# Introduction to GIS Fundamentals

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# Introduction to GIS Fundamentals Part 1: GIS Basics

### Question

How many of you use some sort of geographical product?



### Question

How many of you use paper maps, maps on your smart phone, or a GPS device?



### Question

Would any of you like to guess why I am asking these questions and how they relate to this course?



### Answer

They all use GIS or
 Geographical Information
 Systems.

But, what is GIS?



# GIS is:

- By definition, "A geographic information system (GIS) is a system that creates, manages, analyzes, and maps all types of data. GIS connects data to a map, integrating location data (where things are) with all types of descriptive information (what things are like there)..."
- GIS provides a foundation for mapping and analysis used in almost every industry and government agency.
- GIS helps users understand patterns, relationships, and geographic context.
- GIS improves communication and efficiency as well as management decision making.
- What does this mean?



# GIS is:

- GIS combines the Where(geographical location) and the What (information about a feature or item at that location). A feature is either man-made such as a building or natural such as a mountain.
- GIS combines the Where and the What to:
  - Aide in decision making
  - Provide an at-a-glance reference
  - Highlight and analyze a phenomenon
  - Tell a story
  - Short video explaining what GIS is



### How Does WVDOT Use GIS?

- GIS is used in WVDOT for a variety of functions:
  - Editing and maintaining the state road network
  - Maintaining and providing static and dynamic maps and applications
  - Sharing geospatial information and data with our constituents and the general public
  - Researching and analyzing of transportation infrastructure and its impact on parcels, the environment, and historical places
  - Highlighting different projects and initiatives in WVDOT and WVDOH

# **GIS** Components

- As the name implies, there are three main components of GIS:
  - Geographical or the "where" portion of GIS
    - This includes datums and coordinates the actual physical location of the feature
  - Information or the "what" portion of GIS
    - This includes the descriptive information about a feature including the facts and figures associated with it
    - Any important characteristic that distinguish the feature
  - **S**ystem portion of GIS
    - WVDOT geospatial data and information
    - **WVDOT Infrastructure including:** 
      - Software
      - Hardware
      - GIS Network
    - ✓ Workforce
    - Finished products such as web maps and applications



# GIS Basics Section 1: Geographical Component

# **GIS:** Geographical Component

- All geospatial data have a location or geographical component to it.
- This could include:
  - An address
  - A route number
  - Street name
  - Parcel number
- The GIS software uses a coordinate system to define a location.
  - A coordinate system is a set of two measurements that are defined by a north – south distance (Latitude) and east – west distance (Longitude) from a standard origin.





# Earth as an ellipsoid

- Before we begin any discussion about coordinate systems, it is good to understand a little bit about the earth.
- Think of earth as a soccer ball.
- Both the ball and earth are spheroids, meaning they are round-shaped objects.
- Like any round-shaped object, it can be evenly sliced both horizontally and vertically.
  - These slices are called meridians and parallels.
- <u>https://gisgeography.com/ellipsoid-oblate-spheroid-earth/</u>





### Meridians

Meridians are:

- Imaginary lines that run up and down (north and south)
- Also called longitude lines
- Intersect at the poles
- Circle the globe 360 degrees
  - 🗸 180 Degrees East
  - ✓ 180 Degrees West
- Use East and West to represent direction
  - ✓ East increase in number from 0 to 180
  - ✓ West decrease in number from 0 to -180

https://www.differencebetween.com/difference





### Meridians Cont.

#### ? Origin

- ✓ Prime Meridian (0)
- Sometimes referred to as the Greenwich meridian as it runs through Greenwich in the UK

#### **?** To

- Antemeridian (180)
- Sometimes referred to as the international date line as the international date line roughly follows it





### Parallels

Parallels are

2 Imaginary lines that run left to right (East and West)
2 Also called latitude lines
2 Do not intersect each other
2 Circle the globe 180 degrees
\$ 90 Degrees North
\$ 90 Degrees South





### Parallels Cont.

- Use North and South to represent direction
  - North increase in number from 0 to 90
  - South decrease in number from 0 to -90
- Origin
  - ✓ Equator (0)

#### **?** To

North or South Pole (90 N or S respectively)





### **Origins of Meridians And Parallels**

- The Prime Meridian and the Equator can split a spheroid into 4 equal and distinct areas called Hemispheres
- These are
  - Northern Hemisphere
  - Southern Hemisphere
  - Eastern Hemisphere
  - Western Hemisphere
- The US is located in the Northern and Western Hemisphere



Left: Round data is described with meridians, the equator, and latitude-longitude values. Right: Flat data is described with x,y units.



### Exercise: Meridians

- Navigate to <u>https://gps-coordinates.org/</u>
- Find the latitude and longitude coordinates for the following cities:
  - Charleston, WV
  - P Hannover, Germany
  - Buenos Aires, Argentina
  - Sydney, Australia
- Next in the decimal degree, type in following coordinate pairs:
  Lat: 38.33596, Long: -81.61244, What is at or near this location?
  Lat: 38.06868, Long: -81.08309, What is at or near this location?
  Lat: 39.6349, Long: -79.95527, What is at or near this location?
  Lat: 36.06915, Long: -80.30058, What is at or near this location?
  Finally, in your browser type in the following: https://learn.arcgis.com/en/projects/choose-the-right-projection/
  Try Lesson 1 in this exercise.



# **Coordinate System**

- Quick video on latitude and longitude
- As you learned earlier, GIS uses a coordinate system or measurement of two or more coordinates, but what does this have to do with GIS? Answer: A lot
- Two or more points from an origin (Prime Meridian or Equator)
   These coordinate systems determine the position on earth where an object is.
  - The measurement between these points gives distance.
  - Multiple XY coordinates points in close proximity to one another give us an object's shape.



# Example of locating yourself

- Take out your cellphone and open up whatever you are using for mapping on it.
- Click on the little carrot in the top right corner.
- This brings the map to the exact location where you are.
- Add a point to this location by tapping on the map.
- As you scroll down, you come across the coordinates. It says something like 38.333869N, 81.61046W.
- These are the coordinates of you location. How did the phone track you to that location?
  - The answer is GPS. But, what is GPS/GNSS?



### **GPS:** Global Positioning System

- GPS stands for Global Positioning System.
- A constellation of 24 or more satellites that are part of a larger, multinational satellite array called Global Navigation Satellite System (GNSS) that circulates the globe about 20,350 KM (about 12,644 miles) above the earth.
- Each of these satellites broadcast a radio signal back to earth where a small receiver built into your phone or receiving device receives it.
- The device notes the time of its arrival and uses it to calculate the distance from the satellite.
- When the device receives at least 4 of these distance calculations from 4 different satellites, it calculates the exact location on earth (coordinates) where the receiver is.
  - https://www.gps.gov/multimedia/poster/poster-web.pdf
  - https://www.gps.gov/systems/gps/
- But how does the calculation know where the receiver is on earth and how does this relate to GIS?







### Geodetic Markers and CORS

It is done through strategically placed, highly accurate receivers that continuously transmit and record Latitude, Longitude, and Elevation data. Each receiver is called a Continuously Operating Reference Station or CORS.

WV's CORS network can be found at: <u>http://cors.us/Map/SensorMap.aspx</u>

- CORS combined with a series of strategically placed disks at known elevations and LAT/LONG coordinates called Geodetic Markers create an interwoven network (or grid) called a spatial reference system.
  - The spatial reference system defines:
    - Gravity
    - P Height
    - 2 Latitude
    - Longitude
    - Scale
- This allows us to accurately locate the coordinate position of features such as roads, bridges, or in our case, our location.
- This is the basis of the geographic portion of GIS.



### Exercise: Using GPS

- With your Phone GPS, locate the following places:
  - WV State Capitol
  - District 1 Headquarters
  - 2 District 4 Headquarters (next to the Bridgeport Mall)
    2 District 10 Headquarters (exit 14 off the WV Turnpike)
    2 The Greenbrier
  - What are the Latitude and Longitude coordinates for each one?



### Recap



- Earlier in the lesson we learned:
  - The earth is a spheroid shape that can be evenly sliced up by imaginary parallel lines running east and west originating at the Equator called latitude and imaginary north and south lines originating at the Prime Meridian that meet at the poles called longitude.
  - Every place on earth has a set of points or multiple sets of points locating it on earth called coordinates.
  - There is an interwoven network of known Lat and Long points called Geodetic Markers and strategically place GPS receivers called CORS that create a spatial reference system.
- But, how are these things converted into information we can use in a map?



### Converting Coordinates into Mappable Objects

- Think of the Geographical portion of GIS as a model representation of a physical feature you can see.
- To build the GIS model the computer takes the coordinate points and lays them out on a template to create a map.
- To build the GIS model and organize the coordinate points into a map, the system uses three key components :
  - Geodetics /Datums
  - Projections and Geographical Coordinate System
  - Scale



# Datum

- Fundamental building block in creating a map model
- A set of known points(Lat, Long, Height/Depth, etc.)on the earth's surface used as a frame of reference for measuring locations on earth
  - Defines the position of the spheroid relative to the center of the earth
  - Provides a starting` point to map or survey an object located on earth
- Reading: What is a Datum?
- Short Video on Datums



# Datum

Datums can be:

- Geocentric: which relate coordinates and position on the Earth's surface to the center of mass on Earth.
- I Local: which relate coordinates and position on the Earth's surface to a defined area on the Earth's surface called an origin.
  - ✓ Origins are fixed.
  - All other values are calculated from it.
- There are three types of Datums:
  - Provide the measurements of the distances from the equator and prime meridian respectively.
  - Vertical datum: measurements of heights from a specific reference point.
  - Geodetic Datums: a combination of both the horizontal and vertical datums as measured from satellites thus improving horizontal and vertical accuracy.

### Horizontal Datum

A horizontal/geometric datum:
2 Specifies the location of the origin of the coordinate system
2 Specifies the orientation of the coordinate system
2 Specifies the dimensions of the reference ellipsoid
Types of Horizontal Datums: NAD1983, NAD1927, Clarke1866, WGS1984

Most frequently used are NAD1983 and WGS1984



### Vertical Datum

- A vertical datum is:
  - A set of fundamental elevations used as a reference for other elevations.
- Types:
  - Geodetic either directly or loosely based on Mean Sea Level at one or more points (NAVD29, NAVD88, IGLD85, etc.)
  - Tidal defined by observations of tidal variations over a period of time (MSL, MLLW, MLW, MHW, MHHW).

Some light watching about datum for later



# Geographical Coordinate System

- A Geographical Coordinate System defines any geographical position (location) of a feature on earth using:
  - Intitude position (Y Coordinate) degrees North and South of the equator
  - Iongitude position (X Coordinate) or degrees East and West from the prime meridian
  - Optionally, a vertical height (Z Coordinate)
- It is used when GPS and geospatial data are imported into GIS.



