the Regional Construction Engineer may be consulted.

104.1.3-Disposition of Excess Materials As necessary, DOH may exclude an item of work during the project. DOH will compensate the Contractor the reasonable expenses already incurred for the work and reimburse the actual expenses for materials purchased in good faith for use on the excluded work item. The materials then will become the property of DOH. Note that minor work items are subject to variation without limitation. The Contractor will advise the District Construction Engineer of the excess material eligible for disposition under this provision of the contract specifications. The Contractor also must report the location of the materials used and submit certified invoices disclosing the actual price paid. The District Construction Engineer will arrange payment to the Contractor and contact the Operations Division to arrange for moving the materials to the DOH inventory. Until such materials are relocated, the Contractor must store and safeguard them against deterioration, theft, and vandalism.

104.1.4-Value Engineering Change Proposals and Practical Design Change Proposal DOH will accept Value Engineering Change Proposal (VECP) from the Contractor for changes to the Contract that reduce the total cost of construction without reducing design capacity or quality of the final product. VECP will be processed according to Section 104.12 of the Specifications.

104.1.5-Incidentals Several items of work do not have a specific pay item in the Contract but are nonetheless a part of the scope of work. The following items, if applicable, will be incidental to the Contract:

1. Funding Source Identifications Signs. If the Total Contract Bid Amount exceeds $500,000 or otherwise noted on the plans, the Contractor will provide funding source identification signs during project mobilization of the type, size, and location as specified in the Specifications.
2. Bridge Plate. On bridge projects, the Contractor will provide without extra compensation a bridge plate as specified in the Specifications.
3. Final Clean Up. Before final acceptance of the project, the Contractor will clear the highway, waste areas, borrow pits, and all occupied grounds in accordance with the Specifications.

The contract documents may include other items of work which are incidental to the Contract.

104.2-MAINTENANCE OF TRAFFIC

104.2.1-General All DOH construction projects will provide for the safe and efficient maintenance of traffic through the work zone. Large and complex projects typically have a Maintenance of Traffic (MOT) Plan included in the construction plans. Smaller and less complex projects will require the use of sound engineering judgment to provide traffic control in accordance with the DOH Manual on Temporary Traffic Control for Streets and Highways. DOH will monitor and inspect construction operations to ensure that the Contractor conforms to these requirements. If the Contract contains Pay Item 636 – Maintaining Traffic, the Contractor will be paid according to the Contract. Suspensions in construction may require the Contractor to remove and later reinstall traffic control devices for maintaining traffic, and any additional cost associated with the suspension will be paid as provided in the Contract.

104.2.2-Contractor Responsibilities The Contractor will maintain traffic as specified in the Contract to provide for the safe and convenient use by the traveling public. The Contractor's Project Superintendent will designate a representative in charge of these responsibilities. The Contractor must properly erect and adequately maintain the necessary traffic control devices including all advance warning signs, barricades, beacons and signals, channelization, and markings. This includes maintaining the devices in a clean and functional capacity so that, for example, dirt and dust will not hinder reflectivity. The Contractor will perform construction operations to minimize traffic delays and disruptions.

104.2.3-Public Relations Adequate and timely publicity on traveling conditions can have a beneficial effect on the control of traffic during construction. A motorist who is forewarned of construction conditions will be more tolerant of delay and inconvenience. They will also be more alert and responsive to warning signs and other traffic controls. Flagger should be instructed as to what to inform the motorist on specific danger areas, approximate length of delay, etc. Official information will be issued only by the designated authority.

104.2.4-Monitoring Traffic Control During Construction The importance of monitoring traffic control during construction cannot be overemphasized. The Project Engineer/Supervisor must ensure that traffic control is provided in accordance with the Contract plans and specifications. On large projects, this responsibility is usually delegated to other project personnel (e.g., Project Inspectors). Qualified DOH personnel must be used to monitor traffic control operations. This individual must be thoroughly familiar with Section 636 of Specifications and the Manual on Temporary Traffic Control for Streets and Highways and should have previously attended training sessions sponsored by the Traffic Engineering Division. Consider the following guidelines when monitoring traffic control during construction:

1. Routine Checks. Once the traffic control devices are in place, check the devices daily to ensure that they are continually maintained in a clean and acceptable condition and in the location specified in the Maintenance of Traffic Plan and in the DOH Manual on Temporary Traffic Control for Streets and Highways. Report all findings in the Daily Work Report. Bring any deficiencies to the attention of the Contractor for immediate corrective action. Fill out daily Traffic Checklist in the DWR.
2. Weekend and Nighttime Reviews. On high-volume facilities, consider the need to review the traffic control devices on weekends. Contractor and DOH personnel may not be present on weekends to make any necessary adjustments. Although traffic control devices may appear ideal during daylight operations, they may be inadequate or confusing after dark. Check the adequacy of traffic control devices during nighttime operations immediately after they have been installed and then at least once every two weeks afterward to ensure that they are properly maintained and providing adequate reflectivity. Bring any deficiencies to the attention of the Contractor's emergency response personnel.
3. Advance Warning Signs. Lane shifts, cross- overs, and detours pose unusual conditions when negotiated by motorists because such conditions significantly differ from those through which the motorist has just traveled. If unexpected, these conditions could be potentially hazardous. Therefore, it is important to check that the Contractor provides and maintains adequate advanced warning signs.
4. One-Way Traffic Operations. Short and long duration one-way traffic operations are occasionally needed in construction zones (e.g., where transverse cuts are made for underground utility work, lane closures). Safety precautions are paramount in these situations. Check that the Contractor provides the necessary flagger, wireless two-way communication, lead trucks, and/or specialized signals to adequately control the one-way traffic operation.

5. Flaggers. If the Contractor furnishes flaggers, DOH will assume no responsibility relative to the flagger. However, if DOH furnishes flaggers, the associated cost will be part of the engineering and contingency item. Flaggers furnished by the Contractor shall wear approved vests and hardhats, which should not bear the DOH name or symbol.
6. Road Closures/Detours. At locations where an existing roadway facility is being improved, DOH requires the Contractor to take every practical measure to keep the roadway open to the public during construction. However, road closures and detours may be necessary and will be detailed in the MOT Plan. Check that traffic can pass through or around the construction area safely and with little inconvenience or delay. On a new facility, DOH generally prohibits public travel on the facility until the roadway is entirely completed.
7. Traffic Flow Interruptions. Occasionally, it may be necessary to completely interrupt the flow of traffic in the construction zone. When this is necessary, plan the work so that it can be completed during periods of little traffic (e.g., off-peak hours, nighttime operations). If a heavy unit of slow-moving equipment must traverse the facility, check that the Contractor moves the equipment to cause little disruption or delay. Do not permit the Contractor to locate, even temporarily, equipment where it will present a fixed-object hazard or otherwise impede the flow of traffic.
8. Device Removal. Contractors sometimes leave warning signs and other traffic control devices on the job after their usefulness has passed. It is generally not prudent to do this, as motorists tend to lose respect for the traffic control devices. Make a special effort to check for this situation and enforce the requirements of the Contract.
9. Crashes. Investigate and document all traffic crashes that occur during working hours within the project limits on the West Virginia Division of Highways Work Zone Traffic Crash Report Form. Most importantly, check the traffic control scheme and devices to determine if they could have contributed to the cause of the crash. If adjustments or improvements are evident, they should be initiated immediately. Report all fatal crashes immediately to the Project Engineer/Supervisor and notify the District Construction Engineer and FHWA if the crash occurred on the NHS. A Fatal Crash Review Team will investigate all fatal crashes occurring within the project limits. See Section 104.2.5 of this manual for additional information.
10. Assistance. If unique problems or circumstances are encountered that require the expertise of a specialist, contact the Traffic Engineering Division for assistance.

104.2.5-Fatal Crash Review Team

104.2.5.1-Team Members A Fatal Crash Review Team will investigate all fatal traffic crashes that occur within the project limits. The Team will be comprised of the following WVDOH personnel:

1. District Construction Engineer (or representative);
2. Project Supervisor;
3. Claims Investigator;
4. District Safety Officer;
5. District Traffic Engineer/Technician; and

6. Traffic Engineering Representative.

104.2.5.2-Notification Responsibilities When a fatal crash occurs within the project limits, notice must be made to the Traffic Engineering Division. It is the responsibility of the District Construction to provide notification to the Director and Safety Engineer of the Traffic Engineering Division. The Traffic Engineering Division will coordinate the deployment of the Fatal Crash Review Team. When a work zone fatality occurs on the NHS, the FHWA should be notified and encouraged to participate in the review as their schedule permits.

104.2.5.3-Preliminary Documentation Documentation of the work zone should be prepared by the Project Engineer/Supervisor and the District Safety Officer. Preparation should begin as soon as practicable after the police have completed their field investigation and movement of traffic has been restored. Video documentation is suggested in addition to a traffic control schematic if the equipment is available. The Project Engineer/Supervisor is responsible for obtaining a copy of the police report, which can be obtained through Traffic Engineering Division, Traffic Safety Section.

104.2.5.4-Review Process The Team will meet as soon as practicable (preferably within three days) after the fatal crash has occurred. The Team will review the work zone, the field documentation, any modifications made to the Traffic Control Plan, and will talk to WVDOH and Contractor personnel who were present during the fatal crash. If necessary, the Team will make recommendation for improvements to the existing traffic control. These changes will be reviewed and approved by the Director of Traffic Engineering for potential implementation. Note that the review process does not preclude modification to traffic control between the time the fatal crash occurs and the time that the Team conducts its review; however, such changes must be properly approved and documented.

104.2.5.5-Final Report A representative from the Traffic Engineering Division will compile the Final Report for review by the Director of Traffic Engineering, the Director of the Legal Division, and the Chief Engineer of Construction-Deputy State Highway Engineer. The Report will consist of the documentation of the work zone, a summary of the events related to the fatal crash, a copy of the Work Zone Traffic Crash Report Form, a summary of the Team's review activities, and any recommendations to improve the design or implementation process. Copies of the Final Report will be distributed to the District, Contract Administration Division, Legal Division, and Traffic Engineering Division. A copy of the Final Report will also be forwarded to FHWA for all fatal crashes that occur on Federal-aid highways.

SECTION 105
CONTROL OF WORK

Section 105 of the Specifications presents the requirements and conditions related to the control of work (e.g., authorities, responsibilities, conformity, working drawings, inspection, acceptance). The following Section presents specific DOH procedures and additional clarifying information.

105.1-ROLES AND RESPONSIBILITIES

105.1.1-DOH Responsibilities The contract specifications define explicitly the authority of the Engineer, Inspector, and Project Engineer/Supervisor;. see below for the specification reference where these are defined:

a. 105.1-Authority of the Engineer
b. 105.9-Authority and Duties of the Inspector
c. 105.10-Authority and Duties of the Project Engineer or Project Supervisor

105.1.2-Contractor Responsibilities The Contractor is obligated to have on the job, at all times, a competent representative (e.g., Project Superintendent, Project Foreman) authorized to receive and act upon instructions given by the Project Engineer/Supervisor. In addition to completing the construction in accordance with the Contract Plans, Specifications, and Special Provisions, the Contractor must locate project elements from control points established by the Project Engineer/Supervisor, perform investigations to determine required lengths of piles and proper depths of foundations, and furnish shop drawings for steel structures and major formwork. The Contractor shall submit to the Engineer all stress sheets, shop drawings, erection plans, falsework plans, framework plans, cofferdam plans, bending diagrams for reinforcing steel, or any other supplemental plans or similar data for the Engineers use. See below for specifications reference where these are further defined:

a. 105.2-Plans and Working Drawings
b. 105.5-Cooperation by Contractor

105.1.3-DOH and Contractor Relationship Good working relations between DOH personnel and Contractor representatives will help to obtain the high-quality work desired. This does not mean, however, that a close personal friendship should be established. The DOH and the Contractor have separate functions, and DOH employees should always act in a professional manner. The Project Engineer/Supervisor and the Project Inspectors should not allow themselves to become obligated to any Contractor representative in any way. A copy of all pertinent correspondence between the Contractor, District Offices, Area Offices, and Project Offices should be placed in the correspondence folder for the project on ProjectWise.

Proper observation to DOH and project organization can promote a better relationship with the Contractor. Documents should flow from Contractor to the Project level, District level, then Central Office level and in reverse order unless specific procedures dictate otherwise. The Project Engineer/Supervisor should be readily available to the Contractor or its representative for consultation and coordination of the operations. Good relations will do much to discourage the Contractor from attempting to deal directly with the District Construction Engineer or the Central Office. However, if the Contractor and Project Engineer/Supervisor cannot settle a problem, the Contractor has the recourse to contact the District Construction Engineer. If unable to resolve at district level, the Contactor may contact Regional Construction Engineer.

105.2-UTILITIES

Where utilities are involved, the work should be controlled per the requirements of the Specifications and contract provisions. The Notice to Proceed (NTP) should not be given to Contractor until Utility Status Report is checked and verified. When utility delay exists, a Conditional NTP may be option which allows Contractor to begin work on a portion of project not impacted by utility issue.

105.3-SCHEDULES AND TIME EXTENSIONS

105.3.1-Project Schedule Requirements The Contract will specify the time basis for completing the work. The Contractor is responsible for meeting the time requirements of the contract and, in some instances the contractor is required to submit a project schedule. The following criteria apply to project schedule requirements:

1. Projects Without Schedule Requirements. The DOH does not require schedule information to be submitted for projects on which the major portion of work is resurfacing, landscaping, signing, lighting, traffic control, guardrail, bridge painting, or on projects with a Total Contract Bid Amount of $2,000,000 or less. However, the Contractor is responsible for meeting the time requirements of the Contract and the Project Engineer/Supervisor is responsible for ensuring that the Contractor meets these requirements.
2. Projects with Schedule Requirements. For all projects not covered by item 1 and any Project that contains an Incentive/Disincentive (I/D) clause, and all Design Build, Alternative Project Delivery, and Public Private Partnership projects the Contractor is required to submit project schedule information to the Project Engineer/Supervisor. This includes a Preliminary Construction Schedule, if applicable, a Detailed Construction Schedule, and Monthly Schedule Update Reports and, as needed, revised Detailed Construction Schedules. These Project Schedules will be in the form of either a Resource Loaded Schedule or Non-Resource loaded Schedule. All project schedules will include the supporting narrative, tabular, and graphic information.

Non-Resource Loaded Schedules are required on projects where the Contract Bid Amount is between $2,000,000 and $7,500,000.

Resource Loaded Schedules will be required for all projects on which the Contract Bid Amount is equal to or exceeding $7,500,000. Additionally, all Design Build Projects, Public Private Partnerships, and Alternative Project Delivery projects will require Schedule resource loading regardless of the Contract Bid Amount.

The Contractor may submit a 60-day Preliminary Construction Schedule within 30 days of the Contract Award Date. The Contractor shall maintain and submit a 60-day Preliminary Construction Schedule until the Detailed Construction Schedule has been submitted and reviewed.

The Contractor shall submit the Detailed Construction Schedule, describing work activities through project completion, within (60) calendar days from Contract Award. Even after the Notice to Proceed is given to the Contractor, the Contractor may not pursue any item of work until the DOH has reviewed the Preliminary Construction Schedule or the Detailed Construction Schedule. Any schedule information from the Contractor, if it is to be effective, requires complete understanding by all project personnel. Project Supervisor/Engineer must place the base line schedule and sequential updates into ProjectWise.

105.3.2-Review of Detailed Construction Schedule The DOH considers the original Detailed Construction Schedule to be the Contractor's official proposal for satisfactorily meeting the requirements of the contract. The Project Engineer/Supervisor will use this Schedule as the basis for monitoring the construction progress. Within fourteen (14) calendar days of receiving the Schedule, the Project Engineer/Supervisor and as needed, the District Construction Engineer will carefully review the schedule for compliance with the Contract and forward the schedule with notification of any recommendations to the Contractor. Project schedule training documents are available from Contact Administration. It is not the responsibility of the DOH personnel to approve or disapprove any project schedule. The Contractor will incorporate the DOH recommendations and comment and return the Detailed Construction Schedule within (90) calendar days from Contract Award. The Project Engineer/Supervisor may withhold estimated payments for work on the project until the Schedule has been reviewed and all comments have been addressed.

105.3.3-Project Control for Scheduled Projects Each month, the Project Engineer/Supervisor will schedule a Project Control Meeting with the Contractor's Construction Coordinator, or designee, other DOH project personnel, as needed, and FHWA, if applicable, to review actual progress and changes to the schedule and to discuss planned activities and any anticipated changes to the schedule in the month that follows. The Project Engineer/Supervisor will provide advance notice to the Contractor of the date of the Project Control Meeting and, at least five (5) working days before the Meeting, the Contractor's Project Superintendent, or designee, will submit the Monthly Schedule Update Report to the Project Engineer/Supervisor. Should the Contractor fail to submit the Report within seven (7) calendar days of the Engineers written request, the Project Engineer/Supervisor may withhold estimated payments until the Report is received. The Report will include the following information as required in the Specifications:

1. Detailed Construction Schedule Update – a complete update of the CPM schedule, also a narrative which shall include but not be limited to;

2. A description of progress made on work activities along the critical path;
3. Any problem areas (current and anticipated)
4. Any delaying factors and their impact;
5. A description of all work activities completed and or started in the previous month; and
6. A discussion of any current or anticipated schedule changes due to Change Orders or delays, including a description of the delay factors and any corrective actions taken or proposed.
7. Any corrective actions proposed or taken.

The Project Engineer/Supervisor will review the Monthly Schedule Update Report and discuss relevant issues with the Contractor's Project Superintendent during the Meeting. Of particular interest during the review of the Schedule are the following conditions:

1. Delays greater than ten (10) calendar days on work activities on the critical path;
2. Change Orders adding, deleting, or revising work activities in the network; and/or
3. Work activities being performed out of sequence.

If any of the above conditions are evident, the Contractor must provide DOH with a revised Detailed Construction Schedule, and the Contract Administration Division may need to consider granting a contract extension if justified. Within fourteen (14) calendar days of the Project Control Meeting, the Project Engineer/Supervisor will prepare and submit a Time Extension Change Order. The Project Engineer/Supervisor also will provide the Contractor with written notification of the need to submit a revised Detailed Construction Schedule. The Contractor will incorporate DOH recommendations and submit the revised Detailed Construction Schedule within seven (7) calendar days of the Project Engineer/Supervisor's written request. Should the Contractor fail to submit the revised Detailed Construction Schedule, the Project Engineer/Supervisor may withhold estimated payments until the revised Schedule is received. Contract time extensions will be processed and documented according to the procedures in Section 105.3.4.

105.3.4-Contract Time Extensions

105.3.4.1-General The Contract will specify the time basis for completing the work (e.g., number of working days, fixed calendar dates). The District Construction Engineer will evaluate and grant Contract time extensions on a current basis when events occur that warrant revision to interim completion dates or the Contract Completion Date. Consultation/concurrence from Regional Construction Engineer may be necessary. Contract time extensions generally result from either Contract modifications (e.g., Change Orders) or extraneous factors (e.g., delays). Delays may be classified as one of the following two types:

1. Excusable (non-compensable) delays that occur beyond the control of both the DOH and the Contractor; or
2. Excusable (compensable) delays that occur which are caused solely by the Department.

Only delays in the work activities on the critical path or, in the absence of scheduling requirements, delays in the controlling operation will be considered for a Contract time extension provided the Contractor has submitted proper notification and supporting documentation that justifies granting the request. In all cases the Contractor is responsible for notifying the Department of conditions which would change the working time to complete the project within seven calendar days of the Contractor becoming aware of the delays. The Department is responsible for verification of the Contractor submitted request for additional working time in accordance with the provisions of Section 108.6.2 of the Specifications. Failure of the Contractor to notify the Department of a need for a revision in working time within the specified time interval constitutes waiver of all claims for additional time and money arising out of the delay. The specified time intervals will be addressed under the various project types. Approved Contract time extensions will not exceed the amount of delay experienced. All District recommendations pertaining to Contract time extensions require a Time Extension Change Order.

105.3.4.2-Time Impact Analysis/Summary As each modification or delay occurs during the project, the Project Engineer/Supervisor will prepare a Time Extension Change Order. The Project Engineer/Supervisor also will maintain a Time Impact Analysis Summary Form DC-472A that documents a tabulation of all Contract time extensions requested and granted throughout the life of the project. A final Time Impact Analysis Summary Form DC-472A will be prepared and submitted with the Final Time Extension Change Order. The approved change order and all attachments regarding the time analysis will be submitted with the Contract Completion Report (Form 416). Contact the Contract Administration Division for the Time Impact Analysis and Time Impact Summary Form DC-472A.

105.3.4.3-Change Orders The method of evaluating time extensions resulting from work covered by Change Orders will be recorded on a separate Change Order in accordance with Section 110.2.2.

105.3.4.4-Contracts with Schedules Contracts that require Detailed Construction Schedules also require the Contractor to submit Monthly Schedule Update Reports and meet with DOH at monthly Project Control Meetings as discussed in Section 105.3.3. Time extensions for these types of Contracts will be evaluated and processed as follows:

1. Monthly Schedule Update Reports that show delay factors (including weather) will be jointly evaluated by the District, appropriate DOH Division(s), and FHWA (on non-exempt and concurrence Federal-aid contracts) to determine if a time extension is justified.
2. Recommendations regarding time extensions, as well as verbal concurrence and/or comments by the reviewing organizations, will require a Time Extension Change Order (see Section 110 of this manual).
3. The allowable time for the Division to act on properly prepared submissions shall be 14 calendar days after receipt, unless otherwise specified in the Contract documents.
4. Attachments to the Change Order will include a copy of the Contractor's Monthly Schedule Update Report and a copy of the Time Impact analysis.

5. Change Orders will be processed in accordance with Section 110 of this manual.
6. A summary of comments presented during the Project Control Meeting and any DOH decisions on the approval of time extensions for the delays set forth in the Monthly Schedule Update Report will be documented by letter to the Contractor within fourteen (14) calendar days after the Project Control Meeting. Attachments to the letter will Include a copy of the Contractor's Monthly Schedule Update Report and a copy of the Time Impact Analysis.
7. A copy of the notification letter with attachments will be placed in ProjectWise.

<u>105.3.4.5-Contracts Without Schedules</u> For projects that do not require a Detailed Construction Schedule, the Contract completion date is established as a fixed calendar completion date. The Engineer will inform the Contractor weekly, by written statement, the controlling items for the previous week. The Contractor will submit, in writing any protest concerning the weekly statement within seven calendar days. If the Engineer concurs that work was delayed, beyond the control of the Contractor, the Engineer may extend the project completion date as the conditions justify. Time extensions for these types of Contracts will be evaluated and processed as follows:

1. The contractor shall monthly or at the project completion whichever occurs first, submit a written request for extension of time. This will be discussed by the District and appropriate DOH Division(s) to determine if a time extension is justified.
2. The Project Engineer/Supervisor will notify the contractor in writing of the decision of the DOH within fourteen (14) calendar days. A copy of the notification letter and attachments will be placed on ProjectWise.
3. If justified, a Change Order will be generated; attachments will include a copy of the Contractor's written request for an extension of time, when applicable, and a copy of the Time Impact Analysis Form DC-472.
4. Change Orders should be processed in accordance with Section 110 of this manual.

<u>105.3.4.6-Timely Revised Working Time Submission</u> On projects with Schedules, the Contractor must submit a Schedule update within seven (7) calendar days of becoming aware of the delay and another Schedule update when the Contractor indicates or the Engineer believes the delay has been resolved. In the absence of a Schedule, the controlling item will be determined from the Division's records and Contractor shall submit in writing to the Engineer any protest concerning the weekly statement within seven (7) calendar days after receipt of the statement.

Failure of the Contractor to notify the Department of a need for a revision in working time within the specified time interval constitutes waiver of all claims for additional time and money arising out of the delay. However, a request can be made stipulating that the full extent of an action upon the working time will not be known until a later date, at which time a specific amount of time can be determined and subsequently requested.

<u>105.4-CLAIMS</u>

The Project Engineer/Supervisor and Project Inspectors are responsible for maintaining detailed and accurate records of construction operations in the Daily Work Reports. One important objective for this is for DOH to evaluate the validity of any claims made by the Contractor.

The Contractor must file a Notice of Potential Claim and provide written certification as specified in the Contract. If the Contractor verbally states intent to submit a claim, notify the Contractor in writing to proceed with the Contract and to file the claim in the manner and within the period prescribed in the contract specifications.

The Project Engineer/Supervisor should refrain from expressing any opinions on the validity of potential claims. In addition, the Project Engineer/Supervisor should ensure that any extra work has been first approved by DOH before ordering the Contractor to proceed with such work. The Project Engineer/Supervisor must have an approved Change Order before giving verbal direction to the Contractor to proceed. Ensure that the factors and events leading up to a claim are documented accurately in the Daily Work Reports and acknowledge receipt of any Notice of Potential Claim with a letter to the Contractor signed by the District Construction Engineer within the time period in the contract specifications.

During the performance of the work for which a claim is made, a Project Inspector should oversee all work and record the following in the Daily Work Reports:

1. The number and payroll classification of workers and the type of equipment (e.g., size, horsepower, model);
2. The times at which work starts and stops;
3. A detailed description of the operation that is performed;
4. The type and quantity of materials used;
5. The titles of the supervisory personnel present during the work; and
6. Any other information to substantiate DOH's position.

These records should be kept independently of payroll sheets, fuel bills, equipment-operation records, and material records that are maintained by the Contractor and furnished to the Project Engineer/Supervisor.

The Project Engineer/Supervisor must be able to prepare a complete history of each claim, supported by written records in the Daily Work Reports, and to make a recommendation regarding payment. Statements in the Daily Work Reports should be full and complete. The Project Inspector stationed on the work also should be able to prepare a record of each day's operations in detail.

105.4.1-Claim Warning Signs The most frequent subjects of claims in the construction process are as follows:

1. Time problems and liquidated damages
2. Additional compensation for unanticipated and/or changed conditions
3. Ambiguous contract provisions
4. Extra work

5. Changes in design and specifications
6. Utility and right-of-way delays

Causes for these claims can generally be categorized as follows:

A. Contractor Practices
   1. Inadequate investigation before bidding
   2. Unbalanced bidding
   3. Bidding below costs and over-optimism
   4. Poor planning and use of wrong equipment
   5. Failure to follow authorized procedures
B. Department Practices
   1. Changes in plans or specifications
   2. Inadequate bid information issued by the Department
   3. Inadequate time for bid preparation
   4. Excessively narrow interpretation of plans and/or specifications
   5. Restrictive specifications
   6. Contract requirements for social/economic objectives unrelated to the construction process

105.4.2-FACTORS IN MANAGING CONSTRUCTION CONTRACT CLAIMS Many activities beyond the control of the Project Engineer/Project Supervisor can/do occur while managing claims.

The following is an attempt to aid in identifying and managing construction contract claims. There is no one way to do this and as the Department is only one party to the contract as well as the Contractor; the Contractor may propose other routes for solution which may include management level intervention, non-binding mediation, remediation, or having their legal representative go directly to the Division of Highways Legal Division.

105.4.2.1-Identifying a Potential Dispute By identifying a potential dispute early on, appropriate action can be taken to either resolve the problem or mitigate its impact. The identification method should include development of the following basic information at the project and District level:

1. Contract name, number, and date
2. Potential or definite claim
3. Summary of Contractor's position
4. Applicable contract specifications and drawings
5. Alleged cause of dispute/claim
6. Potential cost of dispute/claim
7. Potential magnitude of delay
8. Project or District position on dispute/claim

105.4.2.2-Recording and Monitoring All Items of Work Affected by the Potential Dispute/Claim Good records facilitate the prompt and cost effective resolution of claims. Records at the project level must be kept in detail and should reflect some measure of productivity. For instance, rather than just record the number of cubic yards that were moved over a certain interval of time, if the records indicate a measure of the amount of cubic yards per crew day, per piece of equipment, per man day, or some other measurable productivity unit, it is then possible to determine the degree of any claimed delay.

Photographs and videos should be used in maintaining records relative to claims. Following are guidelines for using photographs or videos for claims purposes (See Section 111.1.2.1 for additional information on photographs and videos):

1. Documentation as mentioned above for photographs and/or videos should be the responsibility of the Project Engineer/Supervisor or their designee.
2. 2 The identification record for each photograph and/or video must be detailed as discussed above.
3. Complete accurate Daily Work Reports should be filled out to document the existence of the photographs and/or videos.
4. Avoid unnecessary photographs and/or videos as they may include irrelevant information to the claim.
5. Do not provide commentary on a video. Avoid making conclusions prematurely while documenting the issue of the claim. Each individual videotape should include documentation for a single claim resolution. Stick to facts; i.e. locations, dates, time, and brief description of what is being filmed. Save the final commentary for a memorandum.
   a. Don't put multiple claims or projects on one video.
   b. Avoid wide panoramic shots, stick to the issue at hand.

<u>105.4.2.3-Notifying All Potentially Affected Administrators of the Dispute and Involving Appropriate Personnel as Soon as Possible</u> The information developed in Section 105.4.2.1 should be transmitted by the District to Contract Administration Division as notification of the potential dispute. The Contract Administration Division should provide the necessary coordination to ensure that other appropriate Divisions and, when applicable, FHWA personnel are involved as soon as possible.

<u>105.4.2.4-Identifying Possible Methods if Resolution at the Project and District Levels</u> As soon as a potential dispute/claim is identified, the project and District should ensure that all documentation related to the problem is assembled in a complete and organized manner. The documentation should be reviewed for completeness and a specific claim file should be established both at the project and District levels. A chronological listing of any actions relating to the potential dispute/claim shall be maintained as part of the claim file.

Once the documentation is organized, the District should perform a preliminary review, which should follow five basic steps:

1. Was there a change?
   The first question that must be answered is, "did the Department require the Contractor either by directive or through some type of constructive change to perform something, which was not clearly specified in the contract documents?" If the potential answer is yes, go to step 2.
2. Who was liable?

Obviously, this is a relatively simple question, did the Contractor cause the change or did the Department? Probably the major factor impeding the process of claims resolution is the lack of objectivity. In determining liability, Department personnel should be as objective as possible.

3. What is the impact of the change?
   Impacts can take many forms such as delays, extra work, inefficiency, increased cost of labor, material, and/or equipment, etc. The impacts must be defined as specific as possible to calculate the damages associated with each particular impact.
4. What are the reasonable costs of the impacts?
   If the impacts are clearly defined, this becomes an easier task to accomplish.
5. What are the recommended actions?

The five steps just outlined should always be followed in sequence. It makes no sense and will probably result in wasted effort to not follow the sequence.

Upon completion of the above preliminary review, the Project Engineer/Supervisor shall prepare a detailed, clear, concise, and documented analysis of the project, the changes, the liability, the impacts, damages, delays, etc., and recommended actions. This analysis and supporting documentation should be submitted to the Regional Engineer from the Contract Administration Division. If concurrence is given from the Regional Engineer, a Change Order should be processed. If concurrence is not obtained, proceed to Section 105.4.2.5.

105.4.2.5-General Workflow for Project Dispute and Claims The Contract Administration Division will advise the District of the CRC decision. The District will notify the Contractor.

Every effort should be made to settle disputes and claims at the lowest level possible by acting within the employee and organization's level of authority and responsibility. The following workflow is intended to provide some general guidance on how to manage these situations with the understanding that each project and dispute contains its own unique circumstances.

1. Dispute comes to Project/District.
2. District attempts resolution – Regional Construction Engineer (RCE) provides input as needed to the District.
3. If District cannot resolve, the RCE is contacted to take lead in the issue.
4. RCE attempts negotiation and resolution.
5. If RCE cannot resolve initially, via the Director of Contract Admin, Legal Division is contacted for advisory opinion.
6. RCE again attempts resolution based on discussions with Legal.
7. If no resolution can be attained at that point, then Contractor should be informed in writing from District that negotiations are over and next recourse is to submit a "Notice of Potential Claim Form" (Specification Section 105.17).
8. "Notice of Potential Claim Form" should be submitted to District from Contractor.
9. Once "Notice of Potential Claim Form" is received by the District it should forwarded via email to the Director of Contract Administration with a copy to the RCE.
10. Director of Contract Admin will forward to Legal.

11. Legal, Contract Admin & District will meet to discuss next course of action and appropriate reply to the "Notice of Potential Claim Form".
    *Note: – if a Dispute Resolution Board (DRB) is included in the contract then it would be implemented as the next recourse at step 7 instead of the "Notice of Potential Claim Form".

105.4.2.6-Legal Division Involvement If the claim is not resolved and results in a formal complaint before the West Virginia Claims Commission or any court of law, Legal Division will become the lead division in resolving the claim:

1. The Legal Division and Contract Administration Division will determine if outside help (claims consultant) is required. If yes, services will be procured by the Legal Division.
2. All communications between the Contractor and the Department should be reviewed by the Legal Division. Department should communicate with Contractor through Legal Division.
3. Legal Division will lead all communications regarding the matter. If Contractor retains legal counsel the Legal Division will communicate directly with the Contractor's counsel. If Contract Administration communicates with the Contractor directly regarding the respective matter, then the communication should be coordinated with Legal Division to ensure a uniform message.
4. The Legal Division will coordinate preparing all formal pleadings with the Contract Administration Division and others as appropriate.
5. No settlement shall be made without a written opinion from Legal Division on the legality of the settlement.
6. Settlement negotiations should be conducted through or with the knowledge of both party's attorneys or with Contractor's representative if they do not have an attorney.

105.4.2.7-Requesting FHWA Reimbursement for any Claim Settlement or Court Award The Contract Administration Division will coordinate preparing requests from the FHWA for any claim settlement which should usually occur with a Change Order. The Legal Division will coordinate preparing requests for reimbursement from the FHWA for any court award.

Supporting data for any requested FHWA reimbursement should include:

1. Information as to the legal and contractual basis for the claim.
2. The factual (engineering evaluation) and cost data supporting the settlement or award.
3. A copy of the complaint filed by the Contractor and the Department's response to the counts in the claim and any amendments thereto.
4. A certification letter from the Auditing Division, when applicable, of the actual costs incurred by the Contractor
5. A memorandum of law (settlement Memorandum) from the Legal Division
6. Submission of any other pertinent court papers, legal briefs, and previous legal determinations and key exhibits that assisted in settling the claim.

7. In negotiated settlements, the history on how the Department rationalized its initial to final position on the claim.

105.5-DAILY WORK REPORTS (DWRs)

105.5.1-Purpose On every construction project administered by the Contract Administration Division, DOH project personnel (e.g., Project Supervisor/Engineer, Project Inspectors) will prepare Daily Work Reports (DWRs) to record the day-by-day accounts of the work in progress, thus demonstrating that the quality and quantity of materials and workmanship are adequately meeting the requirements of the Contract Plans and Specifications. Because the Contract Finalization process begins with the preparation of the first DWR, it is important to make complete and accurate entries in all DWRs throughout the project. The DWRs are used to administer the Contract at the project level and serve as a primary source of input to AASHTOWare Project. The DWRs are the only means by which DOH can ensure that a project is being built as specified. In addition, DWR entries may become important evidence in determining responsibility and liability if a Notice of Potential Claim is filed by the Contractor. See SiteManager manual for DWR entries.

105.5.2-Responsibilities Unless otherwise instructed, each Project Inspector, as assigned, is responsible for submitting a DWR in AASHTOWare Project and its attachments for all items of work inspected. The Project Engineer/Supervisor reviews, checking for completeness and accuracy of measurements before approving, the DWR and prepares the Supervisor's Diaries or DWRs. Each Diary will be dated and approved by the Project Engineer/Supervisor.

105.5.3-AASHTOWare Project - Construction To organize the preparation of the Daily Work Reports by DOH project personnel, AASHTO Project, construction component is used to collect the various data needed to administer the Contract.

The Project Engineer/Supervisor and all Project Inspectors must be thoroughly familiar with AASHTOWare Project (AWP). Some items may require templates in AWP or additional attachments to the DWR. The following are some of the items:

1. Aggregates;
2. Deck removal and rotomilling;
3. Asphalt, pavement, and latex modified concrete;
4. Tack, prime, and surface treatments;
5. Reinforcing steel;
6. Drainage structures and slot inlets;
7. High-strength fasteners and bolt testing;
8. Right-of-way fencing and guardrail;
9. Pavement markings and traffic control;
10. Labor, materials, and equipment.

It is important to use the templates and additional attachments for the item of work being inspected. Request the assistance of the Project Engineer/Supervisor if there is any question on the disposition or completion of a templates or worksheet attachments. Make certain that the templates and worksheets are attached before they are forwarded to the Project Engineer/ Supervisor. Project Inspectors must use separate worksheets for monitoring the labor, materials, and equipment (LME) used by the Contractor for any work associated with Force Account Work Orders. LME Force Account is set up by Project supervisor before any work is started, track with AWP and spreadsheet.

105.5.4-Daily Work Report Entries The entries of events and data on DWRs are likely to be used at a later time. Therefore, if each entry is made promptly after the event occurs or the information is obtained it is more likely to be accurate. Do not wait until the end of the day to record entries on the DWR for the entire day's activities. By making prompt entries, the Project Engineer/ Supervisor and the Project Inspectors are less likely to forget events that may subsequently become overshadowed in importance by others. The sequence of individual DWR entries is not of great importance, if all entries made for the day are present, clear, and complete.

The Project Engineer/Supervisor will begin preparing DWRs after the Starting Notice is given to the Contractor (see Section 105.6.4of this manual). All DWR will provide the names of DOH personnel on the project, the names of the Contractor's personnel, and a list of the equipment. All DWRs will include the following minimum information:

1. Temperature and weather (AM and PM);
2. Controlling line item/item numbers;
3. Chargeable day (Y or N) and if not, why not;
4. All instructions received (regardless of how received);
5. Visitors to project and reason for visit;
6. Documentation of information necessary to develop contact reports. This will include the following:
    a. Reason for needing a contact report; and
    b. All persons contacted and their comments.

The above list is not a comprehensive list and may be expanded to cover as much pertinent data as the Project Engineer/Supervisor considers necessary.

Project Inspectors will begin inspecting work items and preparing DWRs as assigned by the Project Engineer/Supervisor. Each DWR will include sufficient information to verify the quantities of all pay items and to adequately demonstrate that the work is being performed in substantial compliance with the Contract Plans and Specifications. Clearly delineate entries on the DWR (e.g., pay items, classes of workers, types of equipment) and identify the station number of individual operations. Should a question arise as to the propriety of including notes on the DWR for a particular item or event, it is better to include it. There are no restrictions on such notes, and they may become valuable later. If an DWR entry reflects a controversial issue or question, ensure that an entry is made in a subsequent DWR to reflect the resolution of the issue. Although the Project Engineer/Supervisor may request additional information, the following list presents the minimum level of documentation required on DWRs:

1. Authorization number, Contract line number, and item number;

2. Description of the material, quantity of material received, quantity of material placed, including all supporting calculations and drawings;
3. Laboratory numbers for source approval, mix designs, field quality control sampling and testing, and acceptance activities (Samples taken at the project site by the project or Contractor personnel will have the laboratory number assigned by the Project Engineer/Supervisor, or designee);
4. Results of visual inspections;
5. Specify the controlling item of work;
6. Utility work in progress;
7. Equipment used at each location;
8. Weather and average temperature;
9. The number of people working at each location per item and the hours worked by each;
10. Visits by superiors or other employees of the West Virginia Division of Highways or by representatives of the Federal Highway Administration, including their instructions and comments;
11. Inspections made or work performed by employees of any public service company, railroad, or other public carrier in effecting necessary changes to poles, lines, tracks, drainage, or other structures;
12. Inspections by DEP, DNR, or other regulatory agencies and any comments or instructions;
13. References to force account work or extra work performed by the Contractor;
14. Instructions, other than those which are routine, given to the Contractor or his authorized representatives;
15. Decisions reached about changes in Plans and their necessity, and the persons by whom they were authorized;
16. Notes, originating from the beginning of the issue of any questions raised by the Contractor or his representatives which might later develop into disputes or claims, and the Project Engineer's/Supervisor's reply;
17. Extent and cause of delays to work for such reasons as breakdown of equipment or adverse weather conditions;
18. Note any failing material and its disposition; and
19. Records of closing and opening of roads to traffic.

The above list is not a comprehensive list and may be expanded to cover as much pertinent data as the Project Engineer/Supervisor considers necessary.

105.5.4.1-Review of Daily Work Reports To meet engineering fiscal requirements, inspection data should provide sufficient information to determine that the project was built in substantial compliance with the Plans and Specifications and allow verification of pay quantities. If insufficient documentation is provided by the Contractor to determine quality and quantity of work, payment will not be made on current Estimates. Daily Work Reports must be reviewed daily by the Project Engineer/Supervisor and staff to:

1. Verify that the location, measurements, quantity, quality, and progress of work are accurately documented and in compliance with the governing specifications, contract documents, and/or established procedures;
2. Verify the accuracy of the method of measurement, “set-ups” for calculations and subsequent mathematical computations utilized to establish quantities set forth on the daily work report; and
3. Verify that sufficient information exists to substantiate the quality of materials used per the minimum evidence of inspection (see702.4.2 of this manual).

This review is performed prior to generating and approving the Progress Estimate and represents a 100% review of the project records for every item in the Contract, including lump sum items and items which are new to the Contract by change order to ensure proper payment for all work performed to date. All measurements, calculations, and tickets are to be included in this process. Any deficiencies discovered during the verification process are corrected in accordance with established procedures prior to approving the estimate.

The District office must complete a 100% review of the project records in the same manner as previously described in the project review. Every item in the Contract including lump sum items and new items added by change order to the Contract will be checked. This is to be completed prior to the District’s approval of the estimate. If it is not possible to perform the District Check for every estimate, the review should be completed before the next estimate is generated.

105.6-AASHTOWare PROJECT WORKFLOW

At the project level, Project Engineers/ Supervisors and Project Inspectors use AASHTOWare Project (AWP) - Construction component, to collect and manage project data and achieve a higher degree of efficiency to administer the Contract.

The Daily Work Report entries are reviewed to verify that the work is being accurately documented and measured for payment and to ensure that the Contractor is performing in accordance with the Plans and Specifications. This verification process is performed on a day-to-day basis. Any deficiencies discovered during the verification process will be corrected in accordance with established DOH procedures.

Section 105.6.1 describes the documents generally included in the Contract, some of which are primary source documents for input into AWP. Beginning with Section 105.6.2, guidance is presented for the proper use of AWP functions from project initialization to finalization. The AWP functions are numbered sequentially consistent with the recommended workflow. For additional guidance on the use of AWP, see AASHTOWare Project User’s Manual.

105.6.1-Contract Documents The Contractor will be responsible for meeting all obligations imposed by the Contract including furnishing all labor, materials, equipment, and other incidentals and performing all duties necessary to successfully complete the bid items in the Contract. A bid item is a specific unit of work for which a price is provided in the Contract. Several components of the Contract will be used as primary source documents for input to initialize

AASHTOWare Project. The Contract generally includes:

1. Advertisement. The advertisement refers to the notification to Contractors that bids for work or materials to be furnished are being sought.
2. Proposal. The Proposal is the offer of a bidder to perform the work and to furnish the labor and material at the prices quoted. The Proposal Form is the approved form on which the DOH requires a bid to be prepared.
3. Contract Bond. The Contract Bond is the security, executed by the Contractor and their Surety, guaranteeing completion of the work and payment of all legal debts pertaining to the construction of the project. The Surety is the corporation, partnership, or individual, other than the Contractor, executing the Contract Bond furnished by the Contractor.
4. PS&E Package. The PS&E Package consists of the plans, specifications, and estimates. The Plans refer to the plans, profiles, typical cross sections, working drawings, standard drawings, and supplemental drawings which show the location, character, dimensions, and details of the work to be completed. Working Drawings are stress sheets, shop drawings, erection plans, falsework plans, framework plans, cofferdam plans, bending diagrams for reinforcing steel, or any other supplemental data that the Contractor is required to use on the project. The Specifications refer to the Specifications and any Special Provisions. The Estimate is the official itemization of the value of materials in place and work performed.
5. Notice to Proceed. The Notice to Proceed is written notification to the Contractor to proceed with the work including, when applicable, the date of beginning of Contract Time.
6. Change Orders. Change orders refer to the Force Account Work Orders and/or the Supplemental Agreements required to complete construction in an acceptable manner, including any authorized time extensions. A Force Account Work Order is an order signed by the Engineer, or authorized representative, directing additional work to be performed, with payments based on labor, materials used, equipment cost, plus specified percentages (LME). A Supplemental Agreement is a modification to the Contract describing changes to the Plans and/or quantities that establishes the basis of payment and any needed time adjustments for the work necessitated because of the modification. All Change Orders requires the signature of the Commissioner, the Contractor, and the Surety, or their authorized representatives. See SiteManager manual for additional guidance on change orders.

105.6.2-Activation of Project in AASHTOWare Project Once the Contract is awarded, the project information is transferred from Preconstruction to construction AWP. Project Control Section will review the data in AWP against The Notice of Award and Schedule of Prices and other related contractual documents to verify the data in AWP is correct and activate the project in AWP once the contract and bond /insurance are executed.

105.6.3-Give Notice to Proceed After the Preconstruction Conference and once all preliminary requirements of the Contract have been satisfied, official notice to begin work must be given to the Contractor. A Notice to Proceed is written notification to the Contractor to proceed with the contract work including, when applicable, the date of beginning of Contract Time. If the Contractor employs one or more Subcontractors, DOH approval first must be granted. Use the following SiteManager functions to perform these tasks:

1. Generate Notice to Proceed. Use Generate Notice to Proceed to generate the official Notice to Proceed. The official Notice to Proceed authorizes the Contractor to begin work on the project.
2. Input & Transmit Subcontracting Data. Subcontractor Requests will be sent to the Contract Administration Division - Project Control Group. All Subcontractors must be licensed with the DOH and listed in the SiteManager Vendor Library. A signed Subcontractor Affidavit is required for any proposed subcontractor. Project Control Group will enter the information in AWP.

105.6.4-Begin Construction Once the Contractor begins work, document the starting date by generating a Starting Notice for the Contractor and for any of the Prime's Subcontractors. At this time and throughout the remainder of the project, enter into AWP the applicable data describing the work performed from the DWR and Diary. Use the following AWP functions to perform these tasks:

1. Generate Starting Notice. The Contractor's Starting Notice documents the date the Contractor begins work on the project. The starting date is entered in the Key Dates and the report is generated in SM Reports. It is sent to Project Control Group for entry in the Critical Dates.
2. DBE Subcontractor's Starting Notice. Subcontractor's Starting Notices, which document the date the Subcontractor begins work on and/or left the project are required for DBE subcontractors only.
3. Daily Work Reports. Use Daily Work Reports to enter and maintain the documentation of the work performed on the project line items (i.e., bid or added) of the Contract. Use the actual Diaries or DWRs as the source documents for entering the applicable data into AWP.

SECTION 106
CONTROL OF MATERIALS

Section 106 of the Specifications establishes the respective obligations of the Contractor and the DOH concerning the materials to be used. The following Section presents specific DOH procedures and additional clarifying information.

106.1-ACCEPTANCE OF MATERIALS

106.1.1-General All materials used in highway construction projects must conform to the requirements of the contract specifications. The project records must document by proper reports the quality assurance data for all materials used. Control of materials for a project includes the following:

1. Acceptance at the source;
2. Contractor's quality control plans;
3. Acceptance sampling and testing; and
4. Independent assurance sampling.

To avoid misunderstanding, a discussion of material approval procedures will be presented at the Preconstruction Conference. Additionally, "Evidence of Inspection" documentation will be distributed to the Contractor, Project Engineer/Supervisor, and the Project Inspectors at the Preconstruction Conference. This covers the minimum requirements for acceptable materials and evidence of inspection. Material that is covered by less than the minimum evidence of inspection will not be incorporated in the work.

106.1.2-Contract's Proposed Source of Materials (Form PC-454) Immediately after award, the Contractor will be notified by a standard letter from the District Construction Engineer that three copies of a properly executed Contractor's Proposed Source of Materials (Form PC-454) will be submitted to the District Materials Supervisor prior to, or at, the Preconstruction Conference. The address, not the Post Office Box, of the actual point of manufacture of each type of material must be listed separately. If material is supplied by a third party, both the supplier and the manufacturer must be listed. The supplier must be listed first. The intent of Form PC-454 is to disclose to DOH all materials to be provided by subcontractors or suppliers including all raw materials used in the production of bituminous concrete, Portland cement concrete, and other composite materials. The District Materials Supervisor will check Form PC-454 against the contract items to ensure that all project materials have been listed. A copy is placed in ProjectWise under project folder by project personnel. Any changes in material source or supply will necessitate a prompt revision of Contractor's Form PC-454. The initial submission of Form PC-454 by the Contractor may be partial in nature. As the project progresses, supplemental additions to Form PC-454 may be submitted by the Contractor prior to the use of those specific materials.

The procedures for approval of material sources will be fully disclosed at the Preconstruction Conference by the representative of the MCS&T Division and/or the District Materials Supervisor. At this time, the Contractor must prepare a letter to each of its suppliers advising them that all materials should be tested and accepted by DOH prior to shipment to the construction site. The presentation will include a discussion on pre-sampling and pre-testing procedures and the types of samples and certificates required.

Upon receipt of the executed Contractor's Proposed Source of Materials (Form PC-454), the District Materials Supervisor will initiate action to establish initial acceptance arrangements. Relative to DOH, if a new supplier is listed on Form PC-454, the District Materials Supervisor will establish contact with the proposed source to initiate testing.

106.1.3-Evidence of Inspection The Project personnel will ensure that the project materials are delivered to the site with the proper shipping documents and a copy is scanned into ProjectWise, which must include the material information as per evidence of inspection. The Project Inspectors will enter the material information on their DWRs for subsequent entry in the AASHTOWare Project. In addition to the laboratory numbers on the shipping document, some materials have additional inspection requirements and additional indicators for evidence of inspection.

Visually inspect all materials at the point of delivery. The Project Inspectors have the final opportunity to observe project materials to detect any problems before they are incorporated in the project. If evidence of inspection is lacking or less than minimum or if there is any doubt as to a material's acceptability, immediately contact the District Materials Supervisor before the material is accepted.

When materials are shipped to projects from intermediate suppliers, the supplier's shipping document must reference the laboratory number and the original manufacturer's shipping document number. The original manufacturer (i.e., point of sampling) must submit the proper documentation to the MCS&T Division. The Project Engineer/Supervisor will forward a copy of all shipping documents to the District Materials Supervisor.

Documentation for all materials will reference a project Contract ID Number for which the material is intended. This is a unique number assigned by the DOH Finance Division that is used by AASHTOWare Project to track project financial information. Shipping documents also will reference a laboratory number assigned by the MCS&T Division to indicate that the material is acceptable. A laboratory number will represent one of the following types of approval:

1. Approved Source Number. A DOH approved product or source number is a laboratory number that documents a material from the DOH Approved Product and Source Listing. This laboratory number will be identified on the shipping document which is a series of numeric digits. Documentation of acceptability will consist of the quantity received and the Material Section's laboratory number as placed on the DWR and entered in AASHTOWare Project as a sample with approved source. A copy of this documentation

will be placed in ProjectWise under bid item folders. Approved source numbers are typically used for materials such as aggregates, guardrail, and curing com- pounds.

2. Master Number. A master number is a laboratory number that is typically used for drop inlets and fabricated castings (i.e., multiple sources of materials). This laboratory number will be identified on the shipping document with the letter “M” preceded by a series of numeric digits. Documentation of acceptability will consist of the quantity received and the Material Section’s laboratory number as placed on the DWR and entered in AASHTOWare Project. A copy of the documentation will be forwarded to the Fabrication Group of the MCS&T Division.
3. Direct Coverage (DC) Number. DC numbers are laboratory numbers used for project specific materials. They are not applicable to pre-certified approved sources. Materials accepted in this manner will have an associated direct sampling and testing report (i.e., a T-7 Report). For example, a T-7 Report for a fabricated sign will state that all components, each of which have their own laboratory numbers, used in fabricating the sign have been tested and approved during the fabrication process. This laboratory number will be identified with the letter “DC” preceded by a series of numeric digits. Documentation of acceptability will consist of the quantity received and Material Section’s laboratory number Placed on a DWR and entered in AASHTOWare Project.

106.1.4-Contractor’s Quality Control Program Quality control is the responsibility of the Contractor for each item as required by the contract specifications. Requirements for the Contractor’s Quality Control Program are set forth in the contract specifications.

106.1.5-Verification Sampling and Testing Acceptance sampling and testing is the responsibility of DOH. Materials inspection, sampling, and testing performed by Project Inspectors under the Project Engineer/Supervisor are of several types, depending on the materials involved. Requirements are set forth in the contract specifications and the Material Procedures (MPs). The Materials Procedures may be obtained from either the District Materials Supervisor or the MCS&T Division. The MPs are also available from the WVDOH Internet Web Site. Some of this type of testing can be accomplished by the Project Inspector witnessing the Contractor’s quality control tests and documenting the results on the DWR.

All samples taken at the project by the Contractor, or the District will have a laboratory number issued by the Project Engineer/Super- visor to identify the sample. This information will be placed on a DWR and entered in AASHTOWare Project, except for compaction test which will be referenced by laboratory number in the memo field. The Contractor shall submit the original work sheet of all quality control tests to the District Materials Section, except compaction tests, which will have the original submitted to the project for review, before submission to the District’s Material Section.

Any testing of materials after they are delivered to the project site should be expedited, as practical, to avoid potential delays to the Contractor. If there is any problem with inspection, sampling, or testing methods, the Project Engineer/Supervisor should obtain specific instructions from the District Materials Supervisor.

106.1.6-Independent Assurance Sampling The contract specifications provide for Independent Assurance Sampling. Independent Assurance Sampling is a supplemental program to the routine quality control performed by the Contractor and the verification sampling and testing performed by Project Inspectors. Independent assurance sampling procedures must conform to the DOH criteria established for minimum evidence of inspection. See MP 700.00.53 – "Procedures for Evaluating Independent Assurance Samples with Acceptance Samples" for additional information.

106.2-QC/QA AND MATERIALS MANAGEMENT

This Section provides DOH project personnel with an overview of DOH QC/QA program and how DOH performs materials management for all construction projects. It will provide the reader with a better understanding of the roles and responsibilities of the Central Office, District Office, Project personnel, and the Contractor and its materials suppliers and manufacturers.

106.2.1-Quality Control/Quality Assurance To ensure quality, DOH has adapted a systems approach, in the form of a QC/QA program, to the production of many highway construction materials and certain highway construction operations, as specified in the contract specifications. The QC/QA program meets FHWA requirements for Federal-aid projects as documented in 23 CFR 637.205. This approach consists of a Quality Control (QC) function, for which the Contractor and the material producer and/or manufacturer are responsible, and a Quality Assurance (QA) function, for which DOH is responsible for accepting or rejecting the work or material. The QC/QA functions of both the DOH and the Contractor must be staffed by qualified personnel, and the Contractor, where specified in the Contract, must submit a Quality Control Plan.

The data used in the QC/QA process comes from shipping documents, project site test results, and laboratories of the Contractor, manufacturer, producer, District, and MCS&T Division. There are numerous DOH support functions and programs that assist in administering the QC/QA approach (e.g., AASHTOWare Project, MMS, plant evaluations, use of QC tests for acceptance, Independent Assurance Sampling). Because the Contractor conducts tests at the same frequency as those required for DOH acceptance, DOH can use the Contractor's QC test data to assist in making determinations on acceptance, thus significantly reducing DOH on- site testing requirements. A primary advantage of the QC/QA approach is that DOH personnel can focus on inspection activities and better assist those having trouble with process control rather than performing all routine sampling and testing activities. In addition, DOH has fewer disagreements with the Contractor over the quality of test data, and the Contractor no longer must halt operations until a Project Inspector arrives with test results.

106.2.2-AASHTOWare Project Materials The MCS&T Division AASHTOWARE Project to track materials used in DOH construction projects. The database contains information on all materials tested by Central Office, District Office, and Project Field Office laboratories and on those materials where tests were observed at the manufacturing or production source. The software is used to record test data, track, and locate test documents, and provide documentation on the status of material tests and acceptance to DOH project personnel. The MCS&T also uses the AWP to evaluate the acceptability of a Contract pay item and to prepare the final letter of Materials Certification. Materials Certification is needed for all DOH construction projects.

106.2.3-Approval of Off-Site Materials The Contractor must provide DOH with a Contractor's Proposed Source of Materials (Form PC-454) as discussed in Section 106.1.3. Two types of sources may be listed on Form PC-454: a pre-approved source and an unapproved source.

106.2.3.1-Pre-Approval Source A source that is listed on the Contractor's Proposed Source of Materials may have already been approved by DOH.

Pre-approved sources generally will be maintained on the DOH Approved Source and Product Listing for a specific time until a renewed approval is established by the Materials Control, Soils and Testing Division. Contact the MCS&T Division or download from the DOH Internet Web Site the current DOH Approved Source and Product Listing.

106.2.3.2-Unapproved Source If a source is not pre-approved by DOH, the MCS&T Division will contact the source listed on the Contractor's Proposed Source of Materials (Form PC-454) and arrange for source approval or for the testing of a specific "lot" of material. A "lot" generally refers to an isolated quantity of specified material from a single source. The variability of the material to be supplied will become the determining factor for source approval. Lot approval will only apply to the defined quantity of material. Source and lot approvals for unapproved sources are as follows:

1. Lot Approval. Sampling of a specific lot is arranged, and, in most instances, these samples are submitted to DOH laboratories for testing and approval. A sampling report is submitted with each sample. This report is essential because it is used to enter the MMS the information necessary for project- level documentation and to support the final letter of Materials Certification when the pay item is completed.
2. Source Approval. Source approval works like lot approval except that the data used for approval will often include manufacturer quality control data and site inspection results by DOH materials personnel. A report for source approval will be issued similarly to the sample report issued for the sampling of a specific lot.

Lot and source approval reports are essential to MMS because they initiate tracking of the material approval process through project implementation and final Materials Certification.

106.2.4-Laboratory Testing Material samples for projects throughout the State are routinely routed to the Central and District laboratories. Upon receiving a sample for lot or source approval, a DOH laboratory will assign a laboratory number for tracking purposes (see Section 106.1.3 of this manual). Basic information from the sample report is entered into the MMS including source identification, material identification and, if applicable, project identification. As each laboratory completes its testing, the results of the test data are entered, cross-referenced, and tracked using the MMS. Because the MMS data is available to all DOH Districts and their respective project personnel, this allows DOH to track a material sample from the time it is received at a laboratory until the time final Material Certification is needed for the item. The MMS also tracks the approval of composite ingredients for such items as Portland cement concrete. For a PCC item, the MMS would maintain data on the ingredients (e.g., cement, aggregates, admixtures, water) as well as the resulting PCC. If the DOH, Contractor, producer, or manufacturer requests status of a test on a particular sample, DOH personnel can quickly access and provide the information.

106.2.5-Approval and Delivery After materials are tested at a DOH laboratory, DOH personnel will evaluate the test results in accordance with the contract specifications. If the material source or lot is approved, the MCS&T Division will notify the manufacturer or producer. Upon delivery, the manufacturer or producer must provide shipping documents as minimum evidence of inspection to demonstrate that delivered materials are from an approved lot or approved source (see Section 106.1.3). The Project Engineer/Supervisor will ensure that a copy of the shipping document is forwarded to the District Materials Supervisor. Upon receipt of the shipping document, the MCS&T Division will enter in the MMS the source identification, destination identification, material type, lot identification (i.e., the lot number at the time of approval), and the quantity delivered. The MMS allows DOH to verify the status of each shipment and the remaining balance in an approved lot of material.

106.2.6-Project Level Documentation The on-site Project Inspector is responsible for recording on the DWR the quantity of material placed and the acceptability of the material. If a manufacturer or producer delivers material to the site, the Project Inspector must verify that the shipping document references the appropriate laboratory numbers (see Section 106.1.3). DOH project personnel will enter the laboratory number and additional information from the shipping document in the MMS and request verification of acceptability. The MMS will assign the request a tracking number and AASHTOWare Project will upload the data to the MMS, which, in turn, will verify the data entered with data previously entered by the MCS&T Division on the status of the approved lot of material. The MMS will verify the lot identification, delivery date, project identification, and quantity. At the time the data is uploaded, the MMS will immediately notify project-level personnel of any deviations in acceptance criteria. All deviations must be resolved prior to the MCS&T Division performing the final review and audit; otherwise, acceptance criteria have been met and the MMS will document completion and acceptance of the pay item. All data entered at the project level must match the data in the MMS for that material. If the data matches, the MMS will generate a verification report for the Project Engineer/Supervisor documenting the quantity shipped from the approved lot. As part of the tracking and auditing system, the MMS will then adjust the balance of the quantity remaining in the approved lot.

106.2.7-Project Materials Certification The primary objective of the MMS is to track and document Materials Certification for all project pay items during project construction. Refer to MP 700.00.01 for a description of the shipping document. The MMS will use project- level materials data from AASHTOWare Project and DOH laboratories to document the acceptability of pay items (e.g., validity of samples and tests, results comply with Specifications, lot and source approvals properly documented, shipments properly documented and traceable to source). If material discrepancies had been encountered during the project, the MMS would have immediately alerted DOH personnel to resolve the issue. Materials Certification, in essence, occurs as the project is being constructed. At the time Project Materials Certification is required for finalization, the MMS provides DOH personnel with an efficient and relatively routine method of validating project pay items. After project completion, DOH generates the Materials Certification for the project, which is an important FHWA requirement. MCS&T will use the MMS to generate a report documenting the acceptability of each pay item in the project. The final report will be signed and dated by the Finalization Group, and the project records of the MMS will be locked to protect against unauthorized modification.

SECTION 107
LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

Section 107 of the Specifications establishes the respective obligations of the Contractor and the DOH concerning legal relations and responsibility to the public. The following Section presents specific DOH procedures and additional clarifying information.

107.1-PERSONNEL AND PUBLIC RELATIONS

107.1.1-Integrity of DOH Personnel The integrity of DOH personnel must be of the highest caliber to promote a high degree of public confidence. All DOH personnel are subject to the following guidelines:

1. Moonlighting. DOH personnel will not engage in any type of outside work, such as engineering, surveying, or design work for highway Contractors or others doing business with the State, because work of this type may tend to cast doubt on the individual's activity and the DOH. If a DOH employee plans to seek extra employment they must follow the current HR guidelines.
2. Financial Conflicts. No one in DOH, whose job involves negotiating, approving, or administering any contract or transaction on behalf of the Division, will have any financial interest, direct or indirect, in the case.
3. Real Estate Disclosure. Any DOH employee, who has an interest in real property being acquired for highway purposes, will fully document the facts of the interest, and will not engage in any way in the purchase of the real property.
4. Use of DOH Equipment. DOH employees will not use Division equipment for personal business.
5. Gratuities. The solicitation or acceptance of gifts, cash, or loans by DOH personnel from any Contractor or supplier doing business with the State is prohibited. See WV Ethic Commission webpage for further guidance and requirements.
6. Falsification of Records. All project records will be maintained accurately and clearly. When corrections are made on paper, erasures must not be made; corrections will be made by striking out the incorrect data, entering the correct data, and affixing the initials of the person making the correction. When corrections are made in AWP, proper explanation and documentation must be entered. Entering test data where no tests were performed will be construed as falsification of records.
7. Disciplinary Action. Any employee involved in dishonesty or serious conflict of interest will be subject to severe disciplinary action and possible dismissal from the Department.

107.1.2-Employee-Contractor Relationship Consider the following guidelines to better maintain good employee-contractor relations:

1. Treat the Contractor fairly and impartially;

2. Study the Contractor's viewpoint, be friendly but impersonal, and do not obligate yourself;
3. Make suggestions to the Contractor only, and do not discuss with outsiders the Contractor's methods of handling work;
4. Be ready to advise the Contractor when requested, but do not make snap decisions;
5. Issue all orders only to the Contractor's Superintendent or designated representative;
6. Write and retain copies of all important orders given to the Contractor and attach them to the DWR, as appropriate;
7. Discuss with the Contractor the schedule, and coordinate your work with his schedule;
8. Do not be arbitrary or become involved in pointless arguments with the Contractor on matters related to the work; and
9. Do not accept gratuities from the Contractor; do not be threatened or intimidated by Contractor employees and notify your supervisor of any trouble.

107.1.3-Public Relations Courtesy and consideration are necessary in all contacts with the public because the entire DOH is judged by the actions of its employees. Although an employee may not obligate DOH to any course of action or any expense without due authorization, the employee should always be as tactful and helpful as conditions permit. The media of communication with the public are many (e.g., newspapers, radio, television, service clubs, Chambers of Commerce, city and county officials, direct contact with individuals). Consider the following guidelines when dealing with public issues:

1. Controversial Issues. If conditions are encountered that might develop into public controversy, the information should be transmitted through channels so that an early news release can inform the public of the facts. Information given to the public must not be slanted or evasive.
2. Interviews/Press Releases. Where public contact is made by newspaper, radio, or television reporters, the Project Engineer/Supervisor should contact the Construction Engineer and follow any instruction received. This can help avoid issuance of conflicting information to the public that may cause embarrassment to DOH. Approval from the District Construction Engineer and/or District Engineer/Manager for news releases will be obtained as needed. Coordination with Office of Communications may be required.
3. Affected Residents. In dealing with residents along the highway, the Project Engineer/ Supervisor must endeavor to maintain friendly relations. Frequent requests will be made on which the Project Engineer/Supervisor will not have authority to act. In such cases, the Project Engineer/Supervisor should make every effort not to offend the resident making the request. The Project Engineer/Supervisor should not just refer interested residents up the chain of command but should advise the resident that he/she will take the matter up with his/her supervisor. After doing so, the Project Engineer/Supervisor should personally contact the interested resident with a response.
4. Social Media. When using social media, employees are expected to observe a standard of conduct, both on and off duty that does not reflect discredit on themselves, other employees, customers, vendors, or the agency. See WV Division of Personnel and WV Office of Technology Policy for additional information.

107.2-LEGAL ISSUES

107.2.1-Contractor's Responsibility for Work-Legal Issues The entire responsibility for the work resides with the Contractor during construction until final acceptance of the project by the Division. The Contractor must maintain and protect the project from the elements. Exceptions include:

1. Damage due to an act of God;
2. Damage due to unforeseen causes beyond the control or and without the fault or negligence of the contractor.

The Division will not be prevented in any way from ascertaining the true amount and character of the work performed or the materials furnished or from recovering damages that may be sustained because of failure of the Contractor to comply with the terms of the Contract. The Project Engineer/Supervisor must therefore maintain complete records. These records will be the major basis for substantiating the Division's action.

107.2.2-Compliance with Laws The contract specifications require the Contractor to observe and comply with all Federal and State laws and with local ordinances and other regulations that affect the work on the project. In addition, the Contractor is required to keep the DOH and its personnel free from liability for any claim resulting from any violation of any law by the Contractor or its representatives or any of its subcontractors and/or consultants. The Contractor must indemnify the Division and its personnel for any harm suffered because of such a violation. These provisions do not mean that the Project Engineer/Supervisor should attempt to enforce a law. However, if a violation is evident, the Project Engineer/Supervisor should notify the Contractor in writing and maintain a copy in the project records.

107.2.3-Construction Project Safety Safety concerns everyone involved in highway construction, including DOH and Contractor personnel and the traveling public. Consider the following safety related guidelines:

1. Health and Safety Requirements. To reduce the number of accidental deaths and job related injuries and illnesses throughout the United States, the Occupational Safety and Health Ac (OSHA) was enacted by Congress on December 29, 1970. The Act authorizes the U.S. Department of Labor to set and enforce mandatory occupational safety and health standards. The Contractor must comply with the OSHA Federal Construction Safety Standards. Responsibility for enforcement of the safety regulation has been officially assigned to the West Virginia Department of Labor and the U.S. Department of Labor. The Contractor will also meet the sanitation requirements of the State and local Boards of Health.
2. Contractor's Safety Program. The Contractor must comply with the contract specifications for all safety related provisions including health and safety programs, safety training, qualified Safety Officers, and weekly on-site informational safety meetings. On projects with a Total Contract Bid Amount exceeding $2,000,000 or is otherwise noted on the plans, the Contractor must submit both comprehensive safety

and health program and site-specific safety plan to the Project Engineer/Supervisor at the Preconstruction Conference or prior to the start of work. A copy of the comprehensive safety and health program for each subcontractor and the name of the company safety officer must be submitted with the request for subcontract approval. The Project Engineer/Supervisor and the Project Inspectors will monitor the Contractor's safety program. The Project Engineer/Supervisor will promptly notify the District Construction Engineer of any serious safety violations by the Contractor or its employees.

3. Project Personnel. The District Construction Engineer, or designee, will conduct periodic safety meetings with District and DOH project personnel in accordance with current DOH safety directives. Many hazards exist on a construction project that require all project personnel to be constantly alert to avoid injury. Some special precautions that can improve safety in extra-hazard situations are:
   a. Hard Hats. For safety and identification, all DOH personnel assigned to the project will wear safety (hard) hats, where directed by current policy. No other information other than the name of the person should be indicated on the hat. Contractor personnel should not wear hard hats bearing the DOH seal.
   b. Safety Vests. DOH personnel must wear safety vests while working in traffic. Contractor personnel should not wear safety vests that display the DOH seal.
   c. Signs and Flaggers. Project Inspectors should ensure that adequate signs and flaggers are provided where work must be performed on existing highways.
   d. Night Illumination. If an evening or overnight operation is performed, check that the Contractor provides adequate illumination for workers.
   e. Trenches. The Contractor must provide shoring of trenches to protect workers in accordance with the current OSHA safety criteria.
   f. Blasting. Whenever blasting is being performed, adequate protection should be provided, including warning signs to prohibit radio and cell phone transmission. The Contractor must meet the requirements of the Specifications when using explosives, local laws and ordinances, clearances from roads and buildings, and coordination with utility and railroad companies. In addition, the Contractor is solely responsible for property damage and injury claims resulting from blasting.
   g. Railroad-Highway Crossings. The Contractor must comply with the provisions of the Contract related to railroad-highway crossings. The Contractor's key point of contact is the Chief Engineer of the Railroad Company. If construction operations are performed adjacent to or within railroad right-of-way, the Contractor will meet the provisions for notifying the Railroad Company, insurance requirements, use of grade crossings, interference with railroad operations, coordination of schedules, track clearances, and use of railroad flaggers.
   h. Abatement demo and renovation: contractor shall submit the required notifications per specification 107.26.
4. Traveling Public. The traveling public should be protected from danger due to construction operations. Adequate barricades and signs should be placed where they are most effective. The Contractor must perform this task in accordance with the DOH

Manual on Temporary Traffic Control for Streets and Highways. If needed, flaggers should be provided. There should be no doubt when roads are closed and where detours are located. When signs and barricades have served their purpose, they should be removed.

107.2.4-Protection and Restoration of Property The Contractor must take every practical precaution necessary to prevent damage to public and private property adjacent to the project, either above ground or below ground, which will remain and is legally responsible for restoration and any damage claims. The Contractor is responsible for protecting State and National Forests and for complying with all regulations of the State Fire Marshal, WVDNR, and other environmental agencies. A discussion on environmental issues is presented in Section 107.4 of this manual. Before construction begins, the Project Engineer/Supervisor will visit the site with the Contractor to identify trees, monuments, and features of property that will remain in place and undamaged. Frequently, the Contractor will arrange with nearby property owners for the use of facilities or property for the storage of material, office space, or access. See Section 201 for additional information on protection and restoration of property, off-site-property agreements, and selective clearing and grubbing. The Contractor also must restore any alterations to the highway surface permitted for utility adjustments.

107.2.5-Patented Devices, Materials, and Processes The Contractor must obtain all necessary permits or licenses for the use of patented devices, materials, and processes in performing the work. The Project Engineer/Supervisor has no obligation to determine that the Contractor conforms to these requirements but may assist the Contractor by calling attention to any known infringements.

107.3-EMPLOYMENT AND LABOR ISSUES

107.3.1-Equal Employment Opportunity (EEO) For all Federal-aid contracts awarded by DOH in excess of $10,000, all Contractors and Subcontractors must adopt the EEO Policy set forth in the Special Provision included in the Contract Proposal. The Contractor and Subcontractor must submit Annual EEO Report (Form FHWA-1391) in the month of July. In addition, upon request of the Civil Rights Compliance Division, the Contractor must submit a Manpower Utilization Report (WVDOH Form CRCD-150) for the requested month the Contractor or Subcontractor works on the Project. These activities are established by DOH to ascertain that Contractors and Subcontractors are complying with the EEO obligations of the Contract. The EEO program is administered by the External Contract Compliance Section of the Civil Rights Compliance Division. Both External Contract Compliance Section personnel and Project Inspectors will be involved in performing periodic inspections to determine compliance. The following procedures will apply:

1. External Contract Compliance Section personnel should contact the Project Engineer/ Supervisor prior to making periodic inspections of the project.
2. It is recommended that the Project Engineer/Supervisor or Project Inspector accompany the Civil Rights Compliance Specialist during the initial review and any subsequent reviews with the Contractor.

3. The External Contract Compliance Section personnel will furnish the District Construction Engineer with a copy of the EEO Report covering all reviews of the project.
4. The District Construction Engineer will be furnished copies of any correspondence to the Contractor regarding noted deficiencies.

107.3.2-On-the-Job Training The Code of Federal Regulations (23 CFR 230 Subpart A Section 230.111) requires the DOH to review each Federal-aid project regarding its capacity to support training for minority, women, and disadvantaged workers in highway construction. The DOH will determine the number of trainees to receive On-the-Job Training (OJT) and so specify in the Contract by Special Provision and Bid Item (e.g. Item 699). The following sections document the responsibilities of the OJT Program.

107.3.2.1-Contractor Responsibilities Three (3) working days prior to the Preconstruction Conference, the Contractor will submit to the OJT Program Manager within the Civil Rights Compliance Division, a Training Proposal designating the number of trainees and a Training Program for each selected work classification in accordance with the OJT Special Provision. After receiving approval for the OJT Program from the DOH, the Contractor will submit to the Project Engineer/Supervisor a Trainee Enrollment Form for each proposed trainee. During the project, the Contractor is responsible for submitting daily to the Project Engineer/Supervisor an executed WVDOH Form CRCD-153 indicating the training conducted against the OJT Pay Item. The Contractor will obtain WVDOH Form CRCD-153 from the OJT Program Manager within the Civil Rights Compliance Division. The Contractor will submit to the Project Engineer/Supervisor a Trainee Status Change Form (WVDOH Form CRCD-155) for all trainees whose status within the Program changes. Upon completion of the Program, all Trainees must receive a letter or certificate of completion. A copy of the certificate must be provided to the Trainee, Project Engineer/Supervisor, and the OJT Program Manager.

107.3.2.2-External Contract Compliance Section Responsibilities The OJT Program Manager of the Civil Rights Compliance Division administers the OJT Program and maintains a record of all trainees working on projects under contract with the OJT Special Provision. At the Preconstruction Conference, the OJT Program Manager will provide the Contractor with an informational packet outlining Contractor responsibilities regarding the OJT Program. Upon receipt of the Training Proposal and Program, the OJT Program Manager will review the documents for compliance. Once approved, the OJT Program Manager will forward a copy of the Training Proposal and Training Program to the Project Engineer/Supervisor. The OJT Program Manager will periodically monitor the OJT Pay Item to check that the requirements of the OJT Special Provision are being met.

107.3.2.3-Project Engineer/Supervisor Responsibilities Upon receipt of the Contractor's OJT Training Proposal and Program, the Project Engineer/Supervisor is responsible for reviewing the documents and clarifying with the OJT Program Manager any questions. The OJT Program Manager provides a guide of responsibilities regarding the OJT Program. During the project, the Project Engineer/Supervisor verifies and documents that OJT trainees are being trained in accordance with the requirements of the Contractor's Training Proposal and Program. Upon receipt of the Contractor's completed Form CRCD-153, the Project Engineer/Supervisor will verify the information against the Inspector's Daily Work Report. The data entered in AWP will be used to prepare progress estimates for the OJT Pay Item. The Project Engineer/Supervisor will monitor to ensure that the number of chargeable hours recorded on the DWR for the OJT Pay Item is the actual number of hours that the trainee worked within the classification specified in the Contractor's approved Training Proposal. WVDOH Form CRCD-154, which notes current and total training hours, is prepared monthly and forwarded to the OJT Program Manager. If a trainee voluntarily quits or is otherwise terminated by the Contractor before completing the required number of hours for the training classification or one thousand (1000) hours, the Contractor will replace that trainee with a new trainee who will be eligible for up to one thousand (1000) hours of training in the specified training classification, after notifying Civil Rights Division. If the one thousand (1000) hours allotted for the new trainee exceeds the total number established in the Training Proposal for the project, it will be considered an overrun of Bid Item 699 at the conclusion of the Contract.

107.3.3-Labor Regulations The contract specifications require the Contractor to comply with all regulations applicable to labor standards. A working knowledge of these regulations is required of the Projects Engineer/Supervisor to help evaluate compliance by the Contractor.

The External Contract Compliance Section of the Civil Rights Compliance Division is ultimately responsible for monitoring all Federally funded projects to assure compliance with the Labor Standards Provisions of the Contract. However, routine checks for compliance of the following shall be the responsibility of the Project Engineer/Supervisor:

1. Bulletin Board. The required labor posters, wage rates, and prime contractor's EEO information must be always displayed at the project site where they are readily accessible and easily visible to all employees of the Contractor or Subcontractors employed on the site, potential applicants for employment, and union representatives. Placing the required workplace notices and posters in a binder does not meet the requirement for displaying in an accessible place where they are easily visible and will not be accepted. The Project Engineer/Supervisor must inspect the Bulletin Board upon commencement of work and document such on a Federal-Aid Project Required Postings Inspection form (WVDOH Form CRCD-145). Completed forms are to be entered into the Labor Compliance folder in ProjectWise.
2. Interviews. The Project Engineer/Supervisor or designated person shall conduct interviews of a representative of each craft employed on the site of work with such frequency as may be necessary to assure compliance with the established wage classifications for the work actually performed. Interviews are to be documented on an Inspectors Report – Labor Interviews form (Form DCL-2) and entered into the Labor Compliance folder in ProjectWise.
3. Payrolls. The Contractor and all Sub- contractors are required to submit Weekly Certified Payrolls (WH-347) on all Federal- aid projects. The Contractor is not required to submit payroll information on state- funded projects under $500,000.00; however, the Contractor should provide applicable data upon request. State- funded projects over

$500,000.00 fall under the provisions of the West Virginia Jobs Act and require weekly payrolls to be submitted to the DOH and the West Virginia Division of Labor.

4. Payroll Processing for Federal Funded Projects:
   a. The original or an electronic copy of each Weekly Certified Payroll (WH-347) or Supplemental Payroll, with a Statement of Compliance attached, must be submitted to the Project Engineer/Supervisor within seven (7) days following payroll payment date. Payrolls received must be logged on a Record of Contractor's Payroll Submission form (Form DCL-3.
   b. The Project Engineer/Supervisor or designated person will check the: documents for compliance with wage provisions of the Contract. As needed, data will be verified through employee interviews. Spot checks will be made for such items as:
      i. Ensure only the employee's name and last 4 numbers of their Social Security Number or company identification number is listed. Addresses are NOT permitted.
      ii. Work classifications listed match work classifications in the wage rates;
      iii. Hourly wage rates for each employee, including overtime hours and rate,
      iv. The Project Engineer/Supervisor or designated person will check the daily and weekly total hours shown and net wages paid;
      v. Signature on certification; and
      vi. Approved payroll deductions.
   c. If any significant deficiency is found, the Project Engineer/Supervisor should inform the District Construction Engineer, who will contact the External Contract Compliance Section, which will determine if a full-scale investigation is needed.
   d. Certified payrolls should be numbered in consecutive order with the last payroll for the project marked "final." When work is suspended, the Contractor should submit a Weekly Statement of Compliance (WH-348) noting the date the work is suspended.
   e. Minor deficiencies requiring correction must be logged on the DCL-3 along with the date resolved. The Contractor/Subcontractor will submit Supplemental Payrolls for any payroll that requires correction. The original payroll should not be returned to the Contractor.
   f. A West Virginia Division of Highways Labor Compliance Inspection Report Federal-aid Projects form (Form DCL-1) will be used to document inspections made.
   g. Copies of Certified Payrolls that are reviewed should be placed in the payroll folder in ProjectWise for the project.
5. Payroll Processing for State Funded Projects $500,000.00 or Above:
   a. State funded projects $500,000.00 and above fall under the provisions of the West Virginia Jobs Act and are monitored by the West Virginia Division of Labor (WVDOL).
      i. These projects are not subject to prevailing wages, but state minimum wages.

   ii. These payrolls are only required to contain the following information: name and address of the contractor, payroll number and the work week ending date, project name and contract ID number, names of employees, each employee's work classification or job title, county and state of the primary residence for each employee, and days worked.

   b. The original or an electronic copy of each Weekly Payroll or Supplemental Payroll, must be submitted to the Project Engineer/Supervisor and the WVDOL within seven (7) days following payroll payment date. Submissions to the WVDOL are to be sent via e-mail to JobsAct@wv.gov.
   c. Construction Engineers and Project Engineers/Supervisors are not required to monitor these payrolls; however, they must inform contractors of the requirements of the West Virginia Jobs Act and ensure these payrolls are submitted to the WVDOL.

6. Final Inspection. The following applies to Federal funded projects only:
   a. The Project Engineer/Supervisor prior to completing the Final Inspection Report (Form 467) shall conduct a review of the project Labor Compliance records. Any unresolved Labor Compliance items should be added to the punch list for the project. The Project Engineer/Supervisor will then notify the Construction Office Manager/designee that the project is ready for a final labor compliance review.
   b. The Construction Office Manager/designee must submit a copy of the Final Inspection Report to the Civil Rights Compliance Division requesting a Final Release. This will allow for any Contractor compliance issues not noted by the Project Engineer/Supervisor to be considered and to conduct a final labor compliance review prior to the final payment.

If all certified payrolls have been received from the Contractor and all Subcontractors and there are no known exceptions, and a Final Release has been issued by the Civil Rights Compliance Division, the Project Engineer/Supervisor will sign off on the Labor Compliance Inspection Report (DCL-1). The Labor Compliance Inspection Report should be included in the Final Estimate package for the project.

107.3.4-Political Activity Employees are expected to follow current state and DOH requirements when engaged in political activities / lobbying. See WV Division of Personnel and WV Ethics Commission for additional information.

For Federal-aid projects, employees are subject to the provisions of the Hatch Act, a Federal law concerning political activity. The following quotes the applicable section of Title 5 (Section 118K):

(A) *No officer or employee of any State or local agency whose principal employment is in connection with any activity which is financed in whole or in part by loan or grants made by the United States or by any Federal agency shall (1) use his official authority or influence for the purpose of interfering with an election or a nomination for office, or affect the result thereof, or (2) directly or indirectly coerce, attempt to coerce, command or advise any other such officer or employee to pay, lend, or contribute any part of his* *salary or compensation or anything else of value to any party, committee, organization, agency, or person for political purposes. No such official or employee shall take any active part in political management or in political campaigns. All such persons shall retain the right to vote as they may choose and to express their opinions on all political subjects and candidates.*

107.4-ENVIRONMENTAL ISSUES

107.4.1-General Because of the diverse and complex nature of highway construction, its potential impact on the environment encompasses many specific environmental issues. The general policy of the Division is that all construction activities will be implemented to minimize their impact on the environment and to comply with all environmental laws promulgated at the Federal, State and local levels. Failure to adhere to all relative regulations can result in substantial fines and other serious consequences.

Highway construction can cause water pollution, soil erosion, and noise pollution. Damage may not always be restricted to the right-of-way (e.g., siltation of streams outside project limits). Visual pollution (eye sores) can result from poor selection of waste and borrow sites. Haul roads are also a possible source of erosion, pollution and unsightliness if not intelligently located and constructed.

This Section of the Construction Manual briefly discusses those environmental issues that relate to construction. Other Sections of the Manual discuss environmental considerations for specific construction activities (e.g., Section 207.1.4 discusses erosion and sediment control measures during excavation and embankment construction operations).

107.4.2-Project Plan Development Activities During the development phase of project, the Division conducts an in-depth evaluation of the proposed project's environmental impacts. For major projects, the development process will yield an environmental document that will stipulate specific commitments to minimize or mitigate the project's environmental impact during construction. This may include, for example, a Wetlands Compensation Plan, Storm Water Pollution Prevention Plan (SWPPP), Special Provisions for the management of hazardous waste materials, etc. The Contractor under the supervision of the Division is responsible for fulfilling all environmental commitments made during the development phase.

107.4.3-Coordination with Environmental Agencies Within DOH, the primary contact for environmental issues is the Technical Support Division Environmental Section and/or the Permit Unit. The Environmental Section conducts the project's environmental impact analysis during the development phase of the project. In most cases, if a problem arises during construction, the Engineering Division Permits Unit, should be contacted to assist in resolving the problem.

At the State level, the Department of Environmental Protection (WVDEP) and the Division of Natural Resources (DNR) are the principal agencies responsible for environmental protection in

West Virginia. In some cases, these agencies may become directly involved in environmental issues during construction. For additional information, contact the Environmental Section or Permit Unit.

107.4.4-Water Quality

107.4.4.1-Legal References The primary Federal laws on water quality are Sections 401, 402 and 404 of the 1972 Federal Water Pollution Control Act, as amended by the Clean Water Act (1977, 1987). The importance of compliance with all regulations relating to water quality cannot be overemphasized.

107.4.4.2-Purpose The purpose of the Clean Water Act is to restore and maintain the chemical, physical and biological integrity of the Nation's waters through the prevention, reduction and elimination of pollution.

107.4.4.3-Discussion Highway runoff is a significant source of water quality degradation. Erosion and sedimentation are natural processes whereby soil materials are detached and transported from one location and deposited in another, primarily due to rainfall and runoff. Accelerated erosion and sedimentation can occur in conjunction with highway construction. This accelerated process can result in significant impacts such as safety hazards, impaired drinking water, expensive maintenance problems, unsightly conditions, instability of slopes, and disruption of ecosystems.

The prevention and reduction of water quality degradation in highway construction is accomplished through the following mechanisms:

1. Permit Process. During project plan development and where required, Technical Support Division may have secured the Section 401 Water Quality Certification and/or the Section 404 Army Corps of Engineers' Permit. Some projects require the contractor to obtain the necessary permit. As appropriate, the Special Provisions will document any restrictions on construction activities. In addition, a Section 402 National Pollutant Discharge Elimination System (NPDES) Construction Stormwater Permit may be required. See Section 107.4.9 for more discussion on permits. Field reviews for the above should include U.S. Army Corps of Engineers (USACE), WVDNR and WVDEP representatives.
2. Storm Water Pollution Prevention Plan (SWPPP). The WV Department of Environmental Protection Erosion and Sediment Control Best Management Practice Manual documents the Division's policies, procedures and design guidance for erosion control and electronic copy can be obtained from WVDEP webpage. The 2019 NPDES Construction Stormwater (CSW) General Permit conditions also provide important guidance on requirements. All projects that disturb soil, regardless of the amount of disturbance, require an Erosion and Sediment Control Plan, which must be developed by the Contractor and shall be submit at the Preconstruction Conference along with Co-applicant signature page, and the contractor's E&S Manager contact. The Construction Manual discusses erosion and sediment control for specific work activities as follows:

a. Clearing and grubbing (Section 201.1.7);
b. Excavation and embankment (Section 207.1.4);
c. Structure, rock and wet excavation (Section 212.1.5); and
d. Temporary water pollution control (Section 642).

For additional information, contact the Technical Support Division, Permit Unit.

107.4.5-Hazardous Waste

107.4.5.1-Legal References The primary Federal laws on hazardous waste are the 1976 Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response Compensation and Liability Act (CERCLA).

107.4.5.2-Purpose The purpose of RCRA is to protect human health and the environment by prohibiting open dumping, managing solid wastes, and regulating the treatment, storage, transportation and disposal of hazardous waste. The purpose of CERCLA is to provide for the liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and the cleanup of inactive hazardous waste disposal sites.

107.4.5.3-Discussion Hazardous wastes include a wide variety of materials that may be encountered during or produced by construction activities, including:

1. Asbestos;
2. Underground and above-ground storage tanks;
3. Mining waste;
4. Petroleum products;
5. Paints, solvents, enamels, epoxies, etc.;
6. Lead acid;
7. Pesticides; and
8. Heavy metals.

Materials identified as hazardous are known to have adverse environmental and health effects at specific concentrations. In addition to exposing workers to potentially unhealthy levels of chemical contaminants, improper hazardous waste handling can cause contamination to surface water, groundwater, and soil.

During project plan development, Engineering/Technical Support Division will have identified any known or potentially hazardous waste sites, and the contract documents will detail the proper procedures for handling and disposing the hazardous waste. If during construction, a previously unreported site is discovered, construction personnel must:

1. Report previously undiscovered hazardous sites during construction to the Contract Administration Division; and District Environmental Coordinator
2. Temporarily halt work in the vicinity of a previously undiscovered site;
3. Secure area to prevent unauthorized or unprotected personnel access;
4. Request investigation of the site to assess the presence of contamination and to determine the need for any cleanup; and

5. Oversee any mitigation or cleanup which might be required as part of the construction contract because of involvement with a hazardous site.

Any Project that generates hazardous waste must have an Environmental Protection Agency Identification Number and must abide by all applicable regulation concerning the generation, transportation, and disposal of hazardous waste.

For hazardous wastes produced by construction activities, the Contractor in general must comply with all laws promulgated by the West Virginia Department of Environmental Protection (WVDEP). The Construction Manual discusses hazards and hazardous wastes in the following sections:

1. Fire hazards (Section 201.2.4),
2. Combustible material disposal (Section 201.5.2),
3. Non-combustible material disposal (Section 201.5.3),
4. Material disposal off right-of-way (Section 201.5.4),
5. Asbestos (Section 202.1.3),
6. Hazards from building demolition (Section 202.2),
7. Disposal of material from building demolition (Section 202.5),
8. Potential hazards and disposal of materials from dismantling structures (Section 203), and
9. Disposal of waste materials in excavation and embankment (Section 207.4.4).

For additional information, contact the DOH State Safety Officer, the Technical Support Division Permit Unit or visit the WVDEP website: https://dep.wv.gov/WWE/ee/hw/Pages/default.asp.

107.4.6-Historic and Archeological Findings

107.4.6.1-Purpose The purpose of Section 106 of the National Historic Preservation Act of 1966 is to protect to identify, evaluate and consider the effects of undertakings on cultural resources (history and archaeology).

107.4.6.2-Discussion During project plan development, Technical Support Division will have identified any sites or properties impacted by the project which are on or eligible for inclusion on the National Register of Historic Places. This is accomplished through coordination with the State Historic Preservation Officer (SHPO), the Advisory Council on Historic Preservation (ACHP) and the U.S. Department of Interior. The contract documents will contain requirements for avoiding or mitigating the adverse impacts on these sites or properties. In particular, note that Section 106 is applicable to borrow sites on Federal-aid contracts.

State and Federal law require that, when materials of an archeological nature (e.g., Indian ruins, artifacts, fossils) are discovered during construction, this discovery must be reported. In this event, the Project Engineer/Supervisor will immediately halt all work in the vicinity of the discovery and notify the Contract Administration Division and Technical Support Division, Environmental Services Section immediately.

The Construction Manual discusses historical and archeological preservation in the following sections: building demolition (Section 202.1.4) and excavation and embankment (Section 207.1.8).

107.4.7-Construction Noise

107.4.7.1-Legal References The primary legal references for noise impacts resulting from highway activities are the National Environmental Policy Act of 1969, Federal Aid Highway Act of 1970, Federal Noise Control Act of 1972, 23 USC 109(i) and Title 23 Code of Federal Regulations Part 772 "Procedures for Abatement of Highway Traffic Noise and Construction Noise."

107.4.7.2-Purpose The purpose of the cited legal references is to provide procedures for noise abatement measures to help protect the public health and welfare, to supply noise abatement criteria, and to establish requirements for information to be provided to local officials for use in the planning, design and construction of highways.

107.4.7.3-Discussion The noise levels generated during highway construction vary depending on the type of equipment and the nature of the work being performed. Noise impacts can be severe, especially during nighttime activities and, in many cases, simple noise mitigation strategies may not suffice.

Coordination with U.S. Fish and Wildlife Service, W. Va. Division of Natural Resources, or other agencies may be required.

Excessive construction noise may result from the following activities:

1. Equipment,
2. Blasting operations,
3. Pile driving,
4. Hydraulic breakers, and
5. Plant operations.

During project plan development, Technical Support Division will have performed the following assessment with respect to construction noise:

1. Identify land uses or activities that may be affected by noise from construction, especially sensitive receptors (e.g., schools, hospitals, neighborhoods, churches).
2. Determine appropriate noise criteria limits for the identified receptors. These may be dictated by local regulations or ordinances.
3. Document any measures required during construction to minimize or eliminate adverse construction noise impacts to the surrounding area.

The project Special Provisions and plans will document any restrictions or noise abatement measures required of the Contractor. For example, the Contractor may be required to provide sound-deadening devices, shields or physical barriers (e.g., plywood sheets, lead-vinyl curtains, foam boards) or to provide noise abatement measures to restrict the transmission of noise in the immediate vicinity of schools, hospitals, rest homes, churches, libraries, museums, parks and other noise- sensitive sites specified in the Contract. These measures may include limiting working hours to minimize noises during school hours, for example, or may specify certain times for blasting. Other common-sense measures to reduce construction noise include ensuring that equipment is well maintained (e.g., mufflers), operating equipment at lower power, or increasing the spacing of equipment.

For more information, see NCHRP Synthesis 218 Mitigation of Nighttime Construction Noise, Vibrations and Other Nuisances.

107.4.8-Air Quality

107.4.8.1-Legal Reference The primary Federal law on air quality is the 1990 Clean Air Act Amendments.

107.4.8.2-Purpose The purpose of the Clean Air Act is to regulate all sources of air emissions, including transportation projects, and ensure that those sources conform to the State or Federal air quality implementation plans, which are based on the National Ambient Air Quality Standards (NAAQS).

107.4.8.3-Discussion Construction activities generate a number of products that can contribute to air pollution. These include exhausts from equipment, chemical products (e.g., from bridge cleaning and plant operations) and particulate matter (e.g., from dust). In general, the Contractor must comply with the applicable regulations promulgated by the WVDEP Division of Air Quality (DAQ) and, specifically for plant operations, the Contractor must obtain a permit from the DAQ. The contractor must complete the Approval to Conduct Open Burning Form and receive written approval from the DAQ. Also, a DAQ Permit is required for demolition and asbestos removal. In addition, during periods of limited dispersion, construction operations may be temporarily suspended if those operations are producing the specific air pollution elements of concern.

Sections 207.1.5 and 637 of the Construction Manual state that water will be used as a dust palliative, as directed by the Project Engineer/Supervisor, to prevent a public nuisance. Other options for controlling dust include dust suppressants (i.e., cement-based products that form a protective shell once sprayed) and, for open stockpiles, the use of barriers, screens and/or covers. In addition, it may be appropriate to restrict or suspend dust-producing operations during periods of windy and/or dry weather conditions.

107.4.9-Permits

107.4.9.1-General Compliance with the various environmental laws frequently requires DOH to secure permits from Federal or State agencies. For most projects, the Technical Support Division will have accomplished this during the project plan development, and the contract documents will detail any restrictions on construction activities. However, some projects require the contractor to obtain all applicable permits. This Section of the Construction Manual briefly discusses those permits that may be required on a specific project. For additional information, contact the Technical Support Division Permit Unit.

107.4.9.2-Section 401-Water Quality Certification The Section 401 Certification is required in conjunction with any Federal permit (e.g., Section 404) to conduct any activity that may result in any discharge into the waters of the United States. For most projects, during project plan development, Technical Support Division will secure the Section 401 Certification on applicable projects from the West Virginia Department of Environmental Protection (WVDEP), however, some projects require the contractor to obtain all applicable permits.

107.4.9.3-National Pollutant Discharge Elimination System (NPDES) Construction Stormwater Permit (Section 402) NPDES permit registration is required for any construction activities involving clearing, grading and excavation that disturb 0.4 hectares (1 acre) or more of land area. Based on State and Federal law, a general permit was developed that outlines NPDES requirements.

For most projects, the DOH will obtain the initial WVDEP NPDES Construction Storm Water (CSW) General Permit Registration. There are NPDES CSW General Permit Registration Approvals and Conditional Approvals.

An Approval includes a fully developed and/or generic Storm Water Pollution Prevention Plan (SWPPP) and Ground Water Protection Plan (GPP). If the SWPPP and GPP are not sufficiently protective or compatible with the contractors means and methods, the contractor is responsible for modifying the permit through the WVDEP Electronic Submission System (ESS) website.

A Conditional Approval requires the contractor to develop a site specific SWPPP and GPP that is compatible with the contractors means and methods; as well as, preventing pollution and protection the state waters.

The contractor shall sign and provide the co-applicant #1 signature page for the NPDES CSW general permit registration to the WVDOH. The WVDOH will then modify the NPDES CSW general permit registration, making the contractor the #1 co-applicant/permittee. The WVDOH will become the #2 co-applicant/permittee. After WVDEP Approves the NPDES CSW permit registration co-applicant modification, the WVDOH may issue the Notice to proceed and the contractor may start earth disturbing activities; however, if the WVDEP Conditionally Approves the modification, the contractor shall modify the NPDES CSW permit registration and submit their site specific Storm Water Pollution Prevention Plan (SWPPP) and Ground Water Protection Plan (GPP) directly to the WVDEP through the WVDEP Electronic Submission System (ESS) website.

The contractor shall ensure proper preparation and inspection of the SWPPP, GPP, and that all installed erosion and sediment control Best Management Practices (BMPs) are inspected by his designated Qualified Person on a regular basis specified in the SWPPP. Any defective controls identified during the inspection must be repaired and/or installed correctly within 24 hours and corrections verified upon re-inspection by the Qualified Person. Construction activities may begin after the Qualified Person inspects and finds that all erosion and sediment control BMPs are installed properly in the areas where earth disturbing activities are planned to commence. The contractor shall ensure that a Qualified Person inspects the erosion and sediment control for the project on a regular basis as indicated by the NPDES CSW Permit.

The Qualified Person is the responsibility of the Contractor. "Qualified Person" means a person who is knowledgeable in the principles of sediment and erosion controls, pollution prevention, and possesses the education and abilities to assess conditions at the proposed site that could impact storm water quality and to assess the effectiveness of the proposed storm water controls to meet the requirements of the NPDES CSW General Permit.

Large Construction Projects (Projects disturbing 3 or more acres of land) shall submit an application containing:

1. Application Form, to include template for the sign
2. Stormwater Pollution Prevention Plan;
3. Groundwater Protection Plan;
4. Pre-Construction Drainage Map
5. During Construction Drainage Map showing the proposed location of all drainage control structures or BMPs and associated access routes;
6. Post Construction Drainage Map;
7. Annual Progress Map if permitted for longer than one year;
8. Detailed Site Plan (Maps) showing Limits of Disturbance and Receiving Waters; and
9. Design Details for:
    a. Sediment basins, road, cut and fill cross sections, and other engineered structural design calculations; and
    b. Other controls to include post-development stormwater management plans required by local governments
10. Applications for Large Construction Projects shall be submitted 60 days before the anticipated date construction is to begin.
    a. Applications for Large Construction Projects requiring Public Notice per Section II.A.1.b (100 acres or more disturbance, grading phase >1 year, or discharge to Tier 3 stream) of the permit shall be submitted 100 days before the anticipated date construction is to begin.

Minor Construction Projects (Projects disturbing 1 to < 3 acres of land) shall submit an application containing the following:

1. Application form, to include template for the sign
2. Stormwater Pollution Prevention Plan;
3. Groundwater Protection Plan;
4. Pre-Construction Drainage Map;
5. During Construction Drainage Map showing the proposed location of all drainage structures and associated access routes;
6. Post Construction Drainage Map;
7. Annual Progress Map if permitted for longer than one year;
8. Detailed Site Plan (Map) showing Limits of Disturbance and Receiving Waters
9. Typical Design Details.
10. Applications for Minor Construction Projects shall be submitted 30 days before the anticipated date construction is to begin.

a. Applications for Projects requiring Public Notice per II.A.1.b shall be submitted 100 days before the anticipated date construction is to begin.

The following applications are subject to Public Notice in a local newspaper therefore, the Notarized Statement for Billing form is required with the application:

1. Land disturbance of 100 or more acres;
2. Projects of 3 acres or more with a grading phase lasting one year or longer which will not meet final stabilization, as defined in Appendix C of this General Permit, by the end of the year; and
3. Projects discharging to Tier 3 streams.

The Director of WVDEP reserves the right to require advertisement for any other application type.

Earth disturbing activities shall not be initiated until the WVDEP approves the permit modification, SWPPP, and GPP. The DOH will not be responsible for any delays in obtaining NPDES registration due to the contractor's failure to provide a complete application, SWPPP, GPP, or requested corrections in a timely manner. Also, any further modifications to the registration during the life of the project shall be submitted by the contractor directly to the WVDEP through the ESS website.

The contractor shall be responsible for paying the NPDES CSW permit modification fees and the annual renewal fees associated with NPDES registration.

The contractor shall be responsible for quarterly training of all on-site personnel on spill and leak response, internal reporting, good housekeeping, routine inspection, and maintenance.

An annual progress map for projects lasting more than 1 year is required to be submitted to WVDEP for the NPDES CSW registration. The contractor shall be responsible for submitting the annual progress map to the WVDEP through the ESS website showing all areas that have been disturbed, stabilized, and/or plan to be disturbed.

The first order of work for the contractor is to install sediment control structures including but not limited to sediment basins, sumps, silt fence, stabilized clean storm water diversions, etc. Erosion and sediment control will be established at the earliest possible date. Initial clearing and grubbing shall be limited to what is necessary in order to install erosion and sediment control structures.

In addition, projects discharging to any waters other than Tier 1 require the use of Enhanced BMPs, such as:

1. Inspection of all erosion and sediment control BMPs within disturbed areas at least once every four (4) calendar days and within 24 hours after any precipitation event greater than 0.25 inches per 24 hours period.
2. Repairs or maintenance to BMPs shall be performed within 24 hours, however, permittees must implement alternate BMPs prior to storm events while awaiting repair of the primary enhanced BMP.
3. Temporary seeding and mulching within four (4) calendar days when areas will not be re-disturbed for more than 14 calendar days.
4. Permanent seeding and mulching within four (4) calendar days of reaching final grade.

5. Final stabilization within four (4) calendar days after construction is complete.

Inspection report requirements are located in section III.B.2 of the NPDES General permit.

The WVDOH does not have any control of waste and borrow sites outside of WVDOH Right-of-Way; therefore, it is the contractor's responsibility to obtain all required rights and permits for waste and borrow sites.

Periodic inspections will be conducted by representatives of the WVDEP to ensure compliance with the conditions and requirements of the NPDES CSW permit. Representatives of other resource agencies may also conduct periodic inspections through the life of the contract.

107.4.9.3.1-Stormwater Management For Urbanized Areas The contractor is advised when a project is located within an urbanized area regulated by the NPDES Municipal Separate Storm Sewer System (MS4) permit. The MS4 permit requires onsite management of the first one (1) inch of rainfall from an average 24-hour storm preceded by 48 hours of no measurable precipitation or provide equal benefits for water quality. If any changes or substitutions to the project are made by the contractor, the contractor is advised that any proposed changes or substitutions may require additional storm water management mitigation and any costs associated with such mitigation shall be borne by the contractor at no additional cost to the Division. No changes or substitutions will be permitted without the approval of the engineer.

Additionally, the contractor shall allow the Division and the local MS4 agency seven (7) calendar days to review and make comments on the proposed changes.

107.4.9.3.2-Offsite Waste and Borrow Areas Offsite waste and borrow areas one (1) acre or greater must have a valid NPDES Permit registration before material may be removed from or accepted at the site. Offsite waste or borrow sites less than one acre in size that are not contiguous to the construction site must provide sediment and erosion controls and may be included with the application as "Information Only", however, there is no requirement to do so unless otherwise required by the Director of WVDEP.

If a waste/borrow area is unknown at the time of the initial application, the registration can still be issued. Once the location of a waste/borrow area is identified, it is the contractor's responsibility to ensure NPDES Permit registration of the contiguous area(s) or non-contiguous areas of one (1) acre or more. When the WVDOH does not have the "legal ability to control" waste or borrow site outside of WVDOH Right-of-Way of one acre or more, the contractor may contact the DEP to inquire if the non-contiguous site has been properly permitted and therefore, a site suitable for waste or borrow. The contractor may also make an inquiry of the party that has the "legal ability to control" the non-contiguous site to obtain rights for a waste/borrow area and ensure that it is properly permitted before accepting material from or sending material to the site.

The WVDOH will not be party to a NPDES CSW Permit Registration that includes a waste or borrow site outside of WVDOH Right-of-Way.

When contaminated soils are identified, a soil handling plan shall be provided. Contaminated soil is not suitable material for borrow or fill unless approved by the Director of WVDEP.

See Section 207.4.4 and 211.5.4 of this manual for additional information on off site waste and borrow requirements.

107.4.9.4-Section 404 U.S. Army Corps of Engineers (USACE) Permit The Section 404 Permit is required for any discharge of dredge or fill material into waters of the United States (WOTUS), including wetlands. During project plan development, the Technical Support Division will secure the Section 404 Permit on applicable projects from the USACE where a Section 404 Permit is required. Specific minor activities may be authorized under the USACE Nationwide Permit (NWP) program or a Regional General Permit (RGP), while other activities with greater than minor impacts, as defined in the NWP or RGP for the specific activity, require an Individual Permit (IP). An IP is project specific and requires an in-depth review of the project by the USACE. An IP requires public notice and any comments received from the public or other regulatory agencies must be considered.

If an IP is not required, the activities or conditions that affect WOTUS still fall under the jurisdiction of the USACE. In these cases, authorization for use of an NWP or NGP is required. A copy of the permit will be included in the Proposal, that will set forth conditions which must be met. A continued violation of any of these conditions will be cause for the USACE to stop work on the project; to suspend or revoke the 404 permit; or to take other action as appropriate.

The following definitions and other information will aid in administering the Special Provision and the 404 permit:

1. Waters of the United States (WOTUS). Each river, stream, creek, intermittent tributary, pond, impoundment, lake and wetlands are considered part of the WOTUS. More specifically, the WOTUS include:
   a. Rivers and streams that are navigable (i.e., either presently, historically or likely to be used for interstate transport);
   b. All interstate waters including interstate wetlands;
   c. All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, wet meadows, playa lakes, or natural ponds, the use, degradation or destruction of which could affect interstate or foreign commerce including any such waters:
      i. Which are or could be used by interstate or foreign travels for recreational or other purposes; or
      ii. From which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or
      iii. Which are used or could be used for industrial purposes by industries in interstate commerce;
   d. All impoundments of water otherwise defined as WOTUS under this definition;
   e. Tributaries of waters identified in (a) through (d) above; and
   f. Wetlands adjacent to waters (other than waters that are themselves wetlands) identified in (a) through (e).

g. Wastewater treatment systems, including treatment ponds or lagoons designed to meet the requirements of CWA (other than cooling ponds as defined in 40 CFR 123.11(m) which also meet the criteria of this definition) are not WOTUS.

2. Wetlands. Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas. Flood- plains, or areas where water stands on, at or near the groundline may be considered suspected wetlands. Guidelines in accordance with the 1987 Corps of Engineers Wetlands Delineation Manual and the Eastern Mountains and Piedmont Regional Supplement indicate that a wetland must have all of the following characteristics:
   a. A preponderance of water-tolerant plants;
   b. Hydric soils; and
   c. Water on, at or near the surface of the ground during a specified portion of the growing seasons.
3. Adjacent. Bordering, contiguous, or neighboring. Wetlands separated from other WOTUS by man-made dikes or barriers, natural river berms, beach dunes and the like are "adjacent wetlands."
4. Lake. A standing body of open water that occurs in a natural depression fed by one or more streams from which a stream may flow, that occurs due to the widening or natural blockage or cutoff of a river or stream, or that occurs in an isolated natural depression that is not a part of a surface river or stream. The term also includes a standing body of open water created by artificially blocking or restricting the flow of a river, stream, or tidal area. As used in this regulation, the term does not include artificial lakes or ponds created by excavating and/or diking dry land to collect and retain water for such purposes as stock watering, irrigation, settling basins, cooling, or rice growing.
5. Ordinary High Water Mark (OHWM). The line showing on the shore which is established by fluctuations of the water surface elevation and is indicated by physical characteristics such as clear, natural lines impressed on the waterway bank, shelving, changes in the character or the soil, destruction of terrestrial plants, the presence of litter or debris, or other appropriate means that consider the characteristics of the surrounding area. The USACE generally has jurisdiction only below this line. See USACE Regulatory Guidance Letter 05-05 for specific details.
6. Headwaters. Rivers, streams and their lakes and impoundments, including adjacent wetlands, which are part of a surface tributary system of a navigable WOTUS. The source, or headwaters, of a river or stream is the farthest place in that river or stream from its estuary or confluence with another river or stream, as measured along the course of the river or stream that has a bed, bank, and OHWM. The Corps District engineer may estimate this point from available data by using the mean annual area precipitation, area drainage basin maps, and the average runoff coefficient or by similar means.

7. Dredged Material. Material that is excavated or dredged from WOTUS.
8. Discharge of Dredged Material. Any addition of dredged material into the WOTUS. The term includes, without limitation, the addition of dredged material to a specified discharge site located in WOTUS and the runoff or overflow from a contained land or water disposal area. Discharges of pollutants into WOTUS resulting from the onshore subsequent processing of dredged material that is extracted for any commercial use (other than fill) are not included within this term and are subject to Section 402 of the Clean Water Act even though the extraction and deposit of such material may require a permit from the USACE. The term does not include plowing, cultivating, seeding and harvesting for the production of food, fiber, and forest products.
9. Fill Material. Any material used for the primary purpose of replacing an aquatic area with dry land or of changing the bottom elevation of a waterbody. The term does not include any pollutant discharged into the WOTUS primarily to dispose of waste; that activity is regulated under Section 402 of the Clean Water Act.
10. Discharge of Fill Material. The addition of fill material into WOTUS. The term generally includes, without limitation, the following activities:
    a. Placement of fill that is necessary to the construction of any structure in a WOTUS;
    b. The building of any structure or impoundment requiring rock, sand, dirt, or other material for its construction;
    c. Site-development fills for recreational, industrial, commercial, residential, and other uses;
    d. Causeways or road fills;
    e. Dams and dikes;
    f. Artificial islands;
    g. Property protection and/or reclamation devices such as riprap, groins, seawalls, breakwaters, revetments;
    h. Beach nourishment;
    i. Levees;
    j. Fill for structures such as sewage treatment facilities, intake and outfall pipes associated with power plans and subaqueous utility lines; and
    k. Artificial reefs.

The term does not include plowing, cultivating, seeding and harvesting for the production of food, fiber, and forest products.

When the Proposal or plans make no reference to USACE permits and the Contractor indicates an intent to perform dredging or filling below the OHWM, advise the Contractor not to proceed without the appropriate USACE permit and to contact the District Construction Engineer.

107.4.9.5-Section 9 Navigable Waters Permit The Section 9 Permit is intended to ensure that there will be no interference to navigation on the navigable WOTUS. It is required for the construction, modification, replacement or removal of any bridge or causeway over a navigable waterway. During project plan development, Technical Support Division will secure the Section 9 Permit, where applicable, from the U.S. Coast Guard and the accompanying 404 Permit from the USACE.

107.4.9.6-FAA Navigable Airspace Permit The FAA Permit is intended to promote safety in air commerce and to preserve the navigable airspace at public-use airports. It is required for any permanent installation (e.g., a high-mast lighting tower) or construction equipment (e.g., cranes, derricks) that is adjacent to a public airport when the installation or equipment is within specific height and distance parameters from the airport. During project plan development, Technical Support Division will secure the FAA Permit on applicable projects from the Federal Aviation Administration.

SECTION 108
PROSECUTION AND PROGRESS

Section 108 of the Specifications establishes the Contractor's responsibility to furnish adequate labor and equipment forces for meeting specified project schedule requirements. The following Section presents specific DOH procedures and additional clarifying information.

108.1-SUBCONTRACTING REQUESTS

108.1.1-Allowable Subcontracting Arrangements A subcontracting arrangement is generally considered to exist when a person or firm assumes an obligation to perform a part of the Contract work and the following conditions exist:

1. Compensation is based on the amount of work accomplished rather than an hourly basis;
2. Choice of work methods, except as restricted by contract specifications, and furnishing and controlling of labor and equipment are exercised by the subcontractor with only general supervision being exercised by the contractor; and
3. Personnel involved in the operation are under the direct supervision of the subcontractor and are included on the subcontractor's payroll.

All of the above conditions must be met for the arrangement to be considered subcontracting. If the arrangement is difficult to define or there are questions, contact the District Construction Engineer.

108.1.2-Subcontracting Request (Form DC403)

108.1.2.1-Submittal The Contractor must submit to the District Office an executed Subcontracting Request (Form DC403) for each proposed Subcontractor, including lower-tier Subcontractors. The Request may be submitted by the Contractor at the Preconstruction Conference or thereafter during prosecution of the work. The Sub- contractor will not be permitted to perform any Contract work prior to the written approval of the District Construction Engineer. This approval will be based on satisfactory evidence that each Subcontract is in writing and contains all applicable Contract and Labor Provisions.

108.1.2.2-Documentation Requirements Contract and Labor Provisions to be contained in the Subcontract will differ depending on the type of funding authorized for the Contract. The Project Engineer/Supervisor must have a working knowledge of the required documentation to assist in evaluating compliance by the Contractor and all Subcontractors. Consider the following guidelines:

1. All Contracts. On all Contracts, the following documents must be included in the Subcontract File maintained by the Contractor:

a. Fully executed Subcontract agreement;
b. West Virginia Division of Labor Wage Rates;
c. Special Provision for Disadvantaged Business Enterprise (DBE) Utilization; and
d. Special Provision for Notice of Requirements for Affirmative Action to Ensure Equal Employment Opportunity (Executive Order 11246).
e. Special Provision for West Virginia Jobs Act, if applicable.
f. Affidavits due to the contract.

2. Federal-Aid Contracts. In addition to the documents in Item 1, the following must be included on Federal-aid contracts:
   a. FHWA Form 1273 with Attachment A, if applicable, with Special Provision;
   b. US Department of Labor Wage Decisions;
   c. Special Provision for Standard Federal Equal Employment Opportunity Construction Contract Specifications (Executive Order 11246);
   d. Additional Contract Provisions for Equal Employment Opportunity; and
   e. Special Provision for Application of the Standard of Comparison "Projects of a Similar Character" under the Davis- Bacon and related acts.
   f. Special Provision for On-Job-Training, if applicable.
3. Documentation Exception. In lieu of submitting a copy of the above documents with each Form 403, the Contractor may certify that the Subcontract is in the form of a written agreement containing all applicable Contract and Labor Provisions pertaining to the Prime Contract. However, all DBE Subcontractor approval requests must be submitted with the proposed subcontract agreement.

Items 1.b through 1.d and Items 2.a through 2.e can also be found in the Contract Proposal.

108.1.2.3-Review and Approval Prior to the approval of the District Construction Engineer, each submitted Subcontracting Request (Form 403) must be verified for completeness and accuracy by the District Construction Engineer. Use the following guidelines when verifying and processing Subcontracting Requests:

1. Contract and Contractor Data. Compare and verify all data provided on the Subcontracting Request with that documented on the Contract Award Authorization. The Contract ID on Form 403 must match that of the executed Contract.
2. Subcontractor Data. Verify the following Subcontractor data:
   a. Request Number. Verify that the Request Number is next in sequence to that indicated on the previously approved request.
   b. Name, Address, and Phone. Verify the accuracy of the Subcontractor's name and address by using a Vendor Customer Number inquiry provided by AASHTOWare Project Preconstruction system. Although a Subcontractor may have more than one branch office and consequently more than one address, each branch office will have a unique FEIN in the AASHTOWare Project Preconstruction system. The name, address and FEIN combination must be accurate to facilitate data entry in AASHTOWare Project at the Division level

(see Section 105.6.2).

c. FEI Number. Verify that the Sub- contractor is registered with the Division of Administration, Purchasing Section to do business with the State of West Virginia by using the FEIN inquiry provided by the WVFIMS system. Contact Department of Administration, Purchasing Section if difficulties are encountered in verifying a Subcontractor's FEI Number prior to any further processing of Form 403.

d. West Virginia Contractor's License Number. Verify that the Subcontracting Request (Form 403) contains a valid license number for the Subcontractor. Senate Bill 409 requires all Contractors to obtain a license from the West Virginia Division of Labor before they are allowed to perform work as a Contractor in West Virginia. Sub- contractors must furnish a Contractor's license number to the Prime Contractor prior to execution of any binding Subcontract. Failure of the Subcontractor to have a valid license number will result in the Subcontracting request being returned unapproved. Any difficulties encountered by the District in obtaining or verifying a Sub- contractor's license number should be discussed with the Division of Labor prior to any further processing of Form 403.

e. Subcontractor Type. Although the Con- tractor is required to request approval for all Subcontractors, only the amount of work performed by First Tier Subcontractors is used to compute compliance with the 30% limitation noted in Item 4. Requests for the approval of DBE Subcontractors must be accompanied by a copy of the signed Subcontract agreements and must be approved by the DBE Section, Civil Rights Compliance Division.

3. Subcontractor Work. Items of work to be performed by the Subcontractor:

   a. Full Subletting. When an entire Contract item is to be sublet, the Contract quantity, Contract unit price and amount are to be indicated in the tabulation on Form 403. The accuracy of the data must be verified at the District level by comparison with the Schedule of Prices attached to the Contract Award Authorization.

   b. Partial Subletting. When only a portion of a Contract item is to be sublet, the item number followed by the term "PARTIAL" and the estimated or agreed unit price and/or amount are to be indicated in the tabulation on Form 403. The District must verify that the estimated or agreed unit price and/or amount does not exceed that for the item in the Schedule of Prices attached to the Contract Award Authorization.

   c. Specialty Items. When an "Identified Specialty Item" is to be sublet, the item number followed by the term "SPECIALTY," the Contract quantity, unit price, and amount are to be indicated in the tabulation on Form 403. The accuracy of the data must be verified at the District level by comparison with the Schedule of Prices attached to the Contract Award Authorization.

   d. Subcontractor Replacements. In the event a previously approved Sub- contractor fails to perform any of the items indicated on the approved request and the Contractor requests approval of a different Subcontractor to perform the same items of work, a separate request must first be submitted with the same request number stating "revised" by the Contractor to subtract the non-performed quantities and amounts from the previously approved Subcontractor. This is necessary to facilitate an accurate accounting relative to the 30% limitation noted in Item 4.

4. Derivation of Total Percent Subcontracted. The contract specifications stipulate that the Contractor must perform with his own organization at least 30% of the total contract cost modified by excluding any Identified Specialty Items. The phrase "his own organization" will include only workers employed and paid directly by the Contractor and equipment owned or rented by the Contractor, with or without operators. The phrase "Identified Specialty Items" will be limited to work that requires highly specialized knowledge, abilities, or equipment not ordinarily available in the type of contracting organizations qualified and expected to bid on the Contract as a whole. Use the following guidelines to verify the total percent subcontracted:
   a. Computations. The accuracy of all mathematical computations contained on Form 403 must be verified at the District level.
   b. Exclusions. The totals indicated should not include amounts for those items of work to be performed by Tier Subcontractors and should not include amounts for Identified Specialty Items regardless of the type of Subcontract.
   c. Amount Previously Subcontracted. Verify that the "Amount Previously Subcontracted" on the current request is equal to the "Total Subcontracted to Date" amount on the previously approved request.
   d. Original Contract Amount. Verify that the "Original Contract Amount" is equal to the "Bid Amount Per Attached Schedule of Prices" on the Contract Award Authorization less any Identified Specialty Items.
   e. Total Percent Subcontracted. The "Total Percent Subcontracted" is determined by dividing the "Total Subcontracted To Date" amount by the "Original Contract Amount" and multiplying the result by 100. If the "Total Percent Subcontracted" is equal to or greater than 50%, the request must be returned to the Con- tractor unapproved.
5. Signature. Form 403 must bear the signature and title of a duly authorized representative of the Contractor.
6. Distribution of Copies. Following written approval of Form 403, the District Construction Engineer, a copy of the Report will be placed in Project Wise. A link to Project Wise will be sent to Contract Administration and Civil Rights Compliance. A copy of the approved Form 403 will also be sent to the Contractor.

108.2-PROJECT SCHEDULES AND CONTRACT TIME

108.2.1-General The Contractor will submit project schedules and progress reports as required by the contract specifications (see Section 108 of the Specifications). DOH project personnel must monitor the progress of work to ensure that the Contractor is meeting the requirements of the Contract and for taking immediate corrective action, as needed, in accordance with DOH procedures. Section 105.3 of the Construction Manual discusses DOH policies and procedures for monitoring the progress of work including project schedule requirements and contract time extensions relative to the type of Contract. It is important to adhere to these policies and procedures and to maintain adequate documentation because the Division may assess liquidated damages against the Contractor for each calendar day work remains uncompleted after the established Contract completion time is exhausted. Section 108 of the Specifications also specifies the provisions for default and termination of the Contract.

108.2.2-Contract Time Contract time is the time provided to the Contractor for completing the project, which is established based on the type of Contract. The Contract will state the amount and method of calculating Contract time. The Notice to Proceed with the work is usually given to the Contractor at the Preconstruction Conference. Charging of Contract time begins 10 days after the Notice to Proceed. In general, calendar completion dates, working days, or some combination of the two are used to govern construction schedules for progress and completion. Most projects are governed by calendar completion dates. The Project Engineer/Supervisor must maintain complete and accurate records of the current controlling operation and working days because consideration of contract time extensions and calculations of liquidated damages are based on these factors. See Section 105.3 for additional information.

108.2.3-Current Controlling Operations The current controlling operation is defined as that item or key feature of work that must proceed to prevent delaying the completion of the project. The determination of the current controlling operation must be based on the job conditions and on answers to the following questions:

1. What one item or combination of items is making the job move forward to completion? and
2. To what item or group of items are other items incidental at the time, insofar as overall project progress is concerned?

Controlling operations are determined by the Contractor's method of procedure. Each Contractor is responsible for sequencing and scheduling operations to meet the requirements of the Contract. The determination of a particular controlling operation at a specific time can usually be made by comparing actual progress with proposed or scheduled progress for the period in accordance with the following general principles:

1. One of the key features of the work proposed, scheduled, or in progress will be the controlling operation.
2. It is assumed that the Contractor must maintain the progress of all key operations to meet the time requirements of the Contract. Hence, if one operation is greatly behind at a particular time, the operation is likely to be controlling.
3. If two operations are behind and one is significantly more than the other, the operation that is farther behind will probably be controlling.
4. If two operations are behind and substantially equal in percentage of completion, both may be considered together as controlling.
5. If one operation is behind but has no effect on the completion of the project, the operation should not be considered controlling. For example, if clearing and grubbing

is 80% complete, instead of 100%, and disposal of debris is all that remains, the clearing and grubbing operation is probably not controlling.

6. If one operation is ahead and another is meeting progress requirements, the operation that is meeting the Contract's progress requirements is controlling.
7. A controlling operation could be a minor item of work.

The Project Engineer/Supervisor and the Project Inspectors should monitor and record the current controlling operation on the Daily Work Reports and Diary.

108.2.4-Determination of Working Days A working day will be considered as every day shown on the calendar, exclusive of Saturdays, Sundays, and Holidays, as set forth in the Contract, on which weather and other conditions
not under the control of the Contractor will permit construction operations to proceed for a minimum of 60% of the scheduled work hours of the controlling item or items of work. It is mandatory that the Project Engineer/Supervisor determines the chargeability of each day and record working day status in the Diary. The current controlling operation will be determined based on conditions that exist on the day under consideration (see Section 108.2.3). The determination of a working day will be based on the following:

1. Current controlling operation;
2. Weather conditions;
3. Daily work report;
4. Progress in relation to actual operations;
5. Utilization of normal complement of labor and equipment in the controlling operation; and
6. Any delays occurring and the cause, for example:
   a. Weather. Consideration must be given to the prevailing weather on the day in question, particularly as to how it affects the controlling operation. For instance, if the weather is below freezing and the controlling operation is unclassified excavation, which at the time is entirely rock work, then a working day should be charged.
   b. Site Conditions. To consider a day as a working day, there must be substantial progress toward completion of the project. Although weather on a particular day may have been suitable for work and the Contractor's full crew performed work the entire day, progress may not have been made toward completion of the project. For example, if the controlling operation is placing subbase and the grade is too wet from heavy rain on the preceding day, the Contractor's men may spend most of the day rebuilding haul roads and removing saturated material from the top of fills. In this example, the day should be classified as a non-working day. On the other hand, it may be necessary to charge a working day even though weather conditions may be unsuitable for some work items. If, for example, the grade is too wet to use earth moving equipment and the current controlling operation is bridge construction, the Contract can proceed with the controlling item of work. In this example, a working day should be charged.
   c. Progress. Consider progress when determining a working day. For example,

assuming that structures are approximately 15% behind (i.e., controlling) and other project operations are meeting progress requirements, the following deductions can be considered:

Case 1: Some conditions, such as high water, will prevent the Contractor from working on the structure. In this example, a non-working day should be charged.

Case 2: If light rain halts roadway excavation due to slippery haul road conditions but the Contractor is able to proceed with the work on the structure, a working day should be charged.

In these examples, the determination of a working day is because the structure work is seriously behind and, therefore, the controlling operation.

d. Normal Labor and Equipment. The site conditions and weather must be suitable to reasonably allow the Contractor to utilize his normal complement of labor and equipment. For example, if grading, drainage, and structure items are well balanced in terms of progress with no discernable controlling item, the determination between working and non-working days should be made because of the total normal labor and equipment force for the combined structure and roadway excavation items.

e. Delays. A non-working day may be charged for some types of delays (e.g., strikes, failure of utility company to complete work on time, right-of-way not available, DOH delays approving a Change Order). Such decisions are only justified, as specified in the Contract, if the delay prevents the Contractor from proceeding with the current controlling operation, and the Contractor has used every reasonable means to remove the cause of the delay.

108.2.5-Suspension of Work Although not desirable, it may be necessary to suspend construction operations due to factors beyond the control of the Contractor. In such cases, the Project Engineer/Supervisor is responsible for documenting suspension and resumption dates in the Diary. The Contract Administration Division should be promptly notified of the suspension date, including the probable duration of inactivity for major or high- profile projects.

108.2.6-Unsatisfactory Progress If unsatisfactory progress is evident or anticipated, the Project Engineer/Supervisor will notify the Contractor in writing as discussed in Section 105.3 of the Construction Manual. If the Contractor fails to take corrective action, immediately inform the District Construction Engineer of the situation.

SECTION 109
MEASUREMENT AND PAYMENT

Section 109 of the Specifications establishes the responsibilities for measurement and payment. The following Section presents specific DOH procedures and additional clarifying information.

109.1-MEASUREMENT OF QUANTITIES

For each item of work, the Specifications include a section on method of measurement that specifies how the item will be measured for payment. It is important to meet these requirements for measurement of quantities as specified.

109.1.1-Measurement by Volume In the event that the plan cross sections are not available, the Project Engineer/Supervisor should obtain cross sections of the original ground, both in cut and fill areas and in borrow locations, before any earthmoving is begun by the Contractor. These cross sections will be used for measurement of quantities.

Any change from Specifications in method of measurement must be covered by a change order, and any conversion factor or rebates must be included in the change order.

109.1.2-Measurement by Weight For uniformity, the following instructions must be observed when materials are paid for by scale weights:

1. The Contractor shall have the scales inspected and sealed by the State Bureau of Weights and Measures.
2. Scale platforms and working parts shall be clean at all times.
3. Weighers shall make continuing examinations of the scale platform to be certain there is clearance between the scale platform and foundation.
4. The zero balance shall be tested, and adjusted if necessary, at least once each hour when trucks are being weighed.
5. The operator’s weight should be included in or excluded from each weight taken, and the practice should be uniform throughout the project for all operators.
6. Weighers shall be sure that the entire vehicle being weighed is on the scale platform.
7. If a scale appears to be functioning improperly, the Project Engineer/Supervisor should request a recheck of the scale. Reinspection and recertification may become necessary should discrepancies arise.
8. If the load in a vehicle must be trimmed to prevent spillage on streets or highways, the trimming must be done before the load is weighed.
9. The capacity of the scale should not be exceeded. If there is any doubt, the Bureau of Weights and Measures should be consulted to determine the limitations.

109.2-PAYMENT

For each item of work, payment will be made as prescribed under “Basis of Payment” and “Pay Items” of the governing contract specifications. Periodic payments will be made in accordance with procedures described in Section 112.

109.2.1-Stockpiled Material

109.2.1.1-Documentation Requirements Partial payment for material on hand may be made to the extent of the delivered costs of material to be incorporated into the work, provided that the material meets the requirements of the Contract Plans and Specifications when delivered in the vicinity of the project site or stored at approved off-site locations. Prior to payment for stockpiled material, the Contractor must make a written request to the Division specifying the material for which payment is requested. The request, dependent upon the delivery and/or storage location of the material, must include the following information:

1. Project Site Storage. The following must accompany the request for materials delivered and/or stored in the vicinity of the project site:
    a. Supplier Invoice. A copy of an invoice from the supplier showing actual delivered cost of the stockpiled material. Approved stockpiled material payments will not exceed the bid price of the Contract item into which the material will be incorporated OR the actual cost to the Contractor.
    b. Proof of Compliance. Proof of compliance with the contract specifications applicable to the stockpiled material must be provided. Approval for payment of stockpiled material will only be given with the understanding that DOH reserves the right to reject and require placement of any such material which is found to be damaged, defective, or not in conformance with the contract specifications. See Section 106.1 for additional information.
2. Off-Site Storage. The following must accompany the request for materials delivered and/or stored at approved off-site locations:
    a. Supplier Invoice. A copy of an invoice from the supplier showing actual delivered cost of the MDNIP. Approved MDNIP payments will exceed neither the bid price of the Contract item into which the material is to be incorporated nor the actual cost to the Contractor.
    b. Proof of Compliance. Proof of compliance with the contract specifications applicable to the stockpiled material must be provided. Normally proof of compliance is a Laboratory Number. Approval for payment of stockpiled material will only be given with the understanding that DOH reserves the right to reject and require placement of any such material which is found to be damaged, defective, or not in conformance with the contract specifications. See Section 106.1 for additional information.
    c. Statement of Rationale. A statement indicating why the material cannot be stockpiled near the project site must be included. If it is determined that, because of required fabrication at on off-site location, the materials cannot be stockpiled in the vicinity of the job site, the Division may, at its discretion, allow partial payment. Materials that will be considered for payment at off-site

locations will generally include, but not be limited to, structural steel, reinforcing steel, fabricated signs, pumping equipment, specialty items for waterline or tunnels, etc.

d. Statement of Condition/Location. A statement of the condition and place of storage of the stockpiled material must be included.

   If the material is stored on property owned by the supplier, the supplier should submit a notarized affidavit attesting to ownership of the property. If the material is stored on property not owned by the supplier, a copy of the agreement between the owner of the area and the supplier should be furnished. If the agreement is specifically for storing material, the lease should state this and a brief legal description of the property should be included. The lease should cover the period required for the storage or until completion of the project.

e. Right-of-Way Entry. A right-of-way entry, for a DOH employee or agent, to the storage areas must be provided for the purpose of inspecting, sampling, testing, and/or the removal of any or all of the stockpiled material.
f. Bonding Letter. A letter from the bonding company must be provided agreeing to the advance payment for the stockpiled material at the designated location.
g. Certification of Ownership. A certification must be provided indicating that the stockpiled material being stored bears identification as property of the WVDOT, Division of Highways, and that the material will not be sold or used on a project for which it is not designated.
h. Estimate of Transport. An estimate of the cost of transporting the stockpiled material from the off-site location to the project site must be provided if the invoice submitted in Item a. includes transportation costs. Approved stockpiled material payments must exclude the cost of transporting the material from the off-site storage location to the project site.

109.2.1.2-Review and Approval All requests by the Contractor for payment of stockpiled material must be submitted to the District Construction Engineer for review and approval. Once approved by the Construction Engineer, the material can be entered in AWP, under the Stockpiled Materials section, for payment. All documents will be entered under Bid Items folder in ProjectWise. To obtain the storage or release laboratory number for Bridge Structural Items (Steel or Concrete) the following must occur.

1. The fabricator must provide to the Division's inspection representative a copy of all information, required in Section 109.2.1 and Section 109 of the Standard Specifications. If the information is found to be correct, each invoice and attachment, excluding mill test reports and other documentation used for inspection purposes, will be signed by the Division's representative. In addition the final summary letter from the fabricator to the Contractor will also be signed by the Division's representative.

2. That package will be forwarded by the Division's representative to Materials Control, Soil and Testing Division for their review. If the product is in compliance a storage laboratory number will be assigned to the material and referenced on the fabricator's request for payment which will signify the product has been fabricated, inspected, and found to comply with specification but the laboratory number will not indicate pass or fail since the material is not being shipped. If MCS&T Division finds any problem(s) they will notify the fabricator, District, and Contract Administration Division.
3. The fabricator will forward a copy of all information to the contractor who will obtain the other information required in Section 109.2 of this manual and Section 109.2 of the Standard Specifications and request the District process payment for the material in accordance with these same procedures.
4. The District through their Materials Section will forward a copy of the Contractor's submission to MCS&T Division for comparison to that submitted by the fabricator through our plant inspector. If initial review indicates compliance with specifications and the District's submissions agree in content with that from the fabricator, MCS&T Division will sign the Contractor's cover letter indicating agreement and promptly return it to the District for processing.
5. Upon MCS&T Division finding the material acceptable for payment all supporting data will be entered in AWP, under the Stockpiled Materials section, for payment. All documents will be entered under Bid Items folder in Project Wise.

109.2.1.3-Payment Processing Approved requests will be included for payment by invoice number on current estimates.

If any portion of the material that has previously been paid as stockpiled material on an estimate is incorporated into a Contract item, that portion of the material must be deducted from the stockpiled material quantity prior to payment of the related Contract work at the Contract unit price.

The Contractor must furnish a certified paid invoice from the supplier within ninety (90) calendar days of the ending date for the period of the initial estimate on which the delivered materials was paid. A certified paid invoice from the supplier refers to an invoice bearing an explicit certification statement signed by a representative of the vendor originating the invoice for delivered material. All certified paid invoices will be marked paid as required and submitted to the District Construction Engineer.

If a certified paid invoice from the supplier is not received within ninety (90) calendar days of the ending date of the period for the initial estimate on which the delivered material was paid, payment for all remaining stockpiled material on the estimate by that supplier's invoice will be deleted on the next eligible estimate.

When the material is ready for actual shipment to the project it will be re-inspected and if still found satisfactory, the Division's inspectors will assign a release laboratory number which shall be referenced on the shipping documents that accompany the structure to the project. If they find the material has been damaged or changed they will notify the District and this Division.

<u>109.2.2-Specialized and Technical Equipment</u> Some Contracts require the Contractor to furnish expensive office or field equipment for use by DOH personnel. Specialized equipment is paid as part of the lump sum bid price for pay items such as building equipment and construction layout stakes. Consider the following guidelines when processing payment for specialized equipment specified in the contract and not provided for under Section 640 of the Specifications:

1. <u>Estimates/Payment</u>. After the equipment is delivered, installed, and made available for DOH use, the purchase price of the equipment will be added to the next estimate. Check to ensure that sufficient funds remain in the appropriate bid item to cover maintenance obligations (see Item 3). Payment will be made by entering a percentage of the lump sum bid amount equivalent to the purchase price of the equipment in the current column of the estimate. The remaining balance of the lump sum bid amount must be pro-rated over the life of the Contract.
2. <u>Ownership</u>. If the Contract states that the equipment will become the property of the DOH after project completion, the appropriate inventory documents must be processed to move the equipment into the District inventory.
3. <u>Maintenance</u>. Maintenance will be as defined in the Contract.

