GIS Data, Resources, and Applications

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14 May 2022

gis.utah.gov

Overview

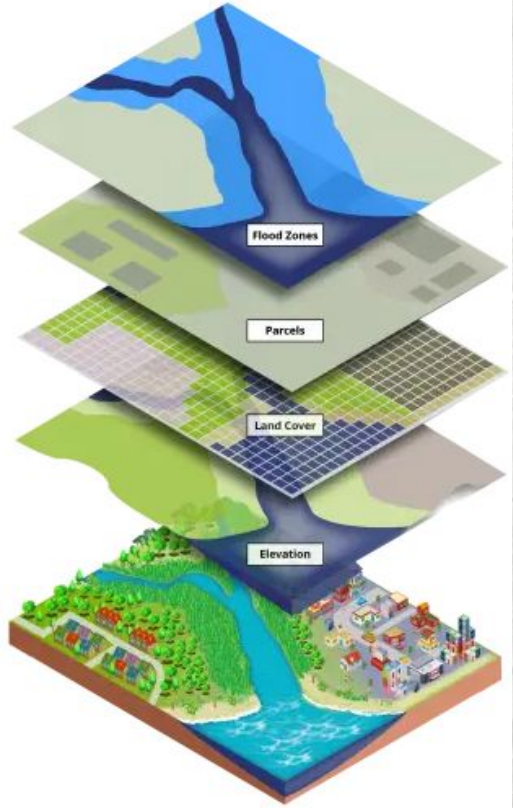
- Quick GIS overview
- UGRC and Utah GIS resources
- Common GIS tasks and applications
- Python automation examples

Utah Geospatial Resource Center

gis.utah.gov

GIS Overview

- Geographic Information Systems (or Science)
  - Systems that store, process, analyze, and visualize geographic data
  - Data (database), Hardware, Software (ESRI, QGIS, Google Earth/Maps)
  - ***Data*** that pairs location with information
  - Adds the "where" component to a huge variety of datasets
  - Requires defined coordinate system and/or data projection



esri

mapbox

Google Maps

QGIS

Microsoft® SQL Server

PostGIS

PostgreSQL

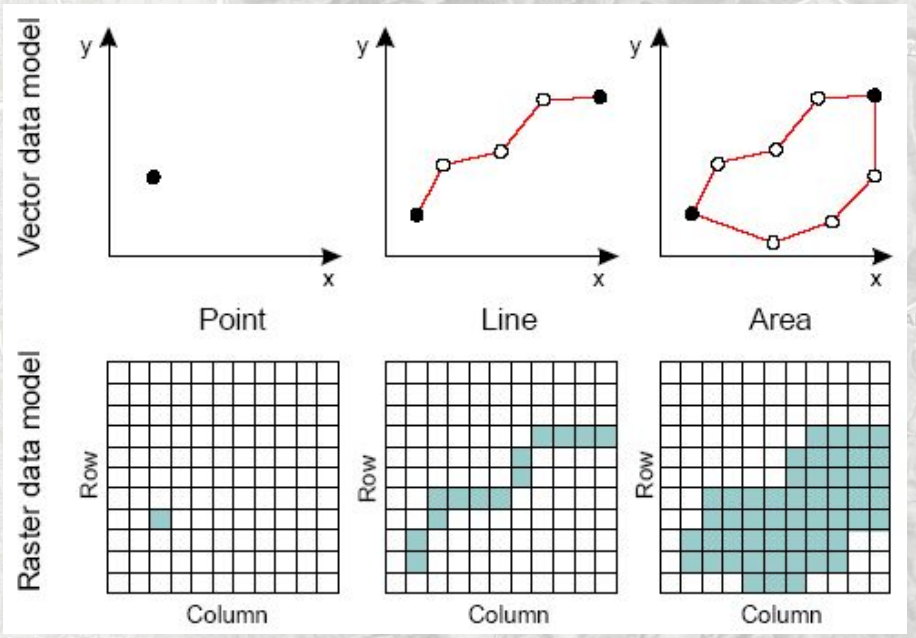
"...collection of computer software and data used to view and manage information about geographic places, analyze spatial relationships, and model spatial processes. A GIS provides a framework for gathering and organizing spatial data and related information so that it can be displayed and analyzed."

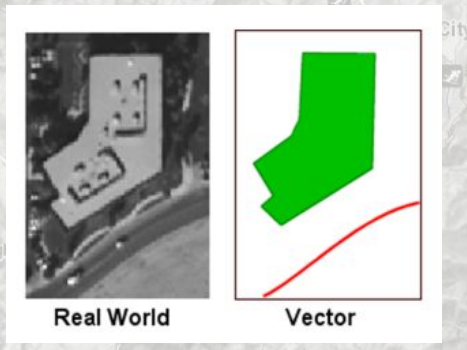
A to Z GIS (ESRI Press)

GIS Overview

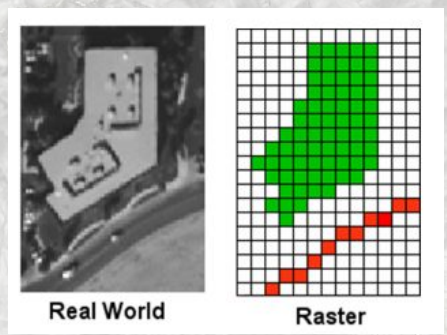
- **Two primary data types used to represent the world:**

Vector





Raster



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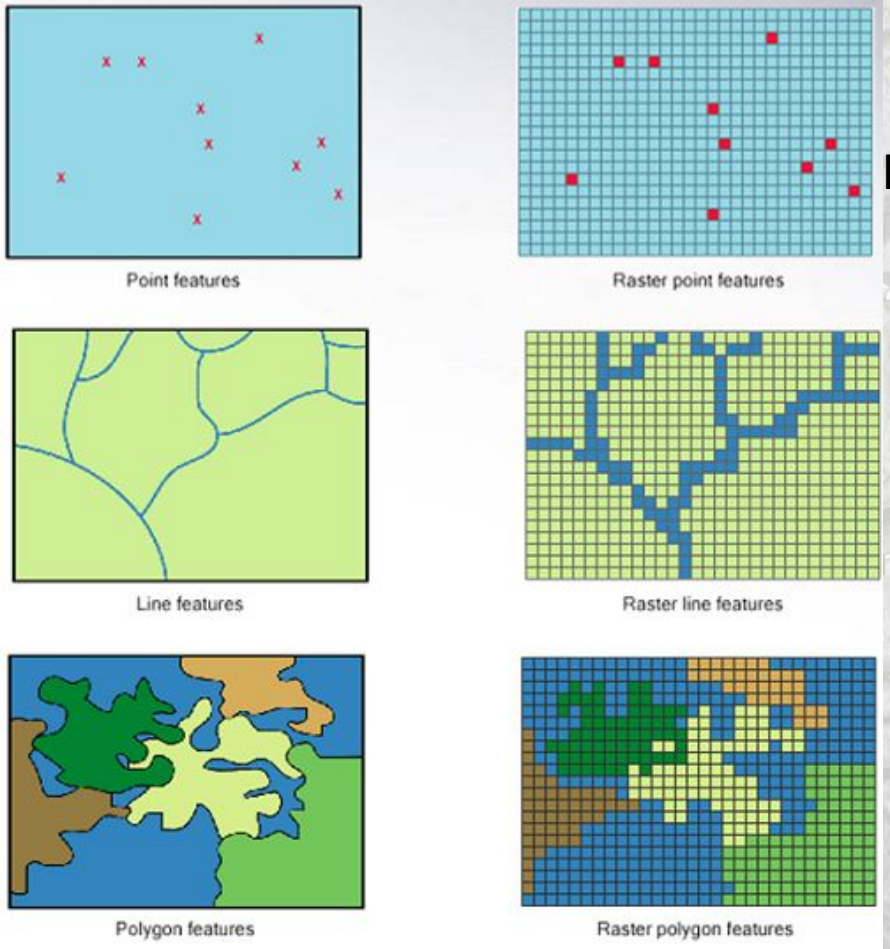
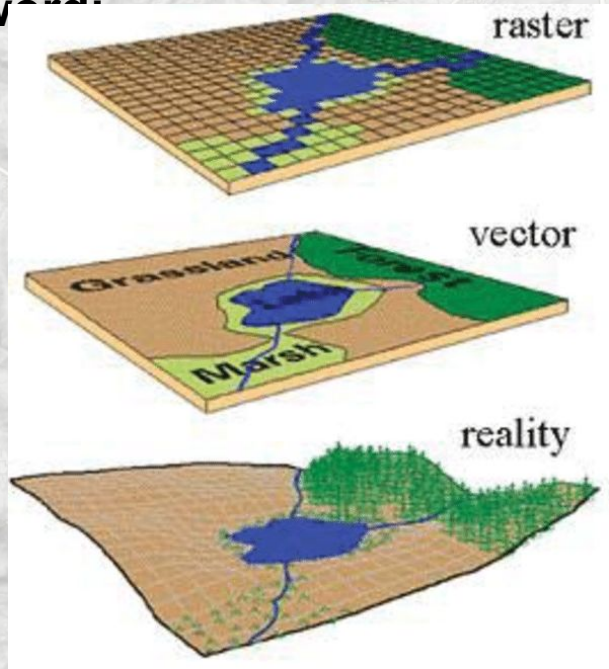
https://firenorth.org.au/nafi3/views/help/Maps_and_Fire_help4.htm

GIS C

- Two he wor





Marc Spiller paper

http://gsp.humboldt.edu/olm/Lessons/GIS/08%20Rasters/RasterToVector.html

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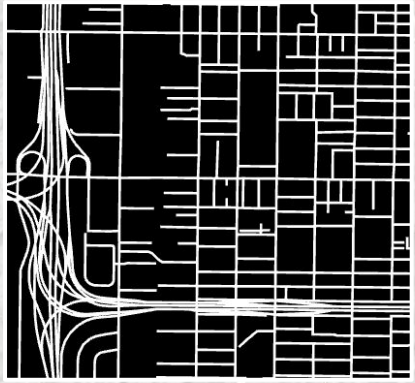
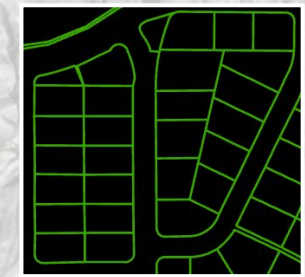
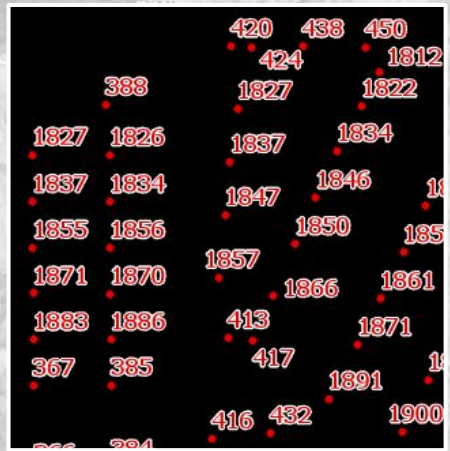
GIS Overview - Vector