Since the coordinate system uses Lat/Long coordinates, it cannot be used to measure distance, area, or volume.



# Projected Coordinate System

- Up until now we have dealt with the Earth as a 3-dimensional model, but how do you deal with a model that is on a flat surface like a computer screen or printed map?
- That is where a projected coordinate system comes into play.
- A projected coordinate system takes any coordinate system in a three-dimensional spheroid shape of the earth's surface and flattens it into a two-dimensional surface.
  - This:
    - Requires the systematic conversions of Lat (X) and Long (Y) into a planar coordinate system.
    - Introduces distortion where the further away the feature is from the origin of the projection, the more exaggerated the shape.
    - Provides dimensionality in linear measures such as feet and mile.



### Projected Coordinate System

- There are six classes of common projections:
  - Conic
    - Cone shape projection where the meridians are mapped equally out from a central apex point, usually one of the poles.
    - ✓ Examples are Lambert Conformal Conic, Albers Conic, Equidistant Conic
  - 2 Cylindrical
    - Any projection of the earth onto a cylinder around it whose meridians are mapped to equally spaced vertical lines, and circles of latitude are mapped to equally spaced horizontal lines.
    - ✓ Examples are Mercator, Lambert Cylindrical Equal Area, Gall Peters
  - Azimuthal
    - Any projection of the earth onto a flat plane that preserves both equal distance and direction from the center point. It is sometimes referred to as a Planar Projection.
    - Examples are Azimuthal Equidistance, Gnomonic, Stereographic, State Plane.



### **Projected** Coordinate System



Planer, Conic, and Cylindrical Projections


## Projected Coordinate System

#### Conformal –

- A projection that preserves the correct shapes and scale of small areas in all directions.
- Examples are Lambert Conformal, Transverse Mercator, Stereographic

#### 😰 Equal Area –

- ✓ A projection that preserves area measures to the same size on earth but usually distorts shape, angle, or scale to do it.
- ✓ Examples are Albers Conic, Bonne, Equal Earth, Mollweide

#### Equidistant –

- ✓ A projection that preserves the distance along one or two lines or between one or two special points to other points on earth.
- Examples are Plate Carree, Azimuthal Equidistant, Equidistant Conic



## **Projected** Coordinate System

- Light reading on projections:
  - Common types of projections in ESRI https://storymaps.arcgis.com/stories/ea0519db9c184d7e84387924c84b703f
  - Different types of Projections in ESRI
    - https://www.esri.com/arcgis-blog/products/arcgis-pro/mapping/gcs\_vs\_pcs/
- Some common types of projections:
  - UTM Universal Transverse Mercator
  - State Plane Coordinate
  - **WGS\_1984\_Web\_Mercator\_Auxiliary\_Sphere**
- The ones commonly used in WVDOT
  - NAD1983 UTM Zone 17N
  - West Virginia State Plane Coordinates North and South (depending where the project is located)

## Scale

- What is Scale?
  - Think of a map as a model of a portion of the earth.
  - ☑ With any model there is some sort of ratio 1:87, 1:160, 1:48, etc.
  - Scale represents that ratio or size of the model compared to the actual object (IE 1:87 means that model is 1/87<sup>th</sup> the size of the actual object).
    - ✓ This can be done in both English and Metric Units
      - 1 inch = 15 Miles
      - 1 cm = 10 Km
    - The larger the scale the map is, the bigger the area it's showing.
    - ✓ The smaller the scale the map is, the smaller the area it's showing.



## Scale

Different map scales and their corresponding ranges Small Scale Maps: 0 - 250,000Medium Scale Maps: 250,001 - 1,000,000 Large Scale Maps: Over 1,000,000 Common sized map scales in WVDOT **?** City: 1:5,000 to 20,000, Small Scale Map **2** County: 1:50,000 to 250,000, Small Scale Map **?** District: 1:500,000 to 1,000,000, Medium Scale Map Statewide: 1:2,200,000 to 2,900,000, Large Scale Map



- Navigate to:
  - \\dotb6gisrh01\WVDOT\_Training\ Course1\Materials and copy the Course1A folder to your C drive.
- Click on:
  - 1. Start
  - 2. ArcGIS
  - 3. ArcGIS Pro
- This should bring up ArcGIS Pro.
- If you get a screen to configure the ArcGIS license, proceed to the next step otherwise skip it.





- Navigate back to C:/course1A folder and open How to configure ArcGIS Pro.
  - This is an easy to follow, step-by-step guide showing how to configure ArcGIS Pro.
  - Follow it until ArcGIS Pro is configured.
  - You will need to restart ArcGIS Pro.
- This will bring up the ArcGIS Pro Start screen where the user can:
  - Open existing projects
  - Create new projects
  - **12** Get help
  - From here, double click on Open Existing

ne	Date modified	Туре	Size
building editor	12/16/2021 4:38 PM	File folder	
charleston_east_wv_USGSAndSAMB_2003	12/16/2021 4:38 PM	File folder	
Exercise1A	12/16/2021 4:38 PM	File folder	
Railroad_Crossings-shp	12/14/2021 10:00 AM	File folder	
WestVirginia.geojson	12/14/2021 10:00 AM	File folder	
charleston_east_wv_USGSAndSAMB_2003	11/24/2021 9:44 AM	Compressed (zipp	13,633 KB
WestVirginia.geojson	11/24/2021 11:33 AM	Compressed (zipp	36,179 KB
How to configure ArcGIS Pro	5/27/2020 11:58 AM	Microsoft Word D	170 KB



- Navigate to Course 1A folder and double click on it. This will bring up the following:
- Click Exercise1A.aprx
- This will bring up the Exercise1A project.
- Navigate to the Content window which is on the left of the screen and double click on Routes and select Source.
- Scroll down until you see Spatial Reference and click on it. The top line tells you the type and name of the coordinate system.
  - 1. What is the coordinate system type?
  - 2. What is the name of the coordinate system ?
- Close out of the Routes.



Metadata

Source

Elevation



	ArcGIS Pro	?	- 0 ×							
Arc <b>GIS</b> <sup>®</sup> Pro		Ô	Not signed in https://www.arcgis.com/ Sign in							
Open	New									
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OpenDataPortal J:\Service_MXDs\OpenDataPortal.aprx rail C:\Users\e087607\OneDrive - State of West Virgin	a\	What's Quick Learn New Start ArcGIS	Esri Academy							
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Open another project	Name	Projects (APRX, PPKX)	-							
र्र्ट्रेङ Settings			Cancel							



- Let's repeat this step for Railroad Crossing.
  - 1. What is the coordinate system type?
  - 2. What is the name of the coordinate system ?
- Close out of Railroad Crossings.
- On the bottom left corner of the map screen, there is a drop down that looks like this.
- This is the scale of the map.
  - 1. What is the map's Ratio?
- - 2. Is this a Large Scale, Small Scale, or Medium Scale Mab5
- Do Not Close out of ArcGIS Pro.
- Once completed, return to choosing the right projection and complete 3 other lessons. https://learn.arcgis.com/en/projects/choosethe-right-projection/





## Geographical Component Quiz

- What is GIS? What does it stand for? Can you describe it?
- What are Meridians and Parallels? Which one is Latitude and which one is Longitude?
- Describe what a spatial reference is?
- What is not a Datum?
  - **2** NAD 1983
  - NAD 1983 UTM Zone 17N
  - **?** WGS1984
  - Lambert



## Geographical Component Quiz

- What is the difference between Geographical Coordinate System and Projected Coordinate System?
- What is the coordinate system WVDOT uses for its GIS Data?
- Which Scale would you use for the following:
  - **?** City
  - **2** DOH District
  - Statewide



# GIS Basics Section 2: Information Component

# **GIS:** Information

- In the previous section we learned about the "where" component of GIS and what makes up that component.
- This section answers the "what" component of GIS.
- It is the information and data shared with the user about an object on a map.
  - GIS uses both Data and Information, but what are they and how do they differ?

		SubRoute	SignSystem	SuppCode	CountyCode			Shape*	Shape.STLength()		
	02100610000NB						26	Polyline ZM	54245.840181	5-Complete/Official	
										5-Complete/Official	
	06100640000EB										
	08100790000048								17394.444523	5-Complete/Official	
3920	10100770016NB						67,21	Polyline ZM	29552,418728	5-Complete/Official	
4919	11100790000NB					83,15	83.55	Polyline 2M	852.141999	5-Complete/Official	
	13100640000EB										
	17100790000NB									5-Complete/Official	
	18100770800NB						156.99	Polyline ZM	81762,981436	5-Complete/Official	
5798	20100640000EB						58,78	Polyline ZM	27386.301906	5-Complete/Official	
\$800	20100640006EB							Polyline 2M	1004.66954	5-Complete/Official	
8848	20100770000\$B							Polyline 2M	45455.023648	5-Complete/Official	
	20100770016NB						95.34	Polyline ZM	57929.268655	5-Complete/Official	
	20100790000NB						21,28	Polyline ZM	44087.225206	5-Complete/Official	
10416	21100790000MB						105.42	Polyline 2M	47146.043775	5-Complete/Official	
	25100790000NB						142.37	Polyline ZM	27383.091386	5-Complete/Official	
14658	28100770000NB						8.98	Polyline 2M	18038.837557	5-Complete/Official	
								Polyline 2M		5-Complete/Official	



## Differences between Information & Data

#### Information

- Is processed, analyzed, organized and structured data that provides meaningful context to an object such as its name, traffic count, etc.
- Relies on Data
- Is measured in meaningful units such as time, quantity, etc.
- Is high-level knowledge
- Is used in decision making
- 2 Is useful data

#### Data

- Are raw unorganized facts that need to be processed such as text and numeric values
- Do not rely on information
- Are measured in Bits and Bytes
- Are low-level knowledge
- 2 Do not have any specific purpose
- Are not used in decision making



## Information:

- In GIS, information is knowledge obtained or provided about a feature or location.
- Information includes both direct knowledge like a street name as well as data that has been assembled, processed, and organized into useful facts and figures like how many houses are on that street.

• Taken together, information about a feature creates a logical picture. For example, a route feature could include information such as surface type, speed limit, route number, number of lanes, grade, etc.



# Information:

For us, information can:

- Aide the user or audience in decision making.
- Illustrate or highlight a feature or theme such as:
  - ✓ Daily Work Projects
  - ✓ Roadway Surface Type
  - ✓ Long Range Projects
- Provide a reference to something that is ongoing like:
  - ✓ Snow and Ice Removal
  - ✓ Traffic Information
  - Weather information

<u>https://byjus.com/biology/difference-between-data-and-information/</u>



## Data are:

- A collection of raw, unorganized facts, figures, descriptions, etc. that alone do not mean much.
- Insufficient for decision making. Data need to be analyzed first and converted into information.
- Measured in bits and bytes.
- Composed of:
  - Characteristics that describe or identify a feature such as:
    - ✓ Feature Name
    - ✓ Feature Type
    - ✓ Unique Identifier
    - ✓ Project Name
  - Measurements in meaningful units such as:
    - ✓ Length
    - ✓ Area
    - ✓ Height
    - ✓ Beginning and ending mile points



#### Components of Data

- From this point forward, we are going to focus on the data component of GIS information.
- Bring up the ArcGIS Pro software again, and return to the exercise we just completed.
- Right click on the Routes feature and select Attribute Table.
  - This will bring up the Attribute Table.
- An attribute is a specific piece of data about a geographic feature usually stored in a table.
- In the remainder of this course, we are going to use data and attribute interchangeably.