<u>109.2.3-Load Limit Violations and Weight Tickets</u>

<u>109.2.3.1-Purpose</u> This section clarifies the intent of Section 109.20 of the Specifications and establishes a uniform inspection procedure for the operation of overweight vehicles on public highways in connection with DOH Contracts.

<u>109.2.3.2-Application of Specification</u> Consider the following when administering Section 109.20 of the Specifications:

1. <u>Commercial Sources/Batch Plants</u>. The Specification applies to any vehicle or combination of vehicles operated on publicly maintained highways that haul materials from a commercial source or batch plant under the terms of the Contract. A commercial source is any location from which materials are shipped to other customers, either public or private. Except for aggregates that are stockpiled for use on DOH projects, the Specification does not apply to materials being hauled into a batch plant for production of PCC, asphalt concrete, or free-draining bases.
2. <u>Continuous Mix Concrete Units</u>. The Specification does not apply to continuous mix concrete units where trucks are charged at or near the project site from non-commercial stockpiles established for DOH continuous mix projects. The term “near,” in this context, means within 10 mi on public highways from the project site.
3. <u>Aggregates</u>. The Specification applies to the hauling of aggregate from a commercial source to Contractor stockpiles or if the stockpiles are located at batch plants. The Specification states that weigh tickets are required for all aggregates regardless of the contract pay item. In this situation, assuming the basis of payment is not by weight, no weigh ticket will be required when the material is moved from the stockpile to the project. If the aggregate material is stockpiled outside the project and sold to other customers, the stockpile could become a commercial source. In this case, the Specification would not apply. However, if the stockpile is considered

a commercial source, the supplier will be required to have scales, and weigh tickets will be required when the aggregate is moved from the stockpile to the project site. If the material is hauled from a commercial source to a stockpile within the project limits, the Specification will apply. In this situation, assuming the basis of payment is not by weight, no weigh ticket will be required when the material is moved from the stockpile to the point of use within the project.

4. Documentation. Any material delivered from a commercial source or batch plant without the documentation necessary to determine the gross weight of the haul vehicle or combination of vehicles as discussed in Section 109.2.3.5 will not be accepted by DOH.
5. Common Carriers. If material is delivered by common carrier where only a portion of the load is unloaded at the project and the remainder is destined for other customers, the Specification does not apply. The rationale behind this determination is that DOH would not know which customer(s) would be responsible for any load limit violation. The common carrier waiver does not apply when the load is split among two or more DOH Contracts or when the entire load is being delivered to the project.
6. Off-Site Stockpile. If material is hauled from a commercial source to a stockpile outside the project limits that is exclusively for use on DOH project(s), the Specification applies and weigh tickets are required. However, tickets are not required for delivery from the stockpile to the project.

109.2.3.3-Load Limit and Motor Vehicle Laws Federal Regulations establish the maximum allowable gross weight on the Interstate System and the Official Code of WV establish the maximum on the WV and US Routes. The Public Service Commission is responsible for the enforcement of these provisions.

However, this does not relieve any party from conforming to all provisions of the West Virginia Motor Vehicle Laws pertaining to vehicle weight including, but not limited to, load restrictions posted for specific bridges and sections of highway and axle loads. When the Project Inspector has reason to believe that load limit violations are occurring, the following procedure will be utilized:

1. Warn the Contractor that the contract specifications require compliance with all legal load restrictions in the hauling of material on public roads and document this notification in the DWR.
2. If apparent load limit violations continue, advise the District Construction Engineer. Give specific data such as route number, location, nearest community or landmark, bridge name or number (if applicable), type of material, date of occurrence, and date notification was given to Contractor.

109.2.3.4-Use of Adjustable Wheels If a truck has a set of adjustable wheels that can be lowered to help distribute the load, the truck will be considered as having an additional axle. If the hauler takes advantage of the adjustable wheels in determining the maximum gross vehicle weight allowed, the hauler is expected to use these wheels while transporting materials to the project. However, due to turning restrictions and other considerations, it is permissible to raise the adjustable wheels once the truck reaches the project site.

109.2.3.5-Weigh Tickets Documentation of the gross weight of the haul vehicle or combination of vehicles will be provided by the Contractor, shipper, or hauler for each load of material delivered from a commercial source or batch plant. The documentation will be provided to the Project Inspector at the project site or DOH facility in one of the following forms:

1. Sources with truck scales. A weigh ticket documenting the gross, tare, and net weights, Contract Number or Project Number, number of axles, and license number(s) of the vehicle or combination of vehicles, time and date of weighing, item number or description of materials, and signature of the weigher certifying the ticket is correct. If the weigher's name is printed by the computer on the ticket, then it only needs to be initialed by the weigher.
2. Sources without truck scales. For material from commercial sources or batch plant, which do not normally have truck scales a weigh ticket documenting the tare weight, number of axles, and license number(s) of the vehicle or combination of vehicles, date of weighing, location of scales, and signature of the weigher certifying the ticket is correct (or initialed if ticket has name printed on it), plus calculations furnished by the supplier to substantiate the weight of the material.

An electronic ticket deliver (e-ticket) is acceptable as documentation, provided it standard information currently on paper ticket is included. The project inspector should have access to the e-ticketing system and to make notes associated with each ticket, if needed. A digital signature of the weigh person on e-ticket or daily summary report will be considered equivalent as hand-signed/initialed printed tickets.

109.2.4-Purchase of Unused Material

109.2.4.1-Application of Specifications The purchase of unused materials may be either due to DOH eliminating items in the Contract or a reduction of work quantities. The following Specifications apply to the purchase of unused materials:

1. Eliminated Items. In accordance with Subsection 109.5 of the Specifications, the Division agrees to compensate the Contractor for the reasonable expense incurred prior to the written notification of eliminated items. from DOH and to assume at actual cost any unused material purchased in good faith for use for the eliminated item(s). The Specification only addresses unused material derived from eliminated items of work. The remaining parts of Section 109.2.4 provide additional guidance.
2. Decreased Work Quantities. The Specification will not be applied to unused material derived from decreased quantities of work. Section 109.3 of the Specifications applies if the decrease in quantity meets the criteria for a "significant change." Under this situation, payment for any resultant unused material will be evaluated in accordance with Subsection 104.11 of the Specifications.

109.2.4.2-Preferred Disposition The following alternatives (listed in order of preference) should be pursued in the disposition of unused material derived from eliminated items:

1. Contractor retains ownership of the material for use on other work without additional compensation from DOH.
2. Contractor returns the material to the supplier for restocking with additional compensation by DOH for any restocking charge.
3. DOH purchases the material and incorporates it into inventory. A Change Order with Form DOT-5 would be required.

109.2.4.3-Disposition of Inventory Purchased by the Division If the unused material is incorporated into Division inventory, one of the following alternatives should be specified (with the Change Order document) to define the intended use of the unused material (for accounting purposes):

1. Federal-Aid Projects. The unused material is mandated for use on a subsequent Federal- Aid project(s) through Contract Provisions added to the subsequent project(s) by the Engineering Division. This alternative requires a coordinated effort between the District Construction Engineer, the Contract Administration Division, the Engineering Division and FHWA.
2. DOH Maintenance. The unused material is placed into inventory for use by the maintenance forces.

109.2.4.4-Restocking Considerations When disposition of unused material is required, consideration will be given to ensure that the cost of the operation (i.e., restocking or placement in Division inventory) does not exceed the value of the material.

109.2.4.5-Change Orders Any payment to the Contractor for unused material must be made through a Change Order which, when fully executed, is included on an Estimate. The Change Order must be prepared in accordance with Section 110 and must reflect the Contract reduction associated with the eliminated item(s).

109.2.4.6-FHWA Participation On all Federal-Aid projects, the status of Federal-Aid participation must be indicated for each Contract modification included on the Change Order. FHWA may participate in the purchase of unused material under the following circumstances:

1. The salvaged item has a value less than $5,000;
2. The salvaged item becomes the contractor’s property through the contract provision; or
3. The salvaged item will be reused in future projects eligible under title 23 USC until its useful life is expended.

109.2.4.7-Receipt of Materials/Services Record (Form DOT-5) The status of Federal-Aid participation also determines the unit cost entered on the DOT-5 which must be an attachment to the Change Order. FHWA participation (under any one of the above circumstances) means that the cost of the unused material reflected on the DOT-5 should be only the DOH share of the total amount paid to the Contractor on the Estimate. Otherwise, if the purchase of unused material is considered ineligible for Federal-Aid participation (does not meet any one of the above circumstances), the cost of the material reflected on the DOT-5 should be the total amount paid to the Contractor on the Estimate.

109.2.5-Railroads and Utilities The railroad or utility company may submit partial invoices for actual costs incurred up to, but not exceeding, the amount of the approved agreement(s) less any credits due DOH.

Final invoices are required within six (6) months after all chargeable work covered by the approved agreement(s) has been completed. Final invoices will be paid upon receipt of a final Audit Certification when the total costs do not exceed 110% of the amount of the approved agreement(s). In addition to a final Audit Certification, a Supplemental Agreement or Revised Agreement will also be required when total costs exceed 110% of the amount of the approved agreement(s). For further details, refer to Section 107.8 Railway-Highway Provisions of the Specifications.

109.2.6-Method of Payment for Items Paid as Each When multiple units in one item are to be paid as each and the contractor has several units substantially completed but none totally finished the Project Engineer/Supervisor may determine the approximate percentage completed and pay for an equivalent number of units (Each) on the next current estimate.

SECTION 110
CHANGE ORDERS

Section 110 presents DOH policies and procedures on documenting, preparing, and processing Change Orders. Adherence to these procedures will ensure that agreements on the scope, necessity, and basis of payment for all modifications and extra work are properly documented. See Section 105.6 for information on how AASHTOWare Project and SiteManager is used to prepare and process Change Orders.

110.1-GENERAL

110.1.1-Legal Basis The Division reserves the right to make any necessary alterations to the Contract Plans and Specifications or to the quantities of work provided they are within the scope of the original Contract. Although the Specifications provide for changes in quantities and performance of unforeseen work for which there is no price included in the Contract, Federal and State laws specifically require that no work be performed unless funds have been properly authorized for payment. The District will not pay the Contractor for extra work until the District receives a Supplemental Authorization.

110.1.2-Overview of Purpose It is impractical to specify in Contract documents exact quantities of labor, materials, and equipment. Therefore, procedures have been established for necessary changes for modifications and extra work through Change Orders. Consider the following:

1. Change Order. A Change Order authorizes an increase, decrease, addition, or deletion of an item(s) or adds prices not included in the original Proposal. These documents are normally developed in cooperation with the Contractor, the Division, and FHWA, as applicable, and reflect all changed items that would affect Contract costs and the completion date. See Section 110.3 for information on Change Orders.
2. Contract Time. Any additional time required due to a Change Order will be documented on a separate Change Order and will be considered for a Contract Time Extension (see Section 105.3).

110.1.3-Types of Change Orders A Change Order is a general term referring to either a Supplemental Agreement or a Force Account Work Order. These terms are defined in Section 101 of the Specifications. Each type is used for a different purpose and is based primarily on the extent and nature of the changed condition as follows:

1. Supplemental Agreement. A Supplemental Agreement is a type of Change Order used for the following purposes:
   a. To provide a unit price for items not included in the original Proposal;
   b. If major Contract items require a change in quantity in excess of 25% of the original and there is a demonstrable change in cost to the Contractor;

c. If there is an addition, deletion, or revision of the contract specifications;
d. If any item is non-performed; and/or
e. For any changes to the contract time.

2. Force Account Work Order. A Force Account Work Order will only be initiated and used when it is necessary to accomplish work not described by the contract specifications and which a price cannot be agreed upon by the Division and Contractor. This type of work can most effectively be described by hours of Labor, the furnishing of Material, and hours of Equipment use, plus a percentage (LME) as detailed in the Specifications. The Project Engineer/Supervisor must exercise strict controls and detailed records to administer this type of Change Order.

   Section 109.4 of the Specifications specifies the provisions. See Section 104.1.2.1 of the Construction Manual, for justification of the Force Account work and Section 110.3.3 for additional information.

110.1.4-AASHTOWare Project (AWP) Change Orders, if required, must be prepared and processed as described in Sections 110.2 and 110.3. AASHTOWare Project is used to generate Change Orders, either Supplemental Agreements or Force Account Work Orders. See Section 105.6.7 for additional information on AASHTOWare Project and Change Orders.

110.2-CHANGE ORDER

110.2.1-Need If a condition warrants a contract modification or extra work, the Project Engineer/Supervisor will immediately notify the District Construction Engineer before taking further action. District personnel will notify the Contract Administration Division. All proposed Contract modifications and extra work require a Change Order.

Change Orders are required on non-exempt Federal-Aid projects under either of the following two conditions:

1. Major Changes/Extra Work. On non-exempt and concurrence Federal-aid projects, FHWA must provide advance written approval of all major changes or major extra work in the Contract Plans and Specifications except, when emergency or unusual conditions warrant, FHWA may provide advance verbal approval with subsequent binding written concurrence. A major change or major extra work is defined as a project change or extra work that would significantly affect the cost to the Federal Government or alter the termini, character, or scope of the work. See Section 110.3.2.1 for types of modifications that represent major changes and major extra work including required documentation.
2. Minor Changes/Extra Work. On non-exempt and concurrence Federal-aid projects, FHWA must approve all minor changes and minor extra work. This includes modifications in construction items within the scope of the Contract Plans and Specifications when such modifications are required during the normal progress of construction. Approval may be given retroactively at the discretion of FHWA.

110.2.2-Preparation The Project Engineer/Supervisor is responsible for preparing Change Orders and employing the requisite features of AASHTOWare Project. See Section 105.6.7. The following discusses documentation requirements.

110.2.2.1-Contacts On the General Change Order explanations, list the name and organization of all District, Division, and FHWA (if applicable) personnel contacted relative to the proposed modification or extra work. On non- exempt and concurrence Federal-aid projects, the Change Order must document agreements by FHWA personnel.

110.2.2.2-Items, Quantities, Unit Prices List each item of work entailed by the proposed modification or extra work, the estimated quantity, and the agreed unit price. Also list any Contract item underrun(s) resulting from the proposed modification or extra work (e.g., payment of material taken into Division inventory should include a decrease in the planned items of work that caused the unused material).

110.2.2.3-Location and Necessity of Work List the following related to the location and necessity of work on the Change Order:

1. Location. Indicate stations with applicable baseline and offset notations for each item of work entailed by the proposed modification or extra work. Modifications or extra work, resulting from revision of the planned project termini, require evidence that the Contract Administration Division has been advised of the revision.
2. Necessity. Indicate the reason in sufficient detail to ensure that the proposed modification or extra work is necessary.
3. Federal-Aid Reimbursement. Include the status of eligibility for Federal-aid reimbursement for each Contract modification. The following options are available:
   a. Eligible for Federal funds pending submission and evaluation of cost data;
   b. Partially eligible for Federal funds pending submission and evaluation of cost data;
   c. Ineligible for Federal funds; or
   d. Other (explain).

   On exempt Federal-aid projects, the eligibility for Federal-aid reimbursement indicated for each Contract modification will follow FHWA policy.

4. Contract Time Evaluation Method. Include the method of Contract time evaluation for each Contract modification. The following options are available for each Contract modification:
   a. Additional working days to the Contract time allowance are not applicable; or
   b. Additional working days to the Contract item allowance will be granted on the basis of the actual working days charged for performing the work under the agreement provided the work is judged to be the controlling operation.

   See Section 105 for additional information on documenting Contract time extensions.

110.2.2.4-Justification of Quantities The documentation required to substantiate estimated quantities is dependent upon the method of measurement of the proposed modification or extra work. Consider the following guidelines:

1. Area or Volume Measurement. Include calculations to substantiate added, increased or decreased quantities. A sketch or drawing is often necessary to show the details of the proposed modification or extra work. As applicable, include the following additional information:
    a. Proposal Quantity Items. Calculations must contain signatures, not just initials, of District Office and project personnel verifying the accuracy of dimensions, computation method and resultant quantity. Detailed drawings must accompany the calculations.
    b. Unclassified Excavation/Borrow Items. Calculations must include a volume breakdown station by station.
2. Linear Measurement. Include data such as stationing and applicable baseline and offset notations, top and bottom elevations, bar details, etc.
3. Weight Measurement. Include data such as stationing, average widths and depth, typical sections, application rates, conversion factors, etc. As-built quantities require notation that properly executed tickets are in the project file.
4. Unit Measurement. Include data such as stationing and applicable baseline and offset notations for each unit.
5. Lump Sum Measurement. The following documentation requirements will apply to lump sum measurements:
    a. Contract Item Revision. Include calculations based upon proposal bid amount, plan quantity, and the proposed extra or deducted quantity to substantiate the proposed payment or deduction.
    b. Force Account Work Basis. Include reason for performance of work on a Force Account Work basis in addition to applicable Labor, Materials Used, and Equipment (LME) records. Use Force Account Work procedures to establish the method of measurement for contract modifications or extra work only when necessary. Possible reasons for the performance of work on a Force Account Work basis are:
        i. Negotiations with the Contractor fail to produce agreement on the price of a new work item;
        ii. The extent of work is unknown;
        iii. The work is of such character that determination of a reasonably accurate price is not achievable; and/ or
        iv. Emergency in nature.
6. Revised Method of Measurement. This applies to such situations as “original versus in-place” and “volume versus weight.” Include data to substantiate that applicable shrink/swell or other conversion factors are representative of the applicable material and verification of the Contractor’s agreement with the factors. Revision of the method of measurement from volume to weight also revises the type of payment documentation required from calculations to properly executed weigh tickets.

However, the material and construction method documentation required to substantiate compliance with the original Contract Plans and Specifications remains unchanged.

7. Inventoried Material. For payment for material incorporated into DOH inventory, include a copy of an executed DOH-5 documenting that the material was received by DOH and invoices showing the Contractor's actual cost of the material. Payment of this type should include a decrease in the planned item(s) of work that caused the unused material. See Section 109.2.4 for additional information.

110.2.2.5-Justification of Unit Prices The documentation required to substantiate unit prices is dependent upon the type of action taken for each item of the proposed modification or extra work. Consider the following guidelines:

1. Adjustment at Unit Price. Modifications or extra work resulting in increased or decreased quantities of major contract items at unit bid price require evidence that the provisions set forth in Section 104.11 of the Specifications were considered, if applicable.
2. Addition of Items. If items are added to the original Contract, include detailed provisions for material requirements, construction methods, method of measurement, and basis of payment for all added items not included in the contract specifications. Attach a copy of any written evidence submitted by the Contractor or prepared by DOH to support the unit prices. Include a cost analysis that verifies that unit prices for added items are reasonable. Examples of methods used to justify unit prices are as follows:
   a. Verification of the accuracy of the cost breakdown submitted by the Contractor noting any special conditions;
   b. Comparison with unit prices of similar Contract items noting any special conditions;
   c. Comparison with average bid prices noting any special conditions;
   d. Comparison with unit prices of same Contract items(s) on other projects (indicate project numbers) within the area or DOH prices on Purchase Order Contracts for similar work and/or materials noting any special conditions; and
   e. Preparation of a cost breakdown for estimated labor, material, equipment, and administrative costs required to perform the work.

110.2.3-Review and Approval Project personnel may not be fully aware of the nature or magnitude of the comments made by Division or FHWA personnel regarding the proposed modification or extra work. Therefore, the following procedures will apply for the review and approval of the Change Order:

1. The Project Engineer/Supervisor will submit a draft of the Change Order, including necessary attachments, to the following personnel for review, approval, and/or comments.
2. The District Area Engineer/Supervisor, District Construction Office Manager, District Construction Engineer, Regional Finalization Coordinator, FHWA Regional Engineer (if

applicable) and Regional Construction Engineer will review the Change Order, in a timely manner, for accuracy and compliance with established procedures.

3. The Regional Construction Engineer will verify that the agreements reached, and comments made by Division and FHWA personnel are accurately represented on the Change Order.
4. The District Construction Office Manager will verify that the Change Order complies with the documentation procedures noted in Section 110.2.2 including the verification of applicable calculations.
5. Upon approval of the Draft Change Order, the Office Manager will place the Change Order into Pending Status.

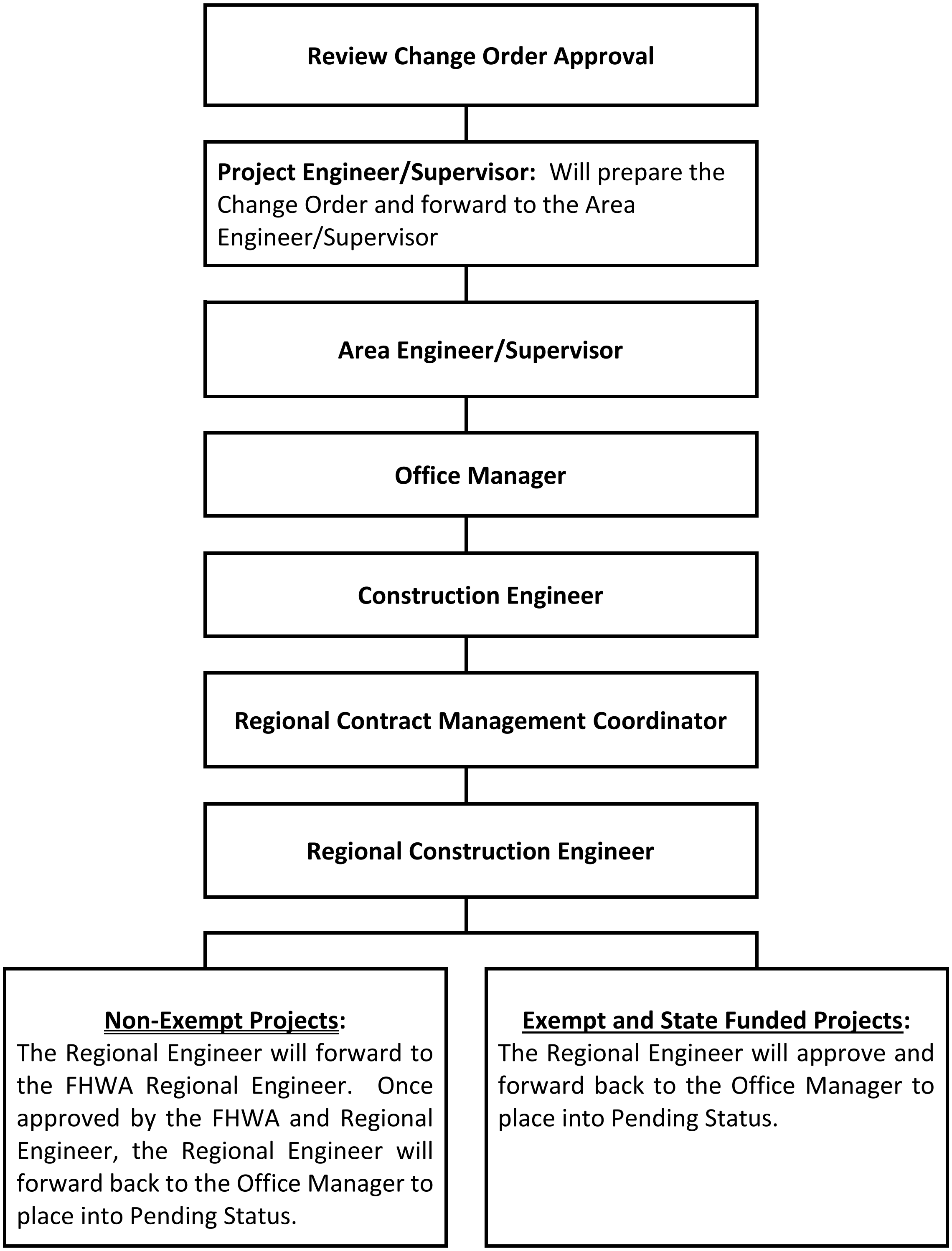
110.3-CHANGE ORDERS

Section 110.3 establishes DOH procedures for preparing and processing Change Orders. Adherence to these procedures will ensure that Change Orders are properly executed. Every Change Order must be approved in Draft (see Section 110.2).

110.3.1-Need All modifications or extra work require an approved Change Order. The Contract modifications and extra work that require the preparation and approval of a properly executed Change Order are as follows:

1. Addition of items not included in the original Contract including items of work performed on an LME Force Account Work basis;
2. Revisions to Contract item quantities under either of the following two conditions:
   a. As needed to update the original funding authorized for contingencies; or
   b. As required in conjunction with approved Value Engineering/Practical Design Proposals;
3. Revisions to the contract specifications and/or Plans that, in the opinion of the District Construction Engineer, will significantly change the cost or alter the termini, character, or scope of the work under the Contract. See Section 104.11 of the Specifications for circumstances that constitute a significant change;
4. Assessment of price reductions that were established by District Materials Reports and/or special evaluations by DOH; and
5. Modifications that include a Contract time extension.

110.3.2-Processing and Approval Figures 110A and 110B illustrate processing flowcharts for Change Orders for non-exempt Federal-aid projects or State funded and exempt aid projects. The following subsections presents further discussion on processing and approval procedures.



PROCESSING FLOW CHART FOR
CHANGE ORDERS IN REVIEW STATUS
Figure 110A

Change Order Approval

Contractor: Contractor approves Change Order and sends to Surety for approval. The Surety will stamp the Signature page with their Seal and return to the Contractor. Contractor will send the Change Order back to the Office Manager. Office Manager will approve the Change Order for the Contractor and Surety, if the contractor does not have access to AWP, and forward to the Regional Engineer.

District Construction Engineer

Regional Construction Engineer

Director of Contract Administration

Chief Engineer of Construction-Deputy State Highway Engineer

Regional Contract Management Coordinator

PROCESSING FLOW CHART FOR CHANGE ORDERS
Figure 110B

110.3.2.1-Exempt/Non-Exempt Federal-Aid Projects Modifications and extra work on exempt/non-exempt Federal-aid projects generally require prior written concurrence and Change Order. However, there are exceptions as follows:

1. Emergency Conditions. In emergency situations or unusual conditions, it may be necessary to request advance verbal approval from FHWA with the intent that FHWA provide the Division with a subsequent binding written concurrence in the form of a Change Order for the modification or extra work. The basis of the verbal agreement will be acceptable rates, and the basis of the Change Order.
2. Minor Changes/Extra Work. Retroactive formal FHWA approval with a Change Order is permissible for minor changes and Minor extra work on non-exempt Federal- aid projects.
3. Major Changes/Extra Work. For the discussion that follows, major change or major extra work will be defined as a change that will significantly affect the cost of the project or alter the termini, character, or scope of the work. The following actions represent major changes or major extra work for which prior written approval from WVDOH management is required:
   a. revision of design details (including standard details) pertaining to geometry, drainage, structures, excavation, embankment, signing, and safety appurtenances, or pavement (main roadway, ramps, frontage roads, cross roads, or detours);
   b. revision of planned access control, project termini, right-of-way limits and/or easements;
   c. revision of the Standard Specifications, Supplemental Specifications, and/or project specific Special Provisions, including any change in material type or quality;
   d. revision of contract time resulting from contract changes or extra work;
   e. LME Force Account Work, Value Engineering Proposals, and contract claim settlements; and
   f. revision of the Contract value of any item by an amount greater than ±$12,500.

For major changes and major extra work on non-exempt Federal-aid projects, a Change Order (i.e., prior written FHWA concurrence) is necessary to ensure consideration of Federal participation. When applicable, submit revised plan sheets to FHWA for approval prior to distribution. Before commencement, a Change Order must be executed to formally document agreement between the Division and FHWA in the following areas:

a. Necessity of the proposed work;
b. Scope of the proposed work; and
c. Basis of payment.

See Figure 110B for approval process.

110.3.2.2-Sequencing Change orders are submitted sequentially for each project as shown by the following example:

Change Order No. 1	--	Supplemental Agreement No. 1
Change Order No. 2	--	LME Force Account Work Order No. 1
Change Order No. 3	--	Supplemental Agreement No. 2
Change Order No. 4	--	LME Force Account Work Order No. 2

110.3.2.3-Administrative Charges Administrative charges will not be required for Change Orders necessitated by price reductions or increases for changes in the work or materials requested by the Contractor or DOH. However, many contract specifications provide for non-conforming materials to be accepted and remain in place with an appropriate price adjustment. These price adjustments fall into one of the following two categories:

1. Within Specification Limits. Price reductions that fall within the Price Adjustment Limits of the contract specifications are placed on an Estimate as an adjustment without an administrative charge.
2. Outside Specification Limits. A special evaluation of the non-conformance must be made if the non-conforming material is outside the limits of the contract specifications. Price reductions that fall outside the Price Adjustment Limits require further effort by DOH. Thus, a $200.00 administrative fee will be charged for each adjusted price.

110.3.3-LME Force Account Work Orders

110.3.3.1-Purpose A LME Force Account Work Order will be used only when it is necessary to accomplish work not covered by contract specifications but most effectively described by hours of Labor, the furnishing of Material, and hours of Equipment use, plus a percentage as detailed in the Specifications. Section 109.4 of the Specifications details the provisions and responsibilities associated with LME Force Account Work.

110.3.3.2-Processing and Approval See Section 110.2 for the documentation needed for the required Record of Contact, and Section 105.6.7 for the AASHTOWare Project processing features related to Change Orders. Prior DOH and, on Federal- aid projects, FHWA concurrence as well as approval of equipment rental rates must be obtained in accordance with the procedures discussed in Section 110.3.2. Supporting data for the amount of insurance, B&O taxes, and bond will be submitted by the Contractor with the properly executed Change Order in accordance with the Specifications.

110.3.3.3-Daily Report Records When work is performed on an LME Force Account Work basis, the Project Engineer/Supervisor must exercise strict controls to ensure that the work is being performed properly and as efficiently and rapidly as is practical. The Project Engineer/Supervisor must ensure that the labor and equipment being charged to the work are actually needed and efficiently employed, and that the materials being charged are actually and properly placed. Consider the following guidelines when administering LME Force Account Work Orders:

1. Daily Work Report. LME Force Account Work records will be maintained daily on specific LME Force Account Work worksheets. The DWR LME worksheets should include separate daily entries on LME Force Account Work labor, materials, and equipment. Each LME worksheet will contain the following minimum information:
   a. Location of the work;
   b. Quantity and type of labor and equipment being used;
   c. Type and quantity of materials used;
   d. Hours worked;
   e. Description of work performed;
   f. Estimate of the amount of work completed each day; and
   g. Any additional information helpful in describing the work accomplished.
2. Records of Work Performed. At the end of each day's operation, the Contractor's representative and the Project Inspector will compare their records for agreement on the work performed and materials used that day. The Project Inspector must make duplicate copies of these records, and each copy should be signed by both the Project Inspector and the Contractor's Project Superintendent, or designee. One (1) copy will be forwarded to the Project Engineer/Supervisor and one (1) copy to the Contractor. To comply with these provisions, records of LME Force Account Work must be maintained daily, and representatives of both DOH and the Contractor must agree to each day's work by signature. See Section 105.5 for additional information.
3. Estimates. Generally, payment for LME Force Account work will be paid for by a Change Order. However, for larger Force Accounts, partial payments may be made by Contract Adjustments and then subtracted off after the Change Order has been approved. Such payments are substantiated by information on the LME Force Account Work Order. Refer to AASHTOWare manual for more information and requirements of Force Account Work. The approved LME Force Account Work Order must be placed in ProjectWise to support payment.

SECTION 111
PROJECT RECORDS AND DAILY WORK REPORTS

111.1-GENERAL

111.1.1-DOH Personnel Responsibilities Maintaining complete and accurate entries of project records and quantity calculations in the Daily Work Reports (DWR), especially on large projects, is one of the most important functions of the Project Engineer/Supervisor to substantiate quality of materials and workmanship, payments to the Contractor, and any claims made. Measurements for payment must be correct, and records must be complete, accurate, and clear. The Project Engineer/Supervisor must ensure that the entries in the DWR and the Project Files are in proper order. Although the Project/Engineer may delegate tasks to other DOH project personnel (e.g., Project Inspectors), the Project Engineer/Supervisor bears the ultimate responsibility for the disposition of the Project Files.

111.1.2-Project Data

111.1.2.1-Purpose and Importance Based on the list of Contract bid items, the entries in the DWR must document measurements and calculations of quantities for payment on every item in the Contract. The DWR must be organized and include entries of notes, sketches, measurements, and/or calculations for each item. This applies even to lump-sum items where the entry may consist only of a note, date, and remarks to documents the work was actually performed as specified. Maintaining complete and accurate entries in the DWR is an important responsibility of the Project Inspector and, ultimately, the Project Engineer/Supervisor. The Project Inspector's observations, notes, sketches, measurements, calculations, and directives are the basis for justifying all aspects of the project. Because much of the Contractor's work is covered by subsequent construction, the results cannot be readily reviewed later. Written reports, records of observation, and measurement are usually the only remaining evidence that the work was performed as specified and that the Division received the complete benefits of the Contractor's work as bid. Emphasis should be placed on recording all portions of the Contractor's work daily, as it is performed and inspected, not at a later time. For example, the following information should be recorded, as applicable, on a day-to-day basis:

1. Material source and product laboratory numbers;
2. Sampling of quality control and acceptance tests (e.g., for compaction) and results;
3. Measurements for progress payments and final payments, as applicable;
4. Locations and results of final depth checks; and
5. Other information as required for substantiation.

Section 111.2 provides additional information on DWR entries for typical Contract items.

Photographs and videos should be an important part of the project records. They can serve to document the record with respect to slides, cave-ins, floods, and other unusual occurrences; actual conditions when a contractor alleges, "Differing Site Conditions", unusual construction features or practices; accidents involving death, personal injury or property damage; encroachments within the right-of-way; reports on experimental features and unusual construction practices; and final construction reports. They are invaluable as evidence in case a controversy develops during a contract which results in litigation.

To best serve their intended purpose, photographs and videos must be taken at appropriate stages of construction; i.e. immediately after unusual occurrences and before unusual conditions are disturbed. Clarity and good composition are very important and proper identification is necessary. Narrative portions of videos should be limited to what is being taped. The identification record for each photograph and video should include the exact location taken (including references to project stations if applicable), time of day and date taken, weather conditions at the scene, name and signature of the photographer or taper, and serial number of the photograph, negative, and/or video. This information is particularly important if the photos or videos are used as evidence in possible legal proceedings.

The photograph and video identification records should be organized so that all can be easily located. The photos and videos should be maintained as a part of the project files. Distribution of any copies of the photos and/or videos should be properly recorded.

111.1.2.2-Materials Certification AASHTOWare Project (AWP) provides an integrated, computerized accounting system that tracks all data essential for Materials Certification on the project (e.g., delivery, testing, placement, payment). AWP is maintained on a day-to-day basis to update and track the current status of all materials for each item on every project under the jurisdiction of the DOH. To a large extent, the beginning of this tracking process is initiated at the Project level when entries (e.g., sample id, laboratory numbers, quantities) are made in the DWR. A critical part of this overall approach is the day-to-day review and validation of DWR entries (see Section 111.3). See Section 106 for additional information on control of materials and Section 105.6 for an overview of the workflow of the AWP.

111.1.3-Inspector's Daily Work Reports The Division requires project field personnel (e.g., Project Engineers/Supervisors, Project Inspectors) to document project records on a day-to-day basis in AWP. This facilitates the collection, review, and validation of complete and accurate project records. See Section 105.5 for additional information on DWR. For example, DWRs should include all reports, survey notes, original measurement sheets, calculations, piling record attachments, and other pertinent worksheets and information as needed for proper administration of the Contract. This information will be either documented on the Diaries or DWRs itself, the worksheet attachments, or in some other manner (e.g., Field Survey Books). This information will become a permanent record in the Project Records (see Section 111.1.4). Emphasis should be placed on maintaining accurate and complete entries of measurements for determining quantities and attaching to the DWRs all substantiating sketches, measurements, calculations, and worksheets.

111.1.4-Maintaining Project DWR Project records include Diaries and DWRs and Field Survey Books (i.e., standard K&E-type field data books). The Dairies and DWRs will be entered in AWP. Field Survey Books may be hard copy field book, digital mapping files or Excel file of stake-out, cross section, or any field information used by Survey Parties and Project Inspectors for recording data, sketches, measurements, and calculations. A general description of Field Survey Books is presented in Section 639. It is very important that DWRs and Field Survey Books be sequentially numbered from the start of the project as follows:

1. Daily Work Reports. DWR are entered in AWP by date to document the work that is performed daily on a Contract. Multiple DWRs may be created per day.
2. Field Survey Books. Field Survey Books will be numbered sequentially throughout the project beginning with the first one completed as follows: F1, F2, F3, etc.

111.1.5-Project Files

111.1.5.1-Purpose The purpose of any filing system is to arrange the files in an organized manner so that documents can be retrieved as desired without delay. To better achieve this objective, a uniform filing system for DOH Project Files is highly recommended. The importance of being able to retrieve on demand any project record cannot be over emphasized. Project records are used to justify payments, determine acceptability of materials, verify conformance of work and materials, substantiate eligibility for reimbursement on Federal-aid projects, and provide evidentiary evidence in disputes and claims.

111.1.5.2-Storage and Protection Project files are generally maintained in the Project Field Office. It is important to store all project files in a fireproof cabinet within the Field Office when not in use. All Project files will be stored electronically in ProjectWise.

111.1.5.3-File Organization The key to maintaining useful project records is to establish a filing system in advance and maintain the filing system throughout the project. The filing system is set up in ProjectWise by Information Services prior to start of work. An organized file of accurate and complete project records will expedite and simplify Contract administration. Project files will include such key items as DWR, Diary, correspondence, and District Materials Reports (MIRs). The DWRs and worksheet attachments should be retained in AWP and ProjectWise. Other original documents will be retained in the District Office with copies retained in files of the Project Field Office. Refer to the ProjectWise User Manual – Construction Electronic Filing System for the setup of all construction contracts in ProjectWise

111.1.6-Project Reference Materials It is good administrative practice to have ready access to reference materials during the project when questions arise. The following list of publications and manuals are available on the Division webpage or by request to District Construction Engineer for the Project Field Office:

1. Standard Specifications Roads and Bridges, WVDOH;
2. Supplemental Specifications, WVDOH;

3. Construction Manual, WVDOH;
4. Materials Procedures, WVDOH;
5. Manual on Temporary Traffic Control for Streets and Highways, WVDOH;
6. Erosion and Sediment Control Best Management Practices Manual, WVDEP;
7. Design Directives, WVDOH
8. Manual on Uniform Traffic Control Devices, FHWA; and
9. Standard Detail Book, Volume I and Volume II, WVDOH.

111.2-DAILY REPORT ENTRIES

Section 111.2 provides guidance for making entries in the Daily Work Reports (DWR) for typical Contract items.

111.2.1-Clearing and Grubbing The quantity for payment of clearing and grubbing will be on lump sum basis, however the estimated quantity may be shown on the Plans. Added areas should be calculated and documented in the Inspector's DWR. Include sketches as needed and note if calculations are based on field measurements or measurements scaled from the Plans. Selective clearing not shown on the Plans and removal of trees outside the limits of clearing and grubbing will be paid for as Extra Work.

111.2.2-Unclassified Excavation The quantities for unclassified excavation and other pay items such as cribbing walls, gutters, sewers, longitudinal drainage ditches, and special rock fill are determined from original and final cross sections. Use the following procedures when determining quantities using cross sections:

1. Record the final cross section data in the Field Survey Book (see Section 639), digital mapping, or Excel file, if obtained.
2. Plot the original and final cross sections on cross-section paper with the Plan template to determine and/or limit the pay quantities.
3. Mark each cross-section sheet clearly for submission with the tentative final estimate.
4. Note in the DWR that the areas were determined by calculation based on cross sections and provide reference to the respective cross section sheets.

Unclassified excavation will be paid to the limits of the template on the Plans, if the Contractor has performed excavation within the tolerance of the contract specifications. Excavation beyond the template will be paid only if such excavation is approved in writing in accordance with Section 207 of the Specifications. Consider the following additional guidelines:

1. Excavation Beyond Template. Explicitly note in the DWR any excavation beyond the Plan template or behind any slopes that are changed in the field.
2. Special Rock Fill. The quantity of special rock fill is measured in-place and determined by the method of average end areas. After placement, final sections are taken and the area that is occupied by the special rock fill can be readily calculated. Calculations based on scaled measurements from the Plans or load counts are not acceptable methods of measurement for this pay item. Where special rock fill must be placed simultaneously with embankment material, measurements should be taken at 50-ft stations on each layer of rock placed.

111.2.3-Underdrains Although the Plans may call for underdrains at particular stations, field conditions frequently necessitate their placement at additional locations. It is important to carefully document placement of additional underdrains in the DWRs. Where an extensive system of pipe underdrains is constructed, include an initial sketch in the DWR showing the general layout of the system. Draw the roadway centerline and denote the location of the pipes in the sketch by offset from the centerline. Excavation and material quantities can then be determined for each conventional section of the system. After determining separate quantities for each section, total them to determine the final quantities for payment. Note this information in the DWR.

111.2.4-Box Culverts and Structures Use the following guidelines to document box culverts and structures in the DWRs:

1. Sequence of Documentation. The following sequence will be used to document sketches and calculations in the DWRs for box culverts and structures:
   a. Structure excavation,
   b. Steel bearing piles,
   c. Class b concrete,
   d. Class k concrete,
   e. Reinforcing steel,
   f. Slope protection,
   g. Select material for backfill,
   h. Approach slabs, and
   i. Lump-sum bid items.
2. Dimensions and Measurements. Dimensions for box culverts and structures should be determined from information on the Plans so that all dimensions will be exact. Specifically denote dimensions that are measured in the field taken for verification.
3. Separate Elements. Structures such as bridges and retaining walls will be documented similar to box culverts; however, elements of these structures should be documented separately as follows:
   a. pilings,
   b. foundations,
   c. footings,
   d. columns,
   e. caps,
   f. bents,
   g. piers,
   h. abutments,
   i. substructure,
   j. individual spans for decks,
   k. handrail,
   l. approach slabs, and
   m. superstructure.

4. Test Piles. Include a note in the DWR if test piles were driven and the date of the operation. Also, make a general note if no test piles were driven.
5. Bridge Deck Tolerance. Upon documenting the completion of bridge deck concrete, note in the DWR whether or not the bridge deck tolerance was acceptable. If it was not acceptable, note in the DWR what action was taken in determining an equitable reduction. See MP 601.11.20 for use of rolling straightedge.

111.2.5-Portland Cement Concert Pavement Use the following guidelines to document Portland cement concrete pavement in the DWRs:

1. Supplemental Measurements. The most important consideration in determining pay quantities for PCC concrete pavements is ensuring that sufficient measurements are obtained for use in calculating the quantities. Selecting the proper field measurements to supplement the Plan dimensions requires foresight and a basic understanding of the formulae used to calculate quantities for aprons, approaches, acceleration and deceleration lanes, and intersections. Consider these preparatory tasks before the operation commences.
2. Acceptability/Core Samples. The degree of acceptability of PCC concrete pavement is based on the thickness criteria established in the contract specifications and is determined by pavement core analysis. When specified in the Contract, a statistical approach will be used in the analysis of pavement thickness and strength. If the Contractor requests to take additional core samples for verification in accordance with the contract specifications, an authorized representative of the Contractor and the Project Engineer/Supervisor should be present at the time the core samples are taken. If the samples reveal that the pavement thickness is within allowable tolerance of the governing contract specifications, note this fact in the DWR. Such information may be obtained from the Materials Inspection Report (MIR).

111.2.6-Liquid Asphalt Material

111.2.6.1-Actual Quantity Use one of the following methods to determine the actual quantity of bituminous material used:

1. Dipstick measurements before and after unloading;
2. Readings before and after unloading from a gage that has been previously checked for accuracy; or
3. Reweighing the vehicle. The fuel tank must be full prior to reweighing.

In methods 1 and 2 above, the temperature at the time of measurement must be recorded in the DWR. Also, clearly note the method of measurement used.

111.2.6.2-Equivalency Adjustment To determine pay quantities, the actual quantity of asphalt material used must be converted to an equivalent quantity (i.e., volume) at a temperature of 60°F using the appropriate criteria. The Contractor must furnish all information necessary to determine the group number of the bituminous material actually incorporated in the project so that the appropriate conversion factor may be selected from the worksheet attachment. This may include any of the following:

1. Group number,
2. Specific gravity,
3. API specific gravity, or
4. Weight per unit volume.

111.2.7-Aggregates The payment measurement for aggregate materials for base, subbase, shoulders, and similar pay items is the number of cubic yards shown on the Contract Plans or tons where weigh tickets are required. Aggregate material used outside Plan limits will not be paid unless properly authorized by DOH. Authorized additions or deletions to Plan quantities must be determined and documented in the DWR. Use the following procedures and guidelines:

1. Section Worksheets. Use worksheets to determine where sections are appropriate for the simplest, most reasonable determination of quantities. These worksheets should itemize section numbers for different section types including slope changes, super-elevations, beginning and ending points for transitions, guardrails, underdrains, and any other features that affect volume. If there is doubt as to what section to use, perform a field check and place the note "verified by field check" in the DWR. Attach these worksheets to the DWR. Using the worksheets, perform an evaluation to determine the typical sections needed and the stations to be represented in the DWR. The worksheets will be placed in ProjectWise to assist in evaluating these items.
2. Separate Calculations. To better organize and effectively calculate the quantities, separate the calculations of quantities for each different item as follows:
   a. The area under the pavement;
   b. Right shoulder; and
   c. Left shoulder.
3. Area Calculations. Include sketches of typical sections and compute the area components using the base course slope equation. Tables can effectively be used in conjunction with typical sections to cover ranges of slopes for particular typical sections. All area calculations of typical sections must be checked before proceeding with volume calculations.
4. Volume Calculations. Perform volume calculations in a tabular format and include sufficient information to identify the typical sections used. The stations and setup of the tables should be carefully checked before calculating the volume quantities.
5. Control of Materials. Where aggregate is tested and stockpiled for subsequent use, the following procedures will apply:
   a. Where aggregate material is delivered and samples are taken for gradation analysis, determine the source and check the DOH Approved Source/Product Listing for acceptability.
   b. Assign the gradation samples a laboratory number and enter the number and requisite information on the DWR. This information will subsequently be entered in AASHTOWare Project.
   c. Ensure that entries are made on the DWR for each item for which the aggregate material is used.

d. Results of Quality Control Samples will be forwarded immediately upon completion to the District Materials Supervisor for further processing.

111.2.8-Weigh Tickets The following guidelines apply to processing weigh tickets at the project level:

1. Contractor Responsibilities. The Contractor will furnish all weigh tickets showing quantities received for items such as stone, bituminous concrete, and water.
2. Signatures. In accordance with the contract specifications, weigh tickets must be signed or initialed at the weigh scale by the Contractor's representative to certify the weights are correct. Where the item is paid for in tons, the Project Inspector must verify all weigh tickets at the point of delivery via signing each weight ticket or by recording them on ticket worksheet, thus documenting that the type and quantity of material shown on the ticket was actually delivered and placed. The Projector Inspector's signature on the weigh tickets or ticket worksheet should be followed by "DOH." Any shipment, or portion thereof, of material rejected by the Project Inspector also will need the word "rejected" written on the weigh ticket. However, the Project Inspector will not sign the rejected tickets. Check weigh tickets daily so that any problems with signatures or ticket worksheets can be detected early in the project.
3. Laboratory Numbers. All weigh tickets must include appropriate laboratory numbers. These numbers must be recorded on the DWR.
4. Mix Design Numbers. The first weigh ticket of each day for hot-mix asphalt concrete will include the mix design number and all necessary laboratory numbers, which will be entered onto the DWR and AASHTOWare Project. If there is a mix design change during the day, the weigh ticket will reflect a new set of laboratory numbers and target density. Note any such changes on the DWR. The same procedure applies to shipments of PCC concrete and aggregate material except that source laboratory numbers must also be recorded on the DWR.
5. Daily Work Reports and Filing. Enter the original signed weigh tickets, including adding machine tapes or worksheet supporting the totals, and file into ProjectWise. One copy of each weigh ticket will be given to the Contractor. Adding machine tapes or worksheet should be attached to the tickets to support the totals represented. The DWR should contain the following minimum information:
   a. The ticket numbers and amounts on DWR attachments; and
   b. The total weight or volume represented by the weigh tickets for that day's payment.

111.2.9-Concrete Sidewalks Care should be taken when representing the quantity of concrete sidewalk constructed across driveways, because some Plans call for extra thickness at driveway crossings. The Specifications will be used to determine the quantity and payment.

111.2.10-Seeding and Mulching The quantity for seeding, mulching, fertilizer, and ground agricultural limestone will be measured for payment and documented in the DWR according to the Specifications.

111.2.11-Stockpiled Materials Stockpiled Materials are recorded in AASHTOWare Project as discussed in Section 109.2.1.

111.2.12-Other Considerations

111.2.12.1-Integrity of Entries All notes, sketches, measurements, and calculations that are made on or attached to the DWR must be neat, legible, complete, accurate, and unquestionable. Consider the following guidelines when making entries:

1. Consistency. A high degree of consistency from day-to-day should be emphasized when making entries in the DWRs.
2. Erasures. Erasures will not be tolerated. To make a correction, strike out the incorrect entry and write in the correct information. Initial all corrections.
3. Measurement/Payment. Before entering any item in the DWR, the "Method of Measurement" and "Basis of Payment" sections of the Specifications should be studied.
4. Measurements/Dimensions. To ensure accuracy, all measurements and dimensions must be obtained by methods that are unquestionable as to their integrity and origin. Each measurement should be denoted as a field measurement, Plan measurement, or calculated measurement. Any dimension contrary to the approved Plans or altered by approved changes must be explained in the Diary or DWR, and the authority for the change clearly stated. Measurements should be taken only to the number of decimal places that can be determined within reasonable accuracy by conventional methods.
5. Clarity. Clarity can best be obtained by adequate spacing of sketches and figures. Formulas should be clearly stated before each calculation. When constants or lookup tables are used, refer to the source of the information.
6. Sketches. Provide sketches, as needed, to substantiate calculations and be consistent when presented sketches.

111.2.12.2-Rounding Numbers When making entries in the DWRs, decisions are necessary on how to round calculated numbers. Rounding provides a stopping place when presenting numbers, makes numbers easier to use without sacrificing the degree of accuracy needed, and provides consistency in the method of calculation. When rounding calculations, use the following guidelines:

1. Interim vs. Final Results. When it is necessary to perform one or more calculations to obtain the final answer, all preliminary or prior results should be carried out and rounded to one decimal place more than is needed for the final answer.
2. Degree of Accuracy. As applicable and appropriate, use the quantity rounding criteria presented in Figure 111A to determine the degree of accuracy needed.
3. Exceptions. Exceptions often are necessary when the contract specifications or other project notes dictate the use of a different degree of accuracy. If the number of decimal places for rounding is not shown in the Specifications, Special Provisions, Plans, or Figure 111A, use the following additional guidelines, listed in order of preference:

a. Use the degree of accuracy for similar items shown in Figure 111A; or
b. Use the degree of accuracy that reflects the most precise measurement that can be practically obtained in the field, especially if the unit price for the item is very large.

4. Rounding Rules. Use the following procedures and guidelines when rounding numbers:
   a. Rule One. Determine the LAST DIGIT TO BE USED. This is the last digit needed for accuracy.
   b. Rule Two. If the digit following the last digit to be used is 0, 1, 2, 3, or 4, then drop it and all that follow. DO NOT CHANGE the last digit to be used.
   c. Rule Three. If the digit following the last digit to be used is 5, 6, 7, 8, or 9, then drop it and all digits that follow. Add 1 to the last digit to be used.
   d. Rounding Examples. The following examples have been rounded off one decimal place to illustrate these rules:

61.4	=>	61	48.63	=>	48.6
61.6	=>	62	48.68	=>	48.7
61.5	=>	62	48.65	=>	48.7
64.5	=>	65	48.75	=>	48.8

QUANTITY ROUNDING CRITERIA
Figure 111A

ITEM	US CUSTOMARY UNITS	DEGREE OF ACCURACY
Division 200 Earthwork		
Unclassified Excavation	Cubic Yard	0.100
Borrow, Rock Borrow, or Select Borrow Excavation	Cubic Yard or Ton	0.100
Impervious Core	Square Foot	0.100
Structure, Wet or Rock Excavation	Cubic Yard	0.100
Select Material for Backfilling	Cubic Yard	0.100
All Types of Engineering Fabric	Square Yard	0.100
Special Rock Fill	Cubic Yard	0.100
Riprap, Grouted Riprap, or Gabion	Cubic Yard	0.100
Crushed or Concrete Rock Slope Protection	Square Yard	0.100
Foundation Protection	Cubic Yard	0.100
Shot Rock	Ton	0.100
Controlled Low Strength Material	Cubic Yard	0.100
Subgrade Preparation	Square Yard	0.100
Shoulders and Ditches	Mile	0.001
Shoulders and Ditches	Mile	0.001
Clean Culvert	Linear Foot	1.000

QUANTITY ROUNDING CRITERIA
Figure 111A

ITEM	US CUSTOMARY UNITS	DEGREE OF ACCURACY
Division 300 Bases		
Aggregate Base Course	Cubic Yard or Ton	0.100
Open Graded Free Draining Base Course	Cubic Yard	0.100
Division 400 Asphalt Pavements		
Asphalt Wearing or Base Course	Square Yard or Ton	0.100
Asphalt Patching and Leveling Course	Ton	0.100
Asphalt Scratch Course	Square Yard or Ton	0.100
Asphalt Skid Resistant Pavement	Square Yard or Ton	0.100
Chip Seal Aggregate	Square Yard	0.100
All Types of Fog Seal, Asphalt Material	Gallon	1.000
All Types of Milling	Square Yard	0.100
Micro Surface Single or Multiple Course	Square Yard	0.100
Micro Surface Rut Fill	Ton	0.100
Division 500 Rigid Pavement		
All Portland Cement Concrete Pavement	Square Yard	0.100
Unbonded Portland Cement Concrete Overlay	Cubic Yard	0.100
Portland Cement Concrete Approach Slab	Square Yard	0.100
Sealing Joints and Cracks	Linear Foot	1.000
Type I or Type II Concrete Pavement Repair	Square Yard	0.100
Crack and Pothole Repair	Ton	0.100
Final Textured Surf Area of Diamond Ground Pavement	Square Yard	0.100
Re-Sealing Trans or Longitudinal Conc. Pavement Joint	Linear Foot	1.000
Grout Used for Subsealing of Slabs	Ton	0.100
Roller Compacted Concrete	Square Yard	0.100
Division 600 Incidental Construction		
All Classes of Structural Concrete	Cubic Yard	0.100
Concrete Protective Coating	Square Foot	0.100
All Reinforcing Steel	Pound	1.000
All Prestressed Concrete Beams and Deck Panels	Linear Foot	0.010
All Types of Pipe Culverts and Underdrains	Linear Foot	0.100
All Types of Guardrail	Linear Foot	0.100
All Right-of-Way and Temporary Fence	Linear Foot	0.100
Concrete Sidewalk	Square Yard	0.100
Bed Course Material for Sidewalk and Curb	Cubic Yard	0.100
All Types of Curbing Curb and Gutter, and Median	Linear Foot	0.100
Tunnel Liner Plate Pipe	Linear Foot	0.100
Steel Piling, Steel Bearing Piles, or Sheet	Linear Foot	0.100
Concrete Lagging	Square Foot	0.100

QUANTITY ROUNDING CRITERIA
Figure 111A

ITEM	US CUSTOMARY UNITS	DEGREE OF ACCURACY
Fabricated Structural Steel	Pound	1.000
All Types of Railing	Linear Foot	0.100
Dampproofing	Square Yard	0.100
Precast Reinforced Concrete Three-Sided Structure	Linear Foot	0.010
Precast Reinforced Concrete Wingwall	Linear Foot	0.100
Steel Grid Flooring	Linear Foot	0.100
All Timber Bridge Structures	M Board Ft	0.100
Shotcrete	Square Yard	0.100
Performed Elastomeric Joint Sealer	Linear Foot	0.100
Drilled Shaft and Rock Socket	Linear Foot	0.100
Retaining Wall, Cast-in-Place Reinforced Concrete	Square Foot	0.100
All MSE Retaining Wall	Square Foot	0.100
Horizontal Drain	Linear Foot	0.100
Concrete Gutter	Square Yard	0.100
Dumped or Grouted Dump Rock Gutter	Cubic Yard	0.100
All Temporary Pavement Markings	Linear Foot	0.100
All Temporary Barriers	Linear Foot	0.100
Water for Dust Palliative or Plants	M Gallons	1.000
All Seed Mixtures, Temporary or Permanent	Pound	0.100
Mulch, Fertilizer, and Agricultural Limestone	Ton	0.100
All Types of Matting	Square Yard	0.100
Sediment Trap, Dam, Pond, or Removal	Cubic Yard	0.100
All Silt Fence	Linear Foot	0.100
Primary Reinforcement	Square Yard	0.100
Topsoil	Cubic Yard	0.100
All Types of Roadside Sign Supports	Linear Foot	0.100
Class B Concrete Footing, Plain or Reinforced	Cubic Yard	0.100
Flat or Extruded Sign	Square Foot	0.100
Edge, Lane, Centerline, or Barrier Lines	Mile	0.001
All Types of Lines or Stripes	Linear Foot	0.100
All Waterline Pipe or Casing	Linear Foot	0.100
All Sanitary Sewer Pipe or Casing	Linear Foot	0.100
Concrete Deck Overlay	Cubic Yard	0.100
Zone Cleaning and Painting Steel Bridge	Square Foot	0.100

111.3-REVIEW AND VERIFICATION OF DAILY WORK REPORTS (DWR's)

111.3.1-Concurrent Project Finalization The project and associated materials control procedures currently employed by the Division essentially establish a concurrent finalization process for projects. In other words, after the Notice to Proceed is given to the Contractor, project finalization begins and continues throughout the project until final DOH acceptance. The importance of DOH personnel maintaining and processing day-to-day project records has been emphasized by the West Virginia Prompt Payment Act.

111.3.2-Overview of Concurrent Finalization Process To effect concurrent project finalization, information from the DWRs is processed on a day-to-day basis at the project level using AWP. DOH project personnel normally prepare and submit progress estimates monthly or semi-monthly if amount due Contractor is greater than $10,000. After the estimates are submitted for payment, the process of certifying materials (e.g., AASHTOWare Project, E 440, MMS), validating pay quantities, and obtaining Contractor concurrence is completed by DOH project and District level personnel within two weeks of submission. The Contractor's review and concurrence occurs concurrently with the Division's acceptance and payment for individual Contract pay items throughout the Contract until final acceptance.

111.3.3-DOH Personnel Responsibilities DOH personnel at the project, District, and Division levels must perform their respective duties in a timely manner to continually document, monitor, and administer project Contracts to effect their concurrent finalization, including any delays caused by DOH or delays or non-compliance caused by the Contractor. The Construction Engineer must assume an active role to ensure that the District Construction Office Manager and the District Materials Supervisor vigorously pursue their duties to concurrently finalize the project. Every Project Engineer/Supervisor and Project Inspector must understand the importance of this objective and perform his/her duties toward this goal.

111.3.4-Verification of Daily Work Report Entries The review of the DWRs is performed on a current basis to verify that all work to date is accurately documented and measured in compliance with the Contract, and to ensure timely entry of appropriate data to the DWRs and the necessary documents. Any deficiencies discovered during the verification process are corrected in accordance with established procedures. All DWRs must be checked by both Project and District level personnel. The DWRs will be reviewed to:

1. Verify that the location, measurements, quantity, quality, and progress of work are accurately documented and in compliance with the Specifications, Contract documents, and/or established procedures;
2. Verify that the accuracy of the method of measurement, "set-ups" for calculations and subsequent mathematical computations utilized to establish quantities set forth in the DWRs;
3. Verify that sufficient information exists to substantiate the quality of materials used as specified by DOH policy for minimum evidence of inspection (see Section 106);
4. Transfer appropriate data from the DWRs to the necessary project documents (e.g., As-Built Plans).

111.3.5-Review of Current Daily Work Reports To ensure proper payment for all work performed to date, the review of the current DWR is performed prior to the generation of the current estimate and represents a 100% review of project records for every item in the Contract, including lump- sum items and items added to the Contract by Change Order. All measurements, calculations, and weigh tickets are included in this review. Any deficiencies discovered during this verification process are corrected in accordance with applicable procedures prior to generation of the current estimate. The DWRs will be reviewed to:

1. Verify that DWRs accurately document measurements and the calculations of quantities for payment;
2. Verify that DWRs accurately document the quality of materials, including laboratory numbers, incorporated into the project;
3. Verify that appropriate data was transferred from the DWRs to the necessary project documents (e.g., As-Built Plans);
4. Verify that only work performed and accepted in accordance with the Specifications, Contract documents, and/or applicable procedures is included for payment on the current estimate;
5. Verify that all materials included for payment on the current estimate are covered by tests that confirm compliance with the Specifications, Contract documents, and/or applicable procedures; and
6. Verify that specific and detailed reasons are given for any variation between Plan quantities and final quantities on every completed item for payment on the current estimate.

To certify that the review has been completed as stated above, the reviewer will approve each DWR in AWP. The Project Engineer/Supervisor will approve the current estimate to signify agreement with the items and quantities represented in the estimate. The approved estimate will be forwarded to the District Office. The estimate report will be placed in ProjectWise.

The District Office must complete a 100% review of the project records for every pay item in the Contract including lump-sum items.

SECTION 112
ESTIMATES

112.1-GENERAL

112.1.1-Estimate The Estimate documents both current and total-to-date quantities based on Contract unit prices. Only work performed and accepted in accordance with the Contract will be included for payment. The Estimate will show all Non-Participating amounts on a separate line, if applicable (see Section 112.1.2).

Shipping documents and invoices that are required for payment of Stockpile Material will be placed in ProjectWise. The Project Engineer/Supervisor must ensure that all material included on the Estimate is covered by tests used to confirm compliance with the contract specifications and meets requirements relative to evidence of inspection.

112.1.2-Non-Participating Amounts The quantities and amounts shown on an Estimate will contain both participating and non-participating components. The Non- Participating Amount contains only non-participating quantities and amounts (on Federal-aid projects only) as determined from the following:

1. All items shown in the original Contract documents as non-participating or items designated by the State as non-participating;
2. All Change Orders approved as non- participating; and
3. Any item or portion of item declared in writing by FHWA as non-participating.

The non-participating total amounts for the current and total-to-date are shown on the front of the Estimate.

Documentation should be assembled and placed in the project files to justify the State's position on accepting or rejecting non-participation of such items. If further participation is justified, the Contract Administration Division will coordinate the appeal with FHWA.

112.1.3-Lump Sum Bid Items Progress payments will be prorated on a time basis, the amount of which will be determined by the duration of either the item or the project. The monthly average of such items will be determined as a percentage by dividing the duration of the item in months into 100. This percentage (rounded to the nearest whole percent) will be the amount of the lump-sum bid due the Contractor on monthly estimates. If the Contractor receives semi-monthly estimates, one-half of the monthly average (rounded to the nearest whole percent) will be used on the estimate.

Lump-sum items such as "mobilization", "cofferdams", "Temporary Structure for Maintaining Traffic", and "Construction Layout Stakes" will be handled in accordance with the contract specifications for the amounts to be paid on the estimates.

All lump-sum bid items must also be recorded in the Daily Work Report with verification that the item was performed in accordance with the contract specifications.

112.1.4-Multi-Authorization Projects When a project includes multiple authorization numbers, the files should be maintained in accordance with the following procedures:

1. An Estimate will be prepared for the work performed in each authorization to assure monetary charges against the proper authorization number; and
2. All data maintained in the project files will be maintained in one set of files because no noticeable benefits would be derived from maintaining a separate file for each authorization.

When more than one project is included in a Contract, a separate estimate must be prepared for each project. When a single Federal-aid project is divided into sections (urban and rural), it is not necessary to prepare a separate estimate for each section.

112.2-CURRENT ESTIMATES

112.2.1-Preparation and Submission A Progress Estimate is used to pay for current Contract quantities as computed by project and District level personnel. The Project Engineer/Supervisor is responsible for the preparation, verification for accuracy, and submission of each Progress Estimate to the District Office. The Project Engineer/Supervisor will review the quantities for payment on the current Progress Estimates from the DWRs that document the work performed.

The cut-off dates for Progress Estimates will be sent out at the beginning of each year, from Contract Administration. Generally, there will be two Estimates per month. Progress Estimates will include payment for all work completed in accordance with the contract specifications through the close of business on the estimate's cut-off date.

All Progress Estimates are to be received in the District Office by the close of business on the 2nd working day following the estimate's cut-off date. Each estimate will reviewed and approved by the District level personnel by the close of business the Friday following the cut-off date. Once approved by the District level personnel, the Estimate Report will be sent to OASIS and Finance & Administration Division, through the Site Manager Reports. One copy will be placed in Project Wise. The District Office Manager or designed district personnel should verify all progress estimates were interfaced successfully into OASIS the following Monday.

A concerted effort by all project and District level personnel involved in the processing of Progress Estimates is required to meet the respective time frames.

Copies of the Progress Estimate will be sent to the Contractor by the District Construction Office.

112.2.2-Unclassified Excavation Current estimates for quantities of unclassified excavation must be computed from cross-section sheets or listed by load count (which may be confirmed after reviewing the cross sections) to document excavation made to date and shown on the estimate. Quantities for current estimates may be determined using one elevation on the centerline. Slope elevations will not usually be required if checks have been made and indicate substantial conformity to Plan templates. However, if the bottom of the cut is not reasonably level, or is stepped, more than one elevation may be necessary. Each section should always be computed from the original ground to the current line of excavation to eliminate the possibility of any carry over of errors in previous determinations.

112.2.3-Stockpile Material The Contractor may request payment for Stockpiled Materials in accordance with the contract specifications. See Section 109.2.1 for documenting and processing.

112.2.4-Overruns Substantial overruns must be covered by approved Change Orders (e.g., Supplemental Agreements, LME Force Account Work Orders) which must be submitted in sufficient time ahead of the change to permit clearance with FHWA before any extra work is performed. The proper preparation and approval of Change Orders provides the basis for approval of overruns, modification of the project agreement, and maximum Federal participation. This procedure also allows the Division to voucher and receive current payments from FHWA on the items overrun.

112.2.5-Retained Percentages Retainage will not be withheld from Progress Payments, unless the Contractor specifically requests that retainage be withheld. Contractors who do not request that retainage be withheld are required to submit a contract bond, in the amount of 102% of the contract bid amount, at the time of acceptance of the bids.

For projects that the Contractor elects to have retainage withheld, two percent (2%) of the total amount shown on each Estimate will be retained by the Division. The total amount retained may be reduced from 2% to 0.5% when all field and punch list items are complete (payment of 75% of 2% retainage results in 0.5% retained). Upon written request by the Contractor, accompanied by proper release by its Surety, and the recommendation of the District Construction Engineer, the release will be considered for approval. When the Contractor requests and obtains approval of the release, the estimate releasing the retained percentage for payment is processed like a monthly estimate and is marked “semi-final.” The semi-final estimate can be submitted on any date.

112.3-FINAL ESTIMATE

112.3.1-Final Estimate Processing Upon completion of the project, the final estimate is prepared for the final payment of the Contract. The final estimate is the ultimate document processed for a Contract and must be accompanied by complete data substantiating the measurements and quantities for each item.

If the Contract is a non-exempt Federal-aid Contract in excess of one million dollars in cost, the final estimate with supporting data will be transmitted to the Contract Management Coordinator, Contract Administration Division, for a Division check review. Federal exempt contracts and State-funded contracts do not require the submission of the tentative final. After review by the Project Control Unit, the final estimate and supporting documents, with corrections or approval noted by the Contract Administration Division, will be transmitted back to the District for generation of the Final Estimate.

112.3.2-Unclassified Excavation The final cross sections must be plotted on the original cross-section sheets on which the templates are shown. Reference blocks giving the dates of plotting and Field Survey Book numbers should be completed for reference purposes. Each sheet should be clearly marked and titled.

Any cross-section station on which the final section varies from the Plan template by an amount greater than the specified tolerance must contain a note signed by the Project Engineer/ Supervisor explaining the deviation.

Pay lines must be drawn before submission and processing of any final. Pay lines are based on the recommendation of the Project Engineer/Supervisor and will depend on the project conditions and contract specifications.

When structure excavation or other items account for volumes of material intersecting the unclassified excavation areas, pay lines must be shown on the cross-section sheets to avoid duplication of payment.

The final pay quantity for unclassified excavation should be broken down as indicated in the earthwork table of balances in the Contract plans. Additionally, significant overruns or underruns for each balance (e.g., STA 100+00 to STA 110+00, STA 110+00 to STA 120+00) should be documented and the discrepancy explained.

112.3.3-Contract Adjustments Items such as bridge deck tolerance penalties, liquidated damages, fuel and asphalt adjustments, incentive and disincentive payments, smoothness testing, asphalt/concrete price adjustments, and penalties for failing materials are considered contract adjustments. These adjustments will be maintained and processed in AASHTOWare Project (AWP).

Reductions in price for deficient materials are initiated by the District Materials Supervisor with the computational methods dictated by the contract specifications or recommendations of MCS&T Division. The acceptability of any material not meeting the requirements of the contract specifications should be documented with appropriate reductions or corrections. Price reductions for material deficiencies should be treated as lump- sum price deductions rather than adjustments to unit prices. This prevents unnecessary changes when quantities are adjusted during finalization.

Liquidated damages are assessed when the actual time for completion of the project exceeds the sum of the time allotted in the Proposal plus approved time extensions. The days for which liquidated damages are to be assessed are shown on the working time report. The recommendation and computation for the monetary charges based on the applicable Specifications will be automatically charged in AWP.

112.3.4-Affidavit of Acceptance Before final payment is made, the Contractor shall execute an Affidavit of Acceptance which is attached to the final estimate. If the Contractor desires to reserve a right to file a claim with the Court of Claims for any sum or compensation not included in the final estimate, growing out of the Contract and the Project, then a reservation of right should be added at the end of the acceptance statement and before the attestation paragraph below. The form for Affidavit of Acceptance, without stipulation and with stipulation, should be identical to that shown in the Paragraph below.

THE WITHIN AMOUNT OF ____________________, dollars ($ ____________________) set out and shown in this final estimate, being Estimate No. ____________________, is hereby accepted and approved by ____________________ (Contractor), as full and complete payment and settlement for all sums, claims and monies due and owing or to become due and owing, to ____________________ (it, him, them) as the Contractor for Federal Project Number ____________________, State Project Number __________________ in __________________ County, West Virginia and the said, __________________ (Name of Contractor) does hereby agree that all previous payments shown deducted therein and all amounts retained or deducted under the provisions of the Contract are proper and correct subject to the exception, if any, and the reservation of the right of the Contractor, (Name of Contractor), to file (it, his, their) petition in the West Virginia Court of Claims against the State of West Virginia and the West Virginia Division of Highways within 120 days from the date of acceptance and approval of this final estimate, for the following (Contractor must state nature, each item and amount of any claim below or all claims for additional time or money shall be deemed waived): The Contractor may attach additions sheets if necessary.

*IN WITNESS WHEREOF, ____________________(Name of Contractor) has caused (its, his, their) name to be signed and (its, his, their) corporate seal(s) affixed hereto by (its, his, their) proper officer(s), thereunto duly authorized this day of __________________________, _____.

____

(Name of Contractor)
Affix
Corporate Seal
By: ______________________________________
Its: ______________________________________

* If more than one individual Contractor, add as many lines as necessary for signature.

SECTION 113
REPORTS

113.1-FINAL ESTIMATE DOCUMENTATION

113.1.1-Overview

The following documents are required with the Final Estimate Package and should be fully executed, unless otherwise indicated, prior to or along with submission of the final estimate.

1. Estimate Report
2. Reservation of Right Clause, with Contractor's Seal
3. All Contract adjustments - if/App
4. Contract Award Document
5. NTP
6. Start Notice
7. Change Order Status
8. Summary of Financial Contract Requirements
9. Liquidated Damages and Contract Adjustments Summary - if/App
10. Time Extension Change Order Explanation – if/App
11. Final Inspection Report
12. District Check Log Sheet
13. Letter of Materials Certification
14. External Contract Compliance Report - if/App
15. Outstanding DWR report
16. Business and Occupation Tax Release – if/App
17. Division Check – if/App
18. Supplemental Disclosure of Interested Parties - if/App
19. BF-150

113.1.2-Contractor's Performance Report The Contractor's Performance Report is a confidential evaluation form that is prepared to evaluate the Contractor's performance on the Contract. The Report is used in consideration of the Contractor for future work. The Report will be submitted directly to the Director of the Contract Administration Division upon completion of the project. After review, the Report will be forwarded to the Contractor Prequalification/Financial Coordinator Unit, Contract Administration Division where it will be filed in the Contractor's records.

113.1.3-Contract Completion Report and Request to Release of Final Estimate Contract Completion Report and Request for Release of Final Settlement are the actual acceptance of the work, list project authorized/spent amounts, and the release of the Contractor by the Division. These reports are prepared by the District Office Manager and are forwarded to the District Construction Engineer for approval.

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113.1.4-Letter of Certification of Materials A letter of certification stating that all materials used on the project met the Specification requirements is prepared and signed by the Director of MCS&T Division. The information used in preparation of this letter is submitted on electronic Form MC-8. The District Construction Engineer is responsible for the accuracy of the statements made on this form.

113.1.5-As-Built Plans Each project will maintain one set of As-Built Plans, which consists of the plan and profile sheets and the cross section sheets. The As-Built Plans will be maintained by the project as a working set and be retained by the District after project completion.

As-Built Plans show the various bid items as they were actually constructed. A desirable set of As-Built Plans is one that is marked only where a change has been made in the original Plans. All work conforming to the original Plans requires no comment. As-Built plans should be saved in 'As Build Plans' folder on ProjectWise.

Consider the following major items relative to the preparation of As-Built Plans:

1. Horizontal and Vertical Alignment. Any changes in alignment will be clearly shown by recording the revised control points such as PIs, PCs, and PTs. Show the revised grade, R/W and/or controlled access lines. Include sufficient data to permit the reestablishment of centerline, right-of-way line, and grade line at any location on the project. Show equations in stationing due to line revisions.
2. Excavation. The following data need not be shown on the as-built cross sections: The elevations of "elevation control hubs" will be recorded on the working set of As-Built Plans to verify the accuracy of original cross sections. Revised sections will be taken where necessary and the monthly cross sections, to substantiate progress estimate payments for unclassified excavation, will be taken and plotted on the working set. The as-built sections will show plan templates, revised original cross sections, and revised grades and slopes with pay lines, where necessary, on the original set. District should follow ProjectWise manual for archiving after project close out.
3. Drainage Structures (Pipe Culverts, Boxes, Headwalls, Inlets, etc.). Show any change from original plan such as location, length, flow line, type, size, etc.
4. Bases, Pavement. Show any changes in type or dimensions of these items with typical sections showing the area affected by this change.
5. Bridges. Show any change such as footer elevations, depth of piling, etc.

The above items are not all inclusive; however, it is essential that all changes from the original Plan be documented so that the As-Built Plans will present a true representation of the project as actually constructed. The As-Built Plans can also be used to plot the clearing and grubbing measurements and seeding and mulching horizontal measurements to ensure that no overlapping or omitted areas are represented for payment. The District should follow ProjectWise manual for arching project after close out.

113.1.6-Final Quantity Change Order (FQCO) The remaining quantities for all contract items shall be zero on the final estimate report. This is archived by final over and under change order to explain all overruns and under The Report compares plan quantity and final quantity, giving specific and detailed reasons for major variations.

113.1.7-Tax Release The Business and Occupational Tax releases from the municipality must be obtained prior to the payment of the final estimate as prescribed by statute of the State of West Virginia, Chapter II, Article 10, Section 11, Paragraph (d), which reads as follows:

> *(d) Prerequisite to final settlement of contract with this State or political subdivision; penalty. – All state, county, district and municipal officers and agents making contracts on behalf of this State or any political subdivision thereof shall withhold payment, in the final settlement of any such contract, until the receipt of a certificate from the tax commissioner to the effect that the taxes imposed by articles thirteen, twenty-one and twenty-four [11-13- 1 et seq., 11-21-1 et seq. and 11-24-1 et seq.] of this chapter against the contractor have been paid or provided for. If the transaction embodied in such contract or the subject matter of the contract is subject to county or municipal business and occupation taxes levied or accrued against the contractor has been paid. Any official violating this section shall be subject to a civil penalty of one thousand dollars, recoverable as a debt in a civil action brought by the tax commissioner.*

SECTION 114
COMPLETION OR PROJECT AND FINAL INSPECTION

114.1-FINAL REVIEW AND VERIFICATION OF PROJECT

Inspection, finalization, and certification begin as soon as the project is started and continue throughout the project duration until final completion and acceptance. The objective is to locate any items or details of the work that do not conform to Contract requirements and to determine what remains to be performed so that the project will be completed in accordance with the Contract. As portions of the project are completed, the Project Engineer/Supervisor should make a thorough inspection in sufficient time to inform the Contractor of all deficiencies so that the Contractor can make necessary corrections before removing equipment from the site.

Finalization at the District level is a seven-step process which represents completion of a 100% review of the project records for every item in the Contract, including lump-sum items and items that were added to the Contract by Change Orders. All items will be checked prior to approval of each Progress Estimate.

The following describes the seven-step process for concurrent and final review and verification of the project Steps 4 through 7 are applicable only to the final review:

1. Step 1. The District will review the DWRs to:
   a. Verify that the location, measurement, quantity, quality, and progress of work are accurately documented and in compliance with the Contract Specifications, Contract documents, and/or established procedures; and
   b. Verify the method of measurement, accuracy of "set-ups" for calculations, and subsequent mathematical computations used to establish pay quantities of every item represented for payment on the Draft final estimate.
2. Step 2. The District will review the Draft Final Estimate to:
   a. Verify that only work performed and accepted in accordance with the Contract is included for payment on the Final Estimate;
   b. Verify that appropriate data was accurately transferred from the DWRs to the necessary project documents (e.g., As-Built Plans); and
   c. Verify that specific and detailed reasons are given for any variations between the Plan quantity and final quantity of every item represented for payment on the current voucher tentative final estimate.

   Any deficiencies discovered during the verification process are corrected in accordance with applicable procedures. Performance of the District level review of the DWRs, and the accuracy of the items and quantities represented on the reports are verified by approval of each Progress Estimate.

3. Step 3. The District will review the Project staff's compliance with established finalization procedures. Notify the Construction Engineer of any major deviations for appropriate action to prevent recurrence.
4. Step 4. Non-exempt Federal-aid projects on the NHS with a final Contract amount equal to or greater than one million dollars requires a Division check and submission of the following support documents to the Finalization Unit, Contract Administration Division for further processing:
   a. All DWRs and worksheet attachments;
   b. Report on Final Quantities;
   c. As-Built Plans and original cross sections;
   d. Excavation Summary Sheets (Form 414) with secondary computations of the excavation between Plan balance points for comparative analysis purposes;
   e. Unapproved Change Orders included for final payment.

   The email transmitting the Final Estimate to the Contract Administration Division should contain all of the items listed in the Final Estimate Package cover letter. All exempt and non-exempt Federal-aid projects having a final Contract amount less than one million dollars and State funded projects require the following:
   i. Resolution of the working time and evidence of Materials Certification;
   ii. Submission of the Request for Release of Final Settlement Form to the Finance & Administration Division for further processing.
5. Step 5. The final estimate will be submitted to the Contractor for signature of the Statement of Acceptance on the reverse side of the first page of the final estimate.
6. Step 6. A complete Final Estimate package should be placed in ProjectWise and forwarded to Finalization Section, Contract Administration for further processing. See Section 113 for required documents in the Final Estimate Package.
7. Step 7. Retention of the Project Records will be in accordance with the DOH Records Management Program.

114.2-FINAL INSPECTION

When all work under the Contract has been completed and Contractor has executed and delivered all required document, certificates, and proof of compliance, and provided written notice of completion to the satisfaction of the Project Engineer/Supervisor, he/she will notify the Office Manager, Area Engineer, and District Construction Engineer that the project is completed and ready for final inspection. The District Construction Engineer will, in turn, notify the Regional Construction Engineer who will then make a formal request to the Federal Highway Administration, if Federal-aid is involved, for a final inspection of the project. The District Construction Engineer will schedule the date selected for this inspection within 30 calendar days. The inspection party should consist of the following:

1. Exempt Federal-Aid and State Funded Projects < $1,000,000. The inspection party will consist of Project and District personnel and other DOH personnel, as appropriate (e.g., designer, traffic, maintenance, geotechnical).

2. Exempt Federal-Aid and State Funded Projects > $1,000,000. The inspection party will include the Regional Construction Engineer from the Contract Administration Division and the personnel in Item 1.
3. Non-Exempt Federal-Aid and Concurrence Projects > $1,000,000. The inspection party will consist of the FHWA Area Engineer, the Regional Construction Engineer from the Contract Administration Division, and the personnel in Item 1.

The Division reserves the right to review any project records to verify the deficiencies (Contractor or DOH) or to attend any final inspection regardless of the project type or dollar amount. The party on the final inspection will examine the project in sufficient detail to determine that the work is complete in accordance with the Plans and Specifications as amended by Supplemental Agreements and Change Orders. The members should note especially that the drainage system is clean and that all cleanup work has been performed. The note keeper designated by the Project Engineer/Supervisor should record every item or detail that the party making the final inspection considers defective in construction or contractual obligation specified in the Contract documents (see Section 114.3). The list must describe the defect, show its exact location, and specify what must be done to improve the item to an acceptable condition and should be entered in AWP. The Contractor will receive a copy of the SiteManager Report that cites each punch list item. A copy of the Final Inspection Report is stored in ProjectWise.

114.3-PUNCH LIST

If the Engineer determines any work, in whole or part, is unsatisfactory, the Engineer will give the Contractor a punch list for correction in writing, within 15 calendar days after final inspection.

114.3.1-Contractor Punch List In addition to physical construction deficiencies, the Contractor also may be deficient in other Contract obligations. The following also may be included on the Contractor Punch List:

1. Municipal B&O tax releases;
2. All current certified payrolls;
3. Property owner releases on all waste sites;
4. Test results and disposal records for hazardous waste;
5. All contractor's materials deficiencies (e.g., missing shipping documents, missing test reports, resolution of hot loads placed, HMA placed in rain);
6. Working time; and
7. Unsigned change orders.

The following represents a partial list of what could be placed on the Punch List:

1. Samples not taken or not completed by the Division or District including:
    a. Coring or smoothness; and
    b. Acceptance samples not tested or not evaluated;

    If evaluation is not complete because the Contractor has not submitted the Quality Control samples, stipulate such and ensure that the missing samples are on the Contractor Punch List;

2. Reports not submitted or processed including:
    a. District Materials Inspection Reports (MIR); and
    b. Change Orders;
3. Working time not evaluated; and
4. Interdepartmental and/or FHWA negotiations.

The Contractor must supply all material certifications, all documents necessary for project finalization, and agree to final quantities within 90 calendar days of punch list notice. If the Contractor fails to give notice of disagreement to the Engineer about any issue within 90 calendar days of punch list notice, including the reason for dispute and justification, the final payment will be based on the Engineer's list of final quantities. If the Contractor fails to provide material certification, the Division may deduct cost of material from the project. The Contractor shall complete all remaining punch list work within 135 calendar days of punch list notice. If the Engineer determines that the punch list is incomplete, the Division may withhold all payments on any and all Contracts.

When the Contractor has completed the items on the Contract Punch List, the normal acceptance process continues, beginning with the Contract Completion Report, regardless of the status of the DOH Punch List activities.

After the final inspection and after all items on the Contractor Punch List have been properly rectified, the District Construction Engineer will prepare a Contract Completion Report (Form 416) and submit it to the Director of the Contract Administration Division with a copy of the Final Inspection Report attached.

SECTION 115
RECORDS MANAGEMENT

In addition to the maintenance of regular and accurate records, the management of these records is an equally important function of any organization. Records management is planned control of all types of records in an organization from their creation to final disposition. It may be further defined as the application of scientific control to creating, processing, filing, maintaining, protecting, and disposing of an organization's records. An adequate records management program coordinates and protects the organization's records, sharpens the effectiveness of records as a management memory, controls the time, equipment, and space allocated to records, and helps to simplify intra-organizational communication problems.

115.1-RECORDS MANAGEMENT

115.1.1-Federally Funded Projects Records management for Federally funded projects includes the flow of all project records from the inception of the project through the date the final voucher is paid. Project records, which include Project files, District files and the Contract Administration Division's files (i.e., master files), constitute primary pay documentation. The project files will be stored in ProjectWise per the current Retention policy, all records will be available for audit by the Federal Highway Administration, independent auditors, in-house auditors, or any other authorized party. Finance & Administration Division provides a monthly report to Contract Administration of Final Estimates received and processed by the Federal Aid Section. The Final Estimate communicates that the project is complete and can be closed once the final payment is process. Final Voucher is the document created by Federal Aid to reconcile the project between State and Federal systems to close the project. Final Vouchers do not usually result in a payment from FHWA. Payments of participating expenses on Progress Estimates and Final Estimates result in payments from FHWA. Project files for federal projects are retained according to the Divisions retention policy which complies with the three year minimum of after the Final Voucher is processed in the FHWA system to close the project.

115.1.2-State Funded Projects The project files will be store in ProjectWise per the current Retention policy.

Except for As-Built Plans and the original cross- sections, all records in the District Office and in the Central Office, Contract Administration Division, will be disposed of three years following final payment to the Contractor. As- Built Plans and original cross sections must be retained permanently, either in hard copy or other media form.

DIVISION 200
EARTHWORK

SECTION 201
CLEARING AND GRUBBING

201.1-GENERAL

201.1.1-Description of Work To prepare the right-of-way for grading, the Contractor usually will perform a clearing and grubbing operation. Within the construction and easement limits and in designated areas within the right-of-way, the Contractor will selectively remove and dispose of natural and manmade objects that are not designated by WVDOH to remain in place (e.g., vegetative undergrowth, trees, stumps, debris, buildings, foundations, abandoned utilities, drainage structures). The Contractor also will clear and grub any needed borrow and waste sites. The contract plans and specifications designate the areas to be cleared and grubbed. Field operations and other factors may require the Contractor to clear and grub additional areas not designated on the plans. The Project Engineer/Supervisor is responsible for informing the Contractor of the desired disposition of any such additional areas.

201.1.2-Protection and Preservation of Property The Contractor must protect and preserve not only the designated items and areas within the right-of-way but also the natural growth and man-made improvements on adjacent properties. Where damage occurs, the Contractor is solely responsibility for correcting the damage. The Contractor will determine the method in which to protect and preserve designated items and areas. Do not direct the Contractor how to accomplish this task unless specifically covered in the plans and specifications and as long as the method is reasonable and consistent with good construction practice.

201.1.3-Plans-In-Hand Meeting Before the Contractor begins work, the Project Engineer/ Supervisor and all Inspectors should review and become familiar with the contract plans, specifications, permits, and agreements. Meet with the Contractor and travel the job site to discuss the general nature of the work to be performed and any special details that are specified in the contract. Ensure the work area and the items to be preserved and protected are clearly marked and communicated to the Contractor. During the meeting, specifically note and discuss the following:

1. Work boundaries, plan limits, and field stakes;
2. Selective thinning areas designated on the plans and any additional clearing and grubbing areas;
3. Roadway alignment and typical sections;
4. Soil Profile, embankment and cut slopes, and shrink/swell factors;
5. Blasting requirements, plans, and permits;
6. Existing and proposed drainage profiles;
7. Erosion and sediment control requirements plans, and in-place treatments;
8. Wetland areas, unusual soil and moisture conditions (e.g., springs, seeps, swamps);

9. Buildings, utilities, railroads, fences, and other obstructions to be demolished, relocated, or protected;
10. Requirements, plans, and permits for demolition/dismantling structures;
11. Private property boundaries, restricted areas, and off-site property agreements;
12. Trees, shrubs, survey monuments, historical markers, and other physical features to be protected, preserved, or relocated;
13. Historical and archaeological sites and related SHPO permits;
14. Borrow sources, waste sites, hazardous material removal and disposal plans, and related DEP permits;
15. Haul roads, access points to the construction site and adjacent properties, drainage, and any restoration and seeding requirements;
16. In-place traffic control measures and plans for maintenance and protection of traffic during construction;
17. Subgrade and embankment stabilization requirements;
18. Right-of-way infringements and unresolved right-of-way agreements; and
19. Any materials issues including sampling frequencies, testing procedures, laboratory numbers, Approved materials list, and Quality Control Plan requirements for the requisite work of the contract.

Emphasize to the Contractor to protect and preserve all alignment stakes, grade stakes, guard stakes, boundary markers, benchmarks, tie points, and other similar items during construction. The Project Engineer/Supervisor will determine when such items are no longer needed and inform the Contractor when they may be removed or destroyed.

201.1.4-Off-Site Property Agreements The Contractor may have to temporarily use private properties or adjacent lands outside the right-of-way for purposes such as staging areas, construction yards, stockpile areas, project access, and/or construction offices. The Contractor should have a written agreement with the property owner before using property off the right-of-way. The agreement primarily serves as written permission from the owner to the Contractor for using the land for an intended purpose. The terms and conditions of the agreement typically define acceptable and unacceptable uses of the property and any required evidence that the owner is satisfied with the Contractor's restoration and cleanup. Representatives of the Contractor and the property owner, not WVDOH personnel, sign the agreement.

201.1.5-Utilities The Contractor is responsible for locating, protecting, and/or adjusting all existing utility facilities. Consider the following guidelines:

1. Miss Utility. The Contractor is responsible for contacting Miss Utility and coordinating with the affected utility companies. and that all existing underground utility locations are established and adequately marked
2. Plans-In-Hand-Meeting. Ensure that representatives of affected utility companies are present during the plans-in-hand meeting to assist in establishing and marking the location and depth of all underground facilities within the right-of-way.
3. Damages. Any damage to existing utilities is solely the Contractor's responsibility. Visually check and report in the Daily Report any damaged utilities.

4. Utility Adjustments. Utility adjustments within the right-of-way may need to be scheduled in a particular sequence with other construction operations. In such cases, check to make certain the Contractor understands the required sequence of events and the operations are implemented accordingly.
5. Abandoned Utility Poles. The Project Engineer/Supervisor is responsible for marking abandoned utility poles to be removed. Visually inspect the area to check that the Contractor removes the abandoned utility poles marked within the limits of the right-of-way and that the poles are properly disposed of (see Section 201.5).

201.1.6-One-and-Off-Site Drainage The Contractor is responsible for maintaining adequate drainage within the right-of-way. Check existing and proposed drainage profiles on the plans to make sure existing drainage has not changed, proposed drainage will not flow onto adjacent properties, and natural drainage will not be altered to impact landowners or structures in either upstream or downstream direction. Impacts can extend a considerable distance from the point of disturbance. Carefully monitor areas near streams and other natural bodies of water for erosion and sedimentation. Inspect the drainage of lands adjacent to the roadway to make certain all drainage structures, inlets, outlets, channels, and dikes are functioning and/or properly located.

201.1.7-Erosion and Sediment Control Roadway construction projects disturb large areas of natural vegetation that can accelerate the rate of soil erosion and sedimentation. Before allowing the clearing and grubbing operation to begin, check that the Contractor has an approved Storm Water Pollution Prevention Plan, and visually inspect that the Contractor has satisfactorily implemented Phase I of the Plan. See the WVDEP Erosion and Sediment Control Best Management Practices Manual for additional information. The Contractor should clear an area sufficient to allow grading operations to progress without interruption; however, do not allow the Contractor to expose an area of erodible soil that exceeds the limits of the contract plans and specifications. Frequently inspect construction operations to check that the Contractor logically sequences activities to minimize potential damage to earthwork during heavy rains. See Section 207.1.4 for additional information on erosion and sediment control and Section 107.4.9 for information on NPDES permits.

201.1.8-Materials and Equipment Project materials must conform to the contract specifications and be delivered with appropriate laboratory numbers. See Division 700 for information on control of materials. Do not direct the Contractor regarding equipment type or usage. Inform the Contractor of any equipment that violates the specifications. Visually inspect equipment that does not perform satisfactorily. Notify the Contractor of any equipment or operation that is an apparent or obvious safety violation. Do not dictate a method of operation unless it specifically violates the specifications or safety requirements and as long as it is reasonable and consistent with good construction practice.

201.2-HAZARDS

201.2.1-Public Safety Public and private roadways and intersections may be affected by the

Contractor's construction activities. The Contractor is responsible for maintaining these facilities in a safe and passable condition. Perform daily visual checks to ensure the Contractor is adequately cleaning and sweeping mud, oil, debris, and any other objectionable materials from the traveled way.

Do not allow the Contractor to place any equipment or materials that would be an obvious hazard to vehicular or pedestrian traffic. Check that the Contractor has an approved plan for maintaining and protecting traffic during construction. Visually inspect that the Contractor is performing this task in accordance with the governing contract specifications and note the observations in the Daily Report. See the WVDOH publication Traffic Control for Street and Highway Construction and Maintenance Operations for additional information. Do not allow the Contractor to engage in any operation that would steepen the slopes of embankments.

<u>201.2.2-Use of Explosives</u> Although infrequent, the Contractor may need to use explosives during clearing and grubbing activities (e.g., use of Primacord to fell trees). The transport, storage, handling, and detonation of explosives pose extreme and potentially hazardous conditions to workers and the general public. Such operations always should be conducted under the careful, competent supervision of licensed personnel to prevent injury to persons and damage to adjacent properties with controlled blasting plans. Inform the Contractor of any apparent or obvious safety violations or acts that do not comply with the contract specifications. See Sections 207.1.7, 207.2.2, and 207.3.3 for additional information on explosives and acceptable blasting operations.

<u>201.2.3-Tall Timbered Regions</u> Clearing and grubbing operations, particularly in dense, tall timbered regions, can be very hazardous. All project personnel should be especially careful in the vicinity of clearing such areas. Immediately inform the Contractor if clearing tall timber endangers personnel, poses a potential hazard to the general public, or damages existing facilities in or adjacent to the right-of-way. The Contractor typically will use specialized methods and equipment to safely and effectively fell extremely tall timber.

<u>201.2.4-Fire Hazards</u> If permitted, the Contractor frequently will elect to burn vegetative waste materials on the project right-of-way (see Section 201.5.2.1). The Contractor is solely responsible for the careful control of such operations. Left unattended or performed improperly, open-air burning of vegetative materials can quickly develop into wildfires outside the right-of-way. The Contractor will be held responsible for any damage caused by fire. Consider the following guidelines:

1. <u>Legal Issues</u>. Check that the Contractor's burning operation is performed in accordance with the contract specifications, applicable laws, ordinances, regulations, and requires an approval from the West Virginia Department of Environmental Protection, Division of Air Quality (DEP).
2. <u>Firefighting Equipment</u>. Check to make sure the Contractor has adequate firefighting equipment (fire extinguisher, bulldozer, excavator, shovel, etc.) readily available.
3. <u>Watchmen</u>. Check that the Contractor provides adequate watchmen to control the spread of fire.

4. Location. Visually inspect that the Contractor is burning debris on the right-of- way and in a location that will prevent the spread of fire to adjacent timber or other combustible materials.
5. Utilities. Do not allow the Contractor to burn materials anywhere near overhead utility lines. Also, give consideration to the type and depth of existing underground utility facilities (e.g., gas lines).
6. Preparation of Area. Inspect the burning operation to make sure the Contractor properly prepares and cleans the sur- rounding area of combustible debris.
7. Unfavorable Conditions. In high winds or very dry conditions, halt burning operations in lieu of more favorable weather and ground moisture conditions. Verify that the Contractor douses smoldering embers to prevent rekindling by high winds.

201.2.5-Poisonous Plants All project personnel should use caution when working in areas known to have poison oak and poison ivy. The oils from these common poisonous plants cause an irritable rash when contact is made with the skin. In addition, the smoke from burning these poisonous plants can cause an equally serious condition, both internal and external. Those individuals with severe allergic reaction to such exposure will require immediate medical assistance.

201.3-EXCAVATION AREAS

201.3.1-Clearing and Grubbing in Excavation Areas The Contractor is responsible for clearing and grubbing all trees, undergrowth, stumps, etc. except for those trees and shrubs that are designated in the plans and specifications to remain in place. As long as the method and equipment used by the Contractor is satisfactory, allow the Contractor to carry out this task without intervention. Inform the Contractor if the specifications or common sense dictates otherwise. Timber clearing methods vary from simply sawing and felling a tree to using heavy equipment to topple the tree and completely remove its stump and attached roots. Very effective machinery exists to perform this task. If explosives are used, the Contractor should use them in a safe and controlled manner (see Section 201.2.2). The Inspector is responsible only for checking that the Contractor performs the work satisfactorily with the contract.

201.3.2-Extent of Removal The Contractor will remove trees, stumps and large roots from excavation areas (e.g., roadway, channel) to a depth that will satisfy the contract plans and specifications and prevent such objectionable items from being mixed with embankment material. In excavation areas, use the following guidelines to inspect the Contractor's clearing and grubbing operation:

1. Construction Limits/Selective Areas. In areas marked on the plans that are not within the construction limits or selective clearing areas, visually check that all stumps are grubbed or cut flush with the ground and that all brush, shrubs, felled timber, rotten wood, rubbish, and other objectionable objects and vegetation are cleared.
2. Backslope Area. Where stumps are located in the backslope area, especially where the cut section is rounded, check that the Contractor cuts tree stumps flush with or below the final grade line.

3. Scalping and Root Raking. The Contractor normally will scalp the area to remove small bushes, vegetation, rubbish, and other objectionable material. In addition, areas with heavy timber, undergrowth, and small trees normally will require root raking to remove roots that remain after clearing.
4. Root Damage. Check the extent of root damage to standing trees to remain near cut slopes and consider the need to remove these trees. The excavation operation may have damaged the roots sufficiently to kill the tree or cause the tree to fall later.

201.3.3-Selective Clearing and Thinning Trees and shrubs in certain areas that will not interfere with the highway or its drainage system often are selected to remain in place for their scenic, horticulture, historic, or other salvage value. WVDOH primarily uses selective clearing and thinning in wetland areas. Consider the following guidelines:

1. Contract Plans. The project plans will designate the selective clearing and thinning areas and those trees and shrubs to remain in place.
2. Advance Notice and Authorization. The Contractor will notify the Project Engineer/ Supervisor at least two weeks in advance of performing clearing and thinning so that the trees and shrubs can be properly marked. The Project Engineer/Supervisor will notify the Contractor when to begin the clearing and thinning operation. The Contractor must not begin until such notification is given.
3. Marking, Protection, and Damage. Ensure that designated trees and shrubs are clearly marked and that the Contractor takes precautionary measures to protect them from injury. Designated trees and shrubs must remain in place without damage. The Contractor is solely responsible for correcting any damage. Check that the Contractor carefully repairs any damages or injuries in accordance with the contract specifications. Note this on the DWR.
4. Ground Preservation. In areas where trees and shrubs are to remain, do not allow the Contractor to unduly disturb or compact the ground surface. As practical in these areas, direct the Contractor to preserve the existing ground cover and maintain the area in a condition that is consistent with natural surroundings. Unless specifically authorized by the Project Engineer/Supervisor, do not allow the Contractor to use tractors, cranes, winches, and any other heavy equipment in areas to be selectively thinned.
5. Extent of Removal. Check that the Contractor removes dead and diseased trees and shrubs, junk, trash, litter, uprooted stumps, and the branches, tops, trunks, and dead wood from woodcutting operations. Visually inspect that all stumps, new or old, are cut to a maximum height of 6 in above the surrounding ground or as otherwise directed by the Project Engineer/Supervisor. Visually inspect the right-of- way line and inform the Contractor to cut any undesirable trees that lean over the right-of-way from adjacent property. Under this situation, contact the Right-of-Way Division to ensure that an agreement is made with the property owner (e.g., temporary construction easement).
6. Pruning. Visually inspect that the Contractor prunes low hanging, dead, diseased, and unsightly limbs from those trees that are to remain. Check that the Contractor trims tree branches that extend over the roadbed to provide a clear height of 20 ft above

the roadbed surface. As necessary through terms of the contract, the Project Engineer/Supervisor may require Contractor to prune certain trees or clear certain areas to improve sight distance, increase overhead clearance, open vistas, remove shade hazards, and improve the general appearance of the site. The Contractor must prune trees and shrubs in a manner that will not damage the plant. Check that skilled workmen use good tree surgery practice to prune trees in accordance with the contract specifications.

201.4-EMBANKMENT AREAS

201.4.1-Clearing and Grubbing in Embankment Areas Unless otherwise designated on the plans, the Contractor will clear and grub all trees and undergrowth in embankment areas. The general requirements for excavation areas will apply to the areas being prepared for embankment. Use the following additional criteria to inspect the Contractor's clearing and grubbing operations in embankment areas:

1. Embankment Depth < 5 ft. In areas where the proposed embankment is less than 5 ft in depth, check that the Contractor completely grubs all trees, stumps, roots, bushes, and/or hedge fences.
2. Embankment Depth ≥ 5 ft. In areas where the proposed embankment is 5 ft or more in depth, measured below the subgrade, check that the Contractor cuts all stumps off as close as practical to the ground. In these areas, do not allow stumps to exceed 6 in above the ground surface as measured at the base of the stump. Stumps that have not been loosened by clearing and grubbing operations and non-perishable solid objects need not be grubbed or removed provided they do not protrude more than 6 in above the original ground surface.
3. Toe Areas. Near the toe of embankment slopes, do not permit stumps to extend higher that 1 ft beneath the embankment slope surface.

201.4.2-Maintenance of Ground Surface To prevent ponding of water, check that the Contractor fills all holes, ruts, and other similar surface deformations after the clearing and grubbing operation. As needed, direct the Contractor to blade the area to improve drainage. Note that backfilling and blading may not be necessary if excavation or embankment work is to begin immediately after the area is cleared and grubbed. Once an area has been cleared and grubbed, double check the effectiveness of the Contractor's erosion and sediment control measures. Ensure that the Contractor is fulfilling the requirements of the Storm Water Pollution Prevention Plan and the contract specifications. See Section 201.1.7 for additional information on erosion and sediment control.

201.5-DISPOSAL OF MATERIALS

201.5.1-Merchantable Timber Timber removed from the construction site may be, all or in part, of merchantable quality. Merchantable timber is not distinguished from other timber and becomes the property of the Contractor unless otherwise specified.

201.5.2-Vegetative Material Disposal on Right-of-Way

201.5.2.1-Burning In areas where burning is permitted, the Contractor usually will burn vegetative waste materials on the project right-of-way. Check that the Contractor burns the materials within the right-of-way limits under the constant care of competent watchmen and that the action does not jeopardize items to remain in place and the surrounding timber and grasslands of adjacent properties. Consider the following guidelines:

1. Prohibited Burning. Federal, State, and local laws, ordinances, and regulations may prohibit the burning of vegetative waste materials. This is especially true in urban areas. Unless a burning permit is obtained from Division of Forestry (and local municipality, if required).
2. Fire and Smoke Hazards. The Project Engineer/Supervisor may prohibit the Contractor from burning materials in areas where it is apparent or obvious that fire and smoke will present a hazard to the health, safety, comfort, and property of the peoples in the vicinity of the project, as noted in specifications 201.7. See Section 201.2.4 for additional information on fire hazards.
3. Time Limits. Check that the Contractor burns timber and vegetation to promote combustion and minimize smoke and that the burning operation takes place between sunup and sundown. The Contractor must extinguish all fires before sundown, unless allowable by state and federal regulations with appropriate observance.
4. Incinerators. Incinerators, including air curtain burners, may be used provided the West Virginia Department of Environmental Protection (WVDEP), Division of Air Quality approves their use.
5. Legal Issues. Inform the Contractor if burning is not in compliance with the contract specifications or with any applicable laws, ordinances, regulations, or approvals from the WVDEP, Division of Air Quality).
6. Damages. The Contractor is solely responsible for damages. Visually inspect any damage to trees, shrubs, fences, or other objects to remain and make sure that the Contractor adequately repairs or replaces the damaged items. Note this in the DWR.
7. Cleanup and Restoration. Check to make certain that the Contractor removes and disposes of burned materials and seeds the burned areas in an acceptable manner.

201.5.2.2-Burying In general, do not allow the Contractor to bury vegetative materials within the right-of-way unless such disposal areas are clearly marked on the plans or otherwise approved by the Project Engineer/Supervisor. Under no circumstance allow the Contractor to bury timber or other vegetative materials in embankment areas. If permitted to bury vegetative clearing debris on the right-of-way, constantly monitor Contractor operations for unacceptable practice and examine embankment areas (e.g., ravine bottoms) to ensure that they are kept clean and ready to receive embankment material. See Section 207.4.4 for additional information.

201.5.2.3-Chipping The Contractor may elect to reduce vegetative material to chips and then place the chips, as a substitute for straw mulch, in areas where erosion control is required. Inspect the Contractor's operations to make certain chipping operations are in conformance with the governing contract specifications and that the use of the chips complies with the Contractor's approved Storm Water Pollution Prevention Plan (see Section 201.1.7). As approved in areas designated by the Project Engineer/Supervisor, the Contractor also may dispose of chips between the construction limits and the right-of- way lines.

201.5.3-Non-Combustible Material Disposal on Right-of-Way The Project Engineer/Supervisor may allow the Contractor to dispose on the right-of-way non- combustible construction and demolition waste materials consisting of concrete, asphalt, crushed stone, bricks and blocks. Check to make sure that the Contractor covers such waste materials with a minimum of 2 ft of soil and that the area is well drained and seeded. The Contractor may dispose of such waste in embankment areas provided that the material is broken into pieces not exceeding 2 ft in any dimension. Do not allow the Contractor to dispose of such material within 2 ft of the subgrade 1½ ft from the top of the side slopes. Do not allow the Contractor to dispose in any portion of an embankment material such as wood, steel, and broken concrete matted together by steel reinforcement. Do not allow the Contractor to create any temporary disposal sites on the right-of-way and check to make sure that construction and demolition waste is disposed in accordance with the contract specifications.

201.5.4-Material Disposal Off Right-of-Way The Contractor may elect or otherwise be required to dispose of all, or part, of construction and demolition waste material, including clearing and grubbing debris, outside the project right-of-way. Under such cases, consider the following guidelines during inspection:

1. Construction/Demolition Waste. Waste from construction and demolition operations includes, but is not limited to, clearing and grubbing waste, pavement materials, wood, plaster, metals, asphaltic substances, bricks, blocks, concrete, crushed stone, and masonry materials.
2. Hazardous Materials. Construction and demolition waste does not include asbestos and other hazardous materials (e.g., lead- based paint, chemicals, fuel oil). Hazardous waste will be disposed of in an approved area for that particular material. Periodically check the Contractor's landfill receipts to ensure that hazardous materials are being disposed of properly.
3. Off-Site Property Agreements. The Contractor must have a written agreement with the owner of the proposed disposal site (see Section 201.1.4). The agreement may involve the application for a DEP permit. Before the Contractor disposes of materials outside the right-of-way, check that the Contractor has a written agreement with the property owner and any requisite permits.
4. Division of Environmental Protection. The West Virginia Division of Environmental Protection (DEP) controls the disposal of construction and demolition waste material outside the right-of-way. The Contractor may dispose of construction and demolition waste material provided the waste is taken to a DEP approved commercial landfill or the Contractor or property owner obtains a DEP permit. The Contractor or landowner must apply for and receive DEP approval for all construction and demolition waste disposal.

201.6-RECORDS AND DAILY REPORTS

The Project Engineer/Supervisor and Inspectors in charge of the work are responsible for recording in the Daily Work Reports all information and measurements necessary to adequately document the prosecution and progress of the work that will justify payment to the Contractor and protect the Division from any future claims.

Consider the following during clearing and grubbing operations:

1. The limits in which work was accomplished for that day;
2. The type and number of pieces of equipment used in the work;
3. The number and classifications of labor used;
4. Discussion of project prosecution with the Contractor which are of an unusual nature and any specific recommendations or instructions to the Contractor;
5. Weather, for the purpose of determine a working day;
6. Any damage to private property caused by the Contractor's equipment or operations and the actions taken;
7. The final disposition of salvable materials (e.g., merchantable timber); and
8. Any other records directly related to the basis of payment.

201.7-MEASUREMENT FOR PAYMENT

The quantity of work performed will be on a lump sum basis. In general, maintain project records in such a manner that all pay items and partial progress and final payments can be easily and clearly supported by recorded data (e.g., when the work was completed, measurements and calculations to support the quantity and quality allowed). Initial all records, calculations and measurements. Use the governing contract specifications for the basis of paying for clearing and grubbing operations.

SECTION 202
BUILDING DEMOLITION, WELL, AND SEPTIC TANK ABANDONMENT

202.1-GENERAL

202.1.1-Description of Work Buildings and other man-made improvements located on the right-of-way that are not of an historic, archeological, or other salvable value usually will need to be removed. The Contractor is responsible for demolishing buildings, the abandonment of Septic Tanks, Water Wells, Gas Wells, Oil Wells and appurtenances that are specifically designated on the plans for removal. Typically, this work consists of surveying the building for asbestos, disconnecting utilities, salvaging and disposing of the resulting materials, and rodent control, as specified in the contract. The duty of the Inspector is to make sure that the Contractor's work conforms to the plans and specifications.

202.1.2-Utilities The Contractor is solely responsible for contacting Miss Utility and coordinating with all affected utility companies and municipalities to locate, interrupt, disconnect, or otherwise alter public utility services such as gas, water, sewage, electricity, and telephone. See Section 201.1.5 for additional information on utilities. Before allowing the Contractor to begin demolition work, check that the Contractor has contacted Miss Utility and satisfactorily coordinated with the affected companies to mark and determine the required disposition of all existing utilities.

202.1.3-Asbestos Survey Before beginning building demolition work, the Division is responsible for performing an asbestos survey of each building and its appurtenances. The Division will supply the Contractor with a report of its findings. The Contractor will prepare a plan for the proper removal and disposal of any asbestos waste material and submit this plan to DEP for review and permit 10 days before demolition. See Section 107.26 of the Specifications. Check that the Contractor is in receipt of the DEP permit. Hazardous waste will be disposed of in an approved area for that particular material (see Section 201.5.4).

202.1.4-Historic and Archeological Findings During demolition operations, historic or archeological artifacts may be uncovered. In such cases, immediately inform the Contractor to halt operations and notify the Project Engineer/Supervisor. It will be the duty of the Project Engineer/Supervisor to contact the Technical Support Division Environmental Services Section who will coordinate with the District Office the State Historic Preservation Officer (SHPO) and any other Persons or Parties of Interest to determine what manner of action should be taken to address said findings.

202.1.5-Materials and Equipment See Section 201.1.8 for general inspection guidelines regarding the Contractor's use of materials and equipment.

202.1.6-Insurance Requirements In addition to the insurance required of the Contractor on all Division Contracts, the Contractor is required to maintain Liability Insurance for this work in the amounts and form as set forth below for the duration of the work:

Public Liability	$1,000,000
Products Liability	$1,000,000
Owner Liability	$1,000,000

The above insurance shall be purchased by the Contractor on behalf of the Division from a company authorized to do business in the State of West Virginia.

202.2-HAZARDS

The Contractor is solely responsible for performing the demolition work in a manner that will not jeopardize the health and safety of project personnel or the general public. Check that the work is being performed in accordance with the Contractor's Safety Plan, as applicable, and the contract specifications. Notify the Contractor of any apparent or obvious health or safety violations regarding the use of heavy machinery, explosives, or the handling of or exposure to asbestos, lead-based paint, rat poisons, or other hazardous chemicals. See Section 201.2 for additional information on hazards during construction operations.

202.3-EXTENT OF REMOVAL

Use the following guidelines when inspecting building demolition operations:

1. Buildings and Appurtenances. Check that the Contractor removes buildings and appurtenances to the existing ground level, including any concrete slabs or floors resting upon the ground.
2. Basements. Visually inspect that the Contractor clears all debris and other obstructions from the basement so that only the foundation walls and basement floor remain. Before backfilling, check that the foundation walls and basement floor are shattered sufficiently to promote drainage.
3. Backfilling and Compaction. All pits, trenches, holes, and basements that will not be eliminated during subsequent excavation operations will be backfilled and compacted. Use the following guidelines:
   a. Inside the Roadway Prism. Check that all backfill within the roadway prism is placed and compacted in accordance with the requirements of the contract specifications.
   b. Outside the Roadway Prism. Inspect the compaction of backfill outside the roadway prism to check that it is compacted to obtain a minimum density equal to that of the surrounding ground.
4. Water Wells. Water wells serving buildings to be demolished will be abandoned to prevent aquifer contamination in accordance with the contract specifications. Before the Contractor initiates work, check that the Contractor has obtained a permit from the County Sanitarian or State Health Department and follows all procedures prescribed in the permit.
5. Natural Gas and Oil Wells. Check that the Contractor abandons any natural gas and oil wells as specified in the contract. The well shall be plugged using bentonite and cement as provided for by law, and the work shall be accomplished by a qualified service company meeting the approval of the Department of Environmental Protection office of Oil and Gas. All work pertaining to plugging the well must be performed under the supervision of the representative of the DEP office of Oil and Gas. The Contractor shall notify the Project Engineer and the DEP office of Oil and Gas at least 14 days in advance of the date on which the Contractor intends to begin work.

The Contractor shall obtain a permit from DEP office of Oil and Gas and must follow all procedures prescribed in the permit.

6. Septic Tanks. Septic tanks serving buildings to be demolished will be abandoned in accordance with the governing contract specifications. Check that the Contractor uses a licensed septic tank cleaner to remove the contents of the tank and that the tank is removed and disposed of at an approved landfill. Periodically check the Contractor's landfill receipts to ensure that materials are disposed of properly. The Contractor will backfill and compact the excavation made to remove the tank. Use the guidelines presented in Item 3 to inspect this work.

202.4-RODENT AND INSECTION CONTROL

When specified in the contract, the Contractor will be responsible for the control of rodents and insects. The Contractor will furnish and place in and around marked buildings insecticide and suitably prepared baits containing rodenticide. Visually inspect the type and placement of rodenticide and insecticide to check that they comply with the contract specifications. Baiting and insecticide dusting should continue until all buildings and rubble are removed from the area. Inspect the area to see that the Contractor erects warning signs on treated buildings. Check the sign size, legend and mounting locations for conformance with the contract specifications.

202.5-DISPOSAL OF MATERIALS

See Section 201.5 for general guidance on the proper disposal of materials. Specifically, the Contractor will dispose of construction and demolition waste materials in a DEP approved landfill. See Section 201.5.4 for additional information on the disposal of construction and demolition waste materials outside the right-of- way. Use the following additional guidelines when inspecting the Contractor's building demolition operations:

1. Hazardous Waste. Pay particular attention to how the Contractor handles and disposes of hazardous waste materials. Construction and demolition waste does not include asbestos and other hazardous materials (e.g., lead- based paint, chemicals, fuel oil). Such hazardous waste must be disposed of in an approved area for that particular material. Check the Contractor's landfill receipts to ensure that materials are being disposed of properly. See Section 202.1.3 for information on asbestos material.
2. Dead Rodents. Check that dead rodents are removed from the building demolition area daily and buried at a minimum depth of 2 ft. The Contractor will provide a disposal area to be approved by the Project Engineer/Supervisor.
3. Salvable Materials. Unless otherwise specified in the contract, all salvable materials are the property of the Contractor. DOH personnel are prohibited from removing material from the demolition area.
4. Field Discoveries. Any excavation work has the potential of uncovering unknown entities (e.g., underground storage containers with unknown contents, archeological artifacts, utilities). In these cases, immediately inform the Contractor to halt the operation and inform the Project Engineer/Supervisor, who will contact the appropriate personnel and provide further guidance.

202.6-RECORDS AND DAILY REPORTS

The Project Engineer/Supervisor and Inspectors in charge of the work are responsible for recording in the Daily Work Reports all information and measurements necessary to adequately document the prosecution and progress of the work that will justify payment to the Contractor and protect the Division from any future claims. The Inspector in charge of the work will maintain a daily record of events in the Daily Work Report. The Project Engineer/Supervisor will maintain the project's Diary. Specifically include the final disposition of any salvable materials and other records directly related to measurement for payment.

202.7-MEASUREMENT FOR PAYMENT

The quantity of work performed will be on a lump sum basis for each building to be demolished and removed and each water well and septic tank to be abandoned. Note that payment for backfill related to building demolition is included as part of the building demolition pay item. In general, maintain project records in such a manner that all pay items and partial progress and final payments can be easily and clearly supported by recorded data (e.g., when the work was completed, measurements and calculations to support the quantity and quality allowed). Initial all records, calculations and measurements. Use the governing contract specifications for the basis of payment for building demolition operations.

SECTION 203
DISMANTLING STRUCTURES

203.1-GENERAL

203.1.1-Description of Work If specified, the objective of this work is to remove the structure from its existing location. Depending on the desired disposition of the structure, the Contractor may be required to dismantle the structure and carefully handle, matchmark, and store the structural elements for reassembly in a different location or to demolish the structure, remove the debris, and dispose of and/or salvage the materials. Various methods may be used to perform this work including, but not limited to, a combination of hand tools (e.g., air wrenches, air hammers, saws, cutting torches), heavy equipment, (e.g., cranes, barges), and/or controlled blasting techniques. The Inspector is responsible for checking that the Contractor is performing the work in accordance with the contract plans and specifications. Emphasize the intended disposition of the structure with regard to ownership (i.e., Department or Contractor) and the required handling, storage, and/or disposal of materials. Inspect the operation to check that the Contractor backfills and compacts any demolished concrete substructure (e.g., piers, abutments) according to plan and to the density requirements of the contract specifications.

203.1.2-Bridge Demolition/Dismantling Plan The Contractor is responsible for determining the structure's condition and employing safe and efficient demolition/dismantling methods and procedures. At least seven calendar days before the demolition/dismantling work begins, ensure that the Contractor has provided the Project Engineer/Supervisor with a copy of the Demolition/Dismantling Plan. Check that the Plan has been prepared and sealed by a Professional Engineer registered in the State of West Virginia with experience in structural analysis of bridges. The Plan will include a complete structural analysis for all phases of demolition/dismantling work with regard to the existing condition of the structure at the time the work is performed. Note that it is not the responsibility of WVDOH to review or approve the Plan. The Inspector is only responsible for ensuring that the Project Engineer/Supervisor is in receipt of the Plan as described above and that the Contractor is operating within the Plan and the contract specifications. The Contractor is solely responsible for the safe and satisfactory removal of the structure. See Section 202.1.3 for information on asbestos material removal. All notifications must be made a minimum of 10 working days prior to the commencement of demolition or renovation operations to the DEP, Division of Air Quality, as specified in Specifications 107.26.4.

203.1.3-Materials and Equipment See Section 201.1.8 for general inspection guidelines regarding the Contractor's use of materials and equipment.

203.2-HAZARDS

Demolition/dismantling work can pose potentially hazardous conditions. The Contractor will submit and operate within a Safety Plan as specified in the contract. The work must be performed in a manner to ensure the health and safety of all peoples. The structure may contain lead-based paint, and the Contractor will provide protection from exposure to meet Federal requirements and the contract specifications. Notify the Contractor of any apparent or obvious health or safety violations regarding the use of heavy machinery, hazardous materials (i.e., lead- based paint, cutting of galvanized metals), or explosives. See Section 201.2 for additional information on hazards.

203.3-DISPOSAL OF MATERIALS

Section 201.5 provides guidance on the proper disposal of construction and demolition waste materials on and off the right-of-way. Use the following additional guidelines when inspecting the Contractor's demolition/dismantling work:

1. Hazardous Waste. Construction and demolition waste do not include asbestos and other hazardous materials (e.g., lead-based paint, galvanized metals). Such hazardous waste must be disposed of in an approved area for that particular material. Pay particular attention to how such materials are handled at the site and check the Contractor's landfill receipts to ensure that materials are being disposed of properly. See Section 202.1.3 for information on asbestos material removal.
2. Salvable Materials. Unless otherwise specified in the contract, salvable materials are the property of the Contractor. Emphasize the intended disposition of the structure with regard to ownership (i.e., Department or Contractor) and pay particular attention to how salvable materials are handled. DOH personnel are prohibited from removing material from the demolition area.

203.4-RECORDS AND DAILY REPORTS

The Project Engineer/Supervisor and Inspectors in charge of the work are responsible for recording in the Daily Reports all information and measurements necessary to adequately document the prosecution and progress of the work that will justify payment to the Contractor and protect the Division from any future claims. The Inspector in charge of the work will maintain a daily record of events in the Daily Work Report. The Project Engineer/Supervisor will maintain the project's Diary. Specifically include the final disposition of any salvable materials and other records directly related to measurement for payment.

203.5-MEASUREMENT FOR PAYMENT

The quantity of work performed will be on a lump sum basis for complete execution of the work (e.g., demolition and dismantling, material handling and storage, removal and disposition of falsework, debris and refuse disposal, restoration and cleanup). Note that payment for backfill and compaction related to this work is included as part of the bridge demolition/dismantling pay item. In general, maintain project records in such a manner that all pay items and partial progress and final payments can be easily and clearly supported by recorded data (e.g., when the work was completed, measurements and calculations to support the quantity and quality allowed). Initial all records, calculations and measurements. Use the governing contract specifications for the basis of payment for demolition/ dismantling structures.

SECTION 204
MOBILIZATION

204.1-GENERAL

204.1.1-Description of Work Mobilization is a contract pay item used to compensate the Contractor for preparatory construction operations and includes the movement of personnel and equipment to the project site and the establishment of construction offices, buildings, and other facilities necessary to begin work on a substantial phase of the contract.

204.1.2-Materials and Equipment See Section 201.1.8 for general inspection guidelines regarding the Contractor's use materials and equipment.

204.2-RECORDS AND DAILY REPORTS

The Project Engineer/Supervisor and Inspectors in charge of the work are responsible for recording in the Daily Work Reports all information and measurements necessary to adequately document the prosecution and progress of the work that will justify payment to the Contractor and protect the Division from any future claims. The Inspector in charge of the work will maintain a daily record of events in the Daily Work Report. The Project Engineer/Supervisor will maintain the project's Diary. Specifically record information on the construction offices, buildings, and facilities provided (e.g., number, type, how they are equipped), the times that various types of machinery and equipment arrive and depart the job site, and any other documentation directly related to the basis of payment. Be diligent in recording the arrival and departure times of the Contractor's machinery and equipment, especially departure times. This information will become very important in resolving disputes if the Contractor falls behind schedule or files a claim.

204.3-MEASUREMENT FOR PAYMENT

204.3.1-Description The quantity of work performed will be on a lump sum basis for mobilization. Note that when mobilization is not a separate bid item in the contract, the cost of mobilization is included in the unit bid price of the related bid item. Use the governing contract specifications for the basis of payment for mobilization. To better understand the procedures for estimating partial payments, use the guidelines in the following sections:

204.3.2-Partial Payment Procedures Two partial payments will be made for mobilization: the first partial payment will be made not less than 15 days after the start of work at the project site; and the second partial payment will be made 30 days after the first partial payment. The final payment for any amount due for mobilization, if not already paid in full with partial payments, will be made upon substantial completion of all work on the project. Carefully check partial payments to ensure they do not exceed the total limits set forth in the contract specifications. Use the following procedures to pay for the mobilization bid item as the work progresses:

Partial payments will be made as the work progresses in accordance with the following schedule.

i. 2.5% of the original contract amount or 50% of the amount bid for mobilization, whichever is less, will be released to the Contractor as the first estimate payable, not less than 15 days after the start of work at the project site.
ii. 2.5% of the original contract amount or the remaining 50% of the amount bid for mobilization, whichever is less, shall be released with the estimate payable 30 days after the first estimate.

When the project is deemed substantially complete, any remaining amount bid for mobilization will be released for payment. Nothing herein shall be construed to limit or preclude partial payments otherwise provided for by the contract. No deduction will be made, nor will any increase be made, in the lump sum mobilization item amount regardless of decreases or increases in the final total contract amount or for any other cause

To better clarify, study the examples in the following sections.

204.3.3-Partial Payment Example #1 This example demonstrates partial payments for mobilization when the controlling factor is 50% of the Total Mobilization Amount (TM). Determine the pay schedule.

Total Original Contract Amount: TC = $3,240,000

Total Mobilization Amount: TM = $48,446

1. Determine First Partial Payment (PP1). PP1 will be the lesser of the following dollar amounts:
   a. 0.025(TC)
      0.025($3,240,000)
      $81,000
   b. 0.50(TM)
   c. 0.50($48,446)
      $24,223 (lesser amount)
2. Pay PP1. Pay $24,223 not less than 15 days after the start of work at the project site.
3. Calculate Second Partial Payment (PP2). PP2 will be the lesser of the following amounts:
   a. 0.025(TC)
      0.025($3,240,000)
      $81,000
   b. 0.50(TM)
      0.50($48,446)
      $24,223 (lesser amount)
4. Pay PP2. Pay $24,223 30 days after the first estimate.

5. Calculate Final Payment (FP). Calculate FP as follows:
   FP = TM – (PP1 + PP2)
   FP = $48,446 – ($24,223 + $24,223) FP = $0
   FP = $0
6. Pay FP. Mobilization has been paid in full with PP2. There is no need to pay FP upon completion of all work on the project.

See Section 204.3.4 for an example that demonstrates how to calculate and pay partial payments for mobilization when the controlling factor is the Total Limit for Partial Payments (TL) as specified in the contract.

204.3.4-Partial Payment Example #2 This example demonstrates partial payments for mobilization when the controlling factor is the Total Limit for Partial Payments (TL) as specified in the contract. Determine the pay schedule.

Total Original Contract Amount: TC = $1,400,000

Total Mobilization Amount: TM = $180,000

1. Determine (PP1). PP1 will be the lesser of the following dollar amounts:
   a. 0.025(TC)
      0.025($1,400,000)
      $35,000 (lesser amount)
   b. 0.50(TM)
      0.50($180,000)
      $90,000
2. Pay PP1. Pay $35,000 not less than 15 days after the start of work at the project site.
3. Calculate PP2. PP2 will be the lesser of the following amounts:
   a. 0.025(TC)
      0.025($1,400,000)
      $35,000
   b. 0.50(TM)
      0.50($180,000)
      $90,000
4, Pay PP2. Pay $35,000 30 days after the first estimate.
5. Calculate FP. Calculate FP as follows:
   FP = TM – (PP1 + PP2)
   FP = $180,000 – ($35,000 + $35,0000)
   FP = $110,000
6. Pay FP. Pay $110,000upon completion of all work on the project.

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SECTION 206
BASE COURSE REINFORCEMENT GEOGRID

206.1-GENERAL

206.1.1-Description of Work If base course reinforcement geogrid is specified, the Contractor is responsible for furnishing, testing, and installing geogrid elements as specified in the contract documents. The Inspector is primarily responsible for checking that the Contractor operates within the limits of the contract specifications and that the geogrid and associated subbase materials are placed/compacted in reasonable conformance to the lines, grades, and thickness of the contract plans, or as otherwise directed by the Project Engineer/Supervisor.

206.1.2-Materials Considerations The Contractor is responsible for obtaining the geogrid reinforcement materials and associated components that meet all requirements of the specifications. Check that the Project Engineer/Supervisor is in receipt of the Contractor and manufacturer submittal package. Inspect geogrid materials upon arrival at the job site; checking that it is proper material and that it is free of tears, cracks, or flaws to the geogrid coating. Ensure the geogrid is stored properly.

206.1.3-Material Submittals Prior to construction, the Contractor is responsible for submitting certification that the geogrid has been evaluated and is in full compliance with the Specifications. A manufacturer's written certification that the resin used to produce the geogrid is virgin and classified as polypropylene or high molecular weight polyester should be included in the Contractor's submittal package.

The manufacturer is responsible for conducting quality control testing and submitting quality control certificates to the Engineer at least fourteen (14) days prior to installation of geogrid. The quality control certificates should include the following elements: roll number and identification; sampling procedures; and results of quality control tests, including a description of each test method.

206.2-INSPECTION GUIDELINES

A qualified and experienced representative of the geogrid manufacturer or its supplier shall be on site, for a minimum of one day at the start of installation, to assist the Contractor and the Engineer in the proper construction/installation techniques. Thereafter, the representative is to be available on an as needed basis.

Section 626 of the Standard Specifications governs the criteria that should be used when inspecting base reinforcement geogrid. Pay particular attention to the requirements for foundation preparation, geogrid placement, placement of base course aggregate, and equipment requirements.

Verify any geogrid damaged during installation is removed and replaced based on provisions of the contract.

SECTION 207
EXCAVATION AND REINFORCEMENT GEOGRID

207.1-GENERAL

207.1.1-Description of Work The construction of a graded roadbed, upon which the base and wearing courses will be placed, is generally referred to as earthwork. Excavation refers to that part of earthwork that is excavated, hauled, and placed to form the embankment. Roadway excavation material is soil, solid rock, loose rock, or any combination of these materials obtained from within the right-of-way. Where there is insufficient suitable roadway excavation, including suitable excess material from channel and structural excavation, to construct the roadbed embankment to the required line and grade (i.e., the “cut” and “fill” do not balance), borrow excavation material will be imported (see Section 211). Roadway excavation/embankment construction, including excavation for channel changes, includes:

1. Removing and hauling all material not removed under some other contract item;
2. Preparing areas upon which embankments are to be placed;
3. Placing and compacting excavated material to construct embankments;
4. Disposing of unsuitable and surplus materials;
5. Preparing the subgrade;
6. Finishing shoulders, slopes, ditches, and drains; and
7. Constructing benches and removing slides as required;

The Inspector is responsible for checking the Contractor’s operations to ensure that the work complies with the contract specifications and that the earthwork reasonably conforms to the lines, grades, thickness, and cross section that are shown on the plans or as otherwise directed by the Project Engineer/Supervisor.

207.1.3-Protection and Preservation of Property During excavation and subsequent embankment construction, the Contractor must continue the property protection and preservation practices that were used during right-of-way preparation. Because the right-of-way already will have been cleared and grubbed, as discussed in Section 201, there will be less restriction to the movement of equipment; however, the Contractor must continue to protect and preserve the overhead and underground utilities, trees, survey control points, etc., that are to remain in place. The adjacent private property also must be continually protected from damage by the Contractor’s equipment.

Pay particular attention to urban projects. Inspect the operations to make sure the Contractor keeps business entrances open and minimizes disruption to utilities and services. On large urban projects, consider discussing this matter weekly with the Contractor. Prior to beginning the excavation and embankment operation, again emphasize to the Contractor the importance of protection and preservation of property. See Section 201.1 for information on other related considerations.

207.1.3-On-and-Off-Site Drainage The Contractor is responsible for maintaining adequate drainage within the right-of-way to protect project earthwork, adjacent properties, and natural drainage. See Section 201.1.6 for additional information on drainage. If the Contractor must suspend grading, subgrade, shoulder, base, or pavement work because of unsuitable weather conditions or other reasons, make sure the Contractor provides sufficient temporary drains and side ditches to adequately drain the grade, subgrade, and shoulders. Visually inspect these temporary facilities to see that they are kept open and free of debris during the suspension period. Upon completion of the subgrade and shoulders and before any base or pavement is placed, the Contractor will provide permanent subgrade drains and/or weeps as designated on the plans or as otherwise directed by the Project Engineer/Supervisor.

207.1.4-Erosion and Sediment Control Roadway excavation and embankment construction operations disturb large areas of erodible soil that can accelerate the rate of soil erosion and sedimentation. Use the following guidelines during inspection:

1. Storm Water Pollution Prevention Plan. Before allowing excavation and embankment operations to begin, check that the Contractor has satisfactorily implemented the temporary erosion and sediment control measures for this phase of work. The Contractor's Erosion and Sediment Control Plan will document a multi-phased plan for erosion and sediment control. See the WVDEP Erosion and Sediment Control Best Management Practice Manual for additional information.
2. Temporary Control Devices. Visually inspect the Contractor's temporary control measures for this phase of work. This may include devices such as berms, dikes, dams, sediment basins, silt fences, netting, gravel, mulches, wood chips, grasses, slope drains, ditches, channels, riprap, and fiber mats. Check to see that the Contractor takes every practical measure to install and maintain these devices operational until permanent controls are installed and become effective.
3. As-Needed Basis. Where temporary erosion and sediment control features are not included in the plans, the Project Engineer/Supervisor will coordinate with the Contractor as the work progresses to anticipate potential erosion and sedimentation problems and provide timely and adequate controls to prevent or at least minimize impacts on the environment.
4. Early Treatment. Emphasize to the Con- tractor that the most effective method of controlling erosion and sedimentation is the early treatment of cut and fill slopes. Treat cut slopes as soon as practical as excavation progresses and fill slopes as soon as practical as embankment construction proceeds.
5. Slope Treatment. Slope treatment varies but generally consists of seeding and mulching. Check that all slopes are stabilized as directed. If the Contractor fails to sufficiently protect slopes to prevent pollution, coordinate with the Project Engineer/Supervisor to limit the surface area of erodible material exposed. The Contractor must repair all damaged slopes as soon as practical. Check to make sure the Contractor has the necessary materials and equipment on hand to provide early slope stabilization and correct slope damage. The contractor should operate all equipment and perform all construction operations so as to minimize pollution.

6. Sequence Operations. In accordance with the permit requirements, frequently inspect construction operations to check that the Contractor logically sequences activities to minimize potential damage to earthwork during heavy rains.
7. Maintenance and Damage. During the operation, continually inspect all installed devices, both permanent and temporary, to ensure that they are maintained in an operating condition to perform as intended. This may require the Contractor to clean out deposited material and debris, replace component parts, and rebuild as needed.

207.1.5-Dust Control During the excavation and embankment operation, dust generation can become a significant problem to the general public and adjacent residents, especially in urban areas. The Contractor is responsible for dust control. Check to make sure that the Contractor takes practical measures to control the generation of dust. Any use of dust palliatives will be in accordance with the contract specifications.

207.1.6-Hauling Consideration

207.1.6.1-Haul Roads The Contractor normally constructs haul roads to access the work site. Where haul roads are constructed within the planned roadway limits, all construction will comply with the contract specifications for embankment construction. Do not allow the Contractor to use the finished grade of the roadbed as a haul road. Pay particular attention to the drainage of haul roads that extend beyond the limits of the right-of- way. Particularly inspect the drainage of haul roads to any borrow or waste sites. Check the slope-stability of all haul road construction. Give special attention to haul roads that involve the traveling public (e.g., placement of construction and advanced warning signs, flag personnel). At intersections with public roadways, check for adequate lane transitions and sight distances. All haul roads will be site graded and seeded at the Contractors expense to the satisfaction of the Project Engineer/Supervisor when the haul roads are no longer needed.

207.1.6.2-Protection of Curtain Walls Where the Contractor hauls over bridges that do not have approach slabs yet constructed, check that the Contractor brings the pavement notch of the curtain walls up to final grade to minimize the possibility of damage to the curtain walls. Generally, timber is an acceptable material to perform this task.

207.1.7-Controlled Blasting Plan Contractors typically use controlled blasting techniques (e.g., pre-splitting, pre-shearing) during excavation, especially in rocky areas. Prior to blasting, the Contractor will typically prepare a Controlled Blasting Plan containing the following minimum requirements:

1. Method of transporting blasting agent;
2. Type of blasting agent and stem material;
3. Size, depth, and angle of drill holes;
4. Size and loads of blast pattern;
5. Ignition source and type of firing device;
6. Method of on-site storage;
7. Procedures in case of misfire;
8. Type of security planned;

9. Name of blasting company;
10. Permits, certification, and licenses, including issuing agency;
11. Method of notifying the public in the immediate vicinity;
12. Insurance and liability proofs; and
13. Advance warning signing.