- Data representing points, lines, and polygons
- Precise coordinates are explicitly stored (geometry)
- Additional information is stored in an attribute table
- Think of a spreadsheet (attribute table), with a special column that stores the "geometry"
- Examples: Address points, road centerlines, parcels
- Data formats
  - shapefile (.shp plus .shx, .dbf, .prj)
  - geodatabase (.gdb)
  - geopackage (.gpkg)
  - GeoJSON (.geojson)
  - KML (.kml/.kmz)
  - and more







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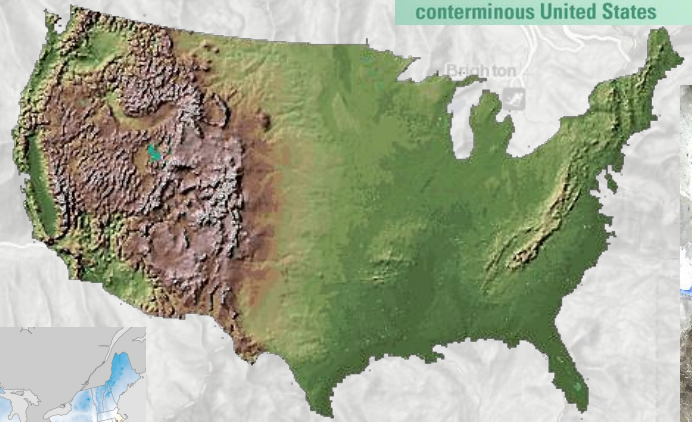
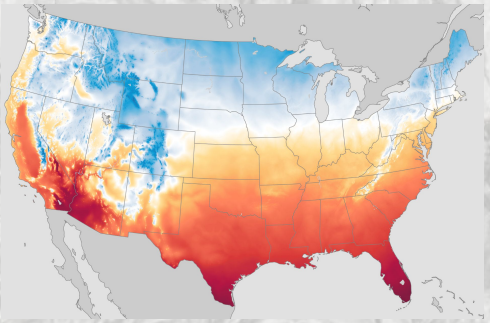
GIS Overview - Raster

- Data that is stored on a regular grid
- Could be discrete or continuous data
- Examples: aerial imagery, elevation data, average temperature, land cover
- Data formats
  - GeoTIFF (.tif plus .tfw)
  - Image files (.img)
  - JPEG (.jpg)
  - geodatabase (.gdb)
  - geopackage (.gpkg)
  - netCDF (.nc)
  - many more





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USGS Elevation, USGS Land Cover, NOAA Climate, ESA Sentinel-2

gis.utah.gov

UGRC

New name, same great taste!

Utah Geospatial Resource Center

- State of Utah's GIS office
- Established in 1989 via Utah Code 63F-1-506
- Department of Government Operations (DGO)
  - Division of Technology Services (DTS)
- State Geographic Information Datasource (SGID)
- Discover - Imagery & Basemap services
- TURN GPS Reference Network
- GIS & Web development
- Funded through combination of state funds and project work

TURN GPS
real-time precision
turngps.utah.gov

SGID
STATE GEOGRAPHIC INFORMATION DATASOURCE

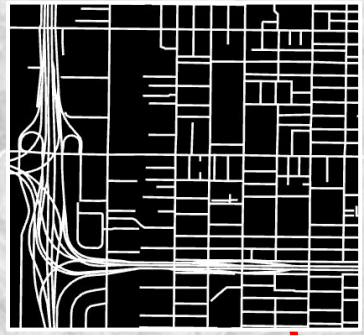
discover
utah's imagery and base map services
gis.utah.gov/discover

Utah Geospatial Resource Center

"Encourage and facilitate the effective use of geospatial information and technology for Utah"

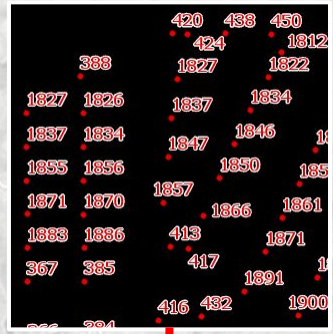
Data Consolidation Efforts

- Aggregate data from counties into statewide datasource (SGID)
  - Frequency based on population
  - Roads, Address Points, Parcels
- Road centerline editing database pushed to production database monthly
- Data provided or maintained by other state agencies
- Other statewide data compiled and updated as needed

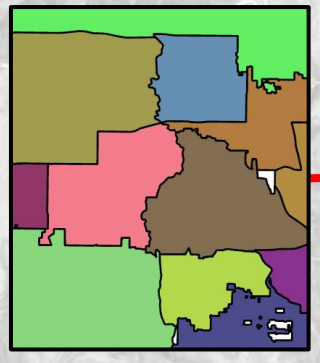


Roads

Address Points



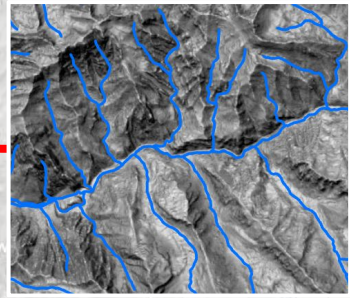
Parcels



Boundaries

SGID

STATE GEOGRAPHIC INFORMATION DATASOURCE



More...

Utah Geospatial Resource Center

State Geographic Information Datasource (SGID)

opendata.gis.utah.gov

gis.utah.gov/data

ALL the data…(300+)

- Zip Codes
- Land Ownership
- Lakes
- Census
- Tax Areas
- Oil and Gas
- Geologic Faults
- Health Districts
- Building Footprints
- Address Quadrants
- Political Districts
- Golf Courses
- Trails
- Libraries

SGID

STATE GEOGRAPHIC INFORMATION DATASOURCE

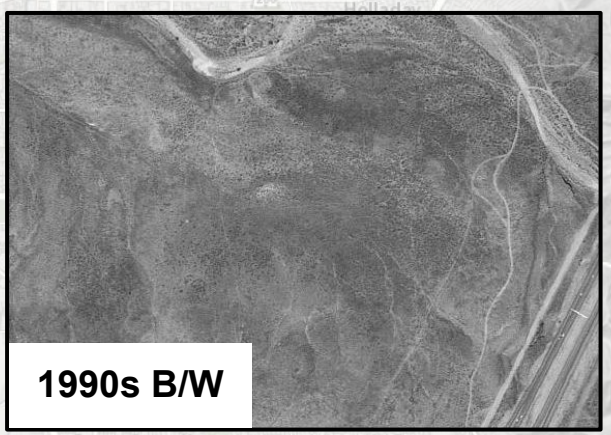
- Schools
- Transit
- Broadband
- Watersheds
- Great Salt Lake
- Flood Plains
- Court Districts
- and more!!!

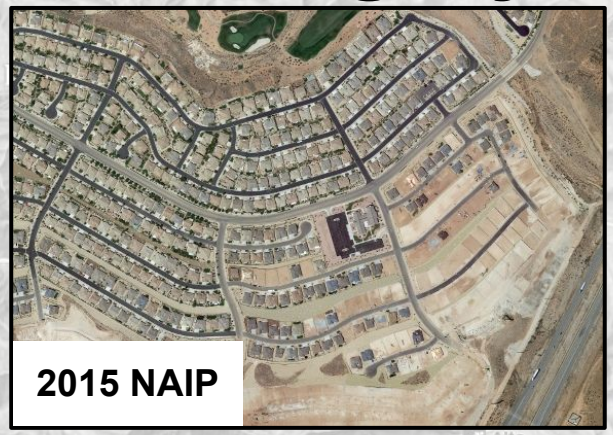
UGRC - Discover Server

- gis.utah.gov/discover
- Free imagery and basemap services (WMTS and WMS) for anyone
  - 1) Sign up using the web form
  - 2) Get unique connection URL (quad-word, not a username/password)
  - 3) Add services in your software (GIS, CAD, web applications)
- Imagery
  - Licensed [L] - government (city, county, state, school, tribal), government contractor, student
    - Additional imagery/higher resolution imagery is available
  - Unlicensed - general access for anyone
  - Layers
    - 1990s B/W, NAIP (2006, 2009, 2011, 2014, 2016, 2018, 2021), Google [L], Hexagon (15cm [L])
- Basemaps
  - Available for everyone
  - Layers
    - Lite, Terrain, Topo, Hybrid/Overlay, Address Points, Hillshade