1	OBJECTID *	FRFRANODE	TOFRANODE	Railroad Name Long	Railroad Owner	Trackage Rights 1	Trackage Rights 2	Passenger 🖒	DIVMN	Division	Subdivision	Dispatcher
1	87	456772	456831	APPALACHIAN AND	AO			NONE	A	WEST VIRGINIA	COWEN DISTRICT	A&O DISPATCHER
2	88	457214	457330	APPALACHIAN AND	AO			NONE	1	WEST VIRGINIA	COWEN DISTRICT	A&O DISPATCHER
3	89	457643	457455	APPALACHIAN AND	A0 🔶	ROW-	->	NONE		WEST VIRGINIA	COWEN DISTRICT	A&O DISPATCHER
4	90	459512	459553	APPALACHIAN AND	AO			NONE		WEST VIRGINIA	COWEN DISTRICT WYE	A&O DISPATCHER
5	217	456796	456803	APPALACHIAN AND	AO			NONE		WEST VIRGINIA	COWEN DISTRICT	A&O DISPATCHER
6	218	456791	456826	APPALACHIAN AND	AO			NONE	V	WEST VIRGINIA	COWEN DISTRICT	A&O DISPATCHER
7	219	456795	456779	APPALACHIAN AND	AO			NONE	J	WEST VIRGINIA	COWEN DISTRICT	A&O DISPATCHER



## Attribute Table

- Is the foundation of all geographic data sources (Shapefile, Feature Class, Raster, etc.).
- Consists of a collection of data and attributes on a specific feature organized in a table.
- For example, this could be:
  - Attributes describing a road network
  - Airport information
  - Consists of:
    - Columns (Fields)

? Rows

https://desktop.arcgis.com/en/arcmap/latest/managedata/tables/a-quick-tour-of-tables-and-attribute-information.htm



## Attribute Table: Column(Field)

- The column represents a value (characteristic) describing a given attribute that is common to all features such as:
  - Measurement
  - 2 Døte
  - A Name or string of text
  - ObjectID (automatically generated)
  - Shape (automatically generated)
  - Is used to organize like information types within an attribute table.

1	OBJECTID *	FRFRANODE	TOFRANODE	Railroad Name Long	Railroad Owner	Trackage Rights 1	Trackage Rights 2	Passenger 🕻	DIVMN	Division	Subdivision	Dispatcher
1	87	456772	456831	APPALACHIAN AND	AO			NONE	A	WEST VIRGINIA	COWEN DISTRICT	A&O DISPATCHER
2	88	457214	457330	APPALACHIAN AND	AO			NONE	T	WEST VIRGINIA	COWEN DISTRICT	A&O DISPATCHER
3	89	457643	457455	APPALACHIAN AND	A0	ROW-	->	NONE		WEST VIRGINIA	COWEN DISTRICT	A&O DISPATCHER
4	90	459512	459553	APPALACHIAN AND	AO			NONE		WEST VIRGINIA	COWEN DISTRICT WYE	A&O DISPATCHER
5	217	456796	456803	APPALACHIAN AND	AO			NONE		WEST VIRGINIA	COWEN DISTRICT	A&O DISPATCHER
6	218	456791	456826	APPALACHIAN AND	AO			NONE	V	WEST VIRGINIA	COWEN DISTRICT	A&O DISPATCHER
7	219	456795	456779	APPALACHIAN AND	AO			NONE	J	WEST VIRGINIA	COWEN DISTRICT	A&O DISPATCHER

4	Field Name	Data Type
	OBJECTID	OBJECTID
	SHAPE	SHAPE
	RR_NAME	Text
	Click here to add a ne	, Short Integer Long Integer Float Double Date
		Text
		GUID
Cli	ck any field above to s	e Global ID
		Raster
Fie	ld Properties	
AI	ias	



## Attribute Table: Column(Field)

#### Fields can be filled in a variety of formats.

- **?** Numeric:
  - $\checkmark$  Short Integer: stores whole numeric values that contain up to 5 digits (0  $\pm$  99999).
  - $\checkmark$  Long Integer: stores whole numeric values up to 10 digits (0 <u>+</u> 999999999).
  - Double: stores whole and decimal numbers. This is mostly used for measuring distances and adding in coordinates.
  - ✓ Float: stores values in a numeric range (IE 0 -10, 11 -50, etc.).
- Text: stores text characters, words or phrases up to 255 characters.
- **2** Date: stores values in a date format such as MM/DD/YYYY.
- GUID or GlobalID: Unique, ESRI-generated values that are used to identify the feature.
- Raster: fields that allow you to record raster data.





### Attribute Table: Rows (Record)

- Set of related data fields containing all the attribute values describing a feature.
- Represents a single record (row) found in the dataset.
- Consists of multiple fields(columns).
- Differences between Columns and Rows

	OBJECTID *	FRFRANODE	TOFRANODE	Railroad Name Long	Railroad Owner	Trackage Rights 1	Trackage Rights 2	Passenger (	DIVAN	Division	Subdivision	Dispatcher
1	87	456772	456831	APPALACHIAN AND	AO			NONE	A	WEST VIRGINIA	COWEN DISTRICT	A&O DISPATCHER
2	88	457214	457330	APPALACHIAN AND	AO			NONE	1	WEST VIRGINIA	COWEN DISTRICT	A&O DISPATCHER
3	89	457643	457455	APPALACHIAN AND	A0 🔶	ROW-	4	NONE		WEST VIRGINIA	COWEN DISTRICT	A&O DISPATCHER
4	90	459512	459553	APPALACHIAN AND	AO			NONE		WEST VIRGINIA	COWEN DISTRICT WYE	A&O DISPATCHER
5	217	456796	456803	APPALACHIAN AND	AO			NONE		WEST VIRGINIA	COWEN DISTRICT	A&O DISPATCHER
6	218	456791	456826	APPALACHIAN AND	AO			NONE	1	WEST VIRGINIA	COWEN DISTRICT	A&O DISPATCHER
7	219	456795	456779	APPALACHIAN AND	AO			NONE	V	WEST VIRGINIA	COWEN DISTRICT	A&O DISPATCHER



## Exercise: Exploring Attribute Table

- Right click on the RouteID Field and select Fields.
- This will bring up a field table that will describe each of the fields.
  - 2 What are some of the column headers?
  - What type of fields are the following:
    - ✓ BMP
    - Route
    - ✓ Sign System
- Now close out of the fields and return to the main attribute table and choose a row. Can you give me the following information?
  - ? Label
  - RouteID
  - Subroute
  - ? District
  - BMP and EMP



## Exercise: Exploring Attribute Table

- Which field would be good to use if you need to run a query to find all routes within Kanawha County?
- What field would you use if you want to label a road number?
- Which field would you use if you want to create a label by route type such as Interstate, US Route, WV Route, etc.?
- Which two fields would you use if you want to calculate the distance of a route?
- Close the table.



## **Geospatial** Data

- Refers to any data that describes features, objects, or events that:
  - Are physically located on the earth's surface.
  - Have some sort of spatial reference assigned to them.
- Close out of the table and go back to the Content Pane. These ore all Geospatial Data.
- They are stored in the following data formats:
  - ? Vector
  - ? Raster
  - Surfaces and Triangulated Irregular Networks (TIN)

https://pro.arcgis.com/en/pro-app/latest/help/data/introduction/data-types.htm



## **Geospatial** Data

- Have rules defining data integrity, geometries, relationships, etc. called topologies.
- Geospatial Data is shared in the following Data Types:
  - Shapefiles
  - Feature Classes
  - KML/KMZ
  - ArcGIS services
- The different geospatial datatypes can be housed in:
  - Geodatabases
  - Databases
  - File Folders



## Vector Data

- Majority of the data you will be working with in ArcGIS Pro.
- A coordinate-based data model that represents geographic features.
- Consists of a geometry (geographical component) and attribute data.
  - Geometry is made up of one or more interconnected vertices (XYZ coordinates associated with the feature).
  - Attributes are associated with each vector feature.



## Vector Data

- The arrangement of XYZ coordinates define either:
  - Point: a feature consisting of a single discrete vertex like a sign, railroad crossing, etc.
  - Line: a feature defined by a sequence of interconnected vertices that are in a path or segment like a road centerline, railroads, rivers and streams, etc.
  - Polygon: a feature defined by a sequence of multiple, interconnected vertices whose origin and end are at the same position such as parcels, counties, etc.





## Vector Data

- Can be easily created and edited.
- Displays discrete real-world features instead of continuous features.
- Are scalable meaning that a feature will grow or shrink in size without becoming distorted.
- Can be used for Spatial Analysis in a GIS application.
- <u>https://docs.qgis.org/2.8/en/docs/gentle\_gis\_introduction/vector\_data.html</u>
- Short video on Vector and Raster Data
- Another Short VIdeo of Raster and Vector Data



## **Raster** Data

- Are continuous data representing an image from a satellite, remote sensing device, or scanned map or orthophoto representing realworld phenomena.
- Can be:
  - Interprete the second state of the second s
  - Continuous data such as temperature, elevation, LiDAR
  - Scanned pictures such an old map, orthophoto, blueprint
- Are continuous in value from point to point rather that discreet like vector data.

https://desktop.arcgis.com/en/arcmap/10.3/manage-data/raster-andimages/what-is-raster-data.htm



# Raster Data

- Are composed of cells organized into a matrix of rows and columns called a grid.
- Are mostly used in the following roles:
  - Basemaps primarily what we use them for
  - Surface or Elevation maps
  - Thematic maps such as land use, soil type, vegetation
  - Are not scalable when zooming in and out, meaning the picture will pixilate when zooming in and become clearer zooming out.
- Short video on rasters





## Raster Data: Cells

- Are the smallest unit of information in a raster dataset
- Are sometimes referred to as pixel
  - Pixel is an abbreviation for picture element and is used when describing imagery.

🗕 Cell

- Cells represent the phenomenon portrayed by the raster data set.
  - Each value represents a numeric piece of information of a real-world phenomena such as height, landuse, color, vegetation.
  - Each value has a Real number (values with a decimal place) and Integer number (values without a decimal place).
  - Each value can be both positive and negative.
- Cells use scale or the ratio/relationship between a distance or area on a map and the corresponding distance or area in reality.