It is extremely important that the Project Engineer/Supervisor enforce the provisions of the contract specifications, including permits and allowable hours for blasting. See Section 207.2.2 for information on the hazards of using explosives and Section 207.3.3 for information on blasting techniques.

207.1.8-Historic and Archeological Findings During the excavation, the Contractor may encounter the remains of prehistoric peoples' dwelling sites or artifacts of historic or archeological significance. In such cases, immediately inform the Contractor to halt operations in the vicinity of the find and notify the Project Engineer/Supervisor. It will be the duty of the Project Engineer/Supervisor to contact the Technical Support Division Environmental Services Section who will coordinate with the District Office, the State Historic Preservation Officer and any other Persons or Parties of interest to determine what manner of action should be taken to address said findings.

207.1.9-Materials and Equipment Check to ensure that the Contractor's embankment and subgrade materials, test methods, and quality control requirements conform to the applicable provisions of the contract specifications. See Section 201.1.8 for general guidelines regarding the Contractor's use of materials and equipment. See Division 700 for additional information on control of materials and quality control. The following Sections discuss the Contractor's quality control requirements.

207.1.9.1-Quality Control Plan The Contractor is responsible for submitting to the Division for approval a Quality Control Plan that details the sampling and testing methods by which the quality control program will be conducted. The Plan will be prepared in accordance with the guidelines presented in MP 307.00.50 and MP 717.04.21. The Division will review the Plan to ensure it conforms to the contract documents. Before work begins, check that the Contractor has a Division-approved Plan and inspect operations frequently to enforce the requirements of the Plan and the provisions of the contract specifications.

207.1.9.2-Quality Control Testing Inspect Contractor operations to check that embankment and subgrade material, placement, compaction, and gradation requirements conform to the Contractor's Division-approved Quality Control Plan and enforce the contract specifications. Check that the Contractor provides Division-qualified Compaction Inspectors to control the placement and compaction of embankment and subgrade materials. See Division 700 for additional information. The Contractor will notify the Project Engineer/Supervisor before constructing the test strip required by MP 700.00.24. Check that the Contractor records compaction test data on the correct forms and that the Project Engineer/Supervisor receives the completed forms after the test.

207.2-HAZARDS

207.2.1-Public Safety Public and private roadways and intersections may be affected by the Contractor's construction activities. The Contractor is responsible for maintaining these facilities in a safe and passable condition. See Section 201.2.1 for additional information.

207.2.2-Use of Explosives Contractors frequently use explosives to excavate rocky areas. The transport, storage, handling, and detonation of explosives pose extreme and hazardous conditions and should be conducted under the careful, competent supervision of licensed personnel to prevent injury to persons and damage to adjacent properties. Enforce the contract specifications. Inform the Contractor of any apparent or obvious safety violations or acts that do not comply with the specifications. See Section 207.1.7 for information on controlled blasting plans and 207.3.3 for information on controlled blasting techniques. Consider the following additional guidelines:

1. Electromagnetic Fields. Radio frequency (RF) transmitters, cellular phones, television, and radar create powerful electro- magnetic fields. If in a strong RF field (e.g., near a transmitter), the unshielded leg wires will act similar to an antenna. The RF field may induce sufficient current to detonate the explosives. Commercial AM transmitters potentially are the most dangerous. FM and TV transmitters are unlikely to be a hazard. The Contractor should inspect the area for RF transmitters.
2. CB Radios. Mobile CB radio transmitters are potentially hazardous because:
   a. They can move directly through the area;
   b. the frequency range is considered the worst for typical blasting circuits; and
   c. illegal linear amplifiers can increase power output.
3. Check that "Blasting Ahead – Turn Off 2- Way Radios and Cellular Phones" signs are posted a minimum of 1000 ft in advance of the area. Emphasize caution when inspection personnel use two-way radios to enhance communications.
4. Static Electricity. Thunderstorms create static electricity and produce lightning. When a thunderstorm is approaching, the Contractor should halt operations and takes adequate precautionary measures (e.g., short-circuiting lead wires). Note that short-circuiting lead wires is a safeguard and may not prevent detonation if struck directly by lightning. During such periods, all personnel should move to a safe distance.
5. Advance Warning ("Fire-in-the-Hole"). Be- fore blasting, the Contractor should inform local law enforcement agencies and adjacent businesses and residential neighbors. The Contractor should adequately secure and cordon off the area.
6. Overshooting. Accidents may occur if poor blasting techniques are used (e.g., overshooting). Overshooting will not be tolerated. If more explosives are used than needed, flying rocks and boulders, shattered windows, etc. may result. The Contractor should take every practical precautionary measure to protect people and property near the site. Consider the following:
   a. Railroad Tracks. If overshooting is witnessed and railroad tracks are near the site, the Contractor should visually inspect the tracks for debris and any rail movement. All debris should be removed by Contractor. If rail movement is suspected, immediately notify the Project Engineer/Supervisor. It may be necessary to halt

operations and contact the Chief Engineer of the railroad for further direction.

b. Falling Rocks. After blasting, pay particular attention to areas near the bottom of rock faces. If overshot, the face may have been fractured sufficiently to loosen a significant number of large boulders.

c. Cover Material. Where horizontal bedrock is being blasted, especially in urban areas, the Contractor should employ suitable cover material to minimize flying rock and reduce the peak noise level. Earth and commercial blanket materials are commonly used for this purpose.

7. Misfire. Because pre-splitting techniques typically employ uniform drill hole patterns, it is relatively easy to visually inspect a rock face for a hole loaded with explosives that did not detonate. If visually evident, inform the Contractor and make sure that personnel follow the misfire procedures documented in the Contractor's Controlled Blasting Plan.

207.2.3-Slide and Trench Areas Where slides or slips occur or are suspected, all construction personnel should use extreme caution when traversing in and around the area. Under some conditions (e.g., oversaturation), failures in potential slide areas can occur swiftly and without warning. See Section 207.3.5 for additional information on slides. To prevent or at least minimize the potential for slides and slips, check that the Contractor takes precautions by benching (see Section 207.3.4) or other methods as designated in the plans or as directed by the Project Engineer/Supervisor. Where trenches are constructed for drainage purposes, visually inspect the operation to make sure the Contractor shores the trenches in accordance with OSHA requirements and the contract specifications.

207.3-ROADWAY EXCAVATION

207.3.1-General Excavation involves the loosening, digging, loading, hauling, and disposal of materials obtained from roadway cuts, channel changes, ditches, fill bench excavation, grading transitions, undercuts, and borrow pits. The Contractor will dispose of the material by either incorporation in embankments, flattening side slopes, or wasting. Roadway excavation includes constructing, shaping, and finishing all earthwork within the construction limits for the entire length of the roadway, including approaches, to conform with the required lines, grades, typical sections, and the contract specifications. Unclassified excavation includes all materials encountered within the construction limits regardless of nature or manner of removal.

207.3.2-Pre-Wetting Near optimum moisture in embankment areas must be present at the time of compaction. To achieve this goal, Contractors commonly sprinkle the embankment area with additional water. Pay particular attention to the weather conditions before and during compaction (e.g., spring brings significant rain, summer brings sunny and dry conditions). Extreme conditions may make it difficult to control moisture content. There are advantages, however, to adding the needed water at the excavation area or borrow source. The practicality of sprinkling, flooding, or irrigating such areas will depend on the soil type and the availability of water. This method will usually achieve a more uniform distribution of moisture in the soil and will minimize additional machine manipulation of the soil on the roadbed. Contact the Project Engineer/Supervisor for guidance if there is uncertainty as to the method the Contractor should be using under extreme weather conditions.

207.3.3-Controlled Blasting Controlled blasting techniques can materially lower the Contractor's cost while producing specified rock material under relatively safe conditions. Consider the following guidelines during blasting operations:

1. Controlled Blasting Plan. Before blasting, ensure that the operation is in conformance with the contract specifications. Although the Division is not responsible for the Contractor's methods and procedures, the Project Engineer/Supervisor and Inspectors should become familiar with the proposed blasting method (e.g., pre-split or production), the drilling plan, and the properties, uses, and precautions of the explosives, detonators, and initiation type.
2. Safety Issues. Blasting operations always should be conducted under the supervision of licensed and competent personnel to prevent injury to persons and damage to adjacent property. See Section 207.2.2 for additional information on the use of explosives.
3. Pre-Splitting Technique. Except for fill bench construction and where slopes flatter than 1:1 are specified, check that the Contractor uses the pre-splitting technique. Pre-splitting is used to prevent over- breakage and produce a reasonably smooth slope face. The Contractor will drill and load a single row of holes along the neat excavation line and fire the pre-split charges before the adjacent primary charges. The collision of shock waves between the pre- split holes will fracture the rock and produces a narrow shear plane. The shear plane will reflect most of the energy generated by the subsequent primary blast preventing it from being transmitted to the finished rock face, thus minimizing over- breakage. Depending on the rock type, the holes will be spaced on center from 2 ft to 5 ft as determined by field demonstration. Check the drilling operation to make sure the holes are along the slope line. The Contractor should string load explosives as recommended by the manufacturer. The Contractor typically will fire pre-split holes during the primary blast; however, the primary charges will be delayed sufficiently to allow the production of the shear plane in the rock.
4. Overshooting. The Division will not tolerate overshooting because it is hazardous and can produce rock fractures beyond the intended line and grade, jagged slopes, uneven ditch grades, and potential slide areas. Pay particular attention to the site bench slope behind the ditch line. Overshooting in this area will create jagged slopes. Also, carefully monitor pipe trench areas. Overshooting trenches may cause future drainage problems due to pipe settlement.

   Closely observe the shooting operation. If the method used results in over-breakage or damages, the Contractor will need to take corrective measures.

5. Undershooting. Undershooting the primary blast can fail to sufficiently shatter the rock. Oversize rock material is unsuitable, cannot be economically hauled, and will require additional drilling and blasting or breaking with hoe ram or drop ball. The Contractor is responsible for the expense of such corrective actions.

6. Records. Record the blasting location and time in the DWR. The Contractor should maintain complete records in the Inspector's Daily Report (e.g., location and time; pre- split or production operation; location, depth, size, direction, and pattern of holes; type of explosive and detonator; loading rates; type of initiation; comments on the results of the blast). Particularly note observations of rock being thrown outside the slopes, evidence of over-breakage, damages, etc. These records are very useful when resolving disputes about over- breakage and alleged changed conditions or damages. In urban areas, the Contractor should inspect the surrounding properties prior to blasting to assist in verifying any claimed damages. Consider the benefits of using still or video cameras.

207.3.4-Benches and Transition Points Benches will be used, either above or below the profile grade, as designated on the plans or as directed by the Project Engineer/Supervisor to minimize embankment slides. Inspect bench locations, types, and dimensions for compliance with the contract plans. Transition points are the points of change from cuts to fills. Inadequate embankment foundation preparation at transition points of sizable excavation and embankment sections may produce roughness in the base and surface courses due to settlement. Transition benches are used to minimize this settlement problem by providing a gradual change in embankment foundation support from a cut section in rock or hard shale to a deep fill section. The use of transition benches also ensures that the embankment material at transition points is constructed of adequately compacted material. Transition benches may be cut just before completing the embankment fill or after completing the embankment fill. If cut after the embankment fill is completed, establish the locations of the transition benches by plotting and staking the excavation limits. The use of transition benches will key the embankment into the natural ground, thus reducing subsurface movement. Check the profile sheets for required locations of transition benches and make sure the benches are constructed as shown on the miscellaneous detail sheets. The work will be paid for as additional unclassified excavation. The Project Engineer/Supervisor must ensure that cross sections are taken and recorded in the survey files and noted in the Daily Reports before the Contractor begins placing embankment material.

207.3.5-Slides and Slips The Contractor should take precautions by benching or other methods to prevent slides and slip outs. Watch for potential slide and slip areas. If a slide or slip is observed, immediately contact the Project Engineer/Supervisor. Use the following procedures to expedite slide correction approval:

1. If a slide condition is observed, the Project Engineer/Supervisor should immediately notify the District Construction Engineer. The District Construction Engineer will inspect the problem as soon as practical.
2. The Project Engineer/Supervisor will review the plans to ascertain that the slide limits are within the original ground cross-sections.

Check that the Contractor excavates the problem materials, including any material that has come into the roadway or ditch or that has slipped out of embankments. Such materials will be excavated by benching or as otherwise designated in the revised plans or as directed by the Project Engineer/Supervisor. Check Contractor operations to make sure the material is disposed of as directed (e.g., in embankment construction, to flatten slopes, wasted). Note that erosion, to any extent, will not be considered a slide or a slip.

207.4-DISPOSAL OF MATERIALS

207.4.1-Suitable Material Check Contractor operations to make certain that suitable excavation is used, as practical, in embankment construction and that such materials comply with the governing contract specifications. Suitable excavation typically is used for roadway, ramp, and approach embankments, subgrade and shoulder construction, and for fill around structures and buildings. Random materials (i.e., soil, granular material, soft slate), where encountered, typically are considered suitable for embankment construction; however, the Division prefers the use of granular soils with greater dry weights, greater percentages of coarse and fine aggregate, and lower liquid limits.

207.4.2-Salvaging Topsoil The material excavated from the deeper soil layers usually is not conducive to good plant growth. The upper soil layer of roadway cut areas, embankment foundation areas, and borrow areas can be stripped before excavation work begins. This topsoil can be stockpiled and used later to cover completed cut slopes, embankment slopes, and other disturbed areas where re-vegetation is desirable. As designated on the plans, check that the Contractor strips and stockpiles salvable topsoil. Give more than a casual inspection to the stripping operation. Although it is usually not necessary to measure the quantity for payment, the quantity stockpiled and the manner in which it is excavated is important. Excavating too deep will result in a greater quantity, but the quality of the topsoil will be reduced. Shallow stripping will waste topsoil and the estimated yield will not be obtained. Check to ensure topsoil is stockpiled in an area that will minimize the haul involved but not interfere with or delay other construction operations. Maintain records of the quantity stockpiled (e.g., truck load counts) to ensure that sufficient topsoil will be available for the intended use. Do not direct the Contractor to stockpile topsoil unless designated in the plans or directed by the Project Engineer/Supervisor.

207.4.3-Unsuitable Material During excavation, unsuitable materials will be encountered due to their natural composition or moisture content. It is essential to use this material wherever practical. The Division will pay for replacing unsuitable material unless it has a high moisture content and can be reused by drying. Many soils, considered unsuitable only because of excessive moisture content, will respond favorably to drainage improvements and mechanical manipulation. If treated to meet the specified acceptance criteria, the Contractor may, at its own expense, dry excessively moist excavation material (e.g., aeration). However, if the Contractor wastes rather than dries the material, the Contractor will furnish borrow material (see Section 211), at its own expense. Do not allow the Contractor to use unsuitable materials (e.g., sod, trash, organic material, muck) because they cannot be satisfactorily placed and compacted to a stable and durable condition. Such materials can cause instability in embankments and should be wasted. Record in the Daily Work Report the disposition and amount of all unsuitable materials.

207.4.4-Waste and Waste Sites The Contractor shall minimize pollution or sedimentation of rivers, streams, lakes, ponds, and other bodies of water while conducting all wasting operations.

Use the following guidelines:

1. Waste Outside of WVDOH Right of Way Limits: Except for sites specifically designated on the plans, the Contractor is responsible for locating and furnishing all sites off the right-of-way for the disposal of waste materials. The Contractor and/or property owner shall bear all costs and responsibilities associated with erosion and sediment control, stability, permitting, mitigation, etc. The Contractor and/or property owner shall comply with existing laws and/or regulations and save the State harmless from any claims for damages which may result from the waste.
2. Construction/Demolition Waste. For any quantity of construction/demolition waste to be disposed of, the Contractor will waste such material in accordance with Section 201.5.4 except that Portland cement concrete (PCC) and hot-mix asphalt (HMA) may be disposed of under the following conditions:
   a. The PCC and HMA material will meet the material and placement requirements for embankment lifts as designated for rock in the specifications (See Section 207.5.4.3 for additional information);
   b. All PCC and HMA will be covered with a minimum of 2 ft of soil;
   c. The waste plan originally approved by the Project Engineer/Supervisor, or subsequently approved supplement, will show specific disposition and location of PCC and HMA materials to be wasted;
   d. The disposal area for HMA will be limited to a maximum area of 2 acres and may be located within a waste site covering more than 2 acres;
   e. PCC and other masonry type material will not count against the 2 acre maximum area if all reinforcing steel and/or wire mesh is removed cut off flush at the outer edges;
   f. The PCC and HMA disposal will be completed and covered with 180 days; and
   g. The PCC and HMA disposal site will not be located within 300 ft of a wetland, perennial stream, or within the 100-year floodplain.
   h. disposal of trees and other degradable material should not be located in waste areas where it could promote sliding or affect stability.
3. Disposal Above Road Grade. Do not allow the Contractor to waste material above the established grade unless written authorization is received.
4. Erosion and Sediment Control. Inspect waste operations to ensure the Contractor wastes materials to minimize pollution and sedimentation to rivers, streams, lakes, ponds, and other bodies of water. See Section 201.1.7 for additional information.
5. Cleanup and Restoration. Check that the Contractor neatly trims and drains all waste sites and disposes of debris and spoil in accordance with the Waste Plan. Check that the Contractor grades, fertilizes, seeds, and mulches all waste sites.

207.4.5-Surplus Material During project plan development, it is desirable to balance material excavation with embankment material needs. However, it may be determined during either planning or construction that the required excavation will yield more suitable material (i.e. surplus material) than that actually needed for embankments. Consider the following guidelines:

1. Shrink/Swell Factors. The amount of surplus material will depend primarily on the accuracy of the shrink/swell factors. Shrink/ swell factors are based either on field

tests or on previous experience. The Contractor should perform field checks to substantiate the accuracy of the shrink/swell factors that are noted on the plans. Emphasize the earthwork balance points and, as the work progresses, perform frequent checks to ascertain the accuracy of the shrink/swell factors. Embankments should be completed before any surplus material is wasted. However, if the Contractor cannot meet this objective, continue to check the validity of the shrink/swell factors as the work progresses to ensure that the remaining excavation is sufficient to complete the embankments.

2. Applications. Before the Contractor wastes surplus material, check with the Project Engineer/Supervisor to determine where the Contractor can use the surplus material to uniformly flatten embankment slopes or widen shoulders. Under no circumstance allow the Contractor to engage in operations that would steepen embankment slopes.
3. Waste and Waste Sites. Inform the Contractor that any wasting of surplus material that is needed to complete embankment construction will be wasted and subsequently replaced at the Contractor's expense. Except for disposal sites designated on the plans, the Contractor will locate and furnish all sites for wasting surplus material according to the criteria presented in Section 207.4.4.
4. Cross-Sectioning. Ensure that the Contractor submits complete original cross-sections of disposal sites before wasting the surplus material. This is very important for the purpose of determining payment. The base line from which cross-sections are taken must be permanently referenced so that the base line can be later re-established when taking final cross-sections at the conclusion of the waste operation.

207.5-EARTH EMBANKMENT

207.5.1-General Emphasize uniform embankment construction. Practical methods that ensure uniform materials, layer thickness, moisture content, and compactive effort must be used. Check all embankments for reasonable conformance to the plan lines and grades and the Contractor's Quality Control Plan. Where measurements are taken for inspection purposes, the roadbed width must conform to the plan width. For other measurements in the horizontal plane, a construction tolerance of ± 1 ft (300 mm) is permitted. Slope rates may vary only by approval of the Project Engineer/Supervisor. Visually inspect embankments to see that they present a neat and uniform surface free of hollows and protrusions and that the tops of all slopes are rounded as shown in the plans.

207.5.2-Embankment Foundation Preparation Frequently, the plan cross-sections specify the placement of embankment foundation material. This blanket of material is very important to the structural integrity of the embankment. Document the type of material and the final elevation of the embankment foundation in the Daily Work Report. Before beginning the construction of an embankment, carefully inspect the area to serve as the foundation. Use the following guidelines to inspect the foundation preparation:

1. Excessive Moisture. Give special attention to any location of questionable supporting capacity and notify the Project Engineer/Supervisor for an appropriate action. The presence of soft or excessively moist material may require:

a. removal of unsuitable materials;
b. installation of underdrains to remove spring or seepage water; or
c. aeration and drying of materials saturated due to poor surface drainage.

2. Fills ≤ 5 ft (1.5 m). Where embankments are 5 ft (1.5 m) or less in depth, check that the Contractor strips the topsoil and sod to the specified depth and that the top 8 in of the embankment foundation is scarified and compacted to the density requirements of Quality Control Plan. If the specified foundation density cannot be obtained (e.g., excessive moisture, organic material), the Project Engineer/Supervisor will direct the Contractor to remove and waste the material to a specified depth and/or place an initial layer of rock, hard shale, or granular material before embankment construction.
3. Embankments ≤ 3 ft on PCC. Where embankments of 3 ft or less in depth are placed on old concrete pavement or a pavement with concrete base, check that the Contractor removes and disposes of the concrete according to the criteria presented in Section 207.4.4 or as otherwise directed by the Project Engineer/Supervisor.
4. Embankments > 3 ft on PCC. Where embankments greater than 3 ft in depth are placed on old concrete pavements, check that the Contractor breaks the concrete pavement up into pieces that do not exceed 1 ft^2. This material may remain under the new embankment, unless otherwise directed by the Project Engineer/Supervisor.
5. Embankments on Non-Rigid Pavements. Where an embankment is placed on other than a rigid type of pavement, check that the Contractor scarifies the pavement to its full depth and re-compacts the material to meet the density requirements of the contract specifications.
6. Slopes. For existing slopes, other than rock slopes, where embankment material will be placed, check that the Contractor plows and/or deeply scarifies the existing slope so as to blend the in-place material with the new embankment material. If designated on the plans or as directed by the Project Engineer/Supervisor, check that the Contractor benches the slopes according to the specified dimensions. Give particular attention to embankment areas on steep slopes. It is critical to obtain good interlock between the sloping foundation and the new embankment material. The contract plans will specify any special treatments. Hard surface areas usually are benched prior to placing embankment material. This method of keying is also employed when widening or raising the grade of old embankments.
7. Salvable Topsoil. Prior to excavation and embankment work, if designated on the plans or as directed by the Project Engineer/Supervisor, make sure the Contractor salvages and stockpiles the existing topsoil. See Section 207.4.2 for additional information.
8. Swamp and Marsh Areas. Carefully inspect that the Contractor's operations conform to the contract plans and specifications where embankment foundations are prepared in swamp, marsh, and old lakebed areas. Special designs and construction methods are usually specified in the contract plans for such areas.

207.5.3-Uniformity of Material To achieve proper embankment consolidation, it is essential that the Contractor breaks down clods and blends the embankment material. Most soils will allow the Contractor to use disc plows, blade graders, and similar equipment to achieve the desired results. Where different types of material are blended in the same embankment layer, pay particular attention the Contractor's equipment and method of blending. A uniform material must be achieved. The result should be a blend of material that can be adequately and uniformly compacted with a uniform application of moisture. Where practical, use poorer suitable materials in the lower lifts of the embankment.

207.5.4-Hauling and Placement

207.5.4.1-General More uniform compaction is obtained when embankment layers are placed in a uniform thickness. Use the following guidelines to check lift thickness:

1. Random Material. Where random material consisting of soil, granular material and soft shale is used for embankment, check that the Contractor places the material in successive lifts not to exceed 6 in in thickness after compaction.
2. Hard Shale. Where suitable random material is to be mixed with hard shale, check that the Contractor places the material as follows (Note that all material percentages may be determined by visual inspection and lift thickness shall be as thin as the fill material will permit).
   a. Random Material > 65%. Mixtures with greater than 65% of suitable random material will be placed in lifts not to exceed 6 in in thickness after compaction.
   b. Random Material 35% to 65%. Mixtures with 35% to 65% of suitable random material will be placed in lifts not to exceed 12 in before compaction.
   c. Random Material < 35%. Mixtures with less than 35% of suitable random material will be placed in lifts not to exceed 24 in. The lift thickness will be as thin as the excavated material will permit.
3. Rock Mixtures. See Section 207.6 for information on placing and compacting lifts of rock mixtures.
4. Swampy Areas. Where embankments are constructed across low swampy ground that will not support hauling equipment, allow the Contractor to construct the lower part of the fill by dumping successive vehicle loads of rock, hard shale, or granular material in a uniformly distributed layer. Do not permit the thickness of the layer to exceed that necessary to support the equipment placing the subsequent layers.
5. Inaccessible Locations. In locations inaccessible to a roller, such as adjacent to culverts, retaining walls and other structures, check that the Contractor places fill material in 6 in maximum compacted layers with approved tampers.
6. Checking and Documentation Procedures. An excellent method of checking lift thickness is by using stakes approximately 7 ft long, a cloth tape, and a hand level. Elevations can be quickly taken before and after each lift is placed by using the following procedures:
   a. At several random locations along the edge of shoulder, drive stakes into the ground.
   b. Measure and make a mark on each stake approximately 5 ft above the ground.

c. Measure points 15 ft, 30 ft, and 45 ft across the embankment from each stake.
d. Using a hand level and rule, at each point across the embankment from each stake, measure and record the vertical distance from the top of the embankment to a point that is level with the 5 ft mark on the stake.
e. Repeat Steps c. and d. after each lift is compacted and determine the lift thickness by subtracting corresponding readings.

The Contractor is responsible for controlling lift thickness and for documenting the lift thickness and type of material used. The Inspector is responsible for confirming the work by checking. The frequency and number of lift thickness measurements will be indicated in the Contractor's approved Quality Control Plan. Visual inspection is necessary but not as reliable as the use of a hand level, cloth tape, and stakes.

207.5.4.3-Moisture Content The success of compaction operations depends mainly on proper moisture control. If the proper amount of moisture is uniform throughout the embankment layer, it will rarely be difficult for the Contractor to obtain the compactive effort necessary to achieve the density required by the contract specifications. Prior to compaction, the moisture content of the soil for earth embankment should not vary from +3% to –4% of optimum moisture. Check that the embankment material is thoroughly mixed and blended with the proper amount of water. To ensure a uniform moist condition where it is necessary to mix and blend moisture into the embankment material, make sure the Contractor breaks down large clods and lumps by machine manipulation (e.g., plowing and turning). Water may be applied with a suitable sprinkling device. When adding water to a layer of embankment material, closely observe how the Contractor performs this task. Care must be taken to avoid overlapping or gapping between successive passes of the sprinkling device. Wet or dry streaks are unacceptable and should be avoided. If this condition is observed, instruct the equipment operator to begin applying water on one side of the embankment and work progressively across the embankment to the other side thus avoiding wet and dry streaks in the center of the embankment. Emphasize the importance of making several light applications of water rather than one heavy application.

207.5.5-Compaction

207.5.5.1-Stability of Embankment Embankment material must be compacted to the density specified in the contract specifications. This will provide adequate stability under traffic loads. Normally, non-plastic and moderately plastic soils will be compacted to the highest practical density and near the optimum moisture content. If it is not practical to confine expansive soils to the lower lifts of large embankments, control of over-compaction and under- compaction may be justified. With these soils, high densities obtained at low moisture contents are not desirable because swelling, loss of stability, and roughening of the finished pavement may occur after construction

207.5.5.2-Control of Compaction The Contractor is responsible for controlling the compaction (i.e., the density) of embankment and subgrade materials. The Contractor must prepare the Quality Control Plan in accordance with MP 717.04.21 and submit the Plan for Division approval to the Construction Engineer at the Pre-Construction Conference. Before the Contractor begins any embankment or subgrade work, check to make sure the requirements of the Quality Control Plan have been satisfied. During compaction operations, check that the Contractor is operating within the Quality Control Plan. See Division 700 for additional information on the control of materials. Perform in-place density tests for checking compaction using the specified equipment and in accordance with the specified test procedures. See Sections 704 and 707, respectively, for information on aggregates and density tests (in-place) for embankment and backfill. The Division will accept the compaction of embankment and subgrade materials based on the criteria presented in MP 700.00.50 and the governing contract specifications.

207.5.5.3-Compaction Equipment Check to make sure the Contractor has sufficient leveling and compaction equipment to perform the work without delay after the material has been deposited. Pay particular attention to any loss of moisture during the delay. If the leveling and compaction operation cannot keep up with the rate of material being deposited, have the Contractor adjust the placement operation with that of the leveling and compaction operation. Do not allow the Contractor to place multiple fills if the number of rollers on hand cannot keep pace with placement of the fills. Balance the operation accordingly. Check that the Contractor uses vibratory compactors (e.g., grid, paddle- foot, vibratory rollers) for fills that are predominantly rock or hard shale. For areas inaccessible to rollers, pneumatic or power driven backfill tampers will be used. Check to make sure that all equipment conforms to the Contractor's Quality Control Plan and the governing contract specifications.

207.6-ROCK EMBANKMENT

207.6.1-Placement The construction methods for placing embankment material consisting principally of rock will depend on the size of the rocks and the amount of rock present. Rock embankments will be placed in level layers of uniform thickness over the full width of the roadway. In general, do not allow rock material to be dumped and roll into place. Oversized rock material that is not suitable for placement can be broken down to proper dimensions or moved for placement in larger rock embankments as required by the contract plans. See Item 9 of Section 207.5.4.1 for additional information on the handling and placement of rock materials. Where rock mixtures as defined in the contract specifications are used for embankment, check that the Contractor places the material as follows (Note that all material percentages may be determined by visual inspection and lift thickness shall be as thin as the fill material will permit):

1. Random Material > 65%. Rock mixtures that contain 66% or more of suitable random material will be placed in lifts not to exceed 6 in after compaction.
2. Random Material 35% to 65%. Rock mixtures that contain 35% to 65% of suitable random material will be placed in lifts not to exceed 12 in before compaction.
3. Random Material < 35%. Rock mixtures that contain less than 35% of suitable random material will be placed in lifts not to exceed 36 in except for the 2 ft underlying the

subgrade will be placed in lifts not exceeding 24 in. The lift thickness will be as thin as the excavated material will permit, except that the rock for the upper 2 ft of the embankment will not be greater in dimension than 18 in.

4. Rock Lifts for Select Embankment. See Section 207.7 for information on placing and compacting rock mixtures for select embankment.
5. Drainage Channels. Where rock is specified for use in lining drainage channels, check that it is placed to the thickness called for on the plans or cross sections. The dimensions of the rock may be as large as the thickness of the blanket will permit.

207.6.2-Compaction Compaction of rock embankments will be in accordance with the Contractor's approved Quality Control Plan and the applicable provisions of the contract specifications. See Division 700 for additional information on the control of materials and compaction. If the embankment material has 40% or more particles retained on the ¾ in. (19 mm) sieve and either a non-uniform gradation or particles larger than a nominal 10 in top size, check to make sure the Contractor proof rolls the embankment with a pneumatic tire roller having an effective weight of 50 tons in accordance with MP 717.04.21.

207.7-SELECT MATERIAL EMBANKMENT

The Project Engineer/Supervisor has discretionary authority and responsibility over the construction of select material embankments. Closely monitor the construction operations and use the following guidelines during inspection:

1. Material Integrity. Visually inspect that the select embankment material contains not more than 15% of other suitable material. The dominant rock size should be 6 in; however, the rock should not be greater than 36 in. During excavation and handling, check that the select material does not get contaminated.
2. Lift Thickness. Rock for select embankment will be placed in approximately level lift of uniform thickness. The lift thickness will not exceed 36 in.
3. Wasting. Rock for select embankment will be reserved from the excavation up to the plan quantity required. If select embankment from the excavation is wasted prior to meeting the plan quantities, the Contractor is responsible for the expense of replacing the material wasted up to the plan quantity.
4. Records. Document the quality of material used in the Daily Report. Specifically document the area and thickness of material placed by taking cross-sections. Generally, three lift thickness measurements per lift will suffice. Also, take elevations on top of the select material embankment. These notes are necessary to settle any disputes.

207.8-FINISHING EARTHWORK

207.8.1-Earth Roads Where the plans do not specify a pavement or surfacing, the roadway, shoulders, and superelevated curves will be constructed simultaneously to the required cross-section and grade. Check that the Contractor uses an approved power grader and that the earth road is maintained in a condition suitable for traffic until final acceptance.

207.8.2-Subgrade Use the following guidelines when inspecting the placement of subgrade:

1. Earthwork. Before beginning subgrade work, carefully inspect the entire roadway to check that the earthwork conforms to the required cross-section and grade within the accuracy of tolerances established by the contract specifications.
2. Unsuitable Materials. Inspect the roadbed and inform the Contractor to treat unsuitable materials and soft areas by aeration or removal and replacement. Ensure that any areas of solid formations (e.g., rock, hard shale, boulders, coal) and any isolated outcrops of ledge-rock or large boulders are excavated to at least 6 in below the subgrade for the full cross-section width of the roadway between the ditches. Other unsuitable materials will be removed to a depth of 12 in and replaced with suitable material. Cuts below grade and low areas will be backfilled with suitable material and graded to eliminate undrained pockets before placing subgrade material.
3. Seeps. Inspect areas that appear to be excessively wet for seeps and other sources of water. If such conditions are found, notify the Project Engineer/Supervisor for corrective measures.
4. Scarification. After removing and replacing unsuitable materials, ensure that the Contractor scarifies the subgrade to remove all deleterious material. Check for large stones and have the Contractor break them down or remove them from the top portion of the subgrade.
5. Subgrade Material. Check the subgrade material to ensure it is granular material or reclaimed asphalt pavement (RAP) free of particles larger than 3 in.
6. Lift Thickness. Check the operations to see that the Contractor achieves a 6 in compacted thickness for all embankment and excavation sections.
7. Compaction. Inspect the compaction operation to see that the subgrade layer is moistened or dried to uniform moisture content and compacted to a firm unyielding condition. See Division 700 for information on control of materials and compaction.
8. Drainage. Carefully monitor the drainage of the subgrade. The Contractor will maintain the subgrade in a condition that will drain at all times. Where trenching is performed for narrow base widening, check that ditches of an adequate depth are constructed across the shoulders at sufficient intervals to permit the free drainage of water.
9. Equipment Considerations. Do not permit equipment to travel in a single track to form ruts in the subgrade. Any ruts or irregularities formed in the subgrade will be scarified and re-compacted.
10. Engineering Fabric. Engineering fabric for subgrade stabilization will be used as specified in the plans. See Section 207.8.4 for additional information.

207.8.3-Slopes, Shoulders, and Ditches

207.8.3.1-Slopes The finished earthwork should have a pleasing contour and be reasonably smooth in all respects. A slight rounding effect at the top of slopes will give a pleasing appearance and reduce erosion. Where excess excavation is available and conditions permit, it is desirable to round the toe of fill slopes to increase the stability of the embankment and reduce erosion.

Any slope transitions should be gradual. Abrupt changes in slopes at intersections of cuts and fills should be avoided as practical. The finished slope should have a uniform appearance. Carefully inspect the slope lines to check that the lines and grades conform to the plans within allowable tolerances. Use the following guidelines to inspect slopes:

1. Measurements and Tolerances. For all slopes back of the ditch line, a tolerance of ±1 ft, as measured in the horizontal plane, is acceptable when taking measurements.
2. Width. The width, grade, and dimension of the roadway ditch must conform to the plan dimensions.
3. Slopes. If the slope varies, check with the Project Engineer/Supervisor for approval.
4. Trimming. Slopes will be trimmed neatly to present a uniform surface, free from hollows, protrusions, and loose or over- hanging rocks.
5. Undercutting. Check for any undercutting of slopes. Slopes will not be undercut.
6. Rounding. The tops of all slopes, except where the material is of solid rock, will be rounded as designated in the plans.
7. Benching. To prevent slides and slips, the Contractor will take precautions by benching or as otherwise directed. See Section 207.3.4 for additional information.

207.8.3.2-Flattening Slopes The additional flattening of slopes, where practical, will provide additional opportunity for errant vehicles to safely recover. Roadside slopes and clear zones are established during the design phase to meet specific criteria for the roadway facility. The clear zone is the total roadside border area, starting at the edge of the traveled way, available for safe use by errant vehicles. This area may consist of a shoulder, a recoverable slope, a non-recoverable slope and/or a clear run-out area. The desired width is dependent upon several factors (e.g., traffic volumes, speed, geometry). Where quantities of surplus and waste materials will permit, carefully consider the opportunity to flatten side slopes. The amount saved by eliminating guardrail in such areas may offset the cost of extending the pipe culverts. Give this issue consideration as soon as practical to facilitate ordering the proper length of pipe, establishing the proper clearing and grubbing area, etc. Where additional embankment material is needed to meet plan width, consider flattening the cut slopes in lieu of borrow excavation. Minor changes can be made without an undue increase in documentation, especially where no additional right-of-way is required. Slope flattening involving substantial quantities of additional excavation or substantial increases in drainage cost may require the approval of plan revisions and change orders. Any change from plan slope must have proper authorization.

207.8.3.3-Shoulders Neat and uniform shoulder lines generally should be maintained, as practical, during all phases of roadbed construction. Unless specifically waived by the Project Engineer/Supervisor (e.g., where concrete base or pavement is constructed, where shoulders are constructed of stabilized material), check that shoulders are constructed to full width and substantially to the line, grade, and depth required by the plans and specifications. This will ensure adequate side support. Check the compaction operation to make sure the Contractor uses at least a 10 ton roller. After placing the pavement surface, the Contractor will shape, dress, and compact the shoulder to plan dimensions and specification requirements. Visually inspect the shoulder to ensure that stone, exceeding 3 in in maximum dimension, is not within 3 in of the surface. Check that the outer edge of the shoulder is trimmed to a neat line parallel with the centerline of the roadway and that the entire surface is rolled to within 12 in of the outside edge. Have the Contractor refill and compact any depressions that develop in the shoulder.

207.8.3.4-Ditches At the completion of the shoulder work, ditches and back slopes will be finally cleaned and trimmed to plan line and grade. Check to make sure that ditches conform to plan dimensions and are maintained free from material and debris.

207.8.4-Engineering Fabric Typical applications of engineer fabric include stabilization, slope protection, erosion and sediment control, subsurface drainage, and layer separation. Where specified in the plans, engineering fabric must conform to the requirements of the contract specifications and be selected from the Division's approved materials list. Consider the following guidelines:

1. Subgrade Stabilization. Before engineering fabric is installed for subgrade stabilization applications, check the site to make sure the application area is relatively smooth and free of sharp protrusions, depressions, and debris. Check that the Contractor places the fabric with the machine direction of the fabric parallel with the alignment. Ensure that the fabric is placed relatively smooth and free of creases. Fabric joints may be either sewn or overlapped. Sewing may be performed either in the field or by portable machine. If overlapped, check to make sure the overlap is a minimum of 3 ft or as otherwise directed by the Project Engineer/Supervisor. Once the fabric is placed, check that the Contractor dumps and spreads cover material with equipment that exerts the minimum ground pressure possible. Do not allow construction equipment to operate directly on the fabric. Check to make sure a minimum of 6 in of cover material is maintained between construction equipment and the fabric.
2. Subsurface Drainage/Layer Separation. Where the plans require engineering fabric for subsurface drainage or layer separation, the fabric will be placed similarly to that for stabilization except that the minimum criteria for overlaps is 2 ft. Construction equipment is permitted on the fabric provided all damage is repaired. Where fabric is used for layer separation, check that the fabric is placed on a prepared grade extending the full width of the subbase layer that is to be protected. The fabric should be placed in a loose and unstretched condition to minimize shifting, tearing, or puncturing. If excessive slippage occurs, secure the fabric with steel pins. The operation of construction equipment on the fabric should be discouraged to minimize the chance of tearing. The fabric should be covered by subbase material within 2 weeks to minimize exposure.
3. Structural Backfill. Where fabric is placed in structural backfill applications, such as bridge abutments, the orientation of the fabric will be as directed by the Project Engineer/Supervisor Engineer.
4. Slope Protection. Where fabric is used for slope protection, it should be placed on areas that are smooth and free from protrusions such as vegetation, large stones, and other debris that can tear or puncture the fabric. Place the fabric in a loose

unstretched manner with the machine direction of the fabric placed in the direction of the water flow. A 3 ft minimum overlap should be used. The fabric should be covered in a direction from the downslope side to the upslope side. Use caution when placing the cover material to prevent tearing, especially with riprap. Dropping heavy granular stones on the fabric from greater than 1 ft is not acceptable. A layer of sand or gravel may use used to cushion the fabric as long as the additional material does not inhibit drainage. Minimize operation of construction equipment directly on the fabric.

207.8.5-Temporary Surcharge Check that temporary surcharge is placed to comply with the location limits and elevations on the plans or as otherwise directed by the Project/Engineer Supervisor. Where temporary surcharge is placed, visually inspect that it is composed of suitable compacted unclassified excavation or unclassified borrow excavation material. The first 5 ft of the material will be placed and compacted as earth embankment (see Section 207.5). However, the remaining surcharge will be compacted to meet a target dry density of 90%. Ensure that the temporary surcharge is maintained for the period indicated on the plans or as otherwise directed by the Project Engineer/Supervisor.

207.9-RECORDS AND DAILY REPORTS

The Project Engineer/Supervisor and Inspectors in charge of the work are responsible for recording in the Daily Work Reports the activities of the excavation and embankment work. Pay particular attention to keeping accurate and up- to-date records of all the work. Separate the men, equipment, and time worked for each excavation and embankment operation in the Inspector's Daily Report. This documentation will be valuable in the event that the Contractor files a claim for work performed on the project. Consider the need to document the following items in the Project Records (e.g., field notes, DWRs, cross sections) during the life of the project:

1. Locations of actual balance points and notes concerning cross-haul that may have occurred, including reasons for cross- hauling and the quantities involved.
2. Measurements and notes to substantiate classification and quantity of various materials encountered in the excavation.
3. Records of dimensions, weights, and calibrations that may be required by the contract specifications for water distribution and compaction equipment.
4. Measurements of excavation below grade necessary for the removal of unsuitable materials.
5. Daily records of events, including:
   a. Narrative of work performed;
   b. Location of work;
   c. Cut and fill locations, lift thickness;
   d. Approximate quantity
   e. Basting record
   f. Compaction testing, proof rolling
6. Density and proof rolling tests made to determine acceptability of embankment with remarks to explain corrective actions at locations where tests fail and reasons for not

testing at other locations.

7. Records of equipment, labor, and materials used in an operation that is, or may later be, determined as extra work.
8. Notes regarding damage to private property caused by the Contractor's equipment and/or operations.
9. Records of the final disposition of salvable materials.
10. Weather conditions and their effect on quality and workability of earthwork.

207.10-MEASUREMENT FOR PAYMENT

Excavation and embankment quantities are measured to compare actual quantities with those in the plans and to balance earthwork as the work progresses. Where borrow is utilized, measurement of embankment also provides a check for "fat fills." The quantity of work performed will be measured and paid as prescribed in the contract specifications. In general, maintain project records in such a manner that partial progress and final payments can be easily and clearly supported by data (e.g., when the work was completed, measurements and calculations to support the quantity and quality allowed). Initial all records, calculations, and measurements. Consider the following additional guidelines:

1. Blasting. Any material outside the authorized cross-section that becomes shattered or loosened by blasting will be removed without compensation as ordered by the Project Engineer/Supervisor.
2. Water. The Contractor is responsible for the expense of water used to adjust the moisture content of soil during compaction.
3. Cross-Sectioning. The survey crew is responsible for cross-sections that are needed for partial progress and final payments. Some estimate and final sections are generated from computer models. Cross- sectioning is used for final payment because it is accurate. The material actually moved is measured in its original position as cross- sections are taken of the excavated areas. The excavation quantity is calculated using the average-end-area method. The method of cross-sectioning is difficult to use at commercial borrow sites because of other unrelated hauling operations.
4. Truck Counting. Truck counting is used for estimating purposes. The quantity of material each truck hauls is estimated as 80% of the truck's total volume. The truck's total volume is calculated based on the length and width of the inside bed and the average height of the load. Where rock is hauled from commercial borrow sources that use weigh tickets, the quantity of material can be determined using the conversion factor 1.65 tons/yd^3 (1.14 Mg/m^3).
5. Shrink/Swell Factors. Refer to the plans for the appropriate shrink/swell factors. The proper factor must be used in each case. Shrink factors will reduce the amount of embankment that is in place, and swell factors will increase the amount. Note that payment for unclassified excavation is for the actual quantity of material moved and disposed or placed.

SECTION 211
BORROW EXCAVATION

211.1-GENERAL

211.1.1-Description of Work The construction of a graded roadbed, upon which the base and wearing courses will be placed, is generally referred to as earthwork. Roadway excavation and embankment materials (See Section 207) are obtained from within the right-of-way. Where there is insufficient suitable roadway excavation material to construct the roadbed embankment to the required line and grade (i.e., the "cut" and "fill" do not balance), borrow excavation material will be imported. Roadway borrow excavation construction, includes:

1. Removing and hauling all material;
2. Preparing areas upon which roadway and/or embankments are to be placed;
3. Placing, compacting, and finishing material to construct the roadway or embankments;

The Contractor is responsible for: selecting the site; developing and submitting any needed plans and applications; obtaining requisite permits and approvals; following all environmental requirements, and excavating, transporting, placing, and compacting borrow excavation in accordance with the contract plans and specifications. This following Sections present what the Inspector can expect of the Contractor before, during, and after the borrow excavation operation.

211.1.2-Site Selection The Contractor will have the option to borrow within the WVDOH right of way limits or on private property located outside the right of way.

Borrow Within WVDOH Right of Way Limits: If the Contractor chooses to borrow any material within the right of way, a site plan is required. Check that each sheet of submittal has been prepared and sealed by a Professional Engineering in the State of West Virginia.

a. Site Plan. The Contractor will submit to the Project Engineer/Supervisor, for review and approval, a Site Plan. The Plan will address permits and agreements, excavation limits, clearing and grubbing, grading, drainage, erosion and sediment control, dust control, haul roads, restoration, etc. as outlined in section 211.3.1 of specifications. Check to make sure that the Site Plan has been submitted and approved before allowing borrow excavation operations to begin.

Borrow Outside of WVDOH Right of Way Limits: Except for sites specifically designated on the plans, the Contractor is responsible for locating and furnishing all sites off the right-of-way for borrow materials. The Contractor and/or property owner shall bear all costs and responsibilities associated with erosion and sediment control, stability, permitting, mitigation, etc. The Contractor and/or property owner shall comply with existing laws and/or regulations and save the State harmless from any claims for damages which may result from the borrow.

Borrow pits should not be excavated below the level of the natural drainage for the area, and the drainage ditches required to keep the pit free from standing water during the progress of the work and upon completion and shall be constructed without extra compensation.

211.1.3-Protection and Preservation of Property During borrow excavation, the Contractor is responsible for the protection and preservation of all property, including the expense of correcting any damages that occur. Inform the Contractor of any apparent or obvious violations of the contract plans and specifications. As needed, report any damage to the Project Engineer/Supervisor, and note any relevant comments or actions in the Inspector's Daily Report. See Section 207.1.2 for additional information on the protection and preservation of property.

211.2-HAZARDS

The Contractor is responsible for performing construction operations in a manner that is safe to both project personnel and the general public. The Contractor is responsible for conducting the operations in accordance with the governing provisions of all applicable Federal, State, and local laws (e.g., OSHA). See Section 207.2 for information on the typical hazards of excavation operations.

211.3-BORROW EXCAVATION

211.3.1-Justification and Approval Before the Division will approve borrow excavation, the Contractor first, in some cases, completely utilize all available suitable material within the right-of-way (i.e., balancing excavation with embankment). Some projects require the borrow excavation to begin prior to the project excavation to construct detours. Furthermore, suitable excess material, including that from slides and slips, and any Division- furnished borrow material, if available, must be fully and completely used before the Contractor may borrow material outside the right-of-way. If the Division approves borrow excavation as a pay item, the Contractor will select the site and the Division must review and approve the use of the borrow site and the material before excavation work begins.

211.3.2-Classification, Placement, and Compaction The Contractor is responsible for excavating, transporting, placing, and compacting borrow excavation in accordance with the contract plans and specifications. Borrow excavation may be classified as follows:

1. Unclassified Borrow Excavation. This classification includes materials that conform to the contract specifications for use in embankments, backfill, shoulders, and other items as designated on the plans or as directed by the Project Engineer/Supervisor. Use the procedures and criteria presented in Section 207.5 to inspect the placement and compaction.
2. Rock Borrow Excavation. Rock borrow excavation includes rock materials that conform to the contract specifications for use in embankment construction and other items as designated on the plans or as directed by the Project Engineer/Supervisor. Use the procedures and criteria presented in Section 207.6 to inspect the placement

and compaction of rock borrow excavation.

3. Select Borrow Excavation. Select borrow excavation includes select granular materials that conform to the contract specifications for use in embankments, backfill, shoulders, and other types of work as designated on the plans or as directed by the Project Engineer/Supervisor. Use the procedures and criteria presented in Section 207.7 to inspect the placement and compaction of select borrow excavation.

Check to make sure that the Contractor places and compacts all borrow material in accordance with the contract plans and specifications.

211.3.3-Impervious Core The Contractor is responsible for installing an impervious core on all sediment dams built of rock, gravel, or pervious soils. Check that the impervious core is meeting the minimum dimensions identified in the specifications.

211.4-RECORDS AND DAILY REPORTS

The Project Engineer/Supervisor and Inspectors in charge of the work are responsible for recording in the Daily Reports the activities for borrow excavation work. Pay particular attention to keeping accurate and up-to-date records in the Daily Work Report of all items related to measurement for payment and any measurements, calculations, and dimensions to support compliance or non-compliance to the contract plans and specifications. Specifically note the pay quantity measurements for each classification of borrow excavation in the Daily Work Report and any damages and directives given the Contractor regarding corrective actions. This documentation will be valuable in the event that the Contractor files a claim for work performed on the project. See Section 207.9 for suggested items to documents during excavation operations.

1. Locations of actual balance points and notes concerning cross-haul that may have occurred, including reasons for cross- hauling and the quantities involved.
2. Measurements and notes to substantiate classification and quantity of various materials encountered in the excavation.
3. Records of dimensions, weights, and calibrations that may be required by the contract specifications for water distribution and compaction equipment.
4. Measurements of excavation below grade necessary for the removal of unsuitable materials.
5. Daily records of events, including:
   a. Narrative of work performed;
   b. Location of work;
   c. Cut and fill locations, lift thickness;
   d. Approximate quantity
   e. Basting record
   f. Compaction testing, proof rolling
6. Density and proof rolling tests made to determine acceptability of embankment with remarks to explain corrective actions at locations where tests fail and reasons for not testing at other locations.

7. Records of equipment, labor, and materials used in an operation that is, or may later be, determined as extra work.
8. Notes regarding damage to private property caused by the Contractor's equipment and/or operations.
9. Records of the final disposition of salvable materials.
10. Weather conditions and their effect on quality and workability of earthwork

211.5-MEASUREMENT FOR PAYMENT

Borrow excavation will be paid for at the contract unit price based on the quantity of material obtained from its original position and incorporated in the work. This will be full compensation for performing acceptable work, including all labor, tools, equipment, supplies, and incidentals. Use the following guidelines:

1. Approval Contingency. Rock material shall meet the requirements specified in 207.6. Select material shall meet granular material requirements of specifications 716.1.1.2. Impervious core shall meet requirements of specification 211.3.3.
2. Unit of Measurement. Determine the quantity of borrow excavation, cubic yards , actually obtained from its original position and incorporated in the work.
3. Method of Measurement. Use either the cross-sectioning method, as described in Section 207.10, or determine the quantity from weigh slips as follows:
   a. Cross-Sectioning. If cross-sectioning is used, the borrow pit must be cross-sectioned before excavation to establish a baseline. Cross-sectioning, although accurate, probably will not be used at common borrow sites.
   b. Weigh-Slips. If weigh slips are used, make sure they come from a Contractor-furnished, State-certified scale in accordance with the contract specifications and that the correct weight-to-volume conversion factor is used.
4. Adjustments. If borrow material is used for embankment that could have been constructed with suitable excess material that the Contractor wasted (e.g., roadway excavation, unclassified excavation, slides, slips), deduct the wasted quantity from the quantity borrowed. To adjust a pay quantity for unauthorized placement, measure and deduct the quantity placed outside the construction tolerance and adjust the quantity for shrinkage or swelling. There will be no additional compensation for furnishing, grading, fertilizing, seeding, and mulching borrow pits.

SECTION 212
STRUCTURE, ROCK, AND WET EXCAVATION

212.1-GENERAL

212.1.1-Description of Work Structure, rock, and wet excavation are specified for the excavation of structural footings and may consist of any of the following activities as designated on the plans or as otherwise directed by the Project Engineer/Supervisor:

1. Excavation, backfill, and disposal of materials required to remove or construct retaining walls, box culverts, catch basins, drop inlets, manholes, bridges foundations, and other structures;
2. Removal of old structures including abutments, piers, and wingwalls; and/or
3. Pumping, draining, sheeting, and constructing cribs and cofferdams.

A foundation, or footing, is constructed to provide adequate bearing support by distributing the load of the structure over the underlying soil or rock. Excavation for footings may be categorized as follows:

1. Structure Excavation. Structure excavation is the excavation needed to allow the placement of the structural foundation. The limits of the area generally extend from the original ground line to the bottom of the footer, with sufficient width to permit placement of forms.
2. Rock Excavation. If a portion of the footer will be seated in rock, the area that is excavated to the neat lines of the footer is classified as rock excavation.
3. Wet Excavation. Where foundations will be constructed in rivers or streams, the type of excavation that is below the low water line normally is classified as wet excavation.

Unless otherwise directed, check that the Contractor performs the work in accordance with the contract specifications and in reasonable conformance to the lines, grades, and typical section of the plans. Consult the plans and specifications for the absolute definitions and pay limits for each particular item. Upon completion, notify the Project Engineer/Supervisor for approval. Do not allow the Contractor to place footing, pipe, or other structures until the Project Engineer/Supervisor approves the depth of the excavation.

212.1.2-Protection and Preservation of Property During excavation, the Contractor is responsible for the protection and preservation of all property, including the expense of correcting any damages that occur. As needed, report any damage to the Project Engineer/Supervisor, and note any relevant comments or actions in the Inspector's Daily Report. See Section 207.1.2 for additional information on the protection and preservation of property.

212.1.3-Shoring, Bracing, and Cofferdams

212.1.3.1-Cofferdams The term cofferdam designates any barrier system that provides an area as watertight as practical, for excavation, inspection, and placing concrete. It may be constructed of sheet piling, wood, sand bags, earth embankment, or a combination of these materials. Cofferdams may extend below the bottom of the footings. The interior dimension will be sufficient to provide adequate clearance for form construction and to permit the pumping of water outside the forms. Where sandy or porous material is encountered in the excavation, it is impractical to completely dewater the area before placing concrete. In these cases, a tremie is used to place concrete in the bottom of the cofferdam to seal the internal area from water intrusion. Do not allow the Contractor to leave internal bracing in the cofferdam that would extend into the substructure concrete. Make sure that the Contractor removes the cofferdam upon completing the substructure in a manner that will not jeopardize the integrity of the structure or its surrounding environs.

212.1.3.2-Construction Plans If shoring, bracing, and/or cofferdams are specified in the contract plans, the Contractor is responsible for their design, construction, and removal. Before the foundation excavation work begins, check that that the Contractor has submitted to the Project Engineer/Supervisor, and the Chief Engineer of the railroad if the work is adjacent to railroad tracks, with a copy of the construction plans (Plan) for any needed shoring, bracing, and cofferdams.

212.1.3.3-Pumping Pay particular attention to how the Contractor pumps water from within the foundation enclosure to make sure that extraneous water does not contact or mix with freshly poured concrete. Unless the Contractor uses a suitable pump that is separated from the concrete by a watertight wall, do not allow the pumping of water during the placement of concrete or for a period of at least 24 hours thereafter.

212.1.4-Drainage Check that porous material, tile, and/or pipe drains are provided to adequately drain water from behind the backs of retaining walls, abutments, and wingwalls. Unless selected material is used for backfill, porous drains should be constructed to collect water and to permit the weep holes to drain. Frequently check the drains to make sure that they are not clogged and the drains and weep holes are functioning. Drains will be placed behind and along the length of the wall draining to the elevation of the outlet. Outlet drains will extend through the walls at the ground line or as otherwise specified or directed. If the end of the outlet drain will be below ground or fill material, make sure the Contractor extends the drain outlets to the toe of the slope. Make sure that drain material, size, placement, and backfilling comply with the contract plans and specifications.

212.1.5-Erosion and Sediment Control During excavation, the Contractor is responsible for all needed permanent and temporary erosion and sediment control treatments. Visually check that the Contractor excavates in a workmanlike manner to minimize erosion, pollution, and sedimentation of streams. Check to make sure that the Contractor does not obstruct or change the stream channel, unless authorized to do so under the contract. See Section 207.1.4.

212.1.6-Blasting Consideration Controlled blasting may or may not be needed during the excavation. Where blasting is needed, check that the Contractor does so in a safe and productive manner. Check that rock is removed reasonably close to the plan lines and with little disturbance to the material left in place. See Sections 207.1.7 and 207.3.3.

212.1.7-Materials and Equipment The Contractor is responsible for the quality control of select backfill material. Check that the testing methods and sampling frequencies conform to MP 717.04.21. Acceptance is based on the Contractor's written certification. Check to ascertain that the test results are included on the certification. Materials (e.g., controlled low- strength material, engineering fabric for subsurface drainage and layer separation) will be in conformance with the contract specifications. As appropriate, check to make sure that materials are selected from the Division's approved list of materials.

212.2-HAZARDS

The Contractor is responsible for performing construction operations in a manner that is safe to both project personnel and the general public. The Contractor is responsible for conducting the operations in accordance with the governing provisions of all applicable Federal, State, and local laws (e.g., OSHA). See Section 207.2 for information on the typical hazards of excavation operations.

212.3-EXCAVATION FOR FOOOTINGS

212.3.1-Footing Elevation The plans show the bottom elevation of each footing and the type of material that will be encountered during excavation. Emphasize to the Contractor not to excavate below the bottom elevation of the footing unless otherwise directed by the Project Engineer/Supervisor. If questionable foundation material is encountered at the planned footing elevation, immediately notify the Project Engineer/Supervisor to properly resolve the matter without jeopardizing the integrity of the structure or unnecessarily delaying the progress of the Contractor. Where ground or other conditions necessitate a bottom elevation below that shown on the plans, notify and obtain approval from the Project Engineer/Supervisor or Construction Engineer before allowing the Contractor to begin any extra excavation. In such cases, Engineering /Technical Support Division will need to analyze the changed conditions to determine a practical solution (e.g., increase the footing thickness, redesign the affected part of the structure). Be prepared to provide the Engineering/Technical Support Division with additional information about the material at the lower elevation. Soil samples at various depths may need to be obtained and analyzed. The Project Engineer/Supervisor is responsible for informing the Contractor in writing of any changes in footing dimensions or elevations. When the footing excavation is complete, notify the Project Engineer/Supervisor to inspect and approve the bottom of the footing excavation before allowing any concrete to be placed.

212.3.2-Foundation Surface Preparation Use the following guidelines when inspecting foundation preparation operations:

1. Rock. If the plan shows a footing on rock or other hard material, check that the Contractor cuts (e.g., level, stepped, serrated) the surface according to plan. A

footing in sound rock or hard shale normally requires a 6-in to 12-in key into the solid foundation material. The foundation should be cleaned free of all loose material, mud, and water. All large seams and cracks in the rock surface will be cleaned and filled with mortar, concrete, or grout. Check that the excavated rock or hard shale foundation is cut, as practical, to the neat lines of the footing. And that concrete is placed against the rock without forming.

2. Other Than Rock. If the plan shows a footing on an excavated surface other than rock or hard shale, pay particular attention to make certain that the Contractor does not disturb the bearing surface. Final removal of the foundation material will not be made until just before the concrete is placed.

212.3.3-Backfilling Around Structures A primary objective of backfilling around structures is to thoroughly compact the material to minimize consolidation and settlement after construction. This will improve the riding qualities of the pavement by helping to eliminate the "bump at the end of the bridge" that sometimes develops due to settlement behind the abutment. Check that the Contractor backfills all voids that are not occupied by abutments, piers, and other structures to the surface of the surrounding ground in accordance with the contract plans and specifications. Backfill material will be suitable random material, controlled low-strength material, or select backfill material as specified. Use the following guidelines during inspection:

1. Timing. Plan notes, if specified, will govern when to allow backfilling to be placed around structures. It is desirable to backfill as soon as practical after the forms have been removed. Normally, backfilling may begin when the concrete has attained the compressive strength specified in Section 601.8.7 of the Specifications.
2. Foundation. Backfill next to a structure must be placed on a firm foundation. Before any material is placed, make sure all loose material and debris have been removed from the foundation area. Any mud or water should be removed and suitable material placed up to the level of the drains or the weep holes in the abutment, and thoroughly compacted.
3. Random Material. Where used, random material will be free from all particles larger than 3 in, frozen lumps, wood, or other extraneous material. The material will be thoroughly compacted by rolling or tamping. The moisture content will be adjusted so that the material will be compacted to the required density. The top surface will be neatly graded. Check the backfill operation behind and around all structures to make certain the Contractor places compacted lifts that do not exceed 4 in. These structures include abutments, wingwalls, piers, bents, pedestals and those inaccessible to rollers. The quality control for random material will be in accordance with the contract specifications. See Section 207.1.9 for additional information. Five density tests are required with a target dry density of 95%.
4. Controlled Low-Strength Material (CLSM). At the Contractor's option and expense, CLSM may be used in lieu of random material where specified. See Section 219 for additional information on CLSM.
5. Select Backfill Material. Where used, select backfill material will be thoroughly compacted by rolling or tamping. The moisture content will be adjusted so that the material will be compacted to the required density. The top surface will be neatly

graded. Check the backfill operation behind all structures to make certain the Contractor places compacted horizontal lifts that do not exceed 4 in. Select backfill material will be placed to plan dimensions behind abutments, wingwalls, retaining walls, and box culverts. The quality control for select backfill material will be in accordance with the contract specifications. See Section 207.1.9 for additional information. Testing of select backfill material will comply with MP 700.00.24 Five density tests are required with a target dry density of 95%.

6. Lot Size. The lot size for quality control testing is not a specified quantity. The quantity may be the quantity to backfill one abutment, if it is a rather large abutment, or that required to backfill both abutments. Where there are piers, the backfill may or may not be included in the quantity with the abutments. The lot size should be the quantity that the Contractor feels can be risked by including in one lot. The Project Engineer/Supervisor and Construction Engineer likewise should feel comfortable and assured that the Contractor is not selecting a lot size that may prove to be too costly to remove or rework should it fail.
7. Backfill Over Structures. Check the backfilling operation to make sure that backfill is placed around and over abutments, culverts, arches, and columns uniformly and as soon as practical after the forms are removed to avoid bending or distortional stresses on the structure.
8. Integral/Semi-Integral Abutments. Check to make sure that the backfill around integral and semi-integral abutments conform to the requirements of the contract plans and specifications.
9. Engineering Fabric. In all areas where select backfill material will contact random material, make sure the Contractor uses engineering fabric to separate the layers. See Section 207.8.4 for additional information.
10. Wedging. Where backfilling around abutments and walls, check to make sure the Contractor uses stepping or serrations to prevent wedge action against the masonry and the slope bounding the excavation.
11. Jetting. Do not permit the jetting or flooding of fill behind retaining walls, abutments, or wingwalls.
12. Equipment. Pay particular attention to how the Contractor operates equipment and machinery (e.g., dozers, rollers) adjacent to structures. Emphasize to the Contractor to be careful not to damage to the structures. In places that are inaccessible to a roller, the Contractor should be using an approved pneumatic or power driven backfill tamper to thoroughly compact the material.
13. Backfilling Around Non-Critical Locations. The Specifications waive some compaction and testing requirements for non-critical locations (e.g., backfill not part of embankment, highway pavement, or shoulder). Use sound judgment in administering backfill compaction for these locations. A reasonable compactive effort applied to material with reasonable moisture content in 6 in maximum lifts will usually be sufficient. The intent is to achieve a density approximately equal to that of the existing soil. Backfill placed in this manner should be slightly higher in elevation than the surrounding soil and sloping away from the structural element for purposes of draining and possible settlement. The Contractor’s Quality Control Plan for structural

backfilling will be considered acceptable if it includes the lot sizes to be used for random material and select backfill and the location and compaction procedures for non-critical locations.

212.4-DISPOSAL OF MATERIALS

The Contractor will use suitable excavated materials for backfill or embankments as designated on the plans or as directed by the Project Engineer/Supervisor. Surplus and waste material will be disposed consistent with the procedures and criteria presented in Section 207.4. Pay particular attention to how the Contractor disposes of materials. Do not allow the Contractor to engage in operations that would impede the integrity, efficiency, or appearance of the structure, cause stream erosion or sedimentation, or obstruct or change the stream channel.

212.5-RECORES AND DAILY REPORTS

The Project Engineer/Supervisor and Inspectors in charge of the work are responsible for recording in the Daily Reports accurate and up- to-date records of the work. Separate the men, equipment, time, and pay quantity measurements for each classification of structure, rock, and wet excavation in the Inspector's Daily Report. Also measure and check the actual dimensions for compliance with plan dimensions of each footing excavation as soon as the excavation has been completed. Document the findings as well as the type of material found in the bottom of the excavation in the Inspector's Daily Report. This documentation will be valuable in the event that the Contractor files a claim for work performed on the project. See Section 207.9 for other suggested items to document during excavation operations.

212.6-MEASUREMENT FOR PAYMENT

Structure, rock, and wet excavation are measured and paid at the contract unit price based on the number of cubic yards represented in the contract plans. This will be full compensation for performing acceptable work, including all labor, tools, equipment, supplies, and incidentals. Use the following guidelines:

1. Structure Excavation. Measure structure excavation as the number of cubic yards (cubic meters) excavated and limit the volume to that within parallel vertical planes 18 in (450 mm) outside the neat lines of the footing. Do not measure or pay separately the excavation and backfilling for drains with sand, crushed stone, or gravel. Do not measure or pay separately the clearing of the right-of-way within the construction limits of piers, abutments, retaining walls etc, nor backfilling to the level of the original ground. These items will be included in the unit price. Measure and pay separately backfill that is placed above the original ground as designated in the contract plans (see Sections 207 and 211).
2. Rock Excavation. Measure rock excavation as the number of cubic yards (cubic meters) excavated and limit the volume to the neat lines of the footing. This includes all material encountered in the excavation, required blasting and removal, and removal of all boulders greater than 0.5 yd^3 (0.4 m^3).
3. Wet Excavation. Measure wet excavation as the number of cubic yards (cubic meters) bounded between the normal pool elevation of the stream and the bottom of the

footing between the lines designated on the plans for the footing. Material paid as rock excavation below the waterline should not be included for payment in wet excavation.

4. Select Backfill Material. Measure and pay separately the placement and compaction of select backfill material. Do not measure and pay separately for engineering fabric that is used in select backfill material. This item is included in the unit price for select material.
5. Additional Work. The Project Engineer/Supervisor must authorize any additional work beyond the limits of the contract plan, especially any increase in foundation depth. Such work will be measured in cubic yards as excavated material removed or select backfill in place. Pay any increase in foundation depth 5 ft or less at the unit bid price. Pay increases in foundation depth over 5 ft as extra work (see Division 100).
6. Blasting. Where drilling and blasting is involved, check to see if the rock was removed in accordance with the contract specifications, in reasonable conformance with the required plan lines, and with as little disturbance as practical to the material that is to remain. If the Contractor removes material beyond the plan dimensions, measure and record the quantity of extra excavation. The volume of excavation to be paid will be computed from original and final cross-sections with pay lines drawn in accordance with plan dimensions.
7. Shoring and Bracing. The cost of bracing, shoring, and supporting excavation that is adjacent to railroad tracks and other structures will be included in the unit price bid for structure, rock, and wet excavation.
8. Cofferdams. Where a footing is placed below the water level and a cofferdam is built, measure and pay for cofferdams for each unit complete in place. This will include all labor, materials, and equipment incidental to design and plan preparation, construction, pumping and removal. Progress payments may be determined and made by Project Engineer/Supervisor.

SECTION 217
SPECIAL ROCK FILL

217.1-GENERAL

217.1.1-Description of Work Special rock fill is specified for the footings of slopes or where called for on the plans, as designed on the plans or as otherwise directed by the Project Engineer/Supervisor.

Unless otherwise directed, check that the Contractor performs the work in accordance with the contract specifications and in reasonable conformance to the lines, grades, and details of the plans. Upon completion, notify the Project Engineer/Supervisor for approval.

217.1.1-Materials and Equipment Check to ensure that the Contractor's equipment conforms to the provisions of the contract specifications. See Section 201.1.8 for general guidelines regarding materials and equipment.

217.2-SPECIAL ROCK FILL

Foundation trenches and other necessary excavations shall be excavated by the Contractor, in accordance with Section 212. Prior to placing the rock, check that the Contractor excavated area is in reasonable conformity to the lines, grades, and dimensions shown on the plans.

See Section 207.6 for general guidelines regarding rock embankment, however specialized equipment or other methods may be employed to spread the material where the use of standard equipment is impractical or not accessible.

Unless otherwise shown on the Plans or directed by the Engineer, the rock fill shall extend approximately 2 ft. below the bed of the stream.

217.3-RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Daily Work Reports all information (e.g., laboratory numbers from the shipping documents, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Daily Work Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWARE Project, and pertinent attachments, to prepare Diaries and DWRs for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it

217.4-MEASUREMENT FOR PAYMENT

Special rock fills are measured and paid at the contract unit price based on the number of cubic yards. Volume quantities may be determined by average end areas method. This will be full compensation for performing acceptable work, including all labor, tools, equipment, supplies, and incidentals.

SECTION 218
SLOPE AND FOUNDATION PROTECTION

218.1-GENERAL

218.1.1-Description of Work Slope and foundation protection consists of installing erosion-free slopes around heavy wash areas of structures, channel changes, and foundations. The surface treatments could consist of stone or concrete (with or without engineering fabric) including graded limestone for crushed-rock slope protection, large sandstone for riprap, rocks and river gravel placed in wire-mesh baskets, concrete for sills and concrete slope protection, grout, reinforcement, pre-cast concrete blocks, and other items as specified. The surface treatments will be designated on the plans. As work progresses, the Project Engineer/Supervisor may identify other locations where such treatments are needed.

218.1.2-Materials and Equipment Check that all materials conform to the requirements of the contract specifications. In some cases, acceptance will be based on the Contractor's written materials certification. Check to make certain that the appropriate samples and test results are reported on all material certifications, including lab numbers. As necessary, check to make certain that the materials are selected from the Division's approved list of materials. See Section 207.1.9 for additional information on materials and equipment. See Division 700 for additional information on control of materials and quality control programs.

218.2-SLOPE PROTECTION

218.2.1-General Slope protection generally is placed to stabilize the slope and protect it from the elements of erosion. Check that any slope protection reasonably conforms to the lines, grades, dimensions, and cross-sections of the contract plans and that the materials used comply with the contract specifications. The following Sections present additional guidelines.

218.2.2-Riprap/Grouted Riprap Riprap often if used in channels and areas exposed to erosion by water. Riprap basically consists of individually placed large stones with smaller stones placed to fill any voids to form a compact mass that protects the slope. Stone size will be specified on the plans. In some cases, the riprap material is grouted to provide additional stability. Use the following guidelines when inspecting riprap operations.

1. Trenching. Where slopes are treated with riprap, check that a 2 ft wide trench is provided at the toe of the slope. Visually inspect that the trench invert is parallel to and 2 ft below the toe.
2. Stone Size. Of the various stone sizes, the larger stones will be approximately 3 in by 12 in with intervening space filled with suitably sized spalls.

3. Placement. Placement operations should begin at the trench invert and proceed up the slope to the plan limit. Occasionally check the stones to see that they are firmly embedded in the slope face. The larger stones are placed with the longer dimension oriented horizontal and parallel to the slope. Adjoining rocks should abut one another to form a single layer. Spalls and smaller rock should fill the voids. The finished riprap surface should appear smooth as practical with abutting stones not differing more than ±1½ in.
4. Grouting. If cement grout is specified, check that the Contractor thoroughly wets the riprap immediately before the grout is applied. As the grout is applied, it will be worked into the exposed joints. The Contractor should then brush the grout to expose the face of the stones. Check that the grout is cured either for 72 hours with a blanket of wet earth or by sprinkling with a fine spray of water every two hours during daylight hours for 3 days.
5. Weep Holes. Weep holes generally are provided in grouted riprap but may not be specified on the plans. Check that the Contractor provides weep holes. The Project Engineer/Supervisor will clarify any uncertainties.

218.2.3-Gabions Gabions are often used along banks of streams and channels. They are constructed by encasing rock in galvanized wire mesh baskets. Equipment may be used to fill the basket; however, the rock at the exposed faces of the basket must be placed by hand to ensure filling of voids and an attractive appearance.

218.2.4-Crushed Rock Where crushed rock is specified for slope protection, the limits and depth will be designated on the plans. Normally, concrete sills also will be specified at the bottom and on each side of the limits of protection. Sills may be pre- cast or cast-in-place and will be placed in a trench excavated to receive them. Visually inspect the trench and sill dimensions for conformance. The crushed rock will be placed on the slope within the limits of the sills. Placement will start at the bottom sill and proceed up the slope to the berm in front of the abutment. The rock may be placed by either hand or equipment; however, if the Contractor uses equipment, inspect both the sills and the adjacent structure for any damage. The rock should be raked in place to obtain a reasonably smooth and continuous surface. Check the finished work to see that the thickness and slope line reasonably conform to the plans.

218.2.5-Concrete Concrete slope protection can consist of either a reinforced cast-in-place concrete slab or adjoining reinforced pre-cast concrete blocks embedded in the slope face. Check to make sure the Contractor uses one or the other, not both, at any one bridge. Use the following guidelines during inspection:

1. Sills. Normally, concrete sills will be specified at the bottom and on each side of the limits of protection. Sills may be pre-cast or cast-in-place and will be placed in a trench excavated to receive them. Visually inspect the trench and sill dimensions for conformance.

2. Cast-in-Place Concrete Slab. Check that the reinforcement of the slab meets specifications, is firmly secured, and will not protrude through the finished face. The forms should be set to receive a slab pour not less than 6 in thick. Construction joints will be placed at intervals of 10 ft in both directions. A wood float finish is acceptable. The concrete will be poured on the slope within the limits of the sills. Placement will start at the bottom sill and proceed up the slope to the berm in front of the abutment.
3. Precast Blocks. The size of the reinforced precast concrete blocks will be 3 ft by 1 ft, 4 in thick. Check that the blocks are firmly embedded in the slope face. The blocks will be placed with the longer dimension oriented horizontal and parallel to the slope. Adjoining blocks should tightly abut one another to form a single, even layer that reasonably conforms to the line, grade, and section of the plans.
4. Weep Holes. Check that weep holes are provided as directed by the Project Engineer/Supervisor.

218.2.6-Engineering Fabric See Section 207.8.4 for information on engineering fabric. The engineering fabric used must be selected from the Division's list of approved materials. Emphasize to the Contractor not to operate machinery directly on the fabric and to protect the fabric from contamination by surface runoff. If the fabric does get contaminated, have the Contractor replace the contaminated runs. The machine direction of the fabric will be placed parallel with the direction of the stream.

218.3-FOUNDATION PROTECTION

Foundation protection, generally rock, is an important element provided in the plans to protect the structural integrity of the structure. The plan will designate the placement of rock material around the footings, abutments, and piers. This will prevent water from scouring (i.e., eroding) the soil material from under footings and other load-bearing structural elements. Pay particular attention to how the Contractor performs this operation. The depth, width, and limits on the plans are critical dimensions. Also, check that the Contractor is placing the type of material called for in the plans. Placement of material can be performed by equipment (e.g., dumped) in lieu of hand placement; however, the material must be properly bulldozed in place and consolidated. Generally, stone for foundation protection will be largely equidimensional and angular with a size ranging between 1 ft^3 to 1 yd^3.

218.4-RECORDS AND DAILY REPORTS

The Project Engineer/Supervisor and Inspectors in charge of the work are responsible for recording in the Daily Reports accurate and up- to-date records. As needed, separate the men, equipment, time, and pay quantity measurements for each type of slope and foundation protection in the Daily Work Report. Also measure and check the actual dimensions for compliance with plan dimensions. Document any particularly relevant findings in the Inspector's Daily Report. This documentation will be valuable in the event of a dispute.

218.5-MEASUREMENT FOR PAYMENT

Unless otherwise specified, all slope protection will be measured and paid at the contract unit price based on the number of cubic yards. Volume quantities may be determined by verified plan dimensions or from measurements of the completed work. Shot rock will be measured in tons based on truck counts and weigh slips from State-certified scales. Crushed rock slope protection, concrete slope protection, and fabric are measured and paid on the number of square yards. Area dimensions will be based on slope measurements. Concrete sills are included in the area measurement. Foundation protection will be measure in cubic yards actually produced and incorporated in the work, determined in its original position from cross sections by the average-end-area method. This will be full compensation for performing acceptable work, including all labor, tools, equipment, supplies, and incidentals.

SECTION 219
CONTROLLED LOW-STRENGTH MATERIAL

219.1-GENERAL

219.1.1-Description of Work Controlled low-strength material (CLSM) is a non-compacted cementitious material used primarily as a backfill in lieu of a compacted material. The work consists of furnishing and placing CLSM as a backfill material in accordance with the plans and specifications. At the Contractor's option and expense, CLSM may be used in lieu of random material where specified around structures.

219.1.2-Materials and Equipment

219.1.2.1-Quality Control The Contractor is responsible for the quality control of CLSM. The materials, mixing, properties, equipment, and tools of CLSM and placement operations must comply with the specifications. Check to make sure that the Contractor is using certified PCC Inspectors during the operation (See Section 705). The Contractor's Quality Control Plan will conform to MP 601.03.50. Check that the Project Engineer/Supervisor is in receipt and has approved the Contractor's Quality Control Plan. Visually observe to see if the Contractor is operating within that Plan (samples, tests, frequencies). The Contractor's quality control sampling and testing may be used for acceptance.

219.1.2.2-Mix Design Prior to the backfill operation, check that the Project Engineer/Supervisor is in receipt of the approved Contractor's mix design and test results for each type of CLSM to be used. The mix design and CLSM properties must meet the requirements of the contract specifications.

219.2-PLACEMENT

During placement operations, use the following guidelines for inspection purposes:

1. Consistency. During placement, visually inspect the consistency of the CLSM to see that it is satisfactorily filling all voids without vibration or other consolidation methods. The Contractor should not be using vibrators with CLSM.
2. Pour Height. The Contractor should not drop CLSM from an excessive height and limited to the minimum necessary by using chutes or other devices. Check that placement is brought up evenly by moving the discharge point and/or by manually spreading the material.
3. Pipes. For backfilling around pipes, check that the CLSM is placed evenly on both sides of the trench to avoid overstressing or laterally moving the pipe.

4. Lift Thickness. The lift thickness of the CLSM backfill operation will be shown on the plans. Do not allow the Contractor to exceed this limit. The limit is specified to avoid overstressing the pipe, forms, structures, etc. and to avoid potentially floating a pipe out of its trench. Prior to placement of subsequent lifts, ensure the Contractor allows each lift to adequately cure until it is self-supporting.
5. Bonding. The Contractor should keep the surface unfinished between lift pours. Check that the surface of the previous lift is clean to ensure bonding with the next.

219.3-RECORDS AND DAILY REPORTS

The Project Engineer/Supervisor and Inspectors in charge of the work are responsible for recording in the Daily Reports accurate and up- to-date records of the work. As needed, separate the men, equipment, time, and pay quantity measurements for each pay item in the Daily Work Report. Also measure and check actual dimensions for compliance with plan dimensions. Document any particularly relevant findings in the Inspector's Daily Report. This documentation will be valuable in the event that the Contractor files a claim for work performed on the project.

219.4-MEASUREMENT FOR PAYMENT

CLSM will be measured and paid at the contract unit price based on the number of cubic yards of backfill in place. Volume quantities may be determined by verified plan dimensions or from measurements of the completed work. This will be full compensation for performing acceptable work, including all labor, tools, equipment, supplies, and incidentals.

SECTION 228
SUBGRADE PREPARATION

228.1-GENERAL

228.1.1-Description of Work Subgrade preparation consists of preparing the subgrade for the placement of base or subbase materials in accordance with the contract specifications and in reasonable conformance to the lines, grades, dimensions, and cross-sections of the contract plans.

228.1.2-Materials and Equipment Check to ensure that the Contractor's subgrade materials, equipment, test methods, and quality control requirements, as applicable, conform to the provisions of the contract specifications. See Section 207.1.9 and Division 700 for general guidelines regarding materials, equipment, and quality control.

228.2-SUBGRADE PREPARATION

Prior to placing the base or subbase, check that the Contractor grades and shapes the entire width of subgrade to present a uniform appearance that is in reasonable conformity to the lines, grades, and dimensions shown on the plans. Visually inspect that the Contractor uses excavated materials to bring any eroded areas up to plan cross-section. Any ruts or irregularities will be scarified and re-compacted. Check to see that the subgrade is maintained in such condition that it will drain at all times. In general, use the applicable guidelines presented in Sections 207 during the inspection of subgrade preparation, especially Section 207.8.2. See Section 207.5.4.2 for procedures to check lift thickness.

228.3-RECORDS AND DAILY REPORTS

The Project Engineer/Supervisor and Inspectors in charge of the work are responsible for recording in the Daily Reports the activities of subgrade preparation. Pay particular attention to keeping accurate and up-to-date records of all the work. Separate the men, equipment, and time worked in the Inspector's Daily Report. Specifically record field measurements for lift thickness checks. This documentation will be valuable in the event the Contractor files a claim for work performed on the project. See Section 207.9 for suggested items to document.

228.4-MEASUREMENT FOR PAYMENT

Subgrade preparation will be measured and paid at the contract unit price based on the number of square yards as determined from the lines and dimension on the plans. This will be full compensation for performing acceptable work, including all labor, tools, equipment, supplies, and incidentals. In general, maintain project records in such a manner that partial progress and final payments can be easily and clearly supported by data (e.g., when the work was completed, measurements and calculations to support the quantity and quality allowed). Initial all records, calculations, and measurements.

SECTION 229
SHOULDERS AND DITCHES

229.1-GENERAL

229.1.1-Description of Work This work consists primarily of trimming, sloping, shaping, grading, subgrading, scarifying, and compacting existing shoulders and ditches including inlets and outlets to pipe culverts, and constructing new shoulders and ditches where necessary in accordance with the contract specifications and in reasonable conformance to the lines, grades, and cross- sections of the plans.

229.1.2-Materials and Equipment Check to ensure that the Contractor's materials, equipment, test methods, and quality control requirements, as applicable, conform to the provisions of the contract specifications. See Section 201.1.8 for general guidelines regarding materials and equipment. See Division 700 for additional information on control of materials and quality control plans.

229.2-PUBLIC SAFETY HAZARDS

Public and private roadways and intersections may be affected by the Contractor during shoulder and ditch work. The Contractor is responsible for maintaining these facilities in a safe and passable condition. Perform daily visual checks to ensure the Contractor is adequately cleaning and sweeping mud, oil, debris, and any other objectionable materials from the traveled way. Do not allow the Contractor to place any equipment or materials that would be an obvious hazard to vehicular or pedestrian traffic. Check that the Contractor has an approved plan for maintaining and protecting traffic during this operation. Visually inspect that the Contractor is performing this task in accordance with the governing contract specifications and note the observations in the Daily Report. See the WVDOH publication Traffic Control for Street and Highway Construction and Maintenance Operations for additional information.

229.3-SHOULDERS AND DITCHES

Use the following guidelines when inspecting shoulder and ditch work:

1. Shoulders. As soon as practical after the surfacing is complete, have the Contractor begin scarifying, shaping, and compacting the shoulders to the grade and cross-section of the plans. Inspect the entire shoulder area to see that it is uniformly compacted by rollers, mechanical tampers, or hand methods and dressed true to the cross- sections of the plans. Ensure that compaction procedures comply with the requirements of the contract specifications. See Division 700 for additional information on compaction.
2. Ditches. Existing ditches are to be trimmed, graded, or otherwise excavated to relieve drainage along the roadway and to and from existing drainage structures. Check that existing ditches are trimmed, sloped, and cleaned and that inlets and outlets are

opened and shaped to a uniform grade. Visually inspect that all drainage appurtenances are open, free of debris and obstructions, graded to drain, and functioning properly.

3. Disposal of Materials. Unless select material is designated on the plans, the Contractor should use suitable excavation material.

   Surplus and unsuitable material will be removed and disposed of properly as discussed in Section 207.4. Unsuitable material that is removed from ditches must be picked up and removed, exercising care not to allow material to be strewn on the roadway. Any material spilled on the roadway must be cleaned up and properly disposed of.

4. Reconstruction Projects. On reconstruction projects, all shoulders will be constructed to the maximum practical width and the material compacted firmly against the existing edge of pavement.
5. Hand Dressing. Hand dressing or grading of shoulders may be required to minimize damage under existing guardrail, or in areas inaccessible to equipment.
6. Public Safety. Check that materials are not scattered on the roadway where it can become a hazard to the traveling public. See Section 229.2.
7. Damages. Caution must be exercised to prevent damage to the pavement, structures, etc. Emphasize to the Contractor not to damage the pavement or any structures during the operation. Any damage will be the Contractor's responsibility. Document in the Daily Report any observed damage and contact the Project Engineer/Supervisor to discuss acceptable alternative methods to prevent future damages.
8. Utilities. Care should be exercised during work to protect and prevent damage to underground utilities. Verify coordination with utility companies before the operation begins. The Contractor is required to repair any resulting damage.

229.4-RECORDS AND DAILY REPORTS

The Project Engineer/Supervisor and Inspectors in charge of the work are responsible for recording in the Daily Reports the activities for shoulder and ditch work. Pay particular attention to keeping accurate and up-to-date records in the Daily Work Report of all items related to measurement for payment and any measurements, calculations, and dimensions to support compliance or non-compliance to the contract plans and specifications. Specifically note the disposition of traffic control operations, any damage to pavement or structures, and any directives given the Contractor regarding corrective actions. This documentation will be valuable in the event that the Contractor files a claim for work performed on the project.

229.5-MEASUREMENT FOR PAYMENT

Shoulder and ditch work will be measured and paid at the contract unit price based on the number of linear miles (kilometers) designated in the contract plans. Do not make deductions for work not performed on either side of the centerline. Stabilization, if specified, will not be included in shoulder and ditch work but will be measured and paid for separately. This will be full compensation for performing acceptable work, including all labor, tools, equipment, supplies, and incidentals. In general, maintain project records in such a manner that partial progress and final payments can be easily and clearly supported by data (e.g., when the work was completed, measurements and calculations to support the quantity and quality allowed). Initial all records, calculations, and measurements.

SECTION 240
CLEANING CULVERTS, INLETS, AND MANHOLES

240.1-GENERAL

240.1.1-Description of Work This work primarily consists of the complete removal of obstructions and thorough cleaning of trash, dirt, and other debris from culverts and their appurtenant structures (e.g., inlets, manholes) at locations designated by and in a manner acceptable to the Project Engineer/Supervisor.

240.1.2-Materials and Equipment Check to ensure that the Contractor's equipment conforms to the provisions of the contract specifications. See Section 201.1.8 for general guidelines regarding materials and equipment.

240.2-PUBLIC SAFETY HAZARDS

The Contractor is responsible for maintaining public facilities in a safe and passable condition during the cleaning operation. Appropriate traffic control measures will be in place during the operation. See Section 229.2 for additional information on public safety hazards.

240.3-CLEANING CULVERTS, INLETS, AND MANHOLES

The Contractor will use a method that is acceptable to the Project Engineer/Supervisor. Use the following guidelines during inspection:

1. Environmental Considerations. Check to make certain that the Contractor is not performing the operation in a manner that would jeopardize bodies of water or the downstream environment. The method used will minimize, as practical, the pollution and sedimentation of all receiving streams, rivers, and other bodies of water.
2. Protection of Property. Check to make sure that the Contractor's operation will not deposit debris or otherwise damage adjacent or downstream properties.
3. Damage to Structures. Visually inspect the drainage structures for damage. The cleaning procedures and equipment used will ensure the removal and disposal of obstructions, trash, and debris without damaging existing drainage structures.
4. Abhorrent Chemicals. Do not permit the use of any abhorrent chemicals during the cleaning operation.

240.4-RECORDS AND DAILY REPORTS

The Project Engineer/Supervisor and Inspectors in charge of the work are responsible for recording in the Daily Reports the activities for cleaning culverts, inlets, and manholes. Pay particular attention to keeping accurate and up-to-date records in the Daily Work Report of all items related to measurement for payment and any measurements, calculations, and dimensions to support compliance or non- compliance to the contract plans and specifications. Specifically note the disposition of traffic control operations, any damage to pavement or structures, and any directives given the Contractor regarding corrective actions. This documentation will be valuable in the event that the Contractor files a claim for work performed on the project.

240.5-MEASUREMENT FOR PAYMENT

Cleaning culvert will be measured and paid at the contract unit price based on the number of linear feet of each size of culvert cleaned. Measure the length along the centerline of the culvert, including branch connections (e.g., tees, wyes, elbows). For skewed and sloped conduit, measure the length along the invert. The portion of culverts extending through to the inside face of headwalls, wingwalls, manholes, inlets boxes, and other similar structures will be included in the measurement. Clean Inlets and manholes will be measured by the unit and will be the number of such structures that are actually cleaned. This will be full compensation for performing acceptable work, including all labor, tools, equipment, supplies, and incidentals. In general, maintain project records in such a manner that partial progress and final payments can be easily and clearly supported by data (e.g., when the work was completed, measurements and calculations to support the quantity and quality allowed). Initial all records, calculations, and measurements.

DIVISION 300
BASE AND SUBBASE COURSES

SECTION 307
CRUSHED AGGREGATE BASE COURSE

307.1-GENERAL

307.1.1-Description of Work The purpose of a crushed aggregate base course (CABC) is to:

1. Distribute the wheel loads transmitted to the subgrade or subbase, if specified;
2. Provide a free-draining underlying material layer; and
3. Provide a material layer that is not readily susceptible to frost on which to support the surface course(s).

The Contractor is responsible for furnishing, spreading, and compacting CABC on top of a suitably prepared subbase, or subgrade if a subbase is not specified in the contract. The contract plans may specify one or more courses of CABC. The depth and width of CABC will depend on several factors including:

1. Pavement cross-section,
2. Anticipated traffic loads,
3. Existing soil conditions,
4. Frost susceptibility, and
5. Drainage requirements.

Occasionally, the depth of CABC may need to be adjusted in the field to accommodate unforeseen conditions once construction has started. In such cases, discuss the issue with the Project Engineer/Supervisor to determine an appropriate action. The Inspector is primarily responsible for checking that the Contractor operates within the requirements of the Contractor's Division-approved Quality Control Plan for CABC and that the CABC is placed and compacted in reasonable conformance to the lines, grades, and thickness of the contract plans, or as otherwise directed by the Project Engineer/Supervisor. It is extremely important that the Inspector becomes thoroughly familiar with the plans, cross-sections, specifications, and Quality Control Plan to effectively administer the provisions of the contract during construction.

307.1.2-Materials and Equipment

307.1.2.1-Materials The CABC will generally consist of gravel, crushed gravel, crushed stone, crushed slag, or a combination of these materials uniformly blended to conform to the quality and gradation requirements of the contract. The Contractor must furnish a CABC material that meets these requirements for the class shown on the contract plans. Use the following guidelines during inspection:

1. Approved Aggregate Quarries. It is important to check that the Contractor uses Division-approved material sources and that the material is delivered to the job site with the appropriate aggregate quarry. This will assure the Division that the

requisite preliminary sampling and testing has been performed and that the CABC material will be acceptable when delivered and placed.

2. Material Consistency. When first started, closely monitor the operation and visually inspect the material for consistency because it may take the Contractor several attempts to produce a consistently acceptable material. Immediately notify the Project Engineer/Supervisor of suspected problems.
3. Unacceptable Materials. Unless otherwise approved by the Project Engineer/Supervisor, do not allow the Contractor to deliver or incorporate in the work any CABC material that fails to comply with the quality requirements of the contract with the intent of later upgrading the material in place. Notify the Project Engineer/Supervisor and inform the Contractor to halt CABC operations if it is suspected that an unacceptable material has been delivered. A special investigation may be needed to determine an appropriate course of action, and the Contractor may be required to remove and upgrade the material.
4. Blading/Road Mixing. Visually inspect the operation to make certain that the Contractor does not blend component CABC materials by blading or road mixing. Inform the Contractor that this is an unacceptable practice and to take corrective actions.
5. Stabilization. Pay particular attention to whether the base called for in the contract plan is to be stabilized or unstabilized because the specifications between the two are slightly different.

See Section 701 and Section 702 for additional information on Division requirements and Inspector duties relative to control of materials, (e.g., laboratory numbers, Daily Work Reports, standard procedures, visual inspections, identification of samples, rejected materials).

307.1.2.2-Quality Control and Acceptance In general, the Contractor is responsible for quality control, and the Division is responsible for acceptance. Consider the following guidelines:

1. Quality Control Plan. The Contractor is responsible for preparing and submitting to the Division for approval a Quality Control Plan for CABC that details the sampling and testing methods the Contractor will administer during the work. The Plan will be prepared in accordance with the guidelines presented in MP 307.00.50 and MP 717.04.21. The Division will review the Plan to ensure conformance to the contract documents. Before CABC work begins, check that the Project Engineer/Supervisor is in receipt of this Plan.
2. Minimum Criteria. Figure 703A presents the Division's minimum sampling and testing criteria for CABC quality, gradation, density, and thickness checks. Acceptance sampling and testing is the Division's responsibility, and the Division may elect to use the Contractor's quality control samples and tests as the basis for acceptance. It is therefore important to inspect CABC operations to make certain the Contractor implements the Quality Control Plan and that the sampling and testing (e.g., sample

size, test type, frequency) is consistent with the minimum criteria presented in Figure 703A, MP 307.00.50, and MP 700.00.06.

3. Compaction and Gradation. Acceptance for compaction will be on a lot-by-lot basis determined from nuclear moisture and density tests conducted at random locations in accordance with MP 712.21.26. Acceptance for gradation will be based on test results from consecutive random samples in accordance with the contract specifications. Check that that gradation results are plotted on control charts consistent with the guidelines presented in MP 300.00.51.
4. Aggregate/Compaction Inspectors. Verify Division-qualified aggregate and compaction inspectors are available to control placement and compaction. See Section 704 for additional information on aggregate and compaction inspectors.

307.1.2.3-Equipment Do not direct the Contractor regarding equipment type or usage. Unless otherwise directed by the Project Engineer/Supervisor, the Contractor may choose the equipment needed to haul, spread, moisten, mix, and compact CABC materials. However, the Contractor's equipment operations must not cause undue segregation of the aggregate material, and the compacted CABC must meet the requirements of the contract specifications. Inform the Project Engineer/Supervisor and notify the Contractor if segregation is suspected. Visually inspect any equipment that does not appear to be performing satisfactorily and inform the Contractor to take corrective action. Notify the Contractor of any equipment or operation that is an apparent or obvious safety violation. Do not dictate a method of operation unless it specifically violates the specifications and as long as it is reasonable and consistent with good construction practice.

307.2-CONSTRUCTION CONSIDERATIONS

307.2.1-Subgrade/Subbase Preparation Before the Contractor begins placing the CABC material, inspect the subgrade/subbase for acceptance in accordance with the requirements of the contract specifications (see Section 228). To achieve a uniform depth of CABC, the subgrade/subbase surface must be constructed and maintained within tolerance of the planned roadway template and profile. Carefully examine the surface to see that it is sufficiently smooth to promote drainage and direct the Contractor to correct any soft spots, ruts, or grade deficiencies by removing and replacing material and/or regrading where necessary. During the operation, periodically monitor the wheel paths of haul trucks. Repetitive trips using the same path may cause deformation or rutting. As practical, haul trucks should travel over the entire surface width. Inform the Contractor not to haul materials under excessively wet conditions or when the surface is sufficiently wet that it can be marred by construction equipment.

307.2.2-Placement Use the following guidelines to inspect CABC placement operations:

1. Frozen Subgrade. Do not permit the Contractor to place base materials on a frozen subgrade.
2. Spreading Equipment. The Contractor generally will use self-propelled spreading machines or spreader boxes, such as the CMI or Jersey box, to place and spread the aggregate material before compaction.

3. Layers. Typical operations require CABC materials to be placed and shaped on the prepared surface in layers to achieve the total compacted thickness shown on the plans. Visually inspect that the loose aggregate is placed a little in excess of the specified maximum layer thickness to allow for compaction. Check that the Contractor shapes and compacts each layer to the required density before the succeeding layer is placed. The Contractor should maintain a 500 ft minimum distance ahead of the succeeding layer; however, do not permit tailgating.
4. Roadway Width. Check that the Contractor spreads the aggregate over the full width of the roadway template without extending one lane too far ahead of adjacent lanes. The Contractor should use two or more spreader boxes to achieve this goal; however, if only one spreader box is used, it must be operated only for a relatively short distance along each lane so that the material is placed across the full roadway width somewhat concurrently along the profile.
5. Segregation. To minimize segregation, check that the Contractor keeps spreader boxes full. It is undesirable for the Contractor to dump the aggregate mixture in piles with the intent of later spreading the piled material with a power grader. This will tend to segregate the larger stones from the fines resulting in a non-uniform density when compacted. In locations where a power grader must be used, the Contractor must place the aggregate in windrows and uniformly and thoroughly mix the material prior to final spreading and compaction. Where segregation is suspected, discuss the matter with the Project Engineer/Supervisor to determine a corrective action.
6. Finishing. Check that all high spots on the finished grade are trimmed and any excess material disposed of properly. Visually inspect the finished grade for any low spots and, if encountered, have the Contractor scarify the area, add new material, and roll to avoid the formation of surface irregularities.

307.2.3-Compaction The compaction operation will follow closely behind the placement operation. Because the CABC is such a critical underlying pavement layer, it is imperative that the Contractor compact the CABC to the target density of the contract specifications. Note that moisture content in the aggregate material at the time of compaction and the compactive effort used are two primary factors that will influence the resulting density. Use the following guidelines to inspect CABC compaction operations:

1. Water. It is important to note that additional water may be required to achieve optimum compaction. If additional moisture is needed, it will be determined during the roller pass test section. See MP 700.00.24 for additional information.
2. Compaction Equipment. Unless otherwise specified in the Contract, the Contractor may choose the type of equipment most adaptable to compacting the CABC material. Equipment typically used to apply the necessary compactive effort includes:
   a. Pneumatic-tired rollers,
   b. Vibratory rollers,
   c. Steel-wheeled rollers, and/or
   d. Pan-type vibrating compactors.

   See Section 307.1.2.3 for additional information on equipment.

3. Layers. Inspect the operation to make certain the Contactor compacts each CABC layer to the specified target density before placing and compacting a succeeding overlying layer. Visually inspect the surface of each compacted layer to see that aggregates are firmly keyed and the surface has a uniform texture. The Contractor must maintain the surface of each compacted layer in an acceptable condition.
4. Density Testing. Density testing for quality control and acceptance must be in accordance with the contract specifications, the Division-approved Quality Control Program, and the minimum sampling and testing criteria presented in Figure 703A. See Section 307.1.2.2 for additional information.
5. Finishing. Check that the Contractor finishes the surface of the top layer of the CABC by blading, if necessary, so that it is trued to within the specified tolerance of the lines, grades, and cross-section of the plans.

307.2.4-Checking Grade and Thickness The finished surface and final depth of the CABC must be constructed within tolerance of the contract plans. Use the following guidelines to perform grade and thickness checks:

1. Grade Checks. Check the grade and shape of the finished surface of the CABC to make certain the resultant cross-section complies with the planned roadway template. This can be performed using one of several methods (e.g., hand level, string line, cross-section).

   Check that the finished surface of the CABC does not vary more than ±3/8 in from plan grade. In addition, orient a 10 ft long straightedge parallel with the centerline of the pavement at various locations along the surface of the CABC to periodically check for localized high or low spots. Check that the finished surface is within the specified ±3/8 in surface tolerance. Direct the Contractor to correct any deviations by scarifying the local area, adding CABC material, if necessary, reshaping the grade, and recompacting the material to meet the density requirements of the contract.

2. Depth Checks. After final compaction, check the CABC for proper thickness. Perform depth checks in accordance with the minimum criteria presented in Figure 703A. Instruct the Contractor to refill all test holes with approved CABC material and recompact the material to meet the density requirements. Check that the total thickness of the final compacted CABC does not vary more than –½ in from that specified in the contract plans. Direct the Contractor to correct any deficiencies.

307.2.5-Maintenance Check that the Contractor adds moisture to the surface, in an amount and frequency determined by the Project Engineer/Supervisor, to prevent loss of fine materials. The Contractor should maintain the surface in a smooth and satisfactory condition for surfacing.

307.3-RECORDS AND DAILY REPORTS

The Project Engineer/Supervisor and Inspectors in charge of the work are responsible for recording in the Daily Work Reports all information (e.g., observations, measurements, directives to the Contractor) necessary to adequately document the prosecution and progress of the work that will justify payment to the Contractor and protect the Division from any future claims. The Inspector in charge of the work will maintain a daily record of events in the Daily Work Report. The Project Engineer/Supervisor will maintain the project's Diary. Record keeping is very important because much of the work cannot be readily checked after it is covered by subsequent construction. The Daily Work Reports are generally the only remaining evidence that the Contractor performed the work as specified in the contract. During CABC inspection, check the following in the Daily Work Report:

1. Location and quantity of gradation samples and test results, including laboratory numbers and any degree of nonconformance.
2. Location and result of quality control and acceptance tests for compaction, including laboratory numbers.
3. Location and result of grade checks and depth checks.
4. Measurements for progress and final payments, including extra work payments.
5. Documentation of following items, when required and saved on ProjectWise:
    a. Aggregate tickets as outlined in 109.2.3 of this manual and specifications 109.20
    b. Sketch, or drawing showing daily placement
    c. Measurements, calculations, and/or Aggregate work sheet showing quantity
    d. Conversion to cubic yard as outlined in specifications 109.1.

307.4-MEASUREMENT FOR PAYMENT

Measure and pay for CABC work based on the contract unit price and the number of cubic yard measured and in place. Any additional work approved by the Project Engineer/Supervisor will be measured in cubic yards in place and paid for as extra work. This will be full compensation to the Contractor for performing acceptable work, including all materials, labor, water, tools, equipment, supplies, and incidentals. Check to make certain that payment for any CABC material that does not conform to the specified gradation requirements is adjusted based on the degree of nonconformance and the price adjustment schedule in the contract specifications. Use the first price adjustment determined for the sublot. Do not adjust the price of a sublot more than once.

SECTION 311
OPEN GRADED FREE-DRAINING BASE COURSE

311.1-GENERAL

311.1.1-Description of Work The open graded, free-draining base course is primarily used by the Division for new construction, reconstruction, and widening projects. The mixture consists primarily of coarse aggregate material with a relatively small amount of fines that is stabilized using either asphalt or Portland cement. The Contractor may choose either type of stabilizer; however, an asphaltic binder is primarily used. The stabilized material is placed and compacted on a prepared surface (i.e., subbase or subgrade) resulting in a durable foundation with relatively large voids to promote drainage to the underlying layer. The Inspector is primarily responsible for checking that the Contractor operates within the requirements of the Contractor's Division- approved Quality Control Plan and that the base course is placed and compacted in reasonable conformance to the lines, grades, and thickness of the contract plans, or as otherwise directed by the Project Engineer/Supervisor.

311.1.2-Materials and Equipment Consider the following guidelines during inspection:

1. Approved Materials. Check that the Contractor uses only Division-approved materials (e.g., aggregate, performance graded binders, Portland cement, water, curing materials). Record laboratory numbers and Sample ID in the DWR as appropriate.
2. Quality Control Plan. The Contractor is responsible for submitting to the Division for approval a Quality Control Plan, prepared in accordance with the applicable sections of MP 307.00.50 and MP 717.04.21, that details the methods by which the Contractor will implement the quality control program. Check that the Project Engineer/Supervisor is in receipt of the Quality Control Plan and that the Contractor is operating within the Plan's limits.
3. Sampling and Testing. Check that the Contractor provides adequate equipment and personnel to perform the required samples and tests and that material properties are maintained within the limits of the specifications. See Figure 703A for minimum sampling and testing criteria. Unless otherwise specified, compaction testing is not required for open graded, free draining bases.
4. Stabilizer Composition. Asphalt cement is limited to 2.0 ±0.5% by weight; however, the Project Engineer/Supervisor may increase this limit if blast furnace slag is used. Portland cement, when used as a stabilizer, will be Type 1 with a cement content of 150 ±5 pounds per cubic yard.
5. Preparation and Batching. The Contractor will prepare and batch the stabilized base course mixture in accordance with the Quality Control Plan and the requisite sections of the contract specifications. Note that, prior to mixing, asphalt cement should be heated to within a temperature range of 250°F to 275°F; and before placement, the

asphalt mix should be within a temperature range of 200°F to 250°F. Check that the Contractor monitors these temperatures.

6. Mixing and Transporting. For asphalt stabilized bases, check that the Contractor uses an asphalt concrete mixing plant inspected and approved by the Division, and that the mix is transported to the site in accordance with the applicable requirements of the contract specifications (see Section 401 for additional information). For Portland cement stabilized bases, the Contractor may use an approved central mixing plant, transit mix truck, or a pugmill type mixer (see Section 501 for additional information). Regardless of the type used, check that the Contractor mixes the Portland cement stabilized base a minimum of two minutes after all component materials are batched.

311.2-CONSTRUCTION CONSIDERATIONS

311.2.1-Subgrade/Subbase Preparation Before placing the open graded, free-draining base course material, the Contractor must suitably prepare the subbase or subgrade. See Section 307.2.1 for applicable inspection guidelines.

311.2.2-Placement Use the following guidelines to inspect the placement of open graded, free-draining bases:

1. Weather Limitations. A stabilized base should only be placed on a dry surface under dry weather conditions. Do not allow the Contractor to place the base material on a frozen subbase or subgrade or when the surface or air temperature fails to meet the requirements of the contract specifications. See Section 401.8 of the Specifications for applicable weather restrictions.
2. Equipment. Check that the Contractor's equipment operation does not tear the engineering fabric or damage the perforated pipes of the drainage system. If operated directly on the drainage system, rubber-tired equipment should be used. Track-based equipment will damage the fabric and pipe. Acceptable equipment includes asphalt pavers for asphalt stabilized bases and spreader boxes, self-propelled spreaders, and conventional concrete placing equipment for Portland cement stabilized bases.

311.2.3-Compaction and Curing Use the following guidelines to inspect the compaction and curing of the open graded, free-draining base:

1. Equipment. Check that the Contractor uses a 4 to 10 ton steel wheel tandem roller to compact the asphalt stabilized free draining base material.
2. Mat Temperature. Unless otherwise directed by the Project Engineer/Supervisor, the mat temperature of the asphalt stabilized base at the time of initial rolling will be in the temperature range of 150°F to 175°F. Check that the Contractor is monitoring this temperature.
3. Roller Passes. Unless otherwise directed, check that the Contractor only uses two to three passes to compact the asphalt stabilized base. The objective is to compact the asphalt base sufficiently to support the weight of equipment needed to place the next base layer or surface course without crushing the aggregate and clogging the voids

in the layer. The porous nature of the compacted base must be maintained to adequately drain water and operate as designed.

311.2.4-Checking Grade and Thickness Use the guidelines presented in Section 307.2.4 to check the grade and thickness of the open graded, free-draining base course.

311.2.5-Maintenance To operate as designed, the porous nature of the open graded, free-draining base must be maintained. During construction, visually inspect the base to check that the Contractor is avoiding damage or deforming lift and maintaining the surface free from contamination that would clog the voids. Especially watch for deleterious material that may be transported and deposited by construction equipment. The Contractor must maintain the surface free of such deleterious material until the surface course is placed. The Contractor must keep final surface of the base course true to the specified line, grade, and cross section until such time that the pavement is placed.

311.3-RECORDS AND DAILY REPORTS

See Section 307.2.2 and 307.3 for applicable guidelines on maintaining records and Daily Work Reports. Use asphalt worksheet if asphalt is utilized.

311.4-MEASUREMENT FOR PAYMENT

Measure and pay for open graded, free-draining base work based on the contract unit price and the number of cubic yard placed. Any additional work approved by the Project Engineer/Supervisor will be measured in cubic yards in place and paid for as extra work. See Section 104 and Section 109 for additional information on extra work and payment measurements. This will be full compensation to the Contractor for performing acceptable work, including all materials, labor, tools, equipment, supplies, and incidentals.

DIVISION 400
ASPHALT PAVEMENTS

SECTION 401

ASPHALT BASE, WEARING, AND PATCHING AND LEVELING COURSES

The performance of asphalt, or flexible, pavements depends primarily on the adequacy of the pavement's structural and mix designs and the quality achieved in producing, placing, and compacting the mix. Although adequate designs may ultimately be specified, misunderstood or misapplied specifications and the use of poor construction techniques and improper equipment operations will greatly affect pavement quality. Section 401 of the Specifications establishes the respective obligations of the Contractor and the DOH. The following section presents specific DOH procedures and additional clarifying information on asphalt pavement construction.

401.1-GENERAL

401.1.1-Description of Work Hot-mix asphalt (HMA) contains sieve-graded coarse and fine aggregate materials, mineral filler, asphalt binder, modifiers (as required), and, at the option of the Contractor, reclaimed asphalt pavement (RAP) material. These component materials are proportioned and mixed mechanically in a plant based on a Job Mix Formula for the project. The HMA is then loaded on trucks, hauled to the laydown site, and placed and compacted on a suitably prepared foundation in one or more courses (i.e., layers). The Project Engineer/Supervisor and the Project Inspectors, both at the plant and at the laydown site, are primarily responsible for ensuring that the mix conforms to the requirements of the Job Mix Formula and the contract specifications and that the work reasonably conforms to the Contractor's Quality Control Plan and the lines, grades, and cross sections of the Contract Plans.

401.1.2-Types of HMA The term hot-mix asphalt (HMA) is used generically to refer to the following types of asphalt pavement mixes:

1. Dense. Dense-graded HMA primarily consists of uniformly graded aggregate material and an asphalt cement or performance-graded binder. Asphalt concrete and bituminous concrete are common terms used to designate dense-graded HMA. It is important to note that asphalt concrete is an HMA, but not all HMA is considered asphalt concrete.
2. Open. Open-graded HMA primarily consists of coarse aggregate, a minimal amount of fine aggregate, and an asphalt cement or performance-graded binder. The primary purpose of open-graded HMA is to provide drainage, such as in a Free Draining Base Course.
3. Gap. Gap-graded and open-graded mixes are essentially the same with one important difference. Gap-graded HMA generally has a greater amount of fine aggregate material, and the amount of medium sized aggregate material, if present, will be very small. WV does not use Gap Graded mixtures.

401.1.3-Types of Asphalt Mix Designs

401.1.3.1-Superpave Asphalt Mix Design "Superpave" stands for Superior Performing Asphalt Pavements. It represents an improved system for specifying the components of asphalt concrete, asphalt mixture design and analysis, and asphalt pavement performance prediction. The Strategic Highway Research Program (SHRP) developed the Superpave asphalt pavement mix design method in the early 1990's. Superpave is now the standard mix design method for asphalt pavements.

401.1.3.2-Marshall Asphalt Mix Design Bruce Marshall developed the "Marshall" method of asphalt mix design in the late 1930's for the Mississippi Highway Department. This method has been used by the WVDOT in the past and was the standard mix design method for many years.

401.1.3.3-Balanced Mix Design Balanced Mix Design (BMD) is similar to Superpave with the use of volumetric testing but includes performance-based testing during the design of a mix to establish limits. The WV DOH will be implementing BMD in the coming years.

401.1.4-HMA Component Materials

401.1.4.1-Aggregate Materials The aggregate materials used in HMA production include coarse and fine aggregates and mineral filler. These materials must meet the material and gradation requirements of Section 401 of the Specifications. Section 704 of this Manual provides guidance on the inspection of aggregate materials. The following briefly describes the aggregate materials used in production:

1. Coarse Aggregate. Coarse aggregate includes crushed stone, crushed gravel, and crushed slag. Crushed particles have sharp edges and corners that interlock and promote pavement stability. Gradation is achieved by combining two or more commercial aggregate sizes at the plant's cold feed. If it becomes necessary to change aggregate sources, a new JMF must be developed and submitted for approval. Note that slag is porous and will readily absorb liquid binder.
2. Fine Aggregate. Fine aggregate includes some combination of manufactured (e.g., screenings from crushed aggregate) and natural sand. Manufactured sand, by itself, provides stability but is more difficult to compact. A mixture of approximately equal amounts of manufactured and natural sand is often used. Fine aggregate passes the No. 4 sieve.
3. Mineral Filler. Mineral filler generally passes the No. 200 sieve. It may include one or more of the following: fines present in the larger graded aggregate, dust returned from the plant's emission-control system, fly ash, Portland cement, and other commercial products. Mineral filler is added for stabilization, but the quantity and type added significantly affects the mix. If too much is added, the mix will be tough and difficult to roll and the finished pavement will become hard and brittle. Once in production, the type of mineral filler should not be changed and the amount added should be closely

monitored. Note that commercial fillers must be kept dry in storage. If too much moisture is present, the mix will look shiny and foamy and the HMA will flatten in the truck bed.

4. Reclaimed Asphalt Pavement (RAP) Material. The Specifications allows the Contractor to optionally use RAP material. Note that if the Contractor elects to use a RAP design, the requirements of MP 401.02.24 will govern.

401.1.4.2-Asphalt Materials Many different types of asphalt material are used in asphalt pavement construction. The type needed depends on the purpose of the mix (e.g., HMA base and wearing course, surface treatment, tack coat). For example, asphalt materials used in surface treatments, tack coats, and winter-grade patching applications include rapid- and medium-curing liquid asphalts, and asphalt emulsions, which have different properties than asphalt binders, which are used in HMA (see Section 705 of the Specifications).

Type PG 64S-22 is usually specified. The PG designation (e.g., PG 64S-22) represents the high and low temperatures at which the asphalt binder is expected to satisfactorily perform. Modifiers are typically used, to achieve the specified temperature requirements.

Different types and grades of asphalt binders, including those from different sources, must not be intermixed during production. Operations should be carefully monitored during the project to ensure this does not inadvertently occur. If it is necessary to change the source of asphalt binder, follow the procedures for revising the Job Mix Formula and Form T-400 in Section 401.1.5.

401.1.5-Quality Control In general, the Contractor is responsible for quality control, and the Division is responsible for acceptance. Section 106 of this Manual presents the DOH and Contractor responsibilities regarding control of materials. Consider the following guidelines during HMA pavement construction:

1. Quality Control Plan. Prior to production, the Contractor will submit a Quality Control Plan for DOH review. The Project Engineer/Supervisor will forward to the District Material Supervisor so they can check that the Plan conforms to the sampling and testing requirements of MP 401.03.50. Frequently monitor operations to ensure that the Contractor operates within this Plan.
2. Certified Technicians. The Contractor will provide at least one DOH-certified HMA Plant Technician at the plant to oversee mix proportioning and materials control and at least one DOH-certified Asphalt field and Compaction Technician at the laydown site to perform the required sampling and testing. Before production, check that the Contractor provides the necessary quality control personnel and equipment.
3. Key References. Division 700 of this Manual, the Specifications, and the Materials Procedures cover various criteria for HMA pavement construction related to the Contractor’s responsibilities for quality control and the Division’s responsibilities for quality assurance. Section 703 of this Manual provides minimum sampling and testing criteria, and Section 706 provides guidance on HMA material and construction inspection. Section 401 of the Specifications specifies quality criteria and material control references, including AASHTO and ASTM materials testing procedures. Refer

to MP 401.03.50 for HMA quality control and acceptance criteria. Other 400-level Materials Procedures should be consulted on an as needed basis. Contact the District Materials Supervisor or the Materials Control, Soils and Testing Division.

401.1.6-Job Mix Formula (JMF) / Form T400 Section 401 of the Specifications establishes minimum and maximum design criteria for the amount of aggregate and asphalt material in various types of HMA. Before production, however, specific values (or range of values) must be specified in a Job Mix Formula (JMF). The Contractor is responsible for developing the JMF in accordance with MP 401.02.22, 401.02.28, or 401.02.24 as applicable. The JMF will differ from project-to- project. For example, Marshall Base type II or Superpave Base type 19 are typically used for patch and leveling courses, and Marshall Wearing Type I / III or Superpave Wearing type 9.5 / 4.75 are typically used for scratch courses. During the project, check and monitor operations to ensure the Contractor fulfills these requirements. The JMF will be documented on Form T400 and include the following information:

1. Source and type of materials;
2. Percentages for each aggregate size;
3. Percentage of asphalt binder;
4. Mix temperature at the plant; and
5. Ratio of fines to asphalt.

The Contractor will forward, through the District Materials Supervisor, the JMF and Form T400 for review by the Materials Control, Soils and Testing Division. Revisions, if any, will be requested of the Contractor through the District Materials Supervisor. During initial production, verify the JMF in accordance with MP 401.02.27 for Marshall and MP 401.02.29 for Superpave. If the mix cannot be consistently produced within tolerance or if there is a subsequent change in the source of aggregate, the Contractor must revise and resubmit a new JMF and Form T400. The source of unmodified asphalt binder may be changed without submitting a new JMF. The binder grade for each mix design must always remain unchanged. If a modified binder source is changed or if the modification process is changed, a new JMF must be submitted.

401.1.7-Quality Control Plan Prior to the start of work, the Contractor is responsible for developing and submitting a Quality Control Plan. The District Materials will review the Plan and discuss with the Contractor any suggested changes or adjustments. Document the salient points of the discussion. During the project, verify that the Contractor operates within this Plan and maintains all equipment in working order (e.g., plant, haul trucks, laydown and compaction equipment). An approved quality control plan shall be e-mailed to Project Supervisor and placed on ProjectWise.

401.1.8-Maintenance of Traffic (MOT) Plan All DOH construction projects will provide for the safe and efficient maintenance of traffic through the work zone and to protect the work in progress. Large and complex paving jobs will have a project specific Maintenance of Traffic (MOT) Plan in the plans. Smaller and less complex jobs will have a MOT case specified in the plans. In either case, the type and location of all traffic control devices, warning signs, barricades, pavement markings, flaggers, pilot trucks, flashers for either daylight or nighttime operations must be in conformance with Section 636 of Specifications and the Manual on Temporary Traffic Control for Street and Highway.

During laydown and compaction, check to ensure compliance and document the Contractor's traffic control activities. Section 104.2 of this Manual provides guidance for monitoring traffic control during construction. Signing and pavement-marking applications are specifically addressed in Section 401 of the Specifications.

If traffic is to be carried on an unpaved shoulder during the paving operation, adequate measures should be taken to prevent blowing dust from becoming a traffic hazard. On pavement widening projects, the open trench is an especially dangerous traffic hazard that requires advance warning and proper signing and marking at all times. Refer to Design Directive (DD) 685 for Drop-off Guidance criteria. To prevent damage to the pavement, it is good practice to keep traffic off fresh tack coat, uncompacted mix, and the newly compacted surface until it has cooled sufficiently to support the load of traffic.

Traffic control should be thoroughly discussed at the preconstruction conference (see Section 401.1.9). The area in the vicinity of the laydown and compaction site deserves special consideration. The operation is generally fast paced and hazardous to both the traveling public and construction personnel. Maximum safety should be afforded to workmen and public without unnecessarily disrupting the paving operation.

401.1.9-Safety Considerations Job safety at both the plant and the laydown site cannot be overemphasized. Both Division and Contractor personnel must continually practice safe working habits. Occupational Safety and Health Administration (OSHA) regulations must be understood and followed by all personnel. Each person should clearly understand what is expected and how to perform the assigned task. Moving conveyors, high temperatures and pressures, dust, noise, haul trucks, paving and compaction equipment, and moving traffic all pose potential hazards. New personnel should be properly instructed, and seasoned personnel should not become lackadaisical or careless. Constant care and vigilance are needed to prevent accidents and injury. It is wise to periodically remind personnel that they are operating in a potentially dangerous environment. If an unsafe work practice is observed, corrective action should be taken immediately, even if the operation has to be temporarily shut down. See Section 107.2.3 of this Manual for additional guidance on construction project safety.

401.1.10-Preconstruction Conference Section 103.3 of this Manual discusses activities that should be considered before construction. Section 103.3.2 specifically addresses the requirements of the Preconstruction Conference (e.g., purpose and need, arrangement and scheduling, attendees, facilitation). The Conference will establish an overall cooperative tone and ensure that all parties involved understand the project and are ready for production work. In general, Conference attendees should discuss contractual items such as scope of work, scheduling requirements and project meetings, quality control, mix design, laydown and compaction, maintenance of traffic, job safety, and any special requirements of the project.

A pre-season paving Pre-Construction Conference is usually held at each District to discuss these items for most resurfacing projects. Subsequent field reviews then address project- specific issues.

401.1.11-Communications During Project During the project, quality and safety depend on continued positive and meaningful communication with the Contractor. Frequent informal meetings provide a forum for meaningful dialog to mitigate potential cost and scheduling problems. In addition, frequent communication between plant and laydown/ compaction personnel during production provides critical feedback to ensure that a quality pavement is being produced. Key points of discussion should be noted in the Daily Work Report.

401.2-HMA PRODUCTION AND HAULING

Hot-mix asphalt (HMA) plants mechanically blend aggregate and asphalt binder materials together to produce a hot, homogeneous paving mix. The Project Inspector at the plant is responsible for verifying plant conditions and operations (e.g., certification, scales and weights, materials, mix proportions, mix temperatures) to ensure compliance with the requirements of the project. Before production, it is good practice to become familiar with the features of the type of plant being used and to thoroughly examine the plant for compliance with the contract specifications. Any deficiencies in mechanical condition or in meeting contract specifications or safety requirements should be corrected immediately.

401.2.1-Plant Certifications The Division must approve the plant prior to use on DOH projects. Before production, verify that the plant has been properly certified. Check compliance as follows:

1. Emission-Control System. The plant must be equipped with an emission-control system to reuse or discard lost fine material. It is preferable to reuse lost fines as mineral filler in the mix to ensure that gradation is maintained; however, where this is not practical or otherwise desired, check to ensure that the Contractor wastes the material in accordance with the governing contract specifications. Check that the plant operator has furnished documentary evidence of compliance with the State's applicable air pollution laws and governing regulations (e.g., West Virginia DEP Division of Air Quality).
2. Scales and Weights. Plant scales that are used to weigh aggregate and asphalt binder materials and final HMA batches, including truck scales, must conform to the requirements of the Specifications. The West Virginia Division of Labor calibrates and certifies scales and test weights every two years. Check for these certifications. Note that the seal on the scale indicates only that the scale was accurate at the time it was certified. Periodically check for scale accuracy and the need to recalibrate. See Section 708.1 of this Manual for additional guidance.
3. Temperature Sensing Devices. The temperature sensing device (e.g., pyrometer) at the discharge end of the aggregate dryer and all thermometers used at the plant should be checked and calibrated before the plant is certified. The pyrometer and thermometers should be recalibrated, as needed, during production.

401.2.2-Plant Laboratory The Contractor is responsible for ensuring that the plant laboratory is provided in accordance with the contract specifications. The laboratory should be located so that production operations are readily visible. The laboratory must be furnished and equipped as specified in Section 401 of the Specifications. The types and frequencies of quality control sampling and testing will be conducted in accordance with the Contractor's Quality Control Plan (See Section 401.1.4). The laboratory should contain copies of all reference materials applicable to the project (e.g., Plans, Specifications, Special Provisions, Materials Procedures, ASTM and AASHTO publications, Quality Control Plan, JMF, Form T-400, Laydown and Compaction Plan, MOT Plan, schedule, test and inspection forms).

401.2.3-HMA Production Operations: Continuous vs. Batch The physical HMA plant (i.e., dryer-drum plant, batch-mix plant, continuous-mix plant) may be either a commercial operation or a portable plant specifically erected for the project. Dryer-drum plants and batch-mix plants are generally used and have many common features (e.g., cold-feed system, surge and storage silos, emission-control system). Two basic types of HMA production operations are currently used: continuous and batch. The type of operation will depend on the type of plant selected for the project.

In continuous HMA production operations, aggregate and asphalt binder materials are proportioned by volume based on weight. The older style continuous-mix plant and the modern dryer-drum plant are both continuous operations. To facilitate truck loading and minimize mix segregation, the dryer-drum plant is equipped with a surge silo that essentially converts the continuous operation to a batch process. The dryer-drum plant is not, however, considered a batch-mix plant. The batch-mix plant is a true batch production operation because the aggregate and asphalt binder materials are proportioned by weight for each batch.

Another noteworthy distinction in plant operations is where the final proportioning of coarse and fine aggregate material occurs. In dryer-drum plants, final proportions are established at the cold-feed system; and in batch-mix plants and the older style continuous- mix plants, final proportions are set at the hot bins.

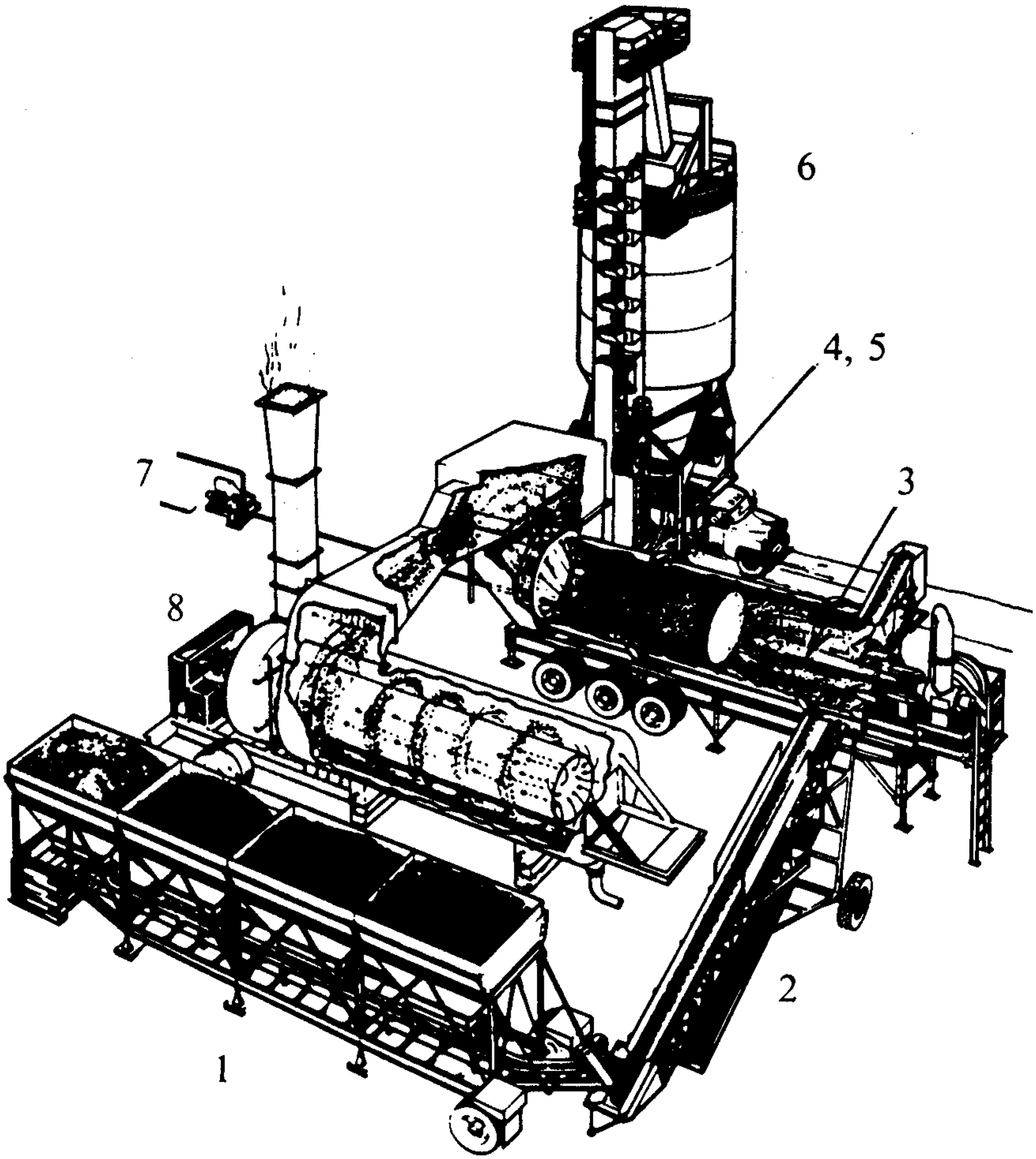
It is important to clearly understand plant operations and material flow to properly check and maintain plant equipment and establish and verify HMA production for the project.

401.2.4-Plant Operation and Material Flow: Overview The following sections briefly describe the operation and material flow of dryer-drum plants, batch-mix plants, and continuous-mix plants.

401.2.4.1-Dryer-Drum Plants Dryer-drum plants proportion aggregate and asphalt binder materials by volume based on weight. The final proportions of coarse and fine aggregates are set at the cold-feed system. The major components of the dryer-drum plant include the cold-feed system, asphalt binder supply system, dryer-drum mixer, surge silo, and emission-control system. The following notes correspond to Figure 401A and briefly describe the operation and material flow of the dryer- drum plant:

1. The cold-feed system includes aggregate stockpiles, cold-feed bins, variable-speed feeder conveyors, gathering conveyor, scalping screen, charging conveyor, and weigh-bridge control system. Coarse and fine aggregate materials are moved from stockpiles to their respective cold-feed bins. The gate openings under each bin and the speed of each bin's feeder belt are adjusted to establish the initial proportions of coarse and fine aggregate delivered to the gathering and charging conveyors and, ultimately, to the dryer-drum mixer. Aggregate proportions must meet the requirements of the Job Mix Formula, and total aggregate flow must not exceed the capacity of the dryer-drum mixer.
2. The charging conveyor feeds the proportioned aggregate material to the dryer-drum mixer. The weigh idler and load cell of the weigh-bridge control system monitors the rate of "dry" aggregate that is being fed to the dryer-drum mixer.
3. The radiation zone of the dryer-drum mixer is where the proportioned aggregate material is heated and dried.
4. The convection-coating zone of the dryer-drum mixer is where asphalt binder, mineral filler, and RAP materials are introduced. The binder material is proportionally pumped through a meter based on the rate of "dry" aggregate that is being fed to the dryer-drum mixer.
5. The dual-zone design of the dryer-drum mixer minimizes emissions (e.g., blue smoke). A physical "divider" separating the two zones, and the aggregate veil that forms in the drum shield the asphalt binder and the RAP material from direct contact with the burner flame.
6. A surge silo is used to convert the continuous operation of the dryer-drum plant to a batch process, which facilitates truck loading and minimizes mix segregation.
7. A pump is used to transfer the asphalt binder from its storage tank to the rear of the dryer-drum mixer. A metering system is used to measure the amount of binder being pumped. The plant control system automatically adjusts binder flow based on the rate of "dry" aggregate that is being fed to the dryer-drum mixer, which is determined by the weigh-bridge control system. The proportion of binder must meet the requirements of the Job Mix Formula.
8. To control plant emissions, the emission-control system (e.g., baghouse, horizontal venturi-type wet collector) removes very fine dust particles from the operation. Unless a wet collector is used, the fines may be returned to the mix as mineral filler at the rear of the dryer-drum.

401.2.4.2-Batch-Mix Plants Batch-mix plants proportion aggregate and asphalt binder materials by weight not volume. Initial proportioning of aggregate materials are established at the cold-feed system, but final proportions of coarse and fine aggregates are set at the hot bins. The major components of the batch-mix plant include the cold-feed system, asphalt binder supply system, aggregate dryer, mixing tower, emission-control system, and, if provided, a storage silo. The mixing tower includes the hot elevator, screen deck, hot bins, weigh hopper, asphalt weigh bucket, and pugmill. The following notes correspond to Figure 401B and briefly describe the operation and material flow of the batch-mix plant:



DRYERDRUM PLANT
Figure 401A

1. The cold-feed system includes aggregate stockpiles, cold-feed bins, variable-speed feeder conveyors, gathering conveyor, scalping screen, and charging conveyor. Coarse and fine aggregate materials are moved from stockpiles to their respective cold-feed bins. The gate openings under each bin and the speed of each bin's feeder belt are adjusted to establish the initial proportions of coarse and fine aggregate delivered to the gathering and charging conveyors and, ultimately, to the aggregate dryer. The proportional flow must not starve the plant's downstream hot bins (i.e., cause imbalance), and the total flow must not exceed the capacity of the aggregate dryer.
2. The gate opening on the fine bin and the speed of the bin's feeder belt control the initial proportion of fine aggregate (e.g., sand) being transferred to the gathering and charging conveyors.
3. The gate opening on the coarse bin and the speed of the bin's feeder belt control the initial proportion of coarse aggregate being transferred to the gathering and charging conveyors.
4. Before the combined material is transferred to the aggregate dryer, it usually passes through a scalping screen (e.g., grizzly-type device) to protect the dryer from oversize and foreign material.
5. The aggregate dryer receives a continuous flow of combined aggregate material for heating and drying. The aggregates are heated and dried through direct exposure to the flame and hot exhaust gases of the burner.
6. The lifting flights in the aggregate dryer repeatedly lift and drop the combined aggregate material in a uniform veil through the flame and hot exhaust gases for maximum heating and drying.
7. A motor and fan supply the air flow needed by the emission-control system and the burner's combustion system in the aggregate dryer.
8. The very fine material collected by the emission-control system (e.g., baghouse) is usually fed by screw conveyor to the boot of the hot elevator.
9. The exhaust stack carries exhaust gases above the plant area.
10. The emission-control system (e.g., dry collector, baghouse) collects the very fine material in the aggregate, indigenous or generated through tumbling in the dryer. These fines may be returned to the mix as mineral filler (See Item #8).
11. The heated and dried combined aggregate material is transported from the dryer to the screen unit, or gradation control unit, at the top of the mixing tower by the hot elevator (e.g., bucket elevator).
12. Upon discharge from the hot elevator, the combined aggregate material is graded (i.e., separated by size) as it passes through a set of vibrating screens to the hot bins. Oversize aggregates are rejected.
13. The hot bins store the graded aggregate material until needed by the pugmill. Final aggregate proportions are established as each aggregate size is discharged through a gate at the bottom of its respective hot bin.