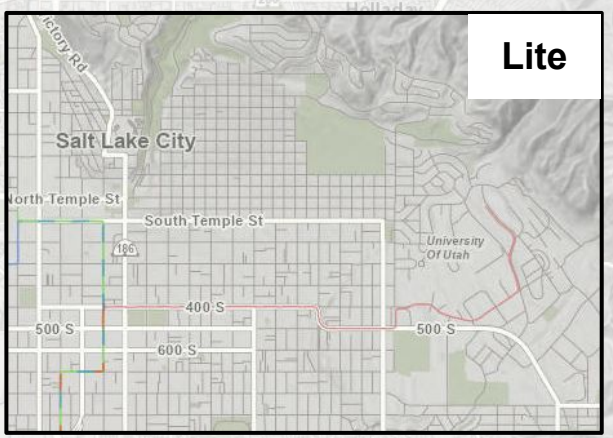
Utah Geospatial Resource Center

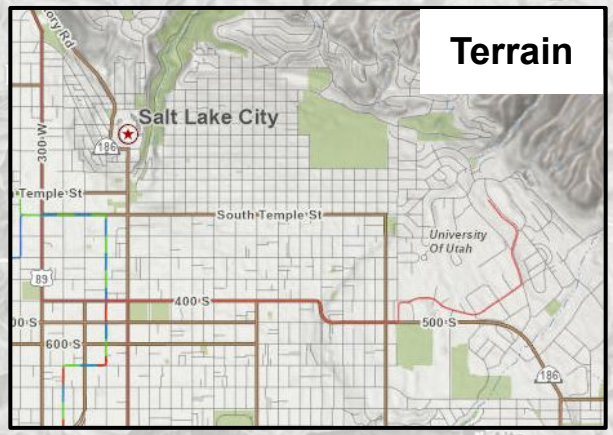
UGRC - Discover Imagery

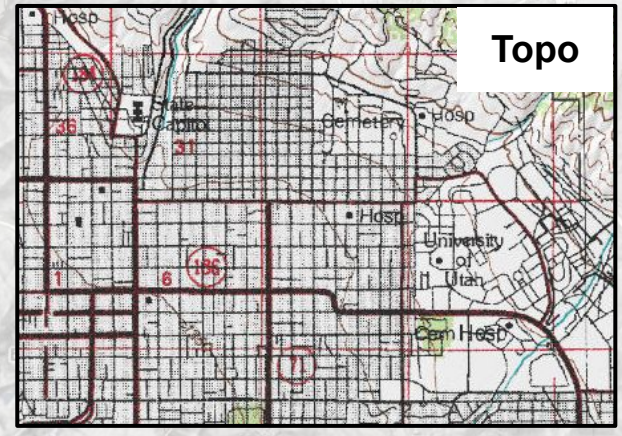


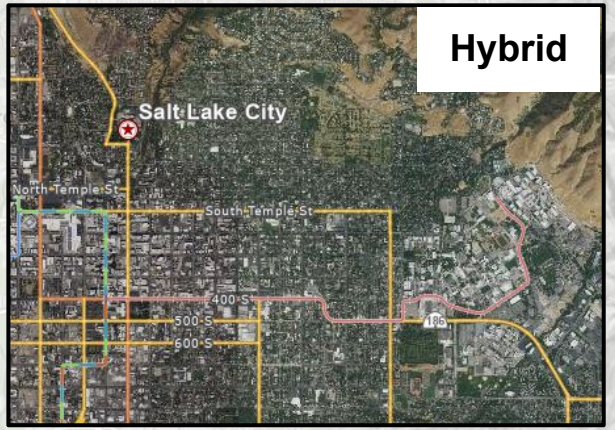


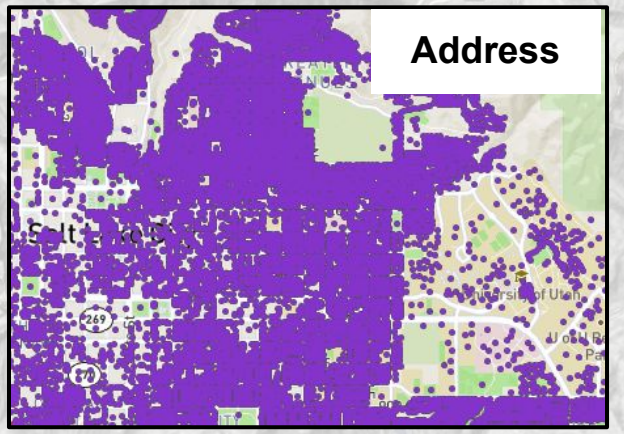
UGRC - Discover Basemaps





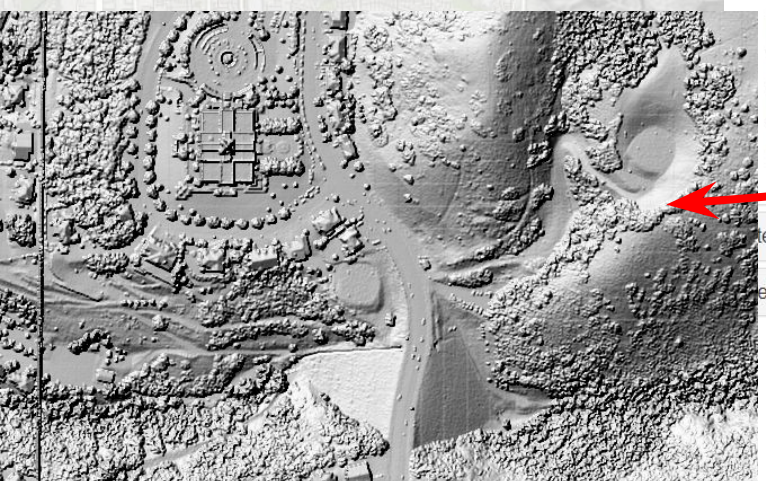


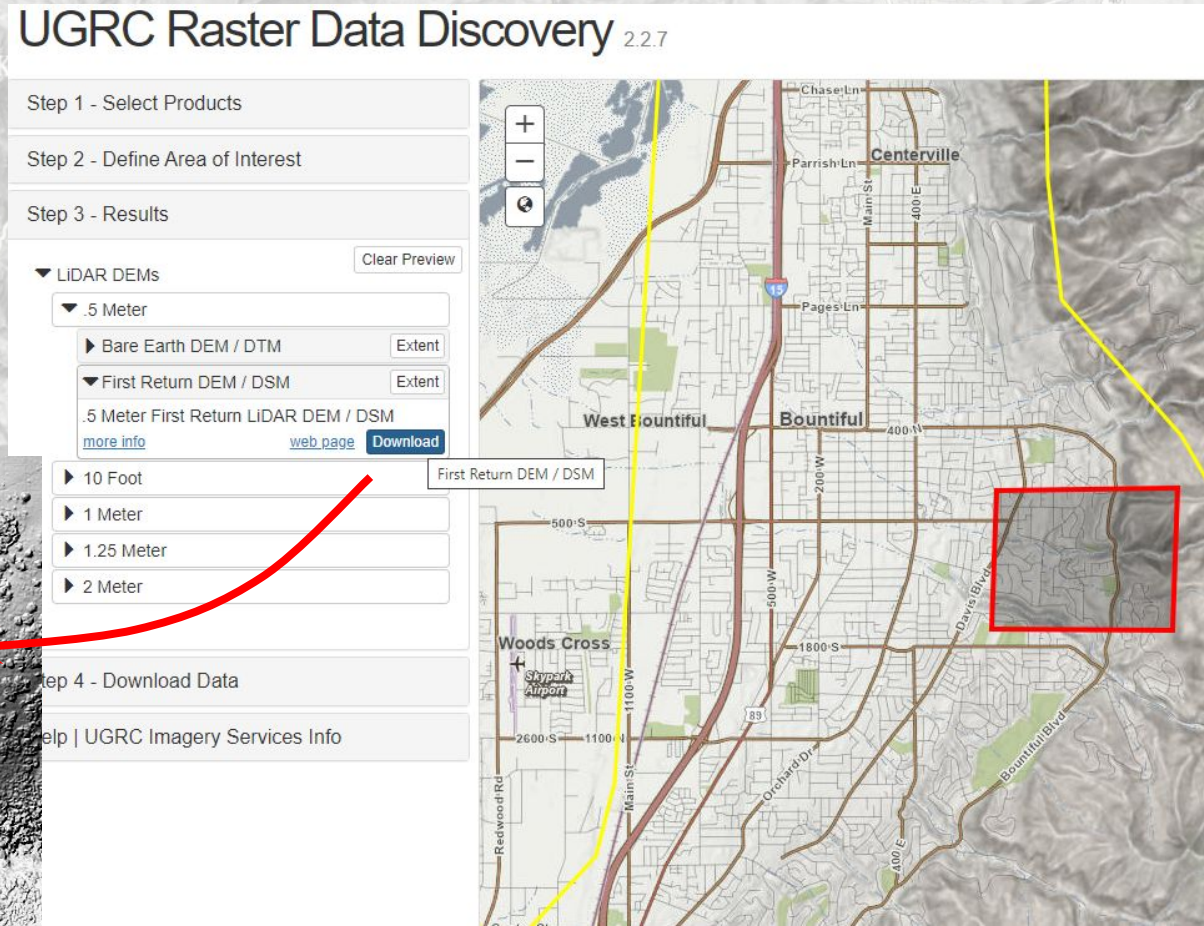




UGRC - Raster Data Downloads

- raster.utah.gov
- **Many datasets available**
  - **Aerial imagery**
  - **Digital Elevation Models (DEMs) and Surface Models (DSMs)**
  - **Contours**
  - **USGS Topo Maps**





UGRC - Web API and Geocoding

- api.mapserv.utah.gov
- Search statewide data layers via the API
  - Perform queries and only gather the data you need
- Geocoding
  - Turn addresses into coordinates that can be used for mapping
  - Single or batch geocoding on large datasets
- API client - https://github.com/agrc/api-client/releases
  - Lightweight software that allows ANYONE to geocode
  - No GIS software required, no licensing
  - No programming skills required
  - Cross-platform, automatic updates
  - Drag and drop