# Raster Data: Resolution

Resolution

Refers to the size of the cells in a raster dataset and the ratio of screen pixels to image pixels
73 m<sup>2</sup>
72 m<sup>2</sup>

 $\checkmark$  IE – 1 screen pixel = 100 image pixels

Is calculated by cell size which is the surface area of the cell (Width \* Height).

✓ Cell Size determines the spatial resolution.



Determines how coarse or fine the image is going to look

- ✓ The smaller the cell size, the smoother (clearer) the image becomes.
- ✓ The larger the cell size, the coarser (pixilated) the image becomes.
- The smaller the raster cell size, the longer it is going to take to process the data in the GIS Software.

https://desktop.arcgis.com/en/arcmap/10.3/manage-data/raster-and images/cell-size-of-raster-data.htm

## Raster Data: Resolution

- There are 4 kinds of resolution:
  - Radiometric: describes the ability of a sensor to distinguish slight differences in the spectrum between adjacent points.
  - Spatial: describes the smallest object that can be resolved by the sensor.
    - $\checkmark$  It is the dimension of the area on the ground represented by a single cell.
    - ✓ It is how detailed objects are in an image.
  - Spectral: describes the ability of a sensor to distinguish between wavelength intervals in the electromagnetic spectrum
    - The higher the spectral resolution is, the narrower the wavelength range for a particular band
  - Temporal: refers to the frequency at which the image was captured over the same place on the earth's surface



## Triangle Irregular Network(TIN)

- Stands for a Triangle Irregular Network
- Used to represent height values and surface morphology across an area
- This is done through triangulating interconnected sets of vertices (vector-based XYZ points) to form a network of interconnected triangles
- These interconnected nonoverlapping triangles create a more accurate surface capturing accurate linear features
- Measured in English and metric units not decimal degrees
- <u>https://pro.arcgis.com/en/pro-app/latest/help/data/tin/tin-in-arcgis-pro.htm</u>


#### Exercise: Exploring Data Formats

- Return to the Exercise 1A project, but this time bring up Exercise 2. Exercise
- Click on the Explore button.
- Navigate to any feature that is a blue line that looks like this.
  Click on it.
  - 2 What is the Sign System of this route?
  - What is the route number?
  - Repeat this step for the red line, black line, and the gray line.
    - What are the different fields in this feature class?
    - What is the route number for each?
    - What Sign System are they in?
    - Which county and district are they in?



## Exercise: Exploring Data Formats

- Next, click on the Traffic Lights.
  - What are the different fields in this feature class?
  - What is the county the light is in?
  - What route is the light on?
- We are going to investigate the basemap. Click on the area not covered by a traffic light or route.
  - What are the fields in that raster feature?
  - What is the value?
  - Finally, zoom in and out on an area where I-77 and WV 61 meet.
    - Does the route line and traffic light size and clarity change or remain the same?
    - Does the basemap change or remain the same, and if so, when you zoom in, did it get clearer or more pixilated?
  - Do not save, but keep the map project open.





#### Data Sources

- In the previous section, we learned about the different formats that Geospatial Data are stored in.
  - ? Vector
  - Raster
  - Triangulated Irregular Network
  - But how are the data stored for each type of format?
    - Raster format
      - ✓ Img
      - ✓ jpeg2
      - ✓ GIF
      - 🖌 LAS
    - 2 Vector format
      - ✓ Shapefile
      - ✓ Feature Class in a Personal, File, or Enterprise Geodatabase
      - 🖌 KML



### Geospatial Data Storage: Shapefile

- A shapefile is probably the simplest and most portable in terms of the types of geospatial data storage.
- Consists of multiple files including a:
  - Database File (DBF): Houses the information and data for the shapefile.
  - Shape Index File (SHX): Contains the column headers and indexes that are used to organize the data in the database file (DBF) for fast retrieval.
  - Shapefile (SHP): Contains the feature's geometry and some of the data.
- Additionally, sometimes there can be a Projection (PRJ) file that contains the projection or geographical coordinate system of the feature.

https://desktop.arcgis.com/en/arcmap/10.3/manage-data/shapefiles/what-is-ashapefile.htm



## Geospatial Data Storage: Shapefile

- Advantages
  - 1 It is easy to create, and you can export data to it very easily.
  - It is very portable and lightweight. It can be used by other GIS software such as QGIS, Mapworks and CAD software such as AutoCAD and MicroStation.
  - 1 It can be housed on it own and does not need a special place to be housed such as a geodatabase.
- Disadvantages
  - It does not have the ability to store complex geographical information such as annotations, topologies, relationships, attribute domains, etc.
  - It is limited in the number of characters you can have in the shapefile (10 for name and 255 in headers, etc.).
  - It cannot use the complex tools and features found in ArcGIS.
  - It cannot be versioned and edited by multiple people concurrently.
  - It stores data in a non-binary format and has trouble storing non-English language data.
  - It has 2GB size for shapefile component.

https://pro.arcgis.com/en/pro-app/latest/tool-reference/appendices/geoprocessingconsiderations-for-shapefile-output.htm

#### Geospatial Data Storage: Feature Class

- Collection of homogenous geographic feature data that share the same geometry type (Point, Line, Polygon, etc.) and the same attribute fields
- Resides in a Geodatabase.
- Can be organized with other like feature classes into groups called feature datasets
- Consists of the basics point, polyline, or polygon shape as well as
  - Annotation saved map text or string of text that are associated with a point, polyline or point feature.
  - Dimension -- special type of annotation showing spatial text (height, distance, etc.).
  - Routing or network a network of point and linear features that are interrelated.
  - Multi-point feature containing clustered multiple point feature classes that represent a feature.
  - Multiple Patch 3D surface that represents a 3D geometry such as building front, tree, etc.

#### Geospatial Data Storage: Feature Class

- Contains both the geometric shape of the feature as well as descriptive attributes
- Can contain both single and multiple parts of a polygon or polyline
  - IE you can have a single feature for Hawaii as a state when it contains multiple polygon values
  - Along with the X,Y,Z coordinates, feature classes can have a M value.
    - The M Value is the linear measurement to interpolate distances along linear features.
    - **1** The "M" stands for Measurement.
    - It is the building block of Linear Referencing. It is something we use in our statewide road network.
    - 12 This value also is used in georeferencing or the process of geolocating an event along a measurement system.

#### Exercise: Shapefile V Feature Class

Bring up a web browser and either copy in or type the following: <u>https://www.esri.com/arcgis-blog/products/arcgis-pro/data-</u>

management/using-common-gis-data-types-in-arcgis-pro/

- This will bring up a brief ArcGIS Exercise showing the differences between shapefiles and different features.
- The data for this exercise is found at: <u>\dotb6gisrh01\WVDOT\_Training\Course1\Materials</u>
- This should not take long, and when finished please let me know what you observed in the database.



#### Geodatabases

- A Geodatabase is a collection of spatial and non-spatial data held in a common folder on a disk or database management system (SQL, Oracle, DB2, etc.).
- It maintains data through a series of interrelated tables (relational) that contain the information, geometries, etc.
- It uses a unique identification (primary key) to interlink the data.
- It can be used for editing, managing, sharing and creating data.
- It houses both vector, raster, tabular (table)data, and TIN networks.
- A Geodatabase can include:
  - Personal Geodatabase (PGDB or MDB)
  - File Geodatabase (FGDB)
  - Enterprise Geodatabase (SDE GDB)



#### Geodatabase: Personal Geodatabase

This is the simplest of all the geodatabase types.

- It is based on the Microsoft Access database that can store up to 2GB of both Spatial and Non-Spatial Data.
  - Attachments
  - Annotation
  - Feature Classes and Datasets
  - Geometric Networks
  - Mosaics
  - Network Datasets
  - Parcel Fabric
  - Relationship Classes
  - Raster Catalog and Datasets

- Schematic
- Table (nonspatial)
- Participation
- Toolboxes
- Topology



#### Geodatabase: Personal Geodatabase

- It can also:
  - Have domains.
  - Use subtypes.
  - Participate in check in and check out replication.
  - Participate in one-way replication .
- Only one user can use it at a time.
- It is not supported or used in ArcGIS Pro.

https://desktop.arcgis.com/en/arcmap/latest/manage-data/administer-file-gdbs/personalgeodatabases.htm

https://desktop.arcgis.com/en/arcmap/10.3/manage-data/geodatabases/what-is-a-geodatabase.htm

https://desktop.arcgis.com/en/arcmap/latest/manage-data/geodatabases/types-of-geodatabases.htm



#### Geodatabase: File Geodatabase

- Middle range of all the ArcGIS databases
- Native version of Geodatabase in ArcGIS
  - Only accessible from ArcGIS Software
  - Does not need to be stored on a database server
- Can also:
  - Contain subtypes and domains
  - Participate in check-out/check-in replication and one-way replication
- Can be accessed simultaneously, but if being edited, each user must work on different datasets.

https://desktop.arcgis.com/en/arcmap/latest/manage-data/administer-gdb-intro/geodatabaseadministration.htm



## Geodatabase: File Geodatabase

- Can store up to 1TB but can be upgraded to 256 TB of both spatial and non-spatial data for:
  - Annotation
  - Attachments
  - Feature Classes and Datasets
  - Geometric Networks
  - Mospics
  - Network Datasets
  - Parcel Fabrics
  - Raster Catalog and dataset
  - 2 Relation lasses
  - Schematic dataset
  - ? Table
  - **?** Terrains
  - Toolboxes



#### Geodatabase: Enterprise Geodatabase

- Most complex of the different types of geodatabases.
- Collection of various types of tables held in table format in a relational database (the recommended native format for ArcGIS).
- Housed on a Relational Database Management System (RDBMS) or database system that houses data in multiple tables that all have a similar unique value called a primary key.
  - SQL Server or SQL Express
  - PostgreSQL
  - ? Oracle
  - DB2 or Infomix
  - **?** SAP
- Has no limit in data size.