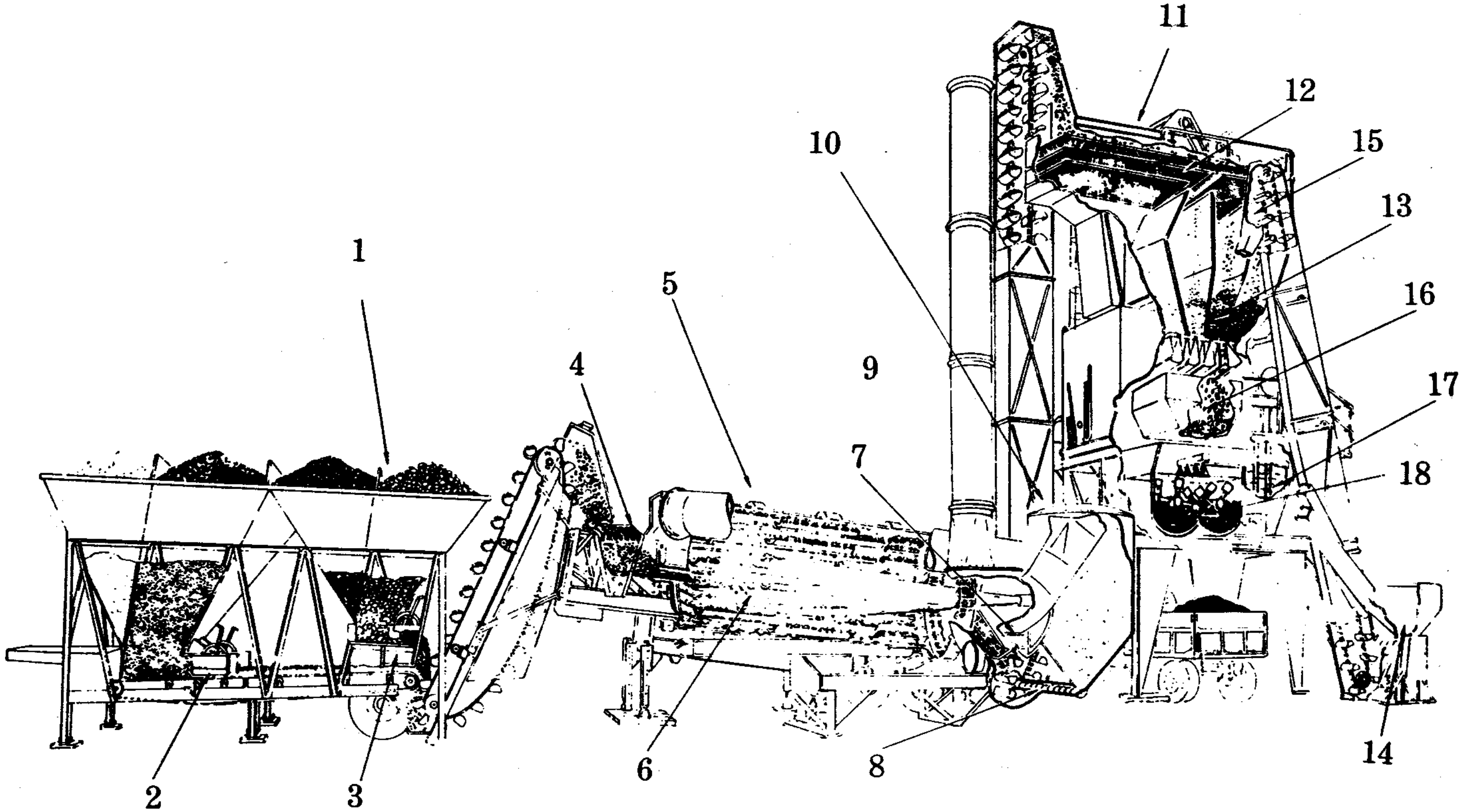


Figure 401B
BATCH-MIX PLANT

14. The mineral filler used in the HMA is usually stored at ground level.
15. The mineral filler is measured and uniformly fed to the weigh hopper by mechanical means.
16. The weigh hopper is used to determine the total weight of aggregate, including mineral filler, required for each batch. The aggregate materials and mineral filler are proportioned, by weight, as they are released from the hot bins or mineral filler storage. Final aggregate proportions must meet the requirements of the Job Mix Formula.
17. The jacketed (i.e., insulated) weigh bucket is used to weigh the correct amount of asphalt binder for each batch as the binder is pumped from its storage tank. The proportion of asphalt binder must meet the requirements of the Job Mix Formula.
18. The aggregate material from the weigh hopper is dumped into a twin-shaft pugmill for a dry-mix period. The asphalt binder from the weigh bucket is then poured into the pugmill, and the combined aggregate and asphalt binder material is mixed for a wet-mix period. After mixing is complete, the gate at the bottom of the pugmill is opened and the HMA batch is discharged either into a haul truck or onto a conveying device that carries the mix to a storage silo, if provided.

401.2.4.3-Continuous-Mix Plants Continuous-mix plants proportion aggregate and asphalt binder materials by volume based on weight. Initial proportioning of aggregate materials are established at the cold-feed system, but final proportions of coarse and fine aggregates are set at the hot bins. The major components of the older continuous-mix plants include the cold-feed system, asphalt binder supply system, aggregate dryer, hot elevator, screen unit, hot bins, pugmill mixer and holding hopper, and emission-control system. The following notes correspond to Figure 401C and briefly describe the older continuous-mix plant:

1. The cold-feed system includes aggregate stockpiles, cold-feed bins, constant-speed feeder conveyors, scalping screen, and cold- feed elevator (e.g., gathering and charging conveyor). Coarse and fine aggregate materials are moved from stockpiles to their respective cold-feed bins. The gate openings under each bin are adjusted to establish the initial proportions of coarse and fine aggregate delivered to the cold-feed elevator and, ultimately, to the aggregate dryer. The proportional flow must not starve the plant’s downstream hot bins (i.e., cause imbalance), and the total flow must not exceed the capacity of the aggregate dryer.
2. The opening of the fine bin’s discharge- control gate establishes the initial proportion of fine aggregate (e.g., sand) being transferred to the cold-feed elevator.
3. The opening of the coarse bin’s discharge- control gate establishes the initial proportion of coarse aggregate being transferred to the cold-feed elevator.
4. The aggregate dryer receives a continuous flow of combined aggregate material for heating and drying. The aggregate material is heated and dried through direct exposure to the flame and hot exhaust gases of the burner.
5. Before the combined material is transferred to the aggregate dryer, it usually passes through a scalping screen (e.g., grizzly-type device) to protect the dryer from oversize and foreign material.

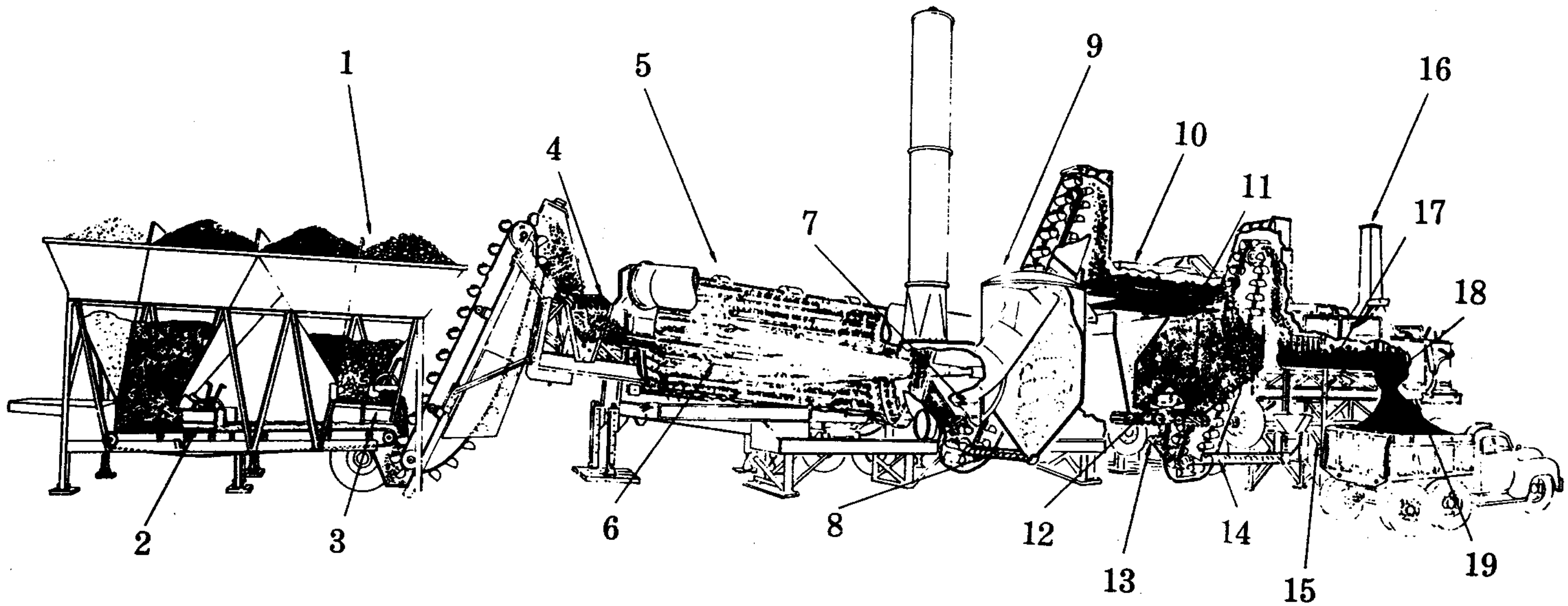


Figure 401C
CONTINOUS-MIX PLANT

6. The lifting flights in the aggregate dryer repeatedly lift and drop the combined aggregate material in a uniform veil through the flame and hot exhaust gases for maximum heating and drying.
7. A motor and fan supply the air flow needed by the emission-control system and the burner's combustion system in the aggregate dryer.
8. The very fine material collected by the emission-control system (e.g., baghouse) is usually fed by screw conveyor to the boot of the hot elevator.
9. The emission-control system (e.g., dry collector, baghouse) collects the very fine material in the aggregate, indigenous or generated through tumbling in the dryer. These fines may be returned to the mix as mineral filler (See Item #8). The exhaust stack carries exhaust gases above the plant area.
10. The heated and dried combined aggregate material is transported from the dryer to the screen unit, or gradation control unit, by the hot elevator (e.g., bucket elevator).
11. Upon discharge from the hot elevator, the combined aggregate is graded (i.e., separated by size) as it passes through a set of vibrating screens to a series of small hot bins where it is temporarily held. Oversize aggregates are rejected.
12. The hot bins' discharge-control gates are adjusted to accurately proportion coarse and fine aggregate materials for the mix. The aggregate is continuously removed from the hot bins in proportion to the desired gradation of the mix.
13. Aggregate samples may be quickly and easily obtained by diverting the flow of material into test containers.
14. The mineral filler is stored, measured and uniformly fed to the pugmill by mechanical means.
15. A positive displacement metering pump is interlocked with the aggregate feed to ensure that the correct volume of asphalt binder is mixed with the proportioned aggregate material. A transfer pump is used to provide a constant head of binder to the metering pump as the binder is transferred from its storage tank.
16. The pugmill mixer automatically meters the correct volume of asphalt binder for thorough mixing with the proportioned aggregate material that is discharged to the pugmill. The aggregate feed rate and the flow of binder are positively interlocked to control final material proportions. The proportions of aggregate and asphalt binder materials must meet the requirements of the Job Mix Formula.
17. The twin-shaft pugmill thoroughly and continuously mixes the aggregate and asphalt binder materials as the mix is moved by the mixing paddles to the discharge end of the pugmill.
18. The pugmill is jacketed (i.e., insulated) to maintain the correct temperature of the mix.
19. A small capacity holding hopper is provided at the discharge end of the pugmill to temporarily store the mix until it can be loaded on a haul truck, thus permitting continuous operation of the plant. The use of the discharge hopper also helps to reduce segregation.

401.2.5-Cold-Feed System The following sections discuss the various components of the HMA plant's cold-feed system.

401.2.5.1-Aggregate Stockpiles The aggregate materials discussed in Section 401.1.3.1 must be properly handled and stockpiled to minimize segregation, contamination, and moisture. See Section 401.4.2 for guidelines on stockpiling and monitoring for segregation during plant production. As needed, graded aggregates are moved from their respective stockpile by equipment such as a front-end loader to charge the cold-feed bins.

401.2.5.2-Cold-Feed Bins A separate cold-feed bin will be provided for each aggregate size/type used in production (e.g., coarse, fine, RAP). RAP bins typically have steeper sides to prevent the material from sticking and bridging the gate opening. Bins usually are top-loaded via front-end loader or similar means. Bin compartments in multi-bin units should be separated by a bulkhead or divider at the top to prevent the material from overflowing into an adjacent compartment. This is especially important if the bins are kept full. A discharge-control gate is provided at the bottom of each bin directly over the feeder conveyor system.

401.2.5.3-Total and Proportional Aggregate Flow The total and proportional flow of aggregate from the cold feed must be established and maintained to:

1. Meet the proportions of the Job Mix Formula,
2. Balance production with the needs at the laydown site, and
3. Ensure that downstream plant components are not starved for material or exceeded in capacity.

The total flow of aggregate from the cold feed controls the overall rate of plant production. This flow cannot exceed the capacity of downstream plant components (e.g., dryer-drum mixer, aggregate dryer, hot bins). For example, when the aggregate is wet and cannot be easily dried (e.g., after a heavy rain), the total flow may need to be reduced.

The Job Mix Formula will specify the required proportions of coarse and fine aggregate materials. In dryer-drum plants, final proportional flow is set at the cold feed. In batch-mix and continuous-mix plants, aggregate proportions are balanced at the cold feed to meet the needs of the downstream hot bins, where final proportions are set according to the Job Mix Formula.

A system of conveyor belts is used to transfer cold aggregate materials from their storage bins to the dryer (batch-mix and continuous-mix plants) or the dryer-drum mixer (dryer-drum plants). The type and configuration of the cold- feed conveyor system varies depending on the type of plant in use. Modern dryer-drum mixing and batch-mix plants usually have a variable- speed feeder belt for each cold-feed bin, a constant-speed gathering conveyor, and a constant-speed charging conveyor. Older continuous-mix and batch-mix plants generally are not equipped with variable-speed feeder belts.

401.2.5.4-Feeder Conveyors In cold-feed systems equipped with variable- speed feeder belts, the proportion of aggregate from each bin is set by first adjusting the size of the opening in the discharge-control gate and then by fine tuning the speed of the individual feeder belts. Belt speeds are then synchronized to a master control to facilitate changing the total flow and the rate of production without having to change aggregate proportioning. Some HMA plants are equipped with a "no flow" device to detect when aggregate is not available from the bins. (e.g., audible warning, auto shutoff).

During production, it is good practice to calibrate and run each feeder belt at approximately 50% of maximum speed. This will facilitate any needed future adjustment to proportional flow without having to change bin gate openings. Initial cold-feed calibration should include trials at three different gate openings as well as three different belt speeds (e.g., at 20%, 50%, and 80% of maximum). In cold-feed systems equipped with constant-speed feeder belts, the proportional flow of aggregate from each bin is set by adjusting the opening in the discharge-control gate. Production should be calibrated at three different gate settings; one at production rate, one greater than production, and one lower than production.

401.2.5.5-Gathering Conveyor Some plants are equipped with a constant speed gathering conveyor, which receives the various sizes of aggregate discharged from the feeder belt system. The coarse aggregate material is generally deposited first, followed by the finer aggregate. This sequence is used to minimize wet fines from sticking to the conveyor belt.

401.2.5.6-Scalping Screen Cold-feed systems are usually equipped with a scalping screen to prevent oversize or deleterious material from entering the plant's drying and mixing unit (e.g., oversized aggregates, large chunks of RAP, tree roots, clay lumps). In the dryer-drum plant, the scalping screen is usually located at the end of the gathering conveyor but may be located elsewhere (e.g., under the cold-feed bins, over the RAP cold-feed bins). In batch-mix and continuous-mix plants, a grizzly-type device may be located just before the aggregate enters the dryer.

401.2.5.7-Charging Conveyor The aggregate material coming from the gathering conveyor is usually discharged onto a constant-speed charging conveyor for transport to the aggregate dryer in batch-mix and continuous mix plants or the dryer-drum mixer in dryer-drum plants. The speed of the charging conveyor is independent of the speed of the feeder and gather conveyors. In batch-mix and continuous-mix plants, the aggregate is usually transferred from the cold elevator to a chute at the upper end of the aggregate dryer. In dryer- drum plants, the aggregate is discharged either into a chute above the burner or onto a slinger conveyor under the burner. If equipped with a scraper blade or brush, the belt of the charging conveyor will be self-cleaning.

401.2.5.8-Weigh-Bridge Control System In dryer-drum plants, a weigh-bridge control system will be provided either on the charging conveyor or the feeder conveyor system. The weigh-bridge control system of the dryer-drum plant monitors the "dry" aggregate feed rate, in tons per hour, so that the asphalt binder can be accurately proportioned and fed to the rear of the dryer-drum mixer.

The primary components of the system include a weigh bridge and a belt-speed sensor. The weigh bridge includes a weigh idler and an electronic load cell, which are usually located at midpoint on the charging conveyor. The weigh idler differs from the other idlers fixed on the conveyor frame because it is free to move and is wired to a load cell. As the proportioned aggregate passes over the weigh idler, the load cell transmits the recorded weight to the plant's control system. A sensor, usually located on the gravity takeup pulley, determines the belt's speed. The moisture content of the aggregate must be provided as input to the system. Based on these three values (i.e., weight, speed, moisture content), the plant's control system calculates an equivalent "dry" aggregate feed rate and proportionally pumps asphalt binder from a storage tank to the rear of the dryer-drum mixer. The proportions of aggregate and asphalt binder materials must meet the requirements of the Job Mix Formula.

It is good practice to periodically check the weigh bridge on the charging conveyor to see that the weigh idler is free to move and that the conveyor belt is tight around the gravity takeup pulley. This will ensure that an accurate weight and speed are being recorded.

The weigh bridge should be calibrated by collecting and weighing a quantity of aggregate passing over the weigh bridge in a set amount of time and comparing that weight to the weight determined by the plant's computer control system. The two weights should be within 1% of each other.

401.2.5.9-Flow Calibration Sampling In general, the calibration of the cold-feed system may be accomplished during production by drawing a sample and determining the dry weight and proportion of the sample that was fed during the sampling interval. A truck may be used to gather diverted samples from the system if the truck's tare weight is known. Another method involves stopping the conveyor system and removing a length of combined material, say 2 ft., from the belt. Then, run the system with the flow of coarse aggregate shut off. Remove the same length of fine aggregate from the belt. Dry and weigh both samples to determine the actual percent of materials.

401.2.5.10-Recycled Asphalt Pavement (RAP) RAP is generally stockpiled and fed through a cold-feed system separate than that used for new aggregate material. During production, manual adjustments are usually necessary to account for the additional moisture in RAP material.

401.2.6-Asphalt Binder Storage and Supply Systems The asphalt binder storage and supply system generally consists of one or more heated storage tanks and a pumping system. The tanks store and heat the specified asphalt binder material (see Section 401.1.3.2 of this Manual) to a constant temperature until it is needed by the mixing unit. The pumping system is used to draw the asphalt binder from its tank to the mixing unit. Depending on the type of plant, the proportion of asphalt binder material will either be manually weighed or automatically metered based on the requirements of the Job Mix Formula. The grade of binder specified for the project is usually sampled and conditionally accepted at the source; however, a bypass valve is usually provided in the system for verification sampling and to calibrate the pump and metering system.

401.2.6.1-Asphalt Binder Storage Tanks Consider the following guidelines when inspecting asphalt binder storage tanks at HMA plants:

1. Capacity. The storage tanks at the plant must be of sufficient number and capacity to maintain continuous production while allowing for some delay to refill. To prevent the accidental mixing of different binders, each tank should be clearly labeled, and the tank which is being drawn from during production should be readily apparent.
2. Heating Coils. Heating coils (e.g., hot oil, steam, electricity) will be provided in the tanks to evenly heat and maintain the binder at a constant specified temperature. Most tanks use a closed-coil system of heating oil.

   Both the tank and the heating system will be insulated to minimize heat loss.

3. Binder Temperature. The required storage temperature, typically between 300°F and 350°F, will depend on the type of asphalt binder being used. The specified temperature must be maintained. This will ensure that the binder is sufficiently fluid to pump and adequately coat the aggregate material in the mixing unit. A thermometer is usually located near the discharge valve for the purpose of verifying binder temperature. An ideal temperature exists for each grade of binder, which is the lowest temperature that the material becomes sufficiently fluid to coat the aggregate material. If set too high, the binder will prematurely harden, soak into the aggregate, or drain from the mix during transport, thus shortening the life of the pavement.
4. Fill, Discharge, and Return Lines. Return lines must be provided between the tank and the mixing unit to recirculate any unused binder material. The fill, discharge, and recirculation lines are usually jacketed (i.e., insulated) and located near the bottom of the tank. This location prevents oxidation of the binder and provides for a much safer operation.
5. Release Agents. Unless otherwise approved, the use of release agents to coat the inside of storage tanks is not permitted.
6. Admixtures. Admixtures (e.g., binder modifiers, liquid antistrip materials), if used to alter HMA characteristics or to improve adhesion to the aggregate material, are usually added as the binder is pumped into the tank.
7. Storage Periods. Asphalt binders used in HMA production may be stored for relatively long periods without any significant change in consistency. However, cut-back asphalts lose their volatile spirits through evaporation, and the components of asphalt emulsions that are used in prime and tack coats tend to separate over time. If quality is in question, the material should be sampled and tested before use in accordance with the contract specifications. See Section 703 of this Manual for guidance on required sampling and testing.

401.2.6.2-Asphalt Binder Pump/Metering Systems In dryer-drum plants, the quantity of binder is proportioned by volume based on weight. The volume of binder that is pumped from the tank is based on the "dry" aggregate feed rate determined by the weigh-bridge control system on the charging conveyer of the cold-feed system; otherwise the binder is recirculated. Depending on the particular type of dryer-drum plant, one of the following three pump and metering systems will be in use:

1. Constant-Volume Pump/Constant-Speed Motor. In this type of system, the same volume of binder is drawn from the tank at all times based on the opening of the proportioning valve in the line between the pump and the meter.
2. Constant-Volume Pump/Variable-Speed Motor. In this system, the volume of binder delivered to the meter is varied by changing the speed of the motor.
3. Variable-Volume Pump/Constant-Speed Motor. This system typically controls the volume of binder drawn from the tank by automatically changing the volume being pumped.

In batch-mix plants, the amount of binder is proportioned by weight, not volume. Thus, volumetric metering and temperature correction (see Section 401.2.6.3 of this Manual) are not necessary to proportion the asphalt binder used in the HMA. Based on the opening of the control valve, the pumping system (i.e., single-line or dual-line) draws the binder from the tank for delivery to the weigh bucket near the pugmill; otherwise it is recirculated back to the storage tank.

401.2.6.3-Asphalt Binder Measurement/ Calibration Because the proportion of asphalt binder in the final HMA greatly affects pavement stability and durability, it is very important to calibrate and frequently check the quantity of asphalt binder being mixed with the aggregate material. Various measurements and calibrations related to the asphalt binder storage and supply system will be necessary to establish and maintain production. Consider the following guidelines:

1. Volume-Temperature Correction. Asphalt binders expand when heated. For example, the volume a binder occupies when heated to 350°F will be greater than the volume it occupies at 300°F. Because binders may be heated to different temperatures during production, it is necessary to normalize the volume of binder to a standardized temperature (i.e., 60°F). This is especially important for plants based on volumetric proportioning such as the dryer-drum plant. Such corrections may be accomplished based on the temperature and specific gravity of the binder either automatically via the plant's computer system, manually using calculations, or lookup tables in the appropriate attachments of the Daily Work Reports.
2. Storage Tanks. Each storage tank should be equipped with a gauge that displays the quantity of binder in the tank. Otherwise, the quantity of binder must be manually determined using the "tank-stick" method. The tank's total volume may be calculated from its length and diameter. The volume of binder in the tank (i.e., used or remaining) will be based on the level indicated on the "tank-stick" and the temperature and specific gravity of the binder. Remember, the volume of the binder must be converted to an equivalent volume at 60°F. See Item #1 above. Note that the volume of the "heel" (i.e., the old non-circulated binder at the bottom of the tank) may need to be considered in the calculation. If the type of binder in the tank is changed, the "heel" should be removed.

3. Automated Proportioning. In dryer-drum plants, the amount of asphalt binder is proportioned by volume as it is pumped through a meter into the rear of the dryer-drum mixer. Before production begins, the pump and metering system must be calibrated to ensure proper proportioning of binder material. Generally, this is accomplished by diverting a binder sample into a container over a specified period and then normalizing the measured volume as discussed in Item #1 above. This will be necessary unless the pump and metering system is a temperature-compensating device. The binder is usually diverted into an empty container, which has a known tare weight (e.g., distributor truck, empty drum). The actual quantity of binder in the container is determined and compared to that which is indicated by the meter. The pump and metering system should be adjusted if found not to be within specified tolerance (e.g., 0.4%). See Section 708.2 of this Manual for additional information on calibrating pump and metering systems.
4. Manual Proportioning. In batch-mix plants, the quantity of asphalt binder is proportioned by weight. A pump is used to draw the binder from its storage tank to the weigh bucket near the pugmill. The scale of the weigh bucket must be periodically checked and calibrated. Test weights will be provided at the plant. This is very important because an excess in quantity of as little as 0.5% above what is specified in the Job Mix Formula can cause shoving, and a deficiency of as little as 0.5% can lead to raveling. Thus, a difference in 20 lbs. of binder added to a 4000-lb batch can lead to serious trouble. Check the scale for zero balance, sensitivity, and accuracy according to the requirements of the contract specifications. See Section 708.1 for additional information.
5. Liquid Asphalt Pump. To be in proper calibration, the values should be within the required tolerance band (typically 1.0 percent) for the asphalt cement supply system.

401.2.7-Dryer-Drum Mixer The operation and material flow of the dryer- drum mixing plant is briefly discussed in Section 401.2.4.1. See Section 401.2.5 and Section 401.2.6, respectively, for information on cold-feed systems and asphalt binder storage and supply systems. The following sections specifically address the dryer-drum mixing unit of the dryer-drum plant.

401.2.7.1-New Aggregate Feed Although other types of systems are used, the conventional dryer-drum mixer is generally a parallel-flow system, meaning that both aggregate material and the burner's exhaust gas flow in the same direction. New aggregate, proportioned at the cold feed, is fed into the drum at the upper end, where the burner is located, by either a charging chute above the burner (i.e., gravity feed) or a slinger conveyor underneath the burner. As needed, the speed of the slinger conveyor can be increased to throw the material farther down the drum away from the flame. The aggregate material travels through the dryer-drum mixer by a combination of drum rotation and gravity and the lifting flights inside the drum.

401.2.7.2-RAP Feed If RAP is added to the mix, it is usually transferred from its own cold-feed system to an opening located near the middle of the length of the dryer-drum mixer. This split-feed process protects the RAP material from high temperatures, thus reducing unwanted emissions. The difference in mix discharge temperature and the temperature of the exhaust gas measured at the stack will typically be greater than 20°F and will usually increase roughly in proportion to the amount of RAP added to the mix.

401.2.7.3-Mineral Filler Feed To stabilize the HMA, mineral filler (e.g., hydrate lime, Portland cement, fly ash, limestone dust) is usually added to the mix pneumatically through a delivery pipe in the rear of the dryer- drum mixer. The material is mixed with asphalt binder without being exposed to the high- temperature exhaust gas in the upper end of the drum. Various systems such as a storage silo/vane feeder system are used to control and meter the flow of mineral filler. The feed rate depends on the flow of new aggregate and RAP material being delivered to the drum. If the plant is equipped with a dry emission-control system (e.g., baghouse), it is good practice to return at least some of the dry material back to the mix. The dust is usually transferred out of the baghouse by screw conveyor through an air lock. Baghouse fines typically are not metered but returned on a continuous basis.

401.2.7.4-Asphalt Binder Feed During production, asphalt binder is continuously pumped from its storage tank by a pump and metering system that controls the amount of binder being fed through the delivery line in the rear of the dryer-drum where the binder is injected onto the aggregate. Moisture released from the aggregate materials causes the binder to expand and foam. The aggregates tumble through the foaming binder and are coated in the process. The aggregate veil created by the lifting flights in the upper half of the drum protects the binder and coated aggregates from direct exposure to the burner flame, thus preventing premature hardening of the binder. The remaining lifting flights in the drum allow the asphalt-coated aggregates to continue to be heated until the desired discharge temperature is obtained. The moisture content of the mix upon discharge from the mixer is normally between 0.5% and 1.5% by weight.

401.2.7.5-Burner System The burner provides the energy necessary to heat and dry the aggregate. The burner system must be able to properly blend sufficient air to obtain complete combustion of the fuel. Otherwise, the unburned fuel may clog the burner, contaminate the mix, and generate unwanted emissions. Several types of fuels may be used (e.g., No. 2 fuel oil). Heavy fuel oil generally requires preheating before use. Periodic checks of the preheated temperature of the fuel oil is good inspection practice to ensure efficient burner operation. Two burner types are generally used: blower-induced draft burner and force-draft, total-air burner. The latter is quieter and more fuel efficient. In some plants, the draft air may be supplied by the emission-control system (see Section 401.2.10). Burner adjustments may be needed during production to compensate for changes in total flow from the cold feed, moisture content in the aggregate, and discharge temperature of the mix. The sound of the burner should be periodically monitored. A uniform, constant roar is desirable. A coughing, sputtering, or spitting sound usually indicates the burner is not completely burning the fuel. Brown stains or lack of binder on coarse aggregates at discharge also indicates fuel is not being completely burned. Visible hydrocarbon emissions (i.e., blue or black smoke from the stack) indicates the temperature of the exhaust gas reaching the rear of the drum is too high.

401.2.7.6-Dual-Zone Configuration The dryer-drum mixer's interior is divided into two zones: the radiant heating zone and the convection-coating zone. The radiant heating zone (i.e., front half) is where the stream of hot exhaust gas from the burner heats and dries the cold, wet aggregate (i.e., radiant heat). Conductive heating occurs where aggregate particles come in contact with each other. The lifting flights inside the drum cause the aggregate to form a dense, uniform veil across the drum in front of the burner flame, thus maximizing heat transfer and moisture removal. The convection-coating zone (i.e., lower half) is where the aggregate is coated with asphalt binder and further heated. The heat transfer process in the convection-coating zone primarily occurs through convection and conduction. The density of the aggregate veil across the drum is the key to efficient operation and economical fuel usage. The adequacy of the veil can be determined by comparing the temperature of the discharged mix to the temperature of the stack exhaust, assuming that no cooling air is added at the emission-control system. The difference should be within approximately 20°F. A significantly greater differential indicates poor veil density. Presence of light brown, uncoated fines on one side of the mix in the discharge chute also is an indication of poor veil density. Veil density can be increased by lowering the slope of the drum or by adding kicker flights, dams, donuts, or retention rings near the drums mid-section.

401.2.7.7-HMA Discharge Upon discharge from the dryer-drum mixer, the HMA is deposited onto a conveying device (e.g., drag slat conveyor, belt conveyor, bucket elevator) for transport to a surge silo (see Section 401.2.11). Because a dryer-drum plant manufactures HMA on a continuous basis, a surge silo is required to temporarily store the HMA until it can be loaded into a haul truck, essentially converting the continuous-mix operation to a batch process. The top of the surge silo is normally equipped with a "batcher" or other device that prevents mix segregation as the HMA is discharged in the silo.

401.2.7.8-Production Considerations Dryer-drum mixing plants are rated by the number of tons of HMA that can be produced per hour. Production rate is determined at a given mix discharge temperature and at an average moisture content in the aggregate, usually 5%. Production capacity is affected by many factors including the moisture content and the temperature of the aggregate coming from the cold feed, mix discharge temperature, drum diameter, fuel type, exhaust gas velocity, etc. An increase in the moisture content and/or an increase in the mix discharge temperature decreases the capacity of the plant. By far, the most significant factor affecting production rate is the moisture content of the combined aggregate. Fines tend to be more problematic because they tend to retain more moisture than coarse aggregates. As the average percentage of moisture increases, the production capacity of a specific dryer-drum mixer decreases because of the limited maximum capacity of the exhaust fan. Production rates for RAP mixes, up to a RAP content of about 50%, will normally be similar to the production rates for mixes containing 100% new aggregate. Above that, the production rate of the conventional dryer-drum mixer decreases as the RAP content increases.

<u>401.2.8-Batch-Mix Plant</u> The operation and material flow of the batch- mix plant is briefly discussed in Section 401.2.4.2. Information applicable to the cold- feed systems used in batch-mix plants is discussed in Section 401.2.5, and Section 401.2.6 discusses asphalt binder storage and supply systems. The following sections discuss the batch-mix plant operation from the aggregate dryer to final discharge of the HMA batch. Some systems discussed in this section, if applicable to the older style continuous-mix plants, will be identified as such.

<u>401.2.8.1-Aggregate Dryer/Burner System</u> The aggregate dryer/burner system found in batch-mix plants and the older style continuous- mix plants is used to heat and dry the aggregate supplied from the cold-feed system to the required temperature and moisture content. The system is composed of a rotating drum, lifting flights, burner system, discharge chute, and temperature sensing element. Consider the following guidelines:

1. <u>Aggregate Flow/Operation</u>. The cold, wet aggregate from the cold feed is fed into the upper end of the drum and moved through the dryer toward the burner at the lower end by a combination of drum rotation and gravity and the lifting flights inside the drum. The lifting flights are longitudinal cups or channels that lift and drop the aggregate in veils through the burner's flame and hot exhaust gas, thus maximizing heating and drying. Moisture is removed and carried out with the exhaust stream. The hot, dry aggregate exits the dryer through a discharge chute where it is transferred to the hot elevator.
2. <u>Burner System</u>. The burner system supplies the energy necessary to heat and dry the cold, wet aggregate. Depending on the plant, the burner may be either manually or automatically controlled. If automated, the burner control unit generally is wired to the temperature sensing element in the discharge chute. The burner is generally fueled by either oil or gas and includes a draft-air system (e.g., fan and motor) that supplies the air needed for total fuel combustion. See Section 401.2.7.5 for additional information on burner systems.
3. <u>Temperature Control</u>. A temperature sensing element (e.g., electric thermometer or pyrometer) is usually located in the discharge chute to measure and record the aggregate discharge temperature and, if so equipped, control the operation of the burner. If the sensing element is not operating correctly, a hand thermometer can be used to check the aggregate discharge temperature. Manual burner adjustments may be necessary until the unit can be properly adjusted.
4. <u>Discharge Temperature/Moisture Content</u>. The magnitude of the aggregate discharge temperature varies based on production, environmental, and other factors. The objective is to obtain a uniform temperature at this point during production. The required moisture content of the aggregate when discharged from the dryer should generally be less than 0.5%.
5. <u>RAP Considerations</u>. RAP should never be placed in the aggregate dryer and exposed directly to the burner flame. For RAP mixes, the recycled material normally is added to the weigh hopper as additional aggregate and heated by conduction.

Operations that add RAP to the hot elevator should place the RAP on top of the superheated new aggregate already in the elevator buckets. The temperature to which the new aggregate must be heated varies and is a function of the percent RAP added, its moisture content, and the required discharge temperature of the mix. To prevent dryer damage, the new aggregate should not be heated in excess of 500°F. Consider reducing the percent RAP if it is determined the new aggregate must be heated to a greater temperature to produce the mix.

401.2.8.2-Screening Unit The screening unit found in batch-mix plants is used to separate the aggregate material that was initially proportioned and combined at the cold-feed system into the aggregate sizes required by the Job Mix Formula. A similar feature is provided in the older style continuous-mix plants. Consider the following guidelines:

1. Aggregate Flow/Operation. The hot, dry aggregate from the aggregate dryer/burner system is transported by a hot elevator (e.g., bucket elevator) to the screening unit at the top of the batch-mix plant's mixing tower. As the material passes through the screening unit, each grade of aggregate material is discharged into its respective hot bin below the unit. The finest aggregate material passes directly into hot bin #1. The screens should be checked regularly for holes, blinding, overruns, and inefficient operation.
2. Screen Selection. The screening unit usually includes four flat, vibrating screen decks with a scalping screen covering the top deck to reject oversized aggregates. Screen selection is based on the aggregate size requirements of the Job Mix Formula and the initial proportioning of the aggregate sizes at the cold feed. To determine a working combination of screen sizes for production, consider using a screen with the smallest practical openings over hot bin #1. Then, select screens that will separate the remaining material into the required sizes by equally dispersing the graded material among the remaining hot bins. If aggregate particles are predominantly round, the use of a slotted No. 6 screen over hot bin #1 is often preferred. However, if the aggregates tend to wedge in the slots, consider using a screen with square openings. Clogging and blinding can also be minimized by using screens with slightly larger openings.
3. Efficiency. The efficiency of the screening unit in separating individual sizes of aggregate should be about 85% to 90%. In other words, no more than 10% to 15% of the total material in a particular hot bin should be finer than the smallest aggregate size specified for that bin.
4. Capacity/Overrun Problems. The rate and gradation of fines passing through the screening unit and entering hot bin #1 are controlled primarily at the cold-feed system and the emission-control system, if the latter is set to return captured fines. When the screening unit is properly operated, the rate and gradation of the coarser aggregates entering the other hot bins will be practically constant. However, if too much material is being fed to the screening unit, a thick layer of aggregate will form on the screens causing #1 fines to fall into other bins. The capacity of the screening unit varies from plant to plant and should be closely monitored for problems. More than 16% of #1 fines appearing in another bin is a definite sign

of trouble. Such overruns greatly affect mix uniformity and should be corrected immediately.

401.2.8.3-Hot Bins The hot bins found in batch-mix plants are used to hold the aggregate sizes graded by the screening unit and to proportion the material based on the requirements of the Job Mix Formula. Similar hot bins are found in the older style continuous-mix plants, albeit in a somewhat different operation and configuration. Consider the following guidelines:

1. Aggregate Flow/Operation. In batch-mix plants, several hot bins will be provided under the screening unit to catch and store the hot, dry aggregate as it passes through the vibrating screens of the screening unit. The number of hot bins required will depend on the number of aggregate sizes required by the Job Mix Formula. The capacity of the hot bins will be sufficient to store the quantity of graded material necessary for batch production. When a batch of HMA is to be produced, the discharge-control gates at the bottom of the hot bins are opened to allow the aggregate to fall into the weigh hopper.
2. Bin Partitions/Overflow Pipes. Each hot bin will be separated by a partition that must be tight, free from holes, and of sufficient height to prevent intermingling of material between bins. Each bin will be equipped with an overflow pipe designed to discharge excess material before it overflows into an adjacent bin. Overflow pipes must be checked regularly to ensure that they are not clogged. If material overflows into an adjacent bin or significant intermingling occurs, a large quantity of non-conforming HMA may be produced before the trouble is noticed and corrected.
3. Discharge-Control Gates. In batch mix- plants, a discharge-control gate will be provided at the bottom of each hot bin. The gates are opened only when a batch is to be produced and may be operated either manually or automatically, depending on the type of plant being used. Discharge-control gates must be maintained and regularly checked to ensure that material does not leak into the weigh hopper. Because the amount of fines and filler has such a significant affect on the characteristics of the HMA, check the gate on hot bin #1 regularly to make sure fines do not continue flowing into the weigh hopper after shut-off. In the older style continuous-mix plants, the discharge- control gates must be adjusted and locked in place to provide a continuous and uniform flow of material from each hot bin to the pugmill mixer.
4. Balancing Aggregate Flow. Total and proportional aggregate flow in a batch-mix plant are initially established at the cold feed. Final proportions are set at the hot bins by first adjusting the gate opening of the hot bin that contains the desired aggregate size and then measuring the quantity deposited in the weigh hopper in proportion to the total aggregate for the batch. A key to successful batch-mix plant operation is to balance the flow from the cold feed with the capacity of the screening unit/hot bins and the demand for aggregate during production. If the flow at the cold feed is not set properly, the capacity of the screening unit/hot bins may be exceeded and the supply of aggregate in the hot bins may become unbalanced

(e.g., one hot bin may overflow while another runs short). Overflows and shortages must be corrected immediately.

5. Aggregate Sampling. Small gates or windows are usually provided on the sides of hot bins for sampling purposes. Otherwise, samples may be taken by diverting the flow of aggregate from the bin into a sampling container.

401.2.8.4-Weigh Hopper/Weigh Bucket In batch-mix operations, the aggregate and asphalt binder materials are proportioned by weight for each batch of HMA produced. This is accomplished through the use of an aggregate weigh hopper located just below the discharge- control gates of the hot bins and an asphalt weigh bucket located above the pugmill. The materials are weighed and proportioned just before they are emptied into the pugmill mixer. Consider the following guidelines:

1. New Aggregate Feed. The aggregate weigh hopper is located directly underneath the graded aggregate hot bins. The weigh hopper is generally suspended on a springless-dial scale from which the weight of aggregate from each hot bin can be cumulatively observed and recorded. The last reading on the dial will be the total amount of aggregate for the batch of HMA. The sequence of weighing from each hot bin must be strictly observed. The recommended sequence of discharge is to weigh coarse aggregate first followed by the finer material.
2. RAP Feed. If a RAP mix is being produced, RAP material is generally transferred from a separate cold-feed system to the weigh hopper and added to the mix as additional aggregate. The RAP material should be placed in the center of the weigh hopper so that the hopper is not unbalanced, and an accurate weight of the material can be obtained. Heat transfer to the RAP material begins as soon as the RAP comes into contact with the superheated new aggregate. Heat transfer continues as all heated materials are mixed in the pugmill.
3. Mineral Filler Feed. To stabilize the HMA, mineral filler (e.g., hydrate lime, Portland cement, fly ash, limestone dust) is usually added to the mix. Various systems such as a storage silo/vane feeder system are used to transfer the mineral filler to the weigh hopper. If a dry emission-control system (e.g., baghouse) is used at the plant, it is good practice to return at least some of the captured material back to the mix. The dust is usually removed from the baghouse by screw conveyor through an air lock. When placed in the weigh hopper, the mineral filler should be sandwiched between two other aggregate sizes from the hot bins so that the cold material will be warmed by the superheated aggregate. This also promotes thorough mixing when discharged into the pugmill.
4. Asphalt Binder Feed. The asphalt binder is usually weighed in an overflow-type bucket that is suspended on a springless-dial scale. Section 401.2.6 provides additional information on asphalt binder storage and supply systems. At the same time that the aggregate is being proportioned and weighed, the asphalt binder is pumped from its storage tank to a separate weight bucket located on the mixing tower just above the pugmill. The proper amount of asphalt binder is weighed in the heated bucket and held until it is discharged into the pugmill.

5. Scales. The scales used to weigh aggregate and asphalt binder materials must be certified. See Section 401.2.1 for information on certification of scales. Before production begins, it is good practice to check that the scales are clean, operational, and calibrated. Each scale will be equipped with a zero adjustment to allow the operator to quickly compensate for any accumulation of dust and/or asphalt binder during production. Modern batch-mix plants have fully automated controls for material proportioning and mixing, including an automatic printer system that records the weight of each material delivered.
6. Example Batch Procedure. The coarser aggregate, including RAP if used, should be discharged from the hot bins into the weigh hopper first, followed by the mineral filler and then #1 fines. At the same time, the asphalt binder will be weighed in the weigh bucket. This weighing sequence must be strictly observed. When batch tickets are used to guide the plant operator, the ticket will list aggregate materials as cumulative weights (i.e., each greater than the one above it), which will coincide with the dial readings on the weigh hopper scale. The following is an example of an HMA batch ticket:

Hot Bin #3	980 lbs.
Hot Bin #2	2110 lbs.
Mineral Filler	2260 lbs.
Hot Bin #1	3769 lbs.
Asphalt Binder	232 lbs.
TOTAL BATCH	4000 lbs.

In the second line above, 2110 lbs. is the cumulative weight of material from hot bins #3 and #2, or the sum of 980 lbs. and 1130 lbs. Similarly, 3768 lbs. is the cumulative weight of the aggregate materials discharged into the weigh hopper from all three hot bins, including the mineral filler.

401.2.8.5-Pugmill Mixer In batch-mix plants, after the aggregate and asphalt binder have been properly proportioned with the weigh hopper and weigh bucket, the materials are introduced into the pugmill for mixing. The pugmill mixer found in batch-mix plants and the older style continuous-mix plants are essentially the same, except for the variations in the arrangement of the paddle tips. Consider the following guidelines:

1. Mixer Components. The pugmill includes twin shafts equipped with paddles for mixing the materials into a homogenous mass. The primary components include paddle tips, paddle shanks, spray bar, liners, shafts, discharge gate, and heated jacket.
2. Efficiency. Efficient mixing operation depends several factors including the number and shape of the paddle tips, the speed (i.e., RPM) of the mixing shafts, the length of mixing time, the temperature of the combined materials, the quantity of materials in the mixer, and, especially, the clearance between the paddle tips and the liner plates. The paddle tips and liner plates should be periodically checked for excessive wear. When the manufacturers specified clearance is exceeded, the paddle tips and liner plates should be replaced.

3. Material Flow/Operation. The operation of the pugmill in batch-mix plants includes a dry-mix and a wet-mix period. When a batch of HMA is ready to be produced, the proportioned aggregate material in the weigh hopper is dumped into the center of the pugmill and mixed for a brief dry-mix time. The asphalt binder from the weigh bucket is then dumped into the center of the pugmill and mixed with the aggregate for a wet-mix time. The wet-mix time should not be more than that required to completely coat aggregate particles with a thin film of binder. The paddle tips are arranged to mix the combined materials in a figure-eight pattern and produce a hot, homogenous mass. After the wet-mix period, the gates on the bottom of the pugmill are opened and the batch is discharged into the haul vehicle or into a conveying device that carries it to a storage silo. Modern batch-plants are usually equipped with both a control that automatically regulates dry- and wet-mix times and a batch counter that records the total number of batches produced.

401.2.8.6-Production Considerations The aggregate dryer and the pugmill are two locations in the batch-mix plant that have the greatest effect on the rate of production. It is also important that temperatures be monitored at key locations to ensure proper operation. Consider the following guidelines:

1. Aggregate Dryer. The length of time it takes the aggregate material to pass through the dryer is a function of the slope of the dryer, its speed of rotation, diameter, length, and number and design of lifting flights. The length of time required for heating and drying is primarily dependent on the moisture content in the aggregate coming from the cold feed and the required temperature at discharge. Most dryer inefficiencies stem from feeding too much wet material to the dryer and from improper burner operation. The quantity of aggregate fed to the dryer always should be slightly less than that which can be thoroughly heated and dried.
2. Pugmill. The pugmill should be operated at nominal capacity. Both overloading and underloading can significantly decrease production efficiency. The dry-mix time should be minimal, usually no more than 1 to 2 seconds. The wet-mix time should be no longer than that required to properly coat the aggregate, usually around 27 seconds. The length of time needed to open the pugmill gates and discharge can be 7 seconds in some cases. Therefore, the total mix/ discharge cycle, regardless of pugmill size, can be as short as 35 seconds. If trucks or a storage silo are readily available, the plant should not be idled; however, if the material cannot be readily discharged, pugmill operation should be halted.
3. Monitoring Temperatures. Once production and a uniform discharge temperature at the aggregate dryer are established, a temperature check of the aggregate in each hot bin should be performed. This check will provide evidence of incomplete drying. If incomplete drying is occurring, the coarse aggregate in the hot bins will be significantly cooler than the fine material in hot bin #1, due to the cooling effect of evaporation. Furthermore, it is not good practice to have the temperature of the #1 fine aggregate 40°F or more above the mixing temperature. If the temperature of the aggregate is maintained too high, the aggregate will absorb the asphalt and there will be an increased hardening of the binder. Check

temperature regularly during production and calibrate pyrometers and thermometers on an as needed basis.

401.2.9-Continuous-Mix Plant The operation and material flow of the older style continuous-mix plants are briefly discussed in Section 401.2.4.3. The design and operation of the continuous-mix plant is similar to the batch-mix plant up to the point where the hot, dry aggregate is discharged from the hot bins. At this point and beyond, the continuous-mix plant significantly differs from the batch-mix plant. Primary differences include:

1. Aggregate and asphalt binder materials are proportioned by volume rather than weight;
2. Aggregate and asphalt binder feeds are interlocked to mix and discharge the HMA continuously rather than in a batch process;
3. Production rate is independent of mixing time and is a function of the number of revolutions of a single shaft in the pugmill, not the number and quantity of batches; and
4. Variations in material proportions are very small once established, but changing from one type of HMA to another is difficult and time consuming.

401.2.9.1-Cold-Feed System Section 401.2.5 discusses the cold-feed systems typically used in HMA plants. The cold-feed systems used in continuous-mix plants are similar to those used in batch-mix plants with one exception: a constant-speed feeder belt system is generally used under the cold-feed bins. The total flow and initial proportions of the cold, wet aggregate material are initially established at the cold feed by adjusting the openings of the cold bins' discharge-control gates. The combined material is deposited on a gathering conveyor, which is then transferred to a charging conveyor for delivery to the aggregate dryer. If a RAP mix is being produced, the RAP material is usually transferred from a separate cold-feed bin to the pugmill by a charging conveyor.

401.2.9.2-Aggregate Dryer/Burner System From the cold-feed system, the cold, wet aggregate is transferred by the charging conveyor to the upper end of the aggregate dryer. Inside the aggregate dryer, the moisture in the combined aggregate is removed as the material is heated from ambient temperature to the desired mixing temperature. The hot, dry aggregate then exits the dryer and is carried up by an inclined hot elevator (e.g., bucket elevator) to the screening unit. If a RAP mix is being produced, RAP material should never be introduced into the aggregate dryer where it would be exposed to the direct flame of the burner. See Section 401.2.8.1 for additional information on aggregate dryer/burner systems.

401.2.9.3-Screening Unit From the aggregate dryer, the hot elevator transfers the hot, dry aggregate to the screening unit. The screening unit separates the combined material into the various aggregate sizes required by the Job Mix Formula and deposits each size into their respective hot bins. See Section 401.2.8.2 for additional information on screening units.

401.2.9.4-Hot Bins Section 401.2.8.3 presents a discussion on the hot bins that are typically used in batch-mix plants. Although similar, the hot bins generally found in continuous-mix plants are smaller and are used only to temporarily queue the hot, dry and graded aggregate in a continuous operation. Up to the discharge point of the hot bins, the functions of the continuous-mix plant and the batch-mix plant are essentially the same.

401.2.9.5-Pugmill Mixer/Holding Hopper Hot, dry aggregate material is continuously removed from the hot bins for transport to the pugmill mixer based on the proportions required by the Job Mix Formula. See Section 401.2.8.5 for additional information on pugmill mixers. Consider the following guidelines:

1. New Aggregate Feed. In continuous-mix plants, the discharge-control gates on the hot bins must be adjusted and locked in place to provide a continuous and uniform flow of proportioned material from each hot bin to the pugmill mixer. The final proportion of aggregate material, including mineral filler, is set based on the requirements of the Job Mix Formula.
2. Asphalt Binder Feed. The asphalt binder is delivered to the pugmill through a calibrated metering pump. The aggregate feed and the asphalt binder pump are interlocked, geared, and wired to a common power source so that proportions of aggregate and asphalt binder remain constant, regardless of variations in power supply. Asphalt binder is continuously pumped from its storage tank to the pugmill and sprayed on the aggregate based on the feed rate of the proportioned aggregate material coming from the hot bins. The asphalt binder, measured by volume instead of weight, is mixed continuously with the aggregate as the two materials are moved toward the discharge end of the pugmill by the mixing paddles.
3. Holding Hopper. Because the mixing is a continuous process, a small-capacity, temporary holding hopper is provided at the discharge end of the pugmill to queue the material until it can be discharged into a haul truck.
4. RAP Feed. If a RAP mix is being produced, the RAP material is usually transferred from a separate cold feed to the pugmill by a charging conveyor. The RAP material is added proportionally, by volume, to the new superheated aggregate. Heat transfer to the RAP occurs as it is mixed with the superheated materials and moved toward the discharge end of the pugmill.

401.2.9.6-Production Considerations It is good practice to obtain a copy of the manufacturer's operating instructions for continuous-mix plants. These instructions will show the operating speed of the hot aggregate feed in relation to the asphalt binder delivery rate for various sprocket sizes. Consider the following guidelines:

1. Aggregate Flow Calibration. Before production begins, carefully calibrate the flow of aggregate from each hot bin. Weigh the quantity discharged at various gate openings and compute the quantity delivered per revolution of the feeder drive shaft. A plotted curve is a convenient way to graphically illustrate the relationship between the quantity delivered and the size of the gate openings.
2. Asphalt Binder Flow Calibration. The sprocket size setting on the asphalt binder pump must correspond to the binder delivery rate required. Check that the sprocket is set correctly. As needed, check the delivery rate by weighing the quantity of binder delivered into a container over a carefully timed interval. Volume-temperature

corrections will apply (see Section 401.2.6.3). To control fluctuations in percent binder, a thermometer will usually be installed in the circulating line just ahead of the pump. Because binder temperature must be tightly controlled, check the operation of this thermometer regularly.

3. Mixing Time Adjustments. In the pugmill of continuous-mix plants, materials are fed into one end and the paddles move the HMA to the discharge end while mixing occurs. Mixing time can be increased or decreased either by changing the pitch of the paddles or by changing the height of the discharge gate. To increase mixing time, it is good practice to first reverse the pitch of the paddles so that the mix is approximately level from the discharge gate to the middle of the pugmill, leaving a gradual slope to the feed end. The mixing time can then be fine-tuned by raising the height of the discharge gate and increasing the level of the mix. Do not allow the mix level to exceed the top of the arc described by the paddles, measured as the paddles are at rest. If the required mixing time cannot be established without exceeding this limit, the plant must be reset to a lower rate of production.
4. Mixing Time Calculations. The following equation may be used to calculate the mixing time for continuous-mix plants:

   $T = C/R$

   Where:

   T = mixing time, sec;
   C = pugmill dead capacity, lb.; and
   R = pugmill discharge rate, lb./sec.

   The pugmill dead capacity (C) may be determined by stopping the pugmill and removing and weighing the entire contents. Some material will adhere to the inside components of the pugmill. A practical method to estimate the weight of this remaining material is to scrape a sample from a given area that is readily accessible, weigh the sample, and estimate the contents assuming the remaining material adheres to other areas at the same rate.

   Alternatively, mixing time can be determined from other data including data obtained from the plate affixed to the pugmill or from the manufacturer's literature. In such cases, use the following equation to calculate mixing time:

   $T = CVD/R$

   Where:

   T = mixing time, sec;
   C = conversion constant, 1.80;
   V = pugmill volume, ft^3;
   D = density of pugmill contents, 100 lb./ft^3; and
   R = rate of plant production, ton/hr.

Unless otherwise directed, the minimum mixing time (T) should be approximately 45 seconds. If an examination under a strong light of the coarser particles discharged shows that at least 95% of the particles are completely coated with binder, the minimum mixing time is sufficient. Otherwise, the mixing time must be increased to literally provide a complete coating of the particles. If small uncoated areas or specks are visible on the aggregate particle, that particle must be classified as uncoated.

<u>401.2.10-Emission-Control Systems</u> All HMA plants have a small quantity of fine material that is ejected with the exhaust stream of the dryer-drum mixer or aggregate dryer. To meet Federal and State air-quality requirements, emission-control systems are required on HMA plants to capture fine particulate matter, which otherwise may be released into the atmosphere. In addition, rather than wasting collected fines, most plants return the material back to the mix, thus preserve the integrity of the original aggregate gradation.

<u>401.2.10.1-Purpose and Classification</u> Emission-control systems serve two purposes: they reduce the amount of emissions to the atmosphere, and they return the collected material back to the mix. Emission-control systems may be classified as either primary or secondary. The purpose of the primary collector is to remove the largest of the finer particles from the plant's exhaust stream, thus reducing the load on the secondary system. The secondary collection system is used to capture the finest of particles.

<u>401.2.10.2-Types of Systems</u> There are three basic types of emission-control systems found in HMA plants: dry collectors, wet collectors, and baghouses. The dry collector is a primary collector, which will be located before one of the other two types of systems. The baghouse and wet collector are secondary systems, through which the exhaust gas flows once cleaned by the primary system. Most plants use a dry-collection system as its primary system and a baghouse as its secondary system. The fines collected are either wasted or, desirably, fed uniformly back to the mix. If a wet collector is used in lieu of a baghouse, the fines collected should not be returned to the mix.

<u>401.2.10.3-Production Considerations</u> HMA plants in West Virginia are required to have a baghouse as the secondary system. See Section 401.2.1 for additional information on plant certification and emission-control systems. Consider the following guidelines during inspection of emission-control systems:

1. <u>Dust Trail</u>. Check the plant's stack exhaust for a dust trail at the end of the steam plume. If one exists, check the operation of the emission-control system.
2. <u>Pressure Drop</u>. The pressure drop across the bags in baghouse operations should be in the range of 2 in. to 6 in. of water column.
3. <u>Exhaust Temperature</u>. The temperature of the exhaust gas entering the baghouse should not exceed 400°F; otherwise, the plant's automatic shutoff should stop production. Higher temperatures are a good indication of an inefficient veil of aggregate inside the dryer-drum mixer or aggregate dryer.

4. Wet Collector. If a wet collect is used, periodically check the spray nozzles in the venturi to ensure that all are open and spraying water. Additionally, check the cleanliness of the water being returned to the spray nozzles from the pond at the point where the water is drawn by the pump. This is the point where clogging occurs. If a wet collector is used, the fines collected should not be returned to the mix.
5. Gradation. During production, the design and actual mix gradation should be compared, whether or not collected fines are returned to the mix. Either case significantly affects gradation.

401.2.11-Surge and Storage Silos At the discharge end of many HMA plants, the final mix is transported to a specially designed bin called a silo. Silos come in a variety of shapes including circular, oval, elliptical, rectangular, and square. The circular shape is commonly used because it tends to introduce less mix segregation. Depending on the type of plant, the silo may be either a surge or storage silo.

401.2.11.1-Surge Silos The primary purpose of the surge silo is to turn a continuous-mix operation (e.g., dryer-drum plant) into a batch process and to temporarily hold batch surges from batch-mix plants when haul trucks are not available. Surge silos are designed to hold HMA for relatively short periods (e.g., 2 to 3 hours) and, thus, are smaller in capacity and generally insulated but not heated. This makes the surge silo unsuitable for use as a storage silo. The proper use of surge silos increases productivity by minimizing stop- and-go operations, which also minimizes plant emissions and variability in mix composition and temperature.

401.2.11.2-Storage Silos The primary purpose of the storage silo is to hold the HMA for periods longer than a surge silo (e.g., overnight). Storage silos have relatively larger capacities and are both insulated and heated, either partially or completely. The discharge gates are heated and sealed to reduce the amount of air infiltration, and inert gases and additives (e.g., silicone) are usually added to retard hardening of the mix. A storage silo can also be used as a surge silo.

401.2.11.3-Conveyor Systems A variety of systems are used to transport the mix from the plant's discharge to the silo. These systems include belt conveyors, bucket elevators, skip hoists, screw conveyors, and slat conveyors. Slat conveyor systems are commonly used. Their primary purpose is to convey and charge the silo without introducing mix segregation or causing an appreciable drop in mix temperature. On some systems, the speed of the conveyor can be adjusted to better match the plant's rate of production.

401.2.11.4-Charging Operations Mix segregation will occur if the mix is continually dropped in a conical pile or thrown to one side of the silo. To minimize segregation, the top of surge and storage silos are equipped with baffles, splitters, rotating chutes, or batchers to disrupt the continuous flow of mix into the silo. The most effective and commonly used system is the batcher, which is a holding hopper that momentarily holds the mix coming from the conveyor. The conveyor system must be set to deposit the mix in the center of the batcher. When dumped from the batcher, the mix falls in a mass and uniformly splats in all directions, thus minimizing segregation. For the batcher system to function properly, the silo cannot be completely full and the batcher's gate timer must be properly controlled. If the batcher gate is improperly timed or left open, the mix will continuously flow, defeating the purpose of the batcher. To help monitor mix level, some silos are equipped with a high-level warning indicator.

401.2.11.5-Discharge Operations The bottom of silos generally have a conical shape, which are generally heated in storage silos. The steep angle of the cone walls and a large gate opening at the bottom ensures that larger aggregates do not roll into the center of the cone when discharged and, thus, cause mix segregation. Even with this design, segregation may occur if the level of mix drops below the top of the cone. To help monitor this situation, silos may be equipped with a low-level warning indicator. Additionally, silos may have a discharge batcher to load trucks in the same manner the silo is charged, which further reduces the potential for mix segregation.

401.2.11.6-Production Considerations Segregation caused by improper silo operation is common and most evident behind the paver, appearing as a dark strip along one side of the lane being paved. Gap-graded mixes and mixes that have a significant proportion of coarse aggregate material are especially susceptible to this phenomena. If this type of segregation is suspected, consider having several haul trucks pull under the silo in a direction opposite their normal loading pattern. If the segregation behind the paver changes from one side to the other, the problem is most likely created at the silo.

Over prolonged storage periods, an HMA mix tends to harden due to oxidation. Although storage silos are designed to minimize premature hardening (e.g., heated cones and batchers, insulated walls, inert gases), it is good practice to check mix temperature and quality if a problem is suspected. The mix should be free of segregation and mix temperature and quality must not degrade below the limits required by the contract specifications. With demonstrated positive results and previous approval from the District Materials Supervisor, HMA mixes may be stored in either surge or storage silos for up to a maximum of 12 hours, and up to 24 hours for some dense-graded mixes. Beyond these limits, consider the need to check mix temperature for acceptance and to visually inspect the mix for hardening or stripping of the binder. Any needed mix samples should be taken from haul trucks immediately after loading.

401.2.12-Truck Loading and Hauling The following sections present guidelines on truck loading and hauling that should be considered during HMA production.

401.2.12.1-Haul Trucks Haul trucks that are used on the project should be inspected prior to beginning plant production. In general, they must be adequately maintained and capable of effectively hauling and loading the completed mix to the paver at the laydown site. The primary objective is to not have the truck fleet become the critical path during the paving operation. There are too many other factors that are critical to production. To adequately document the quantity of mix delivered in the Daily Work Report, ensure that each haul truck is assigned a number, or some other means of identification, before the operation begins. In addition, a small hole shall be provided in the side of all haul trucks to obtain mix temperatures.

401.2.12.2-Release Agents Before loading, the truck bed should be free of all debris and lightly, but uniformly, coated with a soapy water or a mixture with not more than ten percent lubricating oil. The use of diesel fuel, kerosene, or similar solvent-based products, which can dissolve the binder film from the aggregate, are prohibited. A commercial release agent which is certified as harmless to the mix may be used. After treatment, make sure the truck bed is raised to remove any excess release agent before the truck is loaded. All release agents collected from this operation shall be properly disposed of in its entirety. Note that if a polymer modified performance-graded binder is used in the mix, it is best to use a release agent that is recommended by the binder supplier. The Project Inspector can restrict any release agents shown to cause problems during placement of the mix.

401.2.12.3-Covers and Insulation All truck beds shall be insulated and provided with a waterproof cover. The cover shall be suspended slightly above the HMA mixture, extend over the sides of the truck, and be securely fastened to eliminate air infiltration and to prevent water from coming into contact with the mixture. Heat loss of the mixture due to the cooling effects of wind and rain on the top of the load and heat loss through the sides of the truck shall thereby be minimized.

401.2.12.4-Truck Scales All plants must be equipped with truck scales or a hanging weigh hopper under the silo to accurately weigh the quantity of material being delivered. Scales and test weights must be certified by the West Virginia Division of Labor or similar agency if outside West Virginia. Note that truck scales are not required at properly certified automatic batch-mix plants that monitor and print mix quantities delivered. Obtain and attach any digital printouts to Daily Work Report. The printout should include project number, item number, truck identification, number of axles, gross, tare, and net weights as well as the time and date of loading and the signature of the scale operator. The plant/Contactor should notify the Project Engineer/Supervisor of any scale malfunctions and recalibrate when material is being supplied to project.

401.2.12.5-Loading Haul trucks should never be loaded by slowly driving the truck forward as the mix is being delivered from the silo. This will cause coarser aggregate particles to collect at the tailgate of the truck and significantly increase the amount of segregation that occurs at the laydown site. To minimize segregation, each haul truck should be loaded in multiple drops from the silo. The first drop should be placed toward the front of the truck. After the truck moves forward, the second drop should be placed near the tailgate. The last drop should be placed between the first two drops, and so forth. This will minimize segregation of the coarser aggregate materials. The operator should never be allowed to dribble small amounts of mix into the bed for the purpose of topping off the load to legal capacity.

401.2.13-Inspection Guidelines Section 401.1 discusses HMA material requirements, Quality Control Plan, certified technicians, reference materials, and Job Mix Formulas. The following sections present general guidelines that should be considered during HMA production and hauling inspection. Contractor should submit weekly schedule showing where they are paving and coordinate with project personnel prior to paving operation, so that they can inform the District Materials and to allocate personnel needs.

401.2.13.1-Plant and Production Inspection Consider the following guidelines during plant and production inspection:

1. Quality Control. Before production, check the Contractor's Quality Control Plan for compliance with the contract specifications, and make sure the Contractor has provided the requisite number and type of certified technicians (see Section 401.1.4). Make sure you understand both Contractor and Division responsibilities with respect to quality control and acceptance procedures. During production, check that the technicians are sampling and testing in conformance with the Quality Control Plan. Make sure the Contractor submits Form HL 441 and other required test data and reports in a proper and timely manner. See Section 701.4.4 for additional information on Form HL 441.
2. Certification. Check that the plant has been properly certified (see Section 401.2.1). Visually inspect the plant for compliance and any obvious violations. Deficiencies must be corrected before production begins.
3. Laboratory. Check the plant laboratory for compliance with the contract specifications and ensure all testing equipment is on hand and in good condition (see Section 401.2.2).
4. Scales and Weights. Check plant scales and test weights for proper certification (see Section 401.2.1). As needed, check scales for accuracy; zero balance, and sensitivity. During production, make sure that scales are checked at the required frequency and that validation reports are submitted in the proper manner.
5. Operations. Periodically inspect plant operations. Check aggregate stockpiles and the cold-feed system for unacceptable intermingling of aggregate materials. Occasionally watch for evidence of improper plant emissions and incomplete combustion of burner fuel (e.g., blue or black smoke coming from plant exhaust, oily coating of heated aggregate particles, incomplete binder coating on aggregates). Visually inspect screens, hot bins, overflow pipes, and other plant components for proper operation. Check for low levels of aggregate material in hot bins. Excessive carryover of fines into other bins due to worn or blinding of screens is unacceptable. Check bin gate openings periodically because vibrations may cause gates to loosen. Check for insufficient binder supply due to clogged strainers, partially closed valves, or line leaks.
6. Extremely Hot Mixes. Extremely high temperatures usually occur at the start of operations and should be carefully monitored. Extremely hot mixes can be spotted by blue smoke coming from the mix. If the temperature is too high, production must be immediately adjusted, and the overheated mix must be discarded. High

temperatures cause premature hardening of the asphalt binder, which results in a less durable pavement.

7. Extremely Cold Mixes. Extremely cold temperatures should also be monitored at the start of operations. Cold mixes can be detected by a rather grayish color in the mix. This is caused by the larger aggregate particles not being completely coated with asphalt binder. If the condition is serious, the cold aggregate must be removed from the hot bins and operations adjusted accordingly.
8. Proportioning and Mixing. Before production begins, check that the Contractor has supplied the plant operator with the appropriate Job Mix Formula for the project (see Section 401.1.5). During production, make sure the plant operator establishes aggregate and asphalt material proportioning, moisture content, and mix temperature in accordance with the requirements of the Job Mix Formula. As needed, have material proportions, moisture content, and aggregate and binder temperatures checked for compliance. Visually inspect the discharged mix for evidence of non-uniformity and incomplete mixing. Occasionally check the mixing unit to determine if aggregate and asphalt binder materials are being properly mixed. Complete coating of aggregate materials is required. Periodically check and record the discharge temperature of the mix.
9. Surge and Storage Silos. Check surge and storage silos to ensure that the requirements of the contract specifications are not being exceeded.

401.2.13.2-Loading and Hauling Inspection Consider the following guidelines during loading and hauling inspection:

1. Scale Certification. Check that the truck scale has been certified by the West Virginia Division of Labor. The seal of current approval should be affixed to the scale (see Section 401.2.1).
2. Truck Weighing. Frequently check the truck weighing process to ensure that it is in compliance with the requirements of the contract specifications. Pay particular attention to weighing platform. It should be clean and free to move with no binding.
3. Batch-Mix Plants. In batch-mix plant operations, the theoretical weight of batches should be periodically compared to the weight of the material in the truck as determined by the scale. Multiply the theoretical batch weight by the number of batches deposited into the truck and compare it to the weight of material determined by the truck scale. If there is a discrepancy greater than 2%, investigate to determine the cause of the discrepancy.
4. Release Agents, Tarps, and Insulation. Inspect truck beds for the proper use of release agents, tarps, and insulation. Ensure that truck beds are insulated and clean, with no foreign substances or dried chunks of mix present. Ensure that tarps are present and in good condition.
5. Truck Loading. Visually inspect haul trucks and truck beds for compliance during loading. Develop a mental picture of the appearance of the proper mix when loaded in the truck. A load of mix that peaks more than usual is an indication of a lean mix (i.e., too much fines and/or insufficient asphalt binder). A load that flattens in the truck bed indicates a fat mix (i.e., too much asphalt binder, too much coarse

aggregate, and/or insufficient fines). Occasionally check with the Project Inspector at the laydown site concerning the workability and uniformity of the mix being delivered.

401.3-HMA LAYDOWN AND COMPACTION

Although construction may take several months, public opinion of the Division is ultimately based on the final quality of the pavement and the effectiveness of maintaining traffic during construction. Unsafe or inefficient traffic operations during construction and bumps, choppy waves, long swells, and the early appearance of cracks, potholes, and raveling joints are highly criticized. As taxpayers, the public expects a quality product. The Project Inspector at the laydown site must be proactive in enforcing the contract specifications to ensure the provision of safe and efficient traffic operations and a smooth riding surface that will not require premature maintenance.

The principal duty of the Project Inspector at the laydown site is ensure that the pavement is constructed to the line, grade, and cross section required by the Contract Plans and to the density, riding surface, and texture required by the contract specifications. To achieve this objective. the Project Inspector must continually monitor surface preparation, mix delivery, paving operations, compaction operations, and the finished surface for compliance.

401.3.1-Pre-Paving Considerations Before paving operations begin, become thoroughly familiar with the Contract Plans and Specifications including the requirements of the Quality Control Plan (see Section 401.1.4), Job Mix Formula (see Section 401.1.5), and Maintenance of Traffic Plan (see Section 401.1.7). Check that the proper certified technicians, traffic control, and paving and compaction equipment are in place and in conformance before construction begins. Inspect the paving surface for correct grade and cross section and that the surface has been adequately prepared. To ensure paving continuity, check that pavement edges are marked at the correct width and grade by taut stringline or electronic paver guide.

401.3.2-Weather Considerations Weather plays an important role in determining whether or not the Contractor should begin or continue with HMA paving, tacking, or priming operations. Consider the following guidelines:

1. Wet Weather. The laydown surface must be dry (i.e., no standing water) and the weather conditions must permit the proper handling, finishing, and compaction of the mix. If rain is imminent or the surface is wet – don’t pave. As soon as practical, direct the plant to halt production until further advised. Only the mix in route to the site should be spread, and then the operation should be properly halted. The HMA placed during wet conditions is to be evaluated prior to finalization of the project for performance as intended with possible price reductions if not satisfactory. Paving should not be started again until standing water is no longer on the surface. When downpours occur, the paver should be stopped, the receiving hopper covered, and the crew advised to wait until there is no standing water on the surface.

2. Cold Weather. Unless otherwise directed, do not permit the Contractor to place surface courses when the ambient temperature falls below 40°F. Cold weather provisions of the Contract will apply when the ambient temperature falls below 50°F or the paving surface temperature falls below 60°F. The temperature requirements as listed in Table 401.8 of specifications will apply. During cold weather paving, measure the paving surface temperature at least once an hour and in all shaded areas, monitor mix temperature for each truckload delivered, and measure mat temperature at final density to ensure conformance to the contract specifications. If the provisions of cold weather paving are exceeded, ensure that the Contractor coordinates with the plant to deliver a mix with an acceptable temperature. Mix temperatures will be recorded on the mix delivery ticket and the Daily Work Report.

401.3.3-Laydown and Compaction Equipment Project Inspectors must never operate or adjust Contractor equipment. However, it is good practice to understand the operation of equipment to ensure it is being properly adjusted and operated. The Project Inspector should make a visual inspection of the Contractor's equipment, checking the condition and adjustment of the component parts. Ensure that obvious deficiencies are corrected before the operation begins. Doing so will avoid delays and ensure that a quality surface can be obtained. The following sections present guidelines that should be considered.

401.3.3.1-Paving Machines One of the most important pieces of equipment is the paver. The paver must be capable of spreading and finishing the mat to the required cross section and profile. The self-propelled paver must be equipped with a heated strike-off assembly or activated screed and either mechanical or automatic grade and slope controls. Automatic controls are necessary only if specified in the Contract. If automatic controls fail, allow the Contractor to complete the day's work via manual control; afterward, the controls must be fixed. Check grade and slope controls periodically for proper working order. Consider the following additional points of inspection:

1. Paver motor has governor that operates smoothly without missing;
2. Track linkage on track-laying machines is properly adjusted and tracks and pins are not excessively worn;
3. Pneumatic tires, if present, are inflated to correct pressure and chain drives are properly adjusted and not excessively worn;
4. Tamper bars are adjusted to correct RPM, proper clearance from screed, proper length of stroke and are not excessively worn;
5. Screed vibrator, if provided, is operating properly;
6. Strike-off plate is set at proper height above screed;
7. Screed plates are not excessively worn and are adjusted for proper crown and tilt;
8. Screed heater is operating properly;
9. Screed extensions, if used, are in a true plane and flush with screed bottom;
10. Safety edge device, if required, is attached to paver;
11. There are no gaps between screed plates; and
12. Thickness controls are operating properly.

The Project Inspector must know the surface defects that can be caused by improper adjustment or operation of the paver (see Section 401.4). Poor results must not be accepted. If adjusted and operated properly, little hand work will be required. Hand methods and special equipment may be used for small or irregular areas, if previously approved. However, it is poor practice to scatter loose material to improve mat texture due to paver problems. Proper paver speed will result in a quality mat with uniform texture and density across the full width, provided the mix other conditions are satisfactory. Paver speed must be in balance with mix delivery and sufficiently slow to avoid tearing the mat. If tearing occurs, repairs must be made, and the paver speed adjusted.

401.3.3.2-Compaction Equipment Depending on the sequence of operation in the Contractor's Laydown and Compaction Plan, the compaction equipment used on the project will include steel-wheel rollers, pneumatic-tire rollers, vibratory rollers, or some combination of the three. However, established, the rolling operation must not result in excessive crushing of the aggregate.

Pneumatic-tire rollers are equipped with smooth tires of equal size and ply. Tire pressures and loading of the roller can be varied to achieve the desired ground contact pressure. There are three basic types of steel-wheel rollers: three-wheel rollers, two-axle tandem rollers, and three-axle tandem rollers. Three-wheel rollers are primarily used to initially break down each course laid. The two- and three-axle tandem rollers are primarily used for compaction and finishing. Vibratory rollers can be used as either a breakdown or finishing roller. In inaccessible areas, hand-held rollers and vibrating plates are generally used. Consider the following points of inspection:

1. Wheels are capable of rolling in a true plane and are free from flat spots or ridges;
2. Steering and driving mechanism is free of excessive play or backlash;
3. Motor and transmission free from leaks;
4. Roller's water tank, wetting mats, and spray bars are properly operating;
5. Pneumatic tires are properly inflated and in good condition without wobble or creep;
6. Vibration and propulsion controls of vibratory roller are set and operating properly, and;
7. Total weight, weight per inch of width, average ground contact pressure, and/or vibrations per minute and amplitude set and properly documented.

The compaction density obtained by pneumatic- tire and steel-wheel rollers is related to the weight, speed, and the number of roller passes. The density obtained by a vibratory roller is primarily related to the frequency (i.e., number of vibrations or downward impacts per minute, VPM) and the amplitude (i.e., the greatest amount of movement in one direction from a position at rest). As the vibratory roller travels, the vibrating drum produces rapid impacts on the surface of the mat. These impacts produce pressure waves of equal frequency that pass through the mix. The pressure waves cause the particles to move closer together, thus densifying the mix.

401.3.3.3-Miscellaneous Tools It is good practice before the paving day begins to visually check to see that the Contractor has available an adequate supply of rakes, lutes, shovels, brooms, and other required miscellaneous tools.

401.3.4-Surface Preparation When called for in the plans, before HMA is placed over an existing surface (e.g., subgrade soil, aggregate base, asphalt stabilized material, PCC), the surface must be shaped to the correct grade and cross section and be properly prepared. The following sections discuss typical surface preparation operations.

401.3.4.1-Sealing Cracks in an asphalt surface to be resurfaced should be sealed as specified, either individually or with an appropriate surface sealing treatment. In addition, poorly sealed joints in existing PCC pavements should be routed and sealed, and any rocking slabs should be stabilized before the paving operation begins.

401.3.4.2-Patching and Leveling Depending on the condition of the underlying surface, rough and uneven asphalt surfaces are typically leveled by either placing a patching and leveling course or by milling high spots on the existing surface. The purpose of the patching and leveling course is to repair potholes, correct surface irregularities (e.g., short dips), shape the cross section, and raise the existing outside edge to provide a uniform template. If designated, the application of tack coat as discussed in Section 401.3.4.5 is applied before the patching and leveling course is laid. Either three-wheel or pneumatic-tire rollers may be used for compaction.

Aggregate materials for patching and leveling courses are typically a Base II or 19mm mix. If patching and leveling is not specified in the Contract, ensure that the Contractor corrects surface irregularities with the wearing or base mix material. Where extensive base failures are encountered and no Contract provisions are made for repairs, notify the Project Engineer/Supervisor. It may be necessary to modify the Contract to correct the problem.

401.3.4.3-Scratch Course Prior to paving, all depressions and potholes must be repaired to provide a firm and unyielding paving base. The purpose of the scratch course is to fill in deep ruts and other depressions in the caused by traffic on the existing surface. If specified, the limits of scratch course will be designated on the Contract Plans, and a tack coat must first be applied. Either three-wheel or pneumatic-tire rollers may be used for compaction.

401.3.4.4-Cleaning and Sweeping Once the underlying surface is repaired, the paving surface must be cleaned of all dust, dirt, and caked or loose debris. This is usually accomplished using multiple passes of a mechanical broom and/or flushing with air or water. The limits of cleaning and sweeping are generally beyond the width of paving and will be specified in the Contract.

401.3.4.5-Tack Coat Before an existing asphalt or PCC pavement surface is overlaid, a tack coat is generally specified to seal the contact surfaces. Where designated, the tack coat must be applied in conformance with Section 408 of the Specifications. See Section 408 of this Manual for additional information on tack coats.

401.3.5-HMA Mix Properties The construction of an HMA pavement begins with the delivery to the laydown site of a workable mix that is proportioned and heated in conformance with the Job Mix Formula (see Section 401.1.5) and the contract specifications.

401.3.5.1-Material Proportioning Considerations The pavement will not perform as intended if the material proportions in the mix exceed the limits specified for the type of HMA being produced. For example, if the quantity of asphalt binder is too low, the pavement will become brittle and crack under traffic loading. Brittleness also may occur if the binder material itself is too hard as a result of overheating the mix. Excessive binder material will cause the pavement to move under traffic and push up in waves or cause the binder itself to come to the surface, which causes a hazardous, slippery traffic condition during wet weather. During the project, it is good practice to visually check the mix for any signs of unacceptability. If a problem is suspected, corrective action should be taken immediately.

401.3.5.2-Temperature Considerations When operations are first begun, production operations should be adjusted in accordance with the procedures established in the contract specifications. The temperature of the mix upon delivery must be within tolerance of the limits specified in the Job Mix Formula and the master range of the contract specifications. Otherwise, the mix should be rejected. If cold weather operations are imminent, the mix temperature should be increased, but not beyond the threshold of the master temperature range. The mix temperature will be monitored at both the plant and at the laydown site. To obtain mix temperature upon delivery, a dial-type thermometer can be inserted through the access hole in the gate of the truck. When operating under cold weather paving provisions, the mix temperature of each truckload should be recorded, checked for compliance, and documented on the mix delivery ticket and the Daily Work Report.

401.3.5.3-Mix Inspection Guidelines When haul trucks first arrive at the laydown site, it is good practice to visually inspect the mix for acceptability. It is better to reject a bad mix than it is to reject a bad pavement. Usually, the Project Inspector at the plant will reject the mix before it has a chance to be hauled; however, the Project Inspector at the laydown site must be able to spot a bad mix before it is laid and compacted. There are several deficiencies that may warrant rejection of the mix. Consider the following guidelines:

1. Mix Temperature. Reject the mix if its temperature is not within tolerance of the Job Mix Formula or the governing contract specifications. A mix that is too cold generally will appear stiff or have an improper coating of the larger aggregate particles. A mix that is too hot will have blue smoke rising from the truck or spreader hopper. Temperature deficiencies are common and should be closely monitored and properly documented in the Daily Work Report.
2. Asphalt Content. A mix that has too much or not enough asphalt binder must be rejected. If there is too much binder, the mix generally will not peak but flatten in the truck bed and appears slick under the screed. If there is too little binder, the mix will appear lean and granular and lack a shiny black luster. The aggregate also may not be completely coated.

3. Aggregate Proportions. Reject the mix if aggregate proportioning fails to meet specified requirements. A mix that has too much coarse aggregate generally will have a coarse appearance and will exhibit poor workability. A mix that has too much fine material will usually have a lean, brown, or dull appearance and will be very stiff and difficult to work.
4. Moisture Content. Too much moisture in the mix is grounds for rejection. A mix with too much moisture will have steam rising from the material when dumped into the hopper and may be bubbling and popping.
5. Contamination. When delivered, check the mix for contamination, which may include gasoline, kerosene, oil, rags, dirt, or trash that has inadvertently gotten into the mix. Minor contamination may be removed; serious contamination warrants rejection of the load.
6. Segregation. Segregation of the aggregates occurs because of improper handling (see Section 401.4.2). Serious segregation is grounds for rejection.
7. Non-Uniform Mixing. Non-uniform mixing produces a mix that has spots of lean, brown, or dull appearing material that is intermixed with material that has a rich and shiny appearance. This type of mix should be rejected.

A fast means of communication between the Project Inspectors at the plant and the laydown site is essential to placing a workable and uniform mix on the road and keeping load rejection to the minimum. The spread should be checked frequently to ensure that the proper mix is incorporated into the pavement.

401.3.6-Mix Placement

401.3.6.1-Paver Operations Once production and hauling have been established, the Contractor will begin placing the mix. It is good practice for the Project Inspector at the paving site to observe the operation of the paver for any obvious substandard or improper operation. Consider the following guidelines:

1. Edge of Pavement. The exact edge of pavement, except on PCC overlay projects, will be established by a string or chalk line for a distance of not less than 500 ft ahead of the paving operation.
2. Screed Temperature. The screed should be heated to the proper temperature before the paving operation begin.
3. Thickness, Grade, and Slope Controls. Thickness, grade and slope controls should be set and checked for proper operation. This is especially important when paving first begins, because the controls must be set to properly construct a transverse joint.
4. Truck Tarps. To prevent unnecessary heat loss, the tarp over the truck bed should remain in place until just before the truck is emptied.
5. Transfer Operation. Haul trucks should not bump or transfer weight to the paver. Otherwise, the paver may be thrown offline, or the screed may be pushed into the mat. Each truck should stop short of the paver and allow the paver to pick up the truck instead of the truck backing up and possibly bumping the paver.

6. Dumping Procedure. The truck bed should be raised just enough to break the load before opening the tailgate, thus allowing the mix to flow as a mass into the hopper. This will minimize mix segregation.
7. Hopper Level. The mix level in the hopper should not drop below the bottom of the flow gates. The hopper should not be emptied to the point where slat conveyors are visible, and the hopper should not be so full that mix runs out the front.
8. Clinging Mix. Mix that clings to the sides and corners of the hopper should be continually loosened and pushed into a relatively full hopper when the mix consists of finer aggregate and the mix and ambient temperatures are high. When the mix contains coarser aggregates and the mix and ambient temperatures are low, the clinging mix should be allowed to accumulate and periodically removed in a proper manner. When the mix accumulates on the sides of the hopper, it cools rapidly and, if permitted to reach the grade, will result in a nonuniform surface texture. Wings on the paver can be folded, as needed, to prevent cold mix from accumulating in the corners.
9. Paver Movement. Paver starting and stopping operations should be minimized and be smooth without jerky movement. Once the hopper is charged, the paver should maintain constant speed in proportion to mix delivery. This keeps a constant head of material in front of the screed. During truck exchanges, the paver should maintain forward movement to minimize the occurrence of a “bump” at the point of exchange. If the mix pulls under the paver, suspend the operation until the cause can be determined and corrected.
10. Flow Control. Flow gates should be set at a height that permits the slat conveyor and auger to operate at close to 100% capacity. The key to a smooth surface is a constant head of mix in front of the screed, which depends on constant paver speed and continuous operation. The majority of mix in front of the screed should be located near the center of the auger shaft. If automatic flow-control devices are used, the flow- control device should be set at a location near the end plate. This will cause the auger to run continuously and maintain a constant head in front of the screed; otherwise, mix may be carried at the screed’s outside edge.

Soon after the first load of HMA has been spread, check the surface of the mat to ensure that a uniform texture is achieved and that the grade and cross section are in compliance with the Contract Plans. Ensure that the Contractor makes any needed repairs to the mat and adjustments to the paver (e.g., screed, tamping bars, vibrators, feeder screws, hopper feed).

401.3.6.2-Automatic Screed Controls If automatic screed controls are used on the paver for grade and slope adjustment, it is good practice for the Project Inspector at the paving site to become familiar with their proper use and observe the operation of the controls for any obvious substandard or improper operation. Consider the following guidelines:

1. Screed Adjustment. The paver operator should not adjust thickness controls for the purpose of changing the screed’s angle of attack, unless the mat thickness actually needs to be adjusted.

2. Grade Sensor. The grade sensor should be in constant working order. If the wand is raised through input from the stringline or mobile reference, there should be a corresponding movement of the actuator. If not, sensitivity adjustments may be needed. During paving, sensor indicators should properly indicate the signal being received.
3. Tow-Point Actuator. The movement of the tow-point actuator should be smooth, without a constant up and down movement.
4. Stringline. If a stringline is used as the grade reference, the line should be taut without sags between vertical supports, as visually verified by sighting down the line. The vertical supports must not interfere with the path of the wand. Once set, the integrity of the stringline should be protected.
5. Mobile Reference. If a mobile reference is used for grade control, its length should be sufficient to compensate for variations in surface elevation, and each shoe should be checked to ensure that it is clean and free to move. The sensor should be checked for proper operation.
6. Joint Matching Shoe. If a joint matching shoe is used for grade control, check the shoe for proper operation. It should be clean and free to move.
7. Combined Grade/Slope Control. If the paver has grade control on one side and slope control on the other, regularly check the cross slope for compliance. This is particularly important on very wide pavements.

401.3.7-Compaction Operations The number, type, and operation of rollers documented in the Contractor's Laydown and Compaction Plan must be sufficient to obtain the required density when the mix is in a workable condition. After a course has been spread and before the compaction operation is started, check the surface behind the paver for non- conformance and ensure that the Contractor makes the proper corrections. The following sections present guidelines on typical compaction operations that will obtain a uniform pavement density and a smooth riding surface.

401.3.7.1-Thickness and Temperature Considerations The time available for compaction is primarily related to the thickness of the course being placed with mix and ambient temperatures also being important factors. An increase in lift thickness can substantially increase the time available for the roller to densify the mix. Also, mix temperature greatly influences the compaction operations. Temperature affects mix stiffness and workability. If too high, the mix will move or shove under the roller. If too low, the mix will be difficult to compact. The proper mix temperature will allow sufficient time to achieve the required density before the mat cools too much for further rolling to be effective. An increase in laydown temperature can significantly increase the amount of time available for compaction. However, the feasibility of using this approach depends on the properties and tenderness of the mix at the selected temperature and compaction effort.

Mix and paving surface temperatures also are critical considerations, particularly in the spring and fall seasons. As needed, contact the District Materials Supervisor for information on mix temperature and optimum compaction time. The required density must be obtained prior to the mat temperature reaching 175°F, unless otherwise demonstrated by the

Contractor. Mat temperature is normally measured using a non-contact infrared thermometer.

401.3.7.2-Roller Pattern The optimum combination of rollers and roller patterns for a past project may not be the same optimum combination for a current project or even for a different type or layer of mix on the same project. Test sections are normally constructed to determine the most efficient and most effective combination of compaction equipment and roller patterns to use for each combination of job variables. It is not good practice to make more roller passes than are required to satisfy density requirements. For example, two similar rollers run side by side (i.e., in echelon) will typically produce a greater level of density in the mix, with the same number of roller passes, than will the same two rollers operated end to end as a breakdown and an intermediate roller.

After determining the number of passes required to obtain optimum density, the compaction operation can proceed using the same pattern and number of passes as was determined to be successful in the test section. Once a roller pattern has been established, it should not change unless the mix or the lift thickness changes. The roller pattern should be monitored to ensure that the compaction equipment is applying the same amount of compactive effort at all points transversely across the lane being paved. Use the following six rolling procedures, in the order they appear, when paving in echelon or abutting a previously placed lane.

1. Transverse joints,
2. Longitudinal joints,
3. Edges,
4. Initial or breakdown rolling,
5. Secondary rolling, and
6. Final or finish rolling.

401.3.7.3-Roller Speed and Operation Establishing roller speed is very important. A decrease in speed will increase the compactive effort applied to the mix; however, the objective is to obtain target density before the mix cools below the specified minimum temperature. Roller speed will depend on the roller type and its position in the roller pattern. In general, rollers should be operated at a slow and uniform speed with smooth deceleration and acceleration to avoid shoving the mix. For static steel-wheel and pneumatic-tire rollers in the breakdown position, the maximum speed should generally not exceed 2.5 miles/hr. For vibrator rollers in the same position, the maximum speed should not exceed 3 mi/hr. See Section 401.3.7.4 for additional information on vibratory rollers. If rollers cannot keep up with the paver because of laydown productivity, do not change the rolling pattern or increase the roller speed. Add another roller or reduce productivity to better balance with the compaction operation.

Breakdown and intermediate rollers should be operated with the drive wheel as close to the paver as practical. In general, roll as close to the paver as the stability of the mix will permit. Shoving or cracking of the mat or having the mix pick up on the roller wheels is a sign of mix instability and tenderness. If the mat is unstable or subject to too much lateral displacement, drop the roller back a sufficient distance behind the paver to eliminate displacement and not unduly influence the pattern for the density and finishing rollers. If displacement occurs, inform the Contractor to restore the displaced area to proper grade and cross section with loose material and roll the loose material to target density. The finish rolling should be completed while the mat is sufficiently workable for the removal of roller marks.

During rolling, the roller wheels should be kept moist with only enough water to avoid picking up the mix. This, as well as tire temperature, is especially important if pneumatic-tire rollers are used. Changes in direction should be effected gradually and rollers allowed to roll or slowly brake to a complete stop before reversing. Stopping points for alternate trips should be staggered at least 3 ft. It is best to park rollers off of the new mat, or on a portion that has cooled; however, where rollers have to park on the mat, they should do so at a 45-degree angle with the centerline so that subsequent rolling will remove any depressions.

401.3.7.4-Vibratory Roller Operation Compaction of HMA is a complex process made even more complicated by the use of vibratory rollers. Various makes and models are available for various compaction needs. This section emphasizes their characteristics and proper operation, with which the Project Inspector should become familiar.

The addition of a vibratory mode to static rollers makes it possible to increase and vary the total force applied to the pavement. This makes the roller versatile and able to achieve satisfactory results under a wide variety of conditions, including fewer roller passes. No vibratory roller compacts by vibration alone; and, at times, its static weight must be considered to avoid overstressing the pavement, even when the vibratory mode is not being used. The features of the roller that influence compaction are:

1. Frequency in vibrations per minute;
2. Amplitude of the up and down movement of the roller;
3. Downward force applied; and
4. The travel speed of the roller.

Each of the above factors must be set and maintained in proper relationship with each other to achieve the desired results. Although operating a vibratory roller, in many respects, is no different than operating a static roller, the following guidelines should be considered for optimal results:

1. Mix Temperature. Usually, vibratory rollers can operate at higher mix temperatures because of their ability to adjust the total force applied to the material. As a result, density can usually be achieved with fewer roller passes.
2. Rolling Pattern. The basic rolling pattern is similar to that which is used for static rollers except that after the roller completes a pass toward the paver, the roller should be reversed along the same path. The vibratory mode of the roller must be turned off when the roller stops to reverse direction. The adjacent pass then proceeds in the same manner (i.e., in and out, back and forth) on the same path with a minimum overlap of 6 inches. Similar to other compaction rollers, vibratory rollers should be operated as close behind laydown as practical.
3. Longitudinal Joints. The longitudinal joint is not “pinched” by having most of the roll on the previously compacted lane, but with most of the roll on the uncompacted

material. The joint may be pinched in the standard manner with the vibratory mode turned off.

4. Tandem Vibratory Rollers. Some tandem vibratory rollers provide vibration in either or both rolls. Depending on the stability and the temperature of the mix, the breakdown rolling operation may be performed with both rolls vibrating, with only one roll vibrating, or none vibrating. Rolling that is accomplished with as much vibration as practical will achieve the quickest and perhaps the optimum compaction. However, watch for shearing or shoving of the mat and, if necessary, reduce the compactive effort by lowering or turning off the vibratory mode in either the forward or both rolls. After satisfactory breakdown rolling, the vibration can be increased for secondary and intermediate rolling. Finishing rolling (i.e., to iron out roller marks) may be accomplished most effectively in the static mode.
5. Frequency/Amplitude Adjustment. Frequency and amplitude must be properly selected. Use a high amplitude and low frequency for a lift thickness greater than 2 in and a low amplitude and high frequency for a lift thickness of 2 in or less. When running the test pattern, try to select the highest amplitude that will result in the fewest number of passes without blemishing the mat. If two different amplitudes can achieve identical roller patterns, use the lower amplitude. In general, at least 10 to 12 impacts/ft are needed to obtain adequate density and layer smoothness.
6. Roller Speed. There is an important relationship between vibration frequency and roller speed. The spacing between tamps will be too great at high speeds, resulting in low density and roughness. The roller speed should be selected so that the distance between blows of the roll is approximately equal to the depth of the mat being placed, without exceeding a maximum operating speed of 3 mi/hr. In other words, the frequency, in vibrations per minute, multiplied by the thickness of the mat, in inches, will equal the maximum speed of the roller, in inches per minute. For example, using 2400 VPM on a 2 in mat would yield a maximum roller speed of 4800 in/min or 4.5 mi/hr. However, because this is greater than the specified allowable limit, the maximum operating speed of 3 mi/hr will govern. For thin overlays, the blows should be spaced 1 in apart regardless of the lift thickness. This rule provides a practical speed for thin lifts but may not establish the maximum speed that can produce acceptable results. Remember, thin lifts can be easily over-rolled. The amplitude value is very critical and should be kept as low as practical.

401.3.7.5-Joint Construction To ensure pavement durability and a smooth riding surface, the Project Inspector at the laydown site should pay particular attention to how the Contractor constructs joints in the pavement. Consider the following guidelines:

1. Longitudinal Joints. Longitudinal joints are used between two adjacent lanes of paved mix. The paver will overlap the adjacent lane by approximately 1.5 in; if greater, raking is usually required. Minimal raking should be needed; however, if performed, ensure the raker does not broadcast material across the newly placed mix. Excess material should be carefully pushed to within 1 to 2 in of the joint as deposited on the uncompacted side. Extraneous mix must be removed by broom

or lute before rolling. Rolling is usually accomplished from the hot side with the roller wheels lapping approximately 6 in over the cold mat. Where multiple courses are being paved, the longitudinal joint in the top course layer will coincide with the centerline or lane line, and the longitudinal joints of the underlying lifts will be laterally offset by a minimum of 6 inches. The Contractor should start placement of the adjoining lane in sufficient time to close the joint at the end of the day. If the joint is not closed, a hazardous traffic condition is created, and proper traffic control devices must be erected.

2. Construction Joints. Construction joints occur where one day's operation ends, and the next day's operation begins. If required, treated paper is normally used as the bond breaker. Prior to beginning the day's operation, a transverse vertical cut is made in the mat to the full depth of the new course, and the vertical face tacked prior to paving. Because the mix placed on the downstream side must be higher than the compacted side to allow for compaction, screed adjustments are needed initially. Minimal raking should be necessary; however, if performed, rakers should not disturb the paver-placed mix except to clear away extraneous material. Ideally, the joint should be compacted in a transverse roller direction. However, on a practical basis, the joint can be properly compacted in the longitudinal direction. Construction joints in overlying layers will be offset by approximately 6 feet. All construction joints will provide a smooth transition free from irregularities.
3. Heeled-In Joints. Transverse joints at the beginning and end of the project and at other locations where the new HMA terminates against an existing asphalt pavement will be "heel-in" in accordance with the typical sections of the Contract Plans. The heeled-in joint will provide a smooth transition between the old and new surface. The Contractor should use a straightedge or stringline to ensure smoothness of the joint.

401.3.7.6-Quality Considerations A primary object of the Project Inspector at the laydown and compaction site is to ensure that the Contractor fulfills the quality requirements of the contract specifications (see Section 401.1.4). The Contractor is ultimately responsible for quality control, but the Division is responsible for acceptance. Section 401 of the Specifications specifically addresses the following quality criteria:

1. Thickness. Cores will be taken by the Division after the project is completed and measured for thickness in accordance with Section 401.7.3 of the Specifications to verify compacted thickness where a uniform thickness of 3 inches or more is specified, excluding resurfacing. Cores may not be required for short projects (i.e., less than 1000 feet), tapered paving mats, and widening projects. Failure to meet specified requirements may result in either a price reduction or provisions for an additional lift.
2. Density. Test procedures and acceptance criteria for compaction testing methods will be in conformance with the contract specifications and MP 401.05.20. Density will be verified using either the lot-by-lot method or the rollerpass method, depending on the lift thickness and the total new pavement thickness. Do not include the thickness of patching and leveling and scratch courses in the total new

pavement thickness. The method to use for non-uniform thickness or tapered edge pavements will be determined by the Project Engineer/Supervisor on a case-by-case basis. Acceptability of a lift thickness less than two times the nominal maximum aggregate size will be governed by the rollerpass method. Visually inspect areas that restrict access to a full-size roller because acceptance testing is not required for these areas.

3. Surface Tolerance. Check the final compacted surface for acceptability. It should have a uniform texture and a line and grade that conforms to the cross section. The Contractor will provide the specified straightedge and template and check the surface. Monitor this check to ensure that the finished base and wearing course is within specified tolerance of specification 401.7.2. If unacceptable, inform the Contractor to correct high and low places in accordance with the contract specifications.
4. Smoothness. See Section 720 of Specifications for smoothness testing requirements. Failure to meet specified requirements may result in either a price reduction or corrective action.

401.3.8-Inspection Guidelines Consider the following guidelines when inspecting HMA laydown and compaction operations:

1. Check that the roadway is properly marked or staked out. Verify that paver guides are properly set. Check the condition and adjustment of paving machines and rollers for acceptability.
2. Check that traffic control and flaggers are in place and that traffic is flowing properly. At the end of the day, make sure that signs not needed during non-working hours are removed or covered.
3. Check surface preparation for conformance. Verify tack coat is applied uniformly without running and on only those surfaces that can be paved for the day. Verify patching and leveling areas are properly designated, and that potholes are patched according to typical sections. Make sure cold mix or winter-grade patching is completely removed. Verify that the surface is clean.
4. Check that haul trucks are covered and insulated with no oil leaks or damage. Verify that haul trucks properly charge the paver hopper. Observe the mix for obvious signs of unacceptability. Check and record mix temperature on delivery tickets at least once an hour.
5. Inspect the mat behind the paver for signs of non-uniform mix, roughness, or tearing. Verify that the vibrating screed is on. Check rate of application to ensure thickness placed conforms to typical sections. Check mat thickness (prior to compaction) and mat temperature (at final compaction pass) every 1,000 ft or a minimum of three times per day. Calculate and record application rate every 2,500 ft. If field conditions require additional material, record the station and rate of application, as well as the rationale for same. Record the application rate for the day's production. Check that the operation is continuous and in balance with plant production. Check with the Project Inspector at the plant to corroborate daily totals.

6. Check that construction joints are cut back to vertical and tacked. Check that "heeled-in" joints are constructed according to Contract Plans. All joints should have a smooth appearance. Check that longitudinal joints are pinched and not overlapped and that all joints are properly raked and compacted.
7. Verify that the Contractor's density technician is on site. Watch the compaction operation for improper rolling sequence and operation and for compliance with that established for density requirements. Check that the Contractor is performing straight edge checks and the finishing operation is acceptable. Check for compliance with the Quality Control Plan and record results of the requisite quality control tests.
8. When paving is permitted beyond the seasonal limitations, record the air temperature, base temperature, and weather conditions prior to the start of paving each day and when noticeable changes occur.
9. When required, check that an approved asphalt safety edge device is utilized and that the resulting finished surface is same surface profile and texture as the compacted mat surface.

401.4-MODIFIED ASPHALT BINDERS

The following section discusses modified Performance Graded (PG) Binders. Modifiers are typically mixed with the asphalt cement to meet the temperature requirements of the performance grade specified. Mixes that use these modified asphalt binders require special consideration because production and placement characteristics will differ from those of mixes using unmodified binders. At the plant, close control and verification of proportioning and mixing are required. The plant must be able to store and mix the modifier at the appropriate temperature and at the appropriate rate. Proportioning is usually determined based on metering. Any significant deviation in modifier content may change the volumetrics and mechanical properties of the mix. Mixing temperatures are usually higher than for mixes using unmodified binder, and the mix will generally be stiffer and more difficult to place and compact but will result in a paved mat that is resistant to rutting with improved durability.

401.4.1-Plant Production Considerations

401.4.1.1-Asphalt Binder Storage and Handling The performance of mix designs greatly depends on the asphalt binder used in the mix – largely due to the specified performance grade of the modified asphalt binder to resist rutting. Consider the following guidelines:

1. Tank Loading. Individual grades of asphalt must be maintained separately to prevent mixing of differing performance grades. The plant operator must take the necessary precautions to ensure that different grades are not inadvertently mixed when storage tanks are loaded and that the correct asphalt binder is used during production. Where multiple tanks are used to store different types of binders, check that separate plumbing and sampling valves are provided for each tank.
2. Higher Storage Temperatures. Mixes specifically designed to resist rutting against heavy traffic generally use modified asphalt binders with a high temperature performance grade. These stiffer binders generally are more difficult to mix and require a relatively higher storage temperature. Note that long-term storage at

these higher temperatures may degrade some modified binders. Individual temperature controls should be provided for each storage tank to separately control the storage temperature for the specific binder.

3. Stratification. The modified asphalt binders tend to separate and stratify over time. Tanks used for storing these modified binders should be adequately equipped to recirculate the binder.

401.4.1.2-Drying, Mixing, and Storage To minimize potential problems and fully consider production tradeoffs, consider the following factors relative to drying, mixing and storage of Superpave:

1. Metering and Pumping. Performance-graded binders with higher specified temperature grades generally are stiffer and more difficult to pump, especially when modifiers are used. If a significant change in binder stiffness is evident, metering and pumping should be verified and corrected as needed. A different size of pump or type of meter may be required.
2. Recycled Asphalt Pavement (RAP). The heat transfer process may be additionally aggravated if RAP is used in the design. Depending on plant capacity and capabilities, the RAP percentages may need to be limited if heat transfer continues to be a problem.
3. Mix Storage. Storage silos are commonly used to maintain a continuous flow of trucks to the laydown site. High storage temperatures may result in draindown and excessive hardening of the asphalt binder if the mix is stored at high temperatures for extended periods. In addition, when using mixes with larger aggregate sizes, the storage silos should be monitored for signs of segregation.
4. Poor Workability. Mixes, with modified asphalt binders tend to be stiffer and more difficult to work. If the mix is excessively difficult to work at the laydown site, it may be necessary to increase the mix temperature and, as practical, minimize handwork.

401.5-RECORDS AND DAILY REPORTS

It is important that Project Inspectors at the plant and the laydown and compaction site accurately and completely document the necessary information for the project records. Attempting to reconstruct events later without written notes and complete test data is usually frustrating and often results in conflicting opinions. One procedure should be consistently followed. It is important that Diaries and/or Daily Work Reports be utilized for this objective. If in doubt about whether the information is important or beneficial, write it down. All asphalt tickets must be place in ProjectWise and attached to the DWR, and Sample must be entered in AWP as soon as possible.

401.5.1-Plant Records and Reports The DOH Materials Inspector at the plant should document a complete summary of materials incorporated in the project and the plant operations performed, which will form an unquestionable basis for pay quantities. The results of all daily and periodic tests performed at the plant should be recorded in the plant diary. Data that should be considered include:

1. Date and Project Inspector's name;
2. Project number and location;
3. Weather and temperature conditions;
4. Source of materials, including laboratory numbers;
5. Applicable information from the Job Mix Formula;
6. Times of plant scale checks;
7. Aggregate gradation and asphalt content test data and mix test results;
8. Quantity of each material used (i.e., aggregate, asphalt binder, additives);
9. Daily quantity of mix produced;
10. Location on pavement where daily production was placed;
11. Date, time, location of samples taken and name of technician;
12. Procedure used to measure mix properties;
13. Tests conducted or observed, results, and any corrective action taken;
14. Mix material rejected and disposition;
15. Instructions given to the Contractor. or received from Project Engineer/Supervisor;
16. Visitors and their comments and agreements;
17. Remarks, unusual occurrences, or test results failing the contract specifications including corrective action, changes to mix proportions, plant operation, and test procedures; and
18. Number of inspection hours for the day.

For each load of HMA mix dispatched from the plant, there should be a delivery ticket prepared to accompany the truck to the job site. This ticket should include the following:

1. Item number and description;
2. Weighman name, printed and initialed;
3. Date and project number;
4. Truck number;
5. Number of contact axles;
6. Tare weight of truck;
7. Time or loading;
8. Gross or net weight, based on type of scales used;
9. Temperature of mix;
10. Mix design number; and
11. Laboratory number.

401.5.2-Laydown and Compaction Records and Reports The Project Inspector at the laydown and compaction site is key personnel in documenting the acceptability of the construction operation. The purpose of the Daily Work Report and its pertinent attachments is to document for possible later reference the routine and non-routine events that occur during each paving day. The information obtained must be detailed and complete. Many claims and lawsuits have been settled on the basis of information within the DWR. The DWR will allow for more meaningful discussion later if deficiencies develop in test results or in the performance of the pavement under traffic. Section 401.3 covers key information that should be recorded during inspection. During laydown and compaction operations, also consider the following:

1. Project number and location;
2. Weather conditions;
3. Type and quantity of mix placed and the exact location of the mix layer number;
4. Mix delivery tickets and laboratory numbers;
5. Thickness, lane, and station number;
6. Type and make of equipment used by the Contractor;
7. Density results obtained;
8. Type, amount, and location of any tack coat material placed, as required;
9. Location of transverse and longitudinal station number of samples taken;
10. Running total of the quantity of each mix laid on the project;
11. Samples taken and made properly;
12. Location, time, and date of the sample;
13. Reason sample was taken;
14. Name of the technician taking the sample;
15. Unusual conditions or test results that occur during the day;
16. Failing test results, explanation, and steps taken to correct the problem;
17. Results of corrective actions;
18. Changes made in the mode of operation of the asphalt plant or the laydown and compaction equipment;
19. Different or unusual events that occur;
20. Visitors to the site and their comments; and
21. Reason for delays in paving (e.g., equipment breakdown, poor weather).

401.6-MEASUREMENT FOR PAYMENT

The contract unit price for HMA includes furnishing all materials and work such as labor, tools, equipment, field lab, supplies, and incidentals. Cleaning and sweeping is part of HMA construction. No tack coat material for minor spot areas to be patched and leveled will be included in any other HMA items and the Contractor will receive no additional compensation. In addition, interim pavement markings also will not be included, and the Contractor will not receive additional compensation.

401.6.1-HMA Base and Wearing Course The HMA base and wearing course specified in the Contract will be measured by the ton complete in place. For projects paid by the square yard, the plan quantity will be used to determine quantity. The method by which the measurement is determined is similar to that which is described for patching and leveling course in Section 401.6.2.

401.6.2-Patching and Leveling Course Patching and leveling course specified in the Contract will be measured in tons complete in place and accepted. No additional payment will be made for patching or leveling course placed on subbase or base course for another HMA item (e.g., incidental) in the Contract. If measured on the square yard basis, the measurement will be based on the width of the cross sections in the Contract Plans, including additionally approved widening, and the length along the centerline of the main facility and all ancillary ramps. If measured on the ton basis, the measurement will be based on the delivery tickets for each truck load or from the digital printout slips from the plant.

401.6.3-Contract Price Adjustments Depending on the results of quality acceptance criteria as specified in the contract specifications, several Contract price adjustments may govern as follows:

1. Matt and Joint Density. When a Lot of asphalt pavement does not meet the density requirements of the specifications, a price adjustment will be determined based on the criteria presented in 401.13.3 of the specifications.
2. Thickness. Contract price adjustments for HMA pavement thickness not within tolerance will be determined based on the criteria and procedures presented in 401.13.4 of the specifications. Note that one of two situations may be required based on a review by the Division of the Contract Plans and Project Records: either a price reduction or an additional lift. If an additional lift is required, the Contractor will be responsible for the expense of the precipitating actions and requirements.
3. Smoothness. Contract price adjustments for smoothness of surface courses will be determined based on the equations and procedures presented in 401.13.2 of the specifications and Section 720. Note that if the smoothness value measured in the field exceeds the limits specified in the contract specifications by more than 50%, the subject surface course will be corrected by the Contractor at no additional expense to the Division.

SECTION 402
ASPHALT SKID-RESISTANT PAVEMENT

402.1-GENERAL

Section 401 covers many topics that are applicable to the construction of HMA skid- resistant pavements. Section 401.1 covers general topics including aggregate and binder materials, quality control, Job Mix Formulas, maintenance of traffic, preconstruction conferences, and safety considerations. Sections 401.2, 401.3, and 401.4, respectively, present a significant number of topics and inspection guidelines that are associated with HMA production and hauling, laydown and compaction, and troubleshooting equipment and mat problems. The following sections present information specific to the construction of HMA skid-resistant pavements.

402.1.1-Description of Work The HMA skid resistant pavement is an HMA wearing course that has skid resistant properties. The Contract Plans will designate the limits of this work. The wearing course will be constructed in accordance with the guidelines presented in Section 401 of this Manual. The following sections clarifies the exceptions and additions to Section 401. The Project Inspector is responsible for ensuring that the Contractor performs the work in conformance with the Contract Plans and Specifications.

402.1.2-Aggregate and Asphalt Binder Materials The Primary difference between the HMA discussed in Section 401 and the HMA skid-resistant wearing course is that the skid-resistant wearing course is that the skid-resistant wearing course contains a coarse aggregate blend that is polish resistant. Acceptable types of in Section 402 of the Specifications and will be designated in the contract specifications. During the work, verify that the correct materials are being used.

402.2-RECORDS AND DAILY REPORTS

The Project Engineer/Supervisor shall request the performance of skid resistance and smoothness tests when required by the contract specifications. See Section 401.5 for additional information on records and Daily Work Reports for skid-resistant pavements. See Specification section 720 for more information on requirements for smoothness testing. See MP 721.10.01 for more information on the requirements for skid testing.

402.3-MEASUREMENT FOR PAYMENT

See Section 401.6 for applicable guidance on measuring quantities for payment for HMA skid-resistant pavements.

SECTION 405
CHIP SEALS

405.1-GENERAL

Section 401 covers many topics that are applicable to the application of chip seals. Section 401.1 covers general topics including aggregate and asphalt materials, quality control, maintenance of traffic, preconstruction conferences, and safety considerations. Sections 401.2, 401.3, and 401.4, respectively, present a significant number of topics and inspection guidelines that are associated with HMA production and hauling, laydown and compaction, and troubleshooting equipment and mat problems, which are generally applicable to chip seals. The following sections present specific guidelines for the inspection of chips seals.

405.1.1-Description of Work Where chip seal is designated in the Contract, it generally refers to the construction of a wearing course, composed of asphalt emulsion immediately followed by a single layer of aggregate, placed and compacted in one or more courses and followed by a fog seal on an acceptable base course or existing surface. The Contract Plans will designate the type of chip seal and the location, number of courses, and course thickness for the work. The following type of chip seals may be specified:

1. Light Seal. Light Seal is a seal coat that consists of applying an asphalt emulsion material at a specified rate upon an existing surface, and immediately placing a single, uniform application of cover aggregate on the emulsion material. The cover aggregate is then promptly embedded in the emulsion material by rolling. Seal coats are used to lengthen the service life of an existing facility by waterproofing it, slightly increasing its strength, and improving the surface texture.
2. Single Surface Treatment. Single Surface Treatment is similar to Light Seal Treatment except that it is usually applied to prepare base courses and is for the purpose of waterproofing and providing a wearing surface.
3. Double Surface Treatment and Triple Surface Treatment. Double/Triple Surface Treatments are very similar to Single Surface Treatment in that the operation is repeated until the desired number of courses are obtained. The maximum size aggregate for each successive course is usually smaller than the preceding course.

The Project Inspector is responsible for ensuring that the Contractor performs the work in conformance with the Contract Plans and Specifications.

405.1.2-Aggregate and Asphalt Emulsion Materials Section 405 of the Specifications specifies the types of aggregate and asphalt emulsion materials that should be used for each type of chip seal. Check the aggregate delivered to the project to ensure that they are from an approved source (i.e., laboratory number), washed to reduce dust content, and that they meet the gradation requirements for chip seal specified for the project (i.e., Type A, Type B, Type C).

405.1.3-Weather Considerations The temperature limits for paving projects, as governed by the contract specifications, cannot be exceeded unless the request is previously approved in writing by the Project Engineer/Supervisor. Chip seal construction is not permitted between October 1 and May 1. In general, chip seals can only be applied if the temperature of the surface being overlaid is above 50°F. In addition, the surface must be dry, with no imminent rain in the forecast, and immediately suspended when rain begins. See Section 401.3.2 for additional weather considerations.

405.1.4-Maintenance of Traffic The Contractor is responsible for the proper maintenance of traffic and protection of the newly treated surface during construction. Do not permit wheeled traffic to operate on the treated surface before it has fully cured. Otherwise, the surface will ravel or the wheels will pick up and broadcast the material. Check that the required traffic control is in place and that the flow of traffic is satisfactory. Document your findings on the appropriate attachment of the Daily Work Report. See Section 401.1.7 for additional information on traffic control.

405.1.5-Equipment Considerations Chip seal jobs require many types of construction equipment including power brooms, power blowers, broom drags, scrapers, hand brooms, shovels, asphalt distributor truck, aggregate spreader, compaction equipment, and single-pass surface treatment machines. Single-pass surface treatment machines offer one important advantage in that there is no delay between the application of the asphalt emulsion and the aggregate. The same calibrations and adjustments necessary for asphalt distributors and aggregate spreaders must be made for this equipment. All calibrations and adjustments should be made in accordance with the manufacturer's recommendations. It is important to check material distribution equipment for proper calibration so that application rates and quantities used can be accurately determined. All equipment, by which a material is to be distributed or spread, must be adjusted so that the material will be properly and uniformly placed. The following sections briefly discuss the equipment used for chip seal work. Section 401.3.3 presents the types and operation of equipment used on HMA paving jobs. The primary responsibility of the Project Inspector is to check the equipment for good working operation and ensure that the equipment is being used by the Contractor to perform the work as required.

405.1.5.1-Asphalt Emulsion Material Distributor The distribution truck must be a self-powered unit with a heated and pressurized tank to haul the asphalt emulsion while it is being distributed. The tank must be able to uniformly heat the asphalt material to the specified temperature. A thermometer-type device will be provided for the convenience of checking and documenting the material's temperature. The truck also will be equipped with a pressure gage to check and ensure adequate and uniform pressurization of the material, and either a volume gauge or calibrated tank for the purpose of accurately measuring and documenting the application rate and quantity used. The distribution unit (e.g., transverse line of spray nozzles under or behind the truck) must be capable of spraying the asphalt emulsion at variable widths and at controlled rates. The temperature of the asphalt material and the width and rate of application must be within tolerance of the Contract Plans and Specifications. The following discusses the primary components of the asphalt material distributor:

1. Tank. The tank consists of an insulated shell with flues, a thermometer, baffle or surge plates, a manhole, and an overflow pipe. The capacities of distributor tanks vary considerably. All distributors are equipped with a float-type gauge and a measuring stick for determining the amount of material in the tank. The measuring stick should be marked in volumetric increments. To control and check the rate of application and, in some instances, to provide a basis of measurement for payment, the Contractor should be required to furnish calibration data and a notarized statement, both signed by a person of recognized authority. The statement should identify the distributor and give the interior dimensions and a description of the tank. The tank should be inspected to see that it has not been changed from the dimensions and description contained in the statement. If the distributor is new or if the notarized statement and calibration data cannot be furnished, it will be necessary to calibrate the tank to relate the depth of material, as determined by the measuring stick, to the volume contained in the tank.
2. Heating System. The heating system consists of one or two burners and an equal number of heating flues. Each burner emits a flame directly into a flue which transfers heat to the asphalt material. The heating system should be checked to make certain that it is capable of maintaining the asphalt material at the desired application temperature. When being heated, the asphalt material must be circulated. Care should be taken that the safe maximum heat of the material is not exceeded.
3. Circulating System. The circulating system consists of a pump and lines passing through the distributor tank to the spray bar and to the hand spray. The pump should be checked to make certain that it is capable of circulating the asphalt material through the tank and the spray bar, and developing and maintaining a constant, uniform pressure along the entire length of the spray bar so that an equal amount of material will be sprayed from each nozzle without atomizing the asphalt material or emitting a distorted fan. The control for the valve system, by which the discharge of asphalt material from the nozzles is controlled, should be inspected and adjusted, if necessary. There should be no slack in the linkage from the control to the valve system so that all of the nozzles will be completely opened or completely closed immediately when the control is operated. The pump tachometer or pressure gauge, which registers the pump discharge, should be checked for accuracy.
4. Bitumeter. A bitumeter consists of a rubber- tired wheel, mounted on a retractable frame and connected to a dial in the cab of the truck by a cable. The bitumeter should be checked to determine whether it accurately registers all of the data it is designed to measure. The wheel should be maintained in a clean condition because, if material is allowed to build up and remain on the wheel, the bitumeter will register erroneously.
5. Spray Bar. To ensure proper working condition of the spray bar, the following inspections and adjustments must be made:
   a. Nozzles. The nozzles should be removed from the spray bar, cleaned, and examined for size, wear, and damage to the edges of the nozzle opening. Uniform distribution of the asphalt material depends on the nozzles being in good condition and being the proper size. Usually, the smallest size nozzle

available for a distributor will provide the most uniform distribution. The nozzles should be set so that the slots make the angle with the spray bar recommended by the manufacturer of the distributor.

b. Spray Bar Height. The height of the spray bar should be set so that the exact number of laps of asphalt material desired will be obtained. The height for a double lap can be determined by closing every other nozzle, operating the distributor at the proper pump speed or pressure, and raising or lowering the spray bar in small increments until it is determined by visual observation that exactly one single lap of material will be applied. For a triple lap, close the second and third, fifth and sixth, etc., nozzles and follow the above procedure. The distributor truck should be equipped with springs that are strong enough to prevent the difference in the height of the spray bar, when the distributor tank is loaded and when it is empty, from being great enough to significantly affect the uniformity of the distribution of the asphalt emulsion. If the uniformity of the distribution is significantly affected, corrective action, such as installing stronger truck springs or connecting the frame of the distributor to the axle when the tank is fully loaded, should be taken.

c. Spread. To ensure uniform distribution, the transverse spread, and the longitudinal spread should be checked by any of several acceptable methods. The variation should not exceed approximately 10%.

405.1.5.2-Hand Spraying Equipment Hand spraying equipment is typically used for areas that are inaccessible to the distribution truck. The hand sprayer is generally connected to the main distributor tank.

405.1.5.3-Aggregate Spreader Aggregate spreaders are of three general types: tail gate, mechanical, and self-propelled. Of these types, the self-propelled spreader is the most satisfactory. It affords close control on traveling speed, can apply the cover aggregate in a continuous and more uniform manner, and can stay relatively close to the distributor. The aggregate spreader should be calibrated and adjusted in accordance with the manufacturer’s recommendations and operating manual. The transverse spread and the longitudinal spread should be checked to make certain that uniform distribution will be obtained. The operating speed should always be less than that at which the spread will lope or undulate. The hitch by which the spreader connects itself to the aggregate trucks should be checked to make certain that it will afford positive connection. The spreading equipment used to spread the coarse aggregate material must be in good working order and capable of uniformly spreading the aggregate at the specified quantity per unit area. The rate will be designated in the Contract.

Where haul trucks are used, they should be inspected for acceptability and operating condition. Each truck should be assigned an equipment number and only that number should be on the truck. No two trucks should be assigned the same number. If cover aggregate is to be measured by volume, determine the volume of each truck bed and record the dimensions with the assigned truck identification number. If cover aggregate is to be measured by weight, determine the weight of the empty truck at such frequency as considered necessary. This information must be recorded with the truck identification numbers.

405.1.5.4-Compaction Equipment Standard compaction equipment is generally used to key the aggregate into the asphalt emulsion. Hand tampers are used in areas inaccessible to the rollers. See Section 401.3.3 for information on the types and proper operation of compaction rollers. Consider the following additional guidelines:

1. Pneumatic-Tire Rollers. Pneumatic-tire rollers should be checked to determine that it has the desired effective rolling width, the required number of wheels, that it can be loaded to the desired weight, and that the tires are inflated to the pressure necessary to provide the desired ground contact pressure.
2. Power Broom. Power brooms are used for cleaning the existing surface in preparation for construction and for removing excess aggregate from the new surface after the asphalt material has hardened.
3. Drag Broom. Drag brooms are used as a supplement to the aggregate spreader to obtain uniform distribution of the aggregate and proper keying.

405.2-CONSTRUCTION OPERATIONS

The construction operations are of the utmost importance in chip seal work. Even the most precise design will be of no value if the construction operations are not properly conducted. The proper sequence of operations and the rate of materials applied by the Contractor will depend on the type of chip seal specified in the Contract. Section 405 of the Specifications specifies this criteria for the following chip seals types:

1. Light,
2. Single,
3. Double , and
4. Triple.

In general, the level of effort and the rate of materials applied increases from Light to Triple. Light is a light treatment, and Triple is an improved treatment for more deteriorated surfaces. The following sections discuss typical construction operations and present general inspection guidelines.

405.2.1-Surface Preparation The importance of surface preparation cannot be over-emphasized. The riding surface of the new chip seal will be no better than the surface on which it is placed. The existing surface (e.g., base, HMA or PCC pavement) should be prepared as specified for the type of chip seal designated in the Contract Plans. Breaks, holes, depressions, and other surface irregularities will be repaired with minor patching and leveling (see Section 401.3.4.2). Patching and leveling, in this case, does not necessarily imply the need for a full-width, patching-and-leveling course, unless otherwise designated in the Contract Plans. Check that the repaired surface is properly cleaned and swept as discussed in Section 401.3.4.4. After cleaning and sweeping, check that the remaining aggregate is firmly embedded and that edges are neatly trimmed to line. Waste materials should be disposed of in accordance with Contract requirements. Consider the following additional guidelines:

1. New Base Courses. On new base courses, it seldom will be necessary to repair the surface, since the base course has been constructed to the specified tolerance when finished.
2. Existing Pavements. For existing pavement surfaces, it will almost always be necessary to repair surface defects. The most common surface defects are raveling, cracks (e.g., transverse, longitudinal, alligator, slippage, shrinkage), broken edges, potholes, corrugations, depressions, bumps, foreign material adhered to the surface, absorbent areas, and flushed or bleeding areas. These repairs should be made well in advance of the construction operations.
3. Surface Cleaning. The existing surface must be cleaned just prior to the application of the asphalt material. All foreign materials such as paper and mud should be removed, and the entire surface should be thoroughly broomed to remove dirt and dust.

405.2.2-Application of Asphalt Emulsion Material The distribution truck is used to spray the type and rate of asphalt material for the type of chip seal specified over the area designated in the Contract Plans. The operation should be closely monitored. The rate of application is controlled by the length of the spray bar, the pressure developed by the pump, and the speed of the distributor. The speed is measured by a tachometer. The pump must develop enough pressure to produce a sharp, straight-edged spray from each nozzle. The pressure is controlled by setting the governor on the pump engine. If the distributor has been properly adjusted, the material will be applied uniformly in the transverse direction, unless one or more of the nozzles have become clogged. In the longitudinal direction, the circulating pump and the distributor must be operated at a proper and constant speed. The length of spread for each distributor load of material can be determined and marked on the road as an aid to obtaining the desired rate of application. Consider the following additional guidelines:

1. Surface Condition. Before the asphalt emulsion is applied, the surface must be clean, dry, and properly prepared (see Section 405.2.1).
2. Stringline. Application must be made to the width and alignment required by the Contract Plans. Check that a stringline, or similar method, is used by the distributor operator to guide the operation of the equipment. Do not assume that the width of application is correct. It is good practice to frequently measure and check the width for conformance.
3. Contact Surfaces. Check to ensure that contact surfaces such as curbs, gutters, manholes, and adjacent PCC edges are properly sealed. The application of the asphalt material should be uniform without running.
4. Quantity Determination. Before application. check the quantity in the tank. The distributor should be parked off the roadway with the tank in a level position. Also check the temperature for compliance and enforce adjustments as needed. After application, with the truck in a level position, check the quantity remaining in the tank. The volume will have to be corrected for temperature. Volume-temperature correction tables are provided in the attachment of the Daily Work Report.
5. Gauges. Periodically check the temperature and pressure gauges of the distributor truck for proper working order. If a problem is suspected, verify the cause and, as needed, inform the Contractor to repair the equipment.

6. Spray Bar. Periodically check distributor nozzles to make sure all nozzles are open and set at the correct angle and that the spray bar is set at the proper height above the pavement surface. Longitudinal strips with no asphalt material is a sure sign of a clogged distributor head.
7. Application Rate. The application rate should be checked. Too little material will not provide sufficient bonding between layers, and too much material will promote slippage of an overlay or cause bleeding through a thin course. A milled surface may need a higher rate of application.
8. Overspraying. Make sure the operator of the distribution equipment does not splatter asphalt material and mar the surfaces of sidewalks, curbs, structures, and trees in adjacent areas. If overspraying occurs, the Contractor is responsible for correcting the problem.
9. Traffic. Ensure that traffic does not damage surfaces that are treated with uncured asphalt emulsion. Phased construction may be needed. For example, one-way traffic could operate on an untreated section and later be diverted to the treated section after the asphalt material has sufficiently cured. This requirement is to prevent the material from being picked up and distributed by the wheels of the vehicles.
10. Curing. The asphalt emulsion must be thoroughly cured before a subsequent course is placed or traffic is allowed to operate on the surface.

Document points of inspection on the appropriate attachment of the Daily Work Report.

405.2.3-Application of Aggregate Material Because asphalt emulsion cools rapidly, its distribution must be carefully coordinated with the spreading of the cover aggregate, if cover aggregate is specified. The period between the distribution of the asphalt material and the application of the cover aggregate should be kept to an absolute minimum to obtain the greatest wetting action and better seating of the aggregate. The objective is to obtain a layer that is approximately one aggregate particle thick, because additional aggregate cover will not adhere to the asphalt material and will be wasted. Immediately after the asphalt material is applied, the aggregate spreader will apply coarse aggregate of the type and rate specified for the type of chip seal designated in the Contract. It may be necessary to direct the Contractor to wash the aggregate with water to eliminate or reduce the dust coating on the aggregate. This enhances adhesion and penetration of the asphalt material, especially with low-viscous material such as prime coat. If washing is needed, it should be performed the day before the aggregate is spread. Where trucks are used to spread the aggregate, do not allow the Contractor to operate the trucks on areas with asphalt material that does not have an aggregate cover. Check the application rate of aggregate material and record your findings on the appropriate attachment of the DWR.

405.2.4-Brooming and Rolling Operation After the asphalt emulsion has been applied to the suitably prepared surface, the brooming and rolling operation will begin as discussed in the following sections. Document points of inspection on the appropriate attachment of the Daily Work Report.

405.2.4.1-Brooming After each course of aggregate has been spread, the Contractor will broom drag the surface to ensure a uniform distribution of aggregate material. Randomly observe areas to see that the material has a uniform depth. Inform the Contractor of any needed corrections.

405.2.4.2-Rolling The rolling operation should immediately follow the aggregate spreading and brooming operation to embed the aggregate while the asphalt material is still soft and tacky. The purpose of the rolling operation is not to compact the material in terms of achieving a target density, but to key (i.e., firmly embed) the aggregate into the layer of asphalt emulsion. Rolling may have to be conducted over the course of several days to achieve this objective. Consider the following guidelines:

1. Roller Operation. During the operation, the rollers should travel in a direction parallel to the centerline, starting at the edge of pavement and progressing toward the centerline. On superelevated curves, it is good practice to start at the lower edge.
2. Roller Passes. Roller passes should overlap but rolling should not progress to the point where the aggregate is being significantly crushed. Do not use any more roller passes than that needed to firmly embed the aggregate into the asphalt emulsion.
3. Pneumatic-Tire Rolling. Pneumatic-tire rollers should not be used on intermediate courses of cover aggregate but should immediately follow steel-wheel rolling on all final courses. Pneumatic-tire rollers must be operated at a speed low enough to prevent the tires from displacing or picking up the aggregate. The ground contact pressure may be adjusted by adjusting the amount of ballast on the roller or by adjusting the tire pressure, or both. The rolling operation should begin at the outside edge of the surface and progress toward the center. Each pass of the pneumatic-tired roller should overlap the preceding pass by at least one-half of the roller width. Rolling should be discontinued when the asphalt emulsion has set or hardened.
4. Joint Construction. Transverse joints should be carefully constructed so that they will not be rough and unsightly. This is usually performed by starting and stopping the application of materials on building paper. Each successive application should overlap the end of the preceding one by 0.5 in to avoid a gap in the surface. Because it is not practical to use building paper on longitudinal joints, it is better to have a slight build-up due to overlapping adjacent passes than it is to have a gap in the surface. Where half-width operations are used, loose aggregate should be removed from along the longitudinal joint before the adjacent lane is surfaced. Check that longitudinal joints are clean of foreign material and are not constructed with gaps. Where the operation is halted, ensure that transverse joints are constructed with treated paper to prevent the overlapping of asphalt emulsion. Upon continuing the operation, the treated paper should be removed and the joint constructed as discussed in Section 401.3.7.5.
5. Raveling. Periodically inspect areas for evidence of raveling, If raveling is observed, inform the Contractor to repair and reroll the area.
6. Release Agents. If, during the rolling operation, material is adhering to the roller wheels, water or an approved release agent should be applied to the roller wheels to prevent the roller wheels from picking up any more material.

7. Loose Aggregate. Usually there will be some loose aggregate particles on a new surface after the rolling operation has been completed. This loose aggregate should be broomed off in the cool part of the morning when the asphalt emulsion is hard and the bonded aggregate particles will not be disturbed. This is a recommended practice for each half of a roadway that is surfaced in half-widths because the half that is finished first will probably carry traffic while the other half is being surfaced, and damage to automobile finishes and windshields will be minimized. Loose aggregate may be the tool by which traffic will create more loose aggregate.

See Section 401.3.7 for additional information on roller operations. Document points of inspection on the appropriate attachment of the Daily Work Report.

405.3-RECORDS AND DAILY REPORTS

Section 111 discusses the general requirements of project records and daily work reports. See Section 401.5 for additional information on records and daily reports for paving projects. Consider and document the following key points of inspection on the proper attachment on the Daily Work Report:

1. Check and verify that the required equipment is on site and in good working order.
2. Check and verify that traffic control devices and flaggers are in place. At the end of the day's work, ensure that signs that are not needed during non-working hours are covered or removed.
3. Verify that the proper type and quantity of aggregate and asphalt emulsion are available. As required, record quality sampling information (e.g., field samples, stockpiles and location references, laboratory numbers, source approval).
4. Check that the sequence of operation is correct for the type of chip seal designated in the Contract.
5. Check that the surface preparation is in conformance. Verify that the surface has been properly cleaned and swept and that surface breaks, holes, depressions, and other damage has been repaired. The surface must not have standing water when the operation begins.
6. Verify for conformance and record the temperature and application rate of the asphalt material. Calculate and record the application rate twice, minimum, in the morning and afternoon. Check that vehicles are not operating on asphalt material that does not have aggregate cover. Periodically check for evidence of clogging in spray nozzles.
7. Check and record the application rate of aggregate material. Check that each layer of aggregate is broomed to ensure uniform distribution.
8. Check roller pattern and operation for compliance. Check that the aggregate is firmly keyed into the asphalt emulsion and that the aggregate is not being crushed. Check that longitudinal joints are constructed without overlaps or gaps and that treated paper is used for transverse joint construction to prevent overlapping asphalt material.
9. Inspect the surface for raveled areas and ensure that the Contractor properly repairs and rerolls the areas.

10. Record the air and base temperature twice, minimum, in the morning and afternoon.

405.4-MEASUREMENT FOR PAYMENT

All quantities will be paid for at Contract unit prices for the bid items. Use the following guidelines when determining the payment quantities for chip seals:

1. Chip Seal. The quantity for chip seal will be paid in square yards, measured by the total length of the area time the average applied width of treated area. Payment include sweeping, aggregate and all labor and equipment.
2. Asphalt Emulsion Material. Measure the quantity for payment, in gallons, of asphalt emulsion incorporated in the work. The project records will include the volume applied in the project based on the readings from the distributor truck's volume gauge or calibrated tank. Volume- temperature corrections will apply as discussed in Section 401.2.6.3 of this Manual. Volume-temperature correction tables are provided in the attachment of the Daily Work Report.
3. Maintenance of Traffic. Maintenance of traffic will be measured and paid as provided for in Section 636 of the Specifications.

SECTION 407
FOG SEAL

407.1-GENERAL

Section 401 covers many topics that are applicable to fog seal operations. Section 401.1 covers general topics including asphalt materials, quality control, maintenance of traffic, preconstruction conferences, and safety considerations. Sections 401.2 and 401.3, respectively, present a significant number of topics and inspection guidelines for production and hauling, laydown, and troubleshooting equipment and mat problems, which are generally applicable to the application of fog seal. The following sections present information relative to the application of fog seals.

407.1.1-Description of Work Where fog seal is designated in the Contract Plans, it generally refers to preparing and treating an existing HMA pavement surface with asphalt material. Fog seals are used primarily as a pavement rejuvenator, thus extending the life of the pavement. They are also used on chip seals to prevent aggregate loss The Contract Plans will designate the location for the work. The Project Inspector is responsible for ensuring that the Contractor performs the work in conformance with the Contract Plans and Specifications.

407.1.2-Asphalt Materials The asphalt material (i.e., type) for fog seal will be specified in the Contract.

Quality criteria for asphalt materials acceptable for use in fog seal applications are referenced in Section 407 of the Specifications. Check to ensure that the materials are from an approved source (i.e., laboratory number) and are the proper materials for use in the operation.

407.1.3-Weather Considerations Fog seal can only be applied if the temperature of the surface being applied is above 50°F. If the temperature falls below 60°F, it is good practice to periodically check to see that the fog seal “breaks” is cured before opening to traffic. See Section 401.3.2 for additional information.

407.1.4-Maintenance of Traffic See Section 401.1.7 for information on maintenance of traffic during construction.

407.1.5-Equipment Considerations See Section 405.1.5 for information on the asphalt material distribution equipment and the aggregate spreading equipment typically used in fog seal operations.

407.2-CONSTRUCTION OPERATIONS

Unless otherwise designated in the Contract Plans, the proper sequence of operations for cleaning and sweeping and applying asphalt materials, including rates of application, will be as specified in Section 407 of the Specifications. The following sections discuss typical construction operations and present general inspection guidelines.

407.2.1-Surface Preparation The surface preparation activities discussed in Section 405.2.1 also apply to the application of fog seal. All repairs to existing surface should be complete and cured sufficiently prior to placement.