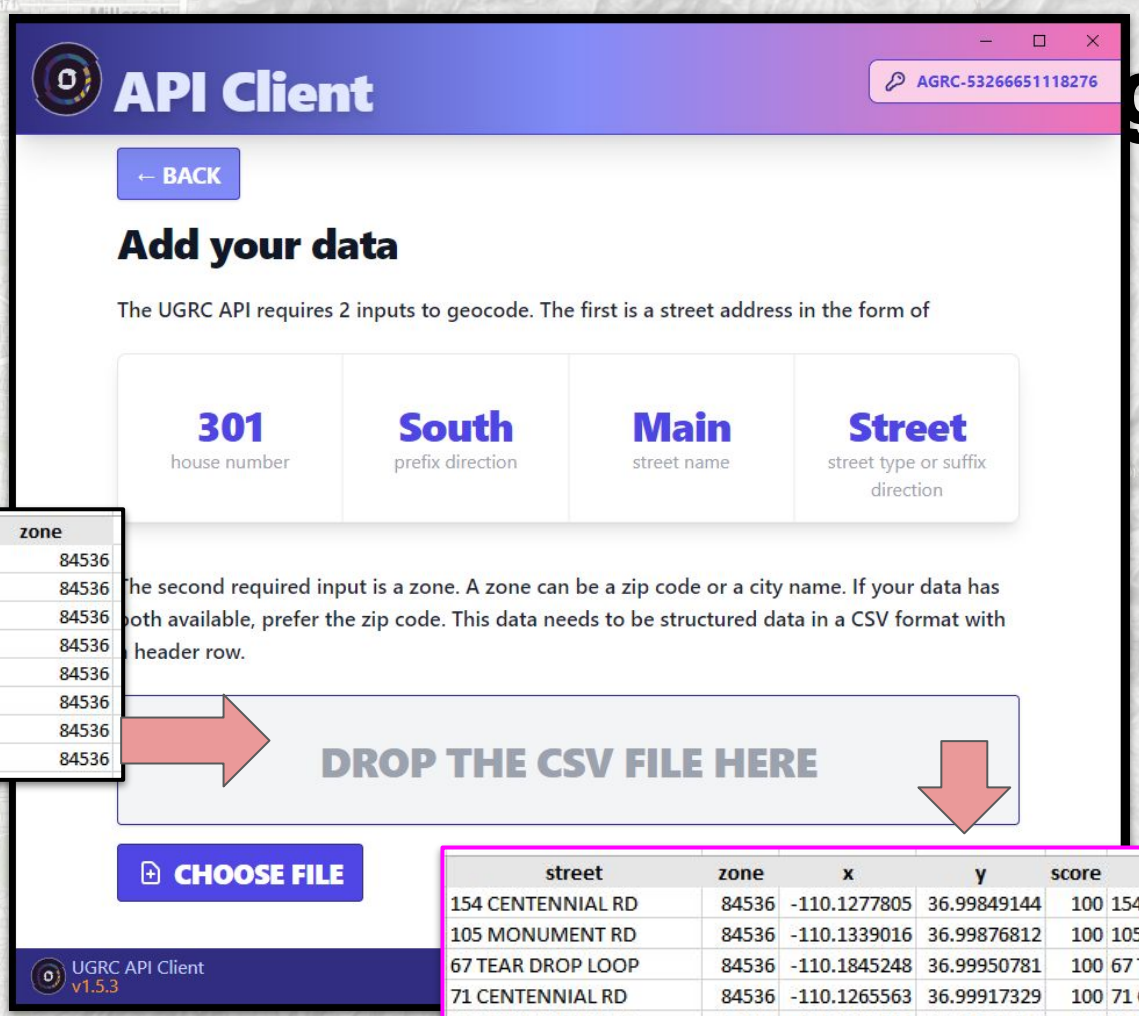
API = Application Programming Interface

[API Client Blog Post]

API Response Example


```
{
 "result": {
  "location": {
   "x": 428015.1619961144,
   "y": 4512994.085205136
  },
  "score": 100,
  "locator": "AddressPoints.AddrGrid",
  "matchAddress": "1320 E 200 S, SALT LAKE CITY",
  "inputAddress": "1320 E 200 S, Salt Lake City",
  "standardizedAddress": "1320 east 200 south",
  "addressGrid": "SALT LAKE CITY"
 },
 "status": 200
}
```

UGRC g

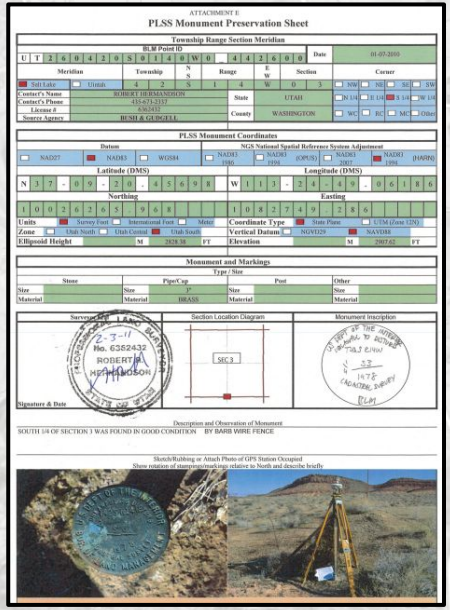


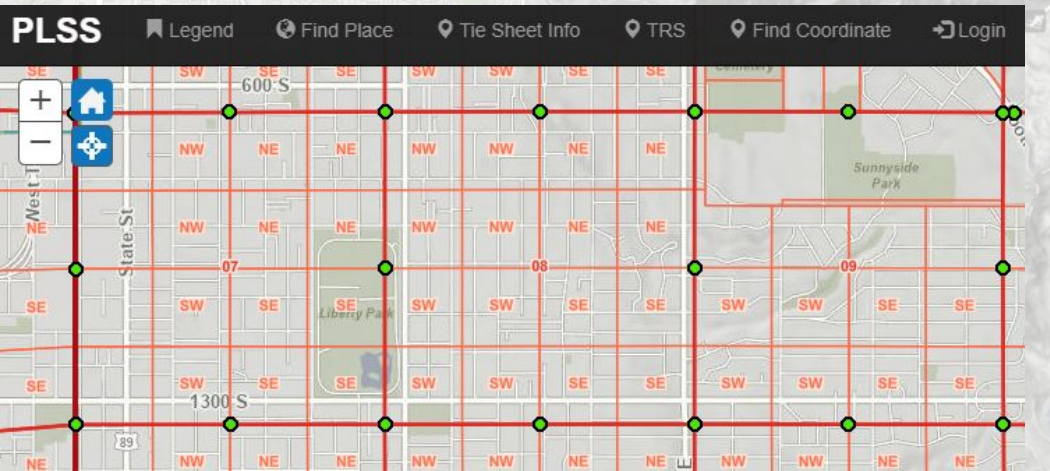
street	zone
154 CENTENNIAL RD	84536
105 MONUMENT RD	84536
67 TEAR DROP LOOP	84536
71 CENTENNIAL RD	84536
142 CENTENNIAL RD	84536
146 BLACK BRUSH HILL RD	84536
76 CENTENNIAL RD	84536
61 TEAR DROP LOOP	84536

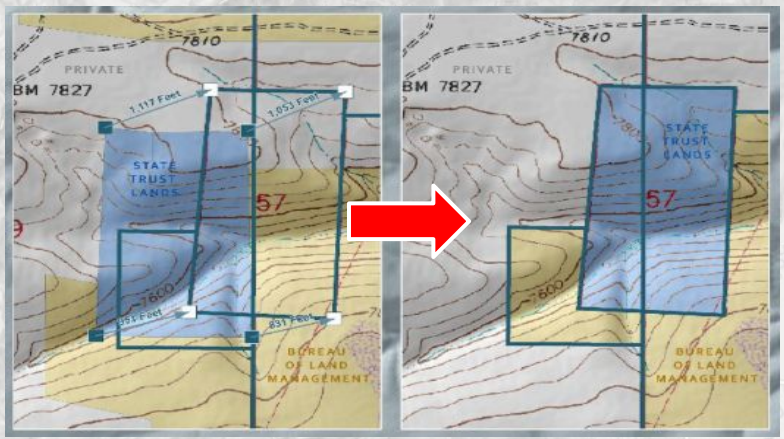
street	zone	x	y	score	match_address
154 CENTENNIAL RD	84536	-110.1277805	36.99849144	100	154 CENTENNIAL RD, BLANDING
105 MONUMENT RD	84536	-110.1339016	36.99876812	100	105 MONUMENT RD, BLANDING
67 TEAR DROP LOOP	84536	-110.1845248	36.99950781	100	67 TEAR DROP LOOP, BLANDING
71 CENTENNIAL RD	84536	-110.1265563	36.99917329	100	71 CENTENNIAL RD, BLANDING
142 CENTENNIAL RD	84536	-110.1302544	36.99945742	100	142 CENTENNIAL RD, BLANDING
146 BLACK BRUSH HILL RD	84536	-110.8116292	37.00262061	100	146 BLACK BRUSH HILL RD, BLANDING

UGRC - PLSS Fabric and Data

- plss.utah.gov
- Public Lands Survey System (PLSS) and Fabric
  - Corner monuments, Townships, Sections, quarters, etc.
- It's all tied together…
  - Plats, parcels, boundaries, land ownership data
- UGRC works with BLM and SITLA
- Monument Replacement and Restoration Committee



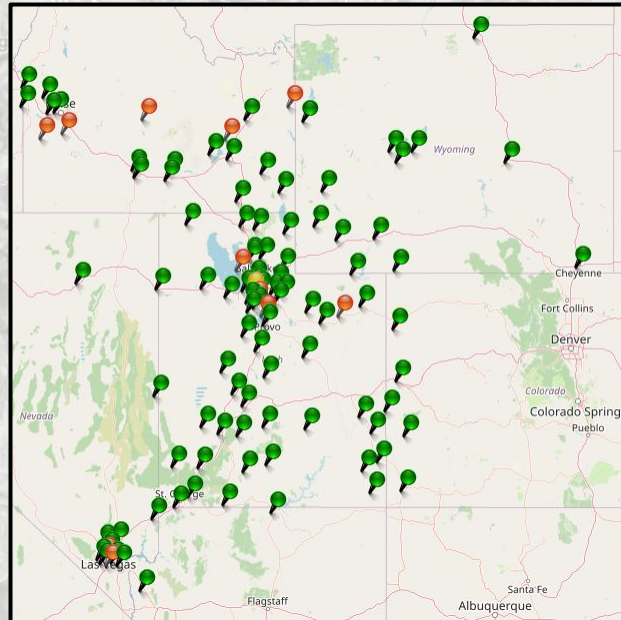




The Utah Reference Network (TURN GPS)

- gis.utah.gov/gps turngps.utah.gov Sensor and Status Map
- High-precision GPS network of permanently located GPS receivers
  - real-time corrections
  - data for post-processing
- Sensors send data to the system, it analyzes, adjusts, and corrects data to provide the most accurate location possible
- Centimeter to sub-centimeter precision
- Ideal for:
  - Surveying
  - Construction & Engineering
  - Field data collection
  - GPS-controlled machinery (agriculture, ski groomers, etc.)
  - Self-driving cars, drone delivery, etc.
- $600/year subscription per user
- Cloud migration - IPs will change in the near future