#### Geodatabase: Enterprise Geodatabase

- Designed for medium to large scale use for enterprise-wide implementations
- Advantages:
  - Better data security by assigning different levels of access to the datasets including:
    - Geodatabase Administrator: creates and owns all the database objects (tables, views, functions, etc.) that make up an enterprise geodatabase and maintains the geodatabase
    - Data Creator: a small number of people who create feature classes, tables, raster datasets, and mosaic datasets that other people in the organization publish, map and analyze
    - Publisher: people who create and configure the web maps and services
    - ✓ Editors: maintain the data through editable features, services, and portal feature layers
    - Analysts: run geoprocessing tools on feature services and image services in ArcGIS Desktop/Pro or through Python
    - Viewer: interact with map, feature, or image services on maps created in ArcGIS Pro and map viewer

#### Geodatabase: Enterprise Geodatabase

- Backup and recovery capabilities
- Multiuser/Multi-editor environment where users can:
  - ✓ Access and edit datasets at the same time
  - Have multiple editors editing the same dataset at the same time
  - Can edit through Versioning (or the use of multiple individual snapshots of a database at a given point in time)
- Implement workflows on data editing, management, creation, and QA/QC
- Implement topology and other editing rules on it
- Archiving which makes it possible to track changes
- Can easily transmit data to other enterprise and file geodatabases through a process of replication (2-way replication)

ttps://enterprise.arcgis.com/en/server/latest/manage-data/windows/enterprisegeodatabases-and-arcgis-enterprise.htm

https://www.esri.com/news/arcuser/0408/entergdb\_101.html







- Open up Exercise 1A again, and this time bring up Exercise 3. Exercise 3
- Double click on the railroad crossing layer and select the Source.
- This time we're going to look at the type of data.
  - Geometry tells whether the feature is a point, polyline or polygon.
    - ✓ What is the feature's geometry type?
  - The data type tells us whether it is a shapefile or feature class. Is it a feature class or a shapefile?
    - ✓ If it is the later, what are the parts that make up a shapefile?
  - I Finally, on the rows below the data type, where does the railroad crossing reside?
  - Close out of the railroad crossing features



Open up Routes and Sources. What data type is this feature? ✓ Is it a feature class or shapefile? 2 Where does the feature reside? ✓ Personal geodatabase Feature geodatabase ✓ Enterprise geodatabase What is the name of the server or location this data is stored on? Does it reside in a feature layer? What geometry type is this feature? Exit out of Routes.



Select the Buildings layer and Source? 2 What is the data type? Is if a feature class or shapefile? Where are the data being stored at? 2 What is the geometry type of this feature? Fingly, click on the Road\_Anno feature then Road\_Name\_Anno. What is the data type of this feature? Where are the data being stored? 2 What is the geometry type of this feature? Close out of the Exercise 1A project.



### Information Component Quiz

- Differentiate between vector and raster data?
- True or False: a shapefile is standard format for raster data?
- What is a shapefile and what are the three things that make up a shapefile?
- True or false: Feature Class can be housed on its own (does not need a geodatabase to reside in)?
- What does M value measure?
- True or False: The smaller the cell size on a raster, the more pixilated the raster is?
- What is a Geodatabase and what are the three kinds of geodatabases?



What does RDBMS stand for and how does it relate to GIS?

# End of Part 1 Any Questions? Thanks



# Introduction to GIS Fundamentals Part 1: GIS Basics Continued...



- GIS stands for Geographical Information Systems.
- Every feature on earth has a geographical location that is defined by a set of two or more points called coordinates.
- There are lines running North and South (Latitude) and East and West (Longitude) that make up the coordinates.
- There are a series of strategically placed disks with known Lat and Long coordinate points and heights called geodetic markers, and highly accurate GPS receivers that continuously transmit Lat, Long, and Height coordinates colled Continuously Operating System (CORS) network.
  - These form an interwoven network (grid) called a spatial reference system.
  - There are two types of spatial refences that further locate the data:
    - Geographic: Which provides the precise location on earth
    - Projection: Which provides measurements such as length, area, and scalability

- There are a set of constraints that specify and define these coordinates called a datum. These include:
  - Provision of the equator and prime meridian
  - Vertical: measures height
  - **2** Geodetic: measures both distance and height as well as time using GPS
  - GIS also consists of an Informational component used for:
    - Identifying characteristics of a feature such as name, type, identifier
    - Measurements for a feature such as distance, elevation, beginning and ending points
    - **P** Figures that:
      - ✓ Aide in decision making
      - ✓ Illustrate a feature or theme
      - ✓ Provide reference



- Information is conceived from data (a collection of raw, unorganized facts, figures, symbols, descriptions, etc.).
- Data we use are called Geospatial data because they have a geographical component associated with them.
- Geospatial data are housed in tables, spreadsheets, or databases.
  All of these forms of data storage utilize an attribute table made up of;
  - Fields or columns which are shared attributes (characteristics) of multiple features.
  - Rows which are the individual record of each feature and consist of many fields.



- Geospatial data can be found in the following formats:
  - ? Vector
  - Raster
  - Triangular Irregular Network (TIN)
  - Geospatial Data are stored in:
    - Peature Classes
    - Shapefiles
    - Various Raster Formats
  - Data can reside in folders (stand alone shapefiles and rasters), personal geodatabases, file geodatabases, or an enterprise geodatabase (feature classes and rasters).



# GIS Basics Section 3: System Component

#### GIS: System Portion of GIS

- Converts the raw materials (the Geographical portion and Information/Data portion) into finished products (maps, applications, etc.)
- These include:
  - Prinished Geospatial data products such as a feature class, shape file, service, etc.
  - Mapping products (maps)
  - Web applications
- But, what are the components that go into creating a GIS System?





## GIS: System Portion of GIS

- The GIS System is used to collect, maintain, organize, and distribute geographical information.
- It consists of four key components:
  - Information being created and maintained by the organization
  - Infrastructure housing the geographical information including:
    - Software creating, maintaining and sharing the data, services, mapping products and applications
    - ✓ Hardware housing the data, services, mapping products and applications
    - Network(Environment) combining both the hardware and software component in an organized fashion
  - Information products being developed and shared with its customers
  - The Organization and processes behind creating, maintaining, and sharing these products



# Introduction to GIS Fundamentals Part 2 – Introduction to WVDOT GIS Section 1: Introduction to WVDOT GIS Data



#### WVDOT GIS Data

- First building block for creating a Geographical Information System
- Refers to the all the data and datasets currently being created and maintained by WVDOT
- These include:
  - Geodatabases
  - Feature datasets and feature classes
  - Shapefiles
  - Corresponding tables, spreadsheets, and figures
  - Shared file locations where data is being housed



#### Enterprise Geodatabases

- As you remember in the previous section, the Enterprise Geodatabase is designed for medium to large scale use enterprise-wide.
- In WVDOT, we have implemented two database servers that house both enterprise geospatial and non-geospatial data. They are:
   2 DOTB6GISDB01
  - DOTB6GISDBST01
- The database management system is MS SQL 2017.
  - SQL stands for Structured Query Language.
  - It is a standard language for storing, manipulating, and retrieving data in databases.
  - It stores data and information in a series of interrelated tables that are connected by relationships.

Video on SQL



#### DOTB6GISDB01

- The Production Database Server
- Houses:
  - Data currently used in all mapping projects and applications
  - Most current data used in the roadway publication (updated semiannually)
- Consists of 82 enterprise databases, 64 of which are operational
  The two enterprise geodatabases most commonly used by WVDOT are:
  - **GTI\_PUB\_UTM**
  - **RIL\_LRS\_PUB**



## DOTB6GISDB<u>ST</u>01

- The Staging Database Server
- Houses all data that is used for:
  - Developing new applications and web maps
  - Developing new datasets and data
  - Testing out and managing how applications will work
- Consists of 59 enterprise databases
- Data and applications on the staging server are not used for operations until tested and moved to the Production Server.



# GTI\_PUB\_UTM

- Location: Production and Staging Database Servers
- Purpose:
  - Main enterprise geodatabase used to house all feature datasets and features classes related to creating maps and mapping products in West Virginia.
  - Contains:
    - Statewide transportation and route data features maintained by WVDOT
    - Statewide Boundaries, Cultural, Economic, Environmental, and Hydrological datasets
- GTI\_PUB\_WM is a mirror of GTI\_PUB\_UTM enterprise geodatabase, but GTI\_PUB\_WM is used for web mapping and application creation.
- Updated semiannually or as needed when new data becomes available


# RIL\_LRS\_PUB

- Location: Production and Staging Database Servers
- Purpose:
  - Main enterprise geodatabase used to house all feature classes and corresponding attribute tables related to WVDOT roadway network including:
    - ✓ State and County Networks
    - ✓ Surface Type
    - ✓ Lane Width
    - ✓ Speed Limit
    - ✓ Bridges
  - It is a copy of the RIL\_LRS database which is the enterprise geodatabase used to edit and maintain the roadway network.



# Important Datasets in GTI\_PUB\_UTM

There are several key datasets in GTI\_PUB\_UTM used within WVDOT.

#### GTI\_PUB\_UTM

Boundaries

✓ Counties: West Virginia Counties

 Incorporated \_Places\_20XX: Location of all incorporated municipalities, towns, and cities within WV

✓ WVDOH\_Districts: Polygon feature of all WVDOH Districts

**2** Economic

✓ Parcels\_20XX: Statewide parcel layer used for right of way

✓ WVDOT\_Parcels: Location of all WVDOT owned parcels

Hydrology

- ✓ Major\_Rivers\_Other\_NHD: Polygon feature of all major rivers in WV
- ✓ Rivers\_Streams\_NHD: Polyline feature of all rivers and streams in WV
- Lakes\_Other\_Waterbodies\_NHD: All lakes, ponds and waterbodies in WV



## Important Datasets in GTI\_PUB\_UTM

#### Routes

- Dominant\_Routes: Feature class derived from the countywide network showing the primary route on the centerline in WV.
  - Dominant routes can be used for displaying routes and eventing tables to the route network.
- Transportation
  - ✓ Bridges: Shows all bridges within West Virginia
  - Lane\_Info\_RH: Shows AADT Traffic Counts, Roadway Surface Type, and Lane Width
  - ✓ WV\_Railroads: WV Railroad Layer
  - ✓ WV\_DOT\_Facilities: Location of WVDOT Facilities
  - ✓ WV\_Airports: WV Airports
  - ✓ WV\_Fuel\_Sites: Location of all WVDOH Fuel Sites



## **Shared** Folders

- Another way to store information within WVDOT is with a shared folder.
- A shared folder contains subdirectories used to house:
  - Geospatial data or information
  - Shared projects or applications
  - Map documents or projects
  - Usually, these folders are:
    - Project or function specific such as:
      - √ Protected animal species and historic sites for the environmental group
    - Unit, Division, or District specific that share geospatial data.



## **District** Share

Now we will go into detail about the District Folder.

- The primary source for all GIS related products for the district, including:
  The District's County Highway Maps (1937 and 2020)
  - The District's Standard Base Mapping products in both ArcMap and Pro
  - Local copies of frequently used Enterprise Geodatabases from DQTB6GISDB01 including:

GTI\_PUB\_UTM

✓ RIL\_LRS\_PUB

- District specific parcel geodatabases
- Training, how-to's and mapping standard documents
- 2 Layers
- Personal Project Folder



## **District Share**

Clipboard	0	rganize New	Open	Select		
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ires	* ^	Name	Date modified	Туре	Size	
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ection		GIS Bacemans	2/12/2021 12:39 PM	File folder		
tructure Ophoarding		GIS Database	11/13/2021 10:40 AM	File folder		
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duction WVDOT GIS System		GIS Projects	3/15/2021 9:22 AM	File folder		
ive - State of West Virginia		GIS Training	11/18/2021 7:53 AM	File folder		
		RIL Data	4/7/2021 5:18 PM	File folder		
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## WVDOT Web Service Directory

- <u>https://gis.transportation.wv.gov/arcgis/rest/services</u>
- WVDOT Web Service Directory is the access site for WVDOT's shared hosted feature services.
- The WVDOT Web Service Directory contains pre-created digital mapping and feature services used for:
  - Web map and application development
  - Adding into any map document or ArcGIS Pro project
  - Shared hosted featured services on the WVDOT services site include:
    - The Basemaps Folder
    - Boundaries, Cultural, Economic, Hydrology, Routes, and Transportation Services
    - Other services associated with web mapping applications such as Fuel Sites, Roadway Surface Type, etc.