407.2.2-Application of Asphalt Material The temperature and application rate of asphalt material for fog seal is defined in Section 407 of the Specifications. See 405.2.2 for additional guidance. Document points of inspection on the appropriate attachment of the Daily Work Report.

407.2.3-Application of Aggregate Material An application of blotter course of sand or stone chips may be applied over asphalt material to absorb excess asphalt material. After the blotter course is spread, check for deficient areas and have the Contractor correct the deficiency by spreading additional sand or stone chips. Where trucks are used to spread the material, do not allow the Contractor to operate the trucks on areas with asphalt material that does not require covering.

407.3-RECORDS AND DAILY REPORTS

Section 111 discusses the general requirements of project records and daily work reports. See Section 401.5 for additional information on records and daily reports for paving projects. Consider and document the following key inspection points on the attachment for fog seal in the Daily Work Report:

1. Check and verify that the required equipment is on site and in good working order.
2. Check and verify that traffic control devices and flaggers are in place. At the end of the day's work, ensure that signs that are not needed during non-working hours are covered or removed.
3. Verify that the proper type and quantity of asphalt materials are available. Note the method of determining quantities (e.g., dip stick, dial gauge, delivery tickets). As required, record quality sampling information (e.g., ticket number, material type and source, samples, stockpiles and location references, laboratory numbers).
4. Check that surface preparation is in conformance. Verify that the surface has been properly cleaned and swept and that surface breaks, holes, depressions, and other damage has been repaired. The surface must not have standing water when the operation begins.
5. Verify for conformance and record the temperature and application rate of the asphalt material. Calculate and record the application rate twice, minimum, in the morning and afternoon. Check that vehicles are not operating on asphalt material that does not have aggregate cover. Periodically check for evidence of clogging in spray nozzles. Verify that the asphalt material is applied uniformly with a triple overlap.
6. Record the air and base temperature twice, minimum, in the morning and afternoon.

407.4-MEASUREMENT FOR PAYMENT

Measure the quantity of Fog Seal based on the quantity, in gallons, of asphalt material (prior to dilution) incorporated in the work. Any applicable dilution rates are to be supplied to the Project Inspector on the material delivery ticket. The project records will include the volume applied in the project based on readings from the distributor truck's volume gauge or calibrated tank. All quantities will be paid for at the Contract unit prices for the items.

SECTION 408
TACK COAT

408.1-GENERAL

Section 401 covers many topics that are applicable to tack coat operations. Section 401.1 covers general topics including asphalt materials, quality control, Job Mix Formulas, maintenance of traffic, preconstruction conferences, and safety considerations. Sections 401.2, 401.3, and 401.4, respectively, present a significant number of topics and inspection guidelines for HMA production and hauling, laydown and compaction, and troubleshooting equipment and mat problems, which are generally applicable to the application of tack coat. The following sections present information relative to the application of tack coats.

408.1.1-Description of Work Where tack coat is designated in the Contract Plans, it generally refers to preparing and treating an existing HMA or PCC pavement surface with asphalt material to ensure a thorough bond between the old and new courses. Tack coats are used primarily in connection with the higher types of asphalt pavements. The Contract Plans will designate the location, lines, grades and, where applicable, the number of aggregate courses, course thickness, and cross section for the work. The Project Inspector is responsible for ensuring that the Contractor performs the work in conformance with the Contract Plans and Specifications.

408.1.2-Aggregate and Asphalt Materials The asphalt material (i.e., type and grade) for tack coat will be specified in the Contract. Quality criteria for asphalt and aggregate materials acceptable for use in tack coat applications are referenced in Section 408 of the Specifications. Check to ensure that the materials are from an approved source (i.e., laboratory number) and are the proper materials for use in the operation.

408.1.3-Weather Considerations Tack coat can only be applied if the temperature of the surface being overlaid is above 40°F. If the temperature falls below 50°F, it is good practice to periodically check to see that the tack coat "breaks" before applying an HMA surface course. See Section 401.3.2 for additional information.

408.1.4-Maintenance of Traffic See Section 401.1.7 for information on maintenance of traffic during construction.

408.1.5-Equipment Considerations See Section 405.1.5 for information on the asphalt material distribution equipment and the aggregate spreading equipment typically used in tack coat operations.

408.2-CONSTRUCTION OPERATIONS

Unless otherwise designated in the Contract Plans, the proper sequence of operations for cleaning and sweeping and applying asphalt and aggregate materials, including rates of application, will be as specified in Section 408 of the Specifications. The following sections discuss typical construction operations and present general inspection guidelines.

408.2.1-Surface Preparation The surface preparation activities discussed in Section 405.2.1 also apply to the application of tack coat. Note that minor (spot) areas that have been tacked, patched and leveled may be retacked and the quantity used in the second tacking included for payment. This is discussed further in Section 408.4.

408.2.2-Application of Asphalt Material The temperature and application rate of asphalt material for tack coat is defined in Section 408 of the Specifications. Although applicable to surface treatments, the application of a prime coat for new base construction is not applicable to tack coat operations. Note that the areas receiving spot patching and leveling, as discussed in Section 408.2.1, will be initially tacked, then patched and leveled, then retacked. This is further discussed in Section 408.4. See 405.2.2 for additional guidance. Document points of inspection on the appropriate attachment of the Daily Work Report.

408.2.3-Application of Aggregate Material An application of blotter course of dry sand or stone chips may be applied over the asphalt material to absorb excess asphalt material. It may be necessary to direct the Contractor to wash the aggregate with water to eliminate or reduce the dust coating on the aggregate. If this treatment is needed, it should be performed the day before the aggregate is spread. After the blotter course is spread, check for deficient areas and have the Contractor correct the deficiency by spreading additional sand or stone chips. Where trucks are used to spread the aggregate, do not allow the Contractor to operate the trucks on areas with asphalt material that does not have a cover. See Section 405.2.3 for additional guidance.

408.2.4-Joints Check that vertical face of longitudinal joints are thoroughly coated without excess runoff.

408.3-RECORDS AND DAILY REPORTS

Section 111 discusses the general requirements of project records and daily work reports. See Section 401.5 for additional information on records and daily reports for paving projects. Consider and document the following key inspection points on the attachment for tack coat in the Daily Work Report:

1. Check and verify that the required equipment is on site and in good working order.
2. Check and verify that traffic control devices and flaggers are in place. At the end of the day's work, ensure that signs that are not needed during non-working hours are covered or removed.
3. Verify that the proper type and quantity of aggregate and asphalt materials are available. Note the method of determining quantities (e.g., dip stick, dial gauge, delivery tickets). As required, record quality sampling information (e.g., ticket number, material type and source, samples, stockpiles and location references, laboratory numbers).

4. Check that surface preparation is in conformance. Verify that the surface has been properly cleaned and swept and that surface breaks, holes, depressions, and other damage has been repaired. The surface must not have standing water when the operation begins.
5. Verify for conformance and record the temperature and application rate of the asphalt material. Calculate and record the application rate twice, minimum, in the morning and afternoon. Check that vehicles are not operating on asphalt material that does not have aggregate cover. Periodically check for evidence of clogging in spray nozzles. Verify that the asphalt material is applied uniformly with a triple overlap.
6. Record the air and base temperature twice, minimum, in the morning and afternoon.

408.4-MEASUREMENT FOR PAYMENT

All quantities will be paid for at the Contract unit prices for the items. Use the following guidelines when determining the payment quantities for tack coat:

1. Patching and Leveling. Where patching and leveling is designated in the Contract Plans, it may be for either a spot improvement (i.e., surface preparation) or full-width treatment. The underlying surface is normally "tacked." Where the tack-coat bid item is designated in the Contract Plans, it refers to a full-width treatment. Tack coat is not placed over a full-width, patching-and- leveling course. The surface preparation work of the tack-coat bid item includes spot improvements (i.e., small areas that must first be tacked then patched and leveled). Where the Contractor performs the work for the tack-coat bid item, it is therefore possible to have small areas where tack material is placed both under and over patching-and-leveling material. When payment is made for the tack-coat bid item, the quantity of tack under the patching-and- leveling material should not be included in the quantity for tack coat placed and accepted. The cost of the underlying tack material will be included in the unit bid price for the minor patching-and-leveling work. Payment for the tack coat operation applies only to the quantity of materials placed over the previously prepared surface.
2. Asphalt Materials. Measure the quantity for payment, in gallons, of asphalt material (prior to dilution in the field) incorporated in the work. Any applicable dilution rates are to be supplied to the Project Inspector on the material delivery ticket. The project records will include the volume applied in the project based on readings from the distributor truck's volume gauge or calibrated tank. Volume-temperature corrections will apply as discussed in Section 401.2.6.3 of this Manual.
3. Maintenance of Traffic. Maintenance of traffic will be measured and paid as provided in Section 636 of the Standard Specifications.

SECTION 410
ASPHALT BASE AND WEARING COURSES, PERCENT WITHIN LIMITS (PWL)

410.1-GENERAL

This work shall consist of constructing one or more courses of asphalt on a prepared foundation in reasonably close conformity with the lines, grades, weights or thicknesses, and cross sections shown on the Plans or established by the Engineer. The unit of measurement for asphalt will be by the square yard. The following Materials Procedures (MP) apply:

1. MP 401.02.31 QC & Acceptance
2. MP 401.07.20 Sampling Loose Asphalt Pavement Mixtures
3. MP 401.07.21 Sampling Compacted Asphalt
4. MP 401.07.22 Thickness of Asphalt Concrete Using Cores
5. MP 401.07.23 Bond Strength
6. MP 401.07.24 Pavement Macrotexture
7. MP 401.07.25 Evaluation of Asphalt Pavements
8. MP 401.13.50 Determination of PWL

410.2-CONTRACTOR'S QUALITY CONTROL

Quality control of the asphalt pavement is the responsibility of the Contractor. The Contractor shall maintain equipment and qualified personnel including at least one certified Asphalt Plant Technician at each plant. The technician shall be in charge of all plant quality control activities such as mix proportioning and adjustment and all sampling and testing activities necessary to maintain the various properties of asphalt within the limits of the specification. The Contractor shall maintain necessary equipment and qualified personnel including at least one certified Asphalt Field and Compaction Technician at each project during paving operations. Additionally, a certified Asphalt Field and Compaction Technician with certification to perform nuclear density testing of asphalt pavements shall perform all testing necessary to assure compaction of the asphalt meets specification requirements.

410.3-JOB MIX FORMULA FIELD VERIFICATION

For each JMF, a mix design field verification shall be conducted during the first days of plant production in accordance with the guidelines established in MP 401.02.31. The field verification is for the purpose of demonstrating that the JMF can be produced within the specified tolerances set forth in the MP 401.02.31. If the mix cannot be produced within these requirements, a new mix design will be required.

410.4-QUALITY CONTROL TESTING REQUIREMENTS

After the JMF design field verification has been successfully completed, sampling frequency and test requirements for quality control shall be as set forth as in MP 401.02.31. If the Division determines that a mix cannot be consistently produced within the tolerance limits of the specified design properties, approval of the mix may be revoked, and the contractor will be required to provide a new mix design.

410.5-ACCEPTANCE TESTING

Material from the paving of the traveled lanes and shoulders will be accepted in the field on a lot by lot basis. Lots will be established cumulatively and will be specific for each JMF. Each lot consists of five equal sublots (n=5). A completed sublot will have cores obtained for Pavement Density, and Bond Strength and a Loose Mixture sample for gradation and asphalt content. Samples for mat density and bond strength shall also be used to measure lift thickness prior to any preparation for density or bond strength. All field samples shall be obtained from locations determined as per MP 401.07.20 and MP 401.07.21. A normal lot size is 2,500 tons with five, 500-ton sublots (n=5), unless operational conditions or project size dictate otherwise. If operational conditions or project size dictate, readjustment of the lot will be made as specified in Table 410.7.1 in the Specifications. Breakdowns or stoppages of short periods due to such causes as weather or equipment failure will not be considered as reason to adjust the lot size. The original lot will be continued when work resumes after stoppages of less than 5 days. If a lot is terminated due to a stoppage of 5 days or more, adjust the lot size and number of sublots as specified in Table 410.7.1.

Immediately after each sample is taken, it shall be identified by labeling or otherwise with the following information:

1. Contract ID
2. State Project Number
3. Sample Type (density, bond, loose, etc.)
4. Pavement Course (surface, base)
5. Lot Number
6. Sublot Number
7. Date
8. Sampled By

A sample labeling standard is shown in MP 401.07.20 Sampling of Loose Asphaltic Pavement Mixtures and MP 401.07.21. Upon fully identifying, marking or labeling, and securing, samples shall be transported to the District Materials Laboratory for testing unless otherwise indicated in the proposal.

410.6-MIXTURE ACCEPTANCE SAMPLES

The Inspector will select sample locations in each sublot according to MP 401.07.20 Sampling of Loose Asphaltic Pavement Mixtures. The Inspector or in the presence of the Inspector, one loose mixture sample shall be obtained for each sublot. This sample is to be taken directly from the uncompacted mixture and immediately processed in accordance with the MP.

410.7-COMPACTION

Compaction testing for mat density shall be performed for all traveled lanes, ramps and shoulders. Acceptance of mat density shall be in accordance with 410.13.3. Maximum density values that are supplied by the asphalt producer shall be verified by the District Materials staff by determining the theoretical maximum specific gravity in accordance with AASHTO T209 Theoretical Maximum Specific Gravity (Gmm). This verification of Gmm shall be conducted once per lot for all mixes, or one in each five reported values from the asphalt producer. Joint density testing is required. Lots for joint density shall also be established cumulatively and laid out as per the applicable provisions within MP 401.07.21. A normal lot size for evaluation of joint density is 10,000 linear feet of constructed joint with five, 2000 feet long sublots unless operational conditions or project size dictate otherwise. Lots for joint density determined to be 4000 feet in length or less shall be incorporated into the previous full lot and two samples shall be taken and the lot be evaluated with seven samples (n=7). Lots for joint density that are greater than 4000 feet in length shall have samples taken representative of each 2000 foot long sublot or portion thereof. Acceptance for joint density shall be as per 410.13.4. Patching-and-leveling and scratch courses shall not be included in determining the total new pavement thickness to be tested for compaction. When asphalt is placed in areas that require a non-uniform thickness or is tapered to a thin edge, the method of acceptance testing shall be determined by the Engineer. Acceptance testing is not required on areas in which a full-size roller is restricted from compacting the mat properly. These areas shall be compacted to the satisfaction of the Engineer.

410.8-SHOULDERS AND RAMPS

As per MP 401.07.21, shoulders and ramp areas that are constructed simultaneously with the mainline are not included in the sampling plan. However, these simultaneously constructed shoulder and ramp areas shall be included in the lot of the adjacent mainline for the purposes of penalty and bonus calculations for compaction and mixture properties. Shoulders that are constructed independently of the mainline shall be tested as per MP 401.07.21. However, compaction penalty calculations for these independently constructed shoulders shall not apply.

410.9-THICKNESS

Thickness testing shall be performed on all traveled lanes and shoulders. Cores obtained for mat density and bond strength will both be measured for thickness as per MP 410.07.22 Measurement for Thickness of Asphalt Pavement Using Drilled Cores, prior to those subsequent analyses. The core measurements which represent the thickness of the sampling units shall be analyzed to determine the average value of the pavement thickness. Pavement Thickness (T), shall include all of the pavement layers as specified excluding any patch and level course and scratch courses. This value will be used to determine the degree of compliance with the provisions and to develop certain factors to be used in the derivation of equitable deductions as set forth in Section 410.13.5, in the event the provisions of this Specification are not met.

410.10-BOND STRENGTH

Bond testing shall be performed on all traveled lanes and shoulders. Additionally, Bond Tests will be performed for all surface layers beginning with the Existing Pavement layer and then all intermediate pavement layers called for in the Proposal and Plans. However, if a scratch course is called for in the plans, then a bond test will be performed at the scratch course layer and the first new surface pavement layer, not between the existing pavement layer and the scratch course layer.

410.11-SURFACE TOLERANCE

Shall be in accordance with Section 720 on the finished mat.

410.12-PATTERN SEGREGATION

Pattern segregation is continuous or repeated areas of nonuniform distribution of coarse and fine aggregate particles in the finished mat. The Division will address pattern segregation as outlined in the Specifications. Pattern segregation evaluation shall be carried out according to the Specifications.

410.13-DEFECTIVE PAVEMENTS

At locations selected by the Engineer and with the Engineer present, drill three 6-inch diameter cores from the area of pattern segregation and three cores from the pavement representing a non-segregated area. Do not compress, bend, or distort samples during cutting and handling and immediately provide the cores to the Inspector. The Inspector will transport cores to the producer's laboratory. With the Engineer present, test the cores at the plant for density, asphalt content, and gradation. Additional cores and/or additional testing as per MP 401.07.24 Measuring Pavement Macrotexture Depth can be used to further evaluate the pavement. An area of pattern segregation contains defective pavement if:

1. The summation of absolute deviations from any two sieves is 20% or more from the JMF;
2. The core density is defective, the mixture is defective in asphalt content or;
3. The mixture is defective for percent passing the 75 µm (No. 200) sieve.

The core density is defective, or the cores are defective for asphalt content or gradation of the 75 µm (No. 200) sieve if the PWL is less than 55 as determined in accordance with MP 401.13.50 and based on three samples (n=3). Remove and replace the full width of the affected lane and a minimum of 5 feet beyond each end of the area with unacceptable pattern segregation. Construct replacement pavement conforming to the appropriate surface tolerances

410.14-FLUSHING

Provide a mix that will not flush. Flushing is continuous or repeated areas of excessive asphalt on the pavement surface. The Division may recognize flushing until the Division approves the project through final inspection. The Division will address flushing as outlined in the Specifications.

410.15-PLANTS

All plants shall meet the general requirements set forth in AASHTO M156 unless it can be demonstrated to the satisfaction of the Engineer that a consistent quality mix can be produced with modifications to any of these requirements. All plants in West Virginia producing asphalt for the Division shall provide documented evidence of compliance with current requirements of the West Virginia Air Pollution Control Commission. All plants which are not in West Virginia but producing asphalt for the West Virginia Division of Highways shall provide documented evidence of compliance with current requirements of the laws and regulations of the State in which they are producing, applicable to air pollution.

410.16-DUST COLLECTOR

An efficient dust collecting system shall be provided to prevent the loss of fine material. The material collected may be returned to the mixture at a uniform rate or discarded.

410.17-TRUCK SCALES

Truck scales shall be provided at each Plant, except that truck scales are not required at properly calibrated automatic batching plant facilities which are equipped with digital printout equipment, and which load the trucks directly from the mixer or the weigh hopper in a surge or storage silo. A person designated as a weigher shall be provided by the producer. The duties of the weigher are outlined in the Specifications.

410.18-SURGE AND STORAGE SILOS

During the normal daily operation of the plant, asphalt may be stored in a surge or storage silo for a maximum of 12 hours, provided the silo has received prior evaluation and acceptance through the District plant inspection. The resulting temperature of the material at time of placement and compaction shall be sufficient to comply with 410.10.3 and 410.10.4 Longer silo storage times, up to 24 hours, may be permitted for dense graded asphalt if the storage silo is insulated and/or heated to assure that the proper mix temperature is maintained. The gates at the bottom of the storage silo shall be adequately heated and sealed when the asphalt is held for the extended period of time. When asphalt is stored for the extended time period, it shall not be used until the temperature has been checked and the asphalt has been visually inspected for hardening of the mix and stripping of the asphalt from the aggregate. Approval of the extended storage time may be revoked if it is determined through inspection and/or testing that the extended storage is having a detrimental effect on the asphalt.

410.19-INSPECTION OF EQUIPMENT AND PLANT OPERATIONS

The Engineer shall have access to the plant to assure the adequacy of the equipment in use, to inspect the conditions and operation of the plant, to verify weights, to verify the proportion and character of materials, and to determine if specified temperatures are being maintained in the preparation of the mixture.

410.20-TRUCKS FOR TRANSPORTING MIXTURE

The use of diesel fuel, kerosene, or similar solvent-based products which can dissolve the asphalt film from the aggregate particles will not be permitted for use as a release agent. Any commercial release agent which is certified as harmless to the mix may be used; however, the Division reserves the right to restrict any release agent that is shown to cause problems during placement of the mix. All excess release agent shall be removed from the truck bed prior to loading the asphalt. All truck beds shall be insulated with approved material. No trucks shall be used which cause segregation of the materials, which show large oil leaks, or which cause undue delays in delivery of material. All trucks shall be provided with a waterproof cover and a hole in the body for the purpose of conveniently checking the temperature of the load. Covers shall be suspended slightly above the mixture, shall extend over the sides of the truck, and shall be securely fastened to eliminate air infiltration and to prevent water from coming in contact with the mixture.

410.21-LABORATORY

A testing facility or laboratory, as described below, shall be provided within reasonable proximity of the asphalt plant. Plant operations must be visible from within the laboratory. The laboratory shall be of sufficient size to hold all laboratory test equipment and supplies with adequate floor space to allow the technicians to test samples in an efficient manner. The laboratory shall be furnished and maintained with adequate ventilation, heat, light, water, sink and drainage, electrical or gas outlets, or both, worktable, shelves, and supply cabinets. The laboratory shall be supplied with the equipment and materials listed in the Specifications and these shall be maintained to meet the applicable requirements of AASHTO or ASTM.

410.22-ASPHALT PAVING EQUIPMENT

Asphalt paving equipment shall be self-contained and of sufficient size, power and stability to receive, distribute and strike-off the asphalt mixture at rates and widths commensurate with the typical sections and other details shown on the plans. The Specifications outline the requirements for the paver.

410.23-COMPACTION EQUIPMENT

Compaction may be performed by self-propelled steel-wheeled, pneumatic-tired and/or vibratory rollers. Hand-held rollers or vibrating plates may be used in small inaccessible areas if approved by the Engineer. Prior to use on any project, the roller shall be inspected to see that it is in good mechanical condition. The total weight, weight per inch of width (steel-wheeled), and average ground contact pressure (pneumatic-tired) shall be documented.

410.24-SPREADING AND FINISHING

Before spreading any material, the contact surfaces of curbs, gutters, manholes, and of adjacent Portland cement concrete pavement edges shall be painted or sealed with asphalt material. The exact procedures for this are outlined in the Specifications.

410.25-PROTECTION OF PAVEMENT AND TRAFFIC CONTROL

The Contractor shall be responsible for the protection of asphalt surfaces from damage by their equipment and personnel. When the construction of asphalt surfaces is undertaken on projects under public traffic and the road surface is 16 feet wide or greater and the ADT is 400 or greater, the Contractor shall place no passing signs, Interim pavement markings, and Temporary pavement markings to delineate the edge line, centerline, and/or lane line of the roadway as required herein and in the project plans. The provision of Section 336: Maintaining Traffic shall apply. Interim markings are described as markings applied to freshly resurfaced roadways between lifts and after placement of the final lift prior to opening the portion of the roadway being resurfaced to traffic. These markings are intended to provide the minimum amount of delineation required for safe navigation of the roadway, and are to be succeeded by Temporary markings within a three (3) to fourteen (14) day period, based on the type of roadway and AADT, as specified herein. Interim and Temporary markings shall conform to the requirements of Section 663: Pavement Markings.

410.26-METHOD OF MEASUREMENT

Asphalt will be measured by the Square Yard (SY). The quantity will be determined by the Plan Quantity as provided for in the proposal unless otherwise directed by the Engineer. Any patching or leveling mixture placed on a subbase or base course constructed in the same Contract with the asphalt items shall be at the expense of the Contractor. No additional compensation will be allowed for the material or any work incidental to its placement unless otherwise approved by the Engineer.

SECTION 415
MILLING OF ASPHALT PAVEMENT SURFACES

415.1-GENERAL

415.1.1-Description of Work These Contract bid items are a cold milling operation that is typically specified to remove all or part of an existing asphalt pavement surface and/or new asphalt pavement to: remove distressed pavement, restore cross section, provide constant cross slope, improve profile, restore clearances, improve drainage, provide skid resistance, and/or to prepare the existing pavement for the placement of additional courses. The pavement will be removed at the locations, depths, widths and in accordance with the typical sections contained in the Contract Plans. The surface cleaned, flushed, and prepared suitable for maintaining traffic prior to resurfacing. The following types of milling may be specified:

1. Standard Millings. This method of removal is most common and possess a minor level of profile and slope control. It is typically used for asphalt overlay or other process.
2. Fine Millings. Fine Millings are used when a thin lift asphalt course or when control of the profile of the milled surface is important.
3. Micromilling. This milling is typically used for smoothness correction, skid correction, bump and/or grade corrections on existing or newly paved surfaces. It is not intended to be used when standard overlays are to be used.

The Project Inspector is responsible for ensuring that the Contractor performs the work in conformance with the Contract Plans and specification.

415.1.2-Maintenance of Traffic Prior to opening milled areas to traffic, check that the Contractor has:

1. Sloped transverse vertical faces so as not to create a traffic hazard;
2. Longitudinal vertical faces do not exceed 2 in, and;
3. The pavement surface has been cleaned by sweeping or flushing.

See Section 401.1.7 for additional information on maintenance of traffic.

415.2-INSPECTION GUIDELINES

415.2.1-Equipment Considerations Equipment for cold milling include self- propelled planers or grinders. These machines must be capable of removing the existing pavement to within tolerance of the required depth of cut and slope. Consider the following:

1. Grade-Control. A grade-control system on the machine is typically used to automatically control the longitudinal profile and cross slope of the milled surface. The system references input from one or more skid sensors moving along the pavement surface or from a preset fixed reference line.

2. Uniform Surface. It is important that the milling machine leave a uniform surface suitable for maintaining traffic, if necessary, without excessive damage to the underlying pavement structure.
3. Material Removal. An integral loading means may be provided to remove the material being cut from the roadway. This material is usually discharged into haul trucks in a single operation. The advantage of this system is that windrow operations are not required.
4. Obstructions. The milling machine should have a control system to uniformly vary the depth of cut while the machine is in motion to prevent cutting or damaging drainages works, manholes, and other appurtenances. Additional equipment may be necessary to remove the pavement in the area of manholes, water valves, curb and gutter, and other obstructions.
5. Dust Considerations. The milling equipment should be equipped with a means to effectively limit the amount of dust escaping from the removal operation.

415.2.2-Milling Operation The Contract Plans will indicate the type of milling (standard, fine, micro), and may include depth, width, grade and cross section for removal. The milling operation should be continually checked to determine that the proper depth of milling has been achieved, that the proper profile and cross slope are achieved, and that the surface texture is free from longitudinal ridges and has a uniform pattern. Consider the following additional guidelines:

1. Surface Uniformity. The machine must be operated to produce a uniform surface. Improper adjustment can cause long swales and other irregularities. Changes in the resulting surface are primarily dependent on changes in the forward speed of the milling machine and the speed of the mandrel. If the machine is leaving a coarse or rough surface and traffic is maintained on the milled lanes, have the Contractor to slow the forward speed of the milling machine to obtain a smoother surface.
2. Surface Damage. Inspect the pavement cutting operation to ensure that the pavement is not torn, gouged, shoved, broken, or otherwise damaged so that the base is unsuitable for a HMA overlay.
3. Cuttings. The cut material may be windrowed behind the miller or directly loaded into haul trucks for transport. It should not be permitted to flow across lanes used by the traveling public or into gutters or drainage facilitates. Disposal or wasting of oversize pieces of pavement or loose aggregate material should not be permitted within the right-of-way. Unless designated areas are identified in the Contract Plans, or approved by the Engineer, stockpiling of the cut material in the right- of-way is not permitted. The cut material is the property of the Contractor, unless noted otherwise in the plans. Cut material from milling operations can be effectively used as additional aggregate in HMA RAP mixtures, subgrade material, or as substitute for Class 10 shoulder stone.
4. Cleaning. The milled pavement surface should be thoroughly cleaned of all loose aggregate particles, dust, and other objectionable material by the use of a power broom, power blower, power vacuum, or similar means.
5. Dust. The pavement removal operation should be conducted to effectively minimize the amount of dust being emitted.

6. Safety. The operation should be planned and conducted so that it is safe for persons and property adjacent to the work including the traveling public. At the end of the day's work, a smooth transition should be provided to the existing, unmilled pavement. Longitudinal vertical faces should not exceed 2 in.

415.3-RECORDS AND DAILY REPORTS

Section 111 discusses the general requirements of project records and daily work reports. See Section 401.5 for additional information on records and daily reports for paving projects. Use the appropriate attachment to the Daily Work Report and consider the following guidelines during inspection:

1. Check that the locations of water, gas valve, manholes, etc. have been properly marked to avoid damage during milling.
2. Check that traffic control devices and flaggers are in place.
3. Check that the width and length limits of milling have been established and properly marked.
4. Verify width and length measurements at all break points that are recorded.
5. Check that the cross section conforms to the Contract Plans after the milling operation. One check should be performed each 2,000 ft, minimum. The surface should be removed to the depth shown on the plans.
6. Verify that haul trucks are not interfering with the flow of traffic.
7. Verify that vertical transverse is sloped to not present a hazard and longitudinal faces greater than 2 in are sloped, prior to reopening to traffic.
8. Check that the pavement is cleaned and swept prior to reopening to traffic.
9. Verify that sidewalk areas are properly cleaned and swept.
10. Check that milled material is stockpiled or removed from the project site, unless otherwise denoted on the Contract Plans.

415.4-MEASUREMENT FOR PAYMENT

Measure the quantity of pavement milled based on the total number of square yards that was planed or ground, without regard to the number of passes or to the thickness of the material removed. Payment will be based on the unit price specified in the Contract.

SECTION 420
SINGLE / MULTIPLE COURSE MICRO SURFACING

420.1-GENERAL
Micro surfacing is a surface treatment designed to extend the life of asphalt pavements in good condition by providing skid resistance, restricting moisture intrusion, protecting the structure from further oxidation and raveling, and restoring a uniform black appearance. Micro surfacing boasts quick construction times and minimal disruption to the traveling public.

420.1.1-Description of Work Micro Surfacing is a mixture of a quick setting polymerized asphalt emulsion, fine aggregate, Portland cement, water, mineral filler, and other additives. These materials are mixed into a slurry and placed onto existing pavements as a pavement preservation treatment that can also correct minor pavement surface flaws. It may be used on low and high traffic volume roadways to fill ruts, improve friction, shim transverse and longitudinal joints, improve the ride, and stop raveling and aggregate pop-outs. This treatment should only be used on structurally sound pavements without extensive cracking or other deterioration.

This pavement preservation treatment can be applied in one or two courses and does not require compaction. Traffic can usually be placed back onto the roadway within one hour under ideal weather conditions. However, the time required is determined by the Micro Surface and dependent upon the mix design and environmental conditions. Nightwork will generally require longer set times because of cooler temperature and higher humidity. The following may be specified:

1. Micro Surface Single Course
2. Micro Surface Multiple Course

420.1.2-Aggregate and Asphalt Materials The aggregate material used for surface treatments chip seal is a fine aggregate material. Section 420 of the Specifications specifies the types of aggregate and asphalt materials that should be used for each type of available Micro Surface treatment.

3FA: Type 3FA microsurfacing is typically used on higher volume roads. Type 3FA has larger aggregate with increased skid resistance in comparison to type 2FA. Type 3FA is typically used when a high skid resistance is required, or when placing a rut fill or leveling course.

2FA: Type 2FA microsurfacing is typically used on lower volume roads instead of Type 3FA. Type 2FA has smaller aggregate than Type 3FA. Lower volume roads which have lower speed limits do not require the same level of skid resistance that higher volume roads require. Type 2FA is generally quieter and smoother.

Rut Fill: Rut fill is used when traffic over time has created ruts in the lines of the wheel-paths of traffic. Rut fill should be used to address ruts over ½ ʻʻ deep.

420.2-MIX DESIGN AND MATERIALS

Ensure that a complete mix design has been done. Ensure what's being delivered to job site matches the mix design for the project. Ensure that all materials used are according to the mix design. Aggregate should be clean and free of deleterious materials. Aggregate should not be wet. Ensure that the emulsion temperature is within application temperature specification. Section 420.2 of the Specifications specifies the types of aggregate and bituminous materials that should be used for each type of available micro surfacing.

420.3-WEATHER CONSIDERATIONS

Ensure that the air and surface temperatures have been checked at the coolest location on the project. Air and surface temperatures must be at least 45 degrees Fahrenheit. High temperatures, humidity, and wind will affect how long the emulsion takes to break. Application should not begin if rain is likely or overnight temperatures could be freezing. Always check weather radar to guard against unexpected rain.

In the event that light rain has fallen on fresh micro surfacing, a road closure should be strongly considered until the pavement surface is dry and can be reopened to traffic. A heavy rain may wash the micro surfacing emulsion off the top of the aggregate. A road closure is required and the micro surfacing emulsion must be allowed to dry and set. Once set, sweep all loose aggregate off the pavement surface and reopen to traffic. A new micro surfacing can be placed over the remaining material.

420.4-MAINTENANCE OF TRAFFIC

Ensure that the signs and devices used match the traffic control plan. The setup must comply with WVDOH requirements. Signs should be removed or covered when they no longer apply. Any unsafe conditions are reported to a supervisor (contractor or agency). If traffic must cross the micro surface during the curing process, make sure they drive carefully and slowly. Also try to have drivers travel in a straight line across the microsurface – to avoid the need to turn their tires, which would cause marks on the microsurface. Otherwise, Traffic Control will be in accordance with Section 636, and the Manual on Temporary Traffic Control for Streets and Highways, or as directed by the Engineer.

420.5-EQUIPMENT

420.5.1-Mixing Machine Ensure the machine is fully functional as well as correctly calibrated with the materials to be used. The name of the person who carried out calibration and documentation should be provided. Ensure spreader rubbers are clean and not worn. All paddles in the pugmill should be intact. Ensure that the spreader box is clean and is a micro surfacing type box.

420.5.2-Broom The bristles should be long enough to effectively sweep the roadway. The broom can be adjusted vertically to avoid excess pressure.

420.5.3-Stockpile Stockpile site is well drained and clean. Contractor should have the necessary equipment to work with the stockpile.

420.5.4-Equipment for Continuous Run Operations Ensure that all equipment is free of leaks. Flow boys or other nurse units should be clean and functional. Ensure that there are enough units to allow continuous running with minimal stops for cleaning box rubbers.

420.5.5-Spreader Box or Rut Box Ensure that the spreader box or rut box is in complete working condition to perform the intended job.

420.5.6-Miscellaneous Equipment Hands Tools and other accessories to perform the job should be available when needed.

420.6-CONSTRUCTION OPERATIONS

420.6.1-Surface Preparation Ensure that the surface is clean and dry. Major pavement distresses should be repaired. The existing surface has been inspected for drainage problems. Walk or drive the entire pavement to be paved for the day to ensure the surface has been properly prepared.

420.6.2-Truck Operation Trucks should be staggered across the fresh tack coat to avoid driving over the same area. Trucks should travel slowly on the fresh tack coat. Stops and turns should be made gradually. Truck operators should avoid driving over micro surfacing. Trucks should stagger their wheel paths when backing into the continuous unit. Ensure enough trucks are on hand to keep a steady supply of material for the micro surfacing paver.

420.6.3-Application Required rates for rut filling and leveling have been calculated or estimated separately. More material is applied to dried-out and porous surfaces. Less material is applied to smooth, nonporous, and asphalt-rich surfaces.

During the application process there are a few common problems that may arise, it is important to be aware of these potential issues as well as know what the causes and solutions to these problems could potentially be. Poor Joints can be a result of a few different issues such as: Too much water or not enough water at start-up. Runners of spreader box running on fresh micro surfacing—use water spray or let the mixture cure longer. Too much or not enough overlap may suggest an inexperienced line driver.

Debonding is another issue that can be avoided by doing the following: Ensure the existing pavement has been swept free of dust and debris. Material characteristics of the existing pavement surface is reducing or preventing bond. The equipment is leaking oil, hydraulic fluid, or spilling dry aggregate. Extensive grease spots or oil saturated surfaces has been cleaned with industrial detergents. For severe problems, acrylic seals are available for oil spot treatment.

Tire Marks and Surface Abrasions (Scuffing) is another issue that can be avoided by doing the following: Place the micro surface during the cooler weather. Broadcast sand on the new surface to break the bond. Avoid using light colored sand, which may discolor the micro surfacing.

Verify that the paver is traveling at the proper speed (no faster than a “brisk” walking pace).

Breaking is a term used to indicate when the water and emulsion begin to separate which is indicated by the emulsion turning from a brown color to a black color. This is something that’s supposed to happen but it should be noted that its important when the breaking takes place.

420.6.4-Longitudinal Joints The meet lines should not be made in the wheel paths. The meet lines are made at the center of the road, center of a lane, or edge of a lane. The meet line is overlapped only 3 inch maximum. The slurry unit spreader box runners do not run on fresh mat.

420.6.5-Transverse Joints All emulsion applications must begin and end on building paper. Ensure that the mixture is not overly wet at start-up. Building paper is disposed of properly.

420.7-TEST STRIP

A test strip should be placed in conditions similar to those that are expected to occur during the project. Problems to be aware of concerning the test strip are below.

420.7.1-Drag Marks Clean spreader box strike-offs and check aggregate supply for oversized stone. The application rate may be too low for the given gradation.

420.7.2-Flush Surface Reduce water content and increase additive. Increase cement. Allow longer time before traffic. The application rate may be too high for the given gradation.

420.7.3-Uneven Surface - Washboarding Assure the paver is not moving too fast. Spreader box is incorrectly set up and the skis are not running smoothly on the pavement. Viscosity of the mix is too high. Add extra additive or water. Mix is breaking too fast. Ambient temperature is too high. Use water sprays on front of spreader. Check strike-off material for compatibility with the application. Depending on the situation, a harder or softer strike-off may be needed.

420.7.4-Excessive Raveling Mix is breaking and curing too slowly. Make mix faster; add cement. The application rate is too low for the given gradation. The mixture is too dry. The wrong strike-off material is being used. Wait until cured before opening to traffic. Traffic or equipment speeds too high. Sweeping or trafficking before the emulsion is properly set.

420.7.5-Mixture is Breaking Too Quickly Temperature variations may require a change in the amount of additive used to control the break from the amount in the mix design. Keep the mixture in constant movement. The spreader box must be equipped with augers to keep the mix in motion. Allow the operator to control the mixture by adding additives to help slow the break. The aggregate has changed and is not consistent with the job mix formula.

420.7.6-Mixture is Breaking Too Slowly Suspend operations until temperature is within the recommended application range. Never allow application outside of the recommended temperature range. In shaded areas, when possible, place the treatment early in the day to provide extra time to facilitate breaking and curing. The aggregate has changed and is not consistent with the job mix formula.

420.7.7-Unsatisfactory Surface Finish from Handwork Try to time handwork for early in the day when cooler ambient and pavement temperatures allow extra time for the mixture to be worked before the set begins. Water should be sprayed on the surface first to be sure the material does not dehydrate during placement. When large areas require handwork, apply small amounts of material at a time and avoid segregation by not overworking the handwork area. Add a little more break time by using more additive. Do not add extra water in the mixture.

420.7.8-Depressions in the Wheel Path Shortly after Rut-Filling If rutting appears before the top micro surfacing layer is applied, there may be too much asphalt in the mixture. Rutting that is irregular or less than ½ in. deep should use a full-width scratch coat. The maximum thickness of a scratch coat is 1 in. Wheel path ruts greater than ½ in. should be filled with a rut box. The rut box must crown the deepest portion of the rut ¼ in. for each 1 in. of rut to allow for traffic compaction. Ruts in excess of 1 in. require multiple placement passes with the rut box.

420.7.9-Adhesion to Crack Sealants and Fillers Before placing crack treatment, obtain crack treatment manufacturer's information about suitability as a micro surfacing pretreatment. Avoid overfilling cracks with sealant. Allow crack treatment sufficient time to cure prior to placing the micro surfacing. Sealant cure time can range from several weeks to several months.

420.7.10-False Break or False Slurry Wet the surface with water to help keep pavement temperatures down. In severe cases, it may be necessary to work earlier in the day before the temperature elevates. Heavy applications of micro surfacing during hot weather may skim over causing water to be sealed inside the mat. Check the break time. Check calibration of placement machine and compliance of materials with the mix design and the job mix formula. Keep traffic off the surface.

420.7.11-Grade Flow Partially compensate by diverting mixture to the higher part of the spreader box. This should only be attempted by an experienced operator. For an uphill application use a more fluid micro surfacing mixture. For a downhill application use a stiffer micro surfacing mixture. Check the spreader box auger clearance over the pavement to properly distribute the mixture.

420.7.12-Non-Uniform Appearance of the Finished Surface Ensure that the placement machine has been properly calibrated. All materials are consistent with the job mix formula. Assure the strike-offs are tight and cleaned frequently. The mixture consistency is uniform throughout the application. A constant application rate is being applied.

420.8-CLEANUP AND RETURN TO NORMAL FLOW OF TRAFFIC

All loose aggregate from brooming is removed from roadway. Excess emulsion and spills are removed.

Pavement markings should be placed before opening pavement to normal traffic. All construction-related signs are removed when opening pavement to normal traffic. Do not allow traffic on the mixture until it has cured sufficiently to prevent pickup by vehicle tires. The new surface must be able to carry normal traffic without damage within one hour of application. Protect the new surface from damage at intersections and driveways. Repair all damage to the mixture caused by traffic. All costs associated with this repair work will be borne by the Contractor.

420.9-RECORDS AND DAILY WORK REPORTS

Section 111 discusses the general requirements of project records and Daily Work Reports. See Section 401.5 for additional information on records and daily reports for paving projects. Use the appropriate attachment to the Daily Work Report.

Micro Surfacing projects should record the following information in DWR for each truck mounted machine (as outline in 420.4.10 of Specification):

a. Control section, job number, route, Engineer
b. Date, air temperature
c. Control settings, calibration values
d. Unit weight of emulsion (lbs/gal), percent residue in emulsion
e. Beginning and ending intervals
f. Counter readings (beginning, ending, and total)
g. Length, width, total area (sq yd), weight of aggregate, gallons of emulsion
h. Percent of each material including asphalt cement
i. Application rate, (lbs/sq yd), combined application rate, (lbs/sq yd)
j. JMF (percent Portland cement, percent emulsion, gradations, percent asphalt cement)
k. Contractor's authorized signature
l. Calibration forms
m. QC aggregate gradations
n. Aggregate certification
o. Asphalt emulsion bill of lading
p. QC sand equivalent test results

420.10-MEASUREMENT AND PAYMENT

All quantities will be paid for at Contract unit prices for the bid items. Use the following guidelines when determining the payment quantities for micro surfacing:

Micro Surface Multiple Course & Micro Surface Single Course. The quantity of pavement Micro Surface will be paid by square yards, as listed in project plans or proposal. Payment will be based on the unit price specified in the Contract.

Micro Surface Rut Fill. Measure the quantity for payment, in tons, of Micro Surface rut fill in place and accepted. The measurement will be based on the delivery ticket for each truck load or digital printout from the plant.

DIVISION 500
RIGID PAVEMENTS

SECTION 501
PORTLAND CEMENT CONCRETE PAVEMENT

501.1-GENERAL

The performance of Portland cement concrete (PCC) pavement depends primarily on the adequacy of the pavement's structural and mix design and the quality achieved in producing, placing, consolidating, and finishing the mix. Although adequate designs may be ultimately specified, misunderstood, or misapplied specifications and the use of poor construction techniques and improper equipment operations can greatly affect pavement quality. Section 501 of the Specifications establishes the respective obligations of the Contractor and WVDOH. The following Sections present specific WVDOH policies, procedures, and additional clarifying information on PCC pavement construction.

501.1.1-Description of Work The construction of PCC pavements is a highly mechanized operation that requires inspection of a vast quantity of material and a working knowledge of numerous types of equipment. The Project Engineer/Supervisor and the Project Inspectors assigned to the work should be thoroughly familiar with the details of the Contract Plans and Specifications, Special Provisions, Quality Control Plan, Maintenance of Traffic Plan, and specific orders of work. In general, the Project Inspector is responsible for ensuring that component materials and the final PCC mix conform to the quality requirements of the Contract and that production is in conformance with the Contractor's Quality Control Plan. The Project Inspector also is responsible for ensuring that the PCC pavement is constructed on a suitably prepared subgrade or base course. The final PCC pavement should conform to the lines, grades, thickness, typical sections, and surface smoothness requirements of the Contract. As with any construction operation, the work zone should be frequently checked for conformance with the Maintenance of Traffic Plan.

501.1.2-Source Approvals, Laboratory Numbers, and Certifications Material source approvals, laboratory numbers, and certifications (e.g., certificates of compliance) must be obtained in accordance with appropriate WVDOH policies and procedures before the materials are used in the work. Check that such approvals and certificates have been properly obtained, placed in ProjectWise, and enter the required materials in AWP Materials module (refer to AWP Materials manual for additional information). The Contractor is responsible for notifying the Project Engineer/Supervisor of any change in the source of materials, because such changes may require submittal of a revised Mix Design Plan. See Section 501.1.8 for additional information.

501.1.3-PCC Mix Materials The following Sections discuss the component materials that are typically used to produce Portland cement concrete pavement mixes.

501.1.3.1-Aggregate Materials Regardless of whether aggregate materials are tested at the source or the job site, a test report and laboratory number will accompany the delivery of the material. Check the documents for acceptability before the material is incorporated in the work. Ensure that laboratory numbers are properly documented on the appropriate attachments, placed on ProjectWise and entered in AWP under the Materials section. The material specifications for fine and coarse aggregates are governed by Sections 702.1 and 703.1 of the Specifications. Consider the following:

1. Supplementary Cementitious Material Additives. Supplementary Cementitious Material (SCM) additives generally include fly ash, slag cement, and silica flume. It is acceptable for the Contractor to use such additives as long as the material conforms to the requirements of Section 707.4 of the Specifications. The Contactor first must obtain source approval from the Division. Where SCM material is stored at the job site, check that the material is enclosed in weatherproof bins and kept free from contamination. Material from different sources or lots should be stored separately. Additivities are not permitted when Portland blast-furnace slag cement (Type IS) or Portland-pozzolan cement (Type IP) are used. Note: They are permitted when Portland-limestone cement (Type IL) blended cement is used.
2. Recycled Materials. On reconstruction projects, the Contract Plans may specify PCC pavement recycling. The pavement generally will be broken in place (rubbilized), crushed, and screened. The resulting aggregate material then will be as base material for either asphalt/PCC pavement or reused in the new PCC mix. Existing reinforcing steel exposed at the surface and HMA overlay material, if present, will be removed and disposed of properly. If material is reused in PCC mix, all reinforcing steel and HMA material, if present will be removed, to minimize contamination of the recycled material. Observe the breaking operation for extensive disturbance of the underlying subgrade or base material. Such disturbance may require unnecessary reworking of the subgrade.

501.1.3.2-Cement Material The materials specifications for cement are defined in Sections 701.1 and 701.3 of the Specifications. The Division generally requires pretesting and source approval. Verify that the Contractor is using an approved source. During the operation, the Contractor may stockpile cement material at the job site. In such instances, check that the material is kept dry and free of contamination and that material from different sources are stored separately. Maintain records on the length of time the Contractor stores cement on the job site. Retesting may be required if the material is stored for a period greater than 90 days. Material failing such tests will be promptly removed from the job site so that it will not be incorporated in the work.

501.1.3.3-Mix Water Water from public treatment systems is generally acceptable for use in Portland cement concrete mixes. However, water from other sources must be pretested and approved in accordance with MP 715.07.20 and frequently monitored for compliance. Where a pipe or hose is used to draw water from a stream or standing water, check that the intake end is covered with wire mesh and is maintained free of foreign matter. Water from temporary settlement containers should be drawn above the layer of sediment. Where water is hauled to the job site, check that the haul containers are clean and properly covered. The Project Inspector at the plant is responsible for quality assurance of water where central mixing or ready-mix facilities are used. If on-the-job or site mixing operations are used, the quality assurance of water is the responsibility of the Project Inspector at the paving site.

501.1.3.4-Admixture Materials The use of admixtures in Portland cement concrete is generally governed by the following:

1. Air-Entraining Admixtures. Air-entraining admixtures are governed by the requirements of Section 707.1 of the Specifications for tests, source approval, and certification. Check that the Contractor uses approved sources and that proper certification is supplied.
2. Water-Reducing and Retarding Admixtures. As required, the Contractor may use either water-reducing or water retarding admixtures in a batch of PCC mix, but not both. Sections 707.2 and 707.3 of the Specifications define the test, source approval, and certification requirements. Check that the Contractor uses approved sources and that proper certification is supplied.

501.1.4-PCC Pavement Construction Materials The following Sections discuss ancillary materials typically used during the construction of Portland cement concrete pavements.

501.1.4.1-Types of Reinforcing Steel Verify that reinforcing steel is stored on blocks, dunnage, etc. above ground to prevent rusting from standing water. Depending on the requirements of the Contract Plans, the following types of reinforcing steel may be used in the PCC pavement:

1. Steel Bar Reinforcement. The testing and acceptance criteria for reinforcing bars are governed by Section 709.1 of the Specifications. In general, this material will be shipped from a source that has been approved by the Division in accordance with the provisions of MP 709.01.50; otherwise, material sampling and testing will be conducted in conformance with MP 700.00.01. Special storage and handling are required to maintain the integrity of epoxy-coated rebars. Check that the Contractor adequately covers epoxy-coated rebars that are stored at the job site. Prolonged exposure to sunlight can degrade the epoxy coating. In addition, periodically spot check the material as it is unloaded and incorporated in the work. If mishandled, the epoxy coating can be damaged, which exposes the underlying steel. If the damage is repairable within the provisions of the Contract, request that the Contractor repair the material before it is incorporated in the work. If the damage exceeds specified limits, the material should be rejected and promptly removed from the job site.
2. Welded-Wire Reinforcement. The testing and acceptance criteria for welded-wire reinforcement is governed by Section 709.4 of the Specifications. Where welded-wire reinforcement is used for PCC pavement construction, the Division requires the use of sheet stock, not rolls. If the Contract Plans call for epoxy- coated reinforcement, check the material for damage and needed repairs.

501.1.4.2-Chairs and Ties Chairs and ties are typically used to seat and secure the steel reinforcement within PCC pavements. Check that the use of such materials meets the requirements of the Contract Plans and Specifications. Plastic or coated chairs and ties are typically required to minimize rusting and damage to epoxy-coated reinforcing steel.

501.1.4.3-Coated Dowel Bars Section 709.15 of the Specifications governs the material specifications for coated dowel bars. MP 709.01.51 and MP 709.15.50, respectively, govern certification requirements for the coating applicator and the manufacturer. Check the bars upon delivery for any damage to the coating. Reject and have removed from the job site any material that does not meet specified requirements.

501.1.4.4-Joint Tie-Bolt Assemblies The materials specifications for joint tie-bolt assemblies are governed by Section 709.7 of the Specifications. Periodically check that tie-bolt assemblies are properly fastened to forms. Typical construction details are illustrated in the Standard Detail Book – Volume I and may be included in the Contract Plans.

501.1.4.5-Curing Materials Materials that are typically used for curing PCC pavements (e.g., polyethylene coated burlap, burlap cloth, waterproof paper, liquid membrane, white polyethylene sheeting) are defined in Sections 707.6 through 707.10 of the Specifications. Upon delivery, check the material for any damage. Acceptance is based on visual inspection. Document laboratory numbers on the DWR.

501.1.4.6-Joint Sealant Materials Three types of joint sealant materials are typically used in PCC pavement construction: preformed expansion joint filler, preformed elastomeric joint seals and lubricant-adhesive, and Type I low modulus silicone joint sealant and back-up material. Sampling and testing requirements and acceptance criteria for these materials are defined in Sections 708.1, 708.2, and 708.4 of the Specifications.

501.1.5-Governing Materials Procedures The Contractor is responsible for quality control of PCC materials and pavement construction, and the Division is responsible for acceptance sampling and testing. See Sections 701 and 702 for information on material control policies and procedures. Section 703 defines the samples and tests typically required by the Division. As needed, see the following Materials Procedures (MP) for additional clarification:

1. MP 601.03.51 – Standard Method for Determining Totals Solids in Portland Cement Concrete.
2. MP 601.04.20 – Curing Concrete Test Specimens in the Field.
3. MP 700.00.01 – Sampling and Testing of Materials at the Source.
4. MP 702.00.20 – Determining Free Moisture in Fine Aggregate Using a Speedy Moisture Tester.
5. MP 709.01.50 – Certification of Producers of Steel Bars for Concrete Reinforcement.
6. MP 709.01.51 – Acceptance Criteria for Epoxy Coated Reinforcing Steel.
7. MP 711.03.23 – Mix Design for Portland Cement Concrete.
8. MP 711.03.26 – Maintaining Specified Level of Strength in PCC

9. MP 715.07.20 – Standard Method of Test for Determining the Quality of Water Used with Hydraulic Cement.
10. MP 601.03.50 - Guide for Quality Control and Acceptance Requirements for Portland Cement Concrete
11. MP 601.03.52 - Procedural Guidelines for Maintaining Control Charts for Portland Cement Concrete
12. MP 601.04.21 – Acceptance Use of The Maturity Method for The Estimation of Concrete Strength on WVDOH Projects
13. MP 700.00.30 - Certification of Batch Scales and Calibration of Standard 50 Pound Test Weights (Replaced ML-23)
14. MP 700.10.01 - Non-Destructive Thickness Determination of Pavements Using Magnetic Imaging Tomography Technology

501.1.6-Quality Control Considerations The following Sections discuss topics that should be considered with respect to the Contractor's responsibilities for quality control.

501.1.6.1-Quality Control Plan The Contractor is responsible for developing a Quality Control Plan in conformance with the requirements of MP 601.03.50 and the contract specifications. The Contractor will generally submit the Quality Control Plan at the Preconstruction Conference. Do not permit the Contractor to begin work until the Quality Control Plan has been thoroughly reviewed for compliance with the Contract. During construction, check that the Contractor is conducting sampling and testing in accordance with the Quality Control Plan. See Section 702.4.3 for additional information on Quality Control Plans.

501.1.6.2-Technician and Inspector Certification Check to ensure that the Contractor has at least one certified Portland Cement Concrete Technician on site to direct quality control operations and an adequate number of certified Portland Cement Concrete Inspectors to perform the field sampling and testing required by the Contract. See Section 705 for additional information.

501.1.7-Quality Acceptance Consideration The following Sections discuss topics that should be considered with respect to the Division's responsibilities for quality assurance.

501.1.7.1-Compressive Strength Evaluation for Opening to Traffic For each day's paving operation, a minimum of three sets of three concrete test cylinders will be made from the PCC mix. Sampling and testing will be conducted in accordance with Section 501.4.4 of the Specifications. The results of compressive strength tests on the specimens will be used to monitor acceptability for opening the paved section to traffic. In general, the paved section will not be opened prior to 28 days, or longer as conditions warrant, after it has been placed and finished. The Project Engineer/Supervisor may, however, permit an earlier opening if test results indicate the paved section has attained its design strength. Prior to opening, check that the paved section has been properly cleaned, signed, marked, and cleared of all obstructions.

The Maturity Method, as outlined in MP 601.04.21, shall also be permitted to be used to determine when the pavement may be opened to traffic.

501.1.7.2-Compressive Strength Evaluation for Acceptance The procedures in Section 501.4.5 of the Specifications shall be used to evaluate compressive strength for project acceptance. If a pavement section fails to meet acceptance criteria, enforce the provisions of the Contract with respect to removal of unacceptable work. Although compressive strength is a primary evaluation factor, the Project Engineer/Supervisor may use other criteria such as freeze- thaw durability, scaling characteristics, abrasion resistance, and density to assess the acceptability of the pavement.

501.1.7.3-Pavement Thickness Evaluation for Acceptance Prior to the start of paving operations, the Project Engineer/Supervisor will contact MCS&T Division and coordinate the placement of the metal plates, which will be used for determination of pavement thickness by the non-destructive method. Within 28 to 90 days after completion of paving and grinding operations, and prior to final acceptance, the Project Engineer/Supervisor will use the procedures in Section 501.19 to evaluate pavement thickness for project acceptance. The Division will apportion the highway proper and auxiliary features (e.g., intersections, entrances, exists, crossovers, ramps) into sampling units and take a minimum of one thickness measurement at each location (see Section 501.19 of the Specifications). Thickness measurements will be performed by a non-destructive method, as outlined in MP 700.10.01. When conditions at a location are such that thickness measurement by a non-destructive method is not possible, then cores shall be taken and used to determine the pavement thickness. The core samples will be measured, and the results of the non-destructive thickness measurements and cores will be analyzed for acceptance. Based on the results of the analysis, additional samples and price adjustments may be warranted. If a paved section fails to meet acceptance criteria, enforce the provisions of the Contract with respect to removal of unacceptable work. If a dispute or claim is anticipated, preserve the core samples so that measurements can be verified by others.

501.1.7.4-Procedures for Pavement Strength and Thickness Evaluation Use the following procedures to evaluate compressive strength and thickness for acceptance of PCC pavements:

1. Prior to the start of the paving operation, the District Construction Engineer, or designee, will prepare a straight-line diagram of the pavement identifying key locations by station number. Locations will include beginning and end stations of paving, beginning and end stations of all interchanges, beginning and end stations of each approach slab and structure, stations representing the location and length of entrance and exit areas in urban projects, and station equalities on the project, if applicable.
2. The District Construction Engineer will submit the diagram to the Director of the Materials Control, Soils & Testing Divisions with a letter of transmittal requesting that the project be tested for pavement thickness.

3. A representative from MCS&T Division will develop a thickness measurement plan based on this straight-line diagram and contact the Project Engineer/Supervisor to coordinate the placement of the metal plates which will be used for the non-destructive measurement of the pavement thickness.
4. After all grinding operations have been completed and within 90 days after the pavement is placed, the Materials Control, Soil and Testing Division will measure the pavement by the non-destructive thickness measurement method and take any cores which are necessary to determine the pavement thickness and perform pavement thickness analyses in accordance with the requirements of the contract specifications. Compressive strength tests for pavement acceptance will be conducted by the Contractor and the Division during construction as outlined in MP 601.03.50 and Section 501.4.5 of the Specifications. The results will be documented in a Materials Inspection Report (MIR).
5. The Director of the Materials Control, Soil and Testing Division will forward the Pavement Thickness MIR to the District Construction Engineer, one copy to the Director of the Contract Administration Division, and one copy to the Federal Highway Administration, as applicable.
6. As part of the tentative final for the project, the District Construction Engineer, or designee, will analyze the Pavement Thickness MIR and make recommendations to the Project Engineer/Supervisor. Price adjustments may be warranted based on the provisions of the Contract. Such adjustments are typically entered on the estimate once the Pavement Thickness MIR becomes available. Early resolution of deficiencies will minimize paperwork and will expedite the project's final estimate and final audit.

501.1.7.5-Refilling Holes After Pavement Coring After the pavement is cored for acceptance evaluation, the Contractor is responsible for refilling core holes at no additional cost to the Division. Failure to do so will promote water infiltration and cause subgrade/subbase failures. It is preferable to fill the holes with the PCC mix used on the project; however, if unavailable, the Contractor may use a non-shrink grout meeting the requirements of Section 715.5 of the Specifications. See the Materials Control, Soil and Testing Division website for a list of acceptable grout materials.

501.1.7.6-Surface Smoothness Evaluation for Acceptance Within 5 calendar days after all lanes are continuously open, the Project Engineer/Supervisor will submit "Bridge and Pavement Testing Request" form to MCS&T to evaluate the smoothness of the final riding surface using an inertial profilometer. The pavement will be divided into sampling units (i.e. lengths of paved sections) and tested in accordance with Section 501.13 and Section 720 of the Specifications. A paved section will be considered acceptable if it exhibits a smoothness value that meets or exceeds the contract specifications. Price adjustments may be warranted based on the provisions of the Contract. Paved sections failing to meet specified requirements by 50% or greater will not be considered acceptable and will be corrected in accordance with the provisions of the Contract (e.g., grinding, sandblasting, leveling with epoxy bonded mortar, reestablishing surface texture). Where a smoothness profile is run across a joint that demarks different project termini (e.g., existing pavement adjoining new, bridge approach adjoining mainline under separate contract), pay particular attention to how smoothness is evaluated across the joint and how the cost of any corrective measure is apportioned. The Division's ultimate objective is to provide the public with a smooth riding surface, regardless of the number of contractors involved.

501.1.8-PCC Mix Design Plan The Contractor is responsible for developing a Mix Design Plan in accordance with the criteria presented in MP 711.03.23. The Mix Design Plan will become a permanent project record. The Mix Design Plan will include:

1. Mix proportions;
2. Gallons of water per sack assumed in arriving at mix quantities;
3. Specific gravity, dry rodded weight per cubic foot and percent absorption of fine aggregate, coarse aggregate (fine fraction), and coarse aggregate (coarse fraction);
4. Target percent of air assumed in arriving at mix quantities;
5. Batch weights for a cubic yard of air-entrained concrete;
6. Source of materials; and
7. Certified test data from a Division-approved laboratory ensuring the adequacy of the mix (e.g., compressive strength, consistency).

Generally, the Contractor will submit the Mix Design Plan to the Project Engineer/Supervisor at the Pre-Construction Conference. The paving operation will not begin until the Mix Design Plan has been checked for conformance with MP 711.03.23 and the contract specifications. The certified PCC Technician will use the Mix Design Plan to control mixing and batching operations. During the project, the Contractor will immediately notify the Project Engineer/Supervisor of any need to change materials (e.g., source, proportions, admixtures). Such requests are generally for the purpose of adjusting yield, strength, or consistency, and the Contract provisions may require the Contractor to submit a revised Mix Design Plan.

501.1.9-Paving Limitations and Pavement Protection The following Sections discuss topics that should be considered with respect to paving limitations and protection of the newly constructed pavement.

501.1.9.1-Cold-Weather Paving Normally, the mixing and placement of concrete should be discontinued when the ambient temperature reaches 40°F and is descending. Operations should not be resumed until the ambient temperature reaches 35°F and is ascending. If paving is anticipated during the colder months of the year, the Contractor's PCC Paving Plan should adequately address cold-weather paving. Consider the following guidelines:

1. Temperatures Below 55°F. Enforce the Contract provisions for cold weather paving when the temperature of the plastic concrete drops below 55°F. Under such cases, the Contractor must provide adequate means to heat and maintain the temperature of the plastic concrete between 50°F and 85°F during placement. When it is necessary to heat component materials (e.g., mixing water, aggregates), check that the Contractor uniformly heats the material to the required temperature and that the temperature of the material does not exceed 150°F. Overheating must be

avoided through close monitoring. Acceptable methods of heating will be defined in the provisions of the Contract. Note that methods of heating which alter or prevent air entrainment and the use of live steam on or through binned aggregate material will not be permitted.

2. Temperatures Below 35°F. When the ambient temperature is expected to fall below 35°F, check that the Contractor adequately covers the pavement with a suitable blanketing material of sufficient thickness to prevent freezing of the concrete during curing. Do not allow the Contractor to use frozen material or pave over frozen subgrade or base material.

501.1.9.2-Hot-Weather Paving When paving is to be performed during the hotter months of the year, the Contractor's PCC Paving Plan should adequately address hot weather paving. During hot, dry, and windy conditions, precautionary measures are required to prevent rapid surface drying and unacceptable temperature increases in the concrete during curing. Such conditions may remove moisture from the paved surface faster than it can be replaced by normal bleeding. This will cause shrinkage cracks to form. Consider the following guidelines:

1. Temperatures Above 85°F. Enforce the Contract provisions for hot weather paving when the ambient temperature approaches 85°F. Under this condition, monitor the temperature of the plastic concrete frequently. When the plastic concrete itself reaches 85°F, ensure that mixing time does not exceed 45 minutes and that the Contractor is sprinkling or wetting the subgrade and forms, maintaining the aggregate in a saturated surface-dry condition, and promptly beginning the curing operation. The application of curing material immediately after finishing is extremely important and, under some conditions, it may be necessary to place wet burlap or cotton mats on the surface for the first 24 hours. If the wet burlap or mat is removed, ensure that Contractor replaces it with an approved curing material during the remaining curing period.
2. Temperatures Above 90°F. When the temperature of the plastic concrete reaches 90°F, take immediate action to ensure cooling of component materials (e.g., water, aggregate). The introduction of crushed or flaked ice in the mixing water or mixer is acceptable as long as the water proportion is properly adjusted. Under no circumstance allow the Contractor to pave with a mix that exceeds 90°F after mixing.

501.1.9.3-Inclement Weather Prior to starting the paving operation, check that the Contractor has sufficient material on hand (e.g., forms, burlap, cotton mats, curing paper, polyethylene sheeting) to properly protect the exposed surfaces of any unhardened concrete. The washing effect of sudden showers and downpours will remove the cement component from these surfaces. If rain is imminent, inform the Contractor to cease mixing, paving, and finishing operations and immediately cover the exposed unhardened surfaces. Under such cases, the Contractor still must finish the surface of the freshly poured concrete. This may be accomplished in one or two ways as follows:

1. Brief Showers. If the shower is brief, the Contractor may completely remove the protective covering after it rains and then finish the surface of the freshly poured concrete.
2. Continuous Showers. For continuous showers, the Contractor must repeatedly roll back the protective covering approximately 3 ft. at a time, finish the surface, and replace the covering without marring the finished surface.

As soon as practical, inspect the surface for defects, and immediately inform the Contractor of any needed repairs. Note your findings and directives to the Contractor on the appropriate attachment on the DWR.

501.1.9.4-Protection of Pavement The edges and the surface of the finished PCC pavement must be protected against damage from vehicular traffic and construction equipment. The edges of slabs in areas where traffic is permitted to cross the new pavement prior to shoulder construction is especially susceptible to damage. Wood blocking, for example, may be used along and against the edge of the slab to minimize potential damage from cross traffic. Visually inspect the edges and surface before acceptance and ensure that the Contractor repairs any damage.

501.1.10-Maintenance of Traffic (MOT) Plan All DOH construction projects will provide for the safe and efficient maintenance of traffic through the work zone. Large and complex paving jobs typically require a Maintenance of Traffic (MOT) Plan; however, smaller, and less complex jobs will require the use of sound engineering judgment. In either case, the type and location of warning signs, barricades, pavement markings, flagger, pilot trucks, and flashers for either daylight or nighttime operations must be in conformance with the WVDOH Manual on Temporary Traffic Control for Street and Highway. During the project, check to ensure that the Contractor is operating in conformance with the requirements of the Contract and document your findings on the appropriate attachment of the DWR. Require immediate correction of non-conforming items. See Section 636 for additional information on maintaining traffic.

501.1.11-Safety Considerations Job safety at both the plant and the paving site cannot be overemphasized. Both Division and Contractor personnel must continually practice safe working habits. Occupational Safety and Health Administration (OSHA) regulations must be understood and followed by all personnel. Each person should clearly understand what is expected them and how to perform their assigned tasks. Dust, noise, haul trucks, pavers, and traffic moving through the work area all pose potential hazards. New personnel should be properly instructed, and seasoned personnel should not become lackadaisical or careless. Constant care and vigilance are needed to prevent accidents and injury. It is wise to periodically remind personnel that they are operating in a potentially dangerous environment. If an unsafe work practice is observed, corrective action should be taken immediately, even if the operation has to be temporarily shut down. See Section 107.2.3 of this Manual for additional guidance on construction project safety.

501.1.12-Preconstruction Conference Section 103.3 of this Manual discusses activities that should be considered before construction. Section 103.3 specifically addresses the requirements of the Preconstruction Conference (e.g., purpose and need, arrangement and scheduling, attendees, facilitation). The Preconstruction Conference will establish an overall cooperative tone and ensure that all parties involved understand the project and are ready for production work. Prior to starting production and paving operations, the Project Engineer/Supervisor will arrange a meeting with the Project Inspectors and the Contractor's Supervisory Personnel to discuss source and handling of materials, plant site and operations, equipment, methods of operations, and any special requirements of the Contract. The minutes of the meeting will be documented and distributed to the appropriate personnel.

501.1.13-Communication During Project During the project, quality and safety depend on continued positive and meaningful communication with the Contractor. Frequent informal meetings provide a forum for meaningful dialog to mitigate potential cost and scheduling problems. In addition, frequent communication between plant and paving personnel during production provides critical feedback to ensure a quality pavement. Key points of discussions should be noted in the DWR.

501.2-PCC PRODUCTION AND HAULING

Based on the provisions of the Contract, concrete may be mixed at the paving site, hauled to the site from a plant, or mixed en route to the site using truck mixers. Inspection of these production methods and hauling equipment cannot be overemphasized. They are key to producing a quality PCC pavement. Project Inspectors in charge of production and acceptance must fully appreciate the linear nature of the paving project – from raw component materials to final slab. Quality greatly depends on the attention given during each step. No amount of extra effort at the paving site can compensate for errors and omissions at the site of production. Regardless of the methods employed, Project Inspectors must ensure that the mix conforms to the contract specifications before it is incorporated in the work.

501.2.1-Inspection and Certification of Production Facilities The Division must certify PCC production facilities (e.g., batch plants, central-mix plants) before use. Prior to certification, the Division will inspect the site, operation, and hauling equipment to ascertain adequate supply and control of materials. Scales and weigh hoppers, either manual or automated, will be inspected as discussed in Section 708.1. Meter proportioning equipment will be inspected as discussed in Sections 708.2.2 and 708.2.3. Before production, check that production facilities have been properly inspected and certified. Become familiar with the equipment and operation, and check for obvious signs of unacceptable use or mechanical condition. Verify that systematic and regular checks are conducted in accordance with WVDOH policy. Do not adjust production settings, scales, or meter proportioning equipment, because this is the Contractor's responsibility.

501.2.2-Material Storage and Handling The following Sections discuss topics that should be considered with respect to material storage and handling.

501.2.2.1-Aggregate Stockpiles Fine and each size fraction of coarse aggregate material will be separately stored in stockpiles or bins. Check that bins are properly maintained to provide a free flow of material without inadvertent intermingling. See Section 401.4.2.3 for additional information on stockpiling.

501.2.2.2-Moisture Considerations The mix design assumes latent moisture, so aggregate must be maintained in a saturated surface-dry condition. Excessively dry conditions may warrant wetting at night and sprinkling during the day, but the storage facility must be capable of draining excess water. Verify that moisture tests are conducted as specified and require additional testing as conditions warrant. Such monitoring is critical to maintaining the water-cement ratio within tolerance.

501.2.2.3-Fly Ash and Cement Storage Fly ash and cement must be kept dry in weatherproof bins. Dark clumps of material are a sign of previous wetting and may be grounds for rejection.

501.2.2.4-Segregation/Acceptance Considerations Become familiar with the physical characteristics of acceptable materials, and check for signs of segregation, intermingling, contamination, and breakage. Segregation is common and typically begins with improper handling. Serious segregation is grounds for rejection. Before production, verify source approvals, laboratory numbers and certifications (see Section 501.1.2), and enforce the provisions of the Contract with respect to rejection. Document all findings, including laboratory numbers, on the appropriate attachment of the DWR.

501.2.3-Mix Proportioning Aggregate, cement, water, and admixture materials will be proportioned based on the requirements of the PCC Mix Design Plan (see Section 501.1.8). It is good inspection practice to become familiar with the Mix Design Plan including control charts, mix proportions, and methods of determining scale weights and batch quantities. Scales and meter proportioning equipment must be inspected and certified (see Section 501.2.1).

501.2.3.1-Aggregate and Cement Proportions Aggregate and cement typically are proportioned by weight using certified scales and weigh hoppers. The tolerance for weighing aggregate material is ±2%. Because the cement proportion is tightly controlled to within ±1%, a separate hopper and scale is normally used for cement. During production, check to ensure cement is discharged completely without loss due to excessive dusting or spillage.

501.2.3.2-Water Proportion Water will be proportioned by either weight or volume. Inspect connections in the supply line for obvious signs of leakage. Control valves must close completely to prevent delivery of an excessive quantity.

501.2.3.3-Proportioning of Admixtures Admixtures (e.g., air entrainment, water reducers, water retarders) generally are supplied in liquid form. They are introduced by means of a positive, automatic mechanical dispenser at the time water is discharged into the mixer. If more than one type of admixture is used, each will be separately proportioned. Each supply tank will have a gage indicating the quantity remaining. Check gages periodically to verify proportioning and supply. Visually inspect each supply line for positive flow and obvious signs of leakage.

501.2.4-Mixing Equipment and Methods The following Sections discuss topics that should be considered with respect to the equipment and methods that are typically used to mix Portland cement concrete for pavement construction.

501.2.4.1-Typical Mixing Operation After the aggregate, cement, water, and admixture materials have been properly proportioned, they are placed in the mixing unit (e.g., truck-mixer, stationary mixer). A small quantity of the liquid component (i.e., water and admixtures) will be introduced first. The remainder of the liquid component will then be introduced uniformly with the aggregate and cement so that the mixer is completely charged within the first 15 seconds of the required mixing period. Mixers generally have a drum configuration with a series of internal blades. The rotating action of the drum-blade combination lifts and kneads the materials into a uniform mass suitable for paving in terms of consistency and workability. Each mixer generally will have a manufacturer's plate that prominently displays volumetric and rotational speed capacities. Minimum mixing time will be either specified or established (see Section 501.2.5).

501.2.4.2-Mixer Performance and Maintenance The PCC Technician is responsible for assessing mixer performance. Mixer performance is generally assessed based on three concrete samples per test batch taken at intervals during discharge as specified in the Contract. Check to ensure that these tests are performed as required. See Section 501.2.6 for additional information. Both stationery and truck mixers must be maintained in good working order to minimize delays during production. Consider the following guidelines:

1. Blade Wear. The mixer's blades must be carefully inspected and monitored for wear. The majority of wear will occur at the center of the blade with very little wear at the tips. If worn ¾ in. or more, discontinue use of the mixer until the blades can be either repaired or replaced. Several methods may be used to check blades for excessive wear. Consider the following:
   a. Straightedge. A straightedge, or stringline, can be placed along the length of the blade. The amount of wear can be determined by measuring the distance between the edge of the blade and the edge of the straightedge or stringline at the blade's midpoint.
   b. Telltale. Permanent marks (e.g., holes ¼ in. in diameter) can be provided ¾ in. from the edge of new blades near the midpoint of the length of each blade. This will provide a readily visible check for excessive blade wear.
   c. Manufacturer's Brochure. Blade measurements can be taken and compared to the dimensions illustrated in the manufacturer's brochure. The Con- tractor is responsible for providing this brochure.
2. Leaks and Spills. Causes of obvious mortar leaks and spills should be addressed and corrected immediately.

3. Cleaning. The throat of the drum and the mixing blades can become fouled with hardened or semi-hardened concrete and, if left unchecked, can cause ineffective mixing and fouling of subsequent batches. Check to ensure that mixers are properly cleaned at suitable intervals.
4. Wash Water. Wash water from auxiliary tanks, if not completely drained from the mixer, will invariably be used in a succeeding batch. Check that a suitable means of measuring this water is employed or require that the mixer be completely drained between batches.

501.2.5-Mixing Time Mixing time begins when the component materials are placed in the mixer. Concrete that is mixed less than the established minimum is grounds for rejection. Require adjustments, if needed, and make appropriate entries on the proper attachment to the DWR. In no case should the volumetric or speed capacity of the mixer exceed the manufacturer's recommendations.

501.2.5.1-Truck-Mixer Operations In truck-mixer operations, component materials are mixed for either a specified amount of time or a specified number of revolutions at normal mixing speed. Check the speed of the drum- blade rotation to ensure that it is within specified limits. Close coordination between Project Inspectors at the plant and the paving site is required to ensure proper mixing. Check delivery tickets, revolution counters, and timing devices frequently to verify mixing time.

501.2.5.2-Other Mixing Operations Mixing time generally should not be less than 75 seconds (i.e., 60 seconds plus 15 seconds for each additional cubic yard of batch). However, a shorter mixing period can be established if the Contractor demonstrates the adequacy of the resultant mix. Mixing time is typically controlled by a timing device and automatic discharge locking system. An audible warning device signals when the discharge lock is released. Using a stopwatch, check the mixing time from charge to discharge at least once a day during production to verify proper adjustment of the control system. In multiple drum-mixer operations, include the transfer time between drums.

501.2.6-Mix Property Checks and Adjustment The certified PCC Technician is responsible for overseeing testing to make certain mix properties are within tolerance of the contract specifications. Unless otherwise directed, seven production batches will be sampled, and each property tested should not exceed tolerance in more than one test batch. Grounds for rejection will be based on the type and magnitude of the infraction. When conditions change (e.g., materials, batch size, mixing operation, hauling method), additional testing may be required. It is good practice for the Project Inspector to review the PCC Mix Design Plan and become familiar with mix proportions, methods of determining batch quantities, yield, effective water and cement factor, and the procedures for adjusting mix proportions. During production, changing conditions will invariably require mix adjustments. The PCC Technician will immediately notify the Project Engineer/Supervisor of any needed adjustments (e.g., changes in material source or proportions, introduction of admixtures), because Contract provisions may require the Contractor to submit a revised Mix Design Plan.

501.2.6.1-Field Laboratory Requirements The Contractor is responsible for furnishing a field laboratory to maintain adequate control over the quality of materials and work on the project. Sampling and testing will be defined in the Contractor's Quality Control Plan. Prior to production, check that the Contractor locates the facility to permit reasonable observation of key operations and furnishes the facility in accordance with contract specifications. During production, check that the facility is maintained in a clean and orderly condition for the most effective work.

501.2.6.2-Aggregate Gradation Checks Verify that gradation and uniformity are checked at least once each production day and more frequently as conditions warrant (e.g., changes in aggregate source, use of multiple stockpiles). If outside specified limits, halt production until corrected in accordance with the provisions of the Contract.

Note that changes in aggregate source will require a new mix design.

501.2.6.3-Strength Checks and Adjustment Make periodic checks of the quantity of cement used. Compare the actual quantity (i.e., the difference between total supply and quantity remaining) to the theoretical quantity determined from the PCC Mix Design Plan. Ensure that the compressive strength is monitored and that the cement factor is adjusted as needed in accordance with the provisions of the Contract. If MP 711.03.26 is used to control the cement factor, the minimum specified criteria should be considered the target value.

501.2.6.4-Consistency (Slump) Checks Consistency, or slump, is an indicator of concrete workability and must be carefully monitored and held within a narrow margin to assure proper placement and consolidation to the prescribed geometry. Check that consistency is tested and monitored within the limits of the contract specifications. The target value will depend on the method of paving. Slip-form paving generally requires a 2-inch consistency. Excessively wet or dry batches is grounds for rejection. For other paving methods, consistency should be within ¾ in. of the target value. If exceeded, require immediate adjustment. Failure to comply is grounds for rejection. It is generally unacceptable for the Contactor to introduce additional water at the paving site for the purpose of adjusting consistency. This adjustment should be made at the production site. However, water may be added to dry batches in truck mixers if the operation can be performed within 45 minutes of initial mixing. Under such cases, do not permit more than 1 gal/yd3 to be added and ensure that the batch is remixed for at least 20 drum revolutions at normal mixing speed.

501.2.6.5-Air Entrainment Checks Check that the amount of entrained air is tested and monitored within the limits of the contract specifications. Require adjustments and reject batches based on the provisions of the Contract.

Two separate air content tests are required to be performed on samples taken from the finished concrete surface, behind the paving operation, at the beginning of the first day's paving operation. These tests shall be used to determine how much air content is being reduced due to the paving operation, and the Contractor shall make any necessary adjustments to the air content of the mix based on these test results. Section 501.4.2 of the Specifications outlines this procedure.

501.2.6.6-Yield Checks and Adjustment After consistency and air entrainment have been established for production, ensure that actual yield is verified and properly adjusted. The actual yield is determined from the average unit weight of specified samples and is compared to the theoretical yield of the mix design. In general, mix adjustment is required if the difference is greater than ±2%.

501.2.7-Hauling Considerations Haul trucks should be inspected for conformance with the contract specifications and the PCC Paving Plan with regard to type, capacity, number, and mechanical condition. The following Sections discuss additional hauling considerations.

501.2.7.1-Truck Types and Maintenance Agitating and non-agitating type trucks are used to haul concrete from plant and central-mix facilities. Agitating type trucks are frequently specified where consistency and workability of the mix are an issue. The haul container must be maintained free of mortar leaks and hardened concrete. The interior walls should be maintained smooth and clean to allow free and complete discharge of the batch. The container should be covered when conditions warrant.

501.2.7.2-Material Segregation Considerations Periodically verify that concrete is being discharged completely without segregation. Bottom discharging trucks are preferred because the batch can be deposited directly onto the subgrade with little segregation. Where titling-body type trucks are used, suitable baffles must be in place to retard the rate of discharge and reduce segregation.

501.2.7.3-Haul Time Considerations Concrete begins to set when water is introduced to the batch. If excessive time elapses before the concrete reaches the site, mix consistency may be compromised making it difficult to place and finish. Consider the following:

1. Non-Agitating Trucks. Concrete that is hauled in non-agitating trucks shall be placed within 30 minutes or less after water is introduced to the batch.
2. Agitating Trucks and Truck Mixers. Where agitating trucks and truck mixers are used, the concrete shall be placed within 60 minutes or less.

501.3-PRE-PAVING OPERATIONS

The following Sections discuss topics that should be considered with respect to pre-paving operations that are typically performed.

501.3.1-Subgrade Preparation Prior to paving, verify that the subgrade is graded to the approximate cross-section and compacted to the specified density. Grading and compaction should extend across the full width plus an additional 2 ft. beyond each edge of pavement to accommodate either the fixed forms or the slip-form paver tracks, depending on the paving method employed. See Sections 207 and 228 for additional information on earthwork excavation and subgrade preparation.

501.3.1.1-Fixed Form Paving Considerations In fixed form paving operations, the subgrade should be constructed slightly higher than the required final elevation of the subgrade. This will allow fine elevation adjustments to be made through trimming rather than filling. Check that the 2 ft. wide foundation under the forms is compacted hard and true to grade so that the entire length of each form can be set to specified grade in firm contact with the foundation. A reference stringline is sometimes used to perform these checks. Low spots should be brought up to grade in ½-in. compacted lifts of granular material and extend 18 in. on either side of the form. High spots should be trimmed or tamped as needed.

501.3.1.2-Slip Form Paving Considerations In slip form paving operations, the subgrade and the 2 ft. wide track-path foundation should be at the required final elevation of the subgrade. Verify that each track-path foundation is graded, compacted, and maintained in a smooth condition until the paved section is constructed; otherwise, irregularities will be reflected in the finished surface of the pavement. Irregularities can also be caused where a supported guide wire is used. Check that the guide wire is maintained taut without measurable sag. It is good practice to periodically walk just ahead of the slip-form paver to check for these irregularities and any needed adjustments.

501.3.2-Setting Forms During the paving operation, check that forms are being set and assembled sufficiently in advance of the paving train to minimize delay and to provide for a continuous operation. Consider the guidelines in the Sections that follow.

501.3.2.1-Form Condition and Acceptability Before forms are set, verify their acceptability with regard to type, number, dimension, and condition. Straight forms will be used on tangent sections, and flexible or curved forms will be used for curves with radii of 200 ft. or less. Check for forms that have bent flanges, bent, twisted or broken forms, and forms with battered top surfaces. If found, require immediate removal and replacement.

501.3.2.2-Form Stability Considerations Forms must be capable of withstanding the impact and vibration of consolidating and finishing equipment. Excessive settlement or springing will not be tolerated. Check that forms are tightly secured and free from play or movement in any direction. Verify that locking devices of abutting forms are tightly secured and working properly and that pins are sufficiently long and locked in stake holes. If excessive movement is observed, require the forms to be reset.

501.3.2.3-Tamping and Seating Operation After the forms have been set, check that the Contractor thoroughly seats the base of the form by tamping the subgrade on each side.

501.3.2.4-Width, Alignment, and Grade Checks After forms are set and properly tamped, take random measurements and sight along the top of the forms to detect irregularities. Verify the width, alignment, and grade of the forms. Consider the following guidelines:

1. Width. Measure and check the width between the inside face of the forms and the distance each face is from the centerline.

2. Alignment. Verify that the inside face is perpendicular to the subgrade and that it is within ¼ in. of the required alignment.
3. Grade. The top face will establish the grade and should not vary more than 1/8 in. in 10 ft of the final grade.
4. Adjustment. Require adjustment, where needed, If adjustments are made, the subgrade at the base of the form must be re-tamped.
5. Safety Edge. Where required, check that concrete safety edge is utilized.

501.3.2.5-Cleaning and Oiling Forms Just before placing the concrete, verify that the forms have been adequately cleaned and oiled.

501.3.3-Final Grade Conditioning During the paving operation, check that the grade is constructed sufficiently in advance of the paving train to minimize delay and to provide for a continuous operation. Consider the guidelines in the Sections that follow.

501.3.3.1-Final Shaping The final grade will be cut with an approved subgrade machine and the extra material moved ahead if needed to correct low spots. If moved ahead and payment for base material is based on weight, deduct the reused quantity from the pay quantity for base material. If not reused, low spots will be brought up to final grade with an approved granular base material.

501.3.3.2-Compaction Operation After final shaping, verify that a steel-wheel roller is used to compact the base to the density required by the contract specifications. Verify that the type and weight of the roller conform to the provisions of the Contract.

501.3.3.3-Grade Checks Immediately ahead of the paving operation, check the shape of the base for conformance to the Contract Plans with respect to cross slope, pavement thickness, and grade. The final base can be checked from measurements taken between the grade and a taut stringline that is stretched across the forms. If slip-form paving is employed, use the control hubs established along each edge of pavement to check cross slope. Record the location and measurements of grade checks on the appropriate attachment to the DWR.

501.3.3.4-Maintenance of Grade Verify that the final grade is maintained in a smooth and compacted condition ahead of the paving train. Require repairs as needed.

501.3.3.5-Moisture Considerations Unless a waterproof base material is specified, the grade must be kept uniformly moist at the time the concrete is placed. Verify that the base is sprinkled sufficiently ahead of the paving train to keep the material moist without ponding of water.

501.4-PCC PAVING EQUIPMENT

The Contractor will have the option to utilize either fixed-form or slip-form paving equipment. It is recommended that brochures from the manufacturer of the equipment be obtained from the Contractor. The Contractor's PCC Paving Plan will describe the proposed method of paving, equipment and tools for the work. Prior to starting PCC paving operations, check that the Contractor has on hand the necessary equipment to place, finish, cure, and protect the concrete. Pay particular attention to the adequacy of the equipment's design, capacity, and mechanical condition. Notify the Contractor of any significant deviation from the requirements of the proposed operation or the provisions of the Contract.

501.4.1-Slip-Form Paving Equipment The slip-form paving method is used to place, spread, form, consolidate, screed and finish plastic concrete in a single-pass operation. These operations may be performed by a single self- contained unit or a train that includes a leading mechanical spreader followed by a slip-form paver. The rigid sliding forms on either side of the paver, which are laterally supported to prevent spreading, progressively form the slab for finishing. Mechanical floats eliminate small surface irregularities in the final finished surface, thus minimizing the need for hand finishing. Slip-form pavers contain various components including auger spreader, spud vibrators, oscillating screeds, clary screed, tamping bars, and pan floats. To ensure quality pavement before the operation begins, verify that the equipment has been properly set and calibrated accordance to the manufacturer's recommendations. Consider the following guidelines:

1. Screeds. Check all screeds with a stringline to ensure that a true plane or crown is provided in accordance with the requirements of the Contract Plans.
2. Elevation. Check the height of the finished pavement elevation to ensure that it conforms to the requirements of the Contract Plans.
3. Vibrators. Check that the type and number of vibrators provided are adequate for proper consolidation across the full width and depth of the slab being placed. Check the vibration frequency to verify that it conforms to the Contract and manufacturer requirements.
4. Line and Grade Sensors. Check the sensitivity of the feelers or sensors and the tightness of the stringline guide to ensure that adequate control of line and grade will be maintained.

501.4.2-Fixed-Form Paving Equipment The following Sections discuss the various types of equipment that are typically used in fixed- form paving operations.

501.4.2.1-Mechanical Spreader Mechanical spreaders are usually equipped with either a screw or plow type distributor. The bottom elevation of the distributor and the strike-off assembly is adjustable. When checking the adjustment of the mechanical spreader, the strike-off should be set level with the top of the forms at which time the gages should read zero. The strike-off should then be adjusted for proper thickness. Finally, the distribution device should be adjusted so that a small quantity of concrete is carried in front of the strike-off.

501.4.2.2-Transverse Finishing Machine The transverse finishing machine is equipped with two transverse screeds. Verify that the top of the forms is kept free of accumulated material and that the screed wearing plates which ride on the forms are not excessively worn. Use the following procedures to check screed adjustment:

1. Center the screed and lift off forms.

2. Stretch fine wires taut between the forms at the front and back of each screed.
3. Place blocks of uniform thickness on top of the wires at each form.
4. Lower the screeds.

The proper crown is placed in the screed by measuring between the taut wire and the face of the screed and adjusting the hanger bolts. The front screed should be tilted with the front edge slightly higher. The rear screed should be set flat or with a tilt not exceeding 1/16 in. Where two finishing machines are used, the screeds on the rear machine should have little or no tilt.

501.4.2.3-Longitudinal Float Finisher Float finishers, in general, greatly affect the finished surface because they correct irregularities that are left by proceeding operations. Therefore, adjustment of the float finisher is extremely critical. During the following procedures, the longitudinal float finisher should be loaded with approximately the same weight, including the operator, that it will carry during operation. Verify the alignment of the float along its centerline and both edges as follows:

1. Check the height of the transfer tracks which carry the float assembly, at the front and the rear of the machine, to ensure that all four ends are equidistant from the horizontal plane formed by the bottom of the wheels.
2. Place taut wires across the top of the forms and verify that the tracks are adjusted to conform to the desired cross section of the finished surface.
3. Stretch two wires across the top of the forms at a distance apart equal to the length of the float. When the float is lowered, all four corners of the float should be the same distance from the wires at a distance equal to the ordinate of the desired cross-section.

To ensure proper operation after alignment, verify that the scrapers are in good condition and in solid contact with the flanged wheels or forms at all times. It is unacceptable for the operator to adjust the float to compensate for either a surplus or a deficit of concrete.

501.4.2.4-Transverse Float Finisher The transverse float finisher is an acceptable alternative to the longitudinal float finisher. The transverse float finisher is carried on a long wheel base frame that rides on the forms and finishes the concrete with transverse oscillating screeds and a stationary float. The front screed normally rides on the forms and may be checked in a similar manner to that described for the transverse finishing machine in Section 501.4.2.2. The second screed and the float do not ride on the forms but are suspended from the frame; therefore, their elevation is much less affected by form irregularities. Check that both screeds and the float are adjusted to the proposed cross-section. When in the down position, verify that the ends of the screeds and the float are set about the same elevation as the top of the forms. Once the operation is started, it is acceptable to make small final adjustments to match the desired cross section and proper surface finish.

501.4.3-Vibrators Vibrators are used to consolidate plastic concrete as it is placed. Depending on the type of paving method and equipment used, either surface pan or immersed tube or multiple spuds will be mounted on the spreader, finishing machine, or separate carriage. Supplemental hand-operated vibrators also are used to consolidate areas inaccessible to machines.

501.4.3.1-Vibrator Frequency Before the operation begins, check the frequency of vibrators for compliance. A minimum frequency of 3,500 impulses per minute is generally specified for surface pan vibrators and 5,000 for immersed tubes and spuds. The manufacturer's certification may be used for guidance; however, visual observation at the time of placement will be the determining factor.

501.4.3.2-Spud Vibrators Spud vibrators typically have an effective working radius of between 5 and 10 inches, depending on the diameter of the spud, its amplitude, and its frequency of vibration. For practicality, spud vibrators should achieve an effective consolidation radius of approximately 9 inches, with a frequency of between 5,000 and 10,000 impulses per minute. In general, the higher the frequency, the better the consolidation. A good target frequency is approximately 8,000 to 9,000 impulses per minute. The vibrator tip amplitude is another important factor. This usually ranges from 0.03 to 0.06 inches. Ideally, the amplitude should be approximately 0.05 inches.

501.4.4-Hand Tools and Auxiliary Equipment Prior to paving, verify that the Contractor has available all necessary hand tools and auxiliary finishing equipment (e.g., hand floats, edging tools, concrete saws, shovels). Check this equipment to ensure it conforms to the requirements of the Contract and is in satisfactory condition. When joint sawing is required, it is critical to ensure that the Contractor has a sufficient number of concrete saws, replacement blades, and power to saw joints at a rate that prevents uncontrolled cracking. Lighting for night sawing may be necessary.

501.5-PCC PAVEMENT CONSTRUCTION

The following Sections discuss topics that should be considered with respect to the construction operations that are typically performed at the Portland cement concrete paving site.

501.5.1-Placement of Concrete The Project Inspector at the paving site must consider many factors regarding the placement of concrete, as discussed in the following Sections.

501.5.1.1-Lane-by-Lane Construction Unless otherwise directed, concrete will be placed to construct two full-width traffic lanes in one operation; however, lane-by-lane construction is generally permitted for variable width sections and other sections as directed or specified. Pay particular attention to equipment operation on the newly constructed adjoining lane. Finishing equipment is generally permitted to operate on the adjoining lane after three days; however, use by other types of equipment will depend on the specified requirements for opening the lane to traffic.

501.5.1.2-Slip Form Paving Considerations Slip form pavers generally are equipped with an initial strike-off blade that is powered fore and aft independent of the forward travel of the paver. A large screed area is provided to roll excess concrete in a forward direction to fill low spots. Because of the relative force of rolling the excess concrete as compared to the static weight of the machine, concrete consistency and distribution uniformity are extremely critical. Non-uniform distribution and piles of "dry" concrete will cause the paver to float or lift above true grade, resulting in high areas or bumps. To ensure pavement smoothness, it is critical that the quantity of excess concrete ahead of the forward screeds be sufficiently small to allow a rolling action rather than a pushing or shoving action of the excess. Check to ensure that the concrete is of the required consistency and that it is being distributed uniformly and properly placed. See Section 501.2.6 for additional guidance on mix adjustment and concrete consistency. Consider the following additional guidelines:

1. Lane Construction. Where slip-form paving is employed, placement of concrete is generally required across the full width of two lanes. However, the Project Engineer/Supervisor may permit fixed-form, lane-by-lane construction on variable width, small, or otherwise restricted sections. See Section 501.5.1.1 for additional information.
2. Paver Speed. As practical, slip-form pavers should be operated in a continuous forward motion at a speed that is coordinated with production, delivery, and spreading operations. If the paver, or train, must be halted, check to ensure that the vibratory and tamping elements are stopped immediately.
3. Haul Trucks. In slip-form paving operations, haul trucks are generally used to place concrete on dowel assemblies immediately ahead of the spreader. Check to ensure that these haul trucks operate on the shoulder and not on the base course and that the operation does not displace the dowel assemblies.
4. Edge Slumping. Appreciable edge slumping of the in-place concrete is unacceptable. Trailing forms should be required if this condition is evident.
5. Hand Redistribution. If the Contractor is properly using the slip-form paver, minimal hand redistribution will be necessary. As practical, limit this type of handwork and require the Contractor to make immediate corrective adjustment to the operation.

501.5.1.3-Fixed Form Paving Considerations In fixed form operations, it is critical that concrete be placed and distributed in a manner to minimize hand redistribution and segregation of component materials. Specially designed equipment generally is used for this purpose (e.g., transit-mix trucks, agitating haul units, paving mixer buckets). Consider the following guidelines:

1. Protection of Underlying Course. Every precaution must be taken to avoid disturbing the underlying course (e.g., subgrade), because depressions and similar variations will be reflected in the finished pavement. Check to ensure that the subgrade is being adequately maintained. Front end loaders and other similar equipment are not permitted on the subgrade.
2. Discharge. Verify that discharge on the subgrade occurs while the container is moving away from the spreader. Concrete that is dumped in piles from a stationary

position will promote segregation, cause non-uniformity during consolidation, increase strain on forms and spreader, and require unnecessary hand redistribution.

3. Intermediate Bulkheads. Concrete will be placed continuously between transverse joints without the use of intermediate bulkheads.
4. Hand Redistribution. Where hand redistribution is necessary, check to ensure that it is performed using shovels rather than rakes. Do not permit personnel to walk through fresh concrete with boots or shoes that are coated with earth or foreign substances.

501.5.1.4-Placement Near Joints Pay particular attention to the placement of concrete near tie-bar/tie-bolt assemblies, dowel assemblies, and expansion joint filler material. Extreme caution must be used in these areas to avoid bumping, moving, and displacing these materials.

501.5.2-Longitudinal Joint Construction Longitudinal joints run parallel with the centerline of the facility (e.g., between lanes) and across transverse joints. They will be either cut by sawing or formed at the locations and within tolerance of the dimensions specified in the Contract Plans and Specifications. Where longitudinal joints are formed, they will be constructed by suitable mechanical methods while the concrete is in the plastic state. For information on sawing longitudinal joints, see Section 501.5.11.

501.5.2.1-Tie-Bar/Tie-Bolt Assemblies Deformed steel tie-bars or tie-bolt assemblies, as specified, will be placed parallel to the pavement surface, at right angles to the longitudinal joint, and at the spacing designated in the Contract Plans. Unless placed by mechanical means immediately behind the spreader, or the strike- off in slip-form paving operations, check that they are installed and rigidly secured by approved supports to prevent displacement during spreading. Verify that tie bars are not painted, coated, or enclosed in tubes or sleeves.

501.5.2.2-Keyways Where forms are used, keyways for multi-lane paving operations must be held in proper position against the face of the forms. In slip- form operations, check the location of keyways during installation. The keyway form must be removed prior to placement of the adjacent lane. Tie-bars or hook dowels must be correctly spaced and securely fastened.

501.5.3-Transverse Joint Construction Transverse joints run perpendicular to the centerline of the facility (e.g., across lanes and longitudinal joints). They will be either cut by sawing or formed at the locations and within tolerance of the dimensions specified in the Contract Plans and Specifications. The transverse joints should be continuous across adjoining lanes, including any concrete median or shoulders. Where transverse joints are formed, they will be constructed by suitable mechanical methods while the concrete is in the plastic state. For information on sawing transverse joints, see Section 501.5.12.

501.5.3.1-Dowel Assemblies Dowel assemblies, which are embedded in the concrete pavement, consist of coated dowel bars, metal supports, and ancillary components. They are provided at transverse joints to transfer the vehicular load between concrete slabs. Consider the following guidelines:

1. Placement. Dowel bars are placed mid-depth within the concrete pavement and are aligned perpendicular to the transverse joint and parallel to the pavement centerline and surface. The location, lateral, and vertical placement criteria will be detailed in the Contract Plans. Check to ensure that placement is within tolerance of the contract specifications. To properly establish the location of the groove for the transverse joint (e.g., saw cut), dowel assemblies must be laid out and marked in such a manner that the exact center of the dowel can be re- established after the concrete is placed and finished.
2. Installation. Dowel assemblies typically must be installed by hand, unless mechanical installation has been approved by the Project Engineer/Supervisor. After the correct location and alignment have been established, dowel bars must be fixed in position (e.g., metal stakes, pins, welds) to prevent displacement during the concrete pour. Details will be provided in the Contract Plans. At transverse contraction and construction joints, do not permit welding within the middle one-third of the dowel length. Check to ensure that the small wires used to bundle dowel assemblies together during shipping are removed during installation.
3. Bond-Breaking Material. A bond-breaking material is applied to dowel bars to promote free movement after the concrete has set. Typically, a bond-breaking lubricant is applied to dowel bars at the shop. However, where a bond-breaking material is specified for application in the field, check that it is of an approved type and carefully applied over the entire length of the bar just before placement of the concrete. Care should be taken not to place excessive lubricant on the dowel so as not to create a void beneath the bar.
4. End Caps/Sleeves. At expansion joints, the free end of dowel bars will be provided with a close-fitting metal cap or sleeve equipped with a stop to prevent closing during the concrete pour. Check to ensure that the dowel caps are placed on the lubricated end of the dowel and that the proper clearance is provided between the closed end of the cap and the end of the bar to accommodate future movement of the concrete slab.
5. Acceptance. The Contractor is fully responsible for supplying, placing, and maintaining the assembly in its proper position and alignment during the paving operation. Acceptance does not relieve the Contractor of this responsibility.
6. When the Contractor uses automatic dowel bar inserters, the Contractor shall use non-destructive methods to check the dowel bar alignment on the first day of paving operations or prior to that time. See Section 501.11.5 of the Specifications for details and for the allowable tolerances.

501.5.3.2-Transverse Contraction Joints Transverse grooves are provided across the pavement surface to create planes of weakness for crack control. These grooves will be either sawed or formed normal to the pavement surface across the mid-length of the dowels. The locations and dimensions of the grooves must be within specified tolerance. Typically, unless otherwise noted in the Plans, contraction joints are constructed by a single sawcut. For information on sawing transverse joints, see Section 501.5.12.

501.5.3.3-Transverse Construction Joints A transverse construction joint will be installed where there is an interruption of more than 30 minutes in the paving operation. Construction joints must not be installed within 10 ft. of any expansion or contraction joint. If the concrete placed is insufficient to form a slab at least 10 ft. long, verify that the Contractor removes the concrete back to the proceeding joint. Construction joints will be constructed in a manner similar to transverse contraction joints (see Section 501.5.3.2).

501.5.3.4-Transverse Expansion Joints Transverse expansion joints will be constructed to the dimensions and at the locations required by the Contract Plans and specifications. Check the expansion joint filler material for acceptability. It must be an approved type, one continuous piece from form to form, and shaped to the subgrade and cross-section of the pavement. Verify that the expansion joint filler is held in a vertical position within tolerance of the contract specifications. It is unacceptable to allow plugs of concrete to remain within the expansion space.

501.5.3.5-Expansion Joints for Structures Expansion joints for structures and bridge approaches will be constructed as required by the Contract Plans and Specifications. Pre-molded, expansion-joint filler material typically is placed around all structures and features projecting through, into, or against the pavement. Expansion joints for bridge approaches will be detailed in the Contract Plans. Verify material acceptability and dimensional tolerance as needed to ensure quality construction.

501.5.4-Placement of Reinforcing Steel Typically, reinforcing steel is no longer used in concrete pavement. If it is specified, the type and arrangement of reinforcing steel will be designated in the Contract Plans (e.g., fabric, bar mat). To achieve an adequate bond with the concrete, the reinforcing steel must be free from dirt, oil, paint, grease, and excessive rust (i.e., reduction in cross-section). The reinforcement should be placed mid-depth within the concrete pavement. Variation is permitted; however, the minimum concrete cover will not be less than one-third of the pavement depth that is designated in the Contract Plans. There are two basic methods of placing reinforcing steel as follows:

1. One-Layer Construction. Where reinforced concrete pavement is placed in one layer, the reinforcing steel is generally either positioned in advance of the paving operation (e.g., chairs) or placed by approved mechanical or vibratory means while the concrete is in the plastic state. If placement equipment is used, carefully observe and check the placement of the reinforcing steel. If the equipment is not properly adjusted or the slump varies significantly, the reinforcing steel will tend to move from the planned position.

2. Two-Layer Construction. Where reinforced concrete pavement is placed in two layers, the first layer of concrete is placed and struck-off at sufficient length, width, and depth to accommodate the reinforcement. The reinforcing steel is then placed on top of this layer. Within 30 minutes of placing the bottom layer of concrete, the second layer of concrete is placed over the reinforcing steel, struck-off, and finished.

See Section 602 for additional information on reinforcing steel.

501.5.5-Strike-Off and Consolidation After the plastic concrete is spread and distributed, it will immediately be struck-off and consolidated to a cross-section and elevation such that, when the concrete is properly consolidated and later finished, the surface of the pavement will be at the designated final cross-section and elevation. The final pass of the strike-off and consolidation operation normally will produce a cross section slightly higher than that designated as the final elevation.

501.5.5.1-Machine Methods Immediately after placement, the plastic concrete will be distributed over the roadbed and struck-off at the proper cross-section and elevation with either a blade-type or screw-type spreader, depending on the type of paving operation employed (e.g., slip-form, fixed-form). In slip-form paving operations, the plastic concrete is spread and struck-off by a blade. The top surface of the pavement is then shaped, and a preliminary finish is imparted to the concrete through the action of a primary screed, which is rigidly attached to the main frame of the slip- form paver, or by an oscillating belt. The purpose of this equipment is to assist in consolidating the plastic concrete and to provide a uniform cross-section at an elevation that is slightly higher than that designated in the Contract Plans. Consider the following guidelines:

1. Adjustment. Verify that the equipment is in proper adjustment to strike-off and consolidate the plastic concrete at the proper cross-section and elevation. When properly adjusted, there should be a uniform roll of concrete in front of the screed. The roll should be sufficient to provide a uniform surface, while leaving sufficient material for the finishing operation. If excess is carried, it will tend to lift the screed off the forms. There also will be surging behind the screed, which results in overloading the equipment that follows. To minimize surge and tearing, the tilt and speed of the screed may need to be adjusted to strike-off and consolidate the particular concrete mix being used. A stiff concrete mix will generally require a rapid oscillation cycle with a long stroke and a slow forward speed. A fluid mix will generally require a slower oscillation cycle with a shorter stroke and a faster forward speed.
2. Number of Screedings. The number of screedings will be determined by field conditions. Excessive screeding should be avoided because it tends to result in undesirable quantities of low strength mortar on the pavement surface.
3. Equipment Wheels/Forms. The wheels of the equipment and the top of the forms should be periodically checked and cleaned as necessary. Substantial accumulation of concrete and dirt will cause the equipment to move up and down. This motion will be reflected in the final pavement surface.

501.5.5.2-Hand Methods The use of hand methods for the strike-off and consolidation operation is undesirable and generally requires prior approval by the Project Engineer/Supervisor. However, equipment malfunctions do occur. In addition, there will invariably be areas of narrow widths or irregular dimensions inaccessible to machinery. Under these conditions, the use of hand methods is necessary. Consider the following where hand methods are employed:

1. Equipment. Portable hand-operated screeds and spud-type vibrators are typically used where hand methods are employed. This equipment should be checked for acceptability prior to use. Where reinforcement is required, it will be necessary for the Contractor to employ a two-layer construction approach. As such, a second screed will be provided to strike-off the bottom layer of concrete. The surface screed will be at least 2 ft. longer than the maximum width of slab to be struck-off and will be sufficiently rigid to retain its shape under the working conditions.
2. Timing. Strike-off and consolidation using hand methods should begin immediately after the concrete has been placed.
3. Hand Operation. The screed will be moved forward on the forms in the direction the work is progressing, using a combined longitudinal and transverse shearing motion. It is undesirable to lift either end of the forms during the striking operation. The operation will continue until the surface is a uniform texture, true to grade and cross- section, and free from porous areas.
4. Checks. Surface checks with a template or other similar method should be considered to assure that the surface has been struck-off to the desired elevation.

501.5.5.3-Consolidation of Concrete Consolidation subsides or slumps the plastic concrete while filling internal voids and removing entrapped air. If the concrete is not adequately vibrated, an excessive quantity of entrapped air will remain, and optimum consolidation will not be achieved. Over consolidating, however, is highly undesirable, because it segregates component materials and leaves a layer of low-strength mortar on the pavement surface. Vibrators are typically attached to the back of the spreader, the front of the finishing machine, or on a separate piece of equipment. The vibrators will be either the surface type (e.g., screed, pan) or the internal type (e.g., immersed tube, multiple spuds) and will be mounted in such a manner that they will not come into contact with reinforcing steel, joint assemblies, forms, subgrade, or base course. However, the entire width of the pavement must be vibrated to affect adequate consolidation throughout the full depth of the plastic concrete. Hand-operated vibrators are also employed. Consider the following guidelines:

1. Reinforcement and Joints. The concrete adjacent to joints will be firmly placed and consolidated using hand-operated vibrators near joint materials, under and around all transfer devices, joint assemblies, and other features designed to extend into the pavement. Check to ensure that these vibrators do not contact and displace or misalign these items. Caution should be used not to over consolidate these areas.

2. Abutting Slabs/Forms. Special attention must be given to properly consolidate the plastic concrete along the face of abutting slabs and side forms. Visually check that these areas are being properly consolidated with hand-operated vibrators.
3. Stopping Equipment. Do not permit equipment-mounted vibrators to be operated when the paving equipment is not moving in the forward direction. All equipment mounted vibrators must be stopped, either manually or automatically, when the paving machinery stops.
4. Surface Maintenance. Should any concrete fall on or be worked into the surface of a completed slab, check to ensure that it is immediately removed.
5. Spud Vibrators. Consider the following guidelines where spud vibrators are used:
   a. Frequency/Amplitude/Working Radius. Check the frequency of vibrators for compliance at least daily during the paving operation. See Section 501.4.3. for additional information on frequency, amplitude, and working radius.
   b. Surcharge. Spud vibrators must not be drowned in an excessive surcharge of concrete. The surcharge should generally not exceed 6 in. to 8 in.
   c. Spacing of Gang-Mounted Spuds. Based on the diameter of the spud and its amplitude and frequency settings, the actual working radius of a spud vibrator can be determined from field tests or manufacturer's certified data. This data can be used to determine the optimal spacing of gang-mounted spuds across the width of the pavement. The number of spud vibrators across a 24 ft. wide slab generally should be between 14 in. and 16 in. to provide adequate consolidation.
   d. Equipment Speed/Vibratory Influence. The equipment speed greatly affects the length of time that the gang-mounted vibrators influence the plastic concrete. In general, the speed of travel should be 12 feet per minute or less. A maximum vibrator spacing of 24 in. will generally require less than 10 feet per minute of forward travel, and a maximum spacing of 18 in. will require a speed of 10 to 20 feet per minute. See the American Concrete Institute publication Guide for Consolidation of Concrete (AC1309R-05) for additional information.

501.5.6-Floating Operation After the concrete has been struck-off and consolidated, it will be further smoothed, trued, and consolidated by mechanical or hand methods, as approved by the Project Engineer/Supervisor, to remove irregularities left by the proceeding operation and shrinkage of the concrete. Excessive floating should be avoided, and care must be taken not to work the crown out of the pavement.

501.5.6.1-Machine Methods Machine methods typically include the use of either longitudinal or transverse floats. Consider the following guidelines:

1. Equipment Adjustment/Maintenance. At the beginning of each day's operation, the float will be checked and adjusted to the design crown of the pavement. If excessive cutting or filling is required, all paving equipment should be checked and adjusted to eliminate the condition. Equipment must be maintained in proper working order.

2. Timing. Floating should not begin until initial settlement of the concrete is complete and will depend on field conditions. If the concrete has not been thoroughly compacted and is in the early stages of shrinkage when the float passes, the final surface will become rough. Floating should be held to a minimum during periods of greater bleeding, because working the surface in the presence of bleed water will dilute the cement paste on the surface of the slab and reduce surface wear resistance and durability.
3. Speed. A continuous operation at a uniform rate of speed is necessary to obtain the most desirable finished surface.
4. Longitudinal Float Considerations. Consider the following where the longitudinal float is employed:
   a. Overlapping Passes. The longitudinal float should be operated so that the entire surface area is covered at least twice. Check that this is accomplished by overlapping the previous transverse pass by one-half the length of the float.
   b. Excess Roll. When operated properly, the longitudinal float will carry a small roll of concrete along all but approximately the rear two feet of its length. Verify that a small amount of mortar is carried ahead of the float at all times.
   c. Speed Adjustment. Require speed adjustment to ensure that succeeding strokes of the float overlap on each transverse trip.
   d. Number of Passes. The float will pass over each area of pavement a sufficient number of times until the surface shows no variation from straightedge requirements, but excessive operation over a given area will not be permitted.
   e. Removal of Water/Laitance. All excess water, laitance, or other foreign material will be wasted over the side forms on each pass.
   f. Pipe Floats. Pipe float devices may be used for longitudinal floating where slip-form equipment is used.
5. Transverse Float. When the transverse float is used, the time of operation must be adjusted to field conditions. This will be similar to the requirements for using a longitudinal float. The screed or screeds working ahead of the transverse float should carry a uniform roll of concrete so that the transverse float will leave a smooth uniform surface free of screed marks with a minimum of surging. Check that the cutting and smoothing operation is adequate and that the wheels are in constant contact with the side forms.

501.5.6.2-Hand Methods Where hand methods of finishing are permitted, the surface should be floated with a hand- operated longitudinal float of specified size. It should be straight and of a rigidity to prevent flexing or warping. The float will be operated from foot bridges that span the entire width. The float will be worked in a sawing motion parallel to the centerline from one side of the pavement to the other. Each pass should overlap the preceding pass by not less than one-half the length of the float. Where it is necessary to smooth or fill in open-textured areas in the pavement surface after the preceding floating, it will be permissible to use an approved long- handle float. Care must be exercised in this operation to avoid distorting the surface. The use of this equipment should be limited to small areas and should not be used to float the entire surface. Excess water, laitance, and other foreign material will be wasted over the side forms on each pass.

501.5.7-Straightedging and Surface Correction After the floating operation is complete and while the concrete is still in its plastic state, any excess water or laitance should be removed from the surface of the pavement with a straightedge 10 ft. or more in length. Successive drags are to be lapped one-half the length of the blade. The surface must then be tested for trueness in the prescribed manner with a 10-ft. straightedge that has been checked against a master straightedge. If high or low spots are observed, concrete will be added or removed, and the area refinished and checked. Pay particular attention to the surface elevation across joints. The straightedge used for testing the surface should not be used for finishing or moving of concrete. Checking of the surface must continue until it conforms to grade and cross-section and is free of irregularities.

501.5.8-Surface Finishing Operation Because of the damage caused to surface mortar by excessive water, especially where chemicals are used for snow removal, the use of water on the pavement or deck surface for the purpose of finishing must be strictly controlled. Require the Contractor to adjust the operation to provide a better and more timely finishing practice rather than wetting down the surface. If fogging or atomized misting is permitted where rapid drying occurs, pay particular attention to the operation to ensure proper control and prevent abuse. In slip-form operations, final finishing is generally performed by means of a secondary ironing screed, followed by an oscillating belt and a "V"-shaped, free floating, smoothing float. In lieu of this equipment, tamping bars followed by an extrusion plate and a transverse reciprocating belt may be used. The sliding forms attached to the paver must be rigidly held together with lateral supports to prevent spreading. They will be of sufficient length so that no appreciable slumping of the concrete will occur, and any necessary hand finishing can be accomplished while the concrete is still within the forms.

501.5.8.1-Surface Texturing The surface of the mainline pavement, acceleration and deceleration lanes, ramps, and all travel lanes will be given a final groove finish, or texture. Wire combs consisting of flat steel spring tines, dimensioned according to the contract specifications, will be used to perform this task. Consider the following guidelines:

1. Equipment Checks. Before the operation, tines should be checked for conformance. In addition, tines should be checked periodically throughout the day to ensure they are not missing, worn, or out of shape. Hand brooms, approximately four feet wide, made of wire tines meeting specified requirements may be used in small inaccessible areas.
2. Timing. Texturing will begin when the concrete surface is of such plasticity as to allow texturing to the specified depth but dry enough to prevent the plastic concrete from flowing back into the grooves being formed.
3. Direction of Grooves. The texturing will be made in a transverse direction perpendicular to the centerline of the pavement.
4. Overlap. Adjacent strokes of the comb will abut one another without appreciable overlap.

5. Number of Passes. All texturing will be made with only one pass per surface area.
6. Superelevated Areas. Particular attention should be given where texturing in superelevated areas. It can be more difficult to obtain uniformity in these areas.

501.5.8.2-Edging at Forms and Joints Before the concrete has taken its initial set, the edge of the pavement along each side of the slab and on each side of all formed joints, except joints initially formed that will be later widened by secondary sawing, will be rounded to their respective specified radius. Check that a well- defined and continuous radius is produced, and a smooth, dense mortar finish is obtained. Care must be exercised to assure that the leg of the tool that is placed between the concrete and the form or joint is held vertical. Marks left on the pavement surface by edging may be removed by a wet paint brush or a small piece of damp burlap. Verify that any tool marks are eliminated without disturbing the radius. Any concrete splashed on top of joint filler material must be immediately removed. Ensure that all joints are checked with a straightedge before the concrete has set and the necessary corrections made if one side is higher than the other.

501.5.8.3-Application of Station Numbers Before the concrete takes its final set, station numbers, dimensioned according the contract specifications, will be impressed on the pavement surface. Consider the following:

1. Location. Station numbers will be located every 100 ft. and where equalities in alignment occur.
2. Placement/Orientation. The station numbers will be placed parallel to transverse joints, approximately 12 in. to 24 in. from the outside edge of the pavement in the following manner:
   a. Two-Lane Highway. Station numbers will be placed along the right edge of a two-lane highway, readable in the direction of increasing stations.
   b. Multi-Lane Highway. On multi-lane highways, numbers will be placed along the outside edge of the two outside lanes of the roadway, readable in the direction of travel.

501.5.9-Removal of Forms Where fixed form paving operations are used, the forms must remain in place for a minimum of 12 hours after placement of the concrete, or longer as directed by the Project Engineer/Supervisor. Good judgment must be exercised in making this determination because both weather and temperature affect the setting of concrete. The concrete should be allowed to harden sufficiently to minimize spalling and other damage upon removal of the forms. Immediately upon removal of the forms, check that the edges and sides are properly cured, and all minor honeycombed areas are patched with mortar. Enforce the provisions of the Contract with respect to removal and replacement of major honeycombed areas.

501.5.10-Curing Methods and Procedures The following Sections discuss topics that should be considered during the curing of Portland cement concrete pavements.

501.5.10.1-Curing Considerations Unless specified otherwise in the Contract, the Contractor has the option of selecting from the various methods of curing that are presented in the Specifications (e.g., burlap mats, waterproof paper, impervious membrane, polyethylene sheeting). Failure to provide adequate and acceptable curing is grounds for suspending the paving operation. Consider the following guidelines:

1. Timing. The curing operation for the entire width of the newly placed concrete must begin as soon as practical after the finishing operation without marring the newly textured surface. Timing is critical. The curing material must be applied before the surface begins to dry out. If left exposed to the sun and wind, surface moisture will rapidly evaporate, and shrinkage cracks will begin to develop in the top portion of the slab.
2. Exposed Areas. Frequently, the curing material must be temporarily removed to perform other operations. Where removal is needed, the surface must not be left exposed for more than 30 minutes between stages of curing or during the curing period.
3. Water Usage. Where the method of curing requires the use of water, the curing operation will take precedence over any other operation demanding water on the project.
4. Cold-Weather Paving. During cold-weather paving operations (see Section 501.1.9.1), the curing period will be a minimum of seven calendar days, unless the Contractor adequately demonstrates that curing has been maintained for a minimum of 7,000 degree-hours. Verify that the surface temperature does not fall below freezing and enforce the provisions of the Contract with respect to removal and replacement of frost- damaged slabs.

501.5.10.2-Burlap Mats/Straw Where this method is employed, water-saturated burlap mats will be used to cover the entire surface and both edges of the slab. The concrete surface must be firm enough to support the weight of the saturated burlap without marring. If placed prematurely, the burlap will sink into the concrete and mar the finish. Initial use of a curing compound will eliminate this problem (see Section 501.5.10.4). Check to ensure that the burlap mats are weighted to keep the material in contact with the concrete surface and maintained in a wet condition for a minimum of 72 hours after finishing. Straw is sometimes used in combination with burlap mats. Where straw is used, the burlap mats must remain for a minimum of 12 hours after finishing or until the concrete has taken its final set. After the burlap mats are removed, the entire surface will be thoroughly wetted and covered with a minimum of 8 in. of straw. This thickness of water-saturated straw must remain in place for a minimum of 72 hours after finishing. Where the straw is removed, check to ensure that it is not burned on or near the pavement, but disposed of properly off the right-of-way.

501.5.10.3-Waterproof Sheet Barriers Waterproof sheet barriers include waterproof paper, white polyethylene sheeting, and polyethylene coated burlap. Before placement, the surface must be firm enough to support the weight of the material without marring and thoroughly wetted by means of a fine spray. The material must be of an approved type and be placed to cover the entire surface and edges of the slab. It is important that the material be weighted to ensure intimate contact with the surface, thus minimizing displacement and air pockets. Verify that the material is overlapped, sewn, or cemented at joints as necessary. The material must remain in place a minimum of 72 hours after finishing.

501.5.10.4-Impervious Membrane Where white impervious membrane is used, the material will be applied over the entire surface and edges immediately after finishing or, where used in conjunction with burlap mats, immediately after the mats are removed. The membrane will be mechanically applied with equipment that will agitate the material to a uniform mixture within the tank and fully atomize the spray upon application at a rate of one gallon to not more than 125 ft2. Hand spraying will be used where needed to ensure coverage. Frequently check and record quantities to ensure proper rate of application. Verify that the material is not applied inside the cavities of unsealed joints. In addition, the material is not to be applied in the rain. Enforce the provisions of the Contract with respect to repairing membrane damage. The material must remain in place a minimum of 72 hours after finishing.

501.5.11-Sawing Longitudinal Joints Longitudinal joints will be cut normal to the surface of the pavement with a suitable concrete saw. Check to ensure that the depth and width of cut are within specified tolerance and record these measurements. Consider the following guidelines:

1. Multi-Lane Construction. Where adjacent slabs are simultaneously constructed, the joint will be cut between 4 and 24 hours after concrete placement, depending upon weather conditions, and before any equipment is permitted to operate on the pavement. The joint then will be sandblasted to remove dirt, dust, and foreign matter. After sandblasting, rope or rod material, approximately 25% larger in diameter than the width of the joint, will be installed to keep the joint clean and dry. The rope or rod material will remain in place until just prior to sealing. At the time of sealing, the rope or rod material will be removed and discarded, and the joint will be cleaned with compressed air, prepared, and sealed as discussed in Section 501.5.13.
2. Lane-by-Lane Construction. Where adjacent slabs are constructed separately, the joint may be cut, sandblasted, cleaned with compressed air, and prepared just prior to sealing. If the joint is not sealed immediately after sawing, the joint will be sandblasted to remove dirt, dust, and foreign matter, and rope or rod material, approximately 25% larger in diameter than the width of the joint, will be installed to keep the joint clean and dry. The rope or rod material will remain in place until just prior to sealing. At the time of sealing, the rope or rod material will be removed and discarded, and the joint will be cleaned with compressed air, prepared, and sealed as discussed in Section 501.5.13.

501.5.12-Sawing Transverse Joints Transverse contraction and construction joints will be cut normal to the surface of the pavement with a suitable concrete saw. Check to ensure that the depth and width of these cuts are within specified tolerance and that the joint spacing conforms to the Contract Plans. Record these measurements. Unless otherwise noted in the Plans, transverse joints will be constructed in a single sawcut.

<u>501.5.12.1-Initial Sawing</u> Unless previously formed in the plastic concrete, all transverse contraction joints will be established by sawing. Consider the following guidelines:

1. <u>Timing</u>. It is critical to perform the initial sawing operation after the concrete has hardened sufficiently to prevent excess raveling but before uncontrolled shrinkage cracking begins. This range is generally within 4 to 24 hours after placement of the concrete. As needed, initial sawing should be performed continuously (i.e., day and night) regardless of weather conditions.
2. <u>Raveling</u>. Slight raveling is not objectionable and generally indicates that initial sawing is being performed at the proper time.
3. <u>Location/Depth</u>. Each joint must be cut over the center of the load transfer unit, within one inch of the dowels' mid-length, normal to the surface, and to the required depth for the full width of the slab.
4. <u>Progression</u>. The joints should be cut in a progressive manner. However, if uncontrol- led cracking is observed ahead of the current sawing location, immediately move ahead and cut a joint ahead of the cracking. Once a joint has been cut at this forward location, return to saw the joints that were skipped. See Section 501.5.12.3 for information on random cracking.

<u>501.5.12.2-Random Cracking</u> Treatment of random cracking will be performed at no additional cost to the Division. Consider the following guidelines where random cracks are observed:

1. <u>3 in. from Dowel</u>. Random cracks that develop within 3 in. of the dowels' mid-length will be immediately cut to the full width and depth as discussed in Section 501.5.12.2. The cut will be cleaned, prepared, and sealed with silicone sealant as discussed in Section 501.5.13.
2. <u>3 in. to 10 ft. from Dowel:</u> <u>One Side</u>. If a random crack develops within 3 in. to 10 ft. of the dowels' mid-length, the cracked slab will be removed and replaced for a distance of 10 ft. from the dowels' mid-length. The new joint will initially be established with a removable insert or by initial sawing (see Section 501.5.12.1). Secondary sawing will be performed as discussed in Section 501.5.12.2. The joint will be cleaned, prepared, and sealed as discussed in Section 501.5.13.
3. <u>3 in. to 10 ft. from Dowel:</u> <u>Both Sides</u>. If random cracks occur on both sides of a joint within 3 in. to 10 ft. from the dowels' mid-length, the entire dowel assembly and the cracked slab will be removed and replaced for a distance of 10 ft. on both sides of the dowels' mid-length. The new joint will initially be established with a removable insert or by initial sawing (see Section 501.5.12.1). Secondary sawing will be performed as discussed in Section 501.5.12.2. The joint will be cleaned and sealed as discussed in Section 501.5.13.

<u>501.5.13-Joint Sealing Methods and Procedures</u> Cleaning and sealing of all joints is not required unless shown in the Plans. If joint sealing is required in the Plans, the following Sections discuss topics that should be considered during the sealing of joints in Portland cement concrete pavements.

501.5.13.1-Joint Sealing Considerations Consider the following guidelines where longitudinal and transverse joints are sealed:

1. Timing. As soon as practical after curing, longitudinal and transverse joints will be sealed before the lane or lanes are opened to construction or public traffic.
2. Temperature. It is not permissible to seal joints where the temperature of the air or pavement surface is less than 40°F. Closely monitor temperature during cold-weather paving operations.
3. Cleaning and Drying. After joints are established to final dimensions (i.e., either formed or cut as specified), the faces and cavity of the grooves must be thoroughly cleaned and dried before sealing. Wire brushing, sandblasting, and high-pressure water are generally used for initial cleaning. Just prior to sealing, any rope or rod material that has been placed to prevent contamination will be removed and the joint cleaned and dried with compressed air to remove all fine dust, loose particles, and any residual debris. Verify that the compressor does not introduce oil or moisture into the joint.
4. Transverse Joints. Transverse contraction and construction joints typically require the installation of a preformed elastomeric seal and application of silicone sealant.
5. Longitudinal Joints. Longitudinal joints typically are sealed with silicone sealant.

501.5.13.2-Silicone Sealant Application Consider the following guidelines where joints are sealed with silicone sealant:

1. Primer Application. The vertical surfaces of the joints will be primed if recommend by the sealant manufacturer. The primer material, its application, and safety precautions will conform to the manufacturer's recommendations. Where used, verify that the primer is allowed to dry tack- free prior to the installation of the back-up material.
2. Back-Up Material. Backer rod is generally used for back-up material. The Contract Plans will designate the required depth of placement. Verify that the backer rod is being installed in the joint at the required depth.
3. Application of Sealant. Silicone sealant should never be applied to frozen, dirty, wet, or damp concrete or during inclement weather. Verify that the sealant is applied (e.g., poured) into the cavity above the backer rod to the dimensions required by the Contract Plans. Check to ensure that the sealant is being tooled to force the sealant to completely wet the vertical faces of the joint and to provide a slightly concave surface of specified dimensions below the pavement surface. Enforce the provisions of the Contract with respect to removal and replacement of unacceptable joint seals. Require the Contractor to immediately clean any sealant material spilled on the exposed surface of the pavement above the joint.

501.5.13.3-Preformed Elastomeric Seal Installation Consider the following guidelines where preformed elastomeric seals are used:

1. Elastomeric Seal Material. The elastomeric seal material must be one-piece of an approved material type preformed to the dimensions required by the Contract

Plans and Specifications in terms of cross-section, width, and depth of installation with the joint cavity. Splicing of the material is not permitted.

2. Lubricant-Adhesive Application. Just prior to installation of the elastomeric seal, verify that lubricant-adhesive material is applied consistent with the manufacturer's recommendations. In general, the lubricant- adhesive material will be applied to the vertical faces of the joint, the sides of the seal, or both as needed to facilitate installation without damage and to ensure a positive seal between the joint face and the elastomeric material.
3. Installation of Seal. Where elastomeric seals are installed to the depth specified in the Contract Plans, the material will be substantially compressed in the direction normal to the sides of the seal. Verify that the seals are installed without damage and within tolerance of specified elongation. From practical experience, elastomeric joint seals are better installed slightly lower than planned elevation rather than higher. If installed too high, the seal will be exposed to traffic during compression cycles and damaged. Any residual or spilled lubricant- adhesive material on top of the seal or the pavement surface above the joint must be immediately removed. Enforce the provisions of the Contract with respect to removal and replacement of damaged seals and unacceptable installation.

See Section 624 of the Specifications for additional information.

501.6-PAVEMENT WIDENING

Where it is necessary to widen one or both sides of an existing Portland cement concrete pavement, the guidelines in Sections 501.1 through 501.5 apply except as follows:

1. Grade Compaction. Compaction of the fine grade may be by means of an approved special roller capable of exerting a compressive force of not less than 100 lbs./in. of width (see Section 207.9 of the Specifications).
2. Forms. Forms may be made of steel or wood, and they will be secured as required by the Project Engineer/Supervisor.

501.7-RECORDS AND DAILY WORK REPORTS

Project Inspectors at the mix production site and the paving site must ensure that accurate and complete records are maintained for the final project records. The Daily Work Report and its pertinent attachments must include the routine and non-routine events that occur during each production and paving day and reflect an unquestionable basis for acceptance or rejection. Many claims and lawsuits have been settled based on such documentation where deficiencies in test results and pavement performance have developed. Attempting to reconstruct events later without written notes and test data is frustrating and often leads to conflicts.

501.7.1-Production Records and Reports The Project Inspector at the production site is responsible for enforcing the provisions of the Contract with respect to compliance and acceptance of raw materials and the PCC mix. The Project Inspector should be familiar with the source and type of aggregate intended for use, mix proportions, moisture content, method of determining scale weights, mixing equipment and operation, required control and acceptance tests, and reports, as discussed in Sections 501.1 and 501.2. Consider the following when preparing the DWR:

1. Date and Project Inspector's name;
2. Project number and location;
3. Item number and description;
4. Weather and temperature conditions;
5. Source of materials, including laboratory numbers;
6. Method and time of production;
7. Information from the PCC Mix Design Plan;
8. Times of plant scale checks;
9. Aggregate gradation, cement content, moisture, and other test results;
10. Proportions of each material used (e.g., aggregate, cement, water, admixtures);
11. Results of mixing time checks;
12. Daily quantity of mix produced;
13. Hauling method, equipment, and time of loading;
14. Location on pavement where daily production was placed;
15. Date, time, location of samples taken and name of technician;
16. Procedure used to measure mix properties;
17. Tests conducted or observed, results, and any corrective action taken;
18. Material or mix rejected and disposition;
19. Instructions given to Contractor. or received from Project Engineer/Supervisor;
20. Visitors and their comments and agreements;
21. Remarks, unusual occurrences, lost time due to breakdowns, or test results failing the contract specifications including corrective action, changes to mix proportions, plant operation, and test procedures;
22. Number of inspection hours for the day; and
23. Signatures of appropriate personnel.

501.7.2-Paving Records and Reports The Project Inspector at the paving site is responsible for enforcing the provisions of the Contract with respect to compliance and acceptance of the constructed pavement. The Project Inspector should be familiar with the Contract Plans and Specifications, pre-paving operations, paving equipment requirements, methods of construction, control and acceptance tests, and reports, as discussed in Sections 501.3 through 501.5. Consider the following when preparing the DWR:

1. Project number and location;
2. Weather conditions;
3. Subgrade/subbase measurements;
4. Type and make of equipment and adjustment checks;
5. Water used and mixing time checks;
6. Results of slump, entrained air, and other tests;
7. Installation of tie bars and hook bolts;
8. Alignment and grade of dowel baskets;
9. Location of keys and flares;
10. Type and quantity of mix placed;

11. Thickness, lane, and station number;
12. Depth of reinforcement;
13. Vibrator and tamper checks and consolidation results obtained;
14. Results of finished crown and straightedge checks;
15. Curing application method and period;
16. Depth and width of joints;
17. Joint sealing operation checks;
18. Location, time, date, and reason for sampling;
19. Unusual events, conditions, or test results;
20. Failing test results, explanation, steps taken for correction, and results;
21. Changes made in production or paving operations or equipment;
22. Visitors to the site and their comments;
23. Reason for delays in paving (e.g., equipment breakdown, poor weather);
24. Discussions with the Contractor, including instructions and directives given; and
25. Signatures of appropriate personnel.

501.8-MEASUREMENT FOR PAYMENT

The contract unit price will be used for full compensation for all labor, materials, and equipment necessary to complete the work. Consider the following guidelines:

1. PCC Pavement. Portland cement concrete pavement will be paid for based on the number of square yards of pavement placed and accepted as determined from the width and centerline length of mainline and ramps designated on the Contract Plans. Include the area of any additional widening as approved by the Project Engineer/Supervisor.
2. Bridge Approach Expansion Joints. Bridge approach expansion joints will be measured separately and will be based on the actual number of joints constructed and accepted.
3. Pavement Widening. Strips of concrete pavement for pavement widening projects will be paid for based on the number of square yards placed and accepted as determined from actual field measurements.
4. Recycled Pavement. Do not pay separately for removing and crushing existing concrete pavement for use as coarse aggregate in the new PCC mix, unless otherwise specified within the contract documents.
5. Payment Adjustment. Where the average value of pavement thickness, as determined from analyzing pavement core measurements, is less than that specified for full compensation, enforce the provisions of the Contract with respect to deductions and complete removal and replacement.

SECTION 502
APPROACH SLABS

502.1-GENERAL

To minimize the bump on the roadway surface caused by the settlement of backfill material behind bridge abutments, most bridge designs call for heavily reinforced concrete slabs at both ends of the structure, called approach slabs.

502.1.1-Description of Work The work for approach slabs generally consists of the construction of specially designed reinforced concrete slabs at the approaches to bridge structures. Construction details will be designated in the Contract Plans and Specifications. It is the responsibility of the Project Inspector to ensure that the Contractor is in reasonable conformance with specified requirements.

502.1.2-Material Requirements Materials requirements for the construction of approach slabs generally conform to those discussed in Sections 501.1.3 and 501.1.4 of this Manual with the following exceptions:

1. Concrete. Class B structural concrete, as specified in Section 601 of the Specifications, may be used in lieu of Section 501 of the Specifications.
2. Compressive Strength Acceptance Testing. Use the compressive strength testing procedures for structural concrete, as specified in Section 601 of the Specifications, to determine acceptability.
3. Forms. Side forms may be made of steel or wood.
4. Reinforcing Steel. Unless otherwise specified, the requirements for reinforcing steel will be governed by Section 602 of the Specifications.

502.1.3-Other Considerations Review Section 501.1 of this Manual for other general topics that should be considered during the project.

502.2-CONSTRUCTION OPERATIONS

Construction methods and equipment used to construct approach slabs will be as described in Section 501 of this Manual except as modified in the following Sections.

502.2.1-Backfill and Base Course Compaction Prior to placement of the approach slab, check to ensure that the backfill material and the base course material have been properly constructed and compacted to the target density. During construction, pay particular attention to the lift thickness, moisture content, and the density obtained for each lift. Achieving target density in these areas with a uniformly constructed and compacted material cannot be overemphasized. Poor construction methods during this operation will invariably cause voids and settlement, and this is the primary cause of pavement failures at bridge approaches.

502.2.2-Setting of Forms Check to ensure that the forms have been properly set for the required grade and cross- section of the Contract Plans. The final grade of the approach slab is controlled by the bridge deck and the roadway pavement.