TURN GPS
real-time precision
turngps.utah.gov



Common GIS Tasks and Applications

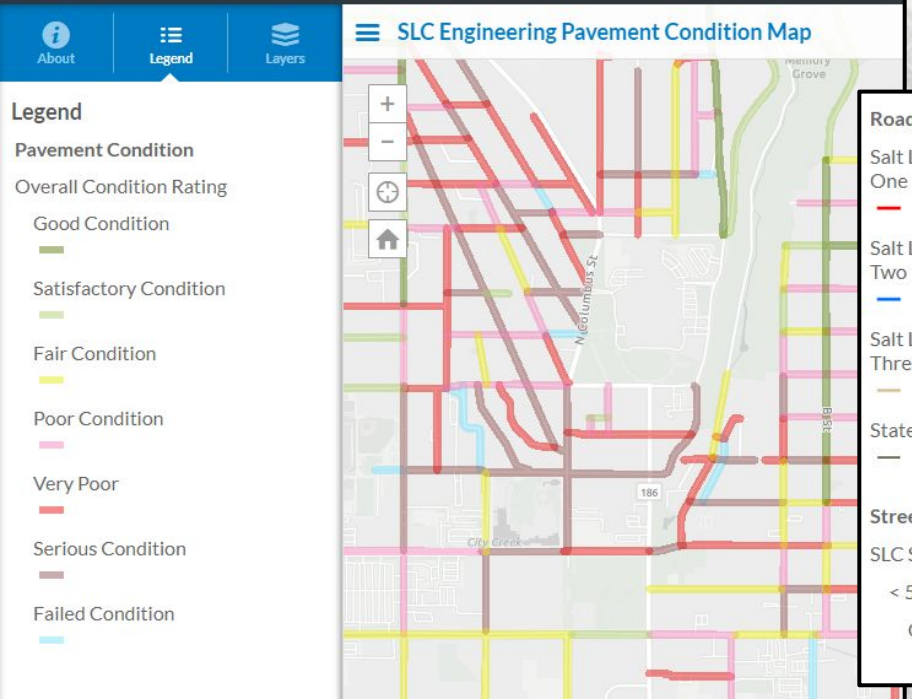
- City operations: asset management, inspections, permitting, work orders
  - Software packages integrate with GIS and manage spatial data

ELEMENTSXS

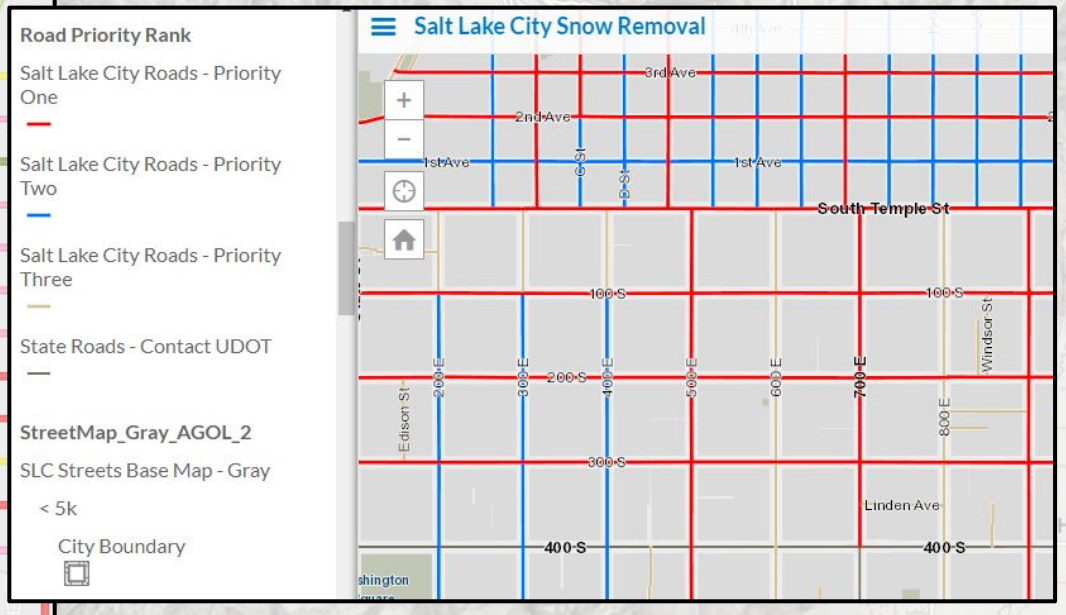
Cityworks® A TRIMBLE COMPANY

SALT LAKE CITY MAPS

SLC Pavement Condition



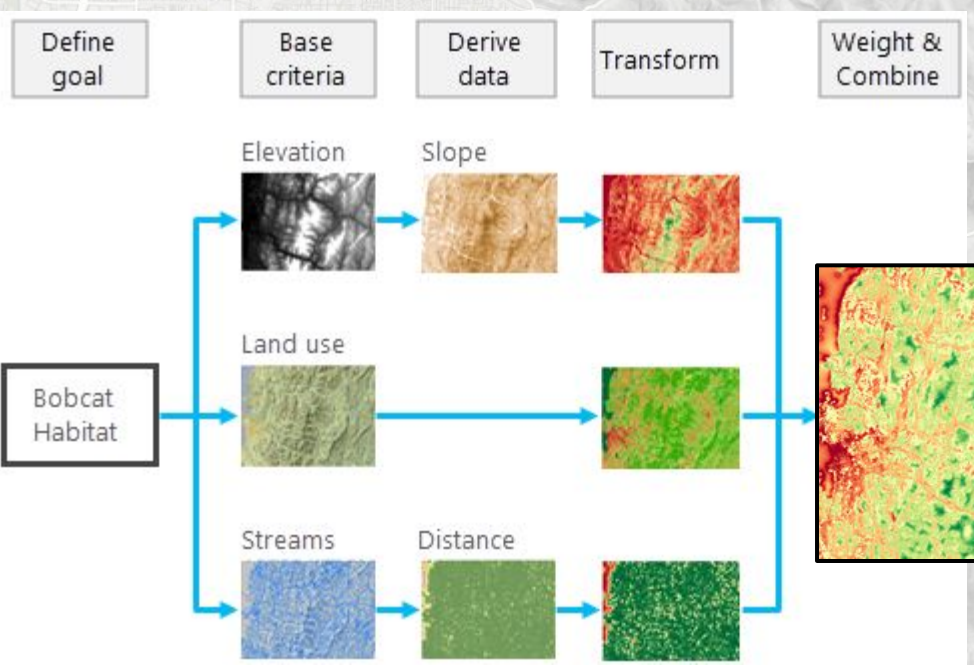
SLC Snow Removal

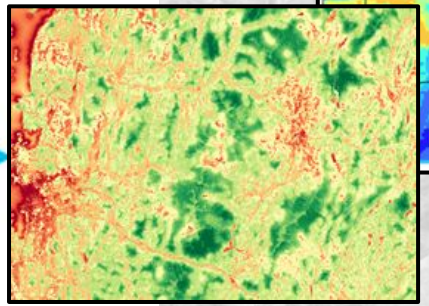


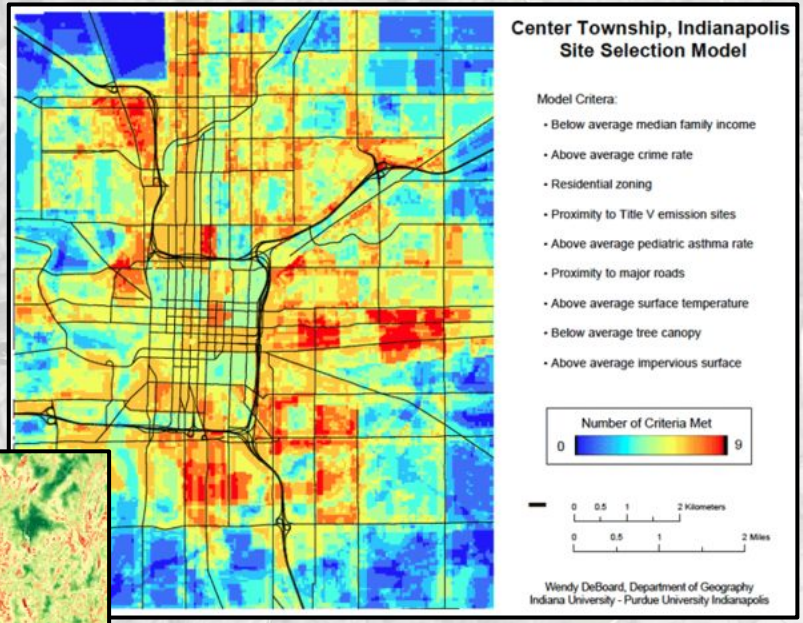
Common GIS Tasks and Applications

- **Site selection/suitability analysis, environmental impacts, habitats**

[ESRI Habitat Example]



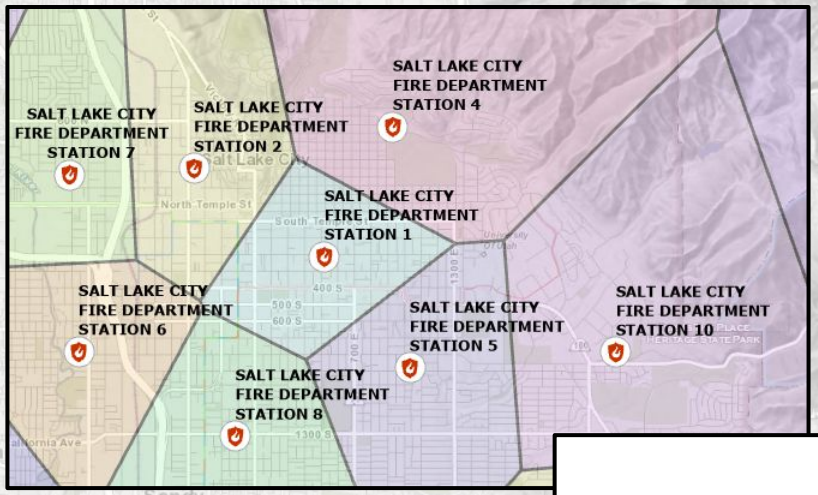




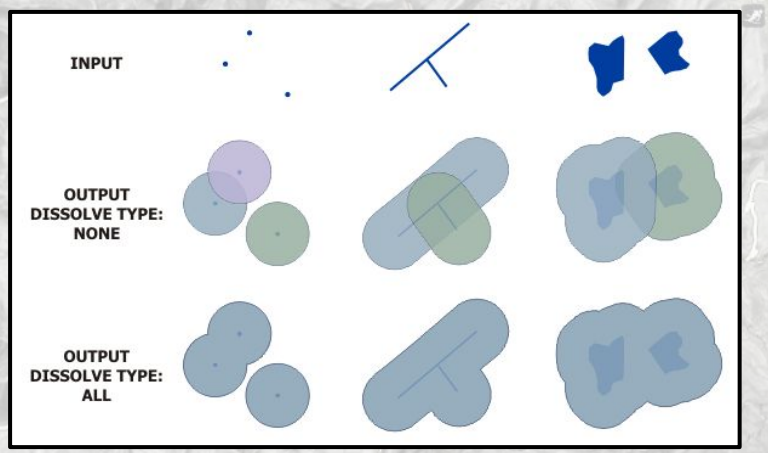
[Indianapolis Site Selection]