#### ArcGIS REST Services Directory Login Help | API Reference

Home > services

JSON | SOAP

Folder: /

Current Version: 10.81

View Footprints In: ArcGIS Online Map Viewer

#### Folders:

- annotation
- Assets
- Base Maps
- Environmental
- GTI Mapping Projects Editor
- Hosted
- Imagery
- Projects
- Roads And Highways
- ROW
- Test
- <u>Utilities</u>
- <u>WMX</u>

Services:

- <u>Airport Runways</u> (FeatureServer)
- <u>Airport Runways</u> (MapServer)
- <u>Boundaries</u> (FeatureServer)
- <u>Boundaries</u> (MapServer)
- <u>Coal Resources Transportation System Routes</u> (FeatureServer)
- <u>Coal Resources Transportation System Routes</u> (MapServer)
- <u>Cultural</u> (FeatureServer)
- <u>Cultural</u> (MapServer)
- Economic (FeatureServer)
- Economic (MapServer)
- <u>Hydrology</u> (FeatureServer)
- <u>Hydrology</u> (MapServer)
- <u>Routes</u> (FeatureServer)
- <u>Routes</u> (MapServer)
- <u>Transportation</u> (FeatureServer)
- <u>Transportation</u> (MapServer)

Supported Interfaces: REST SOAP Sitemap Geo Sitemap



1:45 PM

# SDMT GIS Data Pages

- <u>https://transportation.wv.gov/SDMT/GIS/Pages/DataCatalog.aspx</u>
- Access site for the Strategic Data Management & Technology Division GIS LRS Road Network Data and documentation including
  - Pridges
  - Byways & Backways
  - 2 Gyardrails
  - Interstate Bridges and Exits
  - Mile Markers
  - Park and Rides
  - Public Airports
  - Railroads
  - ? River Ports

- Traffic Counts Station and Segment Data
- DOH Districts, District Headquarters, Equipment/Maintenance/Materials Facilities, and Substations
- Major Roads
  - ✓ Interstates
  - ✓ US Routes
  - ✓ WV Routes
- Dominant Routes
- Routes By Districts



#### **GIS** Data

The West Virginia Department of Transportation (WVDOT) supports free data exchange with other organizations and the general public.

For additional WVDOT GIS data, please visit the WVDOT Open Data Portal at https://data-wvdot.opendata.arcgis.com/

The GIS data is published in ESRI shapefile format and compressed as ZIP files. Some of the data is also published as web services. The spatial reference for the data is Universal Transverse Mercator (UTM), Zone 17, and North American Datum (NAD) 83.

#### Transportation GIS Data

Byways & Backways
Guardrails
Interstate Bridges

Bridges

Interstate Exits

Mile Markers

Park and Rides

Public Airports

Railroads

**Rest Areas** 

**River Ports** 

Traffic Counts Station Data - 2019

Traffic Counts Segment Data - 2019



## WVDOT Open Data Portal

- <u>https://data-wvdot.opendata.arcgis.com</u>
- Another public facing place to obtain data from WVDOT
- The WVDOT Open Data Portal is a hub for users to access, download, and view roadway and transportation data shared by WVDOT.
- This information includes:
  - Downloadable feature datasets
  - Web applications
  - 2 Static maps
  - Dashboards
  - Internal and external web services and portals



### WVDOT Open Data Portal

WVDOT Open Data Portal

#### West Virginia Department of Transportation Open Data Portal

Q Search for Data

Welcome to the West Virginia Department of Transportation Open Data Portal. Our goal is to provide the necessary datasets, apps, and maps for an informed look at West Virginia's Transportation Network and Infrastructure. With it, let's make our transportation system even better!



## **Overview of Data Creation Workflow**





# Introduction to WVDOT GIS

Section 2: Introduction to WVDOT Infrastructure



## Introduction to Infrastructure

- Refers to the software, hardware and environments to convert the GIS data (Section 1) into a usable finished product (static or web map, application, data product, etc. (Section 4)).
- This includes:
  - Software used for creating, managing, sharing and hosting geospatial data
  - Hardware and peripherals where data are:
    - ✓ Created on
    - ✓ Stored by
    - ✓ Hosted from
  - Environment that combines the software and hardware into a cohesive group used to convert the raw GIS data into a finished product.



## Software

- Refers to any program or suite of programs directly or indirectly used to create, maintain, analyze, manage, and share geographical information
- Resides on the hardware as part of the network
- Includes:
  - End-user GIS Software such as ArcGIS Pro, ArcGIS Desktop, etc. used for:
    - Creating, editing and managing geospatial data
    - Performing geospatial data analysis
    - Creating and sharing maps and mapping products



## Software

Server and Enterprise software such as ArcGIS Portal, ArcGIS Server, ArcGIS Datastore used for:

- Creating, maintaining, organizing and hosting feature content such as web maps, services, and applications
- ✓ Governing the WVDOT network such as users, groups, permissions, etc.
- Third Party software including:
  - Software used to house Geospatial Data such as Microsoft SQL Server 2017
  - ✓ Special client software to access some of the data (Microsoft SQL Client)
  - ✓ Software for enhancing the Map or Mapping Product (Adobe Creative Suite)
  - The Operating System that the software runs on or the Server (Windows 10, Server 2017, etc.)
  - Domain Controlling Software which passes the user's credentials into ArcGIS Software (Azure)

## Software

The software used within WVDOT are:

End-user GIS client software

✓ ArcGIS Desktop 10.8.1 soon to be retired

✓ ArcGIS Pro 2.9

Enterprise Software: ArcGIS Portal, ArcGIS Server, ArcGIS Datastore 10.8.1 (soon to be 10.9.1)

Third-party SQL Server and Client software: Microsoft SQL 2017

Server and Operating System software:

✓ Server: Server 2012 R2 (soon to be updated to Microsoft Server 2019)

✓ Client Operating System: Windows 10



### Hardware Diagram





## Hardware

- Most important piece of infrastructure in the GIS System as none of the other parts of the system could function without it.
- Refers to any of the physical infrastructure that contains the following:
  - Physical and virtual components housing the software, geospatial information, etc.
    - The user's workstation
    - Servers (physical, virtual, cloud-based)
    - ✓ Backup, Readily Available Inexpensive Devices (RAID), and Infrastructure
  - Peripheral devices that directly support GIS
    - ✓ Scanners
    - Printers and plotter
    - ✓ External hard drives
  - Networking devices that transmit the data and features
    - ✓ Routers
    - ✓ Switches
    - ✓ Network cables
    - ✓ Firewalls



### WVDOT GIS Environment

- Combines all of the Software and Hardware components of WVDOT's GIS Infrastructure into an interconnected system
- The WVDOT GIS Environment:
  - Phouses WVDOT's Geospatial data
  - Houses programs such as ArcGIS Portal, ArcGIS Server, and ArcGIS Datastore making up ArcGIS Enterprise
  - Manages and maintains the services, applications, information and data sharing through ArcGIS Enterprise
  - Provide the service of the servic
  - Runs backup and long-term data and application storage



### WVDOT GIS Environment

ArcGIS Portal

- Component of ArcGIS Enterprise that acts as the nucleus of the ArcGIS Enterprise Network
- **ArcGIS Portal is where and how:** 
  - ✓ Web maps, scenes, and applications are created, managed, and hosted
  - ✓ User and groups are housed and created
  - Permissions to applications, web maps, and services are assigned
  - ✓ Data and services are shared to other portals and on ArcGIS Online
- 2 Web Address:
  - ✓ Production: <u>Https://gis.transportation.wv.gov/portal</u>
  - ✓ Staging: <u>Https://gisdev.transportation.wv.gov/portal</u>
- Overview of ArcGIS Portal



## WVDOT GIS Environment

- ArcGIS Server
  - Back-end server software component of ArcGIS
  - Hosts and controls all the services and data that run in the background to power the Web Maps and Applications housed in ArcGIS Portal
  - Federated with ArcGIS Portal meaning that security, users, roles, and services are all governed and shared through ArcGIS Portal
  - 2 Web Address:
    - Production: <u>Https://gis.transportation.wv.gov/arcgis</u>
    - ✓ Staging: <u>Https://gisdev.transportation.wv.gov/arcgis</u>

https://enterprise.arcgis.com/en/server/latest/get-started/windows/what-is-arcgis-for-server-.htm

ArcGIS Datastore

- Third part of ArcGIS Enterprise that is used for the storage of data, features, configurations, etc.
- https://enterprise.arcgis.com/en/portal/latest/administer/windows/what-is-arcgis-data-store.htm



## WVDOT Production Environment

- On WVDOT there are two WVDOT GIS Enterprise Environments:
  - Production
  - Staging
- The production environment is the main WVDOT GIS Environment used to:
  - Host shared geospatial products including:
    - ✓ Feature Data Sets
    - ✓ Data Services
    - Web Maps
    - Web Applications
  - Manage and edit certain features and productions such as:
    - ✓ Linear Referencing System
    - ✓ Bridge Network
    - ✓ Mapping product data such as tourism, county highway maps, etc.
  - Create, edit, and view Web Maps and work as a secondary version of ArcGIS Software
  - House user and application information for access to certain ArcGIS features



## WVDOT Production Environment

- Consists of four main servers and two secondary servers that support the production environment. They include:
  - DOTB6GISDB01 Production Enterprise GIS Server and ArcGIS Licensing Server
  - DOTB6GISAPP01 Server housing ArcGIS Server Services, services data sets, and all python scripts used to maintain the ArcGIS Server and Enterprise Site
  - DOTB6GISRH01 Secondary server linked to DOTB6GISAPP01 housing the ArcGIS Server as well as the Roads and Highways Server used for LRS editing and the training course material
  - OTB6GISWEB01 Server housing ArcGIS Portal and ArcGIS Datastore as well as the FTP Site. GIS and Non-GIS websites are hosted as this server has both connections to the intranet and internet.
  - DOTB6GISBKUP01 Backup server for Production network that houses ArcGIS Enterprise configuration backups as well as the SQL backups for DOTB6GISDB01
  - DOTB5STOR01 Location of ArcGIS Monitor, a software used to monitor and view the health of the WVDOT Production Enterprise Network