502.2.3-Paving Notch Construction Each approach slab will rest on a shelf (i.e., paving notch), which is formed in the backwall of the abutment and the uniformly compacted backfill and base course materials. Verify that the construction of the paving notch conforms to the requirements of the Contract Plans and Specifications.

502.2.4-Reinforcement and Keys The reinforcement for approach slabs consists of an upper and lower mat of reinforcing bars. Verify that the lower mat of bars is supported, see Section 501.1.4.2, at least two inches above the surface of the compacted and finished base course, unless otherwise specified. The approach fill end will have keys which act as a load transfer joint between the slab and pavement. Check to ensure that these keys conform to the requirements of the Contract Plans.

502.2.5-Expansion Joints An expansion joint, meeting the specified requirements for preformed joint material, will be placed between the end of the approach slab and the backwall of the abutment. Verify that the expansion joint material is of an approved type and check to ensure that the preformed joint material is properly placed and secured.

502.2.6-Placement of Concrete Check to ensure that the base course, or subgrade, is thoroughly moistened immediately prior to the placement of concrete. The sequencing of the concrete pour is typically specified in the Contract Plans or directed by the Project Engineer/Supervisor. Verify that this sequence is actually performed.

502.2.7-Consolidation of Concrete Check to ensure that hand vibrators are used to thoroughly consolidate the concrete around the reinforcement and imbedded fixtures and into the corners and angles of the forms.

502.2.8-Curb Construction Curbs will be constructed using the same type of concrete as for the approach slab and will be in accordance with the Contract Plans. Verify that the curb is finished in accordance with Section 610 of the Specifications. See Section 610 for additional information.

502.2.9-Form Removal Verify that forms are not removed for least 24 hours after the concrete has been placed, or as otherwise directed by the Project Engineer/Supervisor.

502.2.10-Joint Construction Sawing will be performed within five days after the slab is placed and prior to opening to any traffic. Verify that the longitudinal joints of the approach slabs are in line with the longitudinal joints of the adjacent pavement slabs. Check that longitudinal joints are cut by sawing ¼ in. greater than one-fourth of the slab depth designated in the Contract Plans. Verify that the width of the cut groove is ¼ in., plus or minus 1/16 in. See Section 501.5.13 for information on sealing joints.

502.3-RECORDS AND DAILY WORK REPORTS

See Section 501.7 for applicable guidance on maintaining project records and Daily Work Reports.

502.4-MEASUREMENT FOR PAYMENT

The quantity of work completed and accepted will be measured in square yards based on the area designated in the Contract Plans. The Contract unit price will be used for full compensation for all labor, materials, and equipment to construct the approach slabs.

SECTION 503
SEALING CRACKS IN CONCRETE PAVEMENT

503.1-GENERAL
The intrusion of moisture and incompressible material into cracks will invariably cause the concrete slabs to spall, settle, heave, or buckle due to the softening or removal of underlying material (e.g., base, subgrade), pumping action of the slabs, freeze-thaw action, and corrosion of dowels. Sealing of cracks in new construction and rehabilitative work is performed as a preventative measure to ensure a longer pavement life. A condition survey usually will be performed to determine the need seal cracks in rehabilitation projects.

503.1.1-Description of Work This work generally consists of cleaning and sealing cracks in the concrete pavement. It is the responsibility of the Project Inspector to ensure that the work is performed consistent with the requirements of the Contract Plans and Specifications.

503.1.1.1-Rehabilitation Rehabilitative work on concrete pavements typically includes provisions for sealing any cracks that have developed in the pavement. It is one of the final steps of a rehabilitation project and is typically performed after undersealing, pavement jacking, diamond grinding, and other major rehabilitative activities. It is very important that the slabs be stable for the new seal to function properly. The sealing operation is generally the same as that used for new construction with one important exception. The preparatory operation will include provisions for the removal of all existing sealant materials before thoroughly cleaning and sealing the crack (e.g., backer rod, silicone sealant, preformed expansion joint material).

503.1.2-Material Requirements See Specification, Section 503.2 for information on the materials typically used to seal cracks.

503.1.3-Other Considerations Review Section 501.1 and Section 507 of this Manual for other general topics that should be considered during the project.

503.2-EQUIPMENT CONSIDERATIONS
Equipment that is typically used to place heated sealant material includes conventional hand pouring pots, individual wheel-mounted pouring kettles with pouring shoe, and heating units from which the material may be discharged through a flexible line and pouring shoe. Before the sealing operation begins, verify the acceptability of the equipment with respect to type, number, and maintenance. The equipment used must be able to uniformly heat the material to the correct temperature and accurately control the pouring of the sealant. Direct or localized heating of the material is unacceptable. Verify that the heating kettle is equipped for indirect and uniform heating (e.g., double boiler).

503.3-CONSTRUCTION OPERATIONS

The following Sections discuss topics that should be considered with respect to the crack sealing operation.

503.3.1-Sealant Preparation Before the raw sealant material is placed into the heating kettle, check to ensure that the kettle is clean and free from residual and foreign materials. Monitor the temperature of the sealant for compliance with the supplier's recommended temperature. Do not allow the use of any sealant material that exceeds the maximum recommended temperature. Ensure that discarded sealant is disposed of properly.

503.3.2-Crack Preparation Sawing may be needed to widen cracks. All cracks must be thoroughly clean and dry prior to sealing. Otherwise, the sealant material will not bond to the exposed surface of the concrete. Verify that all dirt, dust, loose and foreign materials are removed from the cavity. A combination of hand and power tools are generally used to perform this task (e.g., sandblaster, rotary brushes, water jet). If the cavity is not immediately sealed, rope or rod may be used to minimize contamination after initial cleaning. Just prior to sealing, ensure that cracks are blown out with compressed air and that the exposed faces of the cavity are primed as specified. Where used, check that backer rods and preformed elastomeric seals are properly installed. See Section 501.5.13 for additional information.

503.3.3-Sealing Operation See Section 501.5.13 for guidance on sealing joints in Portland cement concrete pavements. Consider the following additional guidelines when sealing cracks in concrete pavement:

1. Timing. As practical, cracks should be sealed the same day they are prepared; otherwise, consider the use of rope or rod to minimize contamination. This prevents unnecessary intrusion of moisture, dust, and incompressible materials in the cavity.
2. Moisture/Temperature. The sealant material will not be poured in cracks that are either dirty or wet. If the cracks are wet or damp or if the ambient temperature is below the minimum specified for application, suspend the work until the conditions are favorable.
3. Depth of Pour. Verify that cracks are filled to within ¼ in., plus or minus 1/16 in., of the pavement surface. In rehabilitative work, the sealant will be poured to the full depth of the cavity.
4. Pouring Shoes. Where pouring shoes are used, which overlap the pavement surface adjacent to the crack, verify that the resultant strip of sealant material is neat and straight. Require removal of excess sealant from the pavement surface. As needed, enforce the provisions of the Contract with respect to removal and replacement of unacceptable work.
5. Spills. Verify that any spills on the pavement surface are immediately removed.
6. Traffic. Traffic should not be permitted on the pavement until after the cracks have been properly sealed. In addition, the sealant should be allowed to cure sufficiently to prevent damage prior to opening to traffic.

503.4-RECORDS AND DAILY WORK REPORTS

See Section 501.7 for applicable guidance on maintaining project records and Daily Work Reports.

503.5-MEASUREMENT FOR PAYMENT

The quantity of work completed and accepted will be measured in linear feet based on field measurements and the Contract Plans, as applicable. The Contract unit price will be used for full compensation for all labor, materials, and equipment to seal the cracks.

SECTION 504
UNDERSEALING AND PAVEMENT JACKING FOR CONCRETE PAVEMENT

504.1-GENERAL

During the life of a concrete pavement, water can infiltrate the subsurface and cause settlement or displacement of the base or subgrade material, which can create voids under the slabs. If left untreated, the slabs may eventually fault at joints. Where field tests indicate the presence of voids, undersealing is specified to fill the voids before faulting occurs.

504.1.1-Description of Work This work generally consists of drilling holes in the concrete pavement at the locations designated in the Contract Plans, or as otherwise directed by the Project Engineer/Supervisor, pumping asphalt material through the holes, and refilling the holes with cement ground. It is the responsibility of the Project Inspector to ensure that the work is performed consistent with the requirements of the Contract Plans and Specifications.

504.1.2-Materials Requirements The materials requirements for asphalt undersealing will be governed by Section 504 of the Specifications. The non-shrink grout for refilling core holes will meet the requirements of Section 715.5 of the Specifications.

See the Approved Products list for of acceptable non-shrink grout materials.

504.1.3-Weather Limitations Do not allow the asphalt undersealing operation to be performed where the underlying subgrade or base is frozen, nor where the ambient temperature is below 40°F and is falling. If there is any doubt as to the suitability of the weather conditions to perform this operation, discuss the matter with the Project Engineer/Supervisor.

504.1.4-Hazards In general, construction sites pose many hazards. The asphalt undersealing operation, in particular, should be performed with extreme care. High pressure will be used to pump 400°F asphalt material into cavities under the concrete pavement. If for example, the nozzle is pulled out of the drill hole prematurely, the hot material could backflow and spray out in all directions. In addition, although infrequent, a blowout at the edge of the pavement could occur. Personnel performing this operation should be on constant alert to these possibilities and pay particular attention where they are standing in close proximity to the injection site.

504.1.5-Other Considerations Review Section 501.1 of this Manual for other general topics that should be considered during the project.

504.2-EQUIPMENT CONSIDERATIONS

The asphalt undersealing operation generally requires the following types of equipment:

1. Tank or container sufficient in capacity and operation to indirectly heat and mix the necessary quantity of asphalt material to a uniform consistency and temperature of at least 400°F;
2. Positive displacement pump capable of developing adjustable pressures up to 80 lbs/in^2, including all necessary gauges, valves, hoses, and nozzles;
3. Air compressor, drill, and 1½ in. diameter concrete coring bits for the drilling operation;
4. Pavement movement detection equipment;
5. Tools necessary to refill drill holes with non-shrink grout; and
6. Cleanup tools and materials and water tankers and service trucks.

504.3-CONSTRUCTION OPERATIONS

The following Sections discuss topics that should be considered with respect to the asphalt undersealing operation (i.e., subsealing).

504.3.1-Drilling Operation Asphalt undersealing operations require that 1½ in. diameter holes be drilled in the pavement to inject the heated asphalt material under the surface. The drill hole location, spacing, and depth will either be designated on the Contract Plans or directed by the Project Engineer/Supervisor. Field experimentation may be required to determine an effective pattern Verify that holes are being drilled as specified and that the drill speed is being closely monitored to avoid spalling out of the drill hole on the underside of the pavement. Consider the following additional guidelines.

1. Subsealing Application. Where a treated base supports the pavement, drilling through the pavement, but not through the treated base will usually be necessary. This allows the pumping of the asphalt material to fill the voids between the base and the pavement. For untreated bases, multiple pumping operations may be needed, depending on the viscosity of the asphalt material and the character of the untreated base material.

504.3.2-Surface Preparation Prior to the pumping operation, the surface of the concrete pavement around the drill holes will be thoroughly sprinkled with water. Optionally, the area may be covered with sand, earth, or other suitable material to prevent bonding of any spilled asphalt material on the pavement surface.

504.3.3-Asphalt Material Preparation Just prior to pumping, verify that the asphalt material is being monitored with respect to temperature and uniformity. The Contractor is responsible for heating the material to a uniform temperature of not less than 400°F. Localized or direct heating will not be permitted. The asphalt material can be less fluid for pavement jacking applications than for subsealing applications, especially where pumping in a hole for the second or third time.

504.3.4-Pumping Operation After the material has been heated to the required temperature and the holes have been properly drilled, the pumping operation will begin. The methods and working pressure for the undersealing operation will depend on the type of operation (i.e., subsealing or pavement jacking) and will be either specified in the Contract or directed by the Project Engineer/Supervisor.

504.3.4.1-Subsealing Applications A drill hole will be selected and the nozzle will be inserted in the hole, driven to a snug fit, and the pumping operation begun. The asphalt material will be pumped under pressure through the hole until the void under the pavement is completely filled. Verify that the slab is being properly monitored for undesirable movement. A level, stringline, or Benkleman Beam are commonly used for this purpose. At the first sign of slab movement or a blowout, the pumping will immediately be stopped. The nozzle should not be removed until the material has cooled sufficiently to prevent backflow onto the pavement surface.

504.3.5-Cleanup After the pumping operation has been satisfactorily completed, verify that all asphalt material that may have bonded to the pavement surface has been properly cleaned and that the drill holes have been filled with non- shrink grout to an elevation flush with the pavement surface.

504.4-RECORDS AND DAILY WORK REPORTS

See Section 501.7 for applicable guidance on maintaining project records and Daily Work Reports.

504.5-MEASUREMENT FOR PAYMENT

The quantity of work completed and accepted will be measured as the number of gallons of asphalt material injected, and number of holes drilled and refilled. The Contract unit price will be used for full compensation for all labor, materials, and equipment necessary to perform the undersealing operation.

SECTION 506
CONCRETE PAVEMENT REPAIR

506.1-GENERAL

Concrete pavement repair in Section 506 of the Specifications specifies full-depth patching or partial depth repairs. Areas to receive concrete pavement repairs will be designated on the Contract Plans and constructed in accordance with the Concrete Repair Details in the plans. The following types of concrete pavement repair may be specified:

1. Type 1. Patching shall consist of full depth, full lane width concrete pavement repairs equal to or greater than 4 feet in length.
2. Type 2. Patching shall consist of partial depth concrete pavement repairs that extend a minimum of 2 inches and no deeper than one-half the slab thickness at cracks or no more than one-third the slab thickness at doweled joints.
3. Type 3. Patching shall consist of a repair along the edge of a transverse crack or joint that extends from the bottom of a partial depth repair (Type II) to potentially the full depth of the slab, and isolated within 12 inches of either the longitudinal joint or pavement edge.

506.1.1-Description of Work

506.1.1.1-Full-Depth Patching The work for full depth patching generally consists of removing and replacing severely cracked and deteriorated concrete pavement sections to the full depth of the slab and at the locations and plan dimensions as specified in the Contract, or as otherwise directed by the Project Engineer/Supervisor. Pay particular attention to how reinforcement, where applicable, is to be reestablished for the patched section. It is the responsibility of the Project Inspector to ensure that the work is performed consistent with the requirements of the Contract Plans and Specifications. Partial-Depth Patching Partial-depth patching is used to repair spalls, potholes, and other minor surface defects. Major spalls (i.e., below mid-depth of slab) and cracks that extend through the entire slab generally will require full-depth patching. The depth of partial- depth patching is typically one-third the slab depth, unless otherwise directed. If the Contract also specifies diamond profile grinding and undersealing, partial-depth patching is generally performed first. Where partial-depth patching is specified, the Project Inspector is responsible for ensuring that the work is consistent with the requirements of the Specifications. Partial-depth patching is similar to full-depth patching, as discussed in Section 506, except as follows:

1. Removal of Deteriorated Concrete. The width, length, and depth of the saw cut around the perimeter of the patch area will be only as deep as the dimensions of the patch specified. To prevent damage to the adjacent sound concrete, a relatively lightweight pneumatic hammer is often used to break and remove the deteriorated concrete; however, a milling machine is sometimes used if the area is large enough to justify the use such equipment. The bottom of the area to be patched should be

approximately parallel with the pavement surface. Cuts beyond patch limits or across joints will be sealed with epoxy cement, or other approved material.

2. Preparation of Patch Area. All loose concrete particles, dust, and oil must be removed by sandblasting and compressed air, or other suitable means. Just prior to concrete placement, a bonding agent will be applied to the bottom of the patch area and other exposed surfaces that will come into contact with the new concrete patch material. Faces of joints and working cracks will not receive this treatment.

506.1.2-Material Requirements Verify that the materials used for concrete pavement repair are from an approved source and conform to the provisions of the Contract (see Sections 506.2 and 506.3 of the Specifications). Specifically note the requirements for using Portland cement concrete, structural concrete, accelerating admixtures, Type 3 cement, epoxy bonding compound for partial depth repairs, and epoxy grout for anchoring dowel bars. Joint sealant will typically be of the hot-poured type meeting the requirements of Section 708.3 of the Specifications.

506.1.3-Quality Acceptance Considerations The following Sections discuss topics that should be considered with respect to the Division's responsibilities for quality acceptance.

506.1.3.1-Compressive Strength Evaluation for Opening to Traffic Concrete repairs may not be put into service until representative test specimens indicate that the concrete used for the repair has attained a compressive strength of 2000 lbs/in2. If the Contractor elects to use it, the Maturity Method, as outlined in MP 601.04.21, may be used to determine the compressive strength for opening the pavement to traffic, instead of compressive strength cylinders.

506.1.3.2-Surface Smoothness Evaluation for Acceptance Surface smoothness will be evaluated for acceptance based on the procedures defined in Section 506.8 of the Specifications. Enforce the provisions of the Contract with respect to removal and replacement of unacceptable work.

506.1.4-Protection of Pavement Check for damage to pavement and shoulder areas adjacent to the patching location. Damage sometimes is caused by the concrete removal process and the concrete-placing equipment. Enforce the provisions of the Contract with respect to repairing such damage.

506.1.5-Other Considerations Review Section 501.1 of this Manual for other general topics that should be considered during the project.

506.2-EQUIPMENT CONSIDERATIONS

Many types of equipment are used to perform full-depth patching. Concrete saws and blades, jack-hammers, drop-hammers, and lifting equipment are used to remove the deteriorated concrete. Drilling equipment is used to drill dowel bar holes. Conventional hand-operated concrete construction equipment and tools are used to place, finish, and cure the full-depth patch. See Section 503.2 for information on the equipment typically used for hot-poured joints sealant. Verify that the equipment used conforms to specified requirements or directives. Gang drills shall be used to drill multiple dowel bar holes simultaneously for Type I repairs.

506.3-CONCRETE PRODUCTION

Portland cement concrete, as specified in Section 501 of the Specifications, is generally used for full-depth patching. See Section 501.2 of this Manual for additional information. On projects where the concrete will be overlaid with hot-mix asphalt (see Section 401), the Contractor may optionally use structural concrete as specified in Section 601 of the Specifications. Before the patching operation begins, verify that the Contractor has submitted for review the required Mix Design Plan and compressive strength test data. Special high-early strength mixes may also be needed when the pavement must be re-opened to traffic in an accelerated time frame.

506.4-PRE-PATCHING OPERATIONS

The following Sections discuss topics that should be considered with respect to pre-patching operations.

506.4.1-Removal of Deteriorated Concrete Prior to patching, the deteriorated concrete must be removed. The following two methods are typically used:

1. Lift-Out Method. To minimize potential damage to the sound concrete adjacent to and on the underside surface of the slab, as well as to the underlying base material, the lift-out-method is strongly recommended. The perimeter of the area to be removed will be cut full depth by saw. The section to be removed is then cut full depth into smaller sections that can be easily lifted with available equipment. Typically, one or more transverse cuts are double sawed to minimize wedging when the sections are removed. Holes are drilled into the smaller sections to accommodate cables attached to the lifting equipment.
2. Chip-and-Break Method. In the chip-and- break method, the perimeter of the area to be removed will be cut full depth by saw. Equipment such as a jackhammer or drop-hammer will be used to chip and break the deteriorated concrete within the cut perimeter. Broken pieces are generally removed by a combination of hand and machine methods. This operation must be carefully monitored to prevent damage to sound concrete adjacent to the slab and to minimize spalling of the underside of the pavement. The base also may be disturbed, which will require the removal of the loose material and replacement with acceptable base course material.

506.4.2-Preparation of Underlying Course Investigate the underlying pavement course (e.g., base, subbase, subgrade) for acceptability in terms of moisture and density. Any underlying material that has been disturbed below the desired level of removal will be removed and the patch area shall compacted. The Contractor shall replace any removed subbase material with concrete integral to the pavement. If more than 1 inch of concrete is needed to replace subbase or subgrade, then the additional volume of concrete, required to fill the excavated area up to the bottom of the existing pavement shall be paid for by the cubic yard as a separate pay item.

506.4.3-Shoulder Preparation After the deteriorated concrete has been satisfactorily removed and disposed of properly, verify that the resulting edges and the pavement- to-shoulder interface is tacked or prepared as required.

506.5-PATCHING OPERATIONS

The following Sections discuss topics that should be considered with respect to patching operations.

506.5.1-Joint Replacement Where the full-depth patch will affect existing joints and joint materials, they must be inspected, repaired, or replaced in conformance with the Contract Plans and Specifications, or as otherwise directed by the Project Engineer/Supervisor. Full-depth patches may require installation of load transfer devices (e.g., dowel assemblies). To accommodate expansion, working cracks should be treated similarly to transverse expansion joints. See Sections 501.5.2 and 501.5.3 for additional information on joint construction.

506.5.2-Placement of Reinforcing Steel and Dowel Bars Check to ensure that reinforcing steel (e.g., mesh) is installed as specified or directed. See Section 501.5.4 for additional information. Care must be taken to ensure that holes for dowel bars in Type I and III repairs are drilled properly and that the holes for the dowel bars are adequately filled with epoxy or grout. See Sections 506.6.8.1 and 506.6.8.3 of the Specifications.

506.5.3-Placement of Concrete The concrete will be placed in the area to be patched using a metal chute. Check to ensure that the free fall of the concrete is limited to no more than 3 ft; otherwise, the material components will splatter and segregate. Hand methods will be used to distribute the concrete in the patch area. Rakes should not be used. For Type II repairs, an epoxy bonding compound must be applied to the existing concrete repair area prior to placing fresh concrete in the repair area. The fresh concrete must be placed while the epoxy bonding compound is still tacky. See Section 506.6.8.2 of the Specifications.

506.5.4-Finishing Operations

1. Strike-Off and Consolidation. After the concrete has been placed in the patch area, it will be struck-off to the appropriate profile and cross-section by approved hand methods (see Section 501.5.5.2).
2. Consolidation of Concrete. The concrete in the patch area must be consolidated to ensure that that area beneath the existing concrete pavement is completely filled. Hand-operated spud vibrators are typically used for this operation. See Sections 501.4.3 and 501.5.5.3 for additional information.
3. Floating Operation. The surface of the patch area will be floated to a smooth finish by approved hand methods. See Section 501.5.6.2 for additional information.
4. Straightedging and Surface Correction. Straightedging and surface correction will be performed to ensure a smooth riding surface in accordance with the provisions of the Contract (see Section 506.1.3.2 and Section 501.5.7 for additional information).

5. Final Finishing Operation. Final finishing should produce a profile and cross-section that matches that of the existing pavement, or as otherwise directed by the Project Engineer/Supervisor. The surface texture also should match that of the existing pavement surface. If stations numbers were with the perimeter of the area removed, ensure that that are properly reestablished. See Section 501.5.8 for additional information.
6. Removal of Forms. Any formwork used to construct the patch should be removed without damage to the pavement (see Section 501.5.9).
7. Curing Methods and Procedures. The methods and procedures for curing are discussed in Section 501.5.10 of this Manual. Pay particular attention to the methods employed where early opening to traffic is required.
8. Sawing and Sealing Joints. Where joints are affected, ensure that joints are properly cut by saw and sealed as specified or directed. See Sections 501.5.11 and 501.5.12 for information on joint sawing and Section 501.5.13 for information on joint sealing methods.

506.6-RECORDS AND DAILY WORK REPORTS

See Section 501.7 for applicable guidance on maintaining project records and Daily Work Reports.

506.7-MEASUREMENT FOR PAYMENT

The quantity of work completed and accepted will be measured as the number of square yards of concrete pavement repair. The Contract unit price will be used for full compensation for all labor, materials, and equipment necessary to perform the concrete pavement repair.

SECTION 507
CRACK AND POTHOLE REPAIR

507.1-GENERAL

507.1.1-Description of Work The work for crack and pothole repair generally consists of repairing an existing concrete pavement surface prior to resurfacing with asphalt. It is the responsibility of the Project Inspector to ensure that the work is performed consistent with the requirements of the Contract Plans and Specifications, or as otherwise directed by the Project Engineer/Supervisor.

507.1.2-Material Requirements The material requirements for crack and pothole repair are governed by Section 507.2 of the Specifications. Before the work, verify that the Contract has supplied approved materials.

507.1.3-Other Considerations Review Section 501.1 and Section 503 of this Manual for other general topics that should be considered during the project.

507.2-CONSTRUCTION CONSIDERATIONS

Prior to overlaying with asphalt, all cracks and potholes must be repaired to the grade of the adjacent surface.

507.2.1-Small Cracks Unless otherwise noted in the plans, cracks less than 1 inch do not need repair prior to asphalt overlay. Cracks greater than 1 in. but less than 3 in. in width will be treated in the following manner:

1. Preparation. Verify that the cracks are thoroughly cleaned of all dirt, debris, and loose and foreign materials. Sandblasting and compressed air are typically used for this purpose.
2. Crack Filler. Check to ensure the cracks are being properly filled with a mixture of sand and asphalt. The asphalt content should be approximately 5% to 10%, and the mixture should be heated from 250°F to 325°F before it is applied.

507.2.2-Large Cracks and Potholes Cracks that are greater than 3 in. in width and all potholes greater than 1 in. in depth that are not patched as discussed in Section 506 will be treated in as follows:

1. Preparation. Verify that the cracks and potholes are thoroughly cleaned of all dirt, debris, and loose and foreign materials.
2. Tacking. After cleaning, check to ensure that the cracks and potholes are tacked in accordance with the contract specifications (see Section 408).

3. Crack and Pothole Filler. Immediately after the tacking operation, ensure that the cracks and potholes are filled with the specified asphalt material, or as otherwise directed by the Project Engineer/Supervisor (see Section 401).

507.3-RECORDS AND DAILY WORK REPORTS

See Section 501.7 for applicable guidance on maintaining project records and Daily Work Reports.

507.4-MEASUREMENT FOR PAYMENT

The quantity of work completed and accepted will be measured as the actual number of tons of material used for crack and pothole repair. The Contract unit price will be used for full compensation for all labor, materials, and equipment necessary to perform the work.

SECTION 508
DIAMOND GRINDING

508.1-GENERAL

508.1.1-Description of Work This Contract bid item is a pavement preservation technique that correct surface imperfection on both concrete and asphalt pavements to restore rideability by removing irregularities caused during construction or through repeated traffic loading over time. Diamond grinding may be used to improve smoothness of the pavement, skid resistance, noise reduction, proper drainage, and safety.

Diamond grinding involves removing a thin PCC/asphalt surface layer using closely spaced diamond saw blades

The Project Inspector is responsible for ensuring that the Contractor performs the work in conformance with the Contract Plans and specification.

508.1.2-Maintenance of Traffic See Section 501.1.10 for information on maintenance of traffic during construction.

508.2-INSPECTION GUIDELINES

508.2.1-Equipment Considerations Equipment for diamond grinding include self-propelled machine design for grinding and texturing pavement. The machine must be capable of removing the existing pavement to within the tolerances listed in the specifications. The diamond grinding equipment should be equipped with vacuum that removes the grinding residue and leaves the pavement in a clean condition. Consider the following:

1. Final Surface. It is important that the diamond grinding machine produce a pavement surface which is true to grade and uniform in appearance, without excessive damage to the underlying pavement structure.
2. Slurry Removal. The removal and disposal of concrete slurry is the responsibility of the Contractor and must be disposed of properly and at location which satisfies the environmental regulations. At no time will slurry be allowed to enter a closed drainage system.
3. Smoothness Requirements. If the contract documents do not contain an initial profile index, the Contractor should provide written request of IRI testing, if needed. Prior to performing any grinding work, the Contractor should provide a profile trace to identify the required smoothness of the project.

508.3-RECORDS AND DAILY REPORTS

Section 111 discusses the general requirements of project records and daily work reports. See

Section 501.7 for additional information on records and daily reports for paving projects. Consider and document the following key inspection points on the attachment for fog seal in the Daily Work Report:

1. Check that the locations of water, gas valve, manholes, etc. have been properly marked to avoid damage during diamond grinding.
2. Check that traffic control devices and flaggers are in place.
3. Check that the width and length limits of diamond grinding have been established and properly marked.
4. Verify width and length measurements at all break points that are recorded.
5. Check that the cross section conforms to the Contract Plans after the diamond grinding operation. One check should be performed each 2,000 ft., minimum.
6. Check that slurry material is removed from the project site, unless otherwise denoted on the Contract Plans.
7. Check that the pavement is cleaned and swept prior to reopening to traffic.

508.4-MEASUREMENT FOR PAYMENT

Measure the quantity of pavement diamond grinded based on the total number of square yards that was planed or ground, without regard to the number of passes or to the thickness of the material removed. Payment will be based on the unit price specified in the Contract

SECTION 510
RE-SEALING CONCRETE PAVEMENT JOINTS

510.1-GENERAL

The intrusion of moisture and incompressible material into joints will invariably cause the concrete slabs to spall, settle, heave, or buckle due to the softening or removal of underlying material (e.g., base, subgrade), pumping action of the slabs, freeze-thaw action, and corrosion of dowels. Sealing of joints in new construction and rehabilitative work is performed as a preventative measure to ensure a longer pavement life. A condition survey usually will be performed to determine the need seal cracks and joints in rehabilitation projects.

510.1.1-Description of Work This work generally consists of cleaning and sealing joints in the concrete pavement. It is the responsibility of the Project Inspector to ensure that the work is performed consistent with the requirements of the Contract Plans and Specifications.

510.1.1.1-Rehabilitation Rehabilitative work on concrete pavements typically includes provisions for sealing existing longitudinal and transverse joints. It is one of the final steps of a rehabilitation project and is typically performed after undersealing, pavement jacking, diamond grinding, and other major rehabilitative activities. It is very important that the slabs be stable for the new seal to function properly. The sealing operation is generally the same as that used for new construction with one important exception. The preparatory operation will include provisions for the removal of all existing sealant materials before thoroughly cleaning and resealing the joints (e.g., backer rod, silicone sealant, preformed expansion joint material).

510.1.2-Material Requirements See Specification, Section 510.2 for information on the materials used to seal joints.

510.1.3-Other Considerations Review Section 501.1 and Section 503 of this Manual for other general topics that should be considered during the project.

510.2-EQUIPMENT CONSIDERATIONS

Equipment that is typically used to place heated sealant material includes conventional hand pouring pots, individual wheel-mounted pouring kettles with pouring shoe, and heating units from which the material may be discharged through a flexible line and pouring shoe. Before the sealing operation begins, verify the acceptability of the equipment with respect to type, number, and maintenance. The equipment used must be able to uniformly heat the material to the correct temperature and accurately control the pouring of the sealant. Direct or localized heating of the material is unacceptable. Verify that the heating kettle is equipped for indirect and uniform heating (e.g., double boiler).

510.3-CONSTRUCTION OPERATIONS

The following Sections discuss topics that should be considered with respect to the joint sealing operation.

510.3.1-Sealant Preparation Before the raw sealant material is placed into the heating kettle, check to ensure that the kettle is clean and free from residual and foreign materials. Monitor the temperature of the sealant for compliance with the supplier's recommended temperature. Do not allow the use of any sealant material that exceeds the maximum recommended temperature. Ensure that discarded sealant is disposed of properly.

510.3.2-Joint Preparation Sawing may be needed to reestablish the dimensions of existing joints. All joints must be thoroughly clean and dry prior to sealing. Otherwise, the sealant material will not bond to the exposed surface of the concrete. Verify that all dirt, dust, loose and foreign materials are removed from the cavity. A combination of hand and power tools are generally used to perform this task (e.g., sandblaster, rotary brushes, water jet). If the cavity is not immediately sealed, rope or rod may be used to minimize contamination after initial cleaning. Just prior to sealing, ensure that joints are blown out with compressed air and that the exposed faces of the cavity are primed as specified. Where used, check that backer rods and preformed elastomeric seals are properly installed. See Section 501.5.13 for additional information.

510.3.3-Scaling Operations See Section 501.5.13 for guidance on sealing joints in Portland cement concrete pavements. Consider the following additional guidelines when sealing joints in concrete pavement:

1. Timing. As practical, joints should be sealed the same day they are prepared; otherwise, consider the use of rope or rod to minimize contamination. This prevents unnecessary intrusion of moisture, dust, and incompressible materials in the cavity.
2. Moisture/Temperature. The sealant material will not be poured in joints that are either dirty or wet. If the joints are wet or damp or if the ambient temperature is below the minimum specified for application, suspend the work until the conditions are favorable.
3. Depth of Pour. Verify that joints are filled to within ¼ in., plus or minus 1/16 in., of the pavement surface. In new construction, check that the sealant is poured to the depth specified in the Contract Plans. In rehabilitative work, the sealant will be poured to the full depth of the cavity.
4. Pouring Shoes. Where pouring shoes are used, which overlap the pavement surface adjacent to the joint, verify that the resultant strip of sealant material is neat and straight. Require removal of excess sealant from the pavement surface. As needed, enforce the provisions of the Contract with respect to removal and replacement of unacceptable work.
5. Spills. Verify that any spills on the pavement surface are immediately removed.
6. Traffic. Traffic should not be permitted on the pavement until after the joints have been properly sealed. In addition, the sealant should be allowed to cure sufficiently to prevent damage prior to opening to traffic.

510.4-RECORDS AND DAILY WORK REPORTS

See Section 501.7 for applicable guidance on maintaining project records and Daily Work Reports.

510.5-MEASUREMENT FOR PAYMENT

The quantity of work completed and accepted will be measured in linear feet based on field measurements and the Contract Plans, as applicable. The Contract unit price will be used for full compensation for all labor, materials, and equipment to seal the joints.

SECTION 511
DOWEL BAR RETROFIT

511.1-GENERAL

511.1.1-Description of Work A dowel bar retrofit is a method of reinforcing old joints or cracks in concrete pavement by inserting steel bars in slots cut across the cracks. The slots for the dowels are sawed and the existing concrete is removed. Following dowel placement the slots are backfilled with non-shrink concrete mixture.

511.1.2-Material Requirements Inspect all materials upon arrival. Verify that all materials conform to the requirements specified in Section 511.2 of the Specifications. Ensure that materials are supplied from pre-approved DOH sources, as applicable, and document laboratory numbers from the shipping documents on the Daily Work Report.

511.2-CONSTRUCTION OPERATIONS

The completion of a DBR project involves the steps listed below, which are described in more detail in the following sections:

1. Test section. The Contractor is required to construct a test section to demonstrate their capabilities in construction a Dowel Bar Retrofit project. The test section is one lane wide and of length which contains three joints or cracks to be retrofitted.
2. Slot creation. A diamond bladed slot cut machine capable of cutting three or four slots simultaneously should be used. These slots should be parallel to each other and create a slot which is 2 ½" ± 1/8 inches wide.
3. Slot preparation. After the sawcuts have been made, use lightweight jackhammers (30lb) or hand tools to remove the concrete in each slot. Once completed, the slots are thoroughly sandblasted to removed dust and sawing slurry and provide slightly rough surface to promote bonding.
4. Dowel bar placement. Each dowel bar should be coated with a bond breaking material and dowel bar caps installed on each end prior to placement into the slot. A foam core must be placed at the mid-length of the dowel.
5. Patching material placement. Once the dowel has been placed and the filler board material is in position, the patching material is then placed in the slot according to the manufacturer's recommendations. It is generally recommended that the patching material be placed in a manner that will not move or jar the dowel bar from its position in the slot.
6. Diamond grinding. If required, diamond grinding should be completed within 14 days of final dowel bar and shall meet the requirements of Section 508.
7. Joint sealing. If required, transverse cracks or joints should be prepared and sealed as outlined in Section 510.

511.3-RECORDS AND DAILY REPORTS

See Section 501.7 for applicable guidance on maintaining project records and Daily Work Reports.

511.4-MEASUREMENT FOR PAYMENT

Dowel Bar Retrofit work will be measured and paid at the contract unit price based on the number of dowel bars installed and accepted.

SECTION 512
CONCRETE SLAB STABILIZATION

512.1-GENERAL

During the life of a concrete pavement, water can infiltrate the subsurface and cause settlement or displacement of the base or subgrade material, which can create voids under the slabs. Where the voids have enlarged to the extent that faulting is evident, concrete slab stabilization is specified to both fill the voids and raise the slab back to grade (i.e. pavement jacking), thus reestablishing the pavement profile and cross-section. Pavement jacking is generally specified in lieu of full-depth patching where the pavement is not badly cracked or deteriorated.

512.1.1-Description of Work This work generally consists of drilling holes in the concrete pavement at the locations designated in the Contract Plans, or as otherwise directed by the Project Engineer/Supervisor, pumping Portland cement/fly ash grout through the holes, and refilling the holes with mortar. It is the responsibility of the Project Inspector to ensure that the work is performed consistent with the requirements of the Contract Plans and Specifications.

512.1.2-Materials Requirements The materials requirements for concrete slab stabilization will be governed by Section 512 of the Specifications.

512.1.3-Weather Considerations Grout sealing can only be performed if the temperature is above 40°F. In addition, if the subgrade or base course are frozen, no subsealing should be performed. See Section 401.3.2 for additional information.

512.1.4-Opening to Traffic Unless approved by the Project Supervisor, no traffic is permitted on grouted slabs for at least 3 hours after grouting.

512.2-CONSTRUCTION OPERATIONS

The following Sections discuss topics that should be considered with respect to the bituminous undersealing operation (i.e., subsealing or pavement jacking).

512.2.1-Drilling Operation The Project Inspector is responsible for ensuring that the drilling work is in conformance with the construction methods and details specified in Section 512 of the Specifications..

512.2.2-Application of Portland Cement/Fly Ash Grout The pumping of the grout material should begin at the hole at the lowest point of the dip or settlement of the slab. The nozzle will be inserted in the hole, driven to a snug fit, and the pumping operation begun. Where a treated base supports the pavement, the nozzle should be inserted so that the material will be injected under the treated base, and not just fill any voids between the slab and the treated base. The grout material will be pumped under pressure through the hole until the slab has been raised to the grade of the adjacent slab or as otherwise directed by the Project Engineer/Supervisor. Verify that slab movement is being properly monitored. A level, stringline, or Benkleman Beam are commonly used for this purpose. Constant attention must be given to controlling the movement of pavement in small increments. Too much pressure may cause rapid movement of the slab, radial cracking at the drill hole, undesirable movement of the shoulder, blowouts outside the shoulder, and infiltration of existing underdrains. The nozzle should not be removed until the material has cooled sufficiently to prevent backflow onto the pavement surface.

512.3-RECORDS AND DAILY REPORTS

See Section 501.7 for applicable guidance on maintaining project records and Inspector's Daily Reports.

512.4-MEASUREMENT FOR PAYMENT

The holes drilled for Concrete Slab Stabilization will be measured and paid at the contract unit price based on the number of holes drilled and accepted.

The quantity of work completed and accepted will be measured as the number of tons of grout used for subsealing of slabs and number of holes drilled and refilled. The Contract unit price will be used for full compensation for all labor, materials, and equipment necessary to perform the concrete slab stabilization.

SECTION 513
CONCRETE PAVEMENT CROSS STITCHING

513.1-GENERAL

Cross stitching is a preservation method designed to strengthen nonworking longitudinal joints and cracks that are in relatively good condition.

513.1.1-Description of Work The construction process consists of grouting tiebars into holes drilled across the joint or crack at angles of 30º to the pavement surface. This process is effective at preventing vertical and horizontal movement or widening of the crack or joint, thereby keeping the crack or joint tight, maintaining good load transfer, and slowing the rate of deterioration.

513.1.2-Equipment Considerations The Contractor should use a drill that minimizes damage to the concrete surface (e.g., hydraulic powered drill), and select a drill diameter in accordance with the anchoring material manufacture recommendation.

513.2-CONSTRUCTION OPERATIONS

The cross-stitching process requires the following steps and considerations:

1. Drill holes at an angle to the pavement so that they intersect the joint or crack at mid-depth. It is important to start drilling the hole at a consistent distance from the joint or crack to consistently cross the joint or crack at mid-depth.
2. Blow air into the holes to remove dust and debris after drilling.
3. Pour epoxy into the hole, leaving some volume for the bar to occupy the hole.
4. Insert the tiebar, remove excess epoxy, and finish flush with the pavement surface. The pavement may be reopened to traffic as soon as the epoxy has fully set.

513.3-RECORDS AND DAILY REPORTS

See Section 501.7 for applicable guidance on maintaining project records and Inspector's Daily Reports.

513.4-MEASUREMENT FOR PAYMENT

Installation of Deformed Bars will be measured and paid at the contract unit price based on the number of deformed bars installed and accepted.

SECTION 514
ROLLER COMPACTED CONCRETE

514.1-GENERAL

514.1.1-Description of Work Roller-compacted concrete (RCC) is a special blend of concrete that essentially the same ingredients as conventional concrete but in different ratios. It's a drier mix than traditional concrete and placed with conventional asphalt paving equipment, then compacted with rollers.

514.1.2-Equipment Considerations The Contractor should use any combination of equipment that will produce a completed pavement meeting the requirements for mixing, transporting, placing, compacting, finishing, and curing as specified in Section 514 of the Specifications.

514.2-INSPECTOR GUIDELINES

The Project Inspector is responsible for ensuring that the work for furnishing and installing RCC is in conformance with the construction methods and details specified in Section 514 of the Specifications. Pay particular attention to the mixing RCC, placing RCC, compaction, joints, finishing, curing, and opening to traffic.

514.3-RECORDS AND DAILY REPORTS

See Section 501.7 for applicable guidance on maintaining project records and Inspector's Daily Reports.

514.4-MEASUREMENT FOR PAYMENT

The quantity of work completed and accepted will be measured as the number of square yards (square meters) of Roller Compacted Concrete. The Contract unit price will be used for full compensation for all labor, materials, and equipment necessary to perform the work.

DIVISION 600
INCIDENTAL CONSTRUCTION

SECTION 601
STRUCTURAL CONCRETE

601.1-GENERAL REQUIREMENTS

The performance of concrete structures depends primarily on the quality achieved in producing, placing, consolidating, and finishing the mix. Although adequate designs may ultimately be specified for structural elements, misunderstood or misapplied specifications and the use of poor construction techniques and improper equipment operation can greatly affect quality. Section 601 of the Specifications defines the requirements for structural concrete work and the method of measurement for payment. The following Section presents specific WVDOH policies, procedures, and additional clarification.

601.1.1-Description of Work The Contractor is responsible for controlling the quality of materials and work incorporated in the structure. Before the project begins, become thoroughly familiar with the details of the Contract Plans and Specifications, Special Provisions, required Contractor submittals, and the specific orders of work. The Project Engineer/Supervisor and, as assigned, the Project Inspector are responsible for assessing the acceptability of material and work based on the Contract provisions.

601.1.2-Material Considerations

601.1.2.1-Source Approvals, Laboratory Numbers, and Certifications Many types of materials are required for structural concrete work, including:

1. Portland cement;
2. Water;
3. Aggregates;
4. Admixtures and additives
5. Reinforcing steel;
6. Formwork, falsework, and framework; and
7. Curing and protective coating materials.

Before work begins, check that each material conforms to the requirements specified in Section 601.2 of the Specifications, and reject and require removal of all non-conforming material. Source approvals, laboratory numbers, and Certificates of Compliance must be obtained in accordance with Division policies and procedures before materials are incorporated in the work. Verify that required approvals and certifications have been obtained, and document all laboratory numbers and quantities on the Daily Work Report. The Contractor is responsible for notifying the Project Engineer/Supervisor of any changes in the source or type of materials.

601.1.2.2-Classes of Structural Concrete The classes of structural concrete required for the project will be designated on the Contract Plans. Substitution of a higher class of concrete at no additional cost to the Division is permitted with prior approval from the Project Engineer/Supervisor. Typical applications of structural concrete classes are as follows:

1. Class A**.** Class A is generally used for railing, cribbing, precast shapes, steel grid floors, and filler.
2. Class K. Class K is used for sidewalks, parapets, decks, and median barriers, where they are a part of the superstructure.
3. Class B. Class B is used in beams, girders, roadway sidewalks, columns, hammerhead piers, arch rings, ties and spandrel walls, rigid frames, box culverts, heavily reinforced abutments, retaining walls, footings, pedestals, and other areas not specifically class designated.
4. Class C. Class C is used in massive footings and pedestals, massive pier shafts, gravity walls and, in general, for non-reinforced or lightly reinforced concrete applications.
5. Class D. Class D concrete is used in unformed and non-reinforced concrete applications such as for backfilling of excavated pockets or voids on which footings are to be located.
6. Class H. Class H concrete is used for bridge decks when designated in the plans.
7. Class DC. Class DC concrete is used in rock socketed drilled shaft or when designated in the plans.

Where a structural concrete class requires modification, the designation, as specified on the Contract Plans, will have the following context:

1. Modified. Where a concrete class is designated “Modified,” the concrete class will have an increased design strength requirement.
2. Architectural. Where the concrete class is designated “Architectural,” additional formwork conforming to the requirements of Section 601.8.10 of the Specifications will be required.

601.1.2.3-Structural Concrete Mix Materials Become familiar with the physical characteristics of acceptable materials, and check for signs of segregation, intermingling, contamination, and breakage. Segregation is common and typically begins with improper handling. Serious segregation is grounds for rejection. Before production, check component materials for acceptability and verify source approvals, laboratory numbers, and certifications (see Section 601.1.2.1). To facilitate quality control, the structural concrete mix and its component materials should be supplied from the same source for a given concrete class and project. Consider the following additional guidelines:

1. Cement. Portland cement will be shipped from pretested and approved bins at the mill or distribution terminal. Pay particular attention to the length of time cement is stored. Storage periods longer than 90 days shall require retesting.
2. Bulk Storage. Check that bulk materials are stored in weatherproof bins. Also check that different materials and materials from different sources are stored separately.

3. Supplementary Cementitious Material Additives. Ensure that Supplementary Cementitious Material (SCM) additives are shipped from Division-approved sources. SCM additives typically should not be used in blended hydraulic cement.
4. Siliceous Sand. Unless otherwise directed, siliceous sand will be used as fine aggregate in bridge deck wearing surfaces. Verify compliance of material type and storage.
5. Air-Entraining Admixture. All classes of structural concrete are required to be air entrained. Ensure that the proper type of admixture is provided.
6. Water-Reducing Admixtures. Where used, verify that water-reducing admixtures are of the required type. Do not permit the use of water-reducing admixtures in conjunction with water-reducing retarders.

601.1.2.4-Formwork and Falsework Materials Materials for formwork, falsework, and framework must be of sufficient rigidity to prevent settlement and distortion due to the pressure of concrete and other loads incidental to construction. Verify that all formwork materials comply with the provisions of the Contract by obtaining the appropriate shipping documents. Formwork materials must be in good repair and of the required type and size for the project. Consider the following guidelines:

1. Form Lumber. Pay particular attention to the condition of form lumber. The faces of form panels must be dressed for the type of surface required. Lumber that is too dry will swell when it absorbs rainwater and the moisture from plastic concrete. Lumber that is too green or unseasoned will shrink and warp causing joints to open, difficulties in alignment, and uneven surfaces to develop.
2. Reuse of Form Lumber. Contractors frequently reuse wooden form panels. Split, frayed, and delaminated panels are unacceptable, and their reuse should not be permitted. Where panels are acceptable for reuse, verify that the Contractor cuts the sides and ends to provide a tight joint, thoroughly cleans the contact faces, and reapplies a fresh coat of release agent. Unless form liners are used, it is generally not good construction practice to mix new and old form panels, because doing so will usually result in a non-uniform surface texture.
3. Form Liners. Where form liners are used, verify that they are of an approved material type and surface finish before installation.
4. Steel Tie Rods. Check that steel tie rods and ancillary fasteners comply with the requirements of the Contract Plans and Specifications.
5. Steel Formwork. Rust-stained steel forms are unacceptable. Reject the use of bent, misaligned, pitted, rusted or otherwise damaged forms. Check that the proper type of bolts, rivets, clamps, and pins are provided to rigidly secure the formwork without damaging the concrete when the forms are removed. Bolts and rivet heads typically must be countersunk.
6. Stay-in-Place Forms. Where stay-in-place forms are used for bridge decks, verify that the forms comply with the Contractor’s Fabrication Drawings. Stay-in-place forms must be galvanized and crimped. Reject the use of damaged forms.
7. Architectural Formwork. Review plans and specification requirements for specialized materials and/or items of work.

8. Release Agent. The release agent must not bond with or stain concrete nor impede subsequent repairs, wetting, or curing of the finished concrete surface. Where steel forms are used, the release agent must be a rust inhibitor. Upon receipt of the manufacturer's literature from the Contractor, ensure that the manufacturer has certified that the release agent complies with the governing regulations on the use of volatile organic compounds.

601.1.3-Quality Control/Quality Assurance Considerations

601.1.3.1-Quality Control Plan The Contractor is responsible for developing a Quality Control Plan in conformance with the requirements of MP 601.03.50. The Quality Control Plan should be submitted to the Project Engineer/Supervisor at the Pre-Construction Conference. Before work begins, verify that the District Materials has reviewed and accepted the Quality Control Plan. All project personnel shall be familiar with the Quality Control Plan.

During the project, verify that the Contractor operates within the Quality Control Plan and that the Contractor provides the necessary equipment and personnel for quality control. Check that at least one certified Portland Cement Concrete Technician is provided to direct the required field inspection, sampling, and testing duties and that such duties are performed by certified Portland Cement Concrete Inspectors. See Section 705 for additional information.

601.1.3.2-Quality Acceptance The Project Engineer/Supervisor and Project Inspectors, as assigned, are responsible for quality acceptance. Use Section 601.4.4 and Table 601.3.1A of the Specifications to evaluate acceptability based on compressive strength. The Contractor's quality control samples and tests may be used for acceptance, if previously authorized by the Project Engineer/Supervisor. Where nonconforming concrete is permitted to remain in place, remember to adjust payment based on the specified adjustment factor; otherwise, enforce the Contract provisions with respected to correcting the work. As needed, the Project Engineer/Supervisor may rely on other tests to further evaluate the acceptability of the work.

601.1.3.3-QC/QA Sampling and Testing Quality control and quality assurance sampling and testing methods will be performed as specified in Section 601.4.1 of the Specifications for sampling plastic concrete and aggregate materials, sieve and moisture analyses, and tests for slump, entrained air, unit weight, yield, and compressive strength. Note that slump tests should be delayed for approximately three to five minutes after mixing, when volumetric batching or continuous mixing processes are used. See Section 703 for additional information on sampling and testing.

601.1.4-Structural Concrete Mix Design Before production begins, check that the District Materials has received and accepted the Contractor's Mix Design. The Mix Design will be developed in accordance with MP 711.03.23 and will document the mix proportions, including admixtures, that are necessary to meet the properties specified for the designated concrete class.

Concrete class and design strength will be designated on the Contract Plans. Pay particular attention to compressive strength requirements. If a “Modified” concrete class is designated, refer to the plans and special provisions.

During the project, verify that concrete production conforms to the Mix Design, and immediately notify the Project Engineer/Supervisor of any suspected changes in materials. The Contractor is responsible for resubmitting a revised Mix Design if material type or source has been changed.

601.1.5-Formwork and Falsework Plans

601.1.5.1-General Considerations The Contractor is responsible for the design and construction of all formwork, falsework, and framework. Unless otherwise stipulated for items such as stay-in-place and architectural formwork, the Contractor is generally not required to submit plans for formwork (refer to the plans and specifications when the submittal of drawings and/or calculations are required).

601.1.5.2-Stay-in-Place Forms for Bridge Decks The Contractor will design the bridge deck forming system in conformance with the minimum requirements of Section 601.8.9 of the Specifications, including form material, form sheet gage, design loads, unit working stresses, span lengths, deflections, and forming system changes. The Contractor will submit to the Division detailed Fabrication Drawings, which must be stamped by a West Virginia Professional Engineer. The Project Engineer/Supervisor will review the Fabrication Drawings for compliance with Contract requirements (e.g., PE stamp, service life of forms). The Project Inspector should become thoroughly familiar with the details of the drawings prior to the start of work.

601.1.6-Pour Sequence Plan for Concrete Structures The Project Engineer/Supervisor will review the contract plans for pour sequence details.

601.1.7-Weather Considerations and Protection of Concrete

601.1.7.1-Requirements for Cold Weather Concreting When structural concrete work will occur during cold weather, verify that the Contractor has adequately addressed the requirements for cold weather concreting. Enforce the Contract provisions for cold-weather concreting when the temperature of the plastic concrete falls below 55°F. Under such cases, the Contractor must provide adequate means of maintaining mix temperature between 50°F and 85°F . Check that the mixing water and/or aggregates are properly and uniformly heated; however, do not permit heating above 150°F, because this will promote a false set of the concrete. Do not permit heating methods that will alter air entrainment, the use of live steam to heat the aggregates, nor the use of calcium chloride in the mix.

When the ambient temperature is expected to fall below 30°F, check that the Contractor provides suitable means to maintain the concrete surface temperature between 50°F and 90°F. Insulated forms, enclosures, heaters, and blanket coverings are generally used for this purpose. The concrete surface must be maintained above 35°F during the curing period. Monitor the surface temperature for compliance, and record the readings on the Daily Work Report. Do not count days on which the surface temperature falls below 50°F as curing days. Where frost damage is evident, enforce the Contract provisions with respect to removal and replacement. Consider additional measures such as insulated forms, enclosures, heaters, straw blanketing or tarpaulins.

Special care must be taken to prevent overheating of the concrete, especially during seasons when the air temperature fluctuates greatly from day to day. Venting must be provided in the cold-weather protection to accommodate these rises in temperature. Additionally, after the curing period, ensure that the cold-weather protection is removed in such a manner that will not allow the temperature of the concrete surface to fall more than 20°F in a 24 hour period.

601.1.7.2-Requirements for Hot-Weather Concreting When structural concrete work is to be performed during hot weather, the Contractor is responsible for submitting a Hot-Weather Concreting Plan at the Pre-Construction Conference. The Plan must illustrate that the pour of the bridge deck will occur during days when it is most likely that the ambient temperature will be less than 85°F.

When the ambient temperature reaches 85°F, enforce the Contract provisions for hot-weather concreting. Monitor the temperature of the plastic concrete frequently. When the plastic concrete reaches 85°F, verify that the elapsed time between the introduction of water and the mix discharge does not exceed 1 hour. Concrete tends to set quickly during hot weather. When the temperature of the plastic concrete reaches 90°F, verify the proper use of retarders or cooling of the mix. The introduction of crushed or flaked ice in the mixing water or mixer is acceptable, as long as the water proportion in the mix is properly adjusted. Note that aggregates must be maintained in a saturated, surface-dry condition. Under no circumstance allow the Contractor to place concrete that exceeds 90°F after mixing.

Hot, dry, and windy conditions tend to remove moisture from the concrete surface faster than it can be replaced by normal bleeding, which causes shrinkage cracking. This issue is especially important during the first 24 hours of curing. During hot-weather concreting, verify the application of curing material immediately after finishing. The concrete surface must be maintained in a moist condition throughout the entire curing period.

601.1.7.3-Concreting During Inclement Weather Before the project starts, check that the Contractor is sufficiently prepared to protect the exposed surfaces of unhardened concrete from the effects of rain and running water. The washing effect of sudden showers and downpours will remove the cement component from these surfaces. If rain is imminent, inform the Contractor to halt work and immediately cover exposed unhardened surfaces. The finishing operation can continue as follows:

1. Brief Showers. If the shower is brief, the Contractor should immediately remove the protective covering to finish the surface.
2. Continuous Showers. During a continuous shower, the Contractor must repeatedly roll back the protective covering approximately 3 ft. at a time, finish the surface, and replace the covering without marring the finished surface.

As soon as practical, inspect the surface for defects, and immediately inform the Contractor of any needed repairs. Note your findings and directives to the Contractor on the Daily Work Report.

601.1.8-Preparation for Emergency Stoppage of Work Ensure that the Contractor is adequately prepared to provide for emergency interruptions in the work. Construction joint locations should be planned well in advance of the concrete placement operation, and material for bulkheads and keyways should be readily available during the work.

As practical, individual sections of the structure should be completed without interruption; however, where work must be stopped, a construction joint should be provided. This prevents the formation of cold joints. If wall construction must be stopped before the forms are completely filled, verify that straight wood strips are nailed to the inside of forms to provide a neat line at the top edge of the concrete. Arches should be constructed according to the schedule on the Contract Plans, or as otherwise directed by the Bridge Engineer.

During construction, ensure that telltales are properly monitored by the Contractor to ensure that unacceptable movement or shifting of forms does not occur. Where unacceptable movement is observed, immediately inform the Contractor and Project Engineer/Supervisor. Appropriate corrective action must be taken.

601.2-MIX PRODUCTION AND HAULING

601.2.1-Overview Proper inspection of production and hauling methods and equipment cannot be overemphasized. It is key to producing a quality structure. Project Inspectors in charge of production and acceptance must fully appreciate the linear nature of the project – from raw component materials to the final structure. Quality greatly depends on the attention given during each step. No amount of extra effort at the structure can compensate for errors and omissions at the mix site.

Before production, verify that production facilities have been properly inspected and certified by the Division. Become familiar with the equipment and operation, and check for obvious signs of unacceptable use or mechanical condition. Verify that systematic and regular checks are conducted in accordance with WVDOH policy. Do not adjust production settings, scales, or meter proportioning equipment, because these tasks are the Contractor's responsibility.

601.2.2-Stockpiles and Material Bins See Section 401.4.2.3 for information on proper aggregate stockpiling techniques. Check that bins are compartmentalized to positively separate different aggregate materials without spillage, intermingling, or contamination. Verify that a rapid means of sampling is provided as the aggregate passes from storage bin to weigh hopper or to conveyor feed. Ensure that bulk cement and fly ash, where used, are stored in separate bins that will prevent contamination and wetting. Dark clumps of cement material are a sign of previous wetting and may be grounds for rejection.

601.2.3-Aggregate Moisture Considerations The Mix Design assumes latent moisture, so aggregates must be maintained in a saturated surface-dry condition. Excessively dry conditions may warrant wetting at night and sprinkling during the day, but the storage facility must be capable of draining the excess water. Verify that moisture tests are conducted as specified, and require additional testing as conditions warrant. Such monitoring is critical to maintaining the water-cement ratio within tolerance.

601.2.4-Scales and Automated Weighing Devices Where bulk cement is used, ensure that a separate weigh hopper and scale are provided to proportion the cement material. Verify that the hopper is sealed to prevent dusting. Check that the discharge chute is maintained free of clogs and leaks and is not suspended from the weigh hopper.

Check all scales for proper certification, calibration, and accuracy. Ensure that the Contractor provides the required test weights. See Section 708.1 for additional information on checking batch proportioning scales. Where batch plants are equipped to proportion aggregate and bulk cement materials by means of automatic weighing devices, check to ensure they are of an approved type, properly calibrated, and in good working order.

601.2.5-Water and Admixture Dispensers Verify that water proportioning devices have been properly checked and calibrated (i.e., by volume or weight). Such devices must be capable of proportioning water to within 1% of the actual quantity required for each batch. See Section 708.2.2 for additional information.

Verify that admixture dispensers are of an approved type and provide a positive, automatic method of proportioning the admixture solution. See Section 708.2.3 for information on checking the accuracy of admixture dispensers.

601.2.6-Concrete Mixers and Agitators Depending on the type of production method, many types of mixers and agitators may be used, including site and central mixers, volumetric mixers, truck mixers, truck agitators, and non-agitator trucks. Where central mixers are used, ensure they are equipped with a properly calibrated mix timer and discharge locking system. If the device fails, it is permissible to manually control the batch mixing period while repairs are being made. Verify that mixers, regardless of type, are cleaned at suitable intervals. Check pickup and throw-over blades for unacceptable wear, and enforce the Contract provisions with respect to repair and replacement. See Section 501.2.4.2 for additional information on mixer performance and maintenance.

601.2.7-Ready-Mix Concrete Ready-mixed concrete will be either central mixed, truck-mixed, or shrink-mixed as specified in the Contract and defined in Section 601.7 of the Specifications. Note that shrink-mixed concrete is partially mixed in a central plant and then a truck mixer is used to finish the mixing (i.e., in transit to or at the job site). Shrink-mixed concrete is generally only permitted if expressly provided for in the Contract.

601.2.8-Volumetric Batch and Continuous Mixing Operations Concrete produced in volumetric batching and continuous mixing operations is permitted for incidental construction items; however, it is not permitted for use in bridge, box culvert, pavement, and retaining wall construction.

601.2.9-Concrete Hauling Operations Where truck mixers or agitators are used for transport, pay particular attention to haul time. The maximum elapsed time at discharge, after the cement is introduced to the aggregate, is 1.5 hours. Use 1 hour, maximum, where the concrete temperature exceeds 85°F. Where a truck mixer is the only means provided for mixing, verify that the mixing operation begins within 1 hour of adding the cement. Pay particular attention to evidence of segregation. Segregation will cause honeycombing, rock pockets, and shrinkage cracks. Reject non-conforming batches. Upon delivery of each batch, check the accompanying Form 411A (i.e., batch ticket) for complete and accurate information. Update the Daily Work Report, and retain all batch tickets for the project files.

601.3-MIX PROPORTIONING AND ADJUSTMENT

601.3.1-Characteristics of Plastic Concrete Structural concrete is considered to be in the plastic state during the period from when water is introduced to the cement during mixing to just before the concrete begins to set. Two concrete characteristics need to be closely monitored during this period: consistency and workability, which are discussed in the following Sections.

601.3.1.1-Concrete Consistency Consistency of plastic concrete is a measure of the ability of a concrete mix to flow sluggishly without crumbling or segregating. It is usually specified and measured in inches of slump. Consistency requirements differ from application to application. For example, the consistency of a concrete mix required for a massive but lightly reinforced concrete structure will differ significantly from that required for a heavily reinforced concrete structure that is to be placed in formwork, which is difficult to access. Consistency should be uniform from batch to batch; otherwise, the water content will vary throughout the concrete in the structure. This non-uniform distribution of water will create an uneven surface finish and shrinkage cracking, especially on dry, hot, and windy days. Proper control over mix consistency and the timely curing of the concrete will usually minimize these problems.

601.3.1.2-Concrete Workability Workability is a subjective rating that reflects the ease or difficulty of placing, consolidating, forming, and finishing a concrete mix. It is influenced by aggregate type and gradation, mix proportioning, air entrainment, and consistency. Workability greatly affects the quality of the finished concrete surface and, ultimately, its acceptability. Concrete that is difficult to work with will invariably cause defects in the finished surface.

601.3.1.3-Segregation and Bleeding Plastic concrete can segregate and bleed, which are undesirable conditions. A well-proportioned mix should be homogeneous with all components uniformly distributed as the concrete hardens. Segregation occurs when the coarse aggregate separates from the mortar (i.e., fine aggregate, cement, water) and can be caused by a poorly proportioned mix, improper handling and placing techniques, and excessive vibration during consolidation. Bleeding is the appearance of excess quantities of mix water on the finished surface of bridge decks and other horizontal surfaces and is caused by the use of too much water in a poorly proportioned mix. The mix water is forced to the surface as the heavier components settle. This bleeding problem can be exacerbated by excessive vibration during consolidation. Bleeding will weaken the concrete surface if finishing is not delayed until the bleed water has depleted. A lower water-cement ratio and the use of entrained air in the mix will virtually eliminate bleeding, as long as the mix is not overly vibrated.

601.3.2-Characteristics of Hardened Concrete

601.3.2.1-Compressive Strength of Concrete Different classes of structural concrete will be designated for different applications, and each concrete class will have a minimum compressive strength requirement. Compressive strength is a primary indicator of acceptability; however, it is not the only factor that should be considered. It is measured by breaking 28-day old concrete test specimens under a compressive load. The compressive strength of concrete is primarily affected by water-cement ratio and curing method. A relatively low water-cement ratio will produce a relatively high-strength concrete. The converse is also true.

601.3.2.2-Wear Resistance of Concrete Surfaces A wear-resistant concrete is needed for structural elements such as bridge decks, which are normally subjected to wear by studded tires, chains, cinders, and other abrasive materials. The degree of wear resistance is directly related to the compressive strength of the concrete. The higher the compressive strength, the greater its wear resistance will be.

601.3.2.3-Concrete Durability A durable concrete will resist scaling and spalling, which are detrimental conditions caused by freeze-thaw cycles and de-icing chemicals. Experience and research have shown that concrete durability has a greater influence than compressive strength in mitigating scaling and spalling. High-strength concrete with a low water-cement ratio will not necessarily result in a durable concrete. To provide a durable concrete, the mix must incorporate the specified total air content (i.e., entrapped plus entrained), no more than the maximum specified water cement ratio, and no less than the minimum specified cement content.

601.3.2.4-Permeability of Concrete Permeability must be considered where structural concrete will be exposed to water, such as in piers, abutments, bridge decks, box culverts, and retaining walls. Concrete used in such applications must be relatively watertight (i.e., less permeable). To ensure a watertight concrete, the mix must incorporate the specified water-cement ratio and total air content.

601.3.3-Field Testing and Concrete Mix Adjustments During the project, ensure that the Contractor proportions aggregate, cement, water, and admixture materials in compliance with the Mix Design. It is good inspection practice to become familiar with the Mix Design, including control charts, mix proportions, and methods of determining scale weights and batch quantities. Note that scales and proportioning equipment must be inspected and certified before the operation begins.

601.3.3.1-Field Laboratory Prior to production, verify that the Contractor has provided and furnished the field laboratory as required by Section 501.5.1 of the Specifications. See Section 501.2.6.1 for additional guidance.

601.3.3.2-Adjusting Concrete Mix Consistency Uniform consistency is necessary for the proper placement and consolidation of structural concrete. Use Table 601.3.2 in the Specifications to check that concrete consistency is uniformly maintained for the structure. Superplasticizers (e.g., Type F, Type G) are frequently used to improve consistency. Where used, obtain from the Contractor the required Statement of Compliance from the admixture manufacturer. Verify that the quantity of superplasticizer used per batch (i.e., field or batch plant) does not exceed that recommended by the manufacturer. Check the speed and time of mixing superplasticized concrete for conformance to specified requirements. Under no circumstance allow slump to exceed 8 inches. After mixing, perform the required acceptance tests (e.g., slump, air content, compressive strength). Document the results in the Daily Work Report.

601.3.3.3-Adding Water to Concrete Batches The addition of water to a batch is generally not permitted; however, where truck mixers are used, there may be instances where water needs to be added to adjust concrete consistency. In such cases, verify that at least 20 additional drum revolutions at mixing speed is performed before the concrete is discharged. Reject concrete batches that fail to meet specified consistency requirements.

601.3.3.4-Adjusting Air Content in Concrete Batches Check entrained air of batches at the point of placement based on the specified schedule for measurement. Ensure that immediate corrective adjustments are made to the batching process if entrained air is not within plus or minus 2.5% of the target value (see Table 601.3.1 Specifications). Greater than 3.0% is grounds for rejection. Where truck mixers are used, acceptance will be based on the criteria and conditions established in the Contract.

601.3.3.5-Adjusting Concrete Mix Yield Immediately after consistency and entrained air have been established, determine the average unit weight and actual yield as specified. Ensure that the design mix is adjusted and maintained to correspond to the theoretical yield. As work progresses, make yield checks in the manner prescribed to ensure it is maintained within the required tolerance. If needed, enforce the Contract provisions to adjust other design mix proportions to maintain the concrete in a plastic, workable mix with suitable finishing characteristics. Do not allow changes in the brands or sources of component materials without prior approval from the Project Engineer/Supervisor.

601.3.3.6-Adjusting "Total Solids A" in Concrete Batches Check that the combined grading of coarse aggregate, fine aggregate, and cement used in the structural concrete conforms to the design mix "Total Solids A" plus or minus the allowable tolerance specified in Table 601.3.2.4 of the Specifications. Verify that the Contractor determines the grading of total solids at the specified frequency. Enforce the provisions of the Contract with respect to halting production and requiring proper corrective action if the moving average of test results is not within allowable tolerance.

601.4-PRE-POUR OPERATIONS

601.4.1-Formwork and Falsework

601.4.1.1-General Considerations Formwork and supporting falsework for structural concrete projects must provide a mortartight enclosure that will minimize distortion due to the pressures, loads, and vibrations generated during the operation. Consider the following guidelines:

1. Chamfer Strips. If untreated, the corners of forms will produce sharp, weak edges on structural concrete members. Additionally, it is difficult for the concrete to completely fill the corners of forms, which results in non-uniform edges and corners. To minimize such defects, the corners of forms must be beveled, filleted, and chamfered. Where chamfer strips are used, check to ensure that the strip is of the required size. In addition, verify that forms are filleted where required and that they are provided with a bevel or draft at projections for easy removal.
2. Cleanout. Where needed, check that the Contractor provides a suitable means of cleaning extraneous material from the bottom of formwork. This is especially important where forms are used for deep, narrow structural members. To facilitate removal of dirt and debris, the bottom of the formwork is usually provided with a removable panel or window. The bottoms of forms must be cleaned and inspected prior to the concrete pour.
3. Welding Considerations. Where welding is required, verify that welder's have been certified in accordance with the provisions of the Contract. Under no circumstance allow the welding of form ties, form supports, or screed rail supports to the beams.
4. Falsework Considerations. Elevated horizontal structural members such as beams, roof slabs for box culverts, and some bridge decks will be supported by falsework. The Contractor is responsible for the design and construction of all falsework (see Section 601.1.5). Falsework must be sufficiently rigid to support the concrete without appreciable settlement or deformation of the forms. Vertical posts are generally used to support joists and formwork. Each post will be set on a piece of timber called a mudsill. To prevent settlement, the area of the mudsill must be of sufficient size to ensure adequate bearing support from the soil. Verify that jacks and wedges are used to maintain form elevation and permit form removal without damaging the structure. Periodically observe the Contractor's tell-tales for obvious signs of unacceptable settlement or movement and as needed, require immediate corrective action.

601.4.1.2-Beam and Arch Formwork The formwork and framework for beams and arches must accommodate the tendency of the form and the final structural member to sag at the center of its span. This tendency to sag occurs both during the pour, due to the weight of the plastic concrete, and after the form has been removed, due to the weight of the structural member itself (i.e., dead load deflection). To offset this tendency to sag, the framework provided at the center of the span must elevate the form higher than its intended final elevation. This treatment is called cambering. The framework will generally consist of supports, strike wedges, sand boxes, and jacks. Where vertical post supports are used, verify that they are placed on mudsills of sufficient size to minimize settlement.

The amount of cambering must be sufficient to offset the dead load deflection of the member once the forms have been removed. In addition, the framework that the Contractor uses to provide the cambering must be constructed to allow the gradual removal of the center supports. This will allow the hardened beam or arch member to change its shape slowly, thus minimizing sudden stresses and strains in the structural member. The Contractor's Formwork Plan will provide cambering and formwork removal details, including structural data and analyses (see Section 601.1.5). If the Contractor's methods are questionable, immediately notify the Project Engineer/Supervisor.

601.4.1.3-Bridge Deck Formwork It is important to carefully monitor all bridge deck construction phases, including: installation and fastening of forms; placement and fastening of reinforcing bars; and delivery, placement, consolidation, and finishing of the concrete. Unless otherwise directed, stay-in-place fabricated metal forms will be used to construct all interior bays of beams in concrete bridge decks. Removable forms will be used for overhangs and where longitudinal expansion joints are located between stringers.

Check that stay-in-place forms are installed in compliance with the Contractor's Fabrication Plans (see Section 601.1.5). Verify that the forms are securely fastened to their supports and that the length of bearing at each end is at least 1″. Check form supports to ensure they are placed in direct contact with the flange of stringers or floor beams and that the bolts and clip attachments are secure. Do not walk on forms until they have been securely fastened. Do not allow welding of form supports to the tops of flanges. Check for damage to the forms' galvanized coating and required repair work where needed, and ensure that the forms do not interfere with transverse joints and weep holes, where provided.

Just prior to concrete placement, verify the location of each abutment and pier, check the horizontal and vertical clearance at various points along the structure, and check form alignment and grade for compliance, especially the grade lines for parapets, wheel guards, "V" grooving, and other exposed edges. These checks are generally performed using a surveying transit and level, stringline, tape rule, and plumb bob. "Eyeing in" is acceptable for minor adjustments to grade lines. Check the camber provided for beams and arches. If the amount of camber is not shown on the Plans, contact the Project Engineer/Supervisor for assistance. Pay particular attention to the method of forming deck overhang areas beyond outside girders. These areas are extremely critical due to their cantilever construction. The

Contractor is responsible for all overhang calculations and calculations for determining jack size and spacing. If discrepancies are found, notify the Project Engineer/Supervisor.

601.4.1.4-Architectural Formwork Architectural formwork will be used where designated on the Contract Plans for cast-in-place structural concrete. Check for misaligned forms, open joints, and work that is not level or out of plumb, and verify that openings, offsets, keyways, recesses, chamfers, blocking, screeds, and bulkheads are provided where required. Enforce the Contract provisions with respect to needed corrections. In general, architectural formwork should be assembled so that it can be removed without damaging the exposed concrete surface.

During assembly, check that panels are solidly butted together and that backup material is provided to minimize mortar leaks and the creation of fins. In addition, unless otherwise designated, verify that forms are assembled to provide sharp, clean corners with no visible edges or offsets and that chamfered corners are provided where specified.

Where the interior of formwork will be inaccessible, verify that the Contractor provides temporary form openings so that the bottom of the formwork can be cleaned and inspected before the concrete pour. The location of these openings should be inconspicuous.

The drilling of form panels is typically required to accommodate form ties. Observe this operation to ensure that panels are drilled from the contact side. Any splintering of the contact side will appear in the exposed face of the concrete once the forms are removed. In addition, check that the diameter of the drilled hole matches that of the form tie. If too large, mortar leaks will occur, and if too small, the tie will need to be driven through the panel, which will generally splinter the panel.

601.4.1.5-Formwork for Concrete Walls Forms for concrete walls are generally supported by studs and wales, with form panels for the faces of the wall being separated at the proper distance by metal tie rods and wooden spreaders. The tie rods remain within the concrete; however, the spreaders must be removed during the pour. The protruding ends of the rods will be cut off after the concrete has hardened. Where cut, check that any damage to the concrete surface has been properly repaired.

601.4.1.6-Formwork for Parapet Walls and Median Barriers Contractors will typically use slip forming for structural concrete items such as parapet walls and median barriers. Where slip forming is used, pay particular attention to the joint construction operation. Unless otherwise directed, joints may be either formed or sawed. The joint spacing will be designated on the Contract Plans. Where joints are sawed, review the requirements of Section 601.8.8 of the Specifications.

The timing of initial sawing must be sufficient to prevent uncontrolled cracking. In addition, check compliance of joint width, depth and length along the face, and verify the proper sealing and installation of back-up material.

601.4.1.7-Form Cleaning Once the forms have been erected but before the reinforcing steel is placed, check to ensure that all extraneous dirt and debris have been removed from the bottoms of forms. The surfaces of forms should be cleaned and soaked with a steam jet or a stream of hot water. During cold weather, monitor the inside of forms for ice formation.

601.4.1.8-Application of Release Agent To break the bond between concrete and formwork, check that form surfaces are thoroughly coated with an approved release agent. This operation must be performed before the reinforcing steel is placed. If the release agent is spilled or sprayed on reinforcing steel, require cleaning of the reinforcing steel prior to pouring the concrete. The method and rate of application should be in conformance with that recommended by the manufacturer. Form surfaces that are not coated with release agent should be thoroughly wetted.

601.4.2-Placement of Reinforcing Steel Check the size, location, spacing, and clearance of reinforcing steel for conformance to the requirements of the Contract Plans. Pay particular attention to the method of tying and fastening. Ensure that the minimum concrete cover requirements are not exceeded.

Great care should be exercised in ascertaining that the reinforcing steel is properly located, spaced, and tied. Pay particular attention to bar bending details and the placement of bent bars to ensure that the required slab depth and specified minimum concrete cover at ends, edges, and the top and bottom of the slab are provided. In addition, closely examine reinforcing steel just prior to concrete placement for signs of damage to epoxy coating and any material on the bars that would prevent the proper bonding of the concrete to the steel. Require repair or restoration work where required.

For bridge decks constructed with stay-in-place formwork, check that the bottom layer of reinforcing bars are placed at least 1" from the bottom of the deck slab. Also check that the distance from the bottom layer of reinforcing bars to the top of the deck slab does not exceed that shown on the Contract Plans.

601.4.3-Inspection of embedded Fixtures The Project Inspector should make certain that all embedded fixtures are in their correct position and solidly fastened. If wood inserts are used, they must be soaked in water for at least 24 hours prior to being placed in the forms. After all reinforcing steel has been placed, check that the tubes or inserts required for weep holes have not been displaced. Ensure that all required drainage has been properly installed and that no water will be trapped after the structure has been completed.

601.4.4-Joint Considerations

601.4.4.1-Expansion Joints Each expansion joint must be located as shown on the Contract Plans. The joint must be straight and at right angles to the forms, and care must be taken to prevent concrete from bridging the space left for expansion and contraction. Sliding joints should be lubricated to ensure movement after the concrete has hardened. Where a bridge deck is constructed with a concrete wearing surface, ensure that the expansion joints in the wearing surface are installed at the same location as the joints in the deck slab, curbs, and wheel guards.

601.4.4.2-Construction Joints A roughened concrete surface at a construction joint does not provide sufficient bonding. Therefore, dowel bars and keyways are required. Verify that the dimensions and placement of keyway forms and dowel bars conform to the requirements of the Contract Plans. Horizontal or vertical construction joints must be constructed in accordance with the requirements of Section 601 of the Specifications. Where a vertical joint is constructed on an exposed face, verify that a chamfered strip is placed where the bulkhead meets the form face. This will enhance appearance and prevent concrete spalling.

An unexpected delay in the placement of the concrete may necessitate the installation of a construction joint. In such cases, the Project Engineer/Supervisor is responsible for approving the location of the joint. Depending on the approved location, the Contractor may be required to remove previously placed concrete. Carefully observe the installation operation to ensure that the new concrete will properly bond with the old concrete. To achieve a positive bond, verify that the Contractor thoroughly cleans the stub ends of reinforcing bars that extend through the joints, thoroughly clean the surface of hardened concrete with a stiff wire brush to expose the aggregate and remove foreign material and laitance, and moistens the hardened concrete just prior to placing the new concrete.

601.4.5-General Equipment Inspection Verify that the Contractor has on hand all equipment necessary for the concrete placement operation. Pay particular attention to the acceptability of the type, quantity, and condition of the equipment. Tools for spreading the concrete must have handles long enough to reach all parts of the forms, and the vibrators must be checked to ensure they meet specified requirements and are in good working condition.

Extra vibrators must be on hand in the event of equipment failure.

Unless otherwise specified, concrete for bridge decks will be placed and finished using a self-propelled machine equipped with automated controls. Prior to placement, verify that the Project Engineer/Supervisor has reviewed and accepted the Contractor’s proposed equipment and that the equipment has been properly calibrated and checked during dry runs.

601.4.6-Screed Rail and Screed Inspection The Project Inspector must pay particular attention to how the Contractor sets the elevations of screed rails and end dams. As the concrete is placed, the beams and girders supporting the deck will deflect; and, unless the Contractor takes this deflection into account, the deck surface will deviate from the required profile and produce a non-uniform slab thickness and rough riding surface. The Contract Plans will provide grade elevations at various locations along the profile to account for this deflection. These elevations must be used when setting screed rail elevations to ensure that sufficient camber is provided in the slab. The tops of stringers are generally used as a baseline.

Screed rails should be held in place by fixed supports that are adjustable for height and easily removed after screeding. The supports should be located in a staggered arrangement (i.e., the supports on one side of the roadway should coincide with the midpoints of spaces between the supports on the other side). The spacing between supports should generally not exceed 5' to adequately support the load of the finishing machine without bending the rails.

To check the camber in the screed rails, use a surveyor's level to obtain elevation readings at various points along the top of the rail. Plot these points on an exaggerated vertical scale to verify that they lie on a smooth curve at the proper grade. Ensure that any high or low points are properly adjusted to correct grade.

Additional checks can be made by sighting along the top of the rail.

Check all screeding surfaces for straightness and proper cross section. If the finishing machine will ride above the pavement surface, check the screeds in the down position to ensure they are adjusted to the proper profile and cross section.

When the bridge is on a heavy skew angle, consider setting the machine parallel to the skew and refer to the manufacturer's specifications.

601.4.7-End Dam and Bulkhead Inspection End dams must be secured firmly to maintain proper elevation and to ensure that the check plate will remain parallel with the roadway surface during concrete placement.

Stretch a stringline from the stake to the point on the stringer, ensuring that the stringline is at or parallel above grade at both points.

Compare the grade and alignment of the expansion plate with that of the stringline. Enforce the provisions of the Contract with respect to any needed adjustments.

If the deck is to be poured in sections, ensure that bulkheads are readily available. Check bulkheads for proper fit and dimensions.

601.4.8-Inspecting Height of Reinforcing Steel After screed rails, end dams and bulk heads are set, the Project Inspector should check the height of reinforcing steel and all clearances between the screed and the reinforcing steel by means of a dry run.

601.5-PLACEMENT AND CONSOLIDATION OPERATIONS

Pay particular attention to evidence of mix segregation and displacement of reinforcing steel during the pour and require immediate corrective action. Also watch for any unnecessary jarring of forms or movement of projecting reinforcing steel. In multi-stage pours, ensure that all laitance is removed from the surface of the previous pour and that reinforcing bars are cleaned of all splatter. The top surface of plastic concrete in the formwork must be kept nearly level.

601.5.1-Mix Segregation Segregation of the coarse aggregate will cause honeycombing of the concrete surface, rock pockets, and shrinkage cracks to occur. Pay particular attention to the method used to place and consolidate the concrete. Allowing the mix to fall from an excessive height and excessively vibrating the concrete during consolidation promotes mix segregation.

601.5.2-Use of Chutes and Troughs Do not permit concrete to be dropped from a distance greater than 5' without the use of a tremie, elephant trunk, closed chute, or pipe. Do not allow the use of aluminum chutes or troughs. A chemical reaction between the aluminum and lime materials will cause an uncontrolled increase in entrained air, which will reduce concrete strength.

If concrete is placed using a steeply sloped chute, verify the proper use of baffling at the discharge end of the chute. The baffle should be designed to direct the concrete straight down to minimize segregation.

A chute must have a rounded metal bottom that is clean and smooth on the inside. If the concrete will not move on its own, it must be pushed down the chute with shovels. Extra water should never be added to the concrete mix for the purpose of making it slide down the chute. After each run, ensure that water is used to flush out and discharge residual material outside the formwork.

601.5.3-Pumping of Concrete If the Contractor chooses to use equipment to pump the concrete into position, emphasize to the Contractor that the specified slump must be maintained and that adding excessive water to the mix for the purpose of facilitating pumping is unacceptable. Prior to pumping the concrete mix, ensure that the Contractor lubricates the line.

601.5.4-Protection of Reinforcing Steel Where concrete is placed in deep formwork, care must be exercised to protect the reinforcing steel above the elevation of placement from movement and concrete splatter. This is especially important where a structural element is placed in sections one on top of the other. Mortar that splashes and dries on the bars that are to be covered by a subsequent pour will inhibit the concrete from bonding with the steel. The use of tremies, elephant trunks, or windows in the formwork are generally used to minimize bar movement and splatter.

601.5.5-Placement of Concrete in Bridge Deck Formwork To minimize problems during placement and finishing of a bridge deck and to ensure a smooth riding surface, concrete that is delivered to the site must be uniform in composition, workability and consistency. Variations in any of these factors may produce undulations in the surface during the screeding operation. There should be a small amount of concrete on the surface that is to be struck off by the finishing screed. Too much of a roll or too stiff of a mix in front of the finishing screed will produce a high spot, and too little of a roll will produce a low spot. The use of manual labor to continually adjust the amount of concrete rolled in front of the finishing screed is undesirable.

Where stay-in-place forms are used, concrete must completely fill the forms and be vibrated sufficiently to ensure consolidation without producing honeycomb or voids at construction joints, expansion joints, flutes, or the ends of the form sheets. During placement, ensure that the concrete is properly vibrated around reinforcing steel, joints, and in the corners of forms. Vibrating screeds will not accomplish this task. Require corrective adjustments to the operation or to the concrete mix if any of these conditions become problematic.

To facilitate finishing under hot, dry, and windy conditions, the Project Engineer/Supervisor may authorize the use of a compressed-air fog spray. Water must never be sprinkled, thrown, or brushed onto the surface of the plastic concrete for the purpose of finishing. This will weaken the wearing surface of the deck slab. Monitor this operation closely.

If the Contract Plans call for a deck pouring sequence requiring construction joints, the sequence must be followed precisely to account for beam deflection. Note that the first batch placed in a section between construction joints must be maintained in its plastic state until the last batch for the section has been poured. During hot weather, a retarder that conforms with the contract specifications is generally added to the mix for this purpose.

601.5.6-Placement of Concrete Architectural Formwork Immediately before the concrete is placed, verify that the Contractor has performed a final check of the lines, elevations, and stability of the erected formwork and completed any needed adjustments. During the pour, ensure that the Contractor monitors forms and supports, using telltales or other suitable means, and takes immediate action to correct any undesirable movement. Watch for mortar leaks.

601.5.7-Placement of Concrete in Parapets Slip forming is generally used for concrete parapets and median barriers. Where forms are used, concrete should be placed in the same manner as required for other structural elements. The concrete in the parapet must be spaded or vibrated to ensure a uniform surface texture.

601.5.8-Placement of Concrete Under Water It is sometimes necessary to place concrete under water; however, an adjusted concrete mix and special placement techniques must be employed. The pumping operation itself may create a flow of water within the forms. In such cases, temporarily discontinue the pumping operation. Verify that a tremie or closed-bottom dump bucket is used to deposit the concrete in a compact mass in its final position.

601.5.9-Vibration and Consolidation of Concrete Fresh concrete must be spaded and vibrated to force coarse aggregate away from the surface of the forms and allow entrapped air and free water to come to the surface. The Project Inspector is responsible for checking that approved spades and mechanical vibrators are provided and that the proper consolidation techniques are being employed.

601.5.9.1-Spading Considerations A spade is typically used to push coarse aggregate away from the form and to remove air bubbles that would show up later as shallow holes on the concrete surface. If the proper quantity of mix water is used and the concrete is mixed, placed, and spaded properly, very little free water will bleed to the surface.

Excessive bleed water must be removed from the surface; and if it becomes problematic, the mix may need adjusting (e.g., reducing mix water, adjusting aggregate gradation). If bleed water is allowed to remain on the surface, a scum of thin soupy mortar (i.e., laitance) will form. If allowed to harden, this laitance will produce a very weak surface finish that will wear and spall easily. To prevent laitance from forming, the Contractor should overfill the forms and strike off the excess mix after bleeding has stopped.

Where plywood forms are used, or where pressed-wood or metal liners are used with ordinary lumber, the forms often are so tight that it is difficult to remove air bubbles by spading. In such cases, extra care must be taken to place and thoroughly vibrate the concrete in shallow lifts.

601.5.9.2-Use of Vibrators After concrete is placed in the formwork, it must be properly and thoroughly consolidated. The purpose of using vibrators is to temporarily liquefy the concrete so that entrapped air and water can bleed from the surface. Internal spud vibrators that have a vibrating spud at the end of a long flexible shaft are generally used for this purpose. See Section 501.4.3 for acceptable types and frequency and amplitude settings.

Pay particular attention to the operation of spud vibrators. The spuds must be worked around all reinforcing steel, joints, and angles of forms without coming into direct contact with these features, and the spud must not be left in place too long or dragged through the mix; otherwise, the mix will segregate. When air bubbles stop coming to the surface of the concrete and the surface of the mix around the spud starts to look shiny, the spud should be pulled out and moved to a new position approximately 24" away. Proper vibration should change the appearance of the surface of the mix for about 18" in all directions around the spud. Once hardened, the surface of the concrete will have a smooth appearance if the mix is properly vibrated in the forms.

Vibration produces great pressure on forms, and the form material must be sufficiently strong to withstand this additional pressure. When a thin wall section is filled with stiff concrete and the concrete is vibrated, the pressure on the forms may be high enough to spread the forms apart. On a high wall, the rate of concrete placement, measured in terms of rise of concrete per hour, should be monitored as directed by the Project Engineer/Supervisor.

601.6-FINISHING AND CURING OPERATIONS

601.6.1-Form Removal The Project Inspector must check the method of removing forms to ensure that the concrete is not weakened or damaged in any way. Special care should be used in removing arch forms or forms from the bottoms of beams. These forms should be removed slowly and carefully to prevent sudden unbalanced loads that could damage the concrete or weaken the bond between the concrete and the steel reinforcement.

601.6.1.1-Compressive Strength Considerations Table 601.8.7 of the Specifications presents the minimum compressive strength criteria for removing formwork and falsework and for constructing superimposed structural concrete elements. Any alternate method may be submitted by the Contractor for review. Check that the Contractor makes and monitors compressive test specimens to maintain the operation within specified limits. Otherwise, damage and overstressing of concrete elements may occur.

601.6.1.2-Raising Column Forms Column forms must not be raised prior to the concrete column achieving the minimum compressive strength criteria presented in Table 601.8.7 of the Specifications. After the forms are raised, holes or voids in the surface of the column must be filled with cement mortar in accordance with specified requirements. If a serious defect is found, the Project Inspector should bring the condition to the attention of the Project Engineer/Supervisor.

601.6.1.3-Stay-in-Place Bridge Deck Forms The Division requires sections of stay-in-pace bridge deck forms to be removed for visual inspection and evidence of acceptability. The Project Engineer/Supervisor will select the times and locations for form removal. To check concrete soundness and bonding, the Project Engineer/Supervisor will also perform sounding tests at the frequency and locations specified in the Contract and, where suspect, may require additional sections to be removed.

If cavities, honeycombing, or other defects are found that, in the opinion of the Project Engineer/Supervisor, do not warrant replacement, ensure that the concrete surface is repaired and finished in accordance with the requirements for a Class 1 – Ordinary Surface Finish. If rejection is warranted, form sections will be removed, as needed, to properly repair the bridge deck, and immediate adjustments will be made to the Contractor's operations. Where forms have been removed, inspect adjacent forms and supports to ensure that they have not been damaged. Forms that have been removed do not need replaced.

601.6.1.4-Removal of Architectural Formwork During form removal, check to ensure that crush plates are used where needed to prevent damage to the final concrete surface. Do not allow workers to hammer or pry the final concrete surface for the purpose of removing forms.

601.6.2-Removal of Form Ties Holes left by the removal of form ties should be packed with mortar having the same proportions of cement and sand as the mortar of the concrete. The mortar should be tamped into the holes and kept moist on the surface until the concrete has cured.

601.6.3-Plugging Holes for Anchor Bolts Where anchor bolts are required in a bridge seat, the Contract Plans will show where the holes will be located. In cold weather, if the holes are left open, the concrete may be damaged if they fill with water and freeze. If placement of the anchor bolts is to be delayed until cold weather arrives, all water must be removed from the holes and they must be tightly sealed preferably with rubber stoppers. If wooden stoppers or plugs are used, they must be waterproofed by being heated in metal paraffin until no air bubbles rise to the surface and the pores of the wood are sealed with wax.

601.6.4-Finishing Concrete Surfaces Concrete surfaces must be given a finish, as required by the Contact Plans and Specification. Bearing areas of concrete surfaces of substructures, upon which column bases, bearing shoes of girders and trusses, and similar parts will be placed, must be built to provide full and uniform bearing at plan elevation.

601.6.4.1-Classes of Concrete Surface Finish Bridge parapets, wingwalls, and headwalls are generally given a Class 2 – Rubbed Finish; however, if the Contractor elects to use the optional Class 1 – Ordinary Surface Finish, ensure that the supplemental wood-float rubbing is performed as specified. Other concrete surfaces, including concrete classes designated as architectural, will receive a Class 1 – Ordinary Surface Finish. Horizontal surfaces, other than bridge decks, will receive a Class 6 – Float Finish. Bridge decks will be finished as defined in Section 601.11 of the Specifications.

601.6.4.2-Bridge Deck Surface Finishing The finishing machine or vibrating screed should be moved at a slow, uniform rate. The screed should always be carrying a uniform roll of concrete across its full width. The distance from the surface to the top of the reinforcing steel and the depth of the slab should be checked frequently. In general, the addition of water to assist in finishing concrete is undesirable, because it tends to weaken the concrete wearing surface. However, the Division recognizes that hot, dry, and windy conditions may promote rapid drying and shrinkage cracking. In such cases, an atomized mist may be used to minimize rapid evaporation of surface during the final finishing operation.

After screeding and consolidating the concrete, the screed rails and their supports must be removed without disturbing the concrete surface. Holes left after their removal must be filled with fresh concrete, and not with mortar or the concrete screeded off the surface. Check the surface trueness of the plastic concrete for acceptability using the Contractor-provided straightedge and the procedures defined in the contract specifications. Require high or low areas not within tolerance to be immediately repaired. After the initial straightedge testing and repair work have been completed, the surface should be smoothed with a lute or smoothing float and retested with a straightedge as specified. Ensure that the finished surface is free from observable departures from the straightedge. The final finishing operation should be delayed only long enough to allow the concrete to bleed, shrink, and begin to set.

After the secondary straightedging, check that the surface of the concrete is given a groove finish that meets the specified pattern and dimensions. Pay particular attention to the timing of the grooving operation. Excessive raveling will occur when the concrete is too dry and the mortar will flow back into the grooves when the concrete is too wet. To facilitate drainage, ensure that the 12" width immediately adjacent to the curbline is left untextured. After curing, use a rolling straight-edge to further test surface trueness for compliance. Where high spots are found, the Project Engineer/Supervisor will make the final determination as to the disposition and method of repair or replacement of the area. After the final surface finishing is completed, ensure that an approved curing material is applied to the slab as soon as practical without marring the textured surface.

When the Contract Plans designate the placement of a specialized concrete overlay on a newly placed concrete bridge deck, as defined in Section 679 of the Specifications, check to ensure that the surface of the newly placed concrete bridge deck is intentionally roughened. The surface shall be raked and roughened to provide a surface profile that will facilitate the bond of the specialized concrete overlay. Floating should be minimized to avoid the formation of bleed water on the surface.

601.6.5-Concrete Curing Operation

601.6.5.1-Importance of Curing The final strength and durability of concrete depends primarily on how it is allowed to cure. If the concrete is maintained warm and moist, hydration of the cement takes place, and the cement and water form a gel which fills the voids between aggregates. The gel will eventually harden into a substance that will bind the aggregate particles together. This action of gel formation and hardening generates heat and is accelerated when the freshly mixed concrete is warm. If the concrete is maintained at a temperature of between 50°F and 85°F, the strength of the concrete will continue to increase for many days. The first few hours and days of curing are the most critical. Unless the concrete is allowed to fully cure, it not only will lack strength but also will exhibit other serious defects.

601.6.5.2-Curing Period Verify that the Contractor cures the structural concrete as defined in Section 601.12 of the Specifications. It is important that the concrete surface be maintained completely and continuously moist during the curing period. Class H or K concrete must be cured for at least 7 days, but all other concrete classes may be cured from 3 to 7 days. However, the Project Engineer/Supervisor must authorize the use of any curing period less than 7 days. Prior to curing, check that the curing materials conform to the requirements of the Contract provisions. The application of burlap and water is required for concrete bridge decks. If the Project Engineer/Supervisor has approved the use of an impervious membrane, ensure that the surface finish has been inspected and approved before application. The concrete must be in a saturated, surface-dry condition. In addition, check the rate of application and number of coats for conformance. Check for streaking and membrane damage and, where needed, require immediate corrective action. If the curing material must be removed for the purpose of finishing, ensure that the Contractor restores the covering as soon as practical. See Section 601.1.7 for additional information on cold and hot-weather curing.

601.6.5.3-Use of Linseed Oil When the concrete is at least 14 days old, check that the specified linseed oil mixture is sprayed on the entire top surface of bridge decks, approach slabs, medians, sidewalks (i.e., both top and curb face), and the inside faces of parapets. Prior to application, check temperature requirements for conformance and verify that the surface to be treated is dry and properly cleaned. In addition, ensure that the Contractor shields or masks handrails from overspray.

Verify the rate of application and number of coats for compliance. Caution is advised as the linseed oil mixture is flammable, and the treatment is susceptible to damage from rain. All pedestrian and vehicular traffic are prohibited on the structure during the drying period.

601.6.5.4-Use of Epoxy Resin Coating Verify that the top surface of abutment bridge seats, including drainage areas, and the adjacent bottom 611 of the backwall and the top surface of pier caps are properly treated with the specified epoxy resin protective coating. Check that the surfaces to be treated are dry and properly cleaned, and verify conformance with specified requirements for age of concrete, temperature, rate and method of application, and number and timing of coats.

601.6.5.5-Concrete Protective Coating When required, the Project Inspector is responsible for ensuring that the work for concrete protective coating is in conformance with the materials, construction methods, and details of Section 601.13 of the Specifications.

601.7-RECORDS AND DAILY WORK REPORTS

The types of records that must be maintained for structural concrete work are very similar to those required for concrete pavement work (see Section 501.7). Ensure that the appropriate attachments are completed and attached to the Daily Work Report.

SECTION 602
REINFORCING STEEL

602.1-GENERAL REQUIREMENTS

602.1.1-Description of Work Concrete material is strong in compression but weak in tension. To offset this weakness, concrete structures are reinforced with properly placed deformed steel bars or welded wire fabric. In general, the Project Inspector is responsible for verifying that the Contractor has furnished and placed the reinforcing steel in the manner prescribed by the Contract Plans and Specifications. See the Specifications for the method of measurement for payment.

602.1.2-Material Considerations The Project Inspector must inspect all reinforcing steel (e.g., deformed steel bars, epoxy-coated rebars, welded wire fabric) delivered to the job site for compliance with the type, size, quantity, and material requirements of the Contract Plans and Specifications. Note that the use of rail-steel is not permitted in bridge decks or parapets. Document laboratory numbers on the Daily Work Report and retain all shipping documents in the project file.

602.1.2.1-Rebar Designations Reinforcing bars (rebars) are round in cross section, but their surfaces are deformed to improve bonding with the concrete material. Rebars are designated with a number that represents how many eighths of an inch are in the bar's nominal diameter. For example, a No. 8 bar would have a nominal diameter of 1″. The weight per unit length of reinforcing bars are provided in the Specifications as pounds per foot.

602.1.2.2-Storage and Handling Verify that reinforcing steel is stored above ground on well-drained platforms, skids, or other supports and sorted and labeled with identification tags based on their respective type and size. Prior to acceptance, ensure that the reinforcing steel is free of defects such as cracks and laminations. A thin film of rust or mill scale that cannot be removed by rubbing with burlap is not detrimental and considered acceptable; however, any loose rust or scale must be removed before the steel is placed. Reject all non-conforming material.

602.1.2.3-Epoxy-Coated Rebars In addition to the guidance provided in Section 602.1.2.2, verify that epoxy-coated rebars are handled without damaging the epoxy coating, especially at contact areas. Verify that a suitable means of banding is used to prevent damage to the coating (e.g., padding). Ensure that all bundles of coated rebars are lifted using a spreader bar with multiple supports to prevent coating damage from bar-to-bar abrasion caused by sags in the bundles. Do not permit the rebars to be dragged or dropped.

If epoxy-coated bars will be stored or placed without concrete cover for a period greater than 90 days, verify that the bars are adequately covered to prevent damage to the epoxy coating caused by ultraviolet rays and atmospheric elements. When bars are covered, ensure that adequate ventilation is provided to prevent accumulation of moisture.

Enforce the provisions of the Contract with respect to repairing damage to the epoxy coating. Upon delivery of the first shipment of epoxy-coated rebars, the supplier must furnish the epoxy patching material for touch-up and repair work. The patching material must meet specified requirements as evidenced on the shipping documents.

602.1.3-Order Lists and Bar Bending Considerations Ensure that the Contractor has furnished the order list and bar bending diagrams, if required by the Project Engineer/Supervisor. These documents are for informational purposes only, and acceptance does not relieve the Contractor of the responsibility for accurately complying with the Contract. Reinforcing bars will be cold bent in the shop, and unless otherwise specified, the Contractor should not be permitted to bend bars in the field.

602.2-INSPECTION DURING CONSTRUCTION

602.2.1-General Requirements The Project Inspector must check that the specified type, size, and dimensioned shape of reinforcing steel is positioned, supported, and fastened as designated on the Contract Plans. Such criteria is design dependent and is especially important in thin slabs, because a slight change in the criteria can significantly reduce the load carrying capacity of the concrete member. The support and fastening system must not damage steel nor allow it to move during placement of the concrete. Concrete must not be placed until the reinforcing steel has been inspected and accepted; and prior to any deck pour, an independent check of bar spacing and clearance is required.

602.2.2-Supports and Ties Special attention should be given to the manner in which the reinforcing steel is supported and tied. Verify that bar chairs, mortar blocks, or other acceptable supports are provided to prevent the bars from sagging during concrete placement. Where concrete is laid directly on earth or gravel, the reinforcing steel should not be supported by chairs, because the chairs will tend to sink into the soft underlying material and allow the bars to move. In such cases, ensure that the bars are supported by concrete blocks, as specified. Verify that the bars are securely tied. Bars are generally tied at all intersections, except that alternate intersections may be tied where bar spacing is less than 12" in each direction. For the layer of bars closest to the surface, ensure that the wires are knotted on the side away from the form face to minimize the appearance of rust stains through the finished concrete surface. The final mat of reinforcing steel should be firm and secure.

602.2.3-Splicing Considerations The Project Inspector should remember that bar splicing is a design element. This is a primary reason why it is important that the Contractor furnish all reinforcing steel in the lengths and shapes designated on the Contract Plans. During the design phase of the project, the designer of the reinforced concrete element will locate bar splices where the reinforced concrete will undergo low tensile stress. The location and details of these splices (e.g., length of lap, staggering) will be designated on the Contract Plans. Bar splicing that is not called for on the Contract Plans requires written approval by the Project Engineer/Supervisor. If the Project Engineer/Supervisor approves a splice that is not designated on the Contract Plans, ensure that the bars are lapped per Specification 602.7.1, unless otherwise directed. For example, if two No. 8 (No. 25) bars are spliced together, the minimum required length of lap will be 30". Pay particular attention to compliance of the staggered layout of individual splices. Consider the following guidelines:

1. Wire Ties. Where the use of wire ties has been approved for fastening splices, verify that at least three wire ties are used across the entire length of lap.
2. Mechanical Splice Connectors. Where the use of mechanical connectors has been approved for fastening splices, verify that the connectors are furnished and installed as directed by the Project Engineer/Supervisor. Mechanical splices must be capable of withstanding up to 125% of the yield strength of the steel bar in either tension or compression.
3. Bar Welding. Welding of bar splices is generally not permitted, unless designated on the Contract Plans or otherwise authorized in writing by the Project Engineer/Supervisor. If permitted, ensure that the work is performed by a welder who is certified for the type of welding required. The welding must comply with the current specifications of the American Welding Society, D 1.4, and the weld must develop an ultimate strength equal to or greater than that of the steel bars. During the welding operation, inspect compliance of the weld type, size, and length and ensure that the bars have not been burned or made smaller by the weld. Never allow a weld to be cooled by running water.

602.2.4-Bar Clearance Frequently check the bar clearance from form faces and the tops and bottoms of slabs. Supports and ties must not allow the bars to move during concrete placement. Bar clearance is a design element, which also helps to protect the steel from water and excessive heat. Where bars are spliced, a clear distance of at least 1" must be provided between each pair of lapped bars and the adjacent bar. The clear distance to the form should be at least 2".

602.2.5-Installation of Epoxy-Coated Rebars The installation of epoxy-coated reinforcing bars requires special treatment so that the epoxy coating is not damaged during the process. Verify that epoxy-coated bars are placed on plastic or plastic-coated wire supports, and that the bars are fastened with specially fabricated plastic or plastic-coated wire ties. Any visible damage to the epoxy coating must be repaired prior to the placement of the concrete. Patching of damaged areas must be performed in accordance with the patching material manufacturer's recommendations.

602.2.6-Protection of Steel During Prolonged Exposure If the ends of reinforcing bars or dowels will remain exposed to the elements for more than two months, the Project Inspector must ensure that the Contractor applies a very thin coat of cement paste to the surface of the exposed steel. This coating must be removed by lightly tapping with a hammer or other tool not more than one week before the placement of the concrete.

602.2.7-Cleaning of Bars Just before the concrete is poured, ensure that the surfaces of the reinforcing steel are cleaned of foreign coatings such as loose scale or rust, oil, grease, paint, form release agent, curing compound, mud, dirt, or weak dried mortar. This will ensure that a positive bond between steel and concrete is achieved.

602.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for ensuring that the Contractor furnishes and places the reinforcing steel in conformance with the requirements of the Contract Plans and Specifications. Before work begins, it is good inspection practice to become familiar with the Contract Plans and Specifications and the inspection guidance presented in Sections 601.1 and 601.2. During inspection, record the following information on the appropriate attachment to the Daily Work Report:

1. Structure number and location;
2. Weather conditions;
3. Types of bars placed (e.g., epoxy coated bars, uncoated bars, corrosion resistant bars, welded wire fabric);
4. Bar size, weight per unit length, length, number placed, and total weight should be recorded on rebar sheet with Project Inspector signature and placed in ProjectWise;
5. Inspection notes (see Section 602.1 and Section 602.2);
6. Notes on any deviations from the Contract Plans; and
7. Supporting sketches, including actual measurements.

SECTION 603
PRESTRESSED CONCRETE MEMBERS

603.1-GENERAL REQUIREMENTS

603.1.1-Description of Work Prestressed concrete members differ from conventionally reinforced concrete members in that the member is constructed using high-strength concrete and then compressed before loading by tensioning internal high-strength steel bars or high-strength stranded wires, thus minimizing the tension in the structural member. This allows the use of minimal concrete material and provides for a lighter weight member that can span a longer distance. In general, the Project Engineer/Supervisor and, as directed, the Project Inspector will ensure that the Contractor manufactures, handles, stores, transports, and erects precast/prestressed concrete members in conformance with the requirements of the Contract Plans. See the Specifications for the method of measurement for payment.

603.1.1.1-Pretensioning/Posttensioning There are two basic types of prestressed concrete members. The prestressing force may be applied before the concrete is placed or after the concrete has cured. Consider the following:

1. Pretensioning. Pretensioning is the method of applying the prestressing force before placing the concrete in the forms. The bars or wire strands are anchored by a continuous bond throughout the length of the structural element.
2. Posttensioning. Posttensioning is the method of applying the prestressing force after the concrete has cured. In post-tensioning, the bars or wire strands are mechanically anchored at each end of the member.

In either type, the prestressing steel may be high-strength reinforcing bars, single wires, or twisted strands of wire rope.

603.1.1.2-Creep and Camber Creep is the shortening of a girder after it is prestressed. The actual shortening is very small and occurs rapidly, tapering off over a period of about two months. Because the prestressing force is applied eccentrically, a noticeable uplift, or camber, will occur, which is anticipated during design. However, if the girder cambers beyond specified limits, corrective action may be necessary.

603.1.1.3-Precast Girders Precast girders are fabricated on a flat surface at the precasting yard and shipped to the site for erection, which is similar to steel girders. The girders will camber when the prestressing force is applied. Be aware that girder age and storage conditions can produce additional camber that may render the girder unacceptable.

603.1.1.4-Cast-In-Place Girders Concrete box and “T” girders are typically cast-in-place and posttensioned in the field. During production, galvanized or plastic rigid ducts are cast into the girder webs. Once cured, the wire stands are pulled through the ducts to prestress the member. Because these girders are produced in the field, the forms and falsework must account for deflections due to dead load and prestressing.

603.1.1.5-Segmental Construction Precast or cast-in-place posttensioned segmental structures are generally long in span with limited access area, thus requiring gantries or heavy cranes for construction and erection. Bars, wire strands, or a combination of both may be used to impart the prestressing force in segmental members.

In precast applications, the members are match cast to produce a bridge that conforms to the required geometry, but the post tensioning is performed in the field. Contrary to conventional girders, segmental members must accommodate both heavy construction and final service loads, and special construction techniques are employed to provide stability. It is therefore important to thoroughly study the Contract Plans and working drawings. If the Contract Plans designate the prestressing force required only for the final service load, the working drawings must define the force needed to accommodate both construction and service loads. Note that superstructure camber has already been developed in member segments during match casting but may be adjusted between segments with shims during erection.

603.1.2-Material Consideration Prior to beginning the work, ensure that all materials for the work conform to the requirements of Section 603.2.1 of the Specifications. Many materials will be required, including concrete mix materials, reinforcing and prestressing steel, joint fillers and sealants, bearing pads, steel bolts and nuts, and concrete sealants and grouts. During the project, record laboratory numbers on the Daily Work Report and retain all shipping documents.

603.1.3-Working Drawings Before work begins, the Contractor is required to submit detailed shop drawings and erection drawings for review by the Project Engineer/Supervisor. Shop drawings will provide detailed dimensions and sizes of all component and miscellaneous parts of the structure, and erection drawings will address the following details:

1. Method, phasing, and sequence of erection;
2. Details of all falsework bents, bracing, guys, and dead-men;
3. Forming and bracing details to prevent beam and stringer distortion where the deck overhang exceeds 30″;
4. Member details, including weight of members and location of lifting points;
5. Lifting devices, crane capacities, and locations of cranes and barges; and
6. Design calculations, which must sealed by a Registered Professional Engineer.

The Project Engineer/Supervisor will review the working drawings to ensure that the Contractor has fulfilled the specified requirements. Note that acceptance of the working drawings in no way alleviates the Contractor's responsibility for accurately complying with the requirements of the Contract. Before production, the Project Inspector should become familiar with the working drawings to ensure that the Contractor complies with the proposed methods and details of fabricating and erecting the structure.

603.1.4-Manufacturer Certification The Contractor is responsible for submitting a request for manufacturer approval at least six weeks prior to production. The request will define the plant facilities, materials, and production methods. The plant must demonstrate proper certification from the Precast/Prestressed Concrete Institute (PCI). Before production, ensure that the plant has been certified in accordance with the requirements of Section 603.3.1 of the Specifications and MP 603.10.40.

603.1.5-Equipment Inspection Check the acceptability of all equipment, tools, and machinery that will be used for the work. Ensure that prestressing jacks and monitoring instruments have been properly calibrated, or recalibrated, in the manner specified and that the certified calibration charts have been furnished by an independent laboratory. Note that the use of portable pretensioning beds is not permitted. Check the forms and casting beds for acceptability; however, acceptance does not relieve the Contractor of the responsibility for accurately complying with the requirements of the Contract.

603.1.6-Quality Control Program/Supervisor The Contractor is responsible for ensuring that the manufacturer's quality control program is submitted to the Project Engineer/Supervisor at least 30 days prior to production. Before production, ensure that the quality control program has been accepted, as specified. The use of independent laboratories will be as defined in the Contract. In addition, verify that the Contractor has provided at least one PCI Level II certified technician to supervise the work.

603.1.7-Safety Precautions The prestressing and erection operation can be very hazardous. Both Division and Contractor personnel are both responsible for providing and maintaining a safe working environment. The Contractor is specifically responsible for taking precautionary measures to prevent injuries to personnel due to the breakage of strands or failure of anchorage devices during the tensioning operation. Division personnel are required to abide by all safety rules established at the site. The protection provided must allow the Division personnel to perform normal inspection duties.

603.2-PRESTRESSED MEMBER FABRICATION INSPECTION

The Project Inspector shall review the prestressed members and their documentation to determine if all required repair work was completed prior to final acceptance.

603.2.1-Preparation of Formwork Verify that the formwork is of the proper type and size and is adequately cleaned and prepared. If posttensioned members are being fabricated, pay particular attention to how ducts are formed; check for leaks; and verify that grouting ports and vents will remain accessible and free of concrete.

603.2.2-Placement of Reinforcement and Prestressing Steel Check that all reinforcing steel is properly placed. Ensure that the prestressing steel is installed in the forms, or in the posttensioning ducts, in accordance with the working drawings. The steel strands must be held securely in place by the jacks and end anchors. Where the steel strands or tendons are draped, ensure that they are not kinked or abraded at bends. Pay particular attention to the minimum criteria specified for concrete cover, splicing, and lapping. If a release agent is used, do not allow the compound to contaminate the steel strands. This cannot be overemphasized.

603.2.3-Prestressing Operation

603.2.3.1-Overview The Project Inspector is responsible for ensuring that the Contractor furnishes calibrated jacking equipment and continually monitors the jacking force as it is applied to the steel strands. Carefully review the sequence of operations with the Contractor, and be concerned with safety. Stay away from the back of jacks and dead-end anchorages during the prestressing operation.

In typical prestressing (i.e., pretensioning) operations, the forms and steel strands will be prepared and placed as specified, and the steel strands will be preloaded to develop 10% of the final prestress load. Note that records of the jacking force and strand elongation will be maintained throughout the operation. The members are then set up for concrete placement, typically in a continuous line, and the steel strands will be loaded to 100% of the prestress force. The concrete will then be placed and allowed to cure. When the concrete reaches minimum compressive strength, as evidenced by test cylinders, the forms will be removed and the steel strands will be disconnected from the jacks and anchors in an order that will minimize undesirable eccentric forces in the members. Do not permit anchors to be release until the concrete has attained its minimum compressive strength.

603.2.3.2-Monitoring Jacking Force and Strand Elongation Hydraulic jacks or rams are typically used to generate the force necessary to place the steel strands in tension and prestress the concrete members. Use the following procedures to monitor jacking force and strand elongation:

1. Record Strand Elongation. As the jacking force is applied, the steel strands will elongate. Refer to the Contract Plans and Specifications for elongation details and requirements.
2. Establish Measurement. Bench mark. Mark a strand in a tendon approximately 10″ from the end of the ram. Make sure that the reference point selected on the ram is a part that does not move.
3. Monitor Jacking Force. The hydraulic equipment will be furnished with a calibration curve that should be used to convert pressure gauge readings to an equivalent jacking force. Review and retain the specified calibration records in the project files. Gauge readings are typically within ±2 % of actual pressures in the hydraulic equipment. Using the calibration curve, monitor the gauge as the jacking force approaches the full jacking force required.
4. Check Strand Elongation. When the full jacking force has been reached, measure the distance between the reference point and the mark on the steel strand (see Step #2). The measured strand elongation, less the dead end anchor set, should be equal to or greater than the actual strand elongation. If not, carefully check the calculations and measurements to verify that the strand elongation is actually short.
5. Acceptability. If the measured strand elongation varies more than 5% from the actual strand elongation established in Step #1 or the measurements are erratic,

examine the prestressing operation for possible problems. If the problem cannot be explained or resolved, contact the Project Engineer/Supervisor for assistance. Do not permit the protruding strands to be cut until the problem has been properly addressed and strand elongation has been verified.

6. Breakage of Wires. During the prestressing operation, the breakage of individual wires may occur. This is common and acceptable as long as the broken wires represent less than 2% of the total area of the strand. Recurring failures may indicate a symptomatic problem that will need to be immediately addressed. Require strand replacement based on the provisions of the Contract.

603.2.4-Concrete Production and Hauling Concrete for all prestressed members must be produced in accordance with Section 603.6 of the Specifications or as otherwise provided for in the plans.

603.2.5-Concrete Placement and Consolidation Verify that a suitable means is used to place the concrete in its final position in the forms without segregating the mix. Observe the operation to ensure that the concrete is worked under and around the prestressing steel. Verify that the concrete is properly vibrated. Internal vibrators should be pushed in and pulled out slowly and only long enough to remove the air without segregating the mix. Do not allow internal vibrators to come into contact with the forms or the prestressing steel.

603.2.6-Curing and Finishing Verify that the prestressed concrete members and test cylinders are properly cured. Many options are available to the Contractor, including:

1. Water curing,
2. Wet mat curing,
3. Saturated cover curing,
4. Water spray curing,
5. Accelerated curing,
6. Low-pressure steam curing, and
7. Radiant heat curing.

The proposed method must be reviewed for acceptability by the Project Engineer/Supervisor before the operation begins. Once accepted, review the method's material, equipment, moisture, temperature, curing period and procedural requirements. During the operation, ensure compliance with the approved method and pay particular attention to the results of compressive strength tests. Halt production and reject members for inadequate curing based on the provisions of the Contract. After curing, verify that the members are given the proper surface finish. In general, surfaces should be smooth and even without spalling, damage, or honeycomb. A PCI Grade A finish is required for Fascia Beams.

603.2.7-Dimensional Tolerance and Defects Acceptance of prestressed members at the manufacturing site should be considered tentative. Because the Contractor is responsible for handling, storing, transporting, and erecting the members without damage.

Check the prestressed concrete members for unacceptable defects and breakage, and ensure that honeycomb areas and voids are properly patched and cured. Pay particular attention to the criteria specified for evaluating cracks. In general, members with cracks that are wider than 16 mils should be rejected, unless otherwise approved by the Project Engineer/Supervisor. Cracks with a width less than 16 mils may be repaired as specified, unless the member is rejected for some other defect. Check the dimensional tolerance of the members for acceptability based on the criteria specified for “I” beams, bulb “T” beams, box beams, plank beams, and deck panels. Note that the specified tolerances only represent the limits at which construction becomes unacceptable, not the sole criteria for acceptance.

603.3-STORAGE AND HANDLING CONSIDERATIONS

The Contractor is responsible for handling, storing, transporting, and erecting prestressed members without damage. After fabrication, verify that the prestressed members are handled and stored in the upright position without causing torsion, warps, cracks, or other damage. Vacuum lifters, cables lifts attached to lifting points near the ends of the member, or other acceptable means should be used. Block supports or “Dunnage” for storage of similar members should be located at the same distance from each end of the members to ensure camber uniformity. Stacks should not exceed two members high.

Reject damaged members based on the provisions of the Contract.

During erection, verify that the Contractor provides acceptable means of protecting traffic against falling objects (e.g., nets, flooring), and ensure that the members are installed and, where required, posttensioned in accordance with the working drawings and within specified tolerance. Check that dowel bar and lifting bolt holes are properly filled with non-shrink grout.

603.4-RECORDS AND DAILY WORK REPORTS

The Project Engineer/Supervisor and the Project Inspectors in charge of the work are responsible for recording in Diaries or Daily Work Reports all information (e.g., observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Project Engineer/Supervisor will maintain the project’s Supervisor’s Diaries or DWRs, and the Project Inspector in charge of the work will maintain a daily record of events in the DWR. The Inspector’s Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Many claims and lawsuits have been settled based on such documentation. Attempting to reconstruct events later without written notes or test data is frustrating and often leads to claims. Use AASHTOWare Project, and pertinent attachments, to prepare the Diaries and DWRs. If in doubt as to whether or not information is important or beneficial, record it.

SECTION 604
PIPE CULVERTS

604.1-GENERAL REQUIREMENTS

604.1.1-Desciption of Work When Item 604 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor constructs or reconstructs the pipe culverts in accordance with Section 604 of the Specifications and as designated on the Contract Plans. See the Specifications for the method of measurement for payment.

604.1.2-Adverse Impacts of Water Without a drainage system, water can cause many problems on a highway facility. When compacted soils become saturated, they become very weak and unstable. Water that is allowed to infiltrate and freeze within the underlying strata loosens the compacted material and raises the pavement structure. Once thawed, traffic reconsolidates the material and causes the pavement to break and potholes to form. Embankments that become saturated settle unevenly and become prone to sliding. They are also prone to erosion. In addition, some soils and rocks tend to swell when saturated and, unless removed or well drained during construction, will cause the pavement to raise.

604.1.3-Purpose of Highway Drainage System To minimize the adverse impacts of water, a drainage system must be integrated in the design of the highway facility. This drainage system typically includes an interconnecting system of slopes, open ditches, and buried pipes of various types, sizes, and shapes. The drainage system is designed and constructed to:

1. Prevent water from saturating and weakening the soils in highway cuts and embankments;
2. Prevent water from infiltrating the pavement base and subbase;
3. Intercept and carry away surface and underground water that reaches the roadway prism; and
4. Carry away, as quickly as practical, the water that falls on the pavement surface.

Buried pipe culverts must function both hydraulically and structurally. They will be designed not only to accommodate the design flow of water but also to support the pressures of the surrounding soil and the design loads above them. Open ditches will be designed for both water flow and roadside safety.

604.1.4-Features of Highway Drainage Systems The Contractor should install the features of a highway drainage system, including temporary features, as soon as practical during the project. This helps to lower the water table; prevent water from infiltrating, saturating, and eroding soil materials, and minimize construction delays. See Section 642 for additional information on erosion and sedimentation control. The following sections briefly describe the primary features of a highway drainage system.

604.1.4.1-Cross Slopes The pavement surface is typically crowned or superelevated and the shoulders are typically sloped to allow falling rain and melting snow to quickly runoff the roadway surface.

604.1.4.2-Ditches and Inlets The features that intercept and carry surface runoff away from the highway facility include side ditches, curbs, gutters, inlets, and other similar features. On high embankments, curbs are generally provided to intercept water that flows down the side slopes, and paved channels or "scupper ditches" are provided to channel this water without eroding the earthwork. In deep cuts, ditches are generally constructed along the top of each side slope and down the face of the slopes for the same purpose.

604.1.4.3-Culverts A culvert is an opening under the roadway with a clear span or sum of spans of 20' or less. A larger span is classified as a bridge. Culverts are typically placed at low points in the profile of the natural ground and at intervals along long grades to carry water under the roadway, but may also be installed to accommodate the passage of pedestrians and animals. A culvert with a rectangular opening is called a box culvert, which may be either precast or cast-in-place reinforced Portland cement concrete. A culvert with a round, arch, or elliptical shape is called a pipe culvert. Both pipe and box culverts may be constructed with more than one opening. These configurations are called "multiple culverts." The type, size, number, and location of culverts will be designated on the Contract Plans and will depend on many factors such as purpose, water acidity, soil type, overhead load, surrounding soil pressure, cost, and the likelihood of the culvert material being eroded by sand or gravel in the water it carries. Prior to beginning the work, verify that all culvert materials are shipped from pre-approved DOH sources and comply with the requirements of Section 604.2 of the Specifications. Document laboratory numbers on the Daily Work Report. Consider the following attributes of culverts:

1. Culvert Shapes. The required shape of the culvert (e.g., round, arch, elliptical, box) will depend on the design application. Pipe culvert may be either round, arch, or elliptical in cross section. Box culverts will be either square or rectangular in shape.
2. Culvert Materials. Pipe culverts may be constructed of many different types of materials including: aluminum coated steel, aluminum structural steel, polypropylene, high density polyethylene (HDPE), polyvinyl chloride (PVC), and reinforced concrete (RCP). Box culverts are typically precast, reinforced concrete sections, but may be either non-reinforced or cast-in-place depending on the design application.
3. Sheet Thickness, Corrugations, and Perforations. Sheet thickness for metal pipe will be designated on the Contract Plans. Depending on the design application, pipe culverts may also be either corrugated or perforated. The type and size of corrugations will be specified in the Contract.
4. Coating and Paving. Steel pipe culverts may be aluminized. The flowline (i.e., invert) or the entire inside of the pipe may need to be paved prior to installation. Water will not flow as easily through corrugated metal pipe as it will through a pipe with a smooth inner surface, because of the rough surface provided by the ridges

and furrows of the corrugated material. To increase the water carrying capacity, the diameter of the culvert must be increased or the corrugations filled with an approved paving material (e.g., Portland cement concrete or shotcrete). If the corrugations in only the lower part of the pipe are filled, the pipe is said to have a paved invert or flowline.

5. End Sections. Pay particular attention to the type and shape of end section specified for the culvert (e.g., safety slope end section).
6. Structural Plate Pipe and Pipe Arch. Structural plate pipe and pipe arch culverts are typically prefabricated plate components that have to be assembled in the field.
7. Backfill Material. The Contractor is responsible for the quality control of backfill material. Gradation acceptance for backfill material will be on the basis of the Contractor's written certification with attached test results.
8. Miscellaneous Materials. Many other types of materials also may be required, including field paving materials, pipe joint and joint sealer materials, gaskets, and bedding. Ensure that these materials conform to the requirements of the Contract.

All pipe culverts must be pretested and shipped to the job site from pre-approved DOH sources. The Project Inspector must make sure that the type and size of the pipe delivered to each culvert location conform to the requirements of the Contract. Document laboratory numbers from the shipping documents on the Daily Work Report.

604.1.4.4-Outlet Ditches and Channels Water that is collected by the drainage system will eventually be carried by large outlet ditches or channels to a stream, enclosed body of water, or natural watercourse. Where an outlet ditch must be placed on a steep grade, the sides and bottom of the ditch will typically be lined with broken stone, called riprap or dumped rock, to prevent the soil from being washed away. If the water will flow very rapidly over highly erodible soils, the sides and bottom of the ditch may warrant paving with asphaltic concrete or Portland cement concrete.

604.1.5-Field Adjustments The drainage system design on the Contract Plans is generally based on survey data taken long before the clearing and grubbing work begins. Because conditions uncovered during construction may differ from those originally considered. the type, size, and location of drainage features actually required to meet field conditions may differ from that incorporated in the original design. Project Inspectors must keep this in mind and begin studying drainage conditions early and throughout the project. If a modification to the original design is suspected, immediately notify the Project Engineer/Supervisor.

After the rough grading is completed, carefully inspect the need for additional drainage features. For example, if water is found to eroding sections of shoulder or the side slopes of embankments, additional edge drains should be considered. Where the natural ground slopes toward a cut or an embankment, ditches may be needed at the top of the cut or at the toe of the embankment. Additional drainage may be needed in the median to prevent ponding. To prevent washing of silty soil into drainage ditches at the side of the road, it also may be necessary to make the slope of a cut or fill flatter than that shown on the Contract Plans. In all such cases, discuss possible solutions with the Project Engineer/Supervisor.

On projects that do not provide grade lines, especially on minor jobs and rehabilitation projects, field adjustment is common. It is important that Project Inspectors use common sense when assessing needed adjustments. For example, make certain that culverts are placed at low points and that the outfall is within the right-of-way. Perform field verification of all drainage features after installation. The use of energy dissipaters may be required, especially where excessive surcharges are expected.

604.2-INSPECTION GUILDLINES

604.2.1-Overview As soon as practical after installation of drainage features, check them carefully for proper functionality. Any necessary corrections must be made prior to paving work. Verify that each culvert is in proper working order and that no adjustments or replacements are necessary because of plugging up, settlement, or crushing. If inspection shows that conditions have changed since the structure was built, notify the Project Engineer/Supervisor. Keep a complete record of all culvert locations, types, and sizes, with sketches that show inlet and outlet flowline elevations, on the Daily Work Report. All outlets should be referenced on the As-Built Plans so that they can be easily located by maintenance forces.

604.2.2-Culvert Placement

604.2.2.1-General Before a roadway is built, water flowing over the natural ground will follow drainage channels at low points along its surface. When an embankment is built across a natural channel, water from rain or melting snow will pond, unless it can flow through the embankment. For this reason, it is usually necessary to provide a culvert through the embankment at every natural drainage channel. Drainage-relief culverts are used where the ground or roadway grade slopes in the same direction for a great distance.

604.2.2.2-Small Streams Where a culvert is to carry water from a small stream through an embankment, the centerline of the culvert is typically placed near the centerline of the stream. In addition, the bottom elevation of the culvert should be about the same elevation as the stream bed. Natural drainage channels should be used as much as practical. Changing the course of a stream could result in property owner claims for damages due to flooding or intercepting too much water. The size, location, and grade of each culvert must be constructed as defined in the Contract, unless field conditions warrant adjustment. If an adjustment in location or elevation appears warranted, immediately notify the Project Engineer/Supervisor.

604.2.2.3-Culvert Skew Where a culvert is provided at a natural drainage channel or where a drainage-relief culvert is required for road grades of less than 3%, the culvert is generally set at right angles to the roadway centerline; otherwise, the culvert will be skewed. Culverts are skewed to allow rapidly flowing water to more readily enter the culvert inlet. Drainage-relief culverts installed along road grades that are greater than 3% typically will be skewed at an angle of 15° to 45° with the roadway centerline. The degree of skew will be designated on the Contract Plans. In addition, the culvert will typically be set at approximately the same grade of the ditch that feeds the inlet.

604.2.2.4-Culvert Grade Before embankment construction begins near a culvert location, discuss the type, size, location, and grade of the culvert with the Project Engineer/Supervisor, and obtain approval of all details and adjustments. At the discretion of the Project Engineer/Supervisor, the flowline grade may be altered from that shown on the Contract Plans. The flowline, or invert, of a culvert is the line along the lowest points of its inside surface. The grade of the culvert is the grade of its flowline, which will be designated on the Contract Plans. During construction, the flowline elevation should be set and periodically checked at each cross-section along the culvert's profile. Consider the following guidelines:

1. Siltation. The grade of the culvert should not be so flat as to cause pipe siltation.
2. Inlet Elevation. The elevation of the flowline at a culvert's inlet should be set low enough to meet both of the following requirements:
   a. Surface water must be carried away rapidly to prevent flooding adjacent land; and
   b. Water from underdrains must be able to drain without backing up when the culvert is running full.
3. Outlet Elevation. The elevation of the flowline at a culvert's outlet should be set as close as practical to the existing ground. Less excavation will then be required for the outfall ditch, and the cost of maintenance will be less. In addition, where no endwall is provided at the outlet, the culvert should extend at least 2' beyond the toe of the embankment; and the embankment slope may need to be treated with slope paving, a spillway, or a rock dispersion pad to prevent erosion.

604.2.2.5-Marking Culvert Location Several techniques can be used to perform mark culvert location, including batter boards and stringlines, offset grade stakes, and laser technology. A common procedure is as follows:

1. Stakes are set along the centerline of the roadway at intervals of 25' to 50' for 200' on each side of the proposed location of the pipe.
2. From each centerline stake, the distance from the roadway centerline to the planned outer edge of the shoulder is measured in each direction at right angles to the roadway, and long stakes are set along these shoulder lines.
3. The toe of the slope is determined at right angle measurement to the centerline station where the ends of the pipe will be located.

A stringline can also be used to set and control flowline elevation. A mark is made on each stake either at the elevation of the flowline or at a certain uniform distance above or below the flowline elevation. The stringline, passing through these marks, is pulled tight and secured in position on the stakes. If the stringline is not at the elevation of the flowline, the distance above or below the flowline must be marked on the stakes.

604.2.3-Pipe Trenches

604.2.3.1-Trench Excavation A culvert should never be installed by simply laying it on the natural ground and piling the fill material against and over the pipe. Every pipe culvert must be laid in a trench; because, the ability of the pipe, especially corrugated metal pipe, to support the load at its top depends on the support provided by the pressure of the compacted soil along its sides. Where a pipe is laid in a trench dug in compacted ground or embankment material and the void in the trench on each side of the pipe is backfilled and compacted, the resistance of the pipe to crushing is greatly increased. A trench should only be wide enough to allow room for compacting the backfill around the lower half (i.e., haunches) of the pipe.

In general, the width of the trench should not be less than that required for making proper joints and compacting the backfill, and the trench must be deep enough to permit the top of the pipe to be at least 2' below the top of the trench. Trench excavation depends primarily on the type and size of the culvert being installed. Use Section 604.4 of the Specifications and the Standard Detail Books for trench excavation requirements.

Trench excavation should always start at the low end, and the bottom of the excavation should be maintained even and sloped so that the trench will drain during construction. Where the trench will not drain naturally, a narrow ditch should be dug along one side to lead the water to a sump from which it may be removed by a pump. Ensure that any unsatisfactory foundation material is removed and replace with suitable material to a depth specified by the Project Engineer. If the bottom of the trench becomes soft and muddy, it may be best to undercut (i.e., dig below the normal grade) and backfill with granular material or earth selected from excavation. Only enough granular material to make a firm bottom should be used. Otherwise, water may run beneath and undermine the pipe. Where a Type F Trench is specified, verify it is in conformance with the **S**tandard Detailed Drawings.

604.2.3.2-Safety Considerations Unless alternative methods such as laybacks or trench boxes are used, the sides of trenches must be securely held by shoring and bracing where trenches are excavated in material other than rock. Shoring and bracing is especially important where heavy construction equipment will be operated near the trench or where material thrown out of the trench is piled on one side. The spoil bank formed by the soil removed from the trench should be trimmed back from the edge of the trench. The weight of the soil in the spoil bank tends to overload the sides of the trench and may cause slides or cave-ins. When specified in the Contract, shoring and bracing will be designed by the Contractor and the plans will be signed and stamped by the Contractor's registered Profession Engineer.

604.2.3.3-Pipe Bedding The bedding is the material placed in the bottom of the trench on which the pipe is laid. For rigid pipe, a granular material or crushed aggregate may be used, with a minimum of 3 inch thickness. Flexible pipe bedding should be crushed aggregate with 4 inch minimum thickness. When rock or unyielding material is present in bottom of trench, a 6 inch layer of material should be installed below the bottom of the pipe.

The middle 1/3 of pipe diameter bedding should be uncompacted to allow cradling of pipe. Bedding outside of middle 1/3 should be compacted.

604.2.3.4-Placement Considerations Various methods are used for lowering pipe into the trench. Mechanical equipment must be used for large pipe sections. Rigid pipe sections are typically lifted using hairpin-shaped hooks that can be inserted in the opening of the section or in special lifting holes or eye connectors. This allows each section to be lifted and set into proper position without damage. Note that bell-and-spigot pipe sections must be laid with the bell end upstream, and the laying operation must start at the downstream end of the trench. Each section should be pointed in the proper direction before it is lowered in the trench. Where pipes with a paved invert are being installed, ensure that the pipe is laid with the paving material at the bottom. Where reinforced concrete oval pipe is being laid, verify that the “top” label is uppermost.

Where flexible pipe is placed in the trench, it should be lowered properly. If a section of pipe is dropped, dents may be produced in some of the ridges, or some of the zinc spelter used for galvanizing the steel or some of the asphalt coating may be knocked off. If the protective coating is knocked off a small area, the bare metal at that place must be painted with approved asphalt furnished for the purpose by the manufacturer of the pipe. The manufacturer’s directions for applying the asphalt must be followed. Before lowering the pipe in the trench, flexible pipe should be turned so that the lengthwise lap is at one side. This lap should never be at the top or bottom. If the pipe has a paved invert, it should be turned so that the invert paving is down and the center of the paving is exactly on the centerline of the groove in the bed.

604.2.3.5-Joining Pipe Sections Bell-and-spigot joints are generally used for small sizes of concrete or clay pipe, and large sizes of concrete pipe usually have tongue-and groove joints. Because bell-and-spigot pipe is laid with the bell end upstream and laying it started at the downstream end of the trench, the spigot end of the section being set in place must be inserted in the bell of the section previously placed. The methods used in joining sections of tongue-and-groove and bell-and-spigot pipe should be such that the ends of the sections are fully entered and the inner surfaces are reasonably flush and even. Unless otherwise specified on the Contract Plans, joints for rigid pipe will be made with:

1. Flexible watertight gaskets,
2. Bitumen sealant with external sealing wrap, will not attain full strength when hardened.

Where flexible pipe is used, the shipping lengths of sections must be jointed in place within the trench by means of connecting bands of corrugated metal. Most connections are made with standard bands, each of which is one piece. Two-piece bands are used for larger pipe sizes and in deep trenches where the joint could not be made easily with a standard band. To join two sections of flexible pipe with a standard band, the opened band is first slipped over the end of the pipe section already laid. The end of the next section is then set about 0.75" from the pipe in place, and the band is tightened. The ridges and furrows of the band must match those of the two sections of pipe. A galvanized band without an asphalt coating should be tapped with a mallet or hammer while the bolts are being tightened. This will remove the slack and provide a tight fit. A tight joint cannot be made on large pipe by just tapping the band and tightening the bolts. A chain or cable must be placed around the band and cinched so that the band will be tightly pulled together.