Common GIS Tasks and Applications

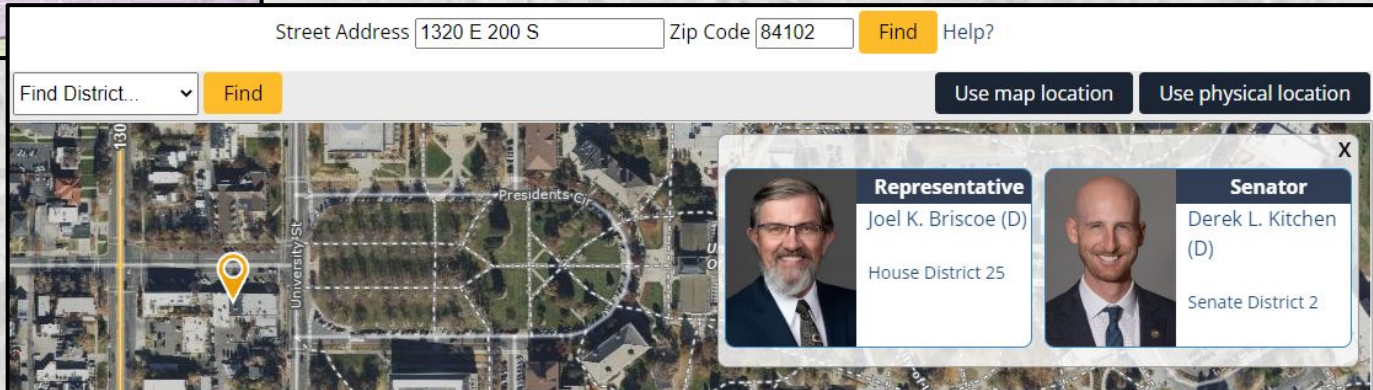
- **Proximity tools: point-in-polygon analysis, thiessen polygons, buffers**



Thiessen Polygons



[Buffer Examples]



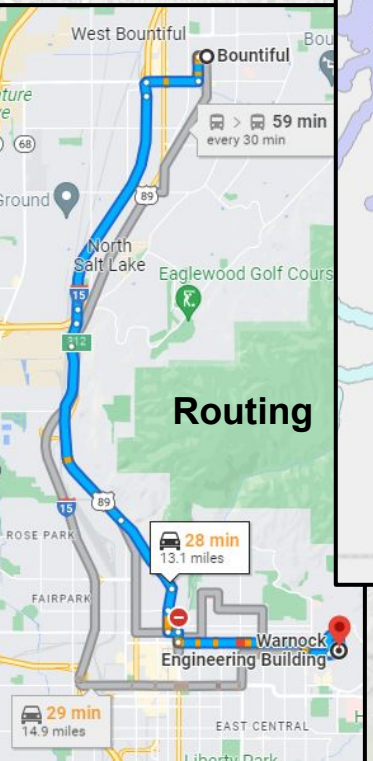
[Utah Legislative Districts]

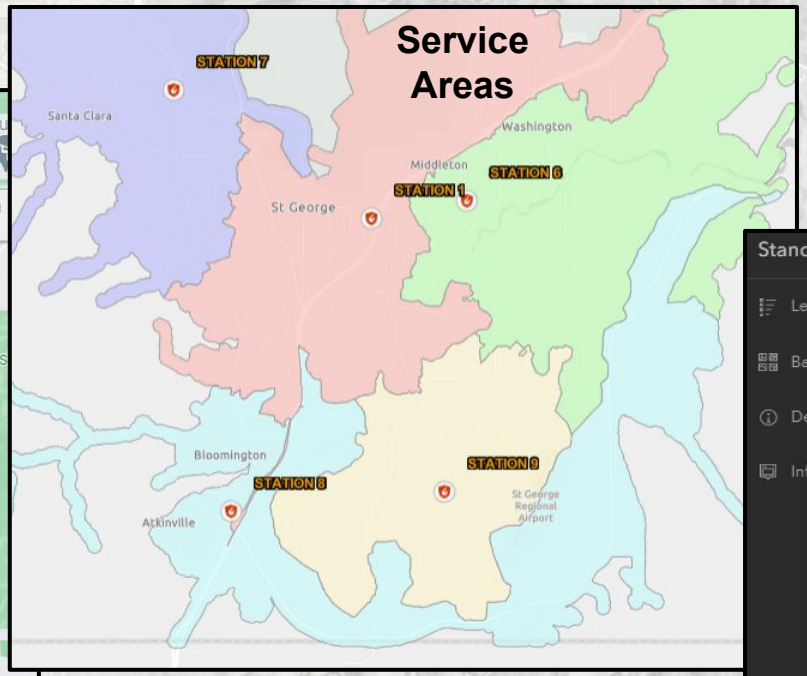
Utah Geospatial Resource Center

Common GIS Tasks and Applications

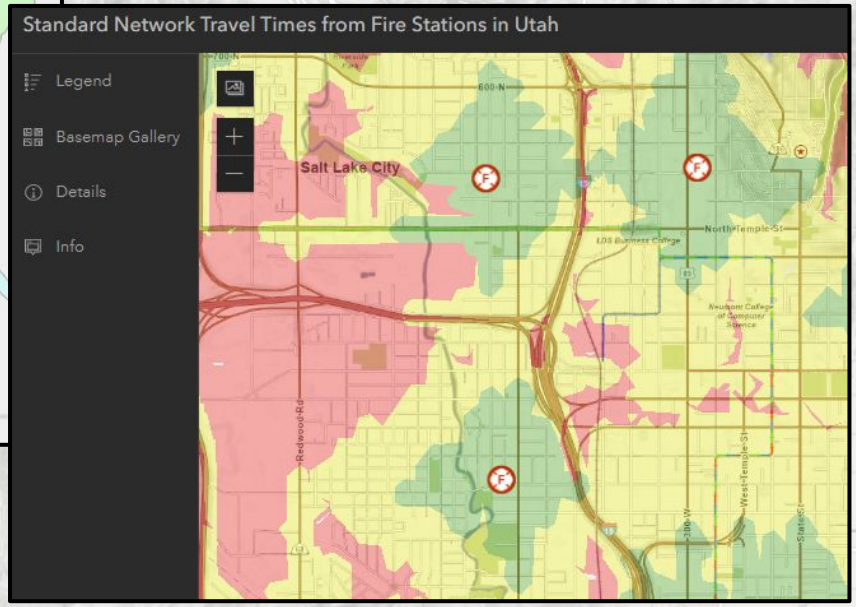
- **Road network analysis: routing, drive-time analysis, service areas**

Google Maps





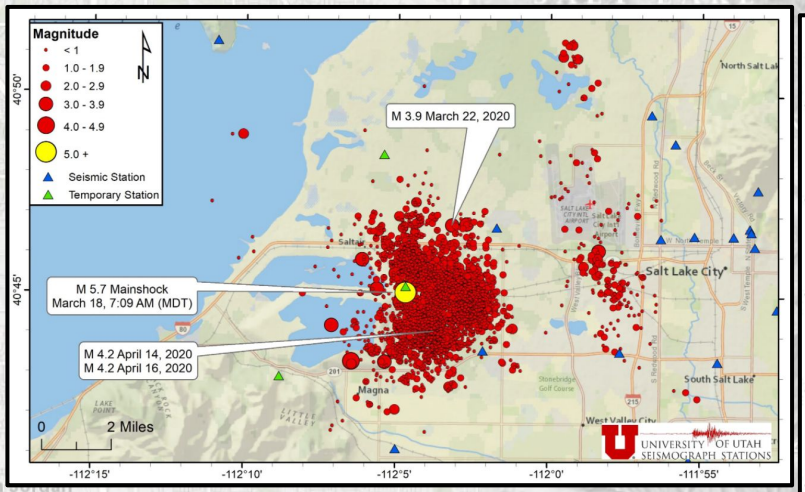
[Travel Times from Utah Fire Stations]