# WVDOT Staging Environment

- Internal development and training environment used for:
  - Development of:
    - ✓ New Applications
    - ✓ New Maps
    - ✓ New Web Maps
  - **2** Testing of:
    - ✓ New Software packages and any software patch or updates
    - ✓ New Applications before going live
    - Proposed changes to existing applications prior to releasing
  - Training environment for certain functions within GIS such as LRS
  - Create, edit, and view Web Maps and work as a secondary version of ArcGIS Software



## WVDOT Staging Environment

- Consists of two servers:
  - DOTB6GISDBST01: Database Server for the staging environment
  - DOTB6GISWEBRHST: Server housing the components of ArcGIS Enterprise including:
    - 🖌 Portal
    - ✓ Server
    - ✓ Data Store
    - ✓ Web Adaptors
- The following slide shows a diagram of the WVDOT Production and Staging Enterprise Environments and how they are related.
- Notice that only the production environment is linked to internal and external users, and the production is independent of the staging environment





#### WVDOT ENTERPRISE Environment



## ArcGIS Online

- <u>https://www.arcgis.com/index.html</u>
- Esri's cloud-based mapping and sharing solution used for: Creating maps, scenes, and apps Developing collection-based applications and features Creating, viewing, and accessing survey data Collaborating with other users and organizations on data Creating new content and view and manage existing content Requires different credentials than in ArcGIS Enterprise 12 To obtain a license, contact James Underwood at: James.H.Underwood@wv.gov
- Has more functionality in add-ons than ArcGIS Enterprise
- Houses Open Data Portal



#### ArcGIS Online



The West Virginia Department of Transportation (WVDOT) Strategic Data Management & Technology Division (SDL, Edit home page managing an enterprise Geospatial Information System that will improve the productivity of the West Virginia Department of

- les dis sur le in Mast Minute is



# Introduction to WVDOT GIS Section 3: Introduction to Geospatial Program



- In the first two sections of the Systems portion of GIS, we learned about:
  - WVDOT GIS Information and Data that go into creating GIS products including:
    - ✓ Geospatial Data Servers
    - **File Shares**
    - ✓ Open Data Portal
    - ✓ Commonly used Enterprise Geodatabases and Geospatial Datasets
  - Infrastructure housing WVDOT GIS Information including:
    - ✓ Software used to create, manipulate, manage, and share GIS information
    - Hardware that the software resides on as well as peripherals that go into using them
    - Environments combining the software and hardware components to create the finished system that will be discussed later.

- This section deals with the people who are responsible for:
  - Creating the data and finished products
  - Maintaining the infrastructure
  - Developing new ways for accessing the data
- For us, it is the Geospatial Program of the Strategic Data Management & Technology Division.
  - It consists of separate units and the GIS Coordinator who works as a liaison between the different parts of WVDOT.
    - ✓ LRS Services Unit
    - ✓ Mapping Services Unit
    - ✓ GIS Services Unit

- Highway Data Services Unit
- Geospatial Programming Unit
- ✓ GIS Coordinator





#### LRS Services Unit

- Consists of 6 specialists that:
  - ✓ Maintain and manage the statewide route network
  - Maintain and manage the route business data
  - Publish LRS (Linear Referencing System) to support business functions such as (Road Inventory Log, WVDOT product map, Core maintenance, etc.)
  - ✓ Carry out special recurring projects:
    - State and municipal maps data
    - Straight Line Diagrams
    - HPMS Support
    - MIRE 2.0
- Contact: Aaron Ferrari

Phone: 304-414-6917

Email: <u>Aaron.M.Ferrari@wv.gov</u>



#### Mapping Services Unit

- Consists of 4 specialists that:
  - Develop and maintain official highway map products such as:
    - General Highway County Map Series
    - General Highway State Map
    - State and Federal Functional Class Maps
    - National Highway System (NHS) Map
    - Fuel Site Map Book
    - State Tourism Map
  - Create ad-hoc maps or other graphic products when needed
- Contact: Sevin Eldridge
  - Phone: 304-414-6910
  - Email: <u>Sevin.C.Eldridge@wv.gov</u>
- Contact: Amanda Adams
  - Phone: 304-414-6952
  - Email: <u>Amanda.Adams@wv.gov</u>


#### GIS Services Unit

- Consists of 4 specialists that:
  - Maintain and improve the Enterprise GIS Infrastructure
  - ✓ Manage GIS user accounts
  - Provide GIS related services and products
- Contact: Lisa King
  - Phone: 304-414-6941
  - Email: <u>Lisa.A.King@wv.gov</u>



#### Highway Data Services (HDS) Unit

- Consists of 7 specialists that:
  - ✓ Maintain Statewide CORS Network
  - ✓ Collect field GIS data including:
    - ADA
    - MS4
    - CRTS

✓ Processes Commissioner's Orders

Coordinates and holds public meetings with citizens

- Conducts problem route research
- Answer citizen's requests/orders for highway maps
- Contact: Dustin Feazell

Phone: 304-414-7114

Email: <u>Dustin.L.Feazell@wv.gov</u>



#### GIS Programming Unit

Develops Web and GIS applications (e.g. Geometry and Measures) Maintains legacy applications (e.g. Bridge Design, Grants) Performs data analysis and database management Produces custom Scripts Contact: Marshall Burgess Phone: 304-414-6905 Email: <u>Marshall.L.Burgess@wv.gov</u> Contact: Fernanda D'Agostin Phone: 304-414-5091 Email: Fernanda.D'agostin@wv.gov

#### GIS Coordinator

- Acts as liaison between the Geospatial Program and the rest of WVDOT user community
- Works with other divisions and districts to develop solutions for them
- Manages and delivers GIS training
- Contact: Andrew Dolch
  - Phone: 304-414-6909
  - Email: <u>Andrew.J.Dolch@wv.gov</u>



#### Highway Assistant Director

- Oversees the entire Geospatial Program
- Answers all requests for Geospatial related products and services
- Develops and manages strategic goals and objectives

Contact: Yueming Wu

Phone:	304-414-6947
Email:	Yueming.Wu@wv.gov



# Introduction to WVDOT GIS Section 4: GIS Products



## GIS Products

- Over the previous three sections, we learned about the building blocks that go into creating a GIS System.
- This section looks at the finished products called Information Products.
- Information Products refer to any product or service of the GIS section.
- They are:
  - Developed from the GIS information found in Section 1
  - Produced by analyzing and manipulating the GIS Information through Section 2 (Infrastructure) and Section 3 (Program)into a product that:
    - ✓ Tells a story
    - ✓ Highlights a phenomena or project
    - ✓ Provides reference to an area or feature
  - Shared with the end user through Section 2 (Infrastructure)



## **GIS** Products

- The ArcGIS software we use produces a variety of Information Products including:
  - Applications
  - ? Charts
  - Data Models such as 3D, Road, and Utility Network, etc.
  - Geospatial or Tabular Datasets
  - **?** Graphs
  - Mapping Products including static and dynamic maps
  - Reports

https://www.esri.com/news/arcuser/0507/garbage.html

- This section will focus on:
  - Applications
  - Mapping Products



## Mapping Products

- Refers to any pre-created, shared map used to convey information on a specific theme or provide general information
- These include:
  - Static Maps consisting of the traditional Paper Map or Map Image
  - Dynamic Maps consisting of Web Maps used for applications, dashboards, etc.
- Some of the purposes of mapping products are to create:
  - Pasemaps
  - Reference Guides or Fact Finders
  - Presentation Maps
  - Thematic Maps



## Static Mapping

- Refers to any specialized reference map or map product that provide a snapshot of a theme at a specific time period
- Consists of your traditional mapping product such as:
  - Paper Map
  - Digital Map Image
  - Used primarily for:
    - Reports and presentations
    - General or topic specific reference maps
    - The basemap image used to create other digital products
- Found in either an image(jpeg, png, etc.) or PDF format



## Introduction to WVDOT Static Mapping

- There are two types of static maps produced by WVDOT:
  - Standard Map Products
    - Federal Functional Classification Map
    - ✓ General Highway State Map
    - ✓ General Highway County Maps
    - ✓ Milepoint Maps
    - ✓ National Highway System (NHS) Map
    - ✓ State Functional Classification Map
    - ✓ WV Tourism Map
    - ✓ WVDOH Fuel Site Map Book
  - Customizable User Specified Maps
  - Most standard map products come in either PDF or GeoTIFF Format



## General Highway County Map

- Generalized reference map showing all routes and route characteristics in an entire county or part of a county
  - Or a supplemental map sheet showing specific areas within a county.
- The route characteristics include:
  - Highway Sign System (Route Type)
  - Roadway Surface Type
  - Functional Classes
- Also includes other features:
  - Image: A state of the state
  - Landmarks such as schools, hospitals, etc.
  - 2 Hydrological features such as rivers, streams and ponds
  - Park, Forest, and Wildlife Area boundaries
  - Municipal and County boundaries
  - Updated Annually

Found at <a href="https://gis.transportation.wv.gov/CountyMapsApp/">https://gis.transportation.wv.gov/CountyMapsApp/</a>



#### General Highway County Map





## General Highway State Map

- Similar to the County General Highway Map except this map focuses on the entire state instead of a single county.
- Generalized reference map showing all main routes and their characteristics in the entire state including:
  - Route Type
  - Roadway Surface Type
- Contains only:
  - Interstates
  - **2** US Routes
  - 2 WV Routes
  - 2 Major County Routes
- Has insets of major cites
- In addition to features found on a County Highway Map, it contains rail trails and an inset of driving distances.
- Is updated annually
- Found at <u>https://gis.transportation.wv.gov/ftp/GeneralHighwayMap/</u>







#### Mile Point Maps

- Provides the mileage of each segment of all Interstates, US Routes, and WV Routes in all 55 counties
- Also included in this map are incorporated places
- Updated annually
- Comes in only PDF Format
- <u>https://gis.transportation.wv.gov/ftp/MilepointMaps</u>



#### Mile Point Map





## Functional Classification Map

- Functional Classification is the process by which roads, streets, and highways are grouped into classes according to the character of service they are intended to provide.
- Defines the role that any particular road or street should play in serving the flow of traffic through a highway network and the type of access it provides to adjacent properties.
- Functional classification describes the importance of a particular road or network of roads to the overall system.
- There are two types of functional classification maps:
  - ? Federal
  - ? State
- Web article about Highway Functional Classifications



#### Federal Functional Classification Map

Allows users to view the Federal Functional Classifications of West Virginia as defined and approved by the Federal Highway Administration (FHWA). These include:

Interstates (rural and urban)

Freeways or Expressways (rural and urban)

Principal and Minor Arterials (rural and urban)

Major and Minor Collectors (rural and urban)

Local Roads (rural and urban)

- Updated annually
- Comes in both PDF and GeoTiff



#### Federal Functional Classification Map





## State Functional Classification Map

- Similar to the Federal Functional Classification System of maps
- However, the route classifications are defined and approved by WVDOT.
- These include:
  - Interstates
  - Trunklines
  - **?** Feeders
  - **2** Essential Arterials

  - Local Roads
  - Comes in both PDF and GeoTIFF

Both state and federal functional class maps are found at: <a href="https://gis.transportation.wv.gov/ftp/FunctionalClassMaps">https://gis.transportation.wv.gov/ftp/FunctionalClassMaps</a>







## National Highway System (NHS) Map

- Static Map of all routes strategic to the Nation's mobility, security, and economy. These include:
  - NHS Main and Not Connector Lines
  - Major Airport Connector
  - Major Port Facility Connector
  - Major Amtrak Station
  - Major Public Transit Multi-Modal Passenger Terminal
- Map shows all Interstates, US Routes, WV Routes and other routes that lie on one of the above designated routes.
- Updated annually
- Comes in both PDF and GeoTIFF
- Found at: <u>https://gis.transportation.wv.gov/ftp/NHSMaps/</u>



#### National Highway System (NHS) Map





## WV Tourism Map

This is the same map you would get at a Welcome Center, rest area, tourist information center, or travel plaza.

