

## What is Resiliency?

Resiliency is the ability to prepare and plan for, absorb, accommodate, recover from, or more
successfully adapt to actual or potential adverse events as appropriate for the importance of the site.
— The TRB AFF70(2) Resilient and Sustainable Buried Structures Subcommittee

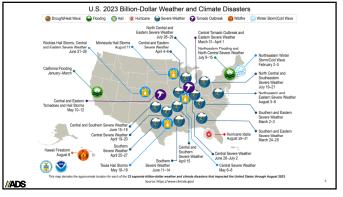
Capability to mitigate against significant all-hazards risks and incidents and to expeditiously recover and reconstitute critical services with minimum damage to public safety and health, the economy, and national security.

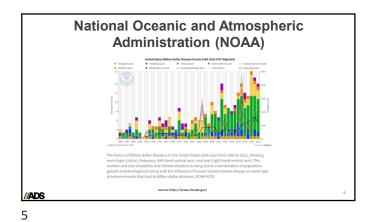
## **Key Points**

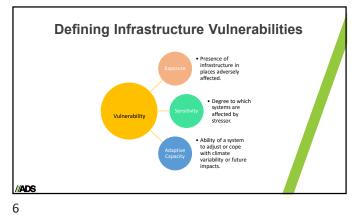
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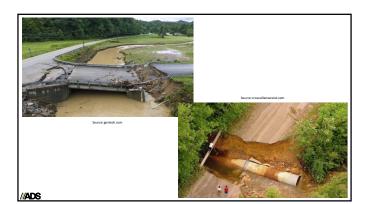








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## Drainage Infrastructure

A conveyance [and/or storage] system for excess stormwater that protects transportation and other infrastructure assets from the <u>destructive forces of water</u>.

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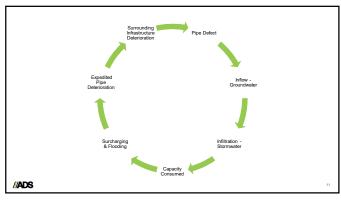
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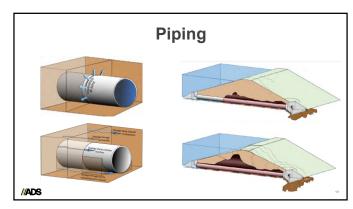


Soil Strength/Consolidation Changing Moisture Conditions Differential Settlement Soil Erosion/Infiltration Voids and Washouts

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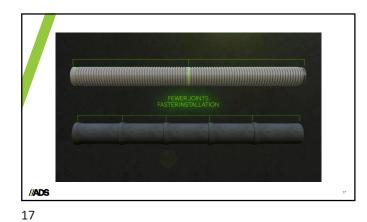


















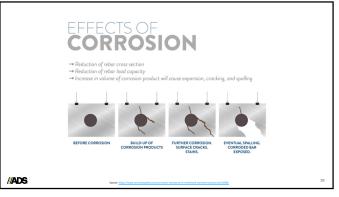


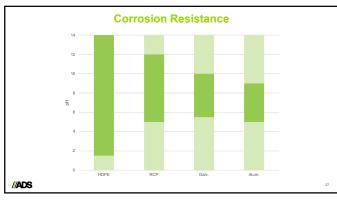




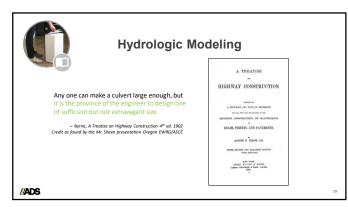
















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Design Conservatively (LRFD) Validate Design (Post-Installation Inspection) Monitor Performance (Asset Management)

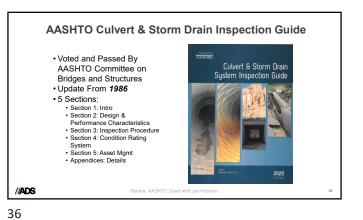
> Protect Vulnerabilities in High Risk Areas Through Design