604.2.3.6-Inspection of Pipe in Place All pipe must be inspected in place before backfilling of the trench is started. Joints in large pipes should be inspected from within the pipe to make certain that they are properly filled. Any damaged joints should be repaired. Any section of pipe that has been critically cracked or broken should be taken out and replaced. At the end of each day, the trench with no pipe in it should be blocked off by a temporary dam or tight bulkhead located a short distance beyond the end of the pipe. The end of the pipe should not be blocked, because water filling the trench would then float the pipe and break the joints. Frequent observation of concrete pipe culverts should be made following the initial placement of the structure through the completion of the roadway fill and pavement. These frequent inspections throughout the building of the project should establish the point at which damage occurs, if any, and also the extent of the Contractor's responsibility.

604.2.4-Rigid Pipe Culverts

604.2.4.1-Material Inspection Pipe should be checked upon arrival to make certain that each section is of the proper type and size to be used. The sections must be shipped from a pre-approved DOH source. As soon as it is unloaded, inspect sections of pipe for defects and record the laboratory number from the shipping documents in the Daily Work Report. If a defect is found, notify the Project Engineer/Supervisor. Pipe also must be inspected after placement to ensure that sections were laid properly and not damaged by rough handling.

604.2.4.2-Handling Considerations Check that pipe sections are handled properly. If the method used causes damage, caution the Contractor and enforce the provisions of the Contract with respect to repairs or replacement. Pipe sections must be lowered carefully and not dumped or dropped from the truck to the ground. The pipe may be lowered by crane or rolled down an inclined ramp. In general, pipe culverts should be rolled, not dragged, from one location to another. If pipe must be rolled over rocky or stony ground, planking should be used.

604.2.5-Flexible Pipe Culverts

604.2.5.1-Material Inspection The inspection of flexible pipe will be as outlined in Section 604.2.4.1.

604.2.5.2-Handling Considerations Flexible pipe must meet all the requirements of the Specifications when it is in place in the trench. The Project Inspector must make sure that the pipe is handled and stored properly. Flexible pipe should never be dropped to the ground or into the trench. Asphalt-coated pipe must never be dragged over the ground. It is good practice to store asphalt-coated pipe on planks or timbers so that dirt and small stones will not be pressed into the coating. Each piece of pipe with a paved invert should be turned so that the paved part is down. In hot weather, sections of asphalt-coated pipe should be stored in a shady place, or covered with light-colored tarpaulins, so that heat from the sun will not cause the asphalt coating to flow out of place.

604.2.5.3-Strutting Considerations Where flexible pipe is to be used under a high embankment, it must be elongated vertically (i.e., its height must be made greater than its width). This procedure serves the following purposes: the pipe will be stronger, and it will look round after the weight of the fill has flattened it.

Flexible pipe may be elongated at the manufacturing plant or in the field. If performed at the plant, which is preferred, wire ties are placed horizontally across the pipe to pull in the sides and push the top and bottom further apart. However, conditions may require that the pipe be elongated in the field by inserting vertical wooden struts at intervals between a wooden cap at the top of the pipe and a wooden sill at its bottom. When strutting is removed, the bituminous pavement, if damaged, should be repaired with bituminous material conforming to the requirements of the Specifications.

Struts should be examined each day from the time the depth of the fill above the top of the pipe exceeds 5' until the embankment is completed and thoroughly compacted. If there is no sign that the top cap or the bottom sill in the pipe is about to bend, or that the corrugations in the pipe are being crushed, the struts are usually left in place until the project is completed. Whenever any sign of such bending or crushing is noticed, the wedges at the ends of the struts should be loosened. If necessary, the struts should be removed. Tied pipe must be watched carefully while the backfill is being placed. If there is any sign that the ties are denting or damaging the pipe, the ties should be cut.

604.2.6-Backfilling and Compaction The Project Inspector must ensure that the pipe has been properly laid, inspected for damage, and approved prior to beginning the backfilling operation, which must be performed as specified in Section 604.8 of the Specifications. Pay particular attention to the quality control testing and density acceptance requirements. The use of flowable fill as substitute is permitted. Check that the granular backfill material conforms to specified requirements and is free of muck, large stones, lumps, and debris so that uniform compaction can be achieved. Verify that there is an approved Quality Control Plan for pipe items.

Do not permit the use of bulldozer or other bladed equipment to place backfill. Mechanical equipment with buckets is permitted. To obtain uniform pressure around the pipe, the backfill material must be placed in approximately 6" layers and thoroughly compacted. Mechanical tampers are normally used. The compacted layers should generally not exceed 4". Water should be added as needed to bring the material to optimum moisture content for maximum consolidation. To avoid displacing or unduly stressing the pipe, verify that backfilling is performed equally on both sides of the pipe simultaneously. Special care should be given to tamping material under the haunches of the pipe. Excessive compactive effort under the haunches may raise the pipe above the intended grade.

The compacted backfill should extend at least to the top of the trench. For pipe 60" or greater in diameter that is not in a trench condition, the compacted backfill should extend 2' above the top of the pipe. All field personnel should be cautioned to carefully observe the few feet of fill placed directly over the pipe to prevent the incorporation of any large rocks in this area. Heavy equipment can maneuver rock into this critical area. Pipe culverts should be adequately protected from damage before heavy equipment is operated near or over them. Water can sometimes be used to facilitate the settlement of granular backfills but it should never be used where conditions are such that liquid or semiliquid pressure may be developed within the berm area.

Timber braces and sheathing must be raised or removed as the trench is filled, but enough timbering should always be left in place to keep the trench safe. If uprights are left in place until the trench has been backfilled, the voids left when they are pulled out should be filled with dry sand. A piece of board should be used to push the sand into the hole and to compact the sand.

If there is any sign of trouble with elongated pipe, and the struts or ties do not interfere too much with the flow of water, the struts or ties should be left in the culvert until the embankment has been completed and has had time to settle. After struts and ties have been removed from a pipe that has been elongated, the vertical diameter of the inside of the pipe, including the thickness of any paving, should not be less than the nominal diameter by more than 1%. Also, the vertical diameter of the inside of any piece 20' long should not vary by more than 2". The removal of struts and ties should always be checked during final inspection.

Upon completion of the installation, perform a final inspection for reasonably close compliance with staking details, specification conformance, and fulfillment of the purpose for which the culvert was planned.

604.2.7-Structural Plate Pipe, Pipe Arches, and Plate Arches

604.2.7.1-Preliminary Studies Detailed instructions for erecting structural plate pipe will be shipped with the material. Obtain a copy of these instructions from the Contractor and study them carefully. In addition, consider the guidelines in these sections. Prior to beginning the work, perform a check measurement to ensure that the design length will be sufficient to fit plan grade and alignment.

604.2.7.2-Pipe Bedding The width of bedding for structural plate pipes need not exceed the width of the bottom plates. The 15% overall height requirements for bedding will not apply except when the pipe is first assembled and then placed in the trench. Where pipe is laid on existing ground, special care must be taken to ensure full uniform support along the barrel of the pipe.

604.2.7.3-Pipe Assembly Assembly of the structural plate pipe should be started at the upstream end. The bottom plates are lapped and offset. Bolt holes near the center should be lined up, and the bolts should be inserted and nuts fastened as soon as each plate is set. The longer bolts are used at points where three plates overlap. The longest bolts are used first to draw the plates together, and these bolts are then replaced with standard bolts. After enough bottom plates are connected, the side plates just above them are added and held in place with a few bolts. The additional side plates and top plates are then assembled. When all plates are in position, any missing bolts should be installed and the nuts snugged. Nuts should be tightened uniformly, those at the upstream end being adjusted first. After all nuts have been tightened, they should be retightened. This adjustment may be started at either end. Use the turn-of-nut method and the manufacturer's recommendations to inspect the tightness of nuts.

A structural plate pipe arch is assembled in much the same manner as a structural plate pipe. The work is begun at the upstream end. After the base angles have been placed, the lowest side plates are set on them. Some other side plates and some top plates are then fastened in place with a few bolts on which the nuts are snugged but not tightened. Next, the remaining side plates and the top plates of one complete ring of the arch should be bolted into place. At this time, just enough bolts should be used to hold the plates in place, and the nuts should not be tightened securely. Drift pins will be helpful in matching the bolt holes, and temporary props can be used to help hold the plates in place until connections can be made. After one complete arch is in place, the next set of plates is assembled. Plates should be overlapped by one corrugation. After all the arch sections are in placed, all bolts and nuts should be installed. Then the nuts should be progressively tightened and retightened, as described for structural plate pipe.

If the assembly procedures are not strictly followed when field assembling structural plate pipes and arches, rotation or spiraling of the barrel of the unit will usually result. Once this condition starts, it becomes worse as succeeding sections are assembled, causing the arch and invert to rotate out of position. This condition weakens the load carrying capacity of the structural plate pipe or arch, necessitating complete removal or removal to a point where a rotation is within acceptable limits, at which point correction plates must be installed. This removal or correction results in unnecessary delays to construction of the project.

604.2.7.4-Strutting Considerations A round structural plate pipe is strutted in much the same way as flexible pipe (see Section 604.2.5.3). A crosspiece of soft wood should be used between each vertical strut and the top sills, so that the pipe can compress slightly under heavy loads. The vertical elongation should be not less than 4% nor more than 6%. Struts of the specified length and sizes should be inserted progressively from one end of the pipe to the other. Jacks are required to elongate heavy gauge structural plate pipe. A structural plate pipe arch should not be strutted. However, props may be required while the embankment material is being placed, to make sure that the full vertical height is maintained.

604.2.7.5-Field Paving of Invert Paving the lower part (i.e., invert) of a structural plate pipe is generally required to improve the flow and prevent wear by sand and gravel that is carried through the pipe during periods of rapid flow. The surface to be field paved should be thoroughly cleaned and dried, and the priming material must be sufficiently applied with a brush or a mop to coat the surface and fill all seams and joints. All other details are provided in Section 604.9 of the Specifications.

604.2.8-Jacking and Tunneling When jacking or tunneling is designated on the Contract Plans or approved by the Project Engineer/Supervisor, the Project Inspector is responsible for ensuring compliance with Section 604.11 of the Specifications. Any departure from the specifications must be approved in writing by the Project Engineer/Supervisor. This procedure is applicable to either reinforced concrete or corrugated metal pipe. The Contractor is responsible for ensuring that the strength of the pipe can adequately withstand the jacking force. Pay particular attention to requirements for approach trench, pipe guides and collars, jacking equipment, and the allowable tolerance of deviation from plan alignment and grade. The jacking operation should be performed on a 24-hour basis to prevent the pipe from "freezing" in place. Lubrication may be required. Verify that joining of sections and backfilling are performed as specified.

604.2.9-Post Installation Inspection The Project Inspector should conduct a post installation inspection of all culverts as detailed in 604.12 of specifications. Pay particular attention to the requirements for rigid pipe criteria, flexible pipe criteria, and testing of pipe.

604.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Reports all information (e.g., laboratory numbers from shipping documents, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use-AASHTOWare Project, and pertinent attachments, to prepare the Diaries and DWRs. If in doubt as to whether or not information is important or beneficial, record it.

SECTION 605
MANHOLES AND INLETS

605.1-GENERAL REQUIREMENTS

605.1.1-Description of Work Section 605 of the Specifications governs the material and construction requirements for manholes and inlets. Unless the type is specifically designated, these items, or portions thereof, may be precast or cast-in-place. See Section 601 for information on reinforced concrete structures and bridge decks and Section 602 for information on reinforcing steel. When Item 605 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor installs or adjusts manholes and inlets in accordance with Section 605 of the Specifications and as designated on the Contract Plans. See the Specifications for the method of measurement for payment.

605.1.2-Curbs, Gutters, Inlets, and Catch Basins In urban areas and some cut sections in rural locations, curbs or combination curbs and gutters are generally provided to intercept and carry surface water to inlets and catch basins, which empty into storm sewers. Such facilities are typically constructed of Portland cement concrete or asphaltic concrete.

605.1.3-Storm Sewers A storm sewer is typically provided to rapidly carry away the water that falls on, or runs onto, a city street or other paved area. Water from the paved surface enters the storm sewer through inlets or catch basins that are placed in the gutter section. To prevent the storm sewer from being filled with dirt or trash that is washed from the paved surface, a catch basin, which is constructed with a void just below the pipe intake, is provided to store this material. Once in operation, the catch basins must be periodically cleaned to prevent this void from overflowing and allowing the material to be washed into the storm sewer. Manholes are placed along a storm sewer to allow access from the street to inspect the pipes for any necessary cleaning. A headwall of concrete or masonry is constructed at the outlet end of a storm sewer to hold the pipe firmly in place and to prevent erosion around the pipe.

605.1.4-Materials Considerations Many different types of materials will be needed for manhole and inlet work. Component materials of manholes and inlets will be sampled, tested, and approved prior to the start of their manufacture and inspected and labeled at the manufacturing plant in accordance with MP 700.00.01 and Section 605.2 of the Specifications. Upon delivery, check that manholes, inlets, catch basins, covers, frames, grates, and other related materials are shipped from pre-approved DOH sources and document laboratory numbers from the shipping documents in the Daily Work Report.

605.2-INSPECTION GUIDELINES

Prior to starting work on manholes and inlets, review the Contract. Verify existing drainage conditions, and check that the structures are staked at the proper location and elevation.

Consider the following:

1. Safety Considerations. Review safety requirements for trenching operations and confined space entry. Do not enter manholes, inlets, or other confined spaces without taking the proper safety precautions. Check the excavation operation for compliance.
2. Precast Structures. Upon delivery of precast structures, verify that they are shipped from an approved DOH source with accompanying shipping documents. Check the type and dimensions of precast items for conformance. Where applicable, check the spacing of stair rungs for compliance. Pay particular attention to defects and damage that may have occurred during shipping.
3. Cast-in-Place Structures. Where cast-in-place structures are used, check forms and reinforcing steel for proper condition and dimension.
4. Flowline Elevation. Regularly check the elevation of the pipe invert.
5. Manholes. Verify that manholes are used at each change of grade line. A smooth flowline must be provided between manholes and pipes. Check that a good union with pipes is achieved. Where precast sections are used, check that neat joints are constructed. Verify the proper use of brick and mortar to make field adjustments.
6. Inlets. Check for proper dimension, formwork, concrete placement, and curing. Where slot inlets are specified, use the Inspector's Slot Inlet Worksheet during inspection.
7. Weep Holes. Verify that weep holes are installed in the sidewalls of inlets to properly drain the subsurface material. Weep holes are approximately 4″ in diameter and are located at or below the subgrade elevation. Check that loose rock is placed around the outside of the structure at the openings to prevent excessive backfill material from passing through the weep holes.
8. Backfill. Check the backfill material and the backfill and compaction operations for conformance.
9. Cleaning. Do not permit the Contractor to store materials or hand tools in inlets or catch basins. Verify that all drainage structures are cleaned of any debris prior to accepting the work.
10. Frames and Grates. Check the setting and bedding or casting of metal frames for compliance. Check grates for acceptability with respect to type, dimension, orientation, and galvanization. The grate should set in the frame without rocking.
11. Manhole Covers. Check the type and dimension of manhole covers for compliance. Where located within pavements, check the slope and elevation of covers.
12. Mortar/Grouting. Verify that any needed mortar repairs and grouting around pipe are properly performed.
13. Grade Adjustment. When grade adjustment of existing structures is specified, check that existing frames are removed and reconstructed and adjustment rings are used, where appropriate.

605.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Work Reports all information (e.g., laboratory numbers, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments, to prepare the Diaries and DWRs. If in doubt as to whether or not information is important or beneficial, record it.

SECTION 606
UNDERDRAINS

606.1-GENERAL REQUIREMENTS

606.1.1-Description of Work Depending on the design application, subsurface drainage may include items such as underdrain pipe, blind drains, aggregate filled engineering fabric, free draining base trenches, underdrain outlet pipes, and pavement edge drains. Pavement edge drains are typically installed parallel to and near the edge of the pavement to intercept subsurface water that seeps through the pavement surface courses. In general, underdrains are installed to:

1. Intercept springs and lower the elevation of the groundwater table below the subgrade;
2. Intercept subsurface water from the backslope before it seeps into the subgrade;
3. Intercept subsurface water that may cause slides on the side slope of a cut; and
4. Correct base failures due to seepage of subsurface water.

Where Item 606 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor installs the underdrains in accordance with Section 606 of the Specifications. The type, size, and location of underdrains will be designated on the Contract Plans. Where field adjustments are required, they must be approved by the Project Engineer/Supervisor. See the Specifications for the method of measurement for payment.

606.1.2-Design Location The location of underdrains is usually determined from a soils investigation prior to plan preparation. The locations will be designated on the Contract Plans by stationing. A quantity will typically be specified with a notation that the underdrain material is to be used as directed by the Project Engineer/Supervisor. Changes in design location or the selection of additional locations must be approved by the Project Engineer/Supervisor and documented in writing. At the earliest practical date after construction begins, a survey should be made to determine where underdrains are required.

606.1.3-Field Adjustment After clearing and grubbing, during grading, and before embankment construction is started, the Project Inspector should look for signs of seepage, springs, and slides, and notify the Project Engineer/Supervisor to determine if underdrains are required. Water seepage often occurs during the spring thaw and after heavy rains. The use of test pits and trenches should be considered to locate the source of seepage, especially in the subgrade. Underdrains must be located at low points to properly collect and remove subsurface water. Pay particular attention to signs of seepage in bench cuts. For underdrains to function properly in slide areas, the loose material must be removed and the underdrains installed above the slide area. It may be necessary to use deep trenches at these locations.

606.1.4-Material Considerations Check that all pipe for underdrains, sand and gravel filter material, and engineering fabric that are delivered to the job site conform to the requirements of Section 606.2 of the Specifications with respect to type, size, class, and gradation. Pay particular attention to allowable substitutions. Verify that materials are shipped from preapproved DOH sources, and document laboratory numbers on the Daily Work Report (DWR) from the shipping documents.

606.2-INSPECTION GUIDELINES

Prior to installation, study the details of the Contract Plans, Specifications, and Standard Detailed Drawings for the types of underdrains to be installed. The installation of underdrains should be performed as soon as grade is achieved, so that the subgrade is not softened and the base course is not weakened by subsurface water.

606.2.1-Protection of Underdrains It is very important to ensure that underdrains are properly installed and adequately protected during construction. If an underdrain clogs or becomes damaged during construction, cleaning and repair work is expensive and not easily performed. If left in this state of disrepair, the subsurface water will saturate the subgrade and promote pavement failure in that area. Once installed, the underdrain must be protected from contamination by mud and sediments and from damage by heavy equipment until the overlying subgrade material can be placed. Pay particular attention to the use of heavy equipment over underdrains, and require adequate protection from damage.

606.2.2-Staking and Adjustments Check the location and elevation of staking for conformance. Be alert for adjustments to underdrain locations that may be performed to enhance the functionality of the system.

606.2.3-Trenching and Bedding Check the grade and dimensions of trenching for compliance. Perform grade checks regularly. Verify that the proper type of bedding material is placed to the proper depth in the bottom of the trench and that underdrain pipe, where used, is firmly embedded in the material.

606.2.4-Pipe Placement Perforated underdrain pipe must be placed with the perforations down, so that the water table can be lowered as much as practical. Perforated underdrain pipe must be laid so that there are an equal number of perforations on both sides of the pipe's invert. Check for proper joining of flexible pipe sections. To permit the entry of water, non-perforated and rigid pipe must be laid with open joints, with the bell and groove end upgrade, and wrapped with engineering fabric. Check for tearing, folds, and wrinkles in the fabric. Ensure that the upgrade end of underdrain pipe is plugged to prevent entry of soil material. The installation of underdrain pipe must be inspected and approved prior to placement of the filter material.

606.2.5-Aggregate Filter Material The aggregate filter material for an underdrain must be clean, handled, and protected so that mud or muck does not foul the material during construction. Check that the aggregate filter material is of the specified type, placed over the underdrain pipe to the required height, and covered with sand as specified. Where pipe is being covered, pay particular attention to any unacceptable movement of the pipe.

606.2.6-Backfilling It is important to prevent surface water from infiltrating the underdrain trench. For this reason, the top of the trench should be sealed with a firmly tamped layer of impervious material, such as clay soil. Surface water not only overloads the underdrain but also tends to wash fine soil particles into the aggregate filter material. Pay particular attention to the quality control testing and acceptance criteria of the backfill material, and verify that the placement and compaction of backfill layers are in accordance with specified requirements. Do not permit bulldozers or other bladed equipment to be used for backfilling. Verify that there is an approved Quality Control Plan for underdrain items.

606.2.7-Outlet Pipe and Slope Walls The purpose of the outlet pipe is to carry away the subsurface water intercepted by the underdrain, not to collect more ground water. Therefore, the outlet pipe should be firmly joined and non-perforated or, if perforated, oriented with perforations in the upward direction. The outlet pipe is placed in a trench and backfilled. Aggregate filter material is not required. Backfilling is similar to that required for underdrains. Verify that each outlet pipe is marked with a stake and referenced on the As-Built Plans. During construction and just before final inspection, check the outlet pipe of each drain to make certain it is open. Slope walls, or pup walls, are small headwalls used for outlet pipes. Precast slope walls are permitted as long as the slope of the wall matches the side slope. Do not permit the adjustment of the side slope to match that of the wall. Check that slope walls are constructed to the dimensions and elevations designated on the Standard Detailed Drawings.

606.2.8-Aggregate Filled Fabric Underdrain An aggregate filled fabric underdrain consists of a trench filled with porous aggregate that is enclosed with filter fabric. The purpose of the filter fabric is to prevent soil from clogging the aggregate. Pay particular attention to the placement and lapping requirements of the fabric. Tears, folds, and wrinkles in the fabric are unacceptable. Verify that this type of underdrain is constructed as specified in the Specifications and in accordance with the Contract Plans.

606.2.9-Free Draining Base Trench Where free draining base trenches are specified, check that they are in installed as specified in the Specifications and in accordance with the Contract Plans. Pay particular attention to the acceptability of trenching, placement and lapping of engineering fabric, bedding and placement of perforated pipe, aggregate backfill, and the location and treatment of outlet pipes and slope walls.

606.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Reports all information (e.g., laboratory numbers from the shipping documents, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments, to prepare the Diaries and DWRs for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

SECTION 607
GUARDRAIL

607.1-GENERAL REQUIREMENTS

607.1.1-Description of Work Section 607 of the Specifications governs the material and construction requirements for guardrail. When Item 607 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor sets, resets, or removes and stores guardrail in accordance with Section 607 of the Specifications and as designated on the Contract Plans. See the Specifications for the method of measurement for payment.

607.1.2-Types of Guardrail Where guardrail is warranted, it is installed to prevent errant vehicles from leaving the traveled way and moving into fixed objects, steep slide slopes, and opposing traffic. Different types of designs exist to address specific conditions. The types of guardrail that are typically specified include Type 1 – Galvanized Steel Deep Beam Type Guardrail or Zinc-Aluminum Magnesium Alloy-Coated Steel Deep Beam Guardrail and Type 5 – Galvanized Steel Double-Faced Guardrail (Deep Beam Type) or Zinc-Aluminum Magnesium Alloy-Coated Steel Double-Faced Guardrail (Deep Beam Type). Both Type 1 and Type 5 are classified as follows, which will be specified in the pay item and designated on the Contract Plans:

1. Class I. Class I guardrail has a 6′-3″ post spacing with blockouts.
2. Class II. Class II guardrail has a 12′-6″ post spacing with blockouts.
3. Class III. Class III guardrail has a 12′-6″ post spacing without blockouts.
4. Class IV. Class IV guardrail has a 3′-1.5″ post spacing without blockouts.
5. Class V. Class V guardrail has a 3′-1.5″ post spacing with blockouts.
6. Modified Cut Slope Terminal. A modified cut slope terminal consists extra-long guardrail posts, an additional W-beam guardrail section placed as the bottom beam, and standard guardrail cut slope terminal components.

607.1.3-Material Considerations Materials for guardrail must conform to the requirements specified in Section 607.2 of the Specifications. Check the type of rail system for conformance, including rail sections, hardware, and posts. Verify that new materials are shipped from pre-approved DOH sources, and document laboratory numbers on the Daily Work Report from the shipping documents. When removal and/or resetting or storage is specified, pay particular attention to damaged materials and storage methods, and know the disposition of all salvable materials.

607.2-INSPECTION GUIDELINES

Consider the following guidelines when inspecting guardrail installation:

1. Staking. Verify stake locations. Check lateral offset, longitudinal length, termini location, post spacing, rail curvature, parabolic flares, and trench width, where applicable.

2. Guardrail Post Installation. Unless designated otherwise, guardrail posts may be driven in place, set in dug holes, or set on a concrete base. Check post spacing, elevation, and alignment regularly. Where posts are driven, watch for irregular movement, possibly indicating an underground obstruction. Check driven posts for damage (e.g., distortion, burring). Where posts are set in dug holes, watch for overdrilling and require backfilling and compaction as needed to adjust depth and provide a firm foundation. After setting, verify that backfill material is placed and compacted in layers around posts. Check that all posts are set firm and plumb and that they are within tolerance of the required alignment and elevation.
3. Installation of Rail Sections. Check that all fittings and metal plates are securely placed in the correct position. Check that rail sections are properly lapped in a smooth, continuous installation. To prevent vehicle snagging rail, the upstream panel should always overlap the downstream panel including terminal connectors. Check that all bolts are drawn tight. Check the rail height and rail face (i.e., with respect to lateral offset and alignment) for conformance and any needed adjustment.
4. Terminals and Transitions. Pay particular attention to the construction details for end treatments, median terminals, and rail transitions (e.g., post type, post spacing, number of rail sections, lapping direction, splices, method of connecting, fastener type, reflector tab location). Specialized hardware and designs are commonly used at these locations and require close inspection prior to acceptance.
5. Traffic Considerations. Where the facility will be maintained open to traffic, it is good construction practice for the installation of rail sections to closely follow the installation of guardrail posts. At the end of the workday, check to ensure that the termini of exposed rail sections are treated as specified.

607.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Reports all information (e.g., laboratory numbers from the shipping documents, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Daily Work Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWARE Project, and pertinent attachments, to prepare Diaries and DWRs for documentation purposes. If in doubt as to whether information is important or beneficial, record it.

SECTION 608
RIGHT-OF-WAY FENCE

608.1-GENERAL REQUIREMENTS

608.1.1-Description of Work Right-of-way fences and gates are generally placed within the WVDOH right-of-way. When Item 608 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor installs right-of-way fences and gates in accordance with Section 608 of the Specifications and as designated on the Contract Plans. See the Specifications for the method of measurement for payment.

608.1.2-Material Considerations Materials for right-of-way fence must conform to the requirements specified in Section 608.2 of the Specifications. Many different types of materials may be required, including:

1. Barbed wire, chain link, and woven wire fence fabric;
2. Steel posts, post braces, gate frames, and gates;
3. Pressure treated wood posts, braces, and preservative treatment;
4. Zinc primer and aluminum paint;
5. Concrete and forms for footers; and
6. Miscellaneous hardware and fittings.

The Contractor will indicate at the Preconstruction Conference the type of post that will be used throughout the project. Know the required type of fencing and gates. Check materials for conformance with respect to type, size, and schedule. Check the weight, length, and coating of steel posts and the preservative treatment, straightness, and size of wood posts for acceptability. Verify that materials are shipped from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Daily Work Report. Reject materials that have been damaged during storage and handling.

608.2-INSPECTION GUIDELINES

Regularly check line, grade, and post spacing, and consider the following guidelines during the installation of right-of-way fencing:

1. Agreements. Activities are generally confined to the area adjacent to the right-of-way fence. As needed, verify the Contractor has obtained agreements with property owners of adjacent private property. Check right-of-way agreements for any special fencing requirements.
2. Temporary Fence. Verify if temporary fence is required (e.g., livestock stock control, pedestrian safety, wetlands protection). Electric fencing may be required for livestock protection and plastic fencing may be required around vegetation that is to be protected.

3. Staking. Check that the staked alignment is approximately 12″ inside WVDOH right-of-way, unless otherwise specified, and that the post spacing is properly marked.
4. Clearing, Grubbing, Trenching, and Hole Excavation. Verify that clearing, grubbing, trenching, and post hole excavation is properly performed. Pay particular attention to the lines, grades, and dimensions specified in the Specifications and designated on the Contract Plans.
5. Posts. Check that posts are set at the specified depth, elevation, orientation, and spacing. Verify that metal posts are set to face the correct direction. Pay particular attention to the requirements of posts that are set in rock.
6. Corner and Line Brace Posts. Check for properly located corner and line brace posts. Verify that line braces have been installed where needed for grade changes. Ensure that junctions with existing fencing is properly performed.
7. Concrete Footers. Check that concrete footers are formed, poured, graded to drain, and cured as specified. Concrete must be allowed to set sufficiently around posts and braces. Verify that the concrete has been permitted to gain the required strength before the fabric or wire is stretched.
8. Wire/Fabric. Know which side of the post the fence fabric or wire is to be installed. Check that the fence fabric or wire is properly stretched and fastened.
9. Electrical Grounds. Check conformance of the installation of electrical grounds.
10. Painting. Verify that fence materials are painted or touched up as specified.
11. Advertising Signs. Ensure that no advertising tags or signs are placed on fencing or within the right-of-way.

608.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Reports all information (e.g., laboratory numbers from the shipping documents, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Daily Work Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments, to prepare the Diaries and DWRs. If in doubt as to whether or not information is important or beneficial, record it.

SECTION 609
SIDEWALKS

609.1-GENERAL REQUIREMENTS

609.1.1-Description of Work Section 609 of the Specifications governs the material and construction requirements for Portland cement concrete sidewalks and curb ramps. When Item 609 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 609 of the Specifications, Standard Details, and as designated on the Contract Plans. See the Specifications for the method of measurement for payment.

609.1.2-Material and Equipment Considerations Verify that the concrete mix components and proportions, preformed, expansion joint filler, bed course material, and joint sealing materials comply with the requirements of Section 609.2 of the Specifications. Check that the concrete complies with the specified class and that the mix design has been approved. Ensure that the specified sampling and testing requirements are met. Where reinforcing steel is required, check to ensure that the reinforcement is of the proper type and size. Check the type, number, and condition of equipment that will be used to place, consolidate, finish, and cure concrete. Where forms are used, ensure that they are in good condition and of the proper type and dimension. Where slipforming is used, check the slipforming equipment for acceptability. Ensure that the Contractor has adequate materials on hand to properly cure and, as needed, protect the concrete during cold weather. As applicable, verify that materials are shipped from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Daily Work Report.

609.2-INSPECTION GUIDELINES

Portland cement concrete sidewalks and curb ramps will be constructed on a solid foundation, typically bed course material, that has been properly graded and compacted. Consider the following guidelines during inspection:

1. Subgrade. Check the cross-slope, elevation, and alignment of the subgrade for compliance. Where bed course material is required, ensure that the required type and depth of material is properly placed, shaped, and compacted. Check for soft spots, and enforce the Contract provisions with respect to needed repairs. Ensure that all unsuitable material is removed and replace with suitable material. Do not permit construction on a frozen base. Freeze-thaw cycles tend to loosen a compacted base. Recheck base density after freezing and thawing. Verify that the subgrade is tested by means of a template.

2. Curb Ramps. Review the location and construction details of curb ramps that are designated in the Contract. Pay particular attention to the slope and surface finishing requirements of curb ramps. A textured surface finish is typically required, and field adjustments may be needed to meet slope requirements. Review the locations of drainage structures to ensure that no new drainage structures are aligned with curb ramps.
3. Forms. Where forms are used, check that they are set to the proper line and elevation with respect to grade stakes and that they are firmly staked into position. Pay particular attention to how forms are set with respect to locations of inlet sections, curb ramps, and driveways, and require adjustments where needed. Ensure that forms are set to accommodate drainage. Prior to placement of concrete, verify that forms are treated with an approved release agent.
4. Reinforcement. Where reinforcing steel is required, check spacing, clearance, and supports for acceptability.
5. Moistening of Foundation. Ensure that the foundation has been thoroughly moistened before the placement of concrete.
6. Placement and Consolidation. Check for the proper placement and consolidation of concrete. Where slipforming is used, check that the grade has been trimmed to the correct line, cross-slope, and elevation. Check grade stakes, grade line, and electronic controls for proper adjustment, including locations of inlet sections, curb ramps, and driveways. Regularly check alignment, elevation, and cross-slope during slipforming, and ensure that the extruded section conforms to typical section, especially the pan (i.e., spill or catch)..
7. Check that transverse expansion joints and saw cuts are located and constructed properly. Joint types and locations should match those in adjacent concrete. Ensure that approved expansion material is placed to full depth in the joint reservoir. Verify that edging is performed where required.
8. Finishing. Verify that the concrete sidewalk is struck off, vibrated, troweled, broomed, edged, and jointed as specified. Check the acceptability of the surface finish. Pay particular attention to texturing requirements (e.g., curb ramps). The finishing operation ideally should be accomplished without the use of additional water.
9. Curing. Verify that concrete is properly cured for the specified curing period. Where curing compound is used, check that it is of an approved type and that the rate and time of application are acceptable. Ensure that the Contactor complies with the provisions for concrete protection during cold weather.
10. Protection. Verify that the Contractor protects the sidewalk for the specified time period. Traffic will be permitted on the sidewalk at the discretion of the Project Engineer/Supervisor.
11. Form Removal and Backfill. Form removal and backfill must not be started until the concrete has reached sufficient strength to withstand damage. Ensure the edges are adequately shouldered. Watch for damage to the concrete during the backfill operation.

609.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Reports all information (e.g., laboratory numbers from the shipping documents, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWRs must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments, to prepare the Diaries and DWRs for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

SECTION 610
CURBS, COMINATION CURBS AND GUTTERS, AND MEDIANS

610.1-GENERAL REQUIREMENTS

610.1.1-Description of Work Section 610 of the Specifications governs the material and construction requirements for constructing or resetting plain concrete curbing, integral concrete curbing, combination concrete curb and gutter, reflective concrete curbing, asphalt curbing, and medians. When Item 610 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 610 of the Specifications and as designated on the Contract Plans. See the Specifications for the method of measurement for payment.

610.1.2-Material Considerations Many different types of materials are required for work under Item 610. Prior to beginning the work, verify that all materials conform to the requirements of Section 610.2 of the Specifications. Check materials that are shipped from pre-approved DOH sources, and document their laboratory numbers from the shipping documents on the Daily Work Report. Know the concrete class and mix requirements for any concrete work to be performed, especially for reflective concrete curbing. For asphalt work, verify the laboratory number assigned to the Contractor's approved Job-Mix Formula. Pay particular attention to quality control sampling and testing requirements for asphalt content and gradation and verify that they are maintained within allowable tolerance.

610.2-INSPECTION GUIDELINES

610.2.1-Concrete Curbs and Medians Consider the following inspection guidelines for plain concrete curbing, integral concrete curbing, combination concrete curb and gutter, and medians:

1. Foundation. Check the alignment, grade, width, and depth of the excavated foundation for acceptability. Ensure that any unsuitable material is removed and replaced with suitable material. If bed course material is specified, check the width and depth for compliance. The foundation must be thoroughly compacted.
2. Concrete Forms. Forms for concrete work may be either wood or metal. Check forms for acceptability. The forms must be clean, free of damage and warps, and set to the proper grade, alignment, and depth. Once installed, verify that the forms are firmly braced and secured.
3. Concrete Placement and Finishing. Just prior to concrete placement, the foundation should be moistened and the forms cleaned and oiled. Check concrete placement and vibration for compliance. Ensure that drainage openings are provided at the required size and elevation. Slip forming is permitted if the work is not required to be integral with or tied to a concrete pavement. If used, check that the track is set to the

proper line and grade, the slip form provides the proper cross-section, and the mix consistency does not allow the formed concrete to slump.

4. Joints. Check section lengths for compliance. Where the work will be abutting concrete pavement, sections should match contraction and expansion joints. Check joint intervals and width for compliance, and ensure that joints are properly filled with joint sealing material or preformed expansion joint filler, as appropriate.
5. Form Removal. Forms should generally not be removed for the first 24 hours. When removed, pay particular attention to any damage to the work and require repairs based on the provisions of the Contract. Once removed, verify that the Contract finishes the exposed faces of the concrete as specified. Plastering will not be permitted.
6. Backfilling. Check that the voids in front and back of the work are properly backfilled and thoroughly tamped.
7. Reflective Concrete Curbing. Where reflective concrete curbing is specified, pay particular attention to the specified reflective mortar mix and application methods. If the entire curb is not constructed of the mix, check that the exposed curb face is treated with the mix within the specified time period. Watch for unacceptable discoloration and the need for repairs.
8. Resetting Curb. Where curbing is reset, ensure the Contractor carefully removes, cleans, and stores the curbing to be reset. Require replacement if damaged. Verify that the curbing is reset on a firm foundation true to the required line and grade. Cutting and fitting may be required. Pay particular attention to the specified maximum joint widths and the requirements for end dressing and preformed expansion joint fillers. Once reset, verify that voids in front and back of the curb are backfilled and thoroughly tamped.

610.2.2-Asphalt Curbing Consider the following guidelines during the inspection of asphalt curing:

1. Equipment & Tools. Asphalt curbing is constructed using a self-propelled curbing machine or paver with a curb attachment. Check the acceptability of the machine and ensure that the formed curb is uniform in texture, shape, and density. Also, verify that the Contractor has on hand necessary hand tools and equipment for the work.
2. Foundation. Where excavation is required, verify that the foundation is the proper alignment and grade and is thoroughly tamped. If laid on a fresh laid asphalt surface, check that the surface is cleaned prior to curbing. If laid on an aged concrete or asphalt base, ensure that the surface is thoroughly swept, cleaned, dried, and tacked prior to curbing. Check the rate of application of tack and watch for overspray.
3. Mix Placement. Check the asphalt mix temperature for compliance. Hand placement and forming is permitted for short inaccessible sections and sections with short radii. Do not allow curbing to be placed during inclement weather or below the specified minimum ambient temperature.

4. Joints. The asphalt curbing operation is generally continuous so that joints are eliminated. However, where joints are required after the operation is halted, verify that the contact surface of previously laid curb is coated with hot asphalt material prior to restarting.
5. Curing and Painting. Once placed, the curbing must be protected from traffic until the heat in the mix dissipates and the curb hardens. The curb should then be painted with a coat of emulsified asphalt as specified to prevent moisture absorption.

610.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Reports all information (e.g., laboratory numbers from the shipping documents, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Daily Work Report for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

SECTION 614
PILING WALLS

614.1-GENERAL REQUIREMENTS

614.1.1-Description of Work Section 614 of the Specifications governs the material and construction requirements for piling walls. In general, this work involves constructing and tying a piling wall directly into an existing stable slope by placing steel piles in predrilled holes and then grouting, backfilling, and lagging the piles. The exposed steel is then painted. When Item 614 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 614 of the Specifications and as designated on the Contract Plans. See the Specifications for the method of measurement for payment.

614.1.2-Material Consideration Inspect all materials for conformance to Section 614.2 of the Specifications. Check that materials are supplied from pre-approved DOH sources, and document laboratory numbers on the Daily Work Report. Pay particular attention to the size, type, and grade of steel piles and timber lagging. The quality control of concrete and grout is the Contractor's responsibility as designated in Materials Procedure MP 601.03.50. The Quality Control Plan and the type of corrosion protection will be submitted to the Project Engineer/Supervisor for review at the Preconstruction Conference.

614.2-INSPECTION GUIDELINES

Prior to beginning the work, the Contractor, Project Engineer/Supervisor, and Project Inspector will conduct a site review to verify the limits of the pile wall. During construction, consider the following guidelines:

1. Staking. Check that the location of the piles has been properly staked. The center of the piles should be within 1″ of the locations designated on the Contract Plans.
2. Drilling. Drilled holes are required. Check the hole depth for compliance. The hole depth depends on the minimum length of pile embedment in the bedrock. The estimated pile length and depth to bedrock will be shown on the piling profile. Deviations in depth greater than 2.5′ require approval by the Project Engineer/Supervisor. Watch the bit alignment during drilling. The bit may deflect along sloping bedrock layers. Alignment can be easily verified using a plumb bob. Check the minimum diameter of the hole for compliance. Temporary casing of holes may be needed. Ensure that the excavated material is disposed of properly.
3. Pile Installation. In general, the piles should be installed without driving, unless an obstacle is encountered. During installation, check that the pile does not rotate and that its final orientation is within specified tolerance. Once installed, check that the elevation of the top of the pile is within specified tolerance. If splicing is required, verify compliance of the use of butt welds and splice plates.

4. Painting. Check that the surface of the piles from the top down to approximately 2′ below the anticipated grout line is properly clean and painted.
5. Grouting. Prior to grouting, check to ensure the hole is pumped free of water and cleaned of loose soil and debris. Verify that concrete or grout, as specified in Section 614.5 of the Specifications, is placed in the bottom of the hole up to the bottom of the lagging. Vibration is not required. This is a continuous operation that should be performed on a daily basis as piles are installed.
6. Lagging and Backfilling. Ensure that lagging of the type and size specified is installed between the piles and that backfilling and restoration of the plan roadway template is performed. Ensure that lagging extends below the original ground line.

614.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers from the shipping documents, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments, to prepare the Diaries and DWRs for documentation purposes. If in doubt as to whether information is important or beneficial, record it.

SECTION 615
STEEL STRUCTURES

615.1-GENERAL REQUIREMENTS

615.1.1-Description of Work Section 615 of the Specifications governs the material, fabrication, assembly, and erection requirements for steel structures. The inspection of steel structures requires a great deal of coordination, attention to detail, and a thorough working knowledge of the Contract documents. These documents include, but are not limited to: Specifications, Special Provisions; ASTM Material and Testing Specifications; AASHTO Standard Specifications for Bridges; AISC Steel Construction Manual; ANSI/AASHTO/AWS Bridge Welding Code D1.5; and the Contractor's Working Drawings and Quality Control Plan. Prior to the start of work, review this documentation and become familiar with the responsibilities of WVDOH and Contractor inspection personnel; quality control sampling and testing requirements; fabrication, assembly, and erection details; welding and painting requirements; dimensional tolerances; and the acceptance criteria specified in the Contract. See the Specifications for the method of measurement for payment.

615.1.2-Working Drawings The following working drawings will be reviewed by the Project Engineer/Supervisor for strength and detail only, not dimensions:

1. Shop Drawings. The Contractor is responsible for submitting detailed shop drawings to the Engineer for review. These drawings will include the State project number, Federal project number, bridge name and number, Contractor's name, fabricator's name and the detail of all structural components and miscellaneous parts, including: material identification, dimensions, sizes, and plate rolling direction.
2. Erection Drawings. The Contractor is responsible for submitting erection drawings to the Project Engineer/Supervisor for review. These drawings will include the proposed method of erection, including; details of all falsework bents, bracings, guys, dead-men, lifting devices, and attachments to bridge members; sequence of erection; location of cranes and barges, crane capacities, location of lifting points, and weights of members. Erection drawings must be sealed by a West Virginia Registered Professional Engineer.
3. Camber Diagrams. The fabricator is responsible for submitting camber diagrams to the Project Engineer/Supervisor for review. These drawings will include the preassembled camber for various structural members, as defined in the Specifications.

615.2-Field Inspection Guidelines

615.2.1-Inspection Upon Delivery Structural materials and fabricated members must be inspected upon delivery and during field assembly and erection. Accept only members that bear the WVDOH stamp of acceptance or are delivered with approved evidence of inspection.

Immediately notify the Project Engineer/Supervisor of any members that have not been previously inspected and accepted. Pay particular attention to the following:

1. Storage and Handling. Girders, beams, and other structural members must be handled carefully to prevent damage, and they must be stored above ground on level platforms or skids to keep them free from dirt and grease. Pay particular attention to how members are lifted and supported. Workers must not be permitted to fasten chains or cable hooks to girder stiffeners, diaphragm connectors, or gusset plates when lifted. Long, non-cambered structural members must be laid flat on supports that are placed fairly close together. Cambered members must be stored so that the proper camber will be maintained. As practical, like members should be stored together and lined up so that errors of length can be easily detected. Check girders and beams for deflection, cracked welds, bends, twists, kinks, and dents. If such damage is found, notify the Project Engineer/Supervisor to ensure that the problem will be satisfactorily addressed. Verify that girders and beams are stored upright and shored and that long members are placed to prevent damage by deflection. Do not allow bent or damaged steel members to be incorporated in the work without prior approval by the Project Engineer/Supervisor.
2. Damaged Members. If the Project Engineer/Supervisor discovers bent members, notify the Design Engineer. All approved repairs are to be visually inspected. If fractures are suspected, magnetic particle and dye penetration testing may be required for verification.
3. Match Marking. Check match marks on members to ensure that they are arranged, assembled, and erected based on the Contractor's erection diagram.
4. Coating Damage. Watch for damage to shop coating caused by mishandling. As needed, require the Contractor to repair the work.

The Project Inspector must maintain a record in the Daily Work Report of each shipment of steel, including the date on which the shipment was received, the number of pieces of each type, laboratory numbers, shipping documents and the invoice weight.

615.2.2-Falsework Falsework for steel structures is entirely the Contractor's responsibility. The Contractor is responsible for submitting erection drawings as discussed in Section 615.1.2. These drawings must be designed and sealed by a West Virginia Registered Professional Engineer. The Project Engineer/Supervisor and the Project Inspector should not discuss the acceptability of the erection drawings with the Contractor. If, however, the Project Inspector notices noncompliance with the erection drawings (e.g., temporary struts or ties that are improperly located) or that falsework is distorting flanges or webs of structural members, immediately notify the Contractor and Project Engineer/Supervisor for corrective action.

615.2.3-Bearings and Expansion Devices

615.2.3.1-Bridge Expansion and Contraction A typical bridge has a fixed end and an expansion end. At the fixed end, the superstructure cannot move. At the expansion end, the superstructure can expand and contract a limited distance along its span during fluctuations in temperature and loading. The expansion device, at the expansion end, and the bearings, on which the superstructure rests, are installed to accommodate this movement.

615.2.3.2-Bearing Devices Many different types of bearing devices are available, including rockers, rollers, and elastomeric bearings. Elastomeric bearings are generally used in structures to level the structure, support the vertical loads of structural members, and isolate specific movements (i.e., longitudinal, transverse, rotational). Stringent quality control governs the manufacture of these devices. Elastomeric bearings may be classified as either laminated (i.e., reinforced with laminate sheeting) or plain (i.e., non-reinforced). Leveling pads are generally not laminated. Fabrication differs with each bearing type and includes component materials such as elastomeric materials, laminate sheeting materials, adhesives, sealing pots, pistons, and anchor bolts. Note that lubricants are not used in bearing devices. Depending on the application and thickness required, some elastomeric bearings may be designated as either laminated or plain and may require a sole plate, radius plate, or an upper and lower sliding element. Other elastomeric bearings are fabricated to accommodate vertical loads and horizontal movement (i.e., longitudinal, transverse, rotational) due to factors such as thermal expansion and contraction, camber changes, and the creep and shrink of structural members. These devices include the following types of designs:

1. Fixed Bearings. Fixed bearing designs accommodate rotation but not longitudinal or transverse movements.
2. Guided Expansion Bearings. Guided expansion bearings accommodate rotational and longitudinal movements but restrict movement in the transverse direction.
3. Non-Guided Expansion Bearings. Non-guided expansion bearings accommodate rotational, longitudinal, and transverse movements.
4. Pot Bearings. Pot bearings are equipped with a piston and may be designated as either guided or non-guided based on the need to accommodate or restrict horizontal movement.
5. Disc Bearings. Disc bearings are equipped with an elastomeric rotational disc and may be designated as either guided or non-guided based on the need to accommodate or restrict movement.

Prior to fabricating these types of elastomeric bearings, the Contractor should submit shop drawings, design calculations, and load data to the Design Engineer. Review these drawings to become familiar with the storage, handling, and installation procedures (e.g., alignment, offset) and the method of protecting the bearings during welding and painting of the structure. If required by the plans, verify that the Contractor has notified the manufacturer of the bearing to make available a representative to guide and inspect initial installation.

615.2.3.3-Expansion Devices The concrete back wall should not be built until all superstructure steel and the concrete deck have been placed. At the fixed end, a bearing is installed that will inhibit movement of the deck. At the expansion end, a fairly wide space is left between the deck slab and the back wall, and a bearing is installed that will allow the end of the deck to easily slide toward or away from the back wall. For expansion devices that have been strapped as a unit, spacing must be allowed relative to temperature as specified in the plans before the concrete is placed in the back wall. Any straps across the joint must be removed as soon as the concrete is strong enough to hold the seat angle in position. If they are not removed promptly, movement of the end of the deck slab will cause failure of the anchorage in the back wall.

615.2.3.4-Installation and Adjustment After the falsework has been removed and the superstructure is bearing its full dead load, bearings and expansion devices must be checked for proper adjustment. The method and amount of adjustment depends on the ambient temperature, the type of device, and the manufacturer's recommendations. At 68ºF, the bearings should be nearly centered or vertical, and the anchor bolts of expansion devices should be nearly centered in their slotted holes. If the ambient temperature is higher or lower than 68ºF when these devices are set, they must be adjusted off-center or at an angle from vertical in the proper direction along the span. The magnitude of adjustment depends on the coefficient of expansion. This coefficient is assumed to be 0.0000067 inch of movement/inch of span/degree Fahrenheit from 68ºF. Adjustments should be made while the steel has a uniform temperature.

For example, if the ambient temperature is 85ºF and the span is 90', the change in span length (i.e., expansion) would be: 0.0000067 • 1080" • 17ºF = 0.123" = 1/8". The steel would be 1/8" longer at 85ºF than at 68ºF. To allow for this difference, each device would be initially set so that it is centered or vertical and then would be shifted or angled away from the span a distance of 1/8". The allowable tolerance of adjustment is ± 1/16".

615.2.3.5-Inspection Guidelines Pay particular attention to the location and setting of bearing devices, expansion devices, rockers, rollers, and anchor bolts. Check that anchor bolts are set in either concrete or grout as specified. Verify proper adjustment to accommodate temperature variation and lengthening of the bottom flange under dead load. Check that movement is not hindered by anchor bolts, nuts, or other obstructions. Consider the following guidelines:

1. Anchor Bolts. Holes for anchor bolts must be at least 1″ deeper than the mortared-in part of the bolt and must be thoroughly cleaned with compressed air. A template should be used to ensure the right bolt spacing. Anchor bolts must be vertical, and each bolt should be set with about 1″ of thread above the nut. Non-shrink grout should be rodded around each bolt and left undisturbed and covered with wet burlap for several days.
2. Concrete Surface/Bearing Seat. Check to ensure that the concrete surface and bearing seat are within tolerance of the required elevation and horizontal or superelevated plane. Verify that the concrete surface is clean and free of cracks. Do not accept grout pads unless previously authorized by the Project Engineer/Supervisor. Check bearing seats for irregularities and proper elevation. If the bearing seat is not properly cleaned and prepared to match the pad surface, the edge of the pad will be loaded sufficiently to cause premature failure of the device. Do not permit elastomeric bearing pads to be used for leveling purposes.

3. Installation and Adjustment. Bearing devices must be set level at right angles to the length of the member it supports, in exact position, with full and even bearing on the masonry. It is essential that the final bearing elevation be checked for compliance. Bearing devices must be in alignment with each other. Check to ensure that sole plates are positioned to the correct grade and superelevation and are in full contact with the bottom flange of the girder. Check the bearing alignment for conformance with the Contract Plans. Verify proper adjustment for temperature, post tensioning, and shrinkage. Watch for interference between anchor bolts and the upper part of the bearing device.
4. Protection of Bearings. Where welding is performed in proximity to non-metallic bearing pads, check for the proper use of wax pencils to monitor the heat generated and prevent damage to the pads. Where the structure is painted, verify protection from overspray and contamination.
5. Metal Railing Considerations. At a location where a rail crosses an expansion joint, provision must be made to allow free movement of the rail section as expansion and contraction of the structure occurs. When provision for this movement is made by means of metal sleeves that are fitted inside hollow rail members, the sleeves should be welded in place on the downgrade side of the joint. Any bends or dips in a railing are easily detected. Care must be taken to ensure that all posts and rails are set to a uniform line and grade.
6. Final Check. Perform a final check of the bearing devices and require corrective work based on the provisions of the Contract. Following completion of the superstructure, inspect the installation and alignment of each device in the presence of the Contractor. Obtain written certification from the Contractor and manufacturer's representative when required by the plans or specifications that the installation of bearing devices have been correctly installed.

615.2.4-Field Welding Considerations

615.2.4.1-General Welding Procedure Steel members must be set in the proper position and held securely in place during welding to prevent bending or twisting. The method of securing must not interfere with the welding. The surfaces of the members to be welded should be cleaned thoroughly for a distance of not less than 1" beyond the edges of the weld on all sides. When two pieces of steel are to be butt-welded, the ends of the pieces must usually be beveled, and rough edges should be made smooth.

615.2.4.2-Quality Welds A finished dependable weld of good workmanship should have the following properties:

1. A reasonably uniform cross-section with a flat or slightly bulging face and a fairly smooth surface;
2. Reasonably straight edges flowing into the base metal;
3. A well-defined crater approximately 1/16″ deep;
4. A surface with ridges or ripples spaced closely and uniformly; and
5. A bright surface of uniform color after it has been cleaned with a wire brush.

615.2.4.3-Defective Welds Common defects in welds and their causes and remedies are as follows:

1. Overlap. Overlap, the term used when the edge of the weld is loose and extends over the base metal, is caused by poor fusion. If the overlap is very small and if the weld need not have its full strength, the weld may be accepted. If the overlap is large or if the full strength of the weld is needed, the weld should be removed and a new weld made.
2. Undercutting. Undercutting is evidenced by not having enough electrode metal. The weld should be thoroughly cleaned and built up to standard size with additional weld metal.
3. Shallow Craters. Shallow craters are caused by not getting enough penetration. Unless the weld is for sealing purposes only, it should be removed and a new weld made.
4. Pits and Pockets. Pits, porosity, and gas pockets are caused by improper procedure. The weld should be removed and a new weld made.
5. Inclusions. Slag and oxide inclusions are caused by improper procedure. Unless the weld is for sealing purposes only, it should be removed and a new weld made.
6. Spatters. If spatters are large and scattered over a wide area, they are caused by the use of an arc that is too long or by poor fusion without enough penetration. The weld should be thoroughly checked, and if there is any doubt about the quality of the weld, the weld should be removed and a new weld made.
7. Irregular Ridge Spacing. Irregular spacing of ridges is caused by variation in the speed of welding. The weld may be accepted unless the arc has been jumped forward so as to leave a space with not enough penetration. Such a fault may be corrected by increasing the length of the weld.

615.2.4.4-Inspection Guidelines Field welding is only permitted where designated on the Contract Plans or as authorized by the Project Engineer/Supervisor. The Contractor must submit the welding procedure to the Materials Control, Soils and Testing Division for approval. Where permitted, each weld should be inspected after the slag has been removed. The Project Inspector must mark each weld that has been inspected and approved in such a manner that it can be easily identified. Consider the following additional guidelines:

1. Welder Certification. Only a welder who has current certification with the West Virginia Division of Highways will be allowed to weld structural members. Notify the Project Engineer/Supervisor of any welder who constantly makes undersized welds or whose workmanship is poor.
2. Size and Length. The size and length of each fillet weld must be compared with the dimensions shown on the Plans. The size or length may be slightly oversize or slightly longer than specified.
3. Joint Width. Where joints are to be field welded, ensure that they are drawn tightly together before welding. If not, the opening may be large enough to allow the weld to pass between the members and tack to the flange under the joint. These welds appear

normal on the surface, are difficult to visually detect, and may cause significant damage to the structure (e.g., fatigue cracks produced by stress risers).

4. Stay-in-Place Forms. Where stay-in-place deck forms are installed, do not allow welding or striking of arcs on the flanges of structural steel members.

615.2.5-Assembly and Erection Considerations

615.2.5.1-Positioning Steel Members The Project Inspector should make certain that all members are placed in the proper positions, and that main supporting members are in correct vertical and horizontal alignment. The marks painted on the steel for identifying pieces should agree with those shown on the erection drawings, and careful attention should be given to match marks at connections. The Project Inspector should recheck the relative positions of bearing connections in the substructure and superstructure just before the steel is put in place. Bearing surfaces and other contact surfaces must be checked to see that they are clean and free from dirt, grease, or rust. After the structural steel has been erected, the Project Inspector should check the bearings to be sure that each bearing part makes full contact.

615.2.5.2-Drift Pins and Temporary Bolts Before splicing is begun, the members are usually held together by drift pins and temporary erection bolts. The Project Inspector must make certain that these temporary connections are made in accordance with the requirements of the Specifications. Members to be spliced together must be held in their correct position so that the connection can be made properly. Drift pins of the proper size are usually installed first in a few sets of holes, to bring the parts into their proper relative position and to keep the holes in alignment. Bolts of the specified size are inserted into other sets of holes and tightened, to hold the members in contact until the first few bolts are installed. Then the drift pins and temporary bolts are removed, and the splice is completed.

615.2.5.3-Allowable Connection Adjustments Steel should fit together with little distortion or strain. A slight adjustment with drift pins is to be expected. If the holes are too far out of place, a workman should not be allowed to force the parts into position with drift pins. Improper use of drift pins may damage the material around the holes and will prestress the members. Striking a member with a heavy sledgehammer should not be allowed.

In most structures, a reasonable amount of reaming and drilling to match up holes is allowable. However, no reaming should be allowed in a splice in a main tension member of a truss, unless specific permission is obtained from the Project Engineer/Supervisor.

Any error which cannot be corrected by light drifting, a moderate amount of reaming and drilling, should be reported to the Project Engineer/Supervisor. The proposed method of correcting the fault must be approved by the Project Engineer/Supervisor obtained before the method is used.

Checks and any necessary corrections should be made as the work progresses. Also, before the members are connected permanently, the Project Inspector should check the work again to make sure that all members are aligned properly and set to the required camber. This final checking should prevent any poor alignment from being built into the final structure.

615.2.5.4-High-Strength Bolts After the members have been drawn together tightly by temporary bolts, the Contractor may tighten high-strength bolts to the required tension by using the turn-of-the-nut method, as defined in the Specifications. During the use of the turn-of-the-nut method, the nut on each permanent bolt is first turned so that it is snug tight and then given additional rotation to final tension, as defined in the Specifications.

Each connection should be checked by the Project Inspector immediately upon completion, because of the tendency of the bolts to freeze. See Section 615.5.6.4 of the Specifications, rotational capacity test records, and turn-of-the-nut test records.

615.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare for documentation purposes. If in doubt as to whether information is important or beneficial, record it.

SECTION 616
STEEL BEARING PILING

616.1-GENERAL REQUIREMENTS

616.1.1-Description of Work Section 616 of the Specifications governs the material and construction requirements for driving steel bearing piles. When Item 616 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 616 of the Specifications and as designated on the Contract Plans. See the Specifications for the method of measurement for payment.

616.1.2-Material Considerations Inspect the material upon arrival at the job site. Verify that steel bearing piles (H piles), splices, and steel pile points materials conform to the requirements of Section 616.2 of the Specifications. Ensure that materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Daily Work Report. Do not accept damaged materials.

616.1.2.1-Steel Piles The steel pile types that are typically used in foundation applications include structural steel shapes, steel pipe, and steel shell piles. The Contract Plans will designate the types required. Upon delivery, review the mill test reports to ensure that the heat numbers on the piles correspond to the those on the reports. Also check and document conformance with respect to pile condition, material grade, length, and cross sectional shape. Steel H-shaped beams are the most commonly used. It is important to verify that the piles are of the type and size designated on the Contract Plans.

616.1.2.2-Pile Tips Pile tips are used to protect the driving end of a pile and as a cutting edge, especially in rocky soil. Where their use is specified, check pile tips and fastening details for compliance. Ensure that closure plates, driving points, and connection welds do not project beyond the perimeter of pile tips. This is especially important where steel pipe piles and steel shell piles, are used.

616.1.2.3-Concrete Concrete is generally used to fill the interior of steel pipe and steel shell piles after they are driven and their interior cleaned of debris and water. Where specified, check the concrete class for conformance.

616.2-INSPECTION GUIDELINES

616.2.1-Overview Piles are load-bearing members made of steel. They are usually used in locations where the surface soil is too weak or too compressible to provide adequate support for a structure. In such a place, piles are used to transfer loads from the structure to stronger underlying layers of soil or rock. In a few cases, piles may be used to resist lateral forces, or anchor piles may be used to resist the effect of a force causing uplift.

Structural steel shapes are typically used as foundation piles. These piles are driven vertically or near vertically into natural ground to help support the structure and minimize settlement. Without a solid foundation, the attention given to constructing a quality structure is meaningless. As such, the Project Inspector must thoroughly and competently inspect the foundation piling provided for structures.

Many types of piles are available for foundation designs, and each design will differ based on the specific conditions at the site. The Contract Plans will designate criteria such as pile type, number, length, horizontal arrangement, orientation (i.e., plumb, batter), and driving specifications such as design load, driving energy, depth, and number of blows. Each pile that is driven to specification will provide a bearing capacity that will support a fraction of the structure's total load (i.e., design load). The pile's bearing capacity results from a combination of resistant forces, including the surface friction between the pile and natural ground and the bearing pressure of the pile tip on the substrata material (e.g., bedrock). Once driven, the pile should not settle under its design load.

Although it is equally important to check items such as pile type, location, and orientation, it is paramount to continuously inspect the driving operation with respect to the number of blows each pile receives. The decision to continue or halt the operation must be made quickly. If driving is stopped too soon, the pile will not have developed the required bearing capacity to resist the design load, and the structure may eventually settle due to a lack of support. If overdriven, the pile may incur structural damage, increasing the chance that the foundation will settle or otherwise fail at the location of the damaged pile. It is important to note that the Project Engineer/Supervisor is responsible for determining the acceptability of the pile with respect to its load bearing capacity. The procedures, methods, and criteria by which this determination is made will be specified in the Contract. In making this determination, the Project Inspector is only responsible for assisting the Project Engineer, as directed.

616.2.2-Pre-Driving Considerations

616.2.2.1-Contract Documents Know the requirements of the job. Review the Specifications and Contract Plans with respect to equipment requirements and pile type, length, location, orientation, driving depth, theoretical refusal, bearing capacity, and cut-off elevation. Know the splicing, capping, and painting requirements.

616.2.2.2-Staking and Utilities Verify that utility locations have been thoroughly checked and marked and that any known conflicts have been resolved before the operation begins. Check to ensure that all pile locations have been properly staked in accordance with the Contract Plans.

616.2.2.3-Excavation and Embankments Where excavation or embankment construction is required, check the plan dimensions, depth, and height for compliance. Unless otherwise directed, excavation and embankment construction must be completed and accepted prior to driving foundation piles.

616.2.2.4-Welder Certification As needed for splice work, ensure that welders are prequalified for the work. Check each welder's certificate of qualification from the West Virginia Division of Highways. Ensure that the document complies with the minimum period of satisfactory performance for the type of welding to be performed. Retain a copy of all certificates of qualification.

616.2.3-Equipment Considerations

616.2.3.1-Selection and Acceptance Various types of drop hammers and power hammers are available for driving piles. They are generally operated by steam, diesel-oil combustion, or compressed air. Power hammers may be single acting or double acting. Energy-rating data for pile drivers can be obtained from the manufacturer of the equipment. Equipment selection depends on the type and size of piles to be driven. More than one type of driver may be required for the project.

Before pile driving is started, the Contractor shall provide written certification to the Engineer that the pile hammer, air compressor and air valves have been inspected and found to be in good working condition.

616.2.3.2-Drop Hammers A drop hammer may be used for driving steel or timber piles.

1. Hammer Weight. The hammer should weigh at least as much as the combined weight of the driving head and the pile. Obtain the actual hammer weight from the Contractor and make sure it meets the minimum specified requirements. As needed, use a certified scale to weigh the hammer and pile cap.
2. Hammer Drop. Hammer drop should not exceed 15' for steel piles. Greater drops, especially when a relatively heavy hammer is used, may injure the pile. The use of a relatively heavy hammer and lower fall will usually result in greater pile penetration per blow with less injury to the pile, because there is a greater blow rate and less chance for the soil to compact around the pile between blows. This is especially important in hard ground.
3. Hoisting Line. The hoisting line for a drop hammer must be mounted on a rotating drum that can turn freely for the full length of the hammer drop, and the line must be slack during the fall. If there is any drag of the cable, adjustment will be necessary.

616.2.3.3-Power Hammers Study the manufacturer's literature and become familiar with the operating characteristics of the power hammer. Ensure that the equipment is in good working order and properly adjusted for the specified rating (e.g., energy per blow, blows per minute).

The weight of the ram must bear the proper relation to the weight of the pile, and the ram must have the proper speed when it hits the pile.

The ram not only must strike the pile with enough energy to overcome the inertia of the pile and the resistance of the soil, but also must be heavy enough to avoid the loss of too much energy during the impact. There will be a great loss of energy if the ram causes damage to the top of the pile. As a general rule, piles should be driven with the heaviest available ram that can be used to obtain the greatest penetration without causing serious damage to the pile. Some manufacturers do not recommend the use of a ram that weighs less than one-fourth the weight of the pile.

For the first few piles, carefully watch the performance of the hammer. When adjusted properly, it should move through its full stroke for the required number of blows per minute. It is important to note that the pressure gage on the air compressor may not indicate the pressure delivered to the ram, due to leaks in valves, rings, bushings, and hoses. For this reason, compressors should be able to furnish 25% greater air pressure than that required at the ram. Nearly all manufacturer's literature specify number of blows per minute based on a mean effective air pressure of 80 psi.

Once started, the driving of a pile should be continuous. If stopped for a short period of time, the soil becomes compacted and increases frictional resistance around the pile and may cause pile damage when driving is resumed.

616.2.3.4-Pipe Caps and Driving Heads A driving head should be used on steel piles when driving conditions cause damage to the pile. Where a driving head is required, verify compliance with the manufacturer's recommendations. Hammer cushions and striker plates are typically used to ensure uniform driving behavior and minimize damage to the pile. Where required, verify conformance with respect to type and size. Extra pile cushions and striker plates should be on hand so that, if damaged, they can be quickly replaced.

616.2.3.5-Pile Driving Leads Leads are required for all pile driving operations. Pile driving leads are used to guide the movement of the hammer, thus ensuring the pile receives a concentric impact with each blow. It is essential that the fall of the hammer be in line with the pile; otherwise the head of the pile may be severely damaged, the hammer may be damaged, the energy of the hammer may be reduced, or the pile may change direction. Leads must be straight, true, rigid, and so constructed that free movement of the hammer is provided. The lead channels should be greased to prevent the hammer from sticking. Leads must be held in position by guys or stiff bracing to ensure support of the pile during the driving operation. The stiffness of the leads is an important factor in holding the pile in line, and this requirement must not be overlooked. The leads should be long enough to accommodate, at a minimum, the pile length and the length of the hammer. It is generally good practice to use a somewhat longer length as a contingency.

616.2.4-Pile Driving Considerations

616.2.4.1-Pile Preparation Before the pile is lifted to the leads, stretch a tape along the pile and place keel marks along its entire length at 1' intervals. From just below the anticipated depth of penetration to the top of the pile, the intervals of the marks should be every 1". At least every fifth mark should be numbered to show the distance from the pile tip.

616.2.4.2-Pile Location and Orientation Depending on the design requirement, the pile may need to be driven on a batter, or slope. The amount of batter will be designated on the Contract Plans. If a pile is to be driven on a batter, the leads and the path of the hammer must be set to the required batter. After the pile has been placed in the leads but before driving is started, the tip of the pile must be carefully placed in the correct location and orientation. As needed, a template should be used as a guide. Verify that the pile is set within tolerance of its designated location. Also, check the pile alignment for deviation from allowable tolerance. Where structural steel shapes are used, verify that flanges are oriented as designated on the Contract Plans.

If a pile for a bridge pier or abutment is found to be out-of-tolerance, give the Contractor the option of driving an offset pile or pulling and redriving the original pile. If the Contractor elects to drive an offset pile, it must be driven where the greater center-to-center spacing occurs. For example, an offset pile would not be required where the center-to-center spacing is less than the plan measurement. This procedure should be used as a guide when minor errors occur. Sound engineering judgment should be applied in selecting the location of offset piling. Complicated situations should be referred to the Engineering/Technical Support Division. For trestle bents, the Contractor will be required to pull and re-drive piles that exceed the ± 1.5" tolerance. The cost of the offset pile and the cost of any pile that is pulled and re-driven will be borne entirely by the Contractor.

616.2.4.3-Pile Penetration When driving first begins, the hammer should strike relatively light blows. After the pile has been driven approximately 3' into the ground, all guy lines and braces should be tightened, and the alignment of the pile should be checked before driving is continued at specification. During the operation, carefully monitor the location and alignment of each pile. Piles must be driven to virtual refusal into natural ground until the penetration per blow is at the specified limit. Penetration readings should be recorded often so that rate of penetration at various depths will be known. If the driving becomes difficult or if the pile begins to rebound, place 1" marks on the pile and carefully monitor the penetrations per blow. Document in Daily Work Report each pile that is driven.

616.2.4.4-Precautions and Driving Difficulties The following are precautions and common difficulties that are encountered during the driving of piles:

1. Springing/Bouncing. Watch for pile springing and hammer bouncing. Springing can occur where spliced members are not properly aligned, the pile head is not squared properly, or the pile and hammer are misaligned. Bouncing can occur where the pile has reached the point of virtual refusal, a hammer of insufficient weight is used, or too much steam or air pressure is used in double-acting hammers.
2. Changes in Direction. Watch the pile as it is driven for sudden changes in direction. This is a good indication that the pile has failed below the ground due to an obstacle. Near vertical rock strata can also contribute to this problem. In such cases, contact the Project Engineer/Supervisor for assistance. Corrective action may be necessary.

3. Sudden Changes in Penetration. Monitor the pile for sudden changes in penetration between blows. This usually indicates that the pile has failed or an unusually soft subsurface strata has been encountered. Sudden disappearance of the pile confirms the presence of a cavern or large void. In such cases, contact the Project Engineer/ Supervisor for assistance. Corrective action may be necessary.
4. Boulders/Rock Strata. Where a pile is driven in an area known to have boulders or varying rock strata, as indicated by boring logs, carefully monitor the operation for a sudden decease in the pile's penetration per blow. Such a rapid change can cause binding and an actual break in the pile. Care must be taken to avoid overdriving the pile. Contact the Project Engineer/Supervisor for assistance. Pre-drilling may be required.
5. Adjacent Piles. Where piles are driven close together into a layer of soft material below firmer soil, the driving of the piles tends to build up pressure in the soft layer. If the pressure becomes high enough, driving more piles will cause piles that have already been driven to push up. Such piles have little or no bearing value; and, if not corrected, serious settlement of a structure can occur. The elevation of the top of each pile in a footer should be determined just after the pile has been driven, and each elevation should be compared with the elevation of the corresponding pile after the driving of the whole group has been completed. Piles raised by the driving of nearby piles should be re-driven until the proper penetration per blow is obtained. No pile should be driven within 15' of a cast-in-place concrete pile until the concrete has fully cured.
6. Embankment Considerations. When an abutment is to be supported on an embankment and piles must be driven into the embankment, compaction of the embankment material to meet specified requirements can make penetration difficult. To prevent damage to the piles, pre-drilling may be necessary. In such cases, the uses of water jets is not permitted.

616.2.4.5-Cutting and Splicing Considerations If a pile has been driven and accepted, but its top is above the elevation shown on the Contract Plans, it may be cut off square with its longitudinal axis. Steel piles and steel reinforcing bars in cast-in-place concrete piles should be cut off with a gas torch.

On a trestle bent where the cut-offs of the several piles in the bent are on an inclined plane, because of skew or superelevation, special care must be taken in establishing the correct elevation and slope for each cut-off. The elevation will be determined by the location of the pile with respect to the reference line and the amount of superelevation. Each pile should be cut off so that there will be full and uniform bearing between the piles and the cap and so that the top of the cap will be at the correct elevation.

If a pile is found to be too short, or one has been cut off too low, it may be extended or rebuilt as approved by the Project Engineer/Supervisor. The Project Inspector must make sure that the work is performed in accordance with the Specifications..

616.2.5-Foundation Piles A foundation column is constructed of reinforced concrete and should rest on good rock or other firm material. The form for such a column is a thin steel shell that is drawn up as the concrete hardens. The shell may be provided in sections, but the bottom section of each shell must be placed in a pit that is excavated below the surrounding ground.

The Project Inspector must make sure that the bottom of each shell for a foundation column is in the correct position, and that the sections of the shell are aligned properly. Steel reinforcing bars of the required length must be set in the shell before any concrete is placed. The steel bars should extend above the top of the column at least to the height shown or specified for the lapping of bars.

Before any concrete is placed, the shell should be inspected for damage, and necessary steps should be taken to make it ready for receiving the concrete. Placing of the concrete, especially in the lower sections, must be carefully monitored by the Project Inspector. The Project Inspector should make sure that each shell has the full diameter, and that the shell is solidly filled with concrete. The concrete must be vibrated and cured properly.

616.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and nonroutine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments, to prepare the Diaries and DWRs. If in doubt as to whether information is important or beneficial, record it.

SECTION 617
RAILINGS

617.1-GENERAL REQUIREMENTS

617.1.1-Description of Work Section 617 of the Specifications governs the material and construction requirements for installing pipe railing, ferrous metal railing, and aluminum railing on a bridge, wall, or other structure. When Item 617 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 617 of the Specifications and as designated on the Contract Plans. See the Specifications for the method of measurement for payment.

617.1.2-Material Considerations Inspect the material upon arrival at the job site. Verify that all railing materials, elastomeric pads, grout, and other required materials conform to the requirements specified in Section 617.2 of the Specifications. Ensure that materials are supplied from a pre-approved DOH source, and document laboratory numbers from the shipping documents on the Daily Work Report. Do not accept damaged materials. Shipping documents shall be scan into ProjectWise.

617.2-INSPECTION GUIDELINES

Section 617 of the Specifications governs the criteria that should be used when inspecting railing installation. Consider the following additional guidelines:

1. Contract Documents. Review the Contract Plans and Specifications. Pay particular attention to the type and limits of railing, material requirements, and fastening details (e.g., hardware and bracket locations). Check if the Contractor is required to submit working drawings. If applicable, review the working drawings and become familiar with the fastening details.
2. Posts/Rail Installation. Check posts for proper location, alignment, and plumb tolerance. Check that the rails are rigidly braced and secured and that connections are tight and free of rattle and noticeable deflection. Check for proper installation and grouting of anchor bolts.
3. Fastening/Welding Considerations. Check to ensure that bolts are long enough to extend beyond nuts and that the thread extensions are oriented away from pedestrian and bicycle traffic (i.e., the smooth, round heads of carriage bolts will face pedestrians). Where welding is required, verify conformance with specified requirements. If timber members are used, the bolts should be recessed. Check hand and rub rails for projections and require immediate correction.
4. Electrolytic Isolation. Where dissimilar metals come into contact with each other, electrolytic isolation may be designated. If specified, verify the proper installation of electrolytic isolation where designated on the Contract Plans.

5. Painting. Where designated for non-galvanized pipe and steel railing, verify that the railing is properly prepared and painted with the designated color.
6. Final Inspection. After construction, ensure that all welds are ground smooth. Watch for burs and sharp edges from cutting, punching, drilling, and tapping and require rounding where needed. Check to ensure that any coating damage is properly repaired.

617.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments, to prepare the Diaries and DWRs. If in doubt as to whether information is important or beneficial, record it.

SECTION 619
WATERPROOFING

619.1-GENERAL REQUIREMENTS

619.1.1-Description of Work Section 619 of the Specifications governs the material and construction requirements for waterproofing concrete retaining walls, abutments, and earth-filled arches, either in the form of dampproofing or waterproofing membrane. When Item 619 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 619 of the Specifications and as designated on the Contract Plans. See the Specifications for the method of measurement for payment.

619.1.2-Materials Considerations Inspect all materials upon arrival at the job site. Verify that all primers, agents, membranes, fabrics, joint sealers, and other required materials conform to the requirements specified in Section 619.2 of the Specifications. Ensure that materials are supplied from a pre-approved DOH source, and document laboratory numbers from the shipping documents on the Daily Work Report.

619.2-INSPECTION GUIDELINES

619.2.1-Dampproofing Where designated on the Contract Plans, dampproofing of concrete surfaces will be governed by Section 619 of the Specifications. Consider the following additional guidelines:

1. Contract Documents. Review the Contract Plans and Specifications. Pay particular attention to the limits of treatment, type of material required, sampling and testing requirements, and the method and sequence of operation.
2. Weather Considerations. Know the limitations of application with respect to inclement weather, surface moisture, and temperature.
3. Concrete Curing. Check to ensure that the concrete has been cured before application of the treatment.
4. Surface Preparation. Before the treatment is applied, check to ensure that the concrete surface has been thoroughly cleaned and prepared as specified.
5. Primer Application. Verify conformance with respect to limits, method, number of coats, and rate of application.
6. Asphalt Dampproofing Application. Verify conformance with respect to timing, method, rate of application, and location.
7. Final Inspection. After the asphalt dampproofing has been applied, check for discoloring of concrete surfaces beyond the designated limits of treatment, and require the Contractor to properly clean the marred surfaces.

619.2.2-Waterproofing Membrane Section 619 of the Specifications governs the criteria that should be used when inspecting waterproofing membrane. Consider the following additional guidelines:

1. Contract Documents. Review the Contract Plans and Specifications. Pay particular attention to the limits of treatment, type of waterproofing designated, sampling and testing requirements, and the method and sequence of operation.
2. Weather Considerations. Know the limitations of application with respect to inclement weather, surface moisture, and surface and ambient temperatures. Pay particular attention to required drying periods.
3. Concrete Curing. Check to ensure that the age of the concrete complies with specified limits before application of the treatment.
4. Surface Preparation. Before the treatment is applied, check to ensure that the concrete surface has been properly prepared. Pay particular attention to the limits of cleaning (e.g., approach slabs, height of curb above asphalt overlay, height of bridge rail above deck, sidewalks), sequence, timing, and methods (e.g., sand blasting, shot blasting, power washing, sweeping). Where water-proofing membrane is designated, verify that rough surface areas that could puncture or create air pockets in the membrane have been corrected.
5. Primer Application. Where waterproofing membrane is designated, verify the limits (e.g., height of curb above asphalt overlay) and application rate for conformance with specified requirements.
6. Placement of Reinforced Membrane. Where designated, verify that reinforced membrane is properly placed. Check that the membrane is not placed too soon after primer application. Check the limits of placement (e.g., height of curb above asphalt overlay). Ensure that the membrane directs runoff toward curbs and drains. Watch for wrinkles and air bubbles, and enforce the Contract provisions with respect to repairing such defects. Pay particular attention to flashing and priming requirements where membrane is placed near expansion joints and drain pipes.
7. Placement of Elastomeric Membrane. Where elastomeric membrane is designated, check the limits of treatment and rate and thickness of application for compliance. If unacceptable, halt the work and require immediate adjustment.
8. Placement of Protective Covering. Protective covering is required where water-proofing membrane is designated. Do not permit any more membrane to be applied that can be properly covered in the same workday. Pay particular attention to the limits of covering and the required treatment of overlaps and joints.
9. Concrete Sealant Application. For protection, a respirator should be worn during the inspection of work involving concrete sealer. Verify the limits of treatment (e.g., height on bridge rails above bridge deck) and the application rate for conformance. Pay particular attention to mishandling and overspray of sealant material, and require immediate corrective action.
10. Final Inspection. Ensure that all corrective work to damaged waterproofing is completed as soon as practical. Immediately after the treatment has been inspected and accepted, notify the Contractor in writing of such approval and that the protective course can be placed. The protective course should be placed immediately upon

receipt of the notification. After a protective course has been placed over waterproofing membrane, coordinate with the Project Engineer/Supervisor for final inspection. It may be necessary to test the effectiveness of the waterproofing system under the protective course. Where such testing is performed and the results fail to meet specified acceptance criteria, enforce the provisions of the Contract with respect to removal and replacement. Once final inspection has been completed, provide the Contractor with written notification of acceptance.

619.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers from the shipping documents, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments, to prepare the Diaries and DWRs. If in doubt as to whether or not information is important or beneficial, record it.

SECTION 620
THREE-SIDED REINFORCED CONCRETE BRIDGE/CULVERT

620.1-GENERAL

620.1.1-Description of Work Section 620 of the Specifications governs the material and construction requirements for three-sided reinforced concrete bridge/culvert. When Item 620 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 620 of the Specifications and as designated on the Contact Plans. See the Specifications for the method of measurement and payment.

620.1.2-Materials Considerations Inspect all materials upon arrival. Verify that all materials conform to the requirements specified in Section 620.5 of the Specifications. Ensure that materials are supplied from pre-approved DOH sources, as applicable, and document laboratory numbers from the shipping documents on the Daily Work Report.

620.2-INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for three-sided reinforced concrete bridge/culvert is in conformance with the construction methods and details specified in Section 620 of the Specifications. Pay particular attention to the design and submission criteria and the requirements for precast three-sided bridge/culvert and cast-in-place reinforced concrete.

620.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments. If in doubt as to whether or not information is important or beneficial, record it.

SECTION 623
PNEUMATICALLY APPLIED MORTAR OR CONCRETE (SHOTCRETE)

623.1-GENERAL REQUIREMENTS

623.1.1-Description of Work Section 623 of the Specifications governs the material and construction requirements for applying pneumatically applied mortar, or shotcrete. When Item 623 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 623 of the Specifications and as designated on the Contract Plans. See the Specifications for the method of measurement for payment.

623.1.2-Materials Considerations Inspect all materials upon arrival at the job site. Verify that the shotcrete and reinforcing steel, as applicable, conform to the requirements specified in Section 623.2 of the Specifications. Ensure that materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Daily Work Report.

623.2-INSPECTION GUIDELINES

Section 623 of the Specifications governs the criteria that should be used when inspecting pneumatically applied mortar. Pay particular attention to the requirements for:

1. Proportioning and Mixing,
2. Surface Preparation,
3. Reinforcing for Concrete Repairs,
4. Reinforcement for Structural Steel,
5. Shotcrete Thickness,
6. Joint and Form Requirements and
7. Finishing And Curing.

Shotcrete is applied to many types of surfaces for various reasons, including:

1. Repairing Concrete Structures,
2. Providing a Protective Covering for Steel Members,
3. Providing a Finishing Coat on Concrete and Masonry Surfaces,
4. Pointing Joints in masonry, and
5. Minimizing deterioration of shale surfaces.

The mortar mix for shotcrete uses air-entrained cement, and the application equipment must be capable of applying the mix uniformly from a mixing nozzle with such speed that nearly all of the mortar will stick to the surface to be covered. Little to no mortar should rebound from the surface. Where steel beams and columns are to be treated, welded wire fabric is first secured to the steel members in the desired shape. The fabric will not be in contact with the steel member;

rather, it will be approximately 0.75" away from the members surface. If a thick covering of shotcrete is needed to build up part of a structure, more than one layer of reinforcement may be necessary.

A surface to be covered with shotcrete must be clean. Shotcrete is applied in thin layers. The equipment for applying the shotcrete should be adjusted so that the moisture content of the mortar, the pressure at the nozzle, and the speed of the stream shot from the nozzle conform to specified requirements. Adjustments must be approved by the Project Engineer/Supervisor and be made before the final coat of mortar is applied. If it is necessary to hold the nozzle so close to the surface to be coated that too much material rebounds at the specified pressure, the pressure should be reduced. After the final coat, a curing compound is typically applied to the shotcrete. Caution should be used when shotcrete is being applied near surfaces that are not to be coated to prevent material that rebounds from marring the surface. Shotcrete may be applied in cold weather with written permission of the Project Engineer/Supervisor; however, heating equipment, housing, and other protection must be provided.

623.3-RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector’s Daily Work Report all information (e.g., laboratory numbers, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments, to prepare the Diaries and DWRs. If in doubt as to whether or not information is important or beneficial, record it.

SECTION 624
PREFORMED ELASTOMERIC JOINT SEALER

624.1-GENERAL

624.1.1-Description of Work Section 624 of the Specifications governs the material and construction requirements for furnishing and installing performed elastomeric joint sealer. When Item 624 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 624 of the Specifications and as designated on the Contact Plans. See the Specifications for the method of measurement and payment.

624.1.2-Material Considerations Inspect all materials upon arrival. Verify that all materials conform to the requirements specified in Section 624.2 of the Specifications. Ensure that materials are supplied from pre-approved DOH sources, as applicable, and document laboratory numbers from the shipping documents on the Daily Work Report.

624.2-INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for furnishing and installing performed elastomeric joint sealer is in conformance with the construction methods and details specified in Section 624 of the Specifications. Pay particular attention to the preparation of the joint and installation.

624.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments. If in doubt as to whether information is important or beneficial, record it.

SECTION 625
ROCK SOCKETED DRILLED SHAFT

625.1-GENERAL REQUIREMENTS

625.1.1-Description of Work Section 625 of the Specifications governs the material and construction requirements for rock socketed drilled shaft. When Item 625 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 625 of the Specifications and as designated on the Contract Plans. See the Specifications for the method of measurement for payment.

625.1.2-Materials Considerations Inspect all materials upon arrival at the job site. Verify that concrete, reinforcement, casing, and other required materials conform to the requirements specified in Section 625.5 of the Specifications. Ensure that materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Daily Work Report.

625.2-INSPECTION GUIDELINES

Drilled shafts are relatively large-diameter, underground columns of reinforced concrete that are constructed in pre-drilled holes to provide foundation support for structures. They are designed to transfer and distribute structural loads to underlying support strata or bedrock (i.e., an end-bearing design). In general, rock socketed drilled shaft construction consists of drilling a hole at a designated location, depth, and diameter; constructing and placing a cage of reinforcing steel; and placing and finishing concrete to the elevation required by the foundation details of the Contract Plans. Each rock socketed drilled shaft consists of an upper drilled shaft portion in a steel cage and a lower rock socket portion. Consider the following inspection guidelines:

625.2.1-Preliminary Considerations Prior to the construction of rock socketed drilled shaft, consider the following guidelines:

1. Contract Plans and Specifications. Review the Contract Plans and Specifications with respect to the requirements for testing, drilling equipment, materials for reinforcing steel and concrete, and caisson location, depth, diameter, and elevation. Pay particular attention to the operation sequence and dewatering requirements.
2. Drilled Shaft Location/Utilities. Verify that utility locations have been thoroughly checked and marked and that any known conflicts have been resolved before the operation begins. Check to ensure that all drilled shaft locations have been properly staked in accordance with the Contract Plans.
3. Boring Log/Geological Reports. Review the boring log and geological reports. Become familiar with the appearance of the type of material anticipated at the depth of the bearing strata. On many projects, the Contract Documents require the Division to perform pre-installation core holes.

4. Equipment. Verify that a heavy-duty drilling rig in good operating condition is provided for the work. The rig must be capable of drilling to the required depth and penetrating the underlying bearing material or bedrock.
5. Blasting. The use of explosives for rock socketed drilled shaft construction is generally not permitted.
6. Materials. Check to ensure that the type of reinforcing steel and class of concrete conforms to specified requirements. Where steel casing is required, verify conformance with respect to wall thickness, strength, diameter, and condition.
7. Alternative Methods. If methods other than those discussed in this Section are proposed, verify that the Project Engineer/Supervisor has reviewed the Contractor's step-by-step procedures prior to beginning the operation, and ensure that the Contractor performs the work as proposed.

625.2.2-Drilling Operation Where holes are drilled for rock socketed drilled shaft, consider the following:

1. Location. Check the location of the center of the shaft to ensure it is within allowable tolerance from that designated on the Contract Plans.
2. Depth of Embedment. The designated bottom elevation is an approximation only, which may be revised by the Project Engineer/Supervisor to ensure proper load bearing capacity. Document the depth drilled into the target bearing strata, and compare the excavated material with geological information to ensure that adequate bearing material has been reached.
3. Diameter/Sides. Check the hole diameter and sides to ensure compliance to size, vertical orientation, and allowable tolerance. This may be accomplished during the miniCID inspection device. Where caving is encountered, halt the operation until the situation can be evaluated and corrected. Contact the Project Engineer/Supervisor for assistance. Protective steel casing may be needed.
4. Excavated Material/Cleaning. Verify that excavated material is disposed of properly. Check to ensure that the hole is dewatered and cleaned of all loose material. The Inspector should verify that the bottom of the hole is clean and flat. If dewatering is not practical, the provisions of the Contract with respect to placing concrete under water will govern. If it is necessary to enter the hole for inspection purposes, ensure that the Contractor provides steel shoring, proper ventilation, electric lighting, and a suitable means of access.
5. Protective Covers. Once the hole has been accepted, verify that protective covering is installed to prevent persons and materials from falling into the hole.
6. Shale/Rock Considerations. Where a drilled shaft is to be socketed into shale or rock, the reinforcing cage, support system, and concrete must be placed within the specified time limit after drilling. If the limit is exceeded, require the Contractor to drill the specified additional depth into the shale just prior to placement of the concrete, and verify that the reinforcement cage is adjusted to the new depth.

625.2.3-Drilled Shaft Reinforcement/Steel Casing Rock socket drilled shaft reinforcement generally consists of a single-unit cage of reinforcing steel with Crosshole Sonic Logging (CSL) tubes and/or Thermal Integrity Profiler (TIP) wires attached for testing. The cage must be inspected prior to being placed into the drilled hole. Consider the following:

1. Cage Construction. Inspect the cage for proper bar size, spacing, and fastening. Check the cage height and diameter for conformance. Where required, verify that splices are reviewed by the Project Engineer/Supervisor. Document the number of splices.
2. Steel Casing. Where designated or as directed, ensure that the proper size of steel casing is installed and properly oiled prior to placement of the cage, support system, and concrete.
3. Installation Timing. After the hole and cage have been inspected, the cage and support system must be installed in the hole just prior to pouring concrete. If the concrete is not immediately poured, require removal of the cage, re-inspect the hole for loose material, and check the surface condition of the steel for acceptability. Where required by the plans or specifications, Crosshole Sonic Logging (CSL) and/or Thermal Integrity Profiler (TIP) wire may be used. See Section 625.6.2 of the Specifications.
4. Support System. A support system must be provided so that the cage does not sit on the bottom nor lean against the wall of the hole. Check bottom and side clearances. Check conformance with respect to the number and interval of spacers along the length of the cage. Verify that the support system does not rack or skew the cage, and require additional steel as needed to stiffen the cage.

625.2.4-Concrete Placement Acceptability of the placement method used for concrete will depend on whether or not the hole is considered dry or wet. If the depth, without pumping, is less than 12″ over a 1-hour period, the hole may be considered dry for the purpose of method approval. Otherwise, the hole should be considered wet. Consider the following guidelines:

1. Dry-Hole Placement. Where the hole is dry, the concrete may be poured continuously in a free fall from the surface with the use of a hopper or approved device. Check to ensure that the concrete does not hit the reinforcing cage nor the sides of the hole on the way down.
2. Wet-Hole Placement. For wet holes, the Project Engineer/Supervisor must review the proposed method of placement. See Section 625.6.3 of the Specifications.
3. Steel Casing. Unless otherwise designated or directed, the steel casing will be removed from the drilled shaft. Where removal is impractical or will cause damage to the rock socketed drilled shaft, contact the Project Engineer/Supervisor for assistance. It may be necessary to leave the steel casing in place. In such cases, ensure that the top of the casing is cut by an approved method to the designated elevation. Ensure that additional concrete is placed, and monitor the elevation of the reinforcing cage and final drilled shaft surface for compliance. Reject the rock socketed drilled shaft if movement or settlement exceeds specified limits.
4. Key Construction. Where designated on the Contract Plans, verify compliance of the key constructed at the top of the rock socketed drilled shaft.
5. Concrete Curing. Check that the top surface of the concrete is properly cured. Pay particular attention to the curing material and curing period used.

6. Adjacent Construction. Where work for foundation piles, excavation, or drilled shaft is to be performed adjacent to the freshly poured rock socketed drilled shaft, check compliance with respect to minimum lateral clearance and compressive strength requirements.
7. Final Inspection. After the rock socketed drilled shaft has been constructed, check the top elevation of the drilled shaft for compliance to that designated on the Contract Plans. Verify that the projecting reinforcing steel is in the correct location and properly cleaned of mortar. See Section 625.7.2.6 of the Specifications regarding requirements for CSL testing where required by the plans or specifications.

625.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers from the shipping documents, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments, to prepare the Diaries and DWRs If in doubt as to whether or not information is important or beneficial, record it.

SECTION 626
RETAINING WALL SYSTEMS

626.1-GENERAL REQUIREMENT

626.1.1-Description of Work Section 626 of the Specifications governs the design, material, and construction requirements for cast-in-place reinforced concrete or mechanically stabilized earth retaining wall systems. When Item 626 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 626 of the Specifications and as designated on the Contract Plans. See the Specifications for the method of measurement for payment.

626.1.2-Materials Consideration Inspect all materials upon arrival at the job site. Verify that all materials conform to the requirements specified in Section 626.5 of the Specifications. Ensure that system materials are supplied with shipping documents or from pre-approved DOH sources, as appropriate. Document laboratory numbers on the Daily Work Report. Pay particular attention to the requirements for concrete mix design, modular block production, reinforcement, geosynthetics, select granular backfill, quality control sampling and testing, and acceptance.

626.1.3-Design Submittals
The Contractor is responsible for submitting detailed design and construction plans for the wall design selected and approved by the Division. The design will be based on the criteria defined in Section 626.3 of the Specifications.

626.2-INSPECTION GUIDELINES

Section 626 of the Specifications governs the criteria that should be used when inspecting retaining wall systems. Pay particular attention to the requirements for foundation preparation, erection, and placement of backfill material for mechanically stabilized earth walls and the requirements for architectural formwork for cast-in-place reinforced concrete walls.

626.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments, to prepare the Diaries and DWRs. If in doubt as to whether information is important or beneficial, record it.

The Contractor is responsible for submitting detailed design and construction plans for the wall design selected and approved by the Division. The design will be based on the criteria defined in Section 626.3 of the Specifications.

SECTION 631
ELECTRICAL WORK

631.1-GENERAL REQUIREMENTS

631.1.1-Description of Work Section 631 of the Specifications governs the material and construction requirements for electrical work. When Item 631 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 631 of the Specifications and as designated on the Contract Plans. See the Specifications for the method of measurement for payment.

631.1.2-Materials Considerations Inspect all materials upon arrival at the job site. Verify that all materials conform to the requirements specified in Section 631.2 of the Specifications. Ensure that materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Daily Work Report.

631.2-INSPECTION GUIDELINES

Section 631 of the Specifications governs the criteria that should be used when inspecting electrical work. The Project Inspector needs to verify that all workmanship for electrical work on WVDOH projects is performed in accordance with the Contract Plans, the current edition of the National Electric Code, and the governing local requirements.

631.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments, to prepare the Diaries and DWRs. If in doubt as to whether information is important or beneficial, record it.

SECTION 632
HORIZONTAL DRAINS

632.1-GENERAL

632.1.1-Description of Work Section 632 of the Specifications governs the material and construction requirements for furnishing and installing horizontal drains. When Item 632 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 632 of the Specifications and as designated on the Contact Plans. See the Specifications for the method of measurement and payment.

632.1.2-Materials Considerations Inspect all materials upon arrival. Verify that all materials conform to the requirements specified in Section 632.2 of the Specifications. Ensure that materials are supplied from pre-approved DOH sources, as applicable, and document laboratory numbers from the shipping documents on the Daily Work Report.

632.2-INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for furnishing and installing horizontal drains is in conformance with the construction methods and details specified in Section 632 of the Specifications. Pay particular attention to the drilling, installation of horizontal drain pipe, terminal chamber installation, and collector pipe installation.

632.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments. If in doubt as to whether information is important or beneficial, record it.

SECTION 633
CONCRETE GUTTER AND DUMPED ROCK GUTTER

633.1-GENERAL

633.1.1-Description of Work Section 633 of the Specifications governs the material and construction requirements for surface drainage, using concrete gutter, dumped rock gutter, or grouted dump rock gutter. When Item 633 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 633 of the Specifications and as designated on the Contact Plans. See the Specifications for the method of measurement and payment.

633.1.2-Materials Considerations Inspect all materials upon arrival. Verify that all materials conform to the requirements specified in Section 633.2 of the Specifications. Ensure that materials are supplied from pre-approved DOH sources, as applicable, and document laboratory numbers from the shipping documents on the Daily Work Report.

633.2-INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for surface drainage, using concrete gutter, dumped rock gutter, or grouted dump rock gutter is in conformance with the construction methods and details specified in Section 633 of the Specifications.

633.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments. If in doubt as to whether information is important or beneficial, record it.

SECTION 636
MAINTAINING TRAFFIC

636.1-GENERAL REQUIREMENTS

636.1.1-Description of Work Section 636 of the Specifications governs the material and construction requirements for maintaining and protecting traffic during construction, protecting construction personnel and the work in progress, and protecting adjacent property from excessive dust. When Item 636 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 636 of the Specifications and as designated on the Contract Plans. See the Specifications for the method of measurement for payment.

636.1.2-Materials Considerations Inspect all materials upon arrival. Verify that all traffic control devices, flaggers, pilot trucks, signs, temporary pavement marking materials, materials for temporary structures, aggregate for temporary roads. and dust palliatives conform to the requirements of the Specifications. Ensure that materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping document on the Daily Work Report.

A notarized Letter of Certification from the Contractor for all traffic control items is required.

636.1.3-Traffic Control Plan

636.1.3.1-Content and Purpose The Division expects the Contractor to implement the Traffic Control Plan that is specified in the Contract. The Traffic Control Plan will address the following:

1. Safety and convenience of the traveling public;
2. Protection of construction personnel and the work in progress;
3. Methods of handling traffic for all phases of construction;
4. Temporary structures, temporary roads, and application of dust palliatives;
5. Contractor and subcontractor activities; and
6. Schedules, deliveries, and project time restrictions.

The method of handling traffic required for each construction phase will depend on the type of construction to be performed.

636.1.3.2-Revision and Review If the Contractor desires to implement a Traffic Control Plan different than the one specified, the proposal must be submitted to the Project Engineer/Supervisor for review prior to implementation. The Traffic Control Plan will be reviewed to ensure compliance with the requirements of Section 636 of the Specifications, Standard Detailed Drawings, and the WVDOH publication Manual on Temporary Traffic Control for Streets and Highways. Methods of handling traffic, specifically, will be evaluated for their adequacy of protecting workers, motorists, pedestrians, and bicyclists during construction. The Traffic Control Plan will also be review as follows:

1. Speed Reductions. As practical, each method of handling traffic in the Traffic Control Plan should allow the facility to operate without reducing the speed of the facility. If a speed reduction is requested, ensure that the proposed reduction is consistent with Division policy and is authorized in writing by the Traffic Engineering Division and the Contract Administration Division.
2. Emergency Vehicle Access. Ensure that the Traffic Control Plan adequately addresses emergency vehicle access.
3. Traffic Control Devices and Flaggers. Do not approve a method of handling traffic that includes unnecessary devices or flaggers. The WVDOH Manual on Temporary Traffic Control for Streets and Highways and Part 6 of the Manual of Uniform Traffic Control Devices specifies the type, number, location, and arrangement of devices and flaggers that are acceptable for use in construction applications. Occasionally, Contractors will propose more devices and flaggers than are warranted, making a false assumption that such practice will provide additional safety. On the contrary, such practice can be a detriment to safety at an additional cost. Too many devices and flaggers can cause confusion, render other control measures ineffective, and exacerbate the hazard potential. If a Contractor insists on using unnecessary traffic control, contact the Regional Construction Engineer for immediate assistance.
4. Pedestrian and Bicycle Traffic. Verify that the Traffic Control Plan adequately provides for pedestrian, bicycle, and other non-motorized traffic, if applicable. Check that bicycle and recreational trail detours have been correctly identified and signed.
5. Access and Crossovers. Verify that the Traffic Control Plan provides adequate access for construction and maintenance traffic, including turnaround locations. Ensure that median crossings and crossovers comply with the requirements of the Contract.
6. Restrictive Clearances. Where the Traffic Control Plan includes detours and construction activities at bridge structures, verify that the appropriate signing has been provided and check for restrictive vertical and lateral clearances. If a vertical clearance of less than 16.5' or if a restriction to the normal lane width of 12' is necessary, verify that the condition is appropriately signed and notify the Traffic Engineering Division and Contract Administration Division. Include the following information in the body of the message:
   a. "RE: RESTRICTION ALERT,"
   b. Highway number,
   c. Beginning mile post for the restriction,
   d. Ending mile post for the restriction,
   e. Direction of travel that is restricted,
   f. Restriction description (e.g., vertical, lateral),
   g. Beginning date and approximate time of restriction, and
   h. Name and phone number of contact for the project restriction.

Note that the ending date of the restriction is an approximation. Although, the restriction will not be removed from the report until notification of the end of the project, an estimate assists permit writers to answer queries about the restriction. Provide the Traffic Engineering Division and Contract Administration Division with as much advance notice as practical to properly notify permit holders. In addition, notify the Traffic Engineering Division and Contract Administration Division when the restriction may be lifted.

636.1.4-Traffic Control Supervisor In accordance with Section 636 of the Specifications, the Contractor is responsible for providing a Traffic Control Supervisor. Traffic Control Supervisor is a person who will monitor the method and devices used for traffic control during the project. The Traffic Control Supervisor will be thoroughly familiar with the WVDOH Manual on Temporary Traffic Control for Streets and Highways. If noted on the plans, this person will have passed an American Traffic Safety Service Association (ATSSA) training course on this subject or demonstrate equal qualifications, for approval by Project Supervisor. After traffic control devices are installed for the active method of handling traffic, the Traffic Control Supervisor will inspect the devices frequently to ensure that they are located and maintained properly and are conveying the proper message for the intended application. The Traffic Control Supervisor will have the authority to take all actions necessary for the safe control of traffic through the work zone. The Contractor is responsible for providing the Project Engineer/Supervisor with the telephone number of the Traffic Control Supervisor, and approved designee, for use in the event of emergencies or crashes at night or on weekends. The Traffic Control Supervisor is responsible for the following:

1. Communication Responsibilities. The Traffic Control Supervisor will manage traffic control on a 24-hour-per-day basis. The required minimum level of communications include:
   a. Prime Contractor. The Traffic Control Supervisor will communicate with the Prime Contractor to determine what traffic control measures need to be provided by subcontractors and material suppliers.
   b. Local Agencies. The Traffic Control Supervisor will inform local police and fire agencies of any lane closures or delays. Regular updates are required as operations change.
2. Emergency Contact Numbers. The Traffic Control Supervisor will provide emergency contact numbers of Contractor and WVDOH personnel to local police and fire agencies. This allows the proper project personnel to be notified in case of an emergency on the project during working or non-working hours.
   a. Response Time. During non-working hours, the Traffic Control Supervisor, or approved designee, will respond to the site as soon as practical, desirably within 1 hour of notification.
3. Project Meetings. The Traffic Control Supervisor will attend all project scheduling meetings. This will ensure that the Traffic Control Supervisor is properly informed of the planned operations so that the proper method of handling traffic can be implemented for the new phase of construction. Any conflicts in traffic control between subcontractors should be addressed at project scheduling meetings.
4. Inspection Duties. The Traffic Control Supervisor, or approved designee, will inspect traffic control devices on each calendar day that they are in use, masked, or turned away from traffic. This includes weekends, especially on high-speed, high-volume

facilities. These inspections will include at least one nighttime inspection per week. Verify that the proper type and number of are located and arranged as designated for the active method of handling traffic. Check devices for damage, undesirable location, and acceptable visibility. Ensure that lights and flashing beacons are functioning properly. Supervise the cleaning of devices as frequently as necessary to preserve legibility and retroreflectivity. All devices must be cleaned a minimum of once every week. Deficiencies should generally be corrected within 24 hours.

Although the Project Engineer/Supervisor and Project Inspector indirectly assist the Traffic Control Supervisor, their duties primarily are to ensure that the Traffic Control Plan, methods of handling traffic, and traffic control devices are in conformance with the governing Contract documents. The Project Inspector should regularly check the following items and note them in DWR:

a. Date and time of inspection;
b. Project number;
c. List of flaggers and hours;
d. Uniformed traffic control hours used;
e. Method of handling traffic used;
f. Weather conditions;
g. Interference with normal traffic flow,
h. Detours in use;
i. Work performed by prime contractor, subcontractors, or utility companies;
j. Location of flagging stations and flagging hours,
k. Problems encountered and corrections made;
l. Crashes or other incidents involving the traveling public;
m. Types and quantities of traffic control devices used;
n. Maintenance or cleaning performed on the traffic control devices; and
o. Any unusual conditions or problems encountered during the day.

5. Relief flagging. The Traffic Control Supervisor should not act as a flagger, except in emergency situations or when it is necessary to relieve the stationed flagger for lunch breaks and rest periods. Relief flagging should be performed only when such action will not interfere with the normal duties of the Traffic Control Supervisor; otherwise, another certified flagger must be provided.

636.1.5-Work Zone Pre-Survey A Work Zone Pre-Survey may be performed to minimize traffic disruption caused by temporary repair work on pavements and bridge decks and to evaluate methods of handling traffic during construction on high-speed, high-volume facilities. A high-speed, high-volume facility is an Interstate highway, APD corridor highway, fully-controlled access highway, or an expressway having a speed limit of 45 mph or greater. The objectives of the Work Zone Pre-Survey are to:

1. Evaluate the structural strength of the existing pavement and its ability to carry the projected traffic loads during construction;
2. Evaluate the condition of drainage structures within the construction area;

3. Check for any evidence of bridge deterioration; and
4. Evaluate the methods of handling traffic for each phase of construction.

Based on the findings of the Work Zone Pre-Survey, the review team will forward recommendations to the Traffic Engineering Division and the Contract Administration Division regarding any needed revisions to the Traffic Control Plan or sequence of construction.

636.1.6-Flagger Certification All flaggers must be certified by passing an American Traffic Safety Service Association (ATSSA) training course on this subject. The Contractor may use noncertified flagger for their benefit, ease of operations, or other activities not receiving payment.

636.2-INSPECTION GUILD LINES

Coordination and advance planning by the Contractor, Project Engineer/Supervisor, Project Inspector, and Traffic Control Supervisor are required to provide for the safe and efficient maintenance and protection of traffic through and adjacent to the work area during construction. A practical effort must be made to reduce hazards and inconvenience to the traveling public and to adequately protect project personnel. Once construction has started, both WVDOH and Contractor personnel must continually monitor the construction area and immediately report potentially hazardous situations for correction. The topic of work zone traffic control will be thoroughly addressed at the Preconstruction Conference and during the Work Zone Pre-Survey. The Project Inspector must record daily in the Daily Work Report and Traffic Control Worksheet the implementation and condition of the traffic control provided for the construction operation.

636.2.1-Contract Documents Check that current versions of the WVDOH Manual on Traffic Control for Streets and Highways, FHWA Manual of Uniform Traffic Control Devices, including up-to-date revisions, Contract Plans, Specifications, Special Provisions, Standard Detailed Drawings, Traffic Control Plans, and detour plan and profile sheets are readily available at the job site. The Traffic Control Supervisor should have their own copy of these documents.

636.2.2-Speed Reduction Verification Where the method of handling traffic requires a speed reduction, verify that the speed reduction has been authorized by the Traffic Engineering Division. Requirements will be spelled out in contract documents.

636.2.3-Personnel Certification Checks Ensure that the Traffic Control Supervisor and all flaggers possess the specified American Traffic Safety Services Association certifications. Where applicable, check that certification cards match the person. Know if certifications require renewal during the course of the project.

636.2.4-Emergency Contact Numbers Verify that 24-hour emergency telephone numbers are provided for the Traffic Control Supervisor and response personnel. Ensure that the appropriate Contractor and WVDOH telephone numbers are posted and provided to local agency dispatchers.

636.2.5-Crash Incident Reporting For the purpose of assessing needed improvements and to protect WVDOH from claims and lawsuits, crashes that occur within the construction area must be thoroughly documented on the Daily Work Report or Diaries. Ensure that the proper authorities have been contacted. The WVDOH Fatal Crash Review Team and FHWA representatives may need to be contacted. Particularly note on the form any property damage, loss-of-life, or school bus involvement. Also note whether the method of handling traffic and traffic control devices were in compliance at the time of the incident. This will be used to assess the likelihood that traffic control was a contributing factor. Any needed corrections to traffic control should be performed immediately. The application of a revised method or the installation of replacement barriers, attenuators, and breakaway signposts may need to be considered.

636.2.6-Traffic Control Supervisor Verify that the Traffic Control Supervisor is available, appropriately dressed in reflectorized clothing, and is performing and documenting the required daytime, nighttime, and weekend inspections. Verify that device cleaning and maintenance activities are being properly supervised. Ensure that that any reported traffic control deficiencies have been corrected in a timely manner.

636.2.7-Flaggers and Traffic Directors The flaggers and traffic director are furnished by the Contractor. Check flaggers for compliance. Verify that flaggers are wearing hard hats and vests of the proper type, that the "Stop/Slow" paddles are the correct size and shape, and that the flaggers' clothing and equipment are properly reflectorized for nighttime operations. Check that proper flagging methods are being used. Check that the flaggers are facing and visible to oncoming traffic, the proper distance in advance of the work, and that the flagger stations are properly illuminated during nighttime operations. Note that the flagger and traffic director are separate functions. The traffic director will be an off-duty uniformed police officer in a properly identified police vehicle, who will be positioned in accordance with the method of handling traffic.

636.2.8-Stockpiled Materials If construction materials are stockpiled, they must not interfere with traffic operations or sight distance. Stockpiled materials must be located so that they will not interfere with traffic through or adjacent to the work area. Stockpiles and construction parking areas must be located a minimum of 30' from the edge of the traveled roadway, unless placed behind an acceptable protective barrier. No materials or equipment should remain on the traveled roadway, median area, or shoulder at the end of the work day.

636.2.9-Traffic Control Devices Traffic control devices are used to warn the traveling public of hazards, advise them of the proper path through the work zone, delineate areas where they may not operate, and separate them from construction workers. Traffic control devices include:

1. Temporary pavement markings;
2. Construction signs;
3. Drums, cones, and delineators;
4. Flashers and warning lights;
5. Electric arrow, changeable message signs; and speed monitoring trailer;
6. Temporary traffic signals and temporary lighting;
7. Temporary guardrail, temporary barrier, and temporary impact attenuators; and
8. Pilot trucks and shadow vehicles.

Traffic control devices will be installed based on the requirements of the method of handling traffic for the active phase of construction. The traffic control devices installed must be fabricated and placed in accordance with the WVDOH Manual on Traffic Control for Streets and Highways. These devices must be installed prior to construction and must remain in place as long as they are warranted; otherwise, they must be removed or obscured.

636.2.9.1-Maintenance of Devices Temporary traffic control devices are subject to wear during use, storage, shipment, installation, relocation, and removal. A large number of worn devices on a project is unacceptable. Maintenance of traffic control devices includes keeping them in good condition, correct position, and free from being obscured by weeds, brush, trees, materials, and equipment. Assessments should be made while the devices are in storage before use on the project, during initial set up, and periodically during the life of the project. Ensure that all traffic control devices are cleaned, as needed, based on the results of weekly inspections. The Project Engineer/Supervisor or Project Inspector should make at least one nighttime inspection every time a new method of handling traffic is implemented to assess conformance.

636.2.9.2-Pavement Markings Pavement markings that conflict with the desired traffic movement must be eradicated as soon as practical prior to shifting traffic. Temporary pavement markings that are used to delineate pavement lane and edge lines will be either temporary reflectorized pavement marking tape or reflectorized paint. Temporary raised pavement markers may be used as an alternate to temporary paint or to temporary tape. Check that temporary pavement striping and raised pavement markers are installed consistent with the requirements of the active method of handling traffic, the Manual on Traffic Control for Streets and Highways, Sign Fabrication Manual, and the Standard Detailed Drawings.

636.2.9.3-Construction Signing Inspect construction signing for proper installation and satisfactory condition. Consider the following:

1. Contract Documents. Ensure that signs conform to the active method of handling traffic in the Traffic Control Plan, the WVDOH Manual on Traffic Control for Streets and Highways and Sign Fabrication Manual, and the Standard Detailed Drawings. Pay particularly attention to compliance of size, shape, and color; reflective sheeting; and location.
2. Sign Condition. Check that the signs are clean, legible, and in good repair.
3. Breakaway Bases. Check for required breakaway bases on post mounted signs or proper placement behind protective barrier.
4. Temporary Signs. Check that temporary signs are properly weighted, mounted, and at the correct height.
5. Stored Signs. Signs that are not in use should be properly stored. Check that signs are:
    a. Laying flat, including the base;
    b. Beyond the shoulder;
    c. Outside the normal roadside recovery area; and

   d. Not on landscaped areas or sidewalks.
6. Conflicting Signs. Ensure that conflicting permanent signs are properly masked.

636.2.9.4-Channelizing Devices Verify that channelizing devices conform to the active method of handling traffic in the Traffic Control Plan, the WVDOH Manual on Temporary Traffic Control for Streets and Highways, and the Standard Detailed Drawings. Pay particular attention to the following:

1. Correct dimensions and clean serviceable condition;
2. Proper retroreflectorized sheeting or collars;
3. Correct placement with proper taper lengths and spacing;
4. Proper and functioning warning lights that are set in the correct mode; and
5. Weighting by acceptable methods.

636.2.9.5-Electric Arrow, Changeable Message Signs, Speed Monitoring Trailer Ensure that electric arrow, changeable message signs, speed monitoring trailer, and portable message signs are in the correct location and functioning properly. Check these devices for:

1. Properly working lights in the correct mode and/or message;
2. Proper automatic dimming at night; and
3. Correct panel size mounted at the correct height.

Note that these devices are located behind the channelizing devices or barriers away from moving traffic in such a manner that their visibility is not reduced or obscured. Check the active method of handling traffic in the Traffic Control Plan for proper location.

636.2.9.6-Temporary Barriers and Guardrail Check that temporary barriers and temporary guardrail are installed in accordance with the active method of handling traffic, Contract Plans, Standard Detailed Drawings, and Specifications. Pay particular attention to the following:

1. Location of face of barrier and guardrail;
2. Cross section shape and height of barrier and rail;
3. Guardrail post spacing, especially at transitions;
4. Fixed object clearance behind face of guardrail;
5. Connections between sections;
6. Transitions between barrier and guardrail;
7. Parabolic flares and end treatments; and
8. The color and retroreflectorization of delineators and sheeting.

Verify the proper removal and resetting of temporary barriers and temporary guardrail when the method of handling traffic changes to accommodate a subsequent construction phase.

636.2.9.7-Temporary Impact Attenuators Ensure that impact attenuators are properly located and installed according to the active method of handling traffic, Contract Plans, Standard Detailed Drawings, and Specifications. Pay particular attention to the weight, quantity, and type of material placed in barrels and the provisions for preventing filler material from freezing during cold weather.

636.2.9.8-Pilot Truck and Shadow Vehicles A pilot truck is a vehicle of the pick-up or jeep type, equipped with a prescribed sign that is mounted on the rear portion of the vehicle to be visible by following motorists. A shadow vehicle is a standard truck equipped with a flashing or rotary yellow beacon and a truck-mounted attenuator mounted on the rear. Verify that the use of pilot trucks and shadow vehicles are in conformance with the active method of handling traffic, Contract Plans, Standard Detailed Drawings, and Specifications. When work is completed for the day, these vehicles must be relocated behind a positive barrier or off the job site in a safe location off of the traveled roadway.

636.2.10-Temporary Roads and Dust Palliatives DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments, to prepare the Diaries and DWRs. If in doubt as to whether or not information is important or beneficial, record it.

Where temporary roads are called for in the Contract, check to ensure that the surface of the temporary road is maintained with aggregate as specified. In addition, dust palliatives are used on haul roads and other locations on the project to minimize pollution from dust, where dust would create a nuisance to the traveling public or adjacent property owners. During the project, verify compliance with the specified application of dust palliatives.

636.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur daily each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report and Inspector's Traffic Control Worksheet for documentation purposes. If in doubt as to whether information is important or beneficial, record it.

SECTION 637
WATER

637.1-GENERAL REQUIREMENTS

637.1.1-Description of Work Section 637 of the Specifications governs the material and construction requirements for the use of water in compacting embankments, stabilizing soils, and dust control. When Item 637 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 637 of the Specifications and as directed by the Project Engineer/Supervisor. See the Specifications for the method of measurement for payment.

637.1.2-Materials Considerations Verify that the water is suitable for the intended purpose, as specified in Section 637.2 of the Specifications.

637.2-INSPECTION GUIDELINES

Water that is used as a dust palliative is intended to prevent a public nuisance and is to be placed as directed and in the quantities ordered by the Project Engineer/Supervisor. Water is also used during embankment construction and to stabilize soils. Check that the application equipment used is suitable for the intended purpose. In addition, verify the application quantities and timing for conformance.

637.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report for documentation purposes. If in doubt to whether or not information is important or beneficial, record it.

SECTION 638
PROJECT MARKERS, RIGHT-OF-WAY MARKERS, SURVEY MARKERS, AND OUTLET MARKERS

638.1-GENERAL

638.1.1-Description of Work Section 638 of the Specifications governs the material and construction requirements for furnishing and placing project markers, right-of-way marker, survey marker, and outlet markers. When Item 638 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 638 of the Specifications and as designated on the Contact Plans. See the Specifications for the method of measurement and payment.

638.1.2-Materials Considerations Inspect all materials upon arrival. Verify that all materials conform to the requirements specified in Section 638.2 of the Specifications. Ensure that materials are supplied from pre-approved DOH sources, as applicable, and document laboratory numbers from the shipping documents on the Daily Work Report.

638.2-INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for furnishing and placing project markers, right-of-way marker, survey marker, and outlet markers is in conformance with the construction methods and details specified in Section 638 of the Specifications.

638.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments. If in doubt as to whether or not information is important or beneficial, record it.

SECTION 639
CONSTRUCTION SURVEYING

639.1-GENERAL REQUIREMENTS

639.1.1-Description of Work Section 639 of the Specifications governs the material and construction requirements for furnishing, placing, and maintaining construction layout stakes and conducting an as-built utility survey. See the Specifications for the method of measurement for payment,

639.1.2-Material Considerations Verify that the materials and equipment required for the specified surveying services and as directed by the Project Engineer/Supervisor.

639.2-CONSTRUCTION LAYOUT STAKES

639.2.1-Overview The "stake-out" is the means whereby the Contractor is shown exactly at what points on the ground and to what dimensions the road, its appurtenances, and structures are to be built. Except when there is a stake-out item in the Contract, staking-out is a responsibility of the Division. Staking responsibilities of the Division and Contractor are clarified in Section 105.8 and Section 639 of the Specifications. The stake-out work must be performed carefully and accurately, because the Contractor is expected to perform the construction work using this control. For this reason, the stake-out should be started well in advance of the beginning of construction to avoid hurried work that may result in errors. All notes in connection with stake-outs must be maintained in a separate notebook, arranged in an orderly sequence, and indexed. When the stake-out has been completed, the notebook is to be submitted to the Project Engineer/Supervisor for reference.

Before staking is started, the Contract Plans should be checked and the notebooks prepared. A set of Contract Plans should be available for the use of the staking party at all times. Any notation of errors that are found in staking should be made on the Field Plans and in the notebooks. All curve data shown on the Contract Plans should be checked before staking starts.

Due to the many stake-out notes that must be maintained on the project, the notes should be maintained in separate books, such as one book for slope stake notes, one for elevation control stakes, one for right-of-way hubs, one for fine grade notes, etc.

639.2.2-Centerline Stakes When staking out a project for grading, the first operation is to stake the centerline. The Division will locate and reference the centerline in all cases. Where the centerline of the project is the same as the base line of the location survey, the line may already be staked. In such cases, the stakes should be carefully checked for errors that may interfere with carrying true grades. Corrections of stationing should be made as equalities (i.e., equations), inserted preferably at the PC of the curve.

If the centerline is a “paper location,” the actual lengths of tangents may vary from the calculated lengths shown on the Contract Plans, and the stationing should accordingly be corrected with equalities.

The angle of each PI should be checked. If necessary, it should be corrected, and the curve should accordingly be adjusted to fit the tangents. A change in the required length of a curve should be corrected by an equality at the PT.

References for each point that must be referenced should be checked. Where the references have been destroyed, or where they are likely to be disturbed in the course of construction work, new references for the point should be established so that they may be preserved.

639.2.3-Elevation Control Stakes With the centerline established, the next operation is the checking of bench marks by the Division. All bench marks must be tied into USGS or suitable reference datum. If it is not feasible to carry the levels through to another bench mark established from the same datum, the circuit should be closed by running an independent line back to the original mark. All bench marks should be used as “turning points,” and under no circumstances should the elevation of a bench mark be determined by a “side shot.”

A hub with a guard stake must be set on each side of the centerline opposite every 50' station or at every original cross-section station. Elevation control hubs and guard stakes will be set at a convenient distance outside the construction limits so as not to be disturbed during construction operations. The guard stakes will be marked as follows:

1. The station number will be marked on the back of the guard stake.
2. The distance out from the centerline will be marked on the front, which is the side facing the centerline, near the top.

The elevation of the top of the hub will be marked, which will be marked on the side facing the centerline and below the distance marking. The distance and elevation markings should be separated by a line drawn across the stake.

Care should be taken to set the marker hubs at right angles to the centerline. When the marker hubs on the elevation control lines have been set, levels should be run over them and over the centerline hubs, and the elevations recorded. The levels will serve as an absolute check on any cross-section, either original or final. In some cases, due to the slope of the ground, it may be necessary to run different sets of levels to obtain centerline elevations and elevations on control stakes on left and right of centerline.

639.2.4-Slope Stakes Slope stakes, consisting of flat marker stakes, are to be set at the computed actual top (cut) and toe (fill) of the side slopes. The distances to slope stakes should not be scaled from the Contract Plan cross-sections, except for temporary use in an emergency. When computing the distance from the centerline to the top of a slope, widening and superelevation must be taken into consideration. At the same time, the distance to the slope stake from the control hub should be marked on the guard stake at the elevation control hub, so that the slope stake can easily be reset if it should be covered up or disturbed. These notes should be entered in the proper stake-out book.

639.2.5-Right-of-Way and Utility Stakes

639.2.5.1-Staking Right-of-Way During Construction Hubs should be set at right angles to the centerline of the roadway, on both sides of the roadway, and at all locations where right-of-way changes width. Marker hubs will be driven flush with the ground. During the operation, guard stakes will be driven, the station number will be marked on the back of the guard stake, and the distance from the centerline will be marked on the other side facing the centerline of the roadway. The staking should conform to the right-of-way as shown on the Contract Plans or as modified by executed deeds. Right-of-way lines for drainage easements and borrow pits should likewise be staked.

639.2.5.2-Utility Right-of-Way Stake-Out The following procedures will be used to expedite stake-out for right-of-way involving utility companies:

1. The District Construction Engineer will assign adequate survey personnel to perform the designated work and will coordinate the survey with the District Utility Supervisor as to priority and progress of the right-of-way stake-out.
2. The District Construction Engineer will inform the utility company of the completion of the right-of-way stake-out so they can conduct their field review and expedite utility agreements. The District Construction Engineer will then contact the Right-of-Way Division Utility Engineer of the stake-out completion and the utility companies contacted.
3. After sufficient time has elapsed for the utility companies' field review, the District Construction Engineer will contact the involved utility companies and the Right-of-Way Division Utility Engineer to determine if any questions have surfaced that will require additional or correctional right-of-way location work.
4. The District will inform the Contract Administration Division, by letter, when the utility right-of-way stake-out has been satisfactorily completed.
5. The Contract Administration Division will notify the Design Division, by letter, of the completion of this phase of right-of-way stake-out with copies to the Right-of-Way Division and the District.

639.2.6-Roadway Cross-Sections The original cross-sections should indicate the elevations of the "elevation control hubs" and "centerline hubs." When considerable difference in elevations is noted, a new cross-section should be taken and plotted. Intermediate sections may be necessary at abrupt changes in slope which would affect the earthwork quantities. Each section should be carried well beyond the construction lines. While a section is being taken, rod readings on the tops of the elevation control hubs should be indicated in the notes by the notations "TH," meaning top of hub. Where it appears probable that slides or breakage may occur, the sections should be referenced to the tops of hubs set well outside the probable slide or breakage area, and the corresponding rod readings indicated in the notes as "TH."

639.2.7-Borrow Cross-Sections Places from which borrow is to be obtained must be cross-sectioned to compute the quantity of material excavated. Where the site for a borrow pit is adjacent to the road, being only a short distance outside the right-of-way line and along a tangent, the road cross-sections may be extended to cover the probable extent of the pit. If the pit is likely to be extremely large, a separate base line which is parallel to the centerline of the road should be established and suitably referenced, preferably by a right-angled tie to the roadway centerline.

Where the site for a borrow pit is not near enough to the road, or where it is adjacent to the road but located along a curve, an independent baseline should be run through the approximate center of the pit, and sufficient cross-sections should be referred to this base line. If the pit is likely to be very large, two or more parallel lines should be referred to this baseline.

Whenever a baseline from which cross-sections are taken is independent of the road centerline, the baseline should be referenced in such a way that the references will not be disturbed, and so that the line and the stationing on it may be re-established for final sectioning.

A reference stake should be set at each limit of each cross-section taken at a borrow site. Such a stake should be marked to show the station number and distance from the base line so that the Contractor will have some idea of the location of the pit limits.

Where there may be slides, the scheme described for sectioning for the roadway under similar conditions should be used.

639.2.8-Pavement Stakes

639.2.8.1-Hubs on Offset Line In staking out a pavement project, a single row of hubs is generally set on an offset line at one side of the centerline. If conditions are favorable, offset hubs preferably should be set on the side of the road in which the first lane of paving is to be placed. When it can be performed without inconvenience, or danger of loss of hubs, the offset distance should be the same for all hubs. In such a case, the hubs can be lined directly with the transit, and the distances between them can be measured along the offset line.

If it is found necessary to set the hubs at varying offset distances, or on different sides of the road, the centerline will have to be located first. Each point on the centerline may be marked by means of a nail and flag, and the offset distances can then be measured from these points to locate the hubs.

A hub should be driven nearly flush with the ground and should be protected with a guard stake. Markings for the hub are made on the guard stake. Hubs for pavements should be set at all 50' stations on tangents and at 25' intervals on horizontal and vertical curves and at intermediate points if necessary. They should also be set at all curve control points (PC, PT, etc.) and ends of run-offs for superelevated curves. Each hub that is referenced to the centerline should have a tack set in it from which to measure the centerline offset.

639.2.8.2-Levels After the offset hubs have been set, levels should be run over them. The rod should be read carefully to the nearest hundredth of a foot.

639.2.8.3-Cross-Sections If the paving contract is on a project which previously has been graded under another contract, new cross-sections should be taken to be used in computing the unclassified excavation involved in subgrade, ditch, and shoulder work. The sections need only be carried as far out on each side as it is probable that such work will be done. Ordinarily, it will be enough to take one or two shots beyond the ditch on the bank in a cut or beyond the outside edge of the shoulder on an embankment.

639.2.8.4-Marking Guard Stakes Before calculating the grades and marking the guard stakes at the offset hubs, the profile notes should be plotted and examined in connection with the proposed grade line, especially on a project where the paving contract is being done separately from the original grading contract. Frequently, a slight change in grade may be found to give a better "fit" to the ground and thus reduce the quantity of unclassified excavation. The Project Engineer/Supervisor should carefully review any change in grade that may be anticipated and should receive approval from higher authority prior to authorizing such change. Extreme care must be used to establish the grade at an elevation which will assure enough material to properly finish the shoulders without excessive waste or borrow.

In marking the guard stakes, the station number should be marked on the upper part of the side facing the centerline, and the offset distance should be put below it on the same side, the two markings being separated by a line drawn across the stake. The cut or fill should be marked on the back. Hubs at the curve control points should be so identified, also on the face of the stake. The amount of superelevation should be marked on the edge of each stake along a curve or tangent run-off.

639.2.8.5-Stake-Out Book When the grades have been calculated, they are entered in one of the stake-out books. The cuts and fills are then calculated and marked on the stakes at the offset hubs. When the stake-out has been completed, copied sheets or recorded information should be given to the Project Engineer/Supervisor for use in checking grades and stored on ProjectWise.

639.2.9-Staking Culverts

639.2.9.1-Preliminary Studies for Pipe Culverts Ordinarily, only a few stakes are needed by the Contractor to set a pipe culvert. Usually, a stake, offset from the centerline of the pipe at each end, and an offset hub are required. If the pipe is long, one or more intermediate stakes may be required. However, when choosing the locations of the stakes and setting them, the Project Engineer/Supervisor must pay careful attention to the required length and skew and other matters.

The angle of the culvert is shown as 90° if at right angles to the centerline, or a certain degree skew from right angles if other than 90°. The skew is written RA or RFS, meaning right ahead or right forward skew, or LA or LPS, meaning left ahead or left forward skew.

The ground must be studied carefully to locate the culvert so that the completed structure will best serve its purpose with a minimum of maintenance. To obtain good results, the inlet and outlet should be in a reasonable direct line with the channel, free from obstruction, and located and protected so as to avoid clogging from fill material.

If feasible, the total length of a pipe culvert should be so chosen that it will not be necessary to cut a standard piece.

639.2.9.2-Placing Stakes for Pipe Culverts When the skew and length of a pipe culvert has been decided upon, stakes are placed at the points on the ground where the ends of the centerline of the pipe are to be located. Each such stake is marked "End Pipe." An offset hub is then set plus or minus 10' from each end. The offset distance should be adequate to place the stakes well out of the way of construction work, and should be marked on the face of each guard stake. Additional information for pipe culvert stake-out is set forth in Section 604 of this Manual.

639.2.9.3-Records for Pipe Culverts The elevation of the flow line at the inlet and outlet of a pipe culvert, and the grade of the culvert, may be established in relation to the ground by using a Locke level or Wye level. The actual end elevations must be determined and must be marked in the structure book and posted on the Plans.

639.2.9.4-Stakes for Box Culverts In the case of a box culvert, more details and measurements for construction and, therefore, more stakes, are necessary. The location must be carefully worked out by considering several factors, as explained for locating a pipe culvert. The skew angle of the centerline should be turned with a transit and recorded so that the lines of the headwalls and wings also can be located at the proper angles. Under no circumstances should the location, skew, or elevation be altered without the approval of proper authorities.

With the centerline established and offset hubs set for future references and checking, the points at the ends of the culvert should be marked on the centerline. At these points, the angles for the lines of the faces of the headwalls should be turned. Offset hubs that are well out of the way of the construction should be set on each side of the work. The inside face, or other required working line, of each of the main walls should be located, and these lines similarly referenced by offset hubs. On these working lines, the intersection points with the lines of the faces of the wingwalls are located, and at those points the angles for the lines of the wingwall faces are turned. Offset hubs are likewise set for the wingwall lines.

All control points, whether on working lines or on offset lines, should be marked with tacks. To avoid confusion, a guard stake should be driven near each hub on an offset line and should be plainly marked to show the offset distance and the point on the structure to which the offset distance refers. Notes and sketches of the stake-out should be maintained in a convenient stake-out book.

639.2.9.5-Other Work for Box Culverts After all stakes needed for a box culvert have been set, levels should be run over a sufficient number of the stakes to permit the cut or fill to grade to be marked on each of them for convenience. A temporary bench mark may be established for use in checking grades during construction. In the case of a box culvert, the grade to which reference is made is customarily the flow line.

Before excavation for a box culvert is begun, cross sections should be taken from the centerline established for the culvert. Sections should be located at enough points to make an accurate computation of the quantities of structural excavation and unclassified excavation by the methods outlined in this Manual.

639.2.10-Staking Bridges

639.2.10.1-Control System Because of the wide range of variations in Contract Plans for bridges, specific rules of standard methods for the stake-out of bridges in general cannot be established. In the stake-out for a bridge, especially one for crossing a large body of water, a highly precise horizontal control system is necessary. Such a system will make it possible to locate accurately and quickly various widely scattered piers and other component parts of the bridge.

639.2.10.2-Preliminary Checking Before any definite location is marked or any working elevations are given, it is necessary to check the positions and elevations of several points of the original location survey to which the design was fitted. The purpose of this checking is to make sure that the points were taken accurately and that the design is based upon accurate information. It is especially essential, in the case of a grade separation structure, to check the elevations and alignment of all railroad tracks and structures by comparison with the information shown on the Plans, in order that the clearances will be as designed. As a rule, drawings for a grade separation structure give the layout distances and measurements with references to the intersection of the centerline of the highway and the centerline of the railroad track. Convenient bench marks should be established so that elevations for the work can be determined from them as required.

639.2.10.3-Setting Stakes As a general method of procedure, the centerline of the bridge is carefully established and referenced. Points at the faces or other working lines of each abutment, and at the axis of each pier or row of footings are located on the bridge centerline, and the angles corresponding to the skew of the bridge are turned at these points. Each line thus located is prolonged to reference points well beyond the area of the work. At each intersection of a face of an abutment and a face of a wing, the wing angle is turned, and the line thus located is referenced.

Ordinarily, a bridge cannot be completely staked out at one time, with no further staking required. It is usually necessary to set stake or marks for new lines at intervals during construction, and to give new grades as the work progresses. For this reason, a transit, level, tape, and leveling rod should be kept at the site of the work so that additional lines and levels can be furnished or checked by the Project Engineer/Supervisor or Project Inspector as needed.

As in any other stake-out, notes should be recorded, and the notebook retained by the Project Engineer/Supervisor or Project Inspector in charge of construction.

639.2.10.4-Checking Stake-Out Accuracy is more essential in layout out a bridge than in any other stake-out. An error is apt to be much more costly than in other construction.

Because of the possibility of a serious error in the stake-out, no bridge stake-out should be considered satisfactorily completed until an independent check has been made. One method of checking a bridge layout, where curves, tangents to curves, and angles from the tangents must be staked, is to go over the Contract Plans carefully and to compute, and have independently checked, the azimuth of every line involved. Then, if the lines have been located by turning deflection angles, they should be checked by azimuths; or vice versa. The advantage of the azimuth method is that the azimuth of a back sight to the point of beginning from any other point and the accuracy of the intervening work can be readily proved, or errors can be detected, by comparing the measured azimuth with the computed azimuth.

639.2.11-Responsibilities for Staking For all projects, including structures, the Division will locate and reference the centerline and will establish bench marks along the line of the improvement for the proper layout of the work. The responsibility of the Contractor for stake-out is set forth in 639 of the Specifications when this item is called for in the contract.

When Item 639 is not provided for in the Contract, the Project Engineer/Supervisor will generally provide the stake-out that is normally expected from the Contractor in the performance of Item 639. The responsibility of the Engineer in placing these stakes will be limited to the initial placement, and the Contractor will be held responsible for the preservation of these stakes. Additional stakes, such as locating batter boards, additional offset lines, additional right-of-way stakes, etc., will be the responsibility of the Contractor. When Item 639 is not called for in the Contract, the Contractor will cooperate with the Project Engineer/Supervisor in preparing a schedule for stake-out to meet the requirements of the Contractor’s work schedule.

When Item 639 is provided in the Contract, it shall be the responsibility of the Project Engineer/Supervisor to require the Contractor to furnish copies of field notes as the work progresses (at least on a weekly basis). These notes will be used in spot checking this item of work. The results of this checking will be recorded in the appropriate Daily Work Report form and the Project Diary.

639.2.12-Final Surveys

639.2.12.1-General The purpose of the final survey on a project is to determine the quantities of the various items of work for which the Contractor is to receive payment in the final settlement of the Contract. The method of calculating the quantity of each individual item is always made a part of the specifications for the item under the subsection “Method of Measurement.”

In determining the final quantity of a pavement, base, or similar item, for which payment is made per square yard or per cubic yard, the final survey usually consists of a measurement of the length along the centerline and upon the surface of the road together with measurements of average widths and separate measurements at turnouts and intersections wherever they are necessary to show all authorized work.