Shows:

? Roads? Tourism Attractions

Counties

Boundaries

Comes in only PDF Format

https://gis.transportation.wv.gov/ftp/Tourism





#### WVDOH Fuel Site Map Book

- PDF Version of the printed Fuel Site book.
- This booklet shows the location, photographs, and directions to all WVDOH fueling sites in every district.
- Comes in only PDF Format and hard copies.
- https://gis.transportation.wv.gov/ftp/Fuelbook/





## Quiz

- What is not a Shared Mapping Product?
  - 2 Web Map
  - Mapping Service
  - ? MXD
  - Static Web Map
- Which map would you use if you wonted to know the classification of a road?
  - Functional Class Map
  - Tourism Map
  - County Highway Map
  - State Highway map

- Which Map is found in Rest Areas and features Surface Type?
  - General Highway Map
  - County Highway Map
  - ? NHS Map
  - ? Tourism
- Which map would you use if you wanted to know the different routes in a county?
  - ? Tourism Map
  - County Highway Map
  - General State Highway Map
  - Pederal Functional Classification Map



## **Dynamic** Mapping

- Often referred to as a real-time map
- This is a map that automatically updates when the user:
  - Navigates to a location
  - Zooms in and out on different features
  - Turns on and off different features to customize the map
- The map is updated automatically when changes are made to the dataset.
  These maps reside primarily on a server.
- They can be accessed through a computer or smart device making them a handy "at a glance" reference.
- Dynamic maps include:
  - Web Map Application such as <u>Geometry and Measures</u>
  - ArcGIS Map and Feature Services as hosted on our <u>servers</u> or on other servers such <u>WV GIS Tech Center</u>
  - ESRI default basemaps
  - 2 Map Package



#### **GIS Web Application**

- Is based on a Dynamic Map
- Is a set of web-based tools used to provide ready access to geospatial data without the need for special GIS software for:
  - Researching and performing analysis on features
  - Editing and managing datasets
  - Producing sharable maps and information
  - Downloading data



#### **GIS Web Application**

- Is shared one of three ways:
  - Group Specific only a specific group of users can access it
  - **2** WVDOT Community
  - General Public everyone can access it
- Resides in one of three places:
  - ArcGIS Online
  - ArcGIS Enterprise Portal
  - Stand Alone



## Frequently Used WVDOT GIS Applications

- Geometry and Measures
- RouteID Builder
- Road Inventory Log Viewer
- Roadway Surface Type Viewer
- Parcel Viewer
- WVDOT Plan Locator
- 1937 County Highway Map <u>Viewer</u>
- Open Data Portal
- WVDOH Fuel Sites
- Street Name Viewer

- We will discuss the following:
  - Geometry and Measures
  - Road Inventory Log Viewer
  - ? RouteID Builder
  - Roadway Surface Map
  - Parcel Viewer
  - Open Data Portal
  - Street Name Viewer
  - WVDOT Plan Locator



#### Geometry and Measures



#### Geometry and Measures

- <u>https://gis.transportation.wv.gov/measures2.0/</u>
- Most useful and most used of the tools within WVDOT
- Interactive basemap application displaying the West Virginia Road Network
- With this application one can:
  - Locate and obtain the RouteID of a route
  - Obtain the Milepoint for a given point on a route
  - Use GPS coordinates to locate the nearest road
  - Use it as as a basemap application for WVDOT data
- Displays useful information about the roadway attribution a list is provided on the following slide.



## Geometry and Measures

- RouteID
- Sign System
- Beginning and Ending Mile Point
- Length
- Surface Type and Pavement Width
- Grade Width
- #of Lanes
- Control
- District
- Supplemental Information
- Survey
- Federal Aid/Federal Forest
- Truck Route

- Rural-Urban/Rural-Municipal
- National/State Functional Class
- NHS
- Urban Area
- Gov ID
- Access Control
- Reversable Lanes
- Special Systems
- Urban Area Code
  - 2 DOH
  - ? Census



## Road Inventory Log Viewer





## Road Inventory Log Viewer

- <u>https://gis.transportation.wv.gov/RoadinventoryLog</u>
- This is an interactive application used to query and provide tabular data by:

Routes

P Districts

Counties

- The Road Inventory Log Data is viewable on the Geometry and Measures App.
- You can download the data with this app or by the website link above.
- It displays useful information about the road as shown on the next slide.
# Road Inventory Log Viewer Fields

- RoutelD
- Sign System
- Beginning and Ending Mile Point
- Length
- Surface Type and Pavement Width
- Grade Width
- #of Lanes
- Control
- District
- Supplemental Information
- Survey
- Federal Aid/Federal Forest
- Truck Route/Subroutes
- Supplemental Code

- Rural-Urban/Rural-Municipal
- National/State Functional Class
- NHS
- Urban Area
- Gov ID
- Access Control
- Reversable Lanes
- Special Systems
- Urban Area Code
  - ? DOH
  - ? Census
- Route number
- Distance



#### **RouteID** Builder

#### WVDOT Route ID Builder

Use the Boate ED Builde to generate a valid WVDOF Route ED. The WVDOF Route ED has & compression. Courty, Sign Sprane, Route Humber, Supplemental Cole, and Directory. The Route ED Builde to designed to be used from the big dome, as provated a value for a component, line cost Brit is Marred to dome only the valid responses for the preventing components. For example, when provable a value for sign sprane that are in that specific courty are doment in the dogulary. Tales a constraint, and private to the specific courty are doment in the dogulary. Tales a value only reasonable a value of the specific courty are doment in the dogulary. Tales are privately, and only reasonable a value of the dogulary. The dogulary are dogulary and the dogulary are dogulary.

Frees Core + C to copy the limits () to your diploced	
Courty /	
Select County	-
Sign System	
	+
Rose Number	
Submitter	
Reparently Sale	
Direction	



#### **RouteID** Builder

- <u>https://gis.transportation.wv.gov/routeidbuilder/Interactive</u>
- Application used to generate a RouteID employing the following interactive fields:
  - County
  - Sign System
  - ? Route
  - Subroute
  - Supplemental Code
  - 2 Direction
- Utilized primarily for:
  - Creating RouteIDs for importing data into the GIS system
  - QA/QCing an existing RouteID



# Portal for ArcGIS Apps

- The next two applications are housed on Portal for ArcGIS.
- As you learned earlier, the Portal:
  - Is part of the ArcGIS Enterprise
  - Is the nucleus of the ArcGIS Enterprise System
  - Houses ArcGIS Applications
- Frequently used applications on the Portal are:
  - Roadway Surface Type
  - Parcels
  - Fuel Sites
- <u>https://gis.transportation.wv.gov/portal</u>



# **Accessing Portal Applications**

- Applications on the Portal can either be password protected or open to the public.
- Accessing any password protected site can be tricky.
- There are two ways to enter a password protected site:
  2 Executive\method
  - ✓ Username: EXECUTIVE\A,B, E Number
  - Password: Password to access your computer daily
  - 2 @Executive method
    - ✓ Username: A,B, E Number@EXECUTIVE
    - Password: Password to access your computer daily

Let's log into Portal for ArcGIS: <u>https://gis.transportation.wv.gov/Portal</u>



#### Accessing ArcGIS Portal



Method 1



Method 2



# **Roadway Surface Type Application**





#### **Roadway Surface Type Application**

- <u>https://gis.transportation.wv.gov/roadwaysurfacetype</u>
- Interactive application used to:
  - View and obtain Roadway Surface Types and Surface Width
  - Perform basic analysis on Road Features
  - Access WVDOH Pavement Viewer
- It contains the following features:
  - Route Symbols
  - Roadway Surface Type
  - Hydrological Features (Rivers and Lakes)
  - Incorporated Places
  - Counties
  - 2 WVDOH Districts
  - Boundaries



### Parcels and Routes App





# Parcels and Routes App

- <u>https://gis.transportation.wv.gov/parcels</u>
- Interactive application used to obtain and view parcel information and right of way information in WV at a glance.
- Used primarily for researching parcels for applications such as the PJ101form road information.
- Contains the following Information:
  - Address Points
  - Routes
  - Railroads
  - WVDOT Parcels
  - Regular Parcels
  - ? Rivers
  - Incorporated Places
  - Counties
  - Route Sign Road Names



# WVDOH Fuel Sites 2.0





# WVDOH Fuel Sites 2.0

- <u>Https://gis.transportation.wv.gov/Fuel\_Sites</u>
- Interactive application of the Fuel Sites Book allowing the user to:
  Search for and view WVDOH fuel sites
  - Filter WVDOH Fuel Sites by hours of operation, fuel type, and division
- It contains the following Information:
  - Route Signs and Street Names
  - District HQ
  - Fuel Sights
  - Traffic Signals
  - ? Routes
  - Railroads
  - Counties
  - 2 WVDOH Districts



# WV Highway Plan Viewer

- <u>https://www.mapwv.gov/dotplans/viewer/</u>
- Interactive application for searching, accessing, and viewing all plans including:
  - Right of Ways
  - Bridges
  - Roadways
  - Contains the following Information:
    - Project Key and Title
    - State and Federal Project ID
    - Fiscal Year
    - Route Number
    - Begin Mileage
    - Unique Identifiers such as bridge numbers



# WV Highway Plan Viewer





# Street Name Viewer

- <u>https://gis.transportation.wv.gov/portal/apps/webappviewer/index.html?id=</u> <u>2e330f86bd6044ccb86dd1db97c508a7</u>
- Interactive application used to view and access all street names within West Virginia as part of a street naming project.
- Features included in this map are:
  - Street names SAMS (E911)
  - Street Names DOH
  - Boundaries
  - Counties
  - Route Sign System







# End of Part 2 Any Questions? Thanks!