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	GOOD	FAIR	POOR	SEVERE	
CONDITION	Like new, with little or no deterioration, structurally sound and functionally adequate.	Some deterioration, but structurally sound and functionally adequate.	Significant deterioration, functional inadequacy, or both, requiring maintenance or repair.	Very poor conditions that indicate possible imminent failure or failure which could threaten public safety.	
	No action is recommended. Note in inspection report only.	No immediate action is recommended, but more frequent inspection may be wernarited. Maintenance personnel should be informed.	Team Leader (Inspector) evaluates need for corrective action and makes recommendation in inspection report.	Corrective action is required and urgent. Engineering evaluation is required to specify appropriate repair.	
	Approach Roadway Embaniument Channel Alignment End Treatments an Concrete Footings Barrel Alignment Plastic Barrel Concrete Barrel Concrete Barrel Masonry Barrel Timber Barrel Joints Seams of Corrugat	and Protection d Appurtenant Struct and Invert Slab	ures	Table No. 4.3.2-1 4.4.2-1 4.5.2-1 4.5.2-1 4.5.2-1 4.5.2-1 4.7.2-1 4.7.2-1 4.10.2-1 4.10.2-1 4.11.2-1 4.12.2-1 4.12.2-1 4.12.2-1 4.12.2-1 4.12.1-1 4.15.1-1 4.17.1-1	