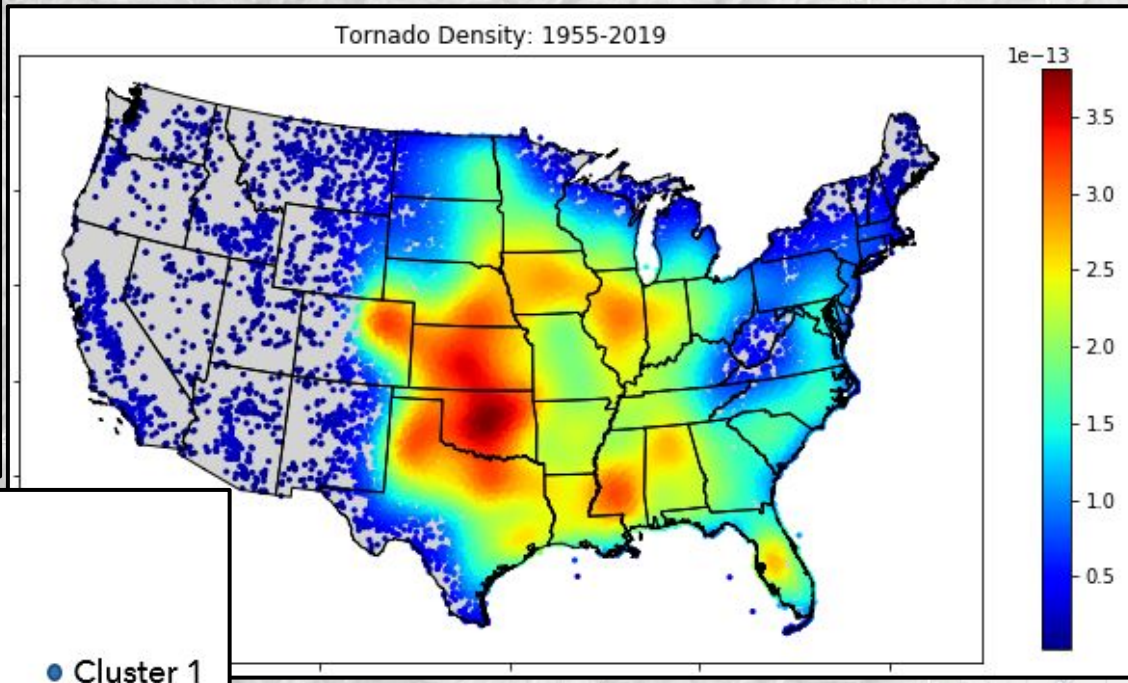


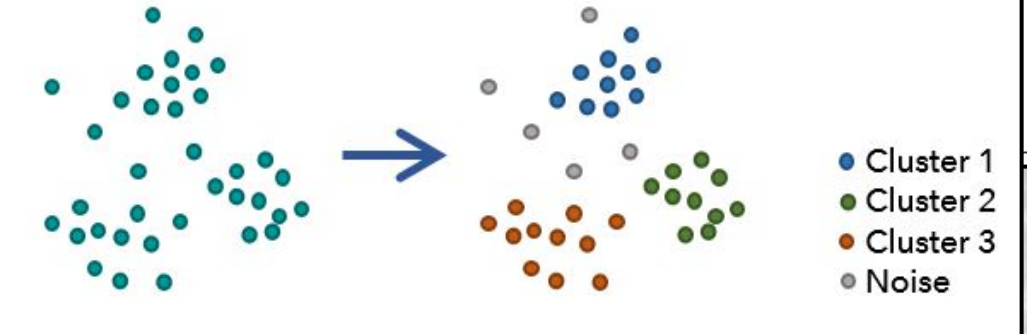
Common GIS Tasks and Applications

- **Point data analysis: density and hotspots, clustering**

[Magna Earthquake]





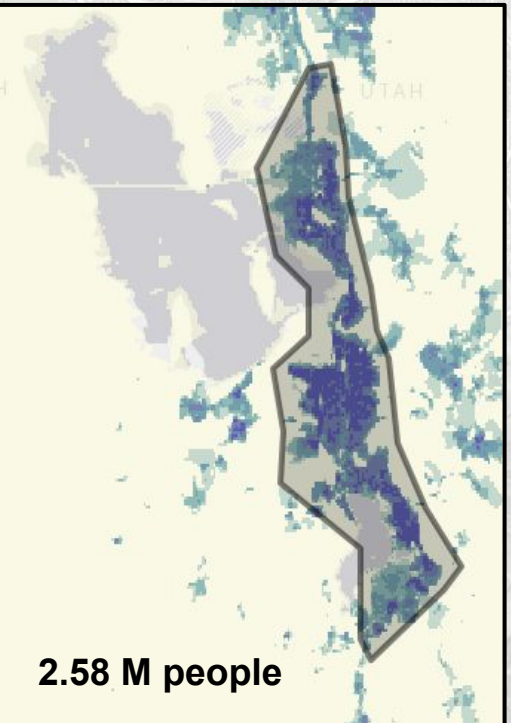


[ESRI Clusters]

Common GIS Tasks and Applications

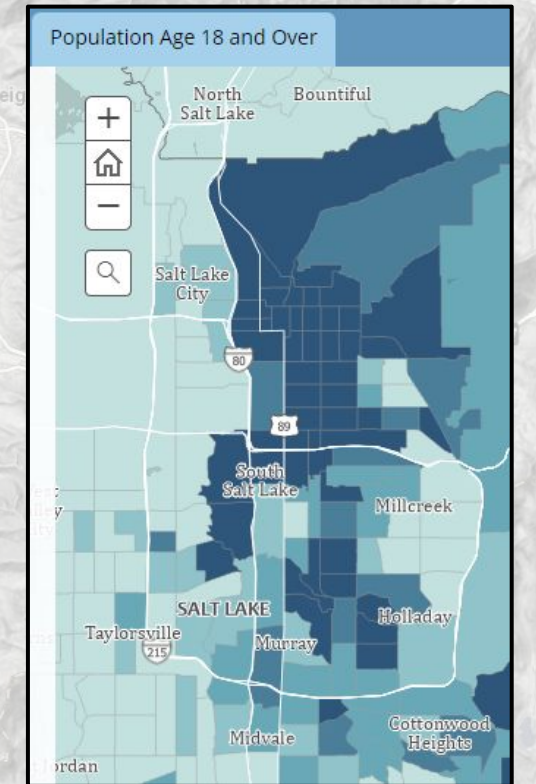
- **Geographic statistics and demographics**

[NASA Population Estimate]

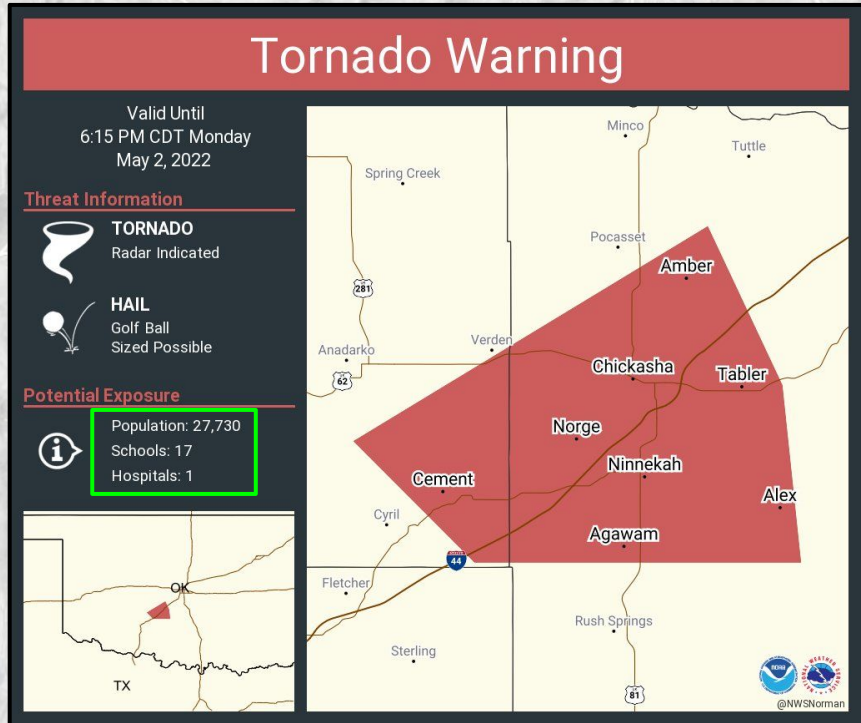


2.58 M people

[Census Data]

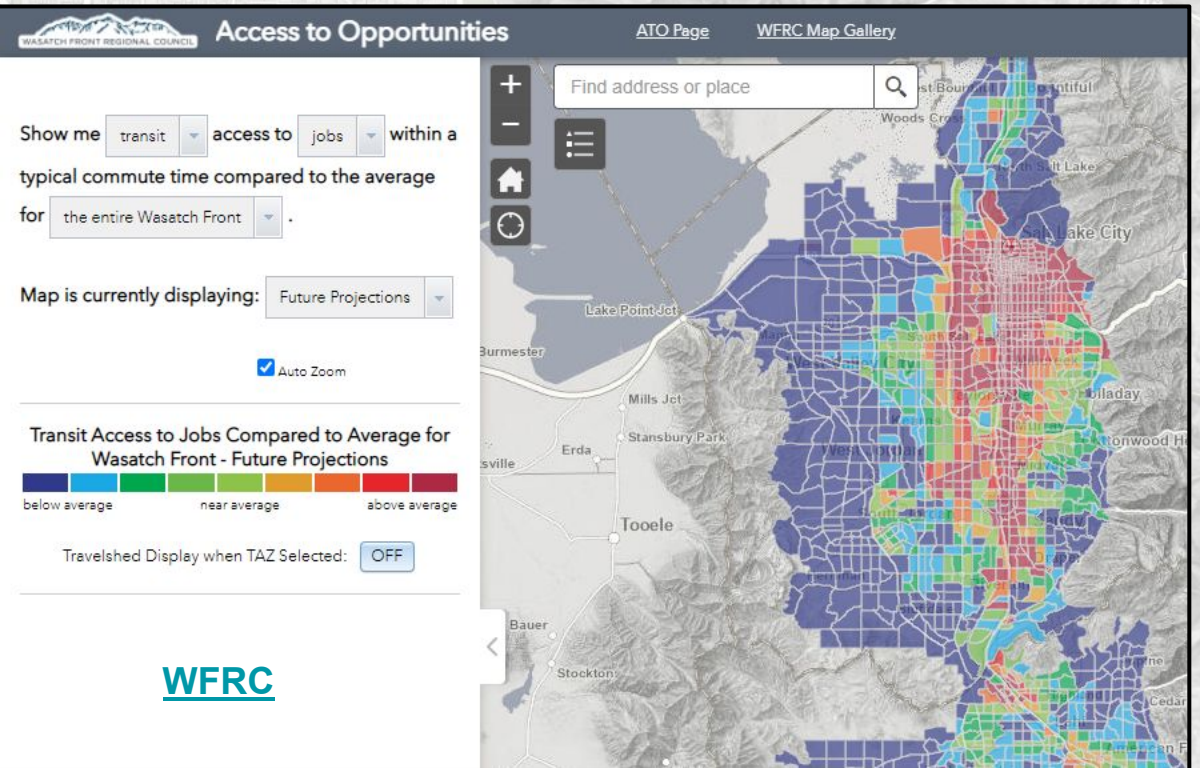


[@NWSTornado Twitter]