For the determination of the final quantities of unclassified excavation, borrow, and similar items, for which payment is made per cubic yard, it is necessary that final cross-sections be taken.

639.2.12.2-Final Section Locations The party taking the final cross-sections should have available the notebooks containing notes for the original sections, the stake-out book, and also a set of prints of the original cross-sections as shown on the Contract Plans.

The first step in the procedure of taking final sections, is to reset the centerline of the road or the base line from which the original sections were taken. In order that the "ties" of the final sections with the originals may be accurate, the final sections must be taken from the same points on the reference line as were the originals. That is, a final section must be taken from every point on the line from which an original section was taken.

Special care must be exercised in taking final sections to minimize discrepancies between original and final checks and special attention should be given to the guidelines hereinafter specified.

1. Before starting any final survey, all original centerline and cross section books, all revised centerline books (if revised cross sections were taken), centerline profile and cross-sections should be available.
2. Every effort is to be made to replace centerline to its original location before construction. A check on adjacent topography from original centerline book will help verify final centerline.
3. Before starting cross-sections, a level check must be made on all available bench marks.
4. Ties from construction bench marks to original marks are to be made if errors show in construction benches.
5. A thorough study must be made of cross sections and templates to determine the limits of construction (i.e., side roads included in the contract but not part of the main project template).
6. On each cross-section, a shot will be taken on old ground at a distance to compare with a distance in the original cross section book. Elevations will be figured at this distance and a check made. If elevations compare within 6″, the cross-section is acceptable. If elevations show a difference greater than 6″, a check of the final section will be made. If the check reveals the original cross-section is in error, a note will be made in the book showing the difference and marked "Final OK."
7. Profile and all cross-section shots on pavement, including paved or stone shoulders will be taken with a precise level to show a more accurate pavement template, and recorded to 0.01′.

In the event discrepancies between original and final sections cannot be resolved, these differences should be further investigated.

639.2.12.3-Final Section Measurements When the points on the reference line have been re-established and marked, levels and measurements are taken and noted substantially as described previously for original cross-sections.

As much care must be used to determine lines at right angles to tangents and radial lines on curves as was used during the original or stake-out surveys. Each final section must be run out on each side of the reference lines far enough to cover all the work and include not less than two readings on original ground (marked “OG” in the section book) beyond the top or toe of a slope. In addition, the sections should always include a rod reading on each elevation control grade stake and on any other stake which may have been set during the original survey or stake-out survey and for which there is a previously determined elevation.

639.2.12.4-Terminal Points In addition to the notes for the regular sections as described above, notes also should be kept to show the stations of terminal points, sometimes called “apex points” or “zero points of cut or fill,” for each side of the road. When entering into a cut, the station of the point where the excavation begins on either the right-hand or left-hand side, as the case may be, should be noted. Similar points should be noted where excavation ends and fill begins.

639.2.12.5-Intermediate Cross-Sections Cuts or fills on approach roads, earthwork for the removal of slides, and some other authorized widenings may not be measurable by means of cross-sections taken at the regular points. In such a case, the quantity may be measured by means of sections taken at intermediate points, unless cross-sections have been previously taken from an independent base line or the quantity has been measured separately by some other method. When an intermediate final section is taken from the road centerline, the corresponding original section is reconstructed by interpolation. The final sections should be located at whatever intervals may be necessary to include the whole volume, and should also show the terminal points of the extra work being measured. Intermediate sections are useless for purposes other than to show widenings, or narrowings in the final survey, unless original sections were actually made for the same points.

639.2.12.6-Slides Accurate measurement and computation of the volume of a slide frequently requires that the original sections be extended and that intermediate original sections be taken prior to the beginning of excavation. It may be found necessary, especially if part of the slide is below the road grade, to take sections at times intervening between the original and final surveys to show areas that had to be removed during construction but would have been backfilled at the time of the final survey. Measurements at such intermediate sections should be taken as soon as the work has been completed. Information needed for the purpose, such as the location of nearby reference points and their elevations, should always be at hand. The final sections should be extended to original ground which is well beyond the limits of the excavation, and notes should be made to show the location and extent of all cracks and breaks appearing in the original ground because of the construction.

639.2.12.7-Benches Benches above the grade of the road will be shown in the final sections. But a bench below grade, which has been excavated for the purpose of removing unstable material or to prevent a fill from slipping must be shown by sections taken at the time of completion of the bench and before the fill is started. Where a bench is formed at a slide, necessary sections should be taken promptly on completion of the work.

639.2.12.8-Structures In addition to taking the final cross-sections as just described, the station number of the point at which each pipe or other culvert intersects the road centerline should be noted in the final survey and checked with that given in the structure book. Also, the angle of skew should be measured and recorded. In the final survey, measurements should be taken to permit plotting of a profile over and along the centerline of each pipe or other culvert. This profile should show the distances out and elevations of the headwalls and flowlines, and be extended beyond each end of the culvert to original ground. Such a profile serves as a check on the structure-book measurements, and is of use in planning future extensions of the culvert. When a structure, such as a pipe underdrain, may be so covered up that only one end is visible, the invisible end should be located by the station number and a right-angle offset from the road centerline.

639.2.12.9-Field Checking Elevations of Ties Final cross-sections must always be checked for errors in elevations before being sent to the office for plotting. For checking, calculations are made for the final elevations of the ties, which consist of the OG's and previously set grade stakes, the positions of which have been plotted on the original sections as shown on the Plans. If the two elevations of each tie agree with reasonable accuracy, no further checking may be necessary. The amount of difference to be allowed at any section will depend on the depth of the excavation or fill at that section. If the two elevations obtained for a tie differ by more than 1', the section should be rechecked. However, smaller differences are to be expected on the shallower sections.

639.2.12.10-Field Investigation of Differences The original and final elevations of the ties may differ for any one of several reasons. If there is an appreciable difference and no error can be found in the calculations, all possible reasons should be investigated in order of their probability. To determine the reason, the condition of the ground should be examined carefully, and special notes should be prepared.

From these notes, a conclusion can be drawn in regard to the probable reason for the changes in elevations, and the section can be reconstructed. Such notes should include evidence of the possibility that slips occurred since the original section was measured, or any other evidence that may indicate the reason for the changes.

An agreement in elevation should never be forced at the expense of the accuracy of the final survey. The final survey party is responsible only for the accuracy of its own survey, and not for that of a previous survey.

639.2.12.11-Miscellaneous Measurements Channel changes are usually measured by original and final sections taken from the centerline of the road and extended far enough to include the channel. A channel should be sectioned immediately upon completion of excavation work.

A drainage ditch, such as an inlet or outlet at a culvert, is usually measured independently or by sections from an independent base line; the method depends on the size and location of the ditch. It is common practice to include such measurements and the volume computations in the structure book. Diversion ditches above cuts or fills and parallel to the roadway should be shown and measured.

When an excavation below grade is authorized to remove rock in a cut and the space is backfilled with earth or other suitable material, cross sections shall be taken and plotted. Where there is rock below grade in a cut, the final survey should contain notes showing the stations of the beginning and ending of the rock, in order to permit comparison with other notes obtained by the Project Inspector during construction.

When excavation below grade is authorized for removal of mucky or poor material and the space is backfilled, the excavation should be measured at the time the work is done and independent notes should be made. Such excavation may not be shown by the final survey.

639.2.12.12-Plotting and Compaction Where practical, the final cross-sections should be plotted on the original sheets which were used for planning or designing purposes, and the original cross-sections should not be re-plotted unless it is absolutely necessary to do so. By using the old sheets, the final sections can be easily compared with the original template sections and areas. For this comparison, errors of plotting or running areas are more readily recognized and checked.

639.3-AS-BUILT UTILITY SURVEY

As-built utility survey is conducted on all specified items included in project under Sections 631, 657, 658, 659, 660, 661, 662, and 664, showing the exact dimensions, geometry, and surveyed location of all these completed elements. This legacy of what was built is important as we continue to build on top of old work. See Specification 639.4 for survey requirements.

639.4-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments, to prepare the Diaries and DWRs. If in doubt as to whether information is important or beneficial, record it.

SECTION 640
FIELD OFFICE AND STORAGE BUILDING

640.1-GENERAL

640.1.1-Description of Work Section 640 of the Specifications governs the material and construction requirements for field office and storage building. When Item 640 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 640 of the Specifications and as designated on the Contact Plans. See the Specifications for the method of measurement and payment.

640.2-INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for field office and storage building is in conformance with the construction methods and details specified in Section 640 of the Specifications. Pay particular attention to the location and time of erection, applicable field office requirements, storage building, maintenance, removal, and equipment.

640.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments. If in doubt as to whether information is important or beneficial, record it.

SECTION 642
TEMPORARY POLLUTION CONTROL

642.1-GENERAL REQUIREMENTS

642.1.1-Description of Work Section 642 of the Specifications governs the material and construction requirements for temporary pollution control. When Item 642 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 642 of the Specifications and as designated on the Contract Plans. See the Specifications for the method of measurement for payment.

642.1.2-Materials Considerations Inspect all materials upon arrival. Verify that all materials conform to the requirements specified in Section 642.2 of the Specifications. Ensure that materials are supplied from pre-approved DOH sources, as applicable, and document laboratory numbers from the shipping documents on the Daily Work Report.

642.2-INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for temporary pollution control is in conformance with the construction methods and details specified in Section 642 of the Specifications. If inspectors are contacted by the WV Department of Environmental Protection (WVDEP) at the project, any recommended modifications or corrective measures must be recorded in DWR and addressed immediately.

At the Preconstruction Conference, the Contractor will submit for approval the Storm Water Pollution Prevention Plan (SWPPP), including the project waste and borrow sites. These plans shall be approved by the District Construction Engineer and District Environmental Coordinator and the WVDEP. Projects with more than one acre of disturbance shall also be approved by the Technical Support Division Permit Unit and WVDEP via a modification to the NPDES registration. All permits related to pollution control issues need to be on file at the project. Pay particular attention to the schedule of requirements for each size threshold of erodible area. Construction of permanent drainage facilities as well as performance of other Contract work that will contribute to the control of erosion and siltation will be accomplished at the earliest practical stage during the life of the Contract. Pollutants such as chemicals, fuels, lubricants, bitumen, raw sewage, and other harmful waste will not be discharged into or alongside rivers, streams, impoundments (e.g., lakes, reservoirs, etc.) or into natural or man-made water courses leading thereto. The Contractor will also comply with the applicable regulations of the Department of Natural Resources and other statutes relating to the prevention and abatement of pollution.

See the WVDOH District Environmental Coordinator for information on DEP permit requirements. See the WVDEP Erosion and Sediment Control Best Management Practice Manual for information the Contractor's SWPPP / Erosion and Sedimentation Control Plan, erosion and sedimentation control at waste and borrow sites, seeding and mulching frequencies, and maintenance of in-place erosion control features.

642.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments, to prepare the Diaries and DWRs. If in doubt as to whether information is important or beneficial, record it.

SECTION 645
REINFORCED SOIL SLOPES

645.1-GENERAL

645.1.1-Description of Work Section 645 of the Specifications governs the material and construction requirements for reinforced soil slopes. When Item 645 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 645 of the Specifications and as designated on the Contact Plans. See the Specifications for the method of measurement and payment.

645.1.2-Materials Considerations Inspect all materials upon arrival. Verify that all materials conform to the requirements specified in Section 645.5 of the Specifications. Ensure that materials are supplied from pre-approved DOH sources, as applicable, and document laboratory numbers from the shipping documents on the Daily Work Report.

645.2-INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for reinforced soil slopes is in conformance with the construction methods and details specified in Section 645 of the Specifications. Pay particular attention to the foundation preparation, geosynthetic installation, backfill placement, and erosion control material placement.

645.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments. If in doubt as to whether information is important or beneficial, record it.

SECTION 651
FURNISHING AND PLACING TOPSOIL

651.1-GENERAL REQUIREMENTS

651.1.1-Description of Work Section 651 of the Specifications governs the material and construction requirements for furnishing and placing topsoil. When Item 651 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 651 of the Specifications and as designated on the Contract Plans. See the Specifications for the method of measurement for payment.

651.1.2-Materials Considerations Inspect all materials upon arrival. Verify that all materials conform to the requirements specified in Section 651.2 of the Specifications. Ensure that materials are supplied from pre-approved DOH sources, as applicable, and document laboratory numbers from the shipping documents on the Daily Work Report.

651.2-INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for furnishing and placing topsoil is in conformance with the construction methods and details specified in Section 651 of the Specifications. Pay particular attention to the location of the topsoil (i.e., on or off right-of-way) and the requirements for stripping, transporting, area preparation, placing, and manipulating the topsoil.

651.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments. If in doubt as to whether or not information is important or beneficial, record it.

SECTION 652
SEEDING AND MULCHING

652.1-GENERAL REQUIREMENTS

652.1.1-Description of Work Section 652 of the Specifications governs the material and construction requirements for seeding and mulching. When Item 652 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 652 of the Specifications and as designated on the Contract Plans. See the Specifications for the method of measurement for payment.

652.1.2-Materials Considerations Inspect all materials upon arrival. Verify that all materials conform to the requirements specified in Section 652.2 of the Specifications. Ensure that materials are supplied from pre-approved DOH sources, in concurrence with West Virginia Department of Agriculture laws, rules and regulations, and document laboratory numbers on the Daily Work Report.

652.2-INSPECTION GUILD LINES

The Project Inspector is responsible for ensuring that the work for seeding and mulching is in conformance with the construction methods and details specified in Section 652 of the Specifications. Watch for Contract provisions regarding State noxious weeds. Pay particular attention to the requirements for seasonal work, area preparation, application methods and rates for mulch and fertilizer, and maintenance requirements.

During dry weather, the mulch application rates, as defined in Section 642 and Section 652 of the Specifications, may not provide the necessary moisture retention for seed germination and plant growth. Under these conditions, the Project Engineer/Supervisor may increase the application by 1.5 times the specified rate when using hay, straw, or wood cellulose mulch. No adjustments are necessary when wood chips are used.

652.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments, to prepare the Diaries and DWRs. If in doubt as to whether or not information is important or beneficial, record it.

SECTION 653
VINE AND GROUND COVER PLANTING

653.1-GENERAL REQUIREMENTS

653.1.1-Description of Work Section 653 of the Specifications governs the material and construction requirements for vine and ground cover planting. When Item 653 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 653 of the Specifications and as designated on the Contract Plans. See the Specifications for the method of measurement for payment.

653.1.2-Materials Considerations Inspect all materials upon arrival. Verify that all materials conform to the requirements specified in Section 653.2 of the Specifications. Ensure that materials are supplied from pre-approved DOH sources in concurrence with applicable West Virginia Department of Agriculture laws, rules, and regulations, and document laboratory numbers on the Daily Work Report.

653.2-INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for vine and ground cover planting is in conformance with the construction methods and details specified in Section 653 of the Specifications. Watch for Contract provisions regarding State noxious weeds. Pay particular attention to the requirements for seasonal work, area preparation, application rates for water, mulch, and fertilizer, and maintenance requirements.

During dry weather, the mulch application rates that are defined in the Specifications may not provide the necessary moisture retention for plant growth. Under these conditions, the Project Engineer/Supervisor may increase the application by 1.5 times the specified rate when using hay, straw, or wood cellulose mulch. No adjustments are necessary when wood chips are used.

653.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments, to prepare the Diaries and DWRs. If in doubt as to whether or not information is important or beneficial, record it.

SECTION 654
TREE AND SHRUB PLANTING

654.1-GENERAL REQUIREMENTS

654.1.1-Description of Work Section 654 of the Specifications governs the material and construction requirements for tree and shrub planting. When Item 654 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 654 of the Specifications and as designated on the Contract Plans. See the Specifications for the method of measurement for payment.

654.1.2-Materials Considerations Inspect all materials upon arrival. Verify that all materials conform to the requirements specified in Section 654.2 of the Specifications. Ensure that materials are supplied from preapproved DOH sources in concurrence with applicable West Virginia Department of Agriculture laws, rules, and regulations, and document laboratory numbers on the Daily Work Report.

654.2-INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for tree and shrub planting is in conformance with the construction methods and details specified in Section 654 of the Specifications. Watch for Contract provisions regarding State noxious weeds. Pay particular attention to the requirements for seasonal work, area preparation, application rates for water, mulch, and fertilizer, and maintenance requirements.

During dry weather, the mulch application rates that are defined in the Specifications, may not provide the necessary moisture retention for plant growth. Under these conditions, the Project Engineer/Supervisor may increase the application by 1.5 times the specified rate when using hay, straw, or wood cellulose mulch. No adjustments are necessary when wood chips are used.

654.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments, to prepare the Diaries and DWRs. If in doubt as to whether or not information is important or beneficial, record it.

SECTION 655
MATTING FOR EROSION CONTROL

655.1-GENERAL REQUIREMENTS

655.1.1-Description of Work Section 655 of the Specifications governs the material and construction requirements for matting for erosion control. When Item 655 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 655 of the Specifications and as designated on the Contract Plans. See the Specifications for the method of measurement for payment.

655.1.2-Materials Considerations Inspect all materials upon arrival. Verify that all materials conform to the requirements specified in Section 655.2 of the Specifications. Ensure that materials are supplied from pre-approved DOH sources, as applicable, and document laboratory numbers from the shipping document on the Daily Work Report.

655.2-INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for matting for erosion control is in conformance with the construction methods and details specified in Section 655 of the Specifications. Pay particular attention to the requirements for area preparation, mat placement method, maintenance, and repair work in accordance with the manufacturer's recommendations.

655.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments, to prepare the Diaries and DWRs. If in doubt as to whether or not information is important or beneficial, record it.

SECTION 657
ROADSIDE SIGN SUPPORTS

657.1-GENERAL REQUIREMENTS

657.1.1-Description of Work Section 657 of the Specifications governs the material and construction requirements for the fabrication and erection of roadside sign supports that are located outside and not above the shoulder. When Item 657 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 657 of the Specifications and as designated on the Contract Plans. See the Specifications for the method of measurement for payment.

657.1.2-Materials Considerations Inspect all materials upon arrival. Verify that all structural aluminum and steel supports, bases, and caps; wood posts; and reinforcing steel. concrete, and anchor bolts materials conform to the requirements specified in Section 657.2 of the Specifications. Ensure that materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Daily Work Report.

657.2-INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for roadside sign supports is in conformance with the construction methods and details specified in Section 657 of the Specifications. The work will be in conformance with the WVDOH Standard Details, FHWA Manual on Uniform Traffic Control Devices for Streets and Highways, and the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals. Review the shop drawings and know the erection details for the sign support. Verify the proper excavation of the footing. Check that the erection and setting of the post complies with the requirements of the Contract. Ensure that the Contractor properly backfills and field paints the post as specified.

657.3-RECORD AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments, to prepare the Diaries and DWRs. If in doubt as to whether or not information is important or beneficial, record it.

SECTION 658
OVERHEAD SIGN STRUCTURES

658.1-GENERAL REQUIREMENTS

658.1.1-Description of Work Section 658 of the Specifications governs the material and construction requirements for the fabrication and erection of overhead frame, cantilever, and butterfly sign supports and fastening accessories. When Item 658 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 658 of the Specifications and as designated on the Contract Plans. See the Specifications for the method of measurement for payment.

658.1.2-Materials Considerations Inspect all materials upon arrival. Verify that all pipe, plate, structural connection bolt, friction cap, structural shapes, u-bolt, reinforcing steel, anchor bolts, and concrete materials conform to the requirements specified in Section 658.2 of the Specifications. Ensure that materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Daily Work Report.

658.2-INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for overhead sign structures is in conformance with the construction methods and details specified in Section 658 of the Specifications. The work will be in conformance with the WVDOH Standard Details, FHWA publication Manual on Uniform Traffic Control Devices for Streets and Highways, and the AASHTO publication Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals. Review the Contract Plans and Standard Detailed Drawings and know the erection details for the sign support system specified. Verify the proper excavation of the footing. Check that the erection and setting of the post complies with the requirements of the Contract. Bolt installation is to be performed with a hydraulic torque wrench. Bolt torque should be checked using the turn-of-the-nut method. Ensure that a crane is used to support the structure during erection so that the bolts are not overloaded. Pay particular attention to the specified requirements for welding aluminum alloys. Ensure that the Contractor properly backfills the excavation.

658.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments, to prepare the Diaries and DWRs. If in doubt as to whether or not information is important or beneficial, record it.

SECTION 659
SIGN LIGHTING

659.1-GENERAL REQUIREMENTS

659.1.1-Description of Work Section 659 of the Specifications governs the material and construction requirements for sign lighting. When Item 659 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 659 of the Specifications and as designated on the Contract Plans. See Specifications for the method of measurement for payment.

659.1.2-Materials Considerations Know the details of the Contractor's bill of materials (equipment list) and drawings. Work should not begin until these drawings are reviewed by the Project Engineer / Supervisor. Inspect all materials upon arrival. Verify that all conduit, pull boxes, cable, connectors, poles, enclosures, sign lighting fixtures, and photoelectric controls conform to the requirements specified in Section 659.2 of the Specifications. Ensure that materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Daily Work Report.

659.2-INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for sign lighting is in conformance with the construction methods and details specified in Section 659 of the Specifications, including local laws and ordinances, the National Electric Code, and other national criteria, as defined. Verify the proper excavating of the footing. Ensure that any fixture that are to be removed and replaced are performed as specified. Check installation of conduit, pull boxes, luminaires, ballasts, isolating transformers, cables, and grounds for compliance. Check for proper backfilling. Ensure that the electrical service is connected as arranged. Coordinate with the Project Engineer/Supervisor to perform the final field test.

659.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments, to prepare the Diaries and DWRs. If in doubt as to whether or not information is important or beneficial, record it.

SECTION 660
TRAFFIC SIGNALS

660.1-GENERAL REQUIREMENTS

660.1.1-Description of Work Section 660 of the Specifications governs the material and construction requirements for the installation of traffic signals. When Item 660 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 660 of the Specifications and as designated on the Contract Plans. See the Specifications for the methods of measurement for payment.

660.1.2-Materials Considerations Know the details of the Contractor's bill of materials (equipment list) and drawings. Work should not begin until these shop drawings are reviewed by the Traffic Engineering Division. Inspect all materials upon arrival. Verify that all signal supports, controllers and cabinets, traffic detectors, signal heads, auxiliary equipment, conduit, junction boxes, messenger cable, and conductors conform to the requirements specified in Section 660.2 of the Specifications. Ensure that materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Daily Work Report.

660.2-INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for traffic signals is in conformance with the construction methods and details specified in Section 660 of the Specifications, the WVDOH Manual on Temporary Traffic Control for Streets and Highways, local laws and ordinances, AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, FHWA Manual of Uniform Traffic Control Devices, National Electric Code, and other national criteria, as defined. Verify the proper removal of existing signal equipment, if specified. Check the excavation of the footing for compliance. Ensure that loop detectors are installed in accordance with the Contract Plans and Standard Detailed Drawings. Verify that the support structure is erected and connected in accordance with Contract Plans. Check the signal head mounting for compliance, paying particular attention to height and viewing angle with respect to a vehicle at the stop bar. Ensure that cabinets are properly located and that messenger cable, conduit, junction boxes, and wiring are installed as specified. Check for proper backfilling. Ensure that the electrical service is connected as arranged. Coordinate with the Project Engineer/Supervisor to perform the final field test.

660.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments, to prepare the Diaries and DWRs. If in doubt as to whether or not information is important or beneficial, record it.

SECTION 661
TRAFFIC SIGNS AND DELINEATORS

661.1-GENERAL REQUIREMENTS

661.1.1-Description of Work Section 661 of the Specifications governs the material and construction requirements for the fabrication and erection of traffic signs and delineators. When Item 661 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 661 of the Specifications and as designated on the Contract Plans. See the Specifications for the method of measurement for payment.

661.1.2-Materials Considerations Know the details of the Contractor's shop drawings. Work should not begin until these drawings are reviewed by the Traffic Engineering Division. Inspect all materials upon arrival. Verify that all sheet and extruded aluminum sign panels, structural steel shapes, fastening hardware, sign sheeting and copy, reflectors, and delineators conform to the requirements specified in Section 661.2 and Section 661.3 of the Specifications. The criteria for sampling, inspection, and acceptance of signing material are documented in MP 661.02.40. Ensure that materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Daily Work Report.

661.2-INPSECTION GUIDELINES The Project Inspector is responsible for ensuring that the work for traffic signs and delineators is in conformance with the construction methods and details specified in Section 661 of the Specifications, WVDOH Standard Details, WVDOH Sign Fabrication Manual, AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, FHWA Manual of Uniform Traffic Control Devices, and USDOT Standard Alphabets for Highway Signs, as defined. Check that the assembly, erection, and location of the signs are in accordance with the Contract Plans. Pay particular attention to the location requirements for multi-lane roadways. Check delineators for proper type, location, and spacing. Ensure that the Contractor cleans the work area as specified.

661.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments, to prepare the Diaries and DWRs. If in doubt as to whether or not information is important or beneficial, record it.

SECTION 662
ROADWAY LIGHTING

662.1-GENERAL REQUIREMENTS

662.1.1-Description of Work Section 662 of the Specifications governs the material and construction requirements for the fabrication and installation of roadway lighting systems. When Item 662 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 662 of the Specifications and as designated on the Contract Plans. See the Specifications for the method of measurement for payment.

662.1.2-Materials Considerations Know the details of the Contractor's bill of materials (equipment list) and shop drawings. Work should not begin until these drawings are reviewed by the Traffic Engineering Division. Inspect all materials upon arrival, including:

1. Concrete and reinforcing steel for footers;
2. Anchor bolts and breakaway bases;
3. Support poles and arms;
4. Lowering devices, ring and winch assemblies for high-mast systems:
5. Luminaires, lamps, and ballasts;
6. Conductors, connectors, conduit, junction boxes, and ground rods; and
7. Service cabinets, control stations, and poles

Verify that all materials conform to the requirements specified in Section 662.2 of the Specifications. Check for proper marking, mill test reports, and certifications of support poles and arms. Ensure that the materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Daily Work Report.

662.2-INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for roadway lighting is in conformance with the construction methods and details specified in Section 662 of the Specifications, local laws and ordinances, AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, National Electric Code, and other national criteria, as defined. Know the type of lighting system required by the Contract (e.g., roadway, underpass, high-mast, navigation). Check the excavation of the footing for compliance. Pay particular attention to the installation of breakaway bases. Verify that the supports are erected and connected in accordance with the Contract Plans and Specifications. Check the luminaire mounting for compliance, paying particular attention to mounting height and angle for the type to be installed. Ensure that service and control cabinets are properly located and that messenger cable, conduit, junction boxes, wiring, and grounds are installed as specified. Check for proper backfilling. Ensure that the electrical service is connected as arranged. Coordinate with the

Project Engineer/Supervisor to perform the final field test.

662.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments, to prepare the Diaries and DWRs. If in doubt as to whether or not information is important or beneficial, record it.

SECTION 663
PAVEMENT MARKINGS AND RUMBLE STRIPS

663.1-GENERAL REQUIREMENTS

663.1.1-Description of Work Section 663 of the Specifications governs the material and construction requirements for furnishing and installing pavement markings and rumble strips. When Item 663 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 663 of the Specifications and as designated on the Contract Plans. See the Specifications for the method of measurement for payment.

663.1.2-Materials Considerations Inspect all materials upon arrival. Verify that all paint, extruded thermoplastic marking material, preformed traffic markings, and raised markers conform to the requirements specified in Section 663.2 of the Specifications. Ensure that the materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Daily Work Report.

663.2-INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for pavement markings is in conformance with the construction methods and details specified in Section 663 of the Specifications, Contract Plans, Standard Detailed Drawings, and the Manual on Uniform Traffic Control Devices for Streets and Highways. Verify that the pavement is properly cleaned and repaired, and the proper per-marking codes are applied. Verify the proper application of the markings, including the location, width, length, spacing, and arrangement of all specified edge lines, lane lines, centerlines, barrier lines, channelizing lines, stop and crosswalk lines, stripes, curb markings, island markings, lane arrows, lane letters, and raised markers. Verify the proper application of rumble strips.

663.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments, to prepare the Diaries and DWRs. If in doubt as to whether or not information is important or beneficial, record it.

SECTION 664
IMPACT ATTENUATORS

664.1-GENERAL REQUIREMENTS

664.1.1-Description of Work Section 664 of the Specifications governs the material and construction requirements for furnishing and Impact Attenuators. When Item 664 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 664 of the Specifications and as designated on the Contract Plans. See the Specifications for the method of measurement for payment.

664.1.2-Materials Considerations Inspect all materials upon arrival. Verify that the proper type and quantity of sand barrels, crash cushions, truck-mounted attenuators, and/or Quad Guard systems have been delivered and conform to the requirements specified in Section 664.2 of the Specifications. Ensure that the materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Daily Work Report.

664.2-INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for traffic safety devices is in conformance with the construction methods and details specified in Section 664 of the Specifications. Obtain and review a copy of the manufacturer's installation instructions. Check the location of each device for conformance with the Contract Plans. Verify that each device is installed per manufacturer's recommendations and, as applicable, the Standard Detailed Drawings.

664.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments, to prepare the Diaries and DWRs. If in doubt as to whether or not information is important or beneficial, record it.

SECTION 670
WATERLINE INSTALLATION

670.1-GENERAL REQUIREMENTS

670.1.1-Description of Work Section 670 of the Specifications governs the material and construction requirements for waterline installation. When Item 670 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 670 of the Specifications and as designated on the Contract Plans. See the Specifications for the method of measurement for payment.

670.1.2-Materials Considerations Inspect all materials upon arrival. Verify that all materials conform to the requirements specified in Section 670.2 of the Specifications. Ensure that materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Daily Work Report.

670.2-INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for waterline installation is in conformance with the construction methods and details specified in Section 670 of the Specifications.

670.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments, to prepare the Diaries and DWRs. If in doubt as to whether or not information is important or beneficial, record it.

SECTION 675
SANITARY SEWERS

675.1-GENERAL REQUIREMENTS

675.1.1-Description of Work Section 675 of the Specifications governs the material and construction requirements for sanitary sewers. When Item 675 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 675 of the Specifications and as designated on the Contract Plans. See the Specifications for the method of measurement payment.

675.1.2-Materials Considerations Inspect all materials upon arrival. Verify that all materials conform to the requirements specified in Section 675.2 of the Specifications. Ensure that materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Daily Work Report.

675.2-INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for sanitary sewers is in conformance with the construction methods and details specified in Section 675 of the Specifications.

675.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Daily Work Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments, to prepare the Diaries and DWRs. If in doubt as to whether or not information is important or beneficial, record it.

SECTION 679
OVERLAYING OF PORTLAND CEMENT CONCRETE BRIDGE DECKS

679.1-GENERAL REQUIREMENTS

679.1.1-Description of Work Section 679 of the Specifications governs the material and construction requirements for furnishing and placing latex modified or silica fume concrete overlays on Portland cement concrete bridge decks. Section 679 also governs the work for the following items:

1. Cleaning of bridge decks;
2. Bridge deck repairs;
3. Cleaning exposed reinforcing steel;
4. Supporting and tying reinforcing steel;
5. Placing slab reconstruction concrete;
6. Abutment backwalls and approach slabs repairs; and
7. Hydrodemolition of existing deck surfaces;

When Item 679 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 679 of the Specifications and as designated on the Contract Plans. See the Specifications for the method of measurement payment.

679.1.2-Materials and Equipment Considerations Latex and silica fume concrete mixes require special designs that require close inspection. Mix designs will be discussed and reviewed at the Pre-Pour Meeting. Test mixes and test slabs will be constructed to ensure compliance. Inspect all materials upon arrival. Verify that aggregate, concrete class and mix proportions, latex, and silica fume admixtures, reinforcing steel, bonding grout, and curing materials (e.g., burlap, quilted covers, polyethylene covers, fiber blankets) conform to the requirements specified in Section 679.2 of the Specifications. Verify that all equipment complies with specified requirements and is in good working order, including all equipment for cutting, hydrodemolition, blastcleaning, proportioning and mixing, placement and finishing, water flushing, saw cutting, and fogging. Note that an effectiveness demonstration will be required prior to using hydrodemolition equipment.

679.2-INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for overlaying Portland cement concrete bridge decks is in conformance with the construction methods and details specified in Section 679 of the Specifications. During the work, check compliance of the following:

1. Removal of deck surface;
2. Equipment restrictions including load limits and protection of steel;
3. Stockpiling, storage, and handling of component materials;

4. Surface preparation and wetting;
5. Equipment calibration and trial runs;
6. Placement limitations and preconditions, including night operations and weather provisions;
7. Concrete placement and finishing operation;
8. Surface texturing and grooving;
9. Straightedge testing; and
10. Curing method, time, and temperature.

Verify that defective or damaged work for this type of application is repaired or removed and replaced based on the provisions of the Contract.

679.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers from the shipping documents, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments, to prepare the Diaries and DWRs. If in doubt as to whether or not information is important or beneficial, record it.

SECTION 681
ASBESTOS ABATEMENT

681.1-GENERAL

681.1.1-Description of Work Section 681 of the Specifications governs the material and construction requirements for asbestos abatement. When Item 681 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 681 of the Specifications and as designated on the Contact Plans. See the Specifications for the method of measurement and payment.

681.1.2-Materials Considerations Inspect all materials upon arrival. Verify that all materials conform to the requirements specified in Section 681 of the Specifications. The Contractor is responsible for submitting an Abatement Plan. Ensure that materials are supplied from pre-approved DOH sources, as applicable, and document laboratory numbers from the shipping documents on the Daily Work Report.

681.2-INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for asbestos abatement is in conformance with the construction methods and details specified in Section 681 of the Specifications. Pay particular attention to the preparation of work area, exhaust system, decontamination enclosure system, work area entry, asbestos removal, site inspection, cleanup, and disposal.

681.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments. If in doubt as to whether or not information is important or beneficial, record it.

SECTION 685
BRIDGE CLEANING

685.1-GENERAL

685.1.1-Description of Work Section 685 of the Specifications governs the material and construction requirements for bridge cleaning. When Item 685 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 685 of the Specifications and as designated on the Contact Plans. See the Specifications for the method of measurement and payment.

685.1.2-Materials Considerations Inspect all materials upon arrival. Verify that all materials conform to the requirements specified in Section 685 of the Specifications. Ensure that materials are supplied from pre-approved DOH sources, as applicable, and document laboratory numbers from the shipping documents on the Daily Work Report.

685.2-INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for bridge cleaning is in conformance with the construction methods and details specified in Section 685 of the Specifications. Pay particular attention to the phases of cleaning, testing of structural steel, and contractor responsibility requirements.

685.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments. If in doubt as to whether or not information is important or beneficial, record it.

SECTION 687
SHOP PAINTING OF METAL STRUCTURES

687.1-GENERAL

687.1.1-Description of Work Section 687 of the Specifications governs the material and construction requirements for shop painting of metal structures. When Item 687 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 687 of the Specifications and as designated on the Contact Plans. See the Specifications for the method of measurement and payment.

687.1.2-Materials Considerations Inspect all materials upon arrival. Verify that all materials conform to the requirements specified in Section 687.2 of the Specifications. The Contractor and shop fabricator are responsible for submitting a Quality Control Plan based on the requirements of MP 688.02.20. Ensure that materials are supplied from pre-approved DOH sources, as applicable, and document laboratory numbers from the shipping documents on the Daily Work Report.

687.2-INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for shop painting of metal structures is in conformance with the construction methods and details specified in Section 687 of the Specifications. The cleaning and painting operation must be in conformance with the Contractor's approved Quality Control Plan. Prior to the operation, review the specified weather limitations. Pay particular attention to the paint application requirements.

687.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments. If in doubt as to whether or not information is important or beneficial, record it.

SECTION 688
FIELD PAINTING OF METAL STRUCTURES

688.1-GENERAL REQUIREMENTS

688.1.1-Description of Work Section 688 of the Specifications governs the material and construction requirements for shop painting for new steel structures and field painting of new and existing structures. When Item 688 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 688 of the Specifications and as designated on the Contract Plans. See the Specifications for the method of measurement payment.

688.1.2-Materials and Equipment Considerations Inspect all materials and equipment upon arrival at the job site. Verify that all materials and equipment conform to the requirements specified in Section 688.2 of the Specifications. The Contractor and shop fabricator are responsible for submitting a Quality Control Plan based on the requirements of MP 688.02.20. Ensure that materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Daily Work Report.

688.1.3-Environmental and Hazard Considerations Know the requirements specified for environmental protection that are defined in Section 688.3.2.2 and 688.3.3.6 of the Specifications. Know the precautions that must be in place to protect workers.

688.2-INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for painting steel structures is in conformance with the construction methods and details specified in Section 688 of the Specifications. The cleaning and painting operation must be in conformance with the Contractor's approved Quality Control Plan. Prior to the operation, review the specified weather limitations.

688.2.1-Cleaning Steel Surfaces Verify that a system is used that allows the steel to be cleaned and inspected just prior to painting. Only as much surface should be cleaned in one day as can be painted on that day. There are two approved methods of cleaning steel: hand cleaning and sand blasting. Oil and grease are removed with an approved cleaner.

688.2.2-Brushing and Rolling Thorough mixing of the paint before it is applied is essential. A mechanical mixer should be used for stirring the paint. Paint should be spread smoothly and uniformly. Paint should be worked into all corners, joints, and other hard to reach placed. A sheepskin dauber may be used to coat any surface that cannot be reached with a brush. The first field coat is started by applying paint only to such surfaces as rivet heads, bolt heads and nuts, and edges of plates, angles, and other rolled shapes. Then, as soon as this paint has dried thoroughly, the first coat is completed by painting all surfaces, including those covered previously. Finally, runs are picked up, and the paint is laid off in one direction.

688.2.3-Spray Painting The paint should be applied in a uniform layer. The pattern to be followed in applying the paint should make it possible to obtain a uniform thickness of not less than the specified mil thickness. There must be some overlapping at the edges of strips covered on successive strokes of the spray gun. The spray gun should be held at right angles and at the correct distance to the surface being painted. Runs and sags must be brushed out right away, or the paint must be removed and the surface repainted.

688.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments, to prepare the Diaries and DWRs. If in doubt as to whether or not information is important or beneficial, record it.

SECTION 690
SURFACE PREPARATION AND POWDER COATING OF
NEW GALVANIZED STEEL OR HIGHWAY SIGNING AND LIGHTING STRUCTURES

690.1-GENERAL

690.1.1-Description of Work Section 690 of the Specifications governs the material and construction requirements for surface preparation and powder coatings of new galvanized steel or highway signing and lighting structures. When Item 690 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 689 of the Specifications and as designated on the Contact Plans. See the Specifications for the method of measurement and payment.

690.1.2-Material Considerations Inspect all materials upon arrival. Verify that all materials conform to the requirements specified in Section 690.2 of the Specifications. Ensure that materials are supplied from pre-approved DOH sources, as applicable, and document laboratory numbers from the shipping documents on the Daily Work Report.

690.2-INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for surface preparation and powder coatings of new galvanized steel or highway signing and lighting structures is in conformance with the construction methods and details specified in Section 690 of the Specifications. Pay particular attention to the application of surface preparation, environmental conditions, powder coating application, and repair of damaged coating.

690.3-RECORDS AND DAILY WORK REPORTS

The Project Inspector is responsible for recording in the Daily Work Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The DWR must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use AASHTOWare Project, and pertinent attachments. If in doubt as to whether or not information is important or beneficial, record it.

DIVISION 700
MATERIALS CONTROL

SECTION 701
PURPOSE AND IMPORTANCE OF CONTROL OF MATERIALS

701.1-GENERAL

A successful highway construction project depends on proper initial planning and scheduling. Prior to construction, carefully consider each major construction phase as it relates to the overall project —what activities need to be performed; who will be responsible for the activity; when will the activity need to begin and end relative to other activities; what if any special equipment or procedures will be required; etc. During this process, it is very important to include the activities related to material quality control and assurance.

The West Virginia Division of Highways (WVDOH) is ultimately responsible for assuring the quality of all materials used in its highway construction projects. It is important that these materials be controlled and monitored uniformly to achieve an acceptable level of quality in the highway project. The importance of this action is two-fold:

1. The public will be assured of receiving the full benefit of tax dollars expended toward highway construction; and
2. A uniform basis of bidding is offered to all Contractors who want to participate in highway projects, either financed with State or a combination of State and Federal funds.

WVDOH publishes its Quality Control/Quality Assurance (QC/QA) procedures and criteria primarily in the Specifications (including Supplemental Specifications and Special Provisions) and Materials Procedures. Obtain these and related documents from the Materials Control, Soils and Testing Division. Division 700 of this Manual provides additional guidance. It is essential that project personnel from both the Contractor (e.g., Project Superintendent, Forman) and WVDOH (e.g., Project Engineer/Supervisor, Inspector, District Materials Supervisor) reference these documents frequently to become familiar with and uniformly apply correct procedures and criteria.

Material quality is a primary concern from project start to finish. Sampling, testing, inspection, and approval duties are integral parts of the project's day-to-day activities. WVDOH is primarily responsible for quality assurance. Personnel from the Contract Administration Division, the Engineering Division, MCS&T Division, and the District will perform their respective duties to verify the quality of material provided by the Contractor and either accept or reject the material at the source, upon delivery, or as placed in the project. The Contractor is primarily responsible for quality control, which includes using pre-approved and certified materials and monitoring and adjusting material production and placement to achieve a level of quality specified by WVDOH.

701.2-COMPLIANCE WITH SPECIFICATIONS

An adequate and effective system for control of materials used in a project is absolutely essential to ensure that the materials furnished and the work performed by the Contractor conform, or reasonably conform as permitted, with the requirements of the plans and specifications.

Control of materials includes: inspection, sampling, testing, and measurement of materials and processes; reporting of procedures and results; and performing any necessary follow-up activities, especially in cases of test failures. If any one of these actions is ignored, the Project Engineer/Supervisor cannot completely or accurately verify whether or not the Contractor is in compliance with the plans and specifications.

701.3-UNIFORM RELATIONS WITH CONTRACTORS

Because the plans and specifications define the minimum requirements that WVDOH expects of the Contractor, they provide an equitable basis for bidding on the project prior to letting the contract. Each prospective bidder has the opportunity to commit to furnishing materials and completed work that will equal or exceed the specified minimum requirements.

The Project Engineer/Supervisor is responsible, through materials control measures, for verifying that the Contractor is at least meeting the specified minimum requirements and that WVDOH is receiving what it is entitled to under the contract. To do otherwise not only would be a disservice to the State but also an undue advantage to the winning Contractor. Other Contractors, having bid on the same project, could contend that they would have offered a lower bid knowing that materials and work below minimum requirements would be acceptable to WVDOH.

Project Engineers/Supervisors and Inspectors are responsible for treating all Contractors and their material suppliers equally by exercising materials control activities uniformly from project to project. Misunderstandings and interpretation differences will hinder this objective. As such, WVDOH prepares its project plans and specifications to be as clear and concise as practical. Division 700 of this Manual provides additional guidance on how to interpret the specifications relative to control of materials.

701.4-DOCUMENTATION FOR EXPENDITURE OF PUBLIC FUNDS

701.4.1-Documentation and Payment Prior to paying the Contractor for materials furnished and work performed, WVDOH requires sufficient documented evidence to support the expenditure. Project personnel use a materials control process, established by the Contract Administration Division, to collect and document this evidence on a day-to-day basis. Through this process, the Project Engineer/Supervisor will acquire sufficient data (e.g., test results, inspection records, field measurements) to substantiate acceptance of the Contractor's work, thus assuring WVDOH that the Contractor has fulfilled its contractual obligations and is entitled to full payment. Upon receipt of such documentation, responsible WVDOH officials can legitimately authorize payment to the Contractor.

701.4.2-Daily Reports Inspectors and Project Engineers/Supervisors respectively use the Daily Work Report and/or project's Diary to collect data on the daily activities and environs of the project. Supplemental attachments to DWR/Diary may be required. These Daily Reports provide a permanent written record of the project.

701.4.3-AASHTOWare Site Manager AASHTOWare SiteManager is a project management system developed by AASHTO. Project Engineers/Supervisors and Inspectors use SiteManager on a daily basis to record and manage data and report on the delivery, testing, placement, and payment of all materials received and placed on the project.

701.4.4-Weekly Suppliers Report (Form HL-441) Material sources that furnish materials to one or more projects are responsible for completing and submitting Weekly Suppliers Reports (Form HL-441) to the District Materials Supervisor. The District Materials Supervisor is responsible for entering pertinent information from Form HL-441 into SiteManager and filed in appropriate ProjectWise folder.

701.4.5-Laboratory Approval Numbers The Division's materials control process uses an index called a sample ID in conjunction with laboratory / approval number to track the test results of materials furnished by the Contractor. Without a laboratory / approval number, the process cannot ascertain be certain whether or not the material has been approved for use on the project. Therefore, it is very important that the Inspector, prior to accepting delivery of the material, check the shipping document to ensure it originated at the point of manufacture (i.e., not the supplier) and that it contains the appropriate laboratory / approval number, project number, and authorization. In the case of a 3rd party distributor, ensure that the original producer's name and laboratory/approval number is on the provided documents. This original producer's name should be clear, not abbreviate, alluded to, or assumed (such as a cryptic item number on the invoice.) Record the laboratory number with other pertinent information on the Daily Work Report. See MP 700.00.01 for additional information on sampling and testing materials at the source.

701.4.6-Basis for Acceptance
Data managed by the materials control process constitutes the Division's basis for accepting or rejecting the materials furnished and the work performed by the Contractor, and ultimately for approving or denying payment to the Contractor. In cases where the Contractor does not meet the specified minimum requirements, this data may be used to negotiate a contract price adjustment with the Contractor if the Division chooses to use the data as a basis for acceptance. It is therefore extremely important to maintain complete and accurate project records (e.g., test procedures and results, laboratory numbers, inspection reports) at all levels including the Project Field Office, the District, and the Contract Administration Division.

Different materials are accepted in difference ways. The following general categories are the methods of acceptance for materials:

1. Direct Test
2. Approved Product List (APL)
3. Direct Coverage (DC)
4. Master Sample
5. Documentation

Materials, and their corresponding test methods are outlined in Specifications and the material's respective Materials Procedures (MP). The WVDOH MCST Evidence of Inspection Form is a tool to help point the inspector in the right direction as far as which test(s) are required and their frequency, though this should only be used as a guideline; the Specifications and MPs are the governing guidelines and should be used if the inspector is not familiar with the testing requirements. The Evidence of Inspection form is discussed in Section 702.4.2 of this manual.

SECTION 702
GENERAL PROCEDURES FOR MATERIALS CONTROL

702.1-APPLICATION OF SPECIFICATIONS

WVDOH determines the acceptability of all construction materials prior to their use in highway projects. Division personnel will inspect, sample, and test the materials and compare the results to the minimum requirements of the contract specifications. The Specifications occasionally references test procedures developed by national organizations such as the American Association of State Highway and Transportation Officials (AASHTO) and the American Society for Testing and Materials (ASTM). Online access and/or reference data of the AASHTO and ASTM material and testing specifications are maintained and available through Materials Control, Soils and Testing (MCS&T) Division. The Standard Specifications also reference specific WVDOH materials and testing procedures (e.g., MP 700.00.01). Current versions of the Materials Procedures are available on MCS&T website.

702.2-FORM PC-454

To expedite material inspection, sampling, and testing, the Contractor will use Form PC-454 to inform the Project Engineer/Supervisor of all proposed material sources, including those supplied by any subcontractors. The Contractor will list separately on Form PC-454 each proposed source for the types of material required by the contract. Any known WVDOH pre-approved and certified material sources and/or mix designs (e.g., asphalt concrete, PCC) should be included on the Form. If a source or mix design has not been pre-approved and certified by the Division, the Contractor will list the sources of all raw materials to be used in production. Ensure that the source's physical address is included on Form PC-454. Post office boxes (i.e., P.O. Box) are not acceptable.

Desirably, the Contractor will submit Form PC-454 to the District before the Pre-Construction Conference; otherwise, the Contractor must bring it to the Conference. The District will cross-reference the types of materials listed on Form PC-454 with those materials specified in the contract and inform the Contractor of any omitted items. Upon District approval, the District will place a copy of Form PC-454 in ProjectWise under the specific project folder. As soon as practical, the Contractor should forward letters to its suppliers advising them that WVDOH will test all materials for acceptance prior to delivery to the project. Immediately after the Pre-Construction Conference, the Materials Control, Soils and Testing Division will verify that each supplier listed on Form PC-454 has been prepared.

The Contractor will include on the initial Form PC-454 all anticipated material sources for plant production and field operations. An updated Form PC-454 will only be required if the Contractor anticipates using a different or additional material source or mix design during construction. If a pre-approved and certified mix design is to be used on the project, the Contractor should use the laboratory number of the pavement mix rather than listing individual material components of the mix on Form PC-454.

702.3-STANCARD PROCEDURES AND THE INSPECTOR
To objectively determine whether or not a material meets the minimum requirements of the Specifications, it is critical to perform the procedures consistently each time.

To achieve this objective, WVDOH references or publishes standardized procedures that are based on either national industry standards or the previous experience of Division personnel in highway construction. These standardized procedures are frequently referenced in the Specifications as ASTM and AASHTO testing and materials specifications or WVDOH Materials Procedures. See Section
702.1 for additional information on the application of contract specifications.

Inspectors at the plant or on the job site are in the best position to pass judgment on whether or not project materials meet the requirements of the contract specifications. Inspectors ensure that each tax dollar is spent to the full benefit of the public and that all Contractors and suppliers are treated objectively. Inspectors ensure that the Contractor has a WVDOH approved Quality Control Plan and that the Contractor and its suppliers are operating within that Plan. If the Division decides to use the Contractor's quality control tests as acceptance criteria for particular contract items, Inspectors ensure that the Contractor's personnel are qualified, that they sample and test the material based on the standardized procedures of the contract specifications, and that they properly document the test results.

702.4-DUTIES OF THE INSPECTOR

702.4.1-Daily Work Report The Inspector is responsible for ensuring that all materials delivered to the project have complete and accurate shipping documents and are identified with appropriate WVDOH laboratory numbers. The Division requires that all materials be inspected, sampled, tested, and approved before they are used on the project. Reject materials that are delivered without laboratory numbers. To expedite the approval process, note the point of inspection if different from the source. Visually inspect all materials to ensure they are delivered in good condition, and reject materials that are obviously damaged from shipping and handling. The arrival of all materials must be properly documented. Document the following information on the Daily Work Report under contact line item for which work is to be used:

1. Description of material;
2. Quantity of material;
3. Source of material;
4. Any test data information (e.g., laboratory numbers, inspection and identification markings, shipping documents);
5. Location, condition, and storage of the material;
6. Any other relevant information; and
7. Invoices/delivery tickets as attachments to DWR

If an unusual material or requirement is identified in the contract plans and specifications, attach a note calling attention to the special condition on any sample of material forwarded to either the District Materials Supervisor or the Materials Control, Soils and Testing Division.

702.4.2-Evidence of Inspection It is extremely important to properly determine and document the acceptability of all construction materials before they are used in the project. Use the Evidence of Inspection to identify, for each contract pay item: the material involved, coverage type, evidence of inspection, and method of documentation required. This can be obtained from the MCS&T website. If a delivered material fails to meet the requirements of Evidence of Inspection or is otherwise questionable, the following actions will be taken:

1. The Inspector will immediately notify the Project Engineer/Supervisor of the situation.
2. The Project Engineer/Supervisor will request the Contractor to furnish the applicable test data or to sample and test the material as may be required by the Specifications.
3. The Project Engineer/Supervisor will enlist the aid of the District Materials Supervisor on any problems with materials sampling and testing and/or documentation that cannot be satisfactorily resolved with the Contractor.
4. Upon receipt and approval of the required test data, a determination of materials acceptability will be made.

702.4.3-Quality Control Plan For some contract pay items, the Division requires the Contractor to submit a Quality Control Plan for review and approval. For those items that require a Quality Control Plan, do not assume that all material sampling and testing activities are the Contractor's responsibility. There usually exists some division of responsibilities between WVDOH and the Contractor. The Contractor is typically responsible for material sampling and testing activities associated with materials quality control, while the Division is responsible for those activities associated with the quality assurance of materials. The Inspector, and ultimately, the Project Engineer/Supervisor is responsible for ensuring that the Contractor is operating within the sampling and testing requirements of the Quality Control Plan. If the Contractor's samples and tests are to be used as part of the Division's material acceptance procedure, ensure that the Contractor's quality control sampling and testing procedures are in compliance with the procedures established by WVDOH (e.g., see MP 307.00.50 for guidelines on base course test procedures, see MP 401.03.50 for guidelines on asphalt concrete test procedures).

702.5-GENERAL INSTRUCTIONS FOR SAMPLING AND TESTING

Numerous types of materials are used in WVDOH highway construction projects. Each material has specific inspection, sampling, and testing procedures established by the Division to assess material quality and acceptability. It is very important to completely understand these procedures and requirements. By understanding how to treat a particular material upon its arrival at the job site, the Inspector can minimize construction delays and better assess material quality.

Use the material inspection and source approval procedures documented in Section 106 of this Manual. If it is not practical to follow these procedures for a particular lot of material, notify and obtain approval from the Project Engineer/Supervisor before any quantity of material from that lot is used in construction work. See Figure 703A for the minimum required sample locations, sample and test frequencies, sample sizes, and test procedures for particular types of materials. Some samples may need field testing while others may need shipped to the laboratory for testing. Use Figure 703A in conjunction with the Specifications, Materials Procedures, and ASTM and

AASHTO specifications. These references describe the details of the procedures. Note that changes in standardized sampling and testing procedures (e.g., Supplemental Specifications) may apply during the project.

702.6-VISUAL INSPECTION

Although a material will be approved for use and identified with a WVDOH laboratory number before it is shipped to the job site, examine each shipment as soon as practical after it is received to identify any damage or undesirable change that may have occurred from shipping and handling. As practical, inspect all material that will be stocked on site while it is being unloaded. This is especially important for relatively large and brittle items such as reinforced concrete pipe. Just prior to their use or placement, conduct a final visual inspection of all materials. If a condition arises that could prevent the material from meeting the contract specifications or otherwise result in unsatisfactory performance, contact the Project Engineer/Supervisor for approval before allowing the Contractor to use the material in the project. See Section 106 of the Specifications.

702.7-IDENTIFICATION OF SAMPLES

For the Division to properly assess the acceptability of a particular type and lot of material, each sample must be processed correctly. An improperly or incompletely identified sample is worthless and may cause a delay in construction. Ensure that complete identification of the sample is provided on a properly executed Form T-100 (Test Sample Data) and that the completed Form T-100 is shipped with the sample. Forward Form T-100 to the District Materials Supervisor prior to submission to the Materials Control, Soils and Testing Division. The District will review Form T-100 and obtain information needed for its files before a formal submission is made. Division project personnel will assign the laboratory number to all samples taken at the job site by either WVDOH or the Contractor. Project personnel also need to enter the material data in SiteManager and generate a Sample ID in the system.

702.8-MATERIAL REJECTION ON THE PROJECT

If the Division rejects a lot of material on the basis of acceptance sampling and testing, inform the Contractor to set the lot of material aside and notify the Project Engineer/Supervisor of the situation. Under certain circumstances, material lots and/or sublots that do not initially conform to contract specifications may be eligible for reworking or partial replacement with Division acceptance based on the outcome of further sampling and testing. For example, if a lift of suitable embankment at optimum moisture content fails to meet the minimum density requirements of the contract specifications, it may be practical for the Contractor to rework the lift and resubmit a new sample for further acceptance testing.

Through visual inspection and acceptance testing, it is extremely important to ensure that project materials meet the requirements of the contract specifications. Do not permit the Contractor to use obviously substandard or damaged materials without first resolving the matter with and obtaining approval from the Project Engineer/Supervisor.

Districts will cooperate fully with the Materials Control, Soils and Testing Division to obtain Independent Assurance (IA) samples and to resolve any identified dissimilarities.

SECTION 703
REQUIRED SAMPLES AND TESTS

703.1-GENERAL

The Division requires that a material's quality be verified prior to using the material in construction. The Project Engineer/Supervisor is responsible for ascertaining that each material has been tested and found to comply with the contract specifications. Under the Division's pre-sampling and pre-testing program and in accordance with the procedures described in MP 700.00.01, most manufactured material products will be pre-approved for use as delivered to the job site. However, the Division may require additional sampling and testing before the material is incorporated in the project. For job control purposes, consider materials that are delivered with proper identification markings and documentation in accordance with MP 700.00.01 as having been adequately sampled and tested. Such materials typically will not require additional sampling and testing. Do not permit the Contractor to incorporate in the project any material that does not have a proper inspection identification marking or laboratory number. Immediately inform the Project Engineer/Supervisor of the situation. The Project Engineer/Supervisor will ascertain whether or not the material complies with the contract specifications and will recommend an appropriate action. Materials that require additional sampling and testing at the job site, whether pre-approved or not, will be sampled and tested according to the criteria presented in this Section.

703.2-MINIMUM SAMPLING AND TESTING REQUIREMENTS

Material Procedures, documents, tools, and other resources are used to determine the Division's minimum sampling and testing criteria (e.g., sample locations, sample and test frequencies, sample sizes, test procedures) for various types of construction materials.

See Section 701.4.6 of this manual for the general categories as methods of acceptance for materials (Direct Test, Approved Product List (APL), Direct Coverage, Master Sample, and Documentation). For Direct Test, the approved material specific Contractor's Quality Control Plan will be the governing documentation for the minimum sampling and testing requirements. The following Material Procedures govern the minimum sampling and testing requirements for each specific material's Direct Test:

1. MP 307.00.50 Guide for Quality Control and Acceptance Plans for Subgrade, Base Course, and Aggregate Items.
2. MP 401.03.50 Guide for Quality Control Plans for Asphalt.
3. MP 601.03.50 Guide for Quality Control and Acceptance Requirements for Portland Cement Concrete
4. MP 717.04.21 Guide for Quality Control of Compaction

Additionally, the Evidence of Inspection Form will assist with determining the minimum sampling and testing requirements for the acceptance method for each item's materials. The Evidence of Inspection form can be found in the Materials Control, Soils & Testing Division's section of ProjectWise.

AASHTO or ASTM materials specification can be located at the Materials Control, Soils, & Testing Division's SharePoint site by clicking on the ASTM Compass link. Material Procedures are available on MCS&T webpage.

See Section 106 of this Manual for additional information on control of materials.

703.3-DENSITY TESTS

See Sections 704, 706, and 707 of this Manual for density test requirements for aggregates, asphalt materials, and embankments and backfill, respectively.

703.4-INDEPENDENT ASSURANCE (IA) SAMPLING AND TESTING PROGRAM

As part of the WVDOH Quality Assurance Program for aggregates, asphalt, and concrete mixes, the Division has established an Independent Assurance (IA) sampling and testing program. Under this program, individuals not having a direct responsibility for quality control or acceptance will independently sample and test project materials to generate a separate and distinct set of test results. The Division will use IA samples and tests to objectively judge the reliability of samples and tests used for acceptance, and not to directly determine the quality or acceptability of material and workmanship.

Depending on the required procedure, an IA sample may be a portion taken from the sample used for acceptance or a separate sample taken in close proximity to the sample used for acceptance in both time and space. IA samples are evaluated according to the procedure described in MP 700.00.53 "Procedure For Evaluating Independent Assurance Samples with Acceptance Samples."

703.5-ACCURACY AND PRECISION IN TESTING

All sampling and testing of materials must be conducted uniformly using standardized procedures to properly compare the results not only to the contract specifications but also to the results of other tests. A test is called repeatable if one person obtains nearly identical results from testing two specimens, each derived from the same sample, using the same test equipment. A test is called reproducible if two people using different test equipment obtain nearly identical results by each testing a specimen derived from the same sample. Material sampling and testing methods established by WVDOH (e.g., Materials Procedures) and national organizations (e.g., AASHTO, ASTM) have been developed so that they not only will be repeatable and reproducible but also will produce accurate and precise results. Accuracy means that all test results are close to true value. Precision means that all test results have nearly the same value, which may or may not be the true value. For a test to be both repeatable and reproducible with accurate results, the test equipment that is specified in the sampling and testing procedure must be used in the specified manner. For example, if a concrete cylinder is tested in a compression machine that is operated at a speed higher than that specified by the procedure, the measured compressive strength will be higher than the true value. The test results may be precise, but they will not be accurate.

SECTION 704
AGGREGATES

704.1-DEFINITION

Aggregates are composed of inert mineral matter, either crushed or uncrushed, which have been properly sized (e.g., sieve analysis) for the intended use. Aggregates are used for Portland cement concrete, asphalt concrete, base courses, granular backfills, surface treatments, pipe bedding, etc. See the respective sections of the Specifications for information on aggregates materials and their application.

704.2-AGGREGATE TECHNICIAN INSTRUCTION MANUAL

The Division certifies inspectors through examination. The Aggregate Technician Instruction Manual, available on the Materials Control, Soils and Testing Division website, is not only a study guide for the Aggregate Technician Certification Examination but also a practical guide for the Aggregate Technician to use on a day-to-day basis. The topics covered by this publication include:

1. General information on aggregate properties and characteristics (e.g., shape and surface texture, gradation, fineness modulus, Atterberg limits);
2. Sampling methods and equipment;
3. Sieve analysis and acceptance procedures;
4. Specific gravity;
5. Unit weight;
6. Liquid limit, plastic limit, and plasticity index;
7. Percent crushed particles and face fracture;
8. Control charts and test result evaluation;
9. Quality control plans;
10. Conversion charts;
11. Applicable Specifications, Materials Procedures, AASHTO and ASTM sampling and testing specifications, and other industry references; and
12. Other practical topics.

704.3-SOIL AND AGGREGATE COMPACTION TECHNICIAN INSTRUCTION MANUAL

The Soil and Aggregate Compaction Technician Instruction Manual, available on the Materials Control, Soils and Testing Division webpage, is primarily a study guide for the Compaction Technician Certification Exam. It is also a practical guide for the Compaction Inspector to use on a day-to-day basis. The topics covered by this publication include:

1. Rock, soil, granular and select material types and properties;
2. Placement, compaction, and testing of embankment, subgrade, backfill, treated and untreated materials, and asphalt concrete pavements;
3. Optimum moisture and maximum density;
4. Sampling and testing methods, procedures and equipment;
5. Radiation safety procedures and operation and transport of nuclear gauges;

6. Evaluation of test results;
7. Rounding procedures and calculations;
8. Applicable Specifications, Materials Procedures, AASHTO and ASTM sampling and testing specifications, and other industry references; and
9. Other practical topics.

704.4-COMPACTION TESTING PROCEDURES

The following WVDOH Materials Procedures describe in detail the Division's compaction sampling and testing procedures:

1. MP 207.07.20, "Nuclear Field Density — Moisture Test for Random Material Having Less Than 40% of 3/4" (19 mm) Material";
2. MP 307.00.50, "Guide for Quality Control and Acceptance Plans for Base Control";
3. MP 401.03.50, "Guide for Quality Control and Acceptance for Hot-Mix Asphalt";
4. MP 700.00.24, "Nuclear Density Test by the Roller Pass Method";
5. MP 700.00.50, "Method of Acceptance of Compaction Testing";
6. MP 712.21.26, "Procedure for Determining the Random Location of Compaction Tests"; and
7. MP 717.04.21, "Guide for Quality Control For Compaction."

704.5-AGGREGATE SAMPLING INSPECTOR INSTRUCTION MANUAL

The Division certifies inspectors through examination. ***The Aggregate Sampling Inspector Programmed Instruction Manual***, available on the Materials Control, Soils and Testing Division website, is not only a study guide for the Aggregate Sampling Inspector Certification Examination but also a practical guide for the Aggregate Sampling Inspector to use on a day-to-day basis. The topics covered by this publication include:

1. Sampling methods and equipment;
2. Sample randomization;
3. Sampling procedures (e.g., roadway, conveyor belt, flowing stream, stockpile, spreader box);
4. Transporting samples;
5. Sampling program planning;
6. Applicable Specifications, Materials Procedures, AASHTO and ASTM sampling and testing specifications, and other industry references; and
7. Other practical topics.

In addition, the following Material Procedures will apply:

1. MP 700.00.06, "Aggregate Sampling Procedures"; and
2. MP 700.00.54, "Procedure for Evaluating Quality Control Sample Test Results with Verification Sample Test Results."

SECTION 705
PORTLAND CEMENT CONCRETE

705.1-PORTLAND CEMENT CONCRETE INSPECTOR AND TECHNICIAN INSTRUCTION MANUAL

The Division certifies inspectors through examination. ***The Portland Cement Concrete Inspector and Technician Programmed Instruction Manual***, available from the Materials Control, Soils and Testing Division, is a study guide for the Portland Cement Concrete Inspector Certification Examination. The Portland Cement Concrete Inspector also may use this manual on a day-to-day basis as a practical reference guide. The topics covered by this publication include:

1. Concrete characteristics and relationship of properties (e.g., durability, strength, wear resistance, slump vs. Air content);
2. Production and operations (e.g., cement, water, air entrainment, aggregate quality, mixing, placement, finishing, curing);
3. Documentation (e.g., Quality Control Plan, Form T-702);
4. Sampling and testing methods, equipment, and procedures (e.g., temperature, consistency, air content, strength);
5. Inspection and control (e.g., material handling, transporting and storage, plant facility, batching, mix proportioning and adjustment);
6. Applicable Specifications, Materials Procedures, AASHTO and ASTM sampling and testing specifications, and other industry references; and
7. Other practical topics.

In addition, MP 601.03.50, "Guide for Quality Control and Acceptance Requirements for Portland Cement Concrete" will apply. See the applicable sections of the Specifications for additional information.

705.2-TOTAL, ABSORBED AND FREE MOISTURE

Aggregate weight calculations for concrete batch operations are based on aggregate material in a saturated surface-dry condition. It is not practical in construction to alter aggregate material to achieve an ideal condition. However, if the amount of free moisture in aggregate material is known, it is relatively easy to adjust the weight of damp or wet aggregate to determine the correct weight of saturated, surface-dry aggregate. For practical purposes, the amount of free moisture is the difference between the percent of total moisture and the percent of absorbed moisture in the aggregate material.

In laboratory testing, determine moisture content with a precision that will achieve results that are accurate to the nearest 0.1%. Each percent of free moisture should be based on the saturated surface-dry weight of the aggregate.

For fine and coarse aggregate materials, determine the total amount of moisture as follows:

1. Determine the weight of a damp sample.
2. Dry the sample by means of heat (e.g., oven).
3. Determine the weight of the dry sample.
4. Compute the loss in weight.
5. Divide the loss in weight by the weight of the dried sample and multiply by 100.

Use the following guidelines to determine the percent of absorbed moisture in aggregate materials:

1. Coarse Aggregate. For practical purposes, because it will usually amount to 1% or less, consider the percent of absorbed moisture in coarse aggregate material to be constant. Note, however, that the percent of absorbed moisture in blast furnace slag may be as much as 5%. The percent of absorbed moisture in coarse aggregate material is often assumed in production calculations. Where careful control is necessary, however, test the coarse aggregate material for absorbed moisture. The Contractor's Quality Control Plan should document the allowable percent of absorbed moisture in coarse aggregate material and how it will be determined; whether estimated or the result of moisture tests.
2. Fine Aggregate. During concrete production, perform moisture tests on fine aggregate material at least four times daily and more often when changed conditions warrant. Adjust batch weight based on the results of the tests to ensure that the maximum allowable water-cement ratio is not being exceeded and to reasonably control concrete consistency. Tests will be performed on fine-aggregate samples taken from the weigh-hopper. Ensure that the results are documented in accordance with the Contractor's Quality Control Plan.

The Contractor is responsible for submitting a Quality Control Plan for Division approval. The Inspector is responsible for ensuring that the Contractor has performed this task and is operating within the limits of the Plan.

SECTION 706
ASPHALT MATERIALS

706.1-ASPHALT TECHNICIAN AND INSPECTOR CERTIFICATION PROGRAMS

The Division certifies inspectors and technicians through examination. Information on certification for Asphalt Plant Technician, Asphalt Field and Compaction Technician, and Asphalt Preservation Technician is available on the Materials Control, Soils and Testing Division website. The Asphalt Inspector also may use this manual on a day-to-day basis as a practical reference guide. The topics covered by these programs include:

1. Fundamentals of asphalt materials and hot-mix asphalt;
2. Sampling asphalt and materials;
3. Designing and testing asphalt;
4. Plant control and inspection;
5. Plant setup and adjustment;
6. Principles of hot-mix asphalt compaction;
7. Plant mix formulas and specifications;
8. Superpave mix design system;
9. Applicable Specifications, Materials Procedures, AASHTO and ASTM sampling and testing specifications, and other industry references; and
10. Other practical topics.

See the applicable sections of the Specifications for additional information on asphalt materials. In addition, the following WVDOH Materials Procedures will apply:

1. MP 106.03.50, "General Information Guide for Quality Assurance Testing";
2. MP 401.02.22, "Mix Design Testing of Hot-Mix Asphalt";
3. MP 401.02.24, "Guide to Designing Hot-Mix Asphalt with Recycled Asphalt Pavement";
4. MP 401.02.27 "Guide for Contractor Quality Control of Asphalt Concrete";
5. MP 401.02.28 "Guide to Designing Hot-Mix Asphalt Using Superpave Volumetric Design";
6. MP 401.02.29 "Guideline for Quality Control and Acceptance Requirements for Superpave Hot-Mix Asphalt";
7. MP 401.02.31 "Guide for Quality Control and Acceptance Requirements for Asphalt Mixtures on Specified Interstate and Expressway Projects";
8. MP 401.03.50, "Guide for Quality Control Plans for Asphalt Concrete";
9. MP 700.00.06, "Aggregate Sampling Procedures"; and
10. MP 700.00.54, "Procedure for Evaluating Quality Control Sample Test Results with Verification Sample Results."

SECTION 707
DENSITY TESTS (IN-PLACE) FOR EMBANKMENT AND BACKFILL

707.1-GENERAL

Use in-place density tests to establish the degree of compaction within an embankment, backfill, or subgrade.

1. Undisturbed Method. By using the undisturbed method, the in-place density of an embankment, backfill, or subgrade can be determined without having to remove a portion of the compacted material. This method primarily employs the use of a nuclear testing device. The nuclear gauge in the device has the ability to measure the density and moisture content of the compacted material in the field without having to remove a sample for off-site testing. The Division prefers the use of the undisturbed method. Unless otherwise specified, use nuclear density testing by the roller-pass method (see MP 700.00.24) or Nuclear Field Density – Moisture Test for Random Material Having Less Than 40% of +3/4 Inch Material (see MP 207.07.20).

In highway construction, determining the in-place density of a material is of little value unless there exists a specific density for which the Contractor is trying to achieve through compaction. For a given material and application, the contract specifications will specify a target value for compaction in terms of a percentage of the material's maximum density. This percentage is commonly named percent compaction. Percent compaction is determined by comparing the in-place density of the compacted material to a standardized value for the material type. This value is commonly named maximum density. Maximum density is determined by compacting the material with a controlled and constant compactive effort at varying levels of moisture content until a point is reached at which additional moisture causes a loss in density. The moisture content at which maximum density is reached is named the optimum moisture content.

The compaction test is the only field test required to control normal earthwork. The number of density tests required depends on the amount and type of material being incorporated in the embankment within a given interval of time. Lot size is controlled by the applicable area of the specifications and all lots will have 5 sublots with a test for each sublot (5 tests per lot). The testing technician determines these locations using random numbers. Use nuclear density testing by the roller-pass method for individual embankment areas of a specific material type where the material contains more than 40% +3/4 inch material and the lift thickness will remain constant during the test period (see MP 700.00.24). Use Nuclear Field Density – Moisture Test for Random Material Having Less Than 40% of +3/4 Inch Material (see MP 207.07.20).

707.2-EQUIPMENT

Equipment selection for density testing will depend on the type of material being tested and the method employed (e.g., disturbed method, undisturbed method). Use only equipment that is specified in the sampling and testing procedure required by the governing contract specifications.

707.3-SELECTING TEST LOCATIONS FOR EMBANKMENTS

A very important aspect of compaction testing is selecting the locations where the tests will be performed. This action is as important as reporting the final results. Although individual test results may be accurate, the overall test results of the compacted area could be misleading if test locations are improperly selected. Use the procedures in MP 712.21.26 to determine random locations for compaction testing and consider the following additional guidelines:

1. Settlement Locations. Consider establishing compaction test locations at points near the beginning of an embankment and just outside a cut area. Material settlement frequently occurs at these locations.
2. Ramps. Material used for ramps from cut to fill areas that are within the embankment section will be compacted as placed and tested for density.
3. Work Interruptions. If material placement for an embankment has been interrupted for a considerable amount of time, conduct new compaction tests to ensure no substantial change in density has occurred.

For additional information on random sampling for embankments, see the ***Soil and Aggregate Compaction Technician Programmed Instruction Manual***.

707.4-SELECTING TEST LOCATIONS FOR EMBANKMENTS

See Section 704.3 and 704.4 of this Manual for information on the ***Compaction Technician Programmed Instruction Manual*** and the compaction testing procedures used by WVDOH.

SECTION 708
MISCELLANEOUS PROCEDURES

708.1-CHECKING BATCH PROPORTIONING SCALES

708.1.1-General It is necessary to check the accuracy of scales that are used to weigh aggregate for Portland cement concrete, Portland cement, aggregate for asphalt concrete, asphalt, and other construction materials. Department of Labor and private company scale checks that are conducted in accordance with these procedures may be observed to fulfill specified requirements. If the scale does not have 500-pound graduations, additional test weights will be used to bring the scale to an even graduation that is repeatable throughout the calibration process. The seal on a scale indicates only that the scale was accurate within certain limits under the conditions existing at the time it was tested and sealed. Collected dirt on the balance arms, damage to or wear of the knife edges settlement of the foundation, mechanical work, or authorized or unauthorized adjustment can change the accuracy of a scale from one day to the next.

Scales that are used to weigh Portland cement, aggregate for Portland cement concrete, aggregate for asphalt concrete, and related construction materials shall conform to Section 109.1 of the Specifications.

The Contractor shall have at each batch proportioning or mixing plant at least 10 standard 50-pound weights. These weights must be kept clean and at a location that is convenient for calibrating the scales. The weigh hopper should have an attached shelf on the outside on which the test weights can be placed. If there is no such shelf on the hopper, the Contractor must furnish a cradle or platform which is to be suspended from the scale to hold the test weights. Any equipment set up by the Contractor or plant operator must be so arranged that the scales can be checked quickly and conveniently.

When a shelf is not permanently attached to the weigh hopper, the weight of the cradle, platform, or sling used to suspend the test weights must be determined accurately by use of a small scale. This weight becomes a part of the test weight used for calibrating the scale. The Materials Control, Soil and Testing Division’s document, MP 700.00.30, provides information pertaining to the calibration of the 50-pound weights.

708.1.2-Frequency of Checking and Documentation All scales shall be checked for zero balance and sensitivity in accordance with the approved Quality Control Plan.

708.1.3-Procedure for Checking Zero Balance and Sensitivity To check a beam scale for zero balance, slide all weights to the zero position. If the beam does not balance, either something is stuck in the weigh hopper or the scale is out of order. The trouble should be corrected before any more batches are weighed out.

In the case of a dial scale, the dial hand should return to zero after the weigh hopper is emptied. If it does not, something is probably stuck in the hopper. Before any more batches are weighed out, the reason for improper operation of the sale should be found and corrected.

The most common trouble with a scale is lack of sensitivity when the weigh hopper is loaded with the full weight of the batch. To determine the sensitivity, read the exact weight of the total batch in the hopper from the beam or dial, and then place or hang a 50-pound weight on the weigh hopper. Unless the total weight increases at least 30 pounds (49 pounds for an asphalt scale), the scale should be inspected carefully as soon as practical. The knife edges which support the scale beam may be worn or dirty, or something may be touching the lever arms, or something may be preventing the free movement of the weigh hopper. The Contractor or plant operator must keep the scales in good working order and adjustment. The Inspector should never try to fix or adjust any type of scale.

708.1.4-Procedure for Checking Accuracy The bins should be filled when the first test is made, because the weight of the filled bins may bend the steel members to which the sale is attached and may therefore affect weighing accuracy. At a new plant, the bins should be filled before the scales are checked since the weight of the binned material may cause settlement of the foundation.

To calibrate a scale used for weighing small quantities, such as an asphalt scale, add 50-pound test weights, one at a time, to the shelf or suspending device until the total weight is slightly above the usual batch weight. For each number of weights, record the actual weight and the weight shown by the scale.

The following simplified procedure must be used for weekly checks of scales used for weighing larger quantities. Add the 10 test weights totaling 500 pounds and record the reading. Leave the test weights in place and draw the material into the hopper until the scale reading is approximately 1/3 of the total batch weight. Record this reading, remove the weights and record the reading. Continue to draw material into the hopper until the scale reading is approximately 2/3 of the total batch weight. Record the reading, add the test weights and again record the reading. Leave the test weights in place and continue to draw material into the hopper until the scale reading is 500 pounds more than the total batch weight. Record the reading, remove the test weights and again record the reading. This check can be conducted without holding up production, and will provide a good insight into the performance of the scale.

Complete calibration should be conducted approximately every six months using the following detailed procedure: Add the 10 test weights totaling 500 pounds, and record the scale reading. Remove the test weights and draw material into the hopper until the scale reads exactly the same as it did with the test weights. Leaving this material in the hopper, put on the test weights again, and record the scale reading. Remove the weights and draw more material into the hopper until the reading is the same as before. Continue this procedure until the scale reading is more than the weight of the heaviest total batch to be weighed on the scale.

708.1.5-Procedure for Checking Scales Using Load Cells The procedure for checking zero balance and sensitivity shall be in accordance with Sections 708.1.3 and 708.1.4. If during any check a scale is found to be inaccurate, it will be calibrated by a scale company or replaced, whichever restores accuracy before use by the Division.

The procedure for checking the accuracy of scales with load cells will be modified from Section 708.1.3 as follows: The check of the scales to 25% of capacity will be 500 pounds at a time, alternating with material for test weight. The scale will then be brought to 50% capacity with material, then the test weights will be returned to determine error at this point. The test weights will be removed and material will be used to bring the scale to 75% of capacity, then the test weights will be
returned to determine error at this point. This process will be replaced at the heaviest total batch to be weighed on the scale.

708.2-CHECKING ACCURANCY OF METER PROPORTIONING

708.2.1-Meters or Pumps for Asphalt Materials Frequently check meters and metering pumps used to proportion asphalt in mixtures. If the average of several carefully run extraction tests result in a difference of more than 0.3% between the measured quantity of asphalt material and the quantity of material required by the job mix formula, halt production immediately and have the equipment checked and properly adjusted. The accuracy of meters and metering pumps may be affected by any of the following factors:

1. Changes in pressure of the liquid as it goes into the meter or pump;
2. Changes in temperature or penetration of the asphalt material; and
3. Changes in back pressure that may be caused by partial stoppage of spray nozzles or openings in the spray bars.

Use the following guidelines when checking the accuracy of meter proportioning:

1. Material Quantity. Because percent asphalt in the job mix is specified on a weight basis, check the accuracy of the meter or pump by weighing a quantity of asphalt material at least equal to the quantity used in one batch (use approximately 2 tons for continuous plants). During the test, ensure that the same material type and temperature used to produce the job mix is used to perform the test. If the temperature of the asphalt material varies more than approximately 15°F under normal operating conditions, perform the test at both the highest and the lowest temperatures to determine how the temperature change affects the quantity of asphalt delivered.
2. Bypass. The system used to deliver the asphalt material should be equipped with a bypass. Use this bypass to discharge the asphalt material into a weigh drum instead of the mixer. The bypass must be equipped with a throttle valve. Use the throttle to regulate the rate of flow through the meter or pump to achieve a back pressure similar to that under normal operating conditions.

3. Equipment. To weigh the asphalt, use a platform scale that has a capacity of 300 lbs and a sensitivity of 0.5 lb. Also needed is a metal drum, or similar container, capable of holding an amount of asphalt in excess of the normal batch weight used in production.
4. Procedure. Use the following procedure to check the accuracy of meters and pumps:
   a. Set the meter or pump to the quantity of asphalt material that is normally used to produce the job mix.
   b. Measure the temperature of the material to ensure that it is approximately equal to the storage temperature during normal production.
   c. Check the rate of discharge of asphalt into the mixer under normal operating conditions.
   d. Shift the discharge of the meter or pump from the mixer to the bypass and let the asphalt material flow into a container until the piping is heated. Simultaneously, check the rate of discharge and adjust as necessary by means of the throttle valve to approximate the rate used during normal operating conditions.
   e. Weigh the empty drum or container accurately and record the weight.
   f. For continuous plants, record the reading of the continuous meter or revolution counter.
   g. Operate the meter or pump so that the quantity discharged into the drum equals the batch weight of asphalt material.
   h. Record the temperature of the material in the drum.
   i. For continuous plants, record the final reading on the continuous meter or revolution counter.
   j. Weigh the drum and its contents and subtract the weight of the drum.
   k. Determine the difference between the weight of asphalt material actually discharged in the drum and the weight of asphalt material indicated by the meter or pump.
   l. Find the percent error: Divide the difference in weight determined in Step k by the weight indicated by the meter or pump and multiply by 100.

5. Allowable Percent Error. The allowable percent error is 0.4% or less. If the percent error determined from initially performing the test procedure is greater than 0.4%, repeat the procedure in Item 4 above. If the percent error is again found to be greater than 0.4%, halt mix production until the Contractor or plant operator can resolve the problem. After the meter or pump has been adequately adjusted or repaired, repeat the test procedure in Item 4.
6. Material Quantity in Supply Tank. When recording test data, note the amount of asphalt material in the supply tank. The results of tests made with a nearly full supply tank may be different from those of tests that are made when the tank is empty.

708.2.2-Water Meter at Concrete Plant Calibrate the water meter by drawing off and measuring various sample quantities over the full range of water quantities required for mix production. The water meter should accurately measure the required quantity of water to within 1% of the quantity actually discharged and measured. If the meter fails to meet this criterion, inform the

Contractor or plant operator. Repeat the test and verify calibration after the meter has been properly adjusted or repaired. Record all calibrations, verifications, and sensitivity results in the Plant Diary.

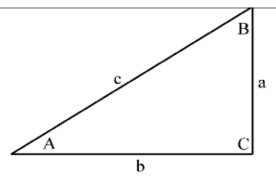
708.2.3-Admixture Dispenser at Concrete Plant Test the admixture dispenser at frequent intervals during mixer operation to ensure that the proper amount of agent is being dispensed for each batch. Calibrate the admixture dispenser by drawing off and measuring various sample quantities over the full range of admixture agent required for mix production. The admixture dispenser should be able to accurately measure the required quantities of admixture agent to within 3% of the quantity actually discharged and measured. If the admixture dispenser fails to meet this criterion, inform the Contractor, or plant operator. Repeat the test after the dispenser has been properly adjusted or repaired. Record the results of all calibrations, verifications, and sensitivity checks in the Plant Diary.

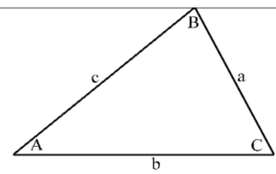
APPENDIX

A.1 — Trigonometric Functions

Angle	Sin	Cos	Tan	Angle	Sin	Cos	Tan
0	0.000	1.000	0.000	46	0.719	0.695	1.04
1	0.017	0.999	0.017	47	0.731	0.682	1.07
2	0.035	0.999	0.035	48	0.743	0.699	1.11
3	0.052	0.999	0.052	49	0.755	0.656	1.15
4	0.070	0.998	0.070	50	0.766	0.643	1.19
5	0.087	0.996	0.087	51	0.777	0.629	1.23
6	0.105	0.995	0.105	52	0.788	0.616	1.28
7	0.112	0.993	0.123	53	0.799	0.602	1.33
8	0.139	0.990	0.141	54	0.809	0.588	1.38
9	0.156	0.988	0.158	55	0.819	0.574	1.43
10	0.174	0.985	0.176	56	0.829	0.559	1.48
11	0.191	0.982	0.194	57	0.839	0.545	1.54
12	0.208	0.978	0.213	58	0.848	0.530	1.60
13	0.225	0.974	0.231	59	0.857	0.515	1.66
14	0.242	0.970	0.249	60	0.866	0.500	1.73
15	0.259	0.966	0.268	61	0.875	0.485	1.80
16	0.276	0.961	0.287	62	0.883	0.469	1.88
17	0.292	0.956	0.306	63	0.891	0.454	1.96
18	0.309	0.951	0.325	64	0.898	0.438	2.05
19	0.326	0.946	0.344	65	0.906	0.423	2.14
20	0.342	0.940	0.364	66	0.914	0.407	2.25
21	0.358	0.934	0.384	67	0.921	0.391	2.36
22	0.375	0.927	0.404	68	0.927	0.375	2.48
23	0.391	0.921	0.424	69	0.934	0.358	2.61
24	0.407	0.914	0.445	70	0.940	0.342	2.75
25	0.423	0.906	0.466	71	0.946	0.326	2.90
26	0.438	0.898	0.488	72	0.951	0.309	3.08
27	0.454	0.891	0.510	73	0.956	0.292	3.27
28	0.469	0.883	0.532	74	0.961	0.276	3.49
29	0.485	0.875	0.554	75	0.966	0.259	3.73
30	0.500	0.866	0.577	76	0.970	0.242	4.01
31	0.515	0.857	0.601	77	0.974	0.225	4.33
32	0.530	0.848	0.625	78	0.978	0.208	4.70
33	0.545	0.839	0.649	79	0.982	0.191	5.14
34	0.559	0.829	0.675	80	0.985	0.174	5.67
35	0.574	0.819	0.700	81	0.988	0.156	6.31
36	0.588	0.809	0.727	82	0.990	0.139	7.12
37	0.602	0.799	0.754	83	0.993	0.122	8.14
38	0.616	0.788	0.781	84	0.995	0.105	9.51
39	0.629	0.777	0.810	85	0.996	0.087	11.43
40	0.643	0.766	0.839	86	0.998	0.070	14.30
41	0.656	0.755	0.869	87	0.999	0.052	19.08
42	0.699	0.743	0.900	88	0.999	0.035	28.64
43	0.682	0.731	0.933	89	0.999	0.017	57.28
44	0.695	0.719	0.966	90	1.000	0.000	Infinity
45	0.707	0.707	1.000				

A.2 — Trigonometric Solution of Triangles



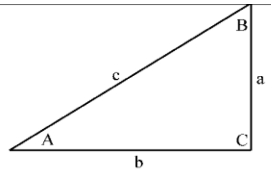


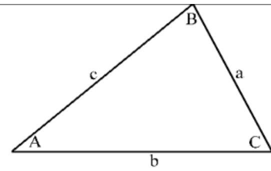
$$S = \frac{a+b+c}{2}$$

Given	Sought	Formulae
RIGHT-ANGLED TRIANGLES		
a,c	A,B,b	$\sin A = \frac{a}{c}$ $\cos B = \frac{a}{c}$ $b = \sqrt{c^2 - a^2}$
	Area	$\text{Area} = \frac{a}{2}\sqrt{c^2 - a^2}$
a,b	A,B,c	$\tan A = \frac{a}{b}$ $\tan B = \frac{b}{a}$ $c = \sqrt{a^2 + b^2}$
	Area	$\text{Area} = \frac{ab}{2}$
A,a	B,b,c	$B = 90° - A$ $b = a \cot A$ $c = \frac{a}{\sin A}$
	Area	$\text{Area} = \frac{a^2 \cot A}{2}$
A,b	B,a,c	$B = 90° - A$ $a = b \tan A$ $c = \frac{b}{\cos A}$
	Area	$\text{Area} = \frac{b^2 \tan A}{2}$
A,c	B,a,b	$B = 90° - A$ $a = c \sin A$ $b = c \cos A$
	Area	$\text{Area} = \frac{c^2 \sin A \cos A}{2}$ or $\frac{c^2 \sin 2A}{4}$

A.2 — Trigonometric Solution of Triangles

(Continued)





$s = \dfrac{a+b+c}{2}$

Given	Sought	Formulae
OBLIQUE-ANGLED TRIANGLES		
a,b,c	A	$\sin\frac{1}{2}A = \sqrt{\frac{(s-b)(s-c)}{bc}}$, $\cos\frac{1}{2}A = \sqrt{\frac{s(s-a)}{bc}}$, $\tan\frac{1}{2}A = \sqrt{\frac{(s-b)(s-c)}{s(s-a)}}$
	B	$\sin\frac{1}{2}B = \sqrt{\frac{(s-a)(s-c)}{ac}}$, $\cos\frac{1}{2}B = \sqrt{\frac{s(s-b)}{ac}}$, $\tan\frac{1}{2}B = \sqrt{\frac{(s-a)(s-c)}{s(s-b)}}$
	C	$\sin\frac{1}{2}C = \sqrt{\frac{(s-a)(s-b)}{ab}}$, $\cos\frac{1}{2}C = \sqrt{\frac{s(s-c)}{ab}}$, $\tan\frac{1}{2}C = \sqrt{\frac{(s-a)(s-b)}{s(s-c)}}$
	Area	Area = $\sqrt{s(s-a)(s-b)(s-c)}$
a,A,B	b,c	$b = \frac{a \sin B}{\sin A}$ $c = \frac{a \sin C}{\sin A} = \frac{a \sin(A+B)}{\sin A}$
	Area	Area = $\frac{1}{2} ab \sin C = \frac{a^2 \sin B \sin C}{2 \sin A}$
a,b,A	B	$\sin B = \frac{b \sin A}{a}$
	c	$c = \frac{a \sin C}{\sin A} = \frac{b \sin C}{\sin B} = \sqrt{a^2 + b^2 - 2ab\cos C}$
	Area	Area = $\frac{1}{2}$ ab sin C
a,b,C	A	$\tan A = \frac{a \sin C}{b - a\cos C}$ $\tan\frac{1}{2}(A-B) = \frac{a-b}{a+b}\cot\frac{1}{2}C$
	c	$c = \sqrt{a^2 \div b^2 - 2ab\cos C} = \frac{a \sin C}{\sin A}$
	Area	Area = $\frac{1}{2} ab \sin C$

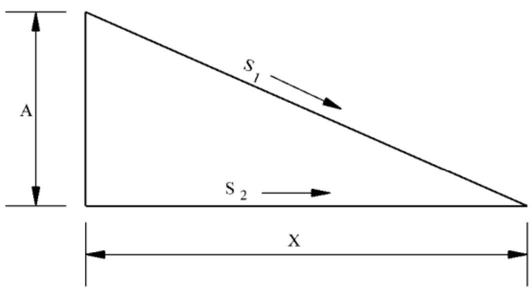
$a^2 = b^2 + c^2 - 2\,bc\cos A$, $b^2 = a^2 + c^2 - 2\,ac\cos B$, $c^2 = a^2 + b^2 - 2\,ab\cos C$

A.3 — Slope Equations

GIVEN: Dimensions A and B
Slopes S_1 and S_2 in feet per foot

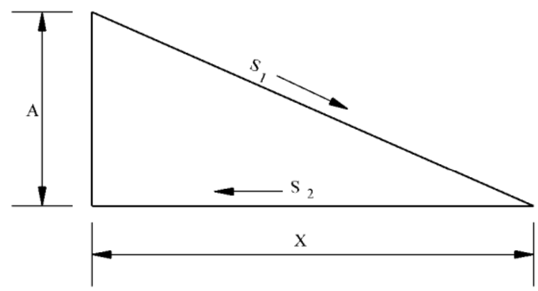
FIND: Horizontal distance X
Area

CASE I



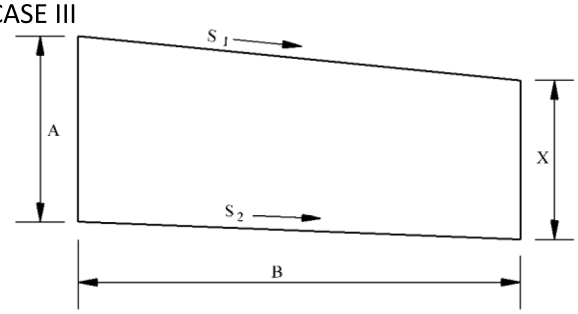
$X = \dfrac{A}{S_1 - S_2}$ Area = $\dfrac{AX}{2}$

CASE II



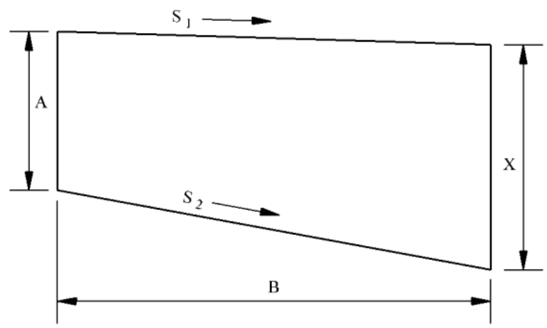
$X = \dfrac{A}{S_1 + S_2}$ Area = $\dfrac{AX}{2}$

CASE III



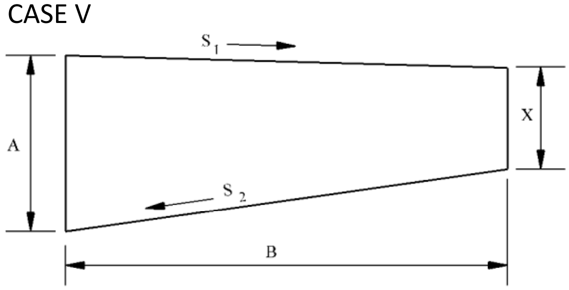
$X = A - (S_1 - S_2)\,B$ Area = $\dfrac{A + X}{2}\,(B)$

CASE IV



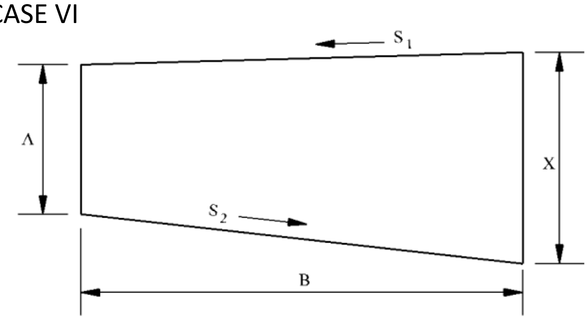
$X = A - (S_1 - S_2)\,B$ Area = $\dfrac{A + X}{2}\,(B)$

CASE V



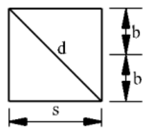
$X = A - (S_1 + S_2)\,B$ Area = $\dfrac{A + X}{2}\,(B)$

CASE VI



$X = A + (S_1 + S_2)\,B$ Area = $\dfrac{A + X}{2}\,(B)$

A.4 — Area of Plane Figures



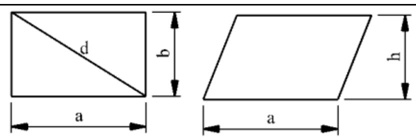
Square

Diagonal = d = s $\sqrt{2}$.

Area = $s^2 = 4b^2 = 0.5d^2$.

Example: s = 6; b = 3. Area = $(6)^2$ = 36 Ans.

d = 6 x 1.414 = 8.484 Ans.

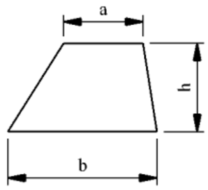


Rectangle and Parallelogram

Area = ab or b $\sqrt{d^2 - b^2}$

Example: a = 6; b = 3.

Area = 3 x 6 = 18 Ans.

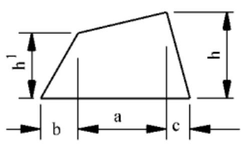


Trapezoid

Area = $\frac{1}{2} h (a + b)$

Example: a = 2; b = 4; h = 3

Area = $\frac{1}{2} \times 3(2 + 4) = 9$ Ans.

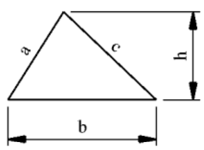


Trapezium

Area = $\frac{1}{2} [a(h + h^1) + bh^1 + ch]$

Example: a = 4; b = 2; c = 2; h = 3; h^1 = 2.

Area = $\frac{1}{2} [4(3 + 2) + (2 \times 2) + (2 \times 3)] = 15$ Ans.



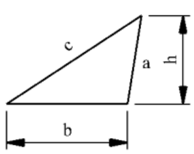
Triangles

Both formulas apply to both figures

Area = $\frac{1}{2}$ bh.

Example: h =3; b = 5.

Area = $\frac{1}{2} (3 \times 5) = 7 \frac{1}{2}$ Ans.

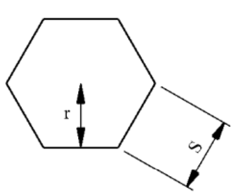


Area = $\sqrt{S(S - a)(S - b)(S - c)}$ when S = $\frac{a + b + c}{2}$

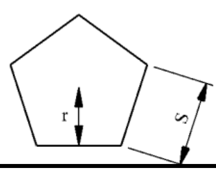
Example: a = 2; b = 3; c = 4.

S = $\frac{2 + 3 + 4}{2}$ = 4.5; Area = $\sqrt{4.5(4.5 - 2)(4.5 - 3)(4.5 - 4)}$ = 2.9 Ans.

Regular Polygons



$$\text{Area}\left\{\begin{array}{lll} 5\text{ sides} & = 1.720477S^2 & = 3.63271r^2 \\ 6\text{ sides} & = 2.598150S^2 & = 3.46410r^2 \\ 7\text{ sides} & = 3.633875S^2 & = 3.37101r^2 \\ 8\text{ sides} & = 4.828427S^2 & = 3.31368r^2 \\ 9\text{ sides} & = 6.181875S^2 & = 3.27573r^2 \\ 10\text{ sides} & = 7.694250S^2 & = 3.24920r^2 \\ 11\text{ sides} & = 9.365675S^2 & = 3.22993r^2 \\ 12\text{ sides} & = 11.196300S^2 & = 3.21539r^2 \end{array}\right.$$

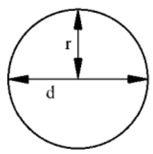


n = number of sides; r = short radius; S = length of side; R = long radius.

Area = $\frac{n}{4} S^2 \cot \frac{180°}{n} = \frac{n}{2} R^2 \sin \frac{360°}{n}$ = $nr^2 \tan \frac{180°}{n}$

A.4 — Area of Plane Figures
(Continued)

Circle



π = 3.1416; A = area d = diameter; p = circumference or periphery; r = radius.

$p = \pi d = 3.1416d.\quad p = 2\sqrt{\pi A} = 3.54\sqrt{A}$

$p = 2\pi r = 6.2832r\quad p = \frac{2A}{r} = \frac{4A}{d}$

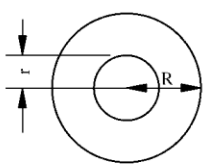
$d = \frac{p}{\pi} = \frac{p}{3.1416}\quad d = 2\sqrt{\frac{A}{\pi}} = 1.128\sqrt{A}$

$r = \frac{p}{2\pi} = \frac{p}{6.2832}\quad r = \sqrt{\frac{A}{\pi}} = 0.564\sqrt{A}$

$A = \frac{\pi d^2}{4} = 0.7854d^2\qquad A = \frac{p^2}{4\pi} = \frac{p^2}{12.57}$

$A = \pi r^2 = 3.1416r^2\qquad A = \frac{pr}{2} = \frac{pd}{4}$

Circular Ring



Area = $\pi(R^2 - r^2) = 3.1416(R^2 - r^2)$

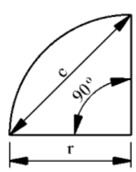
Area = $0.7854(D^2-d^2) = 0.7854(D-d)(D+d)$

Area = difference in areas between the inner and outer circles.

Example: R = 4; r = 2.

Area = $3.1416(4^2-2^2)=37.6992$ Ans.

Quadrant

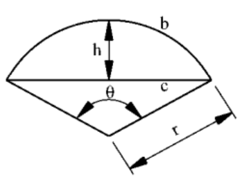


Area = $\frac{\pi r^2}{4} = 0.7854r^2 = 0.3927c^2$

Example: r = 3; c = chord.

Area = $0.7854 \times 3^2 = 7.0686$ Ans.

Segment



b = length of arc $\quad\theta$ = angle in degrees $\quad$ c = chord = $\sqrt{4(2hr - h^2)}$

Area = $\frac{1}{2}\left[br - c(r - h)\right] = \pi r^2 \frac{\theta}{360} - \frac{c(r - h)}{2}$

When θ is greater than 180°, then $\frac{c}{2} \times$ difference between r and h is added to the fraction $\frac{\pi r^2 \theta}{360}$

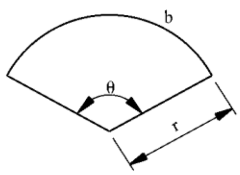
Example: r = 3; θ = 120°; h = 1.5

Area = $3.1416 \times 3^2 \times \frac{120}{360} - \frac{5.196(3 - 1.5)}{2} = 5.5278$ Ans.

A.4 — Area of Plane Figures

(Continued)

Sector



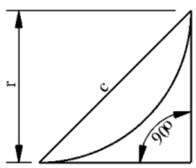
$$\text{Area} = \frac{br}{2} = \pi r^2 \frac{\theta}{360°}$$

θ = angle in degrees; b = length of arc.

Example: r = 3; θ = 120°

$$\text{Area} = 3.1416 \times 3^2 \times \frac{120}{360} = 9.4248 \text{ Ans.}$$

Spandrel

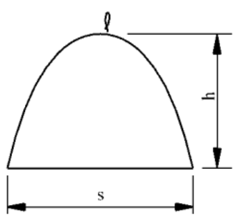


Area = $0.2146r^2 = 0.1073c^2$

Example: r = 3

Area = $0.2146 \times 3^2 = 1.9314$ Ans.

Parabola



ℓ = length of curved line = periphery – s

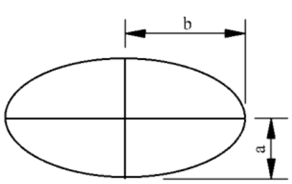
$$\ell = \frac{s^2}{8h}\left[\sqrt{c(1+c)} + 2.0326 \times \log\left(\sqrt{c} + \sqrt{1+c}\right)\right] \text{in which } c = \left(\frac{4h}{s}\right)^2$$

$$\text{Area} = \frac{2}{3} sh$$

Example: s = 3; h = 4

$$\text{Area} = \frac{2}{3} \times 3 \times 4 = 8 \text{ Ans.}$$

Ellipse



Area = π a b = 3.1416ab

$$\text{Circum.} = 2\pi\sqrt{\frac{a^2 + b^2}{2}} \text{ (close approximation)}$$

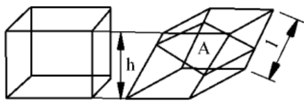
Example: a = 3; b = 4.

Area = 3.1416 x 3 x 4 = 37.6992 Ans.

$$\text{Circum.} = 2 \times 3.1416\sqrt{\frac{(3)^2 + (4)^2}{2}} = 6.2832 \times 3.5355 = 22.21 \text{ Ans.}$$

A.5 — Surface and Volume of Solids

Parallelopiped

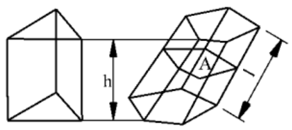


S = perimeter, P, perp. to sides x lat. length, l: Pl

V = area of base, B, x perpendicular height, h: Bh

V = area of section, A, perp. to sides x lat. length, l: Al

Prism, Right or Oblique, Regular or Irregular

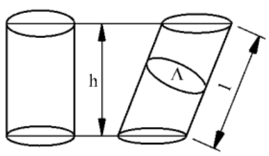


S = perimeter, P, perp. to sides x lat. length, l: Pl

V = area of base, B, x perpendicular height, h: Bh

V = area of section, A, perp. to sides x lat. length, l: Al

Cylinder, Right or Oblique, Circular or Elliptic, etc.



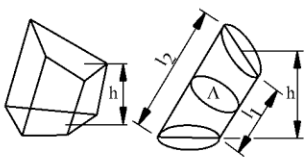
S = perimeter of base, P, x perp. height, h: Ph

S = perimeter, P_1, perp. to sides x lat. length, l: P_1l

V = area of base, B, x perpendicular height, h: Bh

V = area of section, A, perp. to sides x lat. length, l: Al

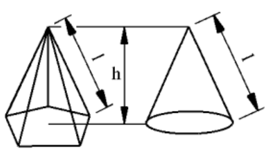
Frustum of any Prism or Cylinder



V = area of base, B, x perp. distance, h, from base to center of gravity of opposite face: Bh

For cylinder: $\frac{1}{2}A(l_1 + l_2)$

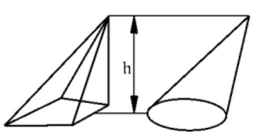
Pyramid or Cone, Right and Regular



S = perimeter of base, P, x $\frac{1}{2}$ slant height, l: $\frac{1}{2}Pl$

V = area of base, B, x $\frac{1}{8}$ perp. height, h: $\frac{1}{8}Bh$

Pyramid or Cone, Right or Oblique, Regular or Irregular

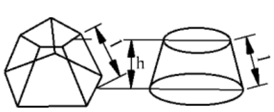


V = area of base, B, x $\frac{1}{3}$ perp. height, h: $\frac{1}{3}Bh$

V = $\frac{1}{3}$ volume of prism or cylinder of same base and perpendicular height

V = $\frac{1}{2}$ volume of hemisphere of same base and perpendicular height

Frustum of Pyramid or Cone, Right and Regular, Parallel Ends



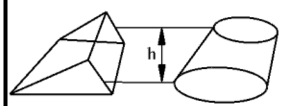
S = (sum of perimeter of base, P, and top, p) x $\frac{1}{2}$ slant height, l: $\frac{1}{2}l(P+p)$

V = (sum of areas of base, B, and top, b + square root of their products) x $\frac{1}{3}$ perp. height, h: $\frac{1}{3}h(B+b+\sqrt{Bb})$

S = Lateral or Convex Surface *V = Volume*

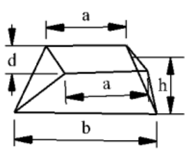
A.5 — Surface and Volume of Solids
(Continued)

Frustum of any Pyramid or Cone, Parallel Ends



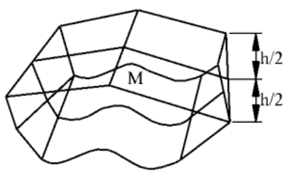
V = (sum of areas of base, B, and top, b + square root of their products) x $\frac{1}{8}$ perp. height, h: $\frac{1}{8}h(B+b+\sqrt{Bb})$

Wedge, Parallelogram Face



V = $\frac{1}{6}$ (sum of three edges, a b a, x perpendicular height, h x perpendicular width, d): $\frac{1}{6}dh(2a+b)$

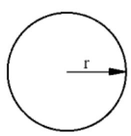
Prismatoid



V = $\frac{1}{6}$ perp. height, h (sum of areas of base, B, and top b, +4 x area of section, M, parallel to bases and midway between them): $\frac{1}{6}h(B+b+4M)$

The Prismatoid formula applies also to any of the foregoing solids with parallel bases, to pyramids, cones, and spherical sections, and to many solids with irregular surfaces.

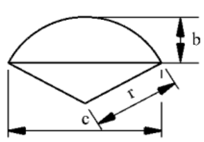
Sphere



$S = 4\pi r^2 = \pi d^2 = 3.14159265\, d^2$

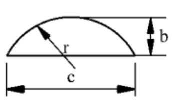
$$V = \frac{4}{3}\pi r^3 = \frac{1}{6}\pi d^3 = 0.52359878\, d^3$$

Spherical Sector



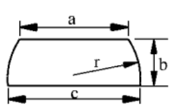
$$S = \frac{1}{2}\pi r(4b + c) \qquad V = \frac{2}{3}\pi r^3 b$$

Spherical Segment



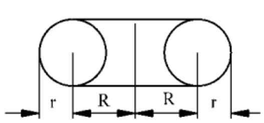
$$S = 2\pi r b = \frac{1}{4}\pi(4b^2 + c^2) \qquad V = \frac{1}{3}\pi b^2(3r - b) = \frac{1}{24}\pi b(3c^2 + 4b^2)$$

Spherical Zone



$$S = 2\pi r b \qquad V = \frac{1}{24}\pi b(3a^3 + 3c^2 + 4b^2)$$

Circular Ring

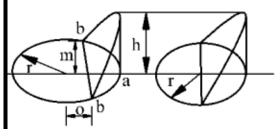


$$S = 4\pi^2 Rr \qquad V = 2\pi^3 Rr^2$$

S = Lateral or Convex Surface *V = Volume*

A.5 — Surface and Volume of Solids (Continued)

Ungula of Right, Regular Cylinder



Base = Segment, b a b

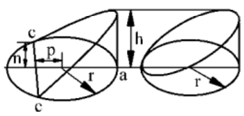
$S = (2\,r\,m - o \times \text{arc, } b\,a\,b)\ \dfrac{h}{r - o}$

$V = \left(\dfrac{2}{3}m^3 - o \times \text{area, } b\,a\,b\right)\dfrac{h}{r - o}$

Base = Half Circle

$S = 2rh$

$V = \dfrac{2}{3}r^2\,h$



Base = Segment, c a c

$S = (2\,r\,n + p \times \text{arc, } c\,a\,c)\ \dfrac{h}{r + p}$

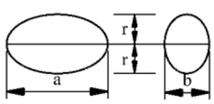
$V = \left(\dfrac{2}{3}n^3 + p \times \text{area, } c\,a\,c\right)\dfrac{h}{r + p}$

Base = Circle

$S = r\,\pi\,h$

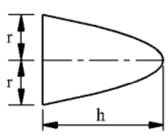
$V = \dfrac{1}{2}r^2\,\pi\,h$

Ellipsoid



$V = \dfrac{1}{3}\pi\,r\,a\,b$

Paraboloid

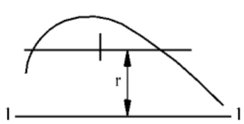


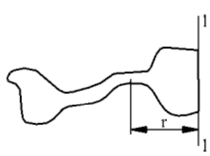
$V = \dfrac{1}{2}\pi\,r^2h$

Ratio of corresponding volumes of a Cone, Paraboloid, Sphere, and Cylinder of equal height:

$$\frac{1}{3} : \frac{1}{2} : \frac{2}{3} : 1$$

Bodies Generated by Partial or Complete Revolution





$\left.\begin{array}{l} l = \text{length of a curve} \\ A = \text{area of a plane} \end{array}\right\}$ rotating about an axis 1 - 1 on one side and in plane of axis

r = distance of center of gravity of line or plane from axis 1-1 and for any angle of revolution, a°

$\dfrac{2\,r\,\pi\,a°}{360}$ = length of arc described by center of gravity.

S = length of curve x length of arc about axis = $l\ \dfrac{2\,r\,\pi\,a°}{360}$

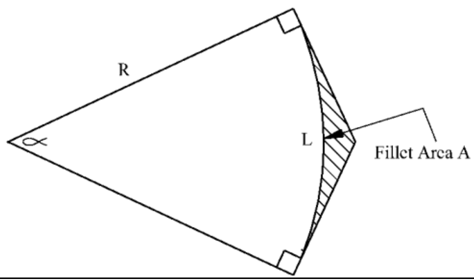
For complete revolution, $S = 2r\,\pi\,l$

V = area of plane x length of arc about axis = $A\ \dfrac{2\,r\,\pi\,a°}{360}$

For complete revolution, $V = 2\,r\,\pi\,A$

S = Lateral or Convex Surface *V = Volume*

A.6 — Methods of Estimating Area of Fillets, Aprons and Approaches



$$T = R \text{ Tan } \frac{\alpha}{2}$$

ESTIMATING FILLETS & RETURN

FILLET AREA

$$\text{Area A} = 2 \times \frac{1}{2} \times R \times R \text{ Tan } \frac{\alpha}{2} - \pi R^2 \frac{\alpha}{360°}$$

$$= R^2 \left[\text{Tan} \frac{\alpha}{2} - (0.008727 \times \alpha) \right]$$

Area 90° Fillet = $0.2146 \times R^2$

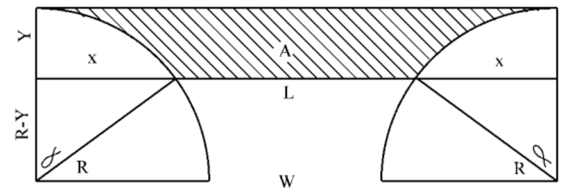
Length of Return

$$L = 2 \pi R \times \frac{\alpha}{360°}$$

$$= 0.01745 \times R \times \alpha$$

Length of 90° Return

$$L = 1.5708 \times R$$

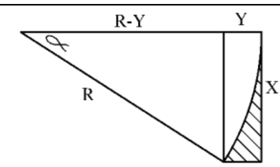


ESTIMATING AREA 90° APRON

$$L = (2R + W) - 2X \qquad \text{Cos } \alpha = \frac{R - Y}{R}$$

$$X = \sqrt{2RY} - Y^2 \qquad A = \text{Area}$$

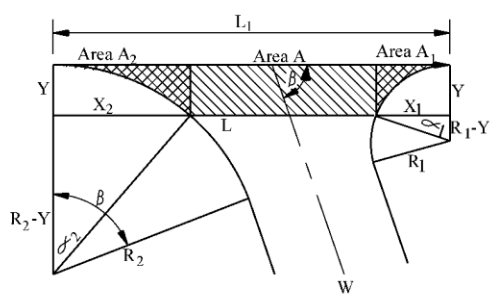
$$A = (2R + W)Y + X(R-Y) - 0.01745\ R^2\alpha$$



A = Area

$$A = XY - \left[\pi R^2 \frac{\alpha}{360°} - \frac{1}{2} \times (R - Y) \right]$$

$$= XY + \frac{X(R - Y)}{2} - 0.08727\ R^2 \alpha$$



ESTIMATING AREA APRON OTHER THAN 90°

$$\text{Cos } \alpha_1 = \frac{R_1 - Y}{R_1} \qquad \text{Cos } \alpha_2 = \frac{R_2 - Y}{R_2}$$

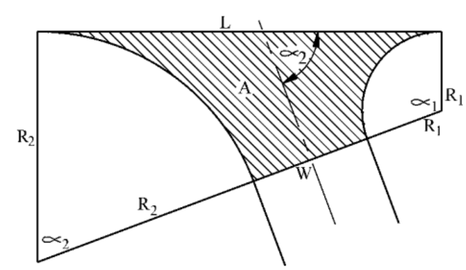
$$X_1 = \sqrt{2R_1 Y - Y^2} \qquad X_2 = \sqrt{2R_2 Y - Y^2}$$

$L_1 = (R_2 - R_1) \text{ Tan } \beta$ $\qquad$ $L = L_1 - (X_1 + X_2)$

$A = LY$

$$A_1 = X_1 Y + \frac{X_1(R_1 - Y)}{2} - 0.008727 R_1^2\ \alpha_1$$

$$A_2 = X_2 Y + \frac{X_2(R_2 - Y)}{2} - 0.008727 R_2^2\ \alpha_2$$



ESTIMATING AREA APPROACH OTHER THAN 90°

$$\alpha_1 = 180° - \alpha_2$$

$$L = (R_2 - R_1) \text{ Tan } \alpha_2$$

$$\text{Area A} = \frac{(R_1 + R_2)L}{2} - 0.008727(R_1^2\ \alpha_1 + R_2^2\ \alpha_2)$$

NOTES:

$\pi = 3.1416$ $\qquad$ $\frac{\pi}{180} = 0.01745$

$\frac{\pi}{2} = 1.5708$ $\qquad$ $\frac{\pi}{360} = 0.008727$

A.7 — Conversion Factors – Length Measurements

Units	Inches	Feet	Yards	Rods	Miles
1 Inch	1	0.08333	0.027778	0.005051	0.0000157828
1 Foot	12	1	0.3333	0.060606	0.00018939
1 Yard	36	3	1	0.181818	0.000568182
1 Rod (Surveyor's	198	16.5	5.5	1	0.003125
1 Mile (U.S.	63360	5280	1760	320	1
1 Meter	39.37	3.280833	1.093611	0.198838	0.00062137
1 Link	7.92	0.66	0.22	0.04	0.000125
1 Chain	792	66	22	4	0.0125
1 Station	1200	100	33.33	6.060606	0.0189394
1 Furlong	7920	660	220	40	0.125
1 Mile	72913	6076.103	2025.366	368.248	1.15078
1 Millimeter	0.03937	0.003281	0.001094	0.000199	—
1 Centimeter	0.3937	0.032808	0.010936	0.001988	—
1 Kilometer	—	3280.833	1093.611	198.836	0.621370

A.8 — Conversion Factors – Area Measurements

Units	Square Inches	Square Feet	Square Yards	Square Rods	Acres	Square Miles
1 Sq. Inch	1	0.00694	0.00077	—	—	—
1 Sq. Foot	144	1	0.11111	0.00367	—	—
1 Sq. Yard	1296	9	1	0.03305	0.00020	—
1 Sq. Rod	39204	272.25	30.25	1	0.00625	—
1 Acre	—	43560	4840	160	1	0.00156
1 Sq. Mile	—	—	3097600	102400	640	1
1 Sq. Meter	1550	10.7638	1.19598	0.03953	0.00024	—
1 Sq. Link	62.7264	0.4356	0.0484	0.0016	0.00001	—
1 Sq. Chain	627264	4356	484	16	0.1	—
1 Square	14400	100	11.1111	0.36730	0.00229	—
1 Section	—	—	3097600	102400	640	1
1 Sq.	0.15499	0.00107	0.00011	—	—	—
1 Hectare	—	107638.	11959.8	395.367	2.47104	0.00386
1 Sq.	—	—	1195985	39536.7	247.104	0.38610

A.9 –Conversion Factors – Volume Measurements

Units	Cubic Inches	Cubic Feet	Cubic Yards	Pints (Liquid)	Quarts (Liquid)	Gallons
1 Cubic Inch	1	0.00057	0.00002	0.0346	0.0173	0.00432
1 Cubic Foot	1728	1	0.03703	59.844	29.922	7.4805
1 Cubic Yard	46656	27	1	1615.8	807.9	201.975
1 Pint (Liquid)	28.875	0.01671	0.00061	1	0.5	0.125
1 Quart (Liquid)	57.75	0.03342	0.00123	2	1	0.25
1 Gallon (U.S.)	231	0.13368	0.00495	8	4	1
1 Liter (1000 cc)	61.025	0.03531	0.00130	2.1133	1.0566	0.26417
1 Gil	7.2187	0.00417	0.00015	0.25	0.125	0.03125
1 Pint (Dry)	33.600	0.01944	0.00072	1.1636	0.5818	0.14545
1 Quart (Dry)	67.200	0.03888	0.00144	2.3273	1.1636	0.29091
1 Quart	69.355	0.04013	0.00148	2.4019	1.2009	0.30023
1 Gallon	277.42	0.16054	0.00594	9.6076	4.8038	1.20095
1 Peck	537.60	0.31111	0.01152	18.618	9.3091	2.32729
1 Bushel (U.S.)	2150.4	1.2444	0.04608	74.473	37.236	9.3092
1 Board Foot	144	0.08333	0.00308	4.9870	2.4935	0.62337
1 Cord	22118	128	4.74074	7660.0	3830.0	957.506
1 Petroleum	9701.9	5.61456	0.20794	336	168	42
1 Barrel (U.S.	7276.3	4.21086	0.15596	252	126	31.5

A.10 — Conversion Factors – Weight Measurements

Units	Ounces	Pounds	Tons
1 Ounce	1	0.0625	—
1 Pound	16	1	0.0005
1 Ton	32000	2000	1
1 Kilogram	35.2739	2.204622	0.00110
1 Ton (Metric)	35273.9	2204.62	1.10231
1 Hundredweight	1600	100	0.05
1 Grain	0.00228	—	—
1 Gram	0.03527	0.002204	—
1 Milligram	—	—	—

A.11 — Conversion Table – Inches to Decimals of a Foot

Inch	0	1″	2″	3″	4″	5″
0	0	0.0833	0.1667	0.2500	0.3333	0.4167
1/32	0.0026	0.0859	0.1693	0.2526	0.3359	0.4193
1/16	0.0052	0.0885	0.1719	0.2552	0.3385	0.4219
3/32	0.0078	0.0911	0.1745	0.2573	0.3411	0.4245
1/8	0.0104	0.0938	0.1771	0.2604	0.3438	0.4271
5/32	0.0130	0.0964	0.1797	0.2630	0.3464	0.4297
3/16	0.0156	0.0990	0.1823	0.2656	0.3490	0.4323
7/32	0.0182	0.1016	0.1849	0.2682	0.3516	0.4349
1/4	0.0208	0.1042	0.1875	0.2708	0.3542	0.4375
9/32	0.0234	0.1068	0.1901	0.2734	0.3568	0.4401
5/16	0.0260	0.1094	0.1927	0.2760	0.3594	0.4427
11/32	0.0288	0.1120	0.1953	0.2786	0.3620	0.4453
3/8	0.0313	0.1146	0.1979	0.2812	0.3646	0.4479
13/32	0.0339	0.1172	0.2005	0.2839	0.3672	0.4505
7/16	0.0365	0.1198	0.2031	0.2865	0.3698	0.4531
13/32	0.0391	0.1224	0.2057	0.2891	0.3724	0.4557
1/2	0.0417	0.1250	0.2083	0.2917	0.3750	0.4583
17/32	0.0443	0.1276	0.2109	0.2943	0.3778	0.4609
9/16	0.0469	0.1302	0.2135	0.2969	0.3802	0.4635
19/32	0.0495	0.1328	0.2161	0.2995	0.3828	0.4661
5/8	0.0521	0.1354	0.2188	0.3021	0.3854	0.4688
21/32	0.0547	0.1380	0.2214	0.3047	0.3880	0.4714
11/16	0.0573	0.1406	0.2240	0.3073	0.3906	0.4740
23/32	0.0599	0.1432	0.2266	0.3099	0.3932	0.4766
3/4	0.0625	0.1458	0.2292	0.3125	0.3958	0.4792
25/32	0.0651	0.1484	0.2318	0.3151	0.3984	0.4818
13/16	0.0677	0.1510	0.2344	0.3177	0.4010	0.4844
27/32	0.0703	0.1536	0.2370	0.3203	0.4036	0.4870
7/8	0.0729	0.1563	0.2396	0.3229	0.4063	0.4896
29/32	0.0755	0.1589	0.2422	0.3255	0.4089	0.4922
15/16	0.0781	0.1615	0.2448	0.3281	0.4115	0.4948
31/32	0.0807	0.1641	0.2474	0.3307	0.4141	0.4974

A.11 — Conversion Table – Inches to Decimals of a Foot

(Continued)

Inch	6″	7″	8″	9″	10″	11″
0	0.5000	0.5833	0.6667	0.7500	0.8333	0.9167
1/32	0.5026	0.5859	0.6693	0.7526	0.8359	0.9193
1/16	0.5052	0.5885	0.6719	0.7552	0.8385	0.9219
3/32	0.5078	0.5911	0.6745	0.7578	0.8411	0.9245
1/8	0.5104	0.5938	0.6771	0.7604	0.8438	0.9271
5/32	0.5130	0.5964	0.6797	0.7630	0.8464	0.9297
3/16	0.5156	0.5990	0.6823	0.7656	0.8490	0.9323
7/32	0.5182	0.6016	0.6849	0.7682	0.8516	0.9349
1/4	0.5208	0.6042	0.6875	0.7708	0.8542	0.9375
9/32	0.5234	0.6068	0.6901	0.7734	0.8568	0.9401
5/16	0.5260	0.6094	0.6927	0.7760	0.8594	0.9427
11/32	0.5286	0.6120	0.6953	0.7786	0.8620	0.9453
3/8	0.5313	0.6146	0.6979	0.7813	0.8646	0.9479
13/32	0.5339	0.6172	0.7005	0.7839	0.8672	0.9505
7/16	0.5365	0.6198	0.7031	0.7865	0.8698	0.9531
13/32	0.5391	0.6224	0.7057	0.7891	0.8724	0.9557
1/2	0.5417	0.6250	0.7083	0.7917	0.8750	0.9583
17/32	0.5443	0.6276	0.7109	0.7943	0.8776	0.9609
9/16	0.5469	0.6302	0.7135	0.7969	0.8802	0.9635
19/32	0.5495	0.6328	0.7161	0.7995	0.8828	0.9661
5/8	0.5521	0.6354	0.7188	0.8021	0.8854	0.9688
21/32	0.5547	0.6380	0.7214	0.8047	0.8880	0.9714
11/16	0.5573	0.6406	0.7240	0.8073	0.8906	0.9740
23/32	0.5599	0.6432	0.7266	0.8099	0.8932	0.9766
3/4	0.5625	0.6458	0.7292	0.8125	0.8958	0.9792
25/32	0.5651	0.6484	0.7318	0.8151	0.8984	0.9818
13/16	0.5677	0.6510	0.7344	0.8177	0.9010	0.9844
27/32	0.5703	0.6536	0.7370	0.8209	0.9036	0.9870
7/8	0.5729	0.6563	0.7396	0.8229	0.9063	0.9896
29/32	0.5755	0.6589	0.7422	0.8255	0.9089	0.9922
15/16	0.5701	0.6615	0.7448	0.8281	0.9115	0.9948
31/32	0.5807	0.6641	0.7474	0.8307	0.9141	0.9974

A.12 — Conversion Factors – Miscellaneous

Multiply	By	To Obtain
Pounds per foot	1.48816	Kilograms per meter
Pounds per square foot	4.88241	Kilograms per square meter
Pounds per square inch	0.07031	Kilograms per square cm
Pounds per square inch	0.0007031	Kilograms per square mm
Pounds per cubic foot	16.0184	Kilograms per cubic meter
Radians	57.29578	Degrees, angular
Horsepower	550	Ft-Lbs per second
Horsepower	2544	B.T.U.'s per hour
Horsepower	745.5	Watts
B.T.U.	251.98	Calories, gram
B.T.U	777.98	Ft-Lbs
Feet per second	0.68182	Miles per hour
Miles per hour	88	Feet per minute
Miles per hour	1.46667	Feet per second
Pounds	444822	Dynes
Kilograms	980665	Dynes
Atmosphere	1.0333	Kilograms per square cm
Atmosphere	14.697	Pounds per square inch
Atmosphere	29.921	Inches of mercury (0°C at sea level)
Atmosphere	0.76	Meters of mercury (0°C at sea level)
Atmosphere	33.9	Feet of water (4°C at sea level)
Pounds of water per minute	0.016021	Cubic feet per minute
Cubic feet per minute	0.12468	Gallons per second
Fathoms	6	Feet
Degrees per foot	0.00057261	Radians per centimeter
Centimeters of mercury (at 20°C)	5.34	Inches of water (at 20°C)

A.13 — Asphalt Pavement – Coverage Per Ton

Lane Width (Feet)	Lane Length (feet) Covered By 1 Ton of Asphalt						
	½″	¾″	1″	1½″	2″	2½″	3″
8	41.6	27.8	20.9	13.9	10.4	8.4	6.9
9	37.0	24.7	18.6	12.3	9.2	7.4	6.2
10	33.3	22.2	16.7	11.1	8.3	6.7	5.6
11	30.3	20.2	15.2	10.1	7.5	6.1	5.1
12	27.8	18.5	13.9	9.2	6.9	5.6	4.6

Note: Thicknesses shown above are compacted thicknesses.

A.14 — Asphalt Specific Gravity and Weight Per Gallon

Specific Gravity	Pounds Per Gallon of Asphalt					
	60°F	200°F	250°F	300°F	325°F	350°F
0.990	8.245	7.852	7.717	7.586	7.522	7.458
1.000	8.328	7.931	7.795	7.663	7.598	7.533
1.010	8.412	8.011	7.874	7.740	7.674	7.609
1.020	8.495	8.090	7.951	7.816	7.750	7.684
1.030	8.578	8.169	8.029	7.893	7.826	7.759
1.040	8.661	8.248	8.107	7.969	7.901	7.934

A.15 — Rigid Pavements – Quantities Per Mile

Cement Width	8′	9′	10′	12′	14′	16′	18′	20′	22′	24′
Square Yard Per Mile	4,693	5,280	5,867	7,040	8,213	9,387	10,560	11,734	12,907	14,080
Tons Per Mile	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons
Plant Mix 80 lbs/yd^2	187.7	211.2	234.7	281.6	328.5	375.5	422.4	469.3	516.3	563.20
Plant Mix 90 lbs/yd^2	211.2	237.6	264.0	316.8	369.6	422.4	475.4	528.0	580.8	633.60
Plant Mix 100 lbs/yd^2	234.7	264.0	293.3	352.0	410.7	469.3	528.0	586.7	645.3	704.00
Plant Mix 110 lbs/yd^2	258.1	290.4	322.7	387.2	451.7	516.3	580.8	645.3	709.9	774.4
Plant Mix 120 lbs/yd^2	281.6	316.8	352.0	422.4	492.8	563.2	633.6	704.0	774.4	844.8
Plant Mix 140 lbs/yd^2	323.5	369.6	410.7	492.8	574.9	657.1	739.2	821.3	903.5	985.6
Plant Mix 160 lbs/yd^2	375.4	422.4	469.3	563.2	657.1	750.9	844.8	938.7	1032.5	1126.4
Plant Mix 180 lbs/yd^2	422.4	475.2	528.0	633.6	739.2	844.8	950.4	1056.0	1161.6	1267.2
Plant Mix 200 lbs/yd^2	469.3	528.0	586.7	704.0	821.3	938.7	1056.0	1173.3	1290.7	1408.0
Plant Mix 220 lbs/yd^2	516.3	580.8	645.3	774.4	903.5	1032.5	1161.6	1290.7	1419.7	1548.8
Plant Mix 440 lbs/yd^2	1032.5	1161.6	1290.7	1548.8	1806.9	2065.1	2323.2	2581.5	2839.5	3097.6

DRAFT

A.16 — Square Yards of Road Surface for Various Road Widths

Road Width	Per Lineal Foot	Per 100 Feet	Per Mile	Road Width	Per Lineal Foot	Per 100 Feet	Per Mile
6′	0.67	66.67	3,520	24′	2.67	266.67	14,080
7′	0.78	77.78	4,107	25′	2.78	277.78	14,667
8′	0.89	88.89	4,693	26′	2.89	288.89	15,253
9′	1.00	100.00	5,280	28′	3.11	311.11	16,427
10′	1.11	111.11	5,867	30′	3.33	333.33	17,600
11′	1.22	122.22	6,453	32′	3.56	355.56	18,773
12′	1.33	133.33	7,040	34′	3.78	377.78	19,947
13′	1.44	144.44	7,627	36′	4.00	400.00	21,120
14′	1.56	155.56	8,213	38′	4.22	422.22	22,293
15′	1.67	166.67	8,800	40′	4.44	444.44	23,467
16′	1.78	177.78	9,387	50′	5.56	555.56	29,333
17′	1.89	188.89	9,973	60′	6.67	666.67	35,200
18′	2.00	200.00	10,560	70′	7.78	777.78	41,067
20′	2.22	222.22	11,733	75′	8.33	833.33	44,000
22′	2.44	244.44	12,907	80′	8.89	888.89	46,933

A.17 — Linear Feet Covered Based on Tank Capacity and Width and Rate of Application

To compute the number of linear feet which will be covered by a tank of any capacity, for various widths and rates of application, use the following formula:

$$L = \frac{9C}{RW}$$

Where:

L = Number of linear feet which will be covered.
C = Capacity of tank in gallons (or quantity of asphalt in tank).
R = Rate of application in gallons per square yard.
W = Width of application in feet.

A.18 — Density and Viscosity of Water at Various Temperatures

Temperature °F	*Density lbs/cu ft*	Viscosity in Centipoises
14.00	62.3128	2.6000
23.00	62.3846	2.1300
32.00	62.4201	1.7921
39.20	62.4283	1.5674
41.00	62.4276	1.5188
50.00	62.4114	1.3077
59.00	62.3739	1.1404
68.00	62.3178	1.0050
68.36	62.3153	1.0000
77.00	62.2453	0.8937
86.00	62.1579	0.8007
95.00	62.0574	0.7225
104.00	61.9438	0.6560
113.00	61.8196	0.5988
122.00	61.6835	0.5494
131.00	61.5374	0.5064
140.00	61.3820	0.4688
149.00	61.2165	0.4355
158.00	61.0430	0.4061
167.00	60.8607	0.3799
176.00	60.6697	0.3565
185.00	60.4711	0.3355
194.00	60.2645	0.3165
203.00	60.0510	0.2994
212.00	59.8300	0.2838

A.19 — Quantities for Various Depths of Cylindrical Tanks in Horizontal Position

% Depth Filled	% of Capacity	% Depth Filled	% of Capacity	% Depth Filled	% of Capacity	% Depth Filled	% of Capacity
1	0.20	26	20.73	51	51.27	76	81.50
2	0.50	27	21.86	52	52.54	77	82.60
3	0.90	28	23.00	53	53.81	78	83.68
4	1.34	29	24.07	54	55.08	79	84.74
5	1.87	30	25.31	55	56.34	80	85.77
6	2.45	31	26.48	56	57.60	81	86.77
7	3.07	32	27.66	57	58.86	82	87.76
8	3.74	33	28.84	58	60.11	83	88.73
9	4.45	34	30.03	59	61.36	84	89.68
10	5.20	35	31.19	60	62.61	85	90.60
11	5.98	36	32.44	61	63.86	86	91.50
12	6.80	37	33.66	62	65.10	87	92.36
13	7.64	38	34.90	63	66.34	88	93.20
14	8.50	39	36.14	64	67.56	89	94.02
15	9.40	40	37.39	65	68.81	90	94.80
16	10.32	41	38.64	66	69.97	91	95.55
17	11.27	42	39.89	67	71.16	92	96.26
18	12.24	43	41.14	68	72.34	93	96.93
19	13.23	44	42.40	69	73.52	94	97.55
20	14.23	45	43.66	70	74.69	95	98.13
21	15.26	46	44.92	71	75.93	96	98.66
22	16.32	47	46.19	72	77.00	97	99.10
23	17.40	48	47.45	73	78.14	98	99.50
24	18.50	49	48.73	74	79.27	99	99.80
25	19.61	50	50.00	75	80.39		

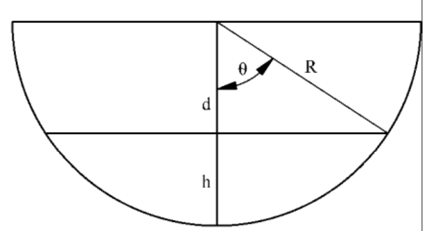
Full capacity of tank in U.S. gallons = $\frac{0.7854 \times D^2 \times L}{231}$

Note: *The formula for direct computation of quantity when tank is less than half full is shown below. When more than half full, compute the full capacity of the tank as noted above; consider the shaded portion to represent the unfilled portion at the top of the tank and compute its volume as indicated below; then, deduct the volume determined for the unfilled portion from the total volume of the tank to arrive at the volume of the filled portion*

First, compute θ where $\cos\theta = \frac{d}{R} = \frac{R - h}{R}$

Then A = $\pi R^2 \frac{\theta}{180} - R \sin\theta (R - h)$

$$\text{And } V = \frac{L\left[\pi R^2 \frac{\theta}{180} - R \sin\theta (R - h)\right]}{231}$$



Where A = Cross section area of filled portion of tank in sq. in.
V = Volume of filled portion of tank in U.S. gallons
L = Length of interior of tank in inches
D = Diameter of interior of tank in inches
R = Radius of interior of tank in inches
h = Depth of liquid in inches
d = R – h, inches

Note: *The volume occupied by any piping, fittings or other material inside the tank must be deducted from the volume computed by use the table or formula.*