RATING SCALE & ASSOCIATED ACTION	(1) Good	(2) Fair	CD Peer	(4) Severe
Condition	Like next with little or no-deterioration, structurally sound and functionally adequate	Some deterioration, but structurally sound and have tionally adrepate	Significant deterioration and/or functional inadequary, requiring maintenance or repail.	Very pear conditions that indicate possible imminant failure which could threater public safety.
Action Indicated	No action is recommended. Note in impection report only	No investigate action is recommended, but more frequent importion may be warrented. Maintenance personnel should'be informed.	Then Leader (repetite) evaluates need for constitue action and makes recommendation in importion report.	Connective action is required and argent. Engineering evaluation is required to specify appropriate repair.
PLASTIC PIPE	(t) Good	(2) Fair	CD Peer	(4) Severe
Shape	Taewi-maintains sourced draper with no local wall fattoning Viersical deformation less than 3% of original inside diameter.	New well-Relieving. Verland delocention 376-7.3% of original inside diameter.	Significant well failuning or increased well curvation. Versical deformation 7.5% 19% of original inside diame- ter. Visual out-of-roundness.	Enterne wall flattening with revenal of convertant ighde- al/boddings, and/or kinks. Horical deformation geneter than 10% of original inside damenes. Significant visual and of routiless.
Surface Damage	No indication of weak abrasion, impact damage or W degradation.	Minor was, abrasian, less than 19% of wall thickness. Never statisting or VV dependation. Eletering over less than 25% of pipe inner surface (FiP).	Nitac absolute that exceeds 10% of wall their exceeds of the second strength of the second strength over greater than 15% of pipe inner surface FRP,	Wear, abrasian that exceeds (5% of null thickness, UV dependation (pipe ands) weating in cracked or londers pipe well.
Local Buckling, Splits, and Cracking	Senandh intenior wall. No-qubits in welded searns nor cracking in wall.	Indiation of local buckling indicated by rippling in wall. Wall-tracking-or splits, loss than a quarter of circumfer- ance. No infiftration. No iongludinal cocking.	Advanced and extensional local wall backling indicated by extension interior surface rippling. Well-cacking-or splits up to hell of drownleances. Minor water infitto- tion-hard new all individuals. Longitudinal cracking less than 12 is in-longth.	Kels through the full and thickness. Pper wall hudden inward locally Holl cocking or spits greater than hulf of the pipe desembersor. Langthafeal cocking more than 'Use's in length. Cracks with indication of eal influences.
CONCRETE PIPE	(1) Good	(2) Fair	(3) Poer	(4) Severa
Cracking	No measurable cock width greater than hairline (maximum Billin).	Longitudinal encire II-01 in, to II-05 in, wide thickness of dens( with spacing of II-0 ft or more. Some circumform- tail ouds with no inflitution. Efformance but ne ruit staining emanating for coacle.	Longitudinal cracks between ILIS in, and ILI in, wide, no expressed robust with spacing Lil - Lil th. Viater infittudios (Evoluti): circumferential-blacks, (Minercance and bit sub staining amounting from coucles, No rocks with vertical offset. No increase in cracking from previous impection.	Longitudinal muchs presimm than 0.1 in, wide, exposed robus, significant autor infiltration and/or solimipation. Cocks with vertical office. Large areas of nut standing emanating from cocks.
Slabbing, Spalling, Delamina- tion, Patches	No spaling or stabbing, in indicated by wall visual appearance. No detamination. Any patched areas are sound.	Localend spails less than 5.5 in, depth and less than 6 in . In diameter, like exposed what, like slabbing Small defaminations indicated by hollow sounds at patishes but patch-remains stable.	Spalling and/or defaminations from 8.5 to 0.75 in. In depth and Larger than 6 in. In diameter. No exposed reliat. Some sud claiming from spalled area, structure table. Patched areas that are defaminated or detasi costing.	Widespend spalling grader than 3.75 in, in depth-or delamination with exposed rober, structure unstable, 3.00.001 gal concrete.
Deterioration	No scaling, abrasion, or other surface damage.	Ught or nodearw scaling lines than 9.25 in, exposed appropriat. Abrasian lines than 9.25 in, deep over lines than 20% of piper and are, localized superficial dies. than 0.25 in 1 imper 4 damage. No rober exposed. Multiple phopped weep-toxies.	Modente to sovers scaling biggregate charly exposed. Abrasion between 0.25 in and 0.5 in, deep over more than 10% of pipe surface legact damage with exposed rebox.	Extensive surface damage and appropriate pop-out in cludes exposed and/or comoted what. Complete invert deterioration and loss of pipe wall section.
CORRUGATE METAL PIPE	(1) Good	(2) Fair	(3) Poer	(4) Severe
Surface Damage	No dents or other localized damage.	Small dents or impact damage to pipe wall or and section with not wall breaches.	Large dents or impact damage to pipe wall or and services add localised wall localism, no more compation over circumferential length of 6 m.	Dents or damage that warrant engineering instruction. Through wallheles greater than one corruppilion over a length more than 6 in allowing unimpedied soil infituation.
Corrosion	builded areas of builded run.	Freddied wat, consular of pipe wall material. No fors of smitter, no through wall penetration from consular.	Consider of pipe material and widespread section lass less than 50% of wall thickness. Localized deep pitting, Second holes less than 1 in, diameters. Penetration possible with harmone pick drifts.	Hidespread through well penetration. Invest existing in localized sections, Though well penetrations peneer. Holes geneter than 1 in, deameter or many anality holes grouped cloudy.
Abrasion	No damage due to abrasion.	Small or local dension of wall or coating with no breaches in the coating exposing disacharal wall or signs of canodian.	Weepward abracion of protective coating with branch- in-suposing the pipe wall material and allowing through wall persetration charing importion proteing with a pick.	Abrasien has worn large holes through the metal pipe greater than one compation is length for more than 6 in around the circumference.
Shape (Closed Shape)	Sensioth curvation in learner, deformation less than 3% of inside diameters.	Tophalf anosth. Minor bulges or fathering of bottom. Deformation 1%: 10% of original inside diameter.	Significant distortions or fattering. Lower bird may be loties. Colornation 129: 139: of original inside diameter. Vioble out-of-roundmen.	Externe distortion throughout pipe, local areas of revenue curvature and kirds, Deformation greater than 15% of original inside diameter, Significant out of reanslesse.
Shape (Open Shape)	Smooth curvature, rise and span measurements within following.	Refer to shape impection requirements for specific shrue have types.	Refer to shape inspection requirements for specific sinustrate types.	Refer to shape inspection requirements for specific situation forms.