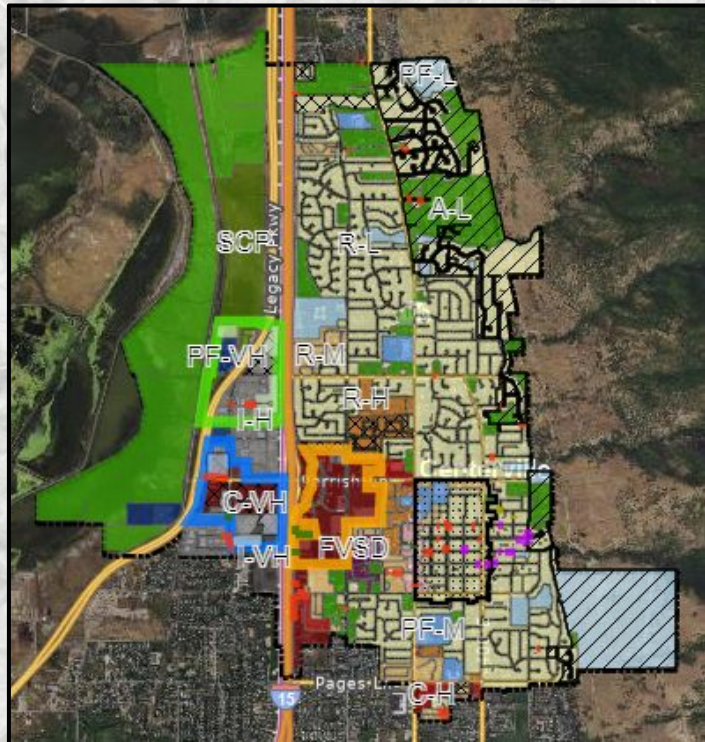
Common GIS Tasks and Applications

- **Planning: data and analysis (transportation, economy, city planning)**
- **UDOT West Davis Corridor project**



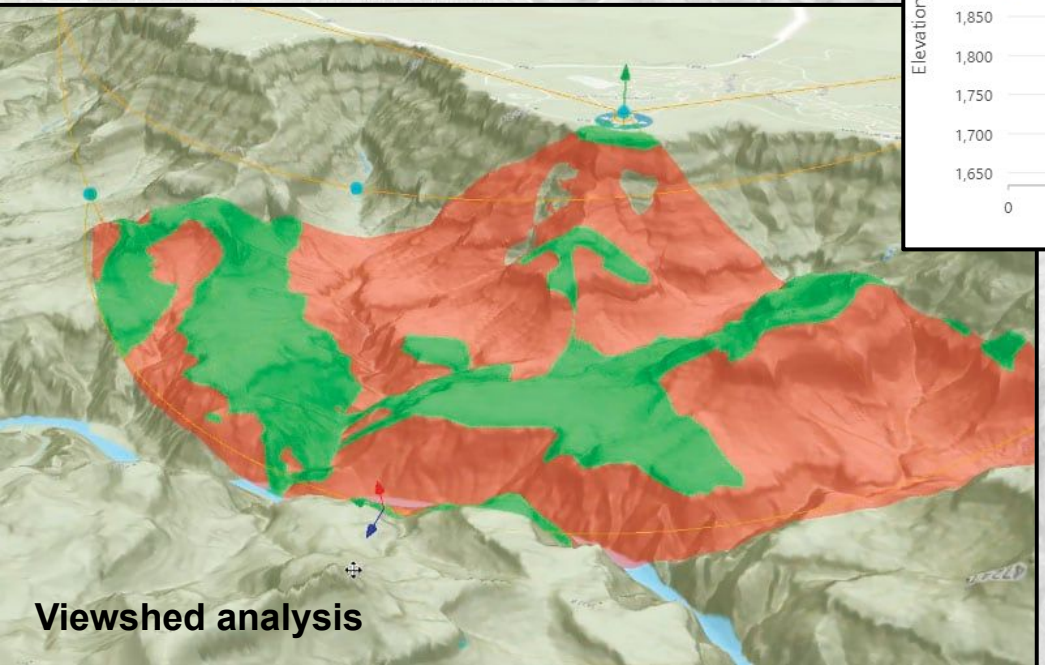
WFRC

Centerville Zoning

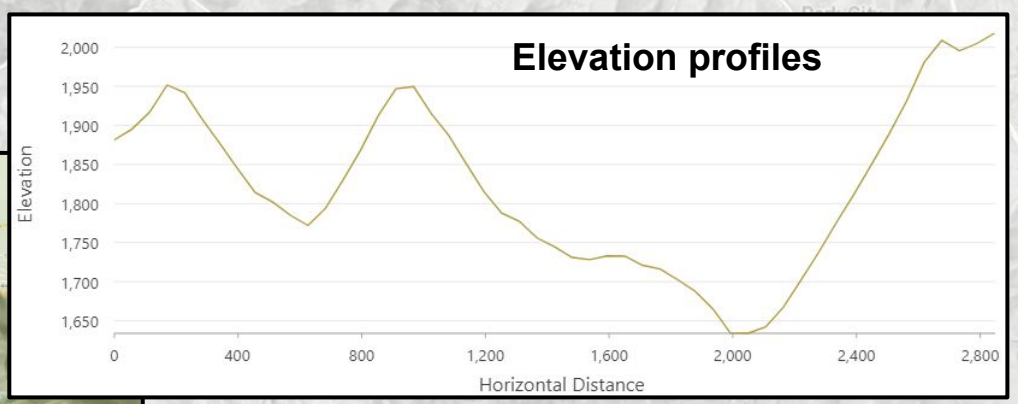


Common GIS Tasks and Applications

- 3D: viewshed analysis, elevation profiles, volume calculations
  - Cut - volume above surface feature
  - Fill - volume below surface feature
- Shadow and solar analysis



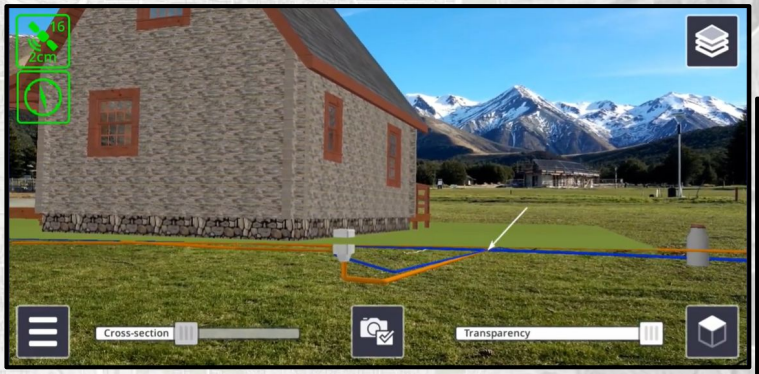
Viewshed analysis

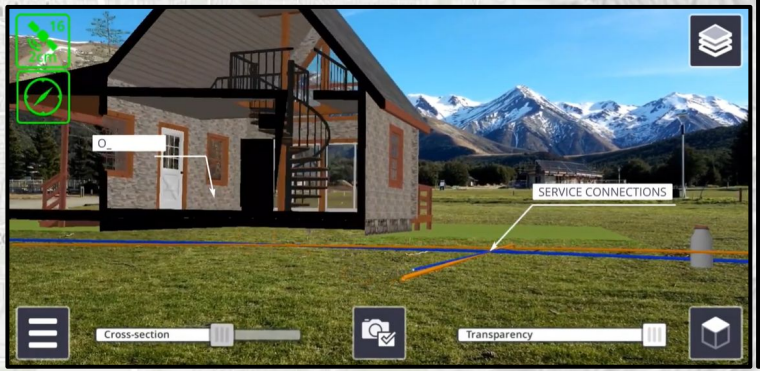


[ESRI viewshed]
[ESRI volume calculation]

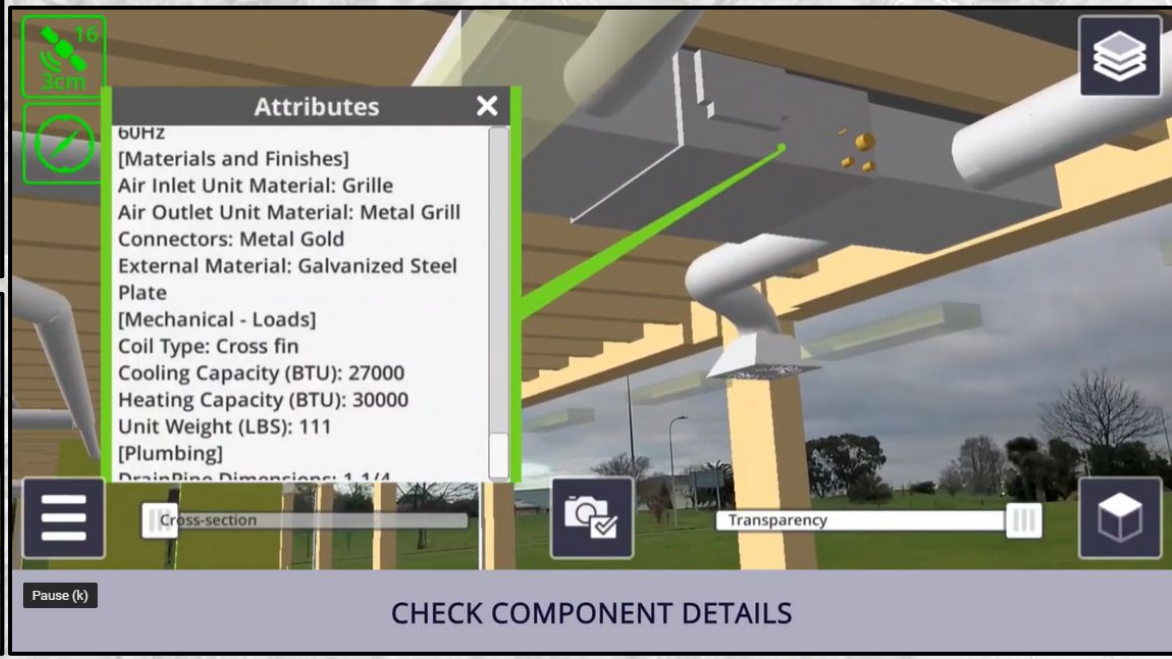
Common GIS Tasks and Applications

- GIS and Building Information Modeling (BIM) integration
  - Detailed views and attribute information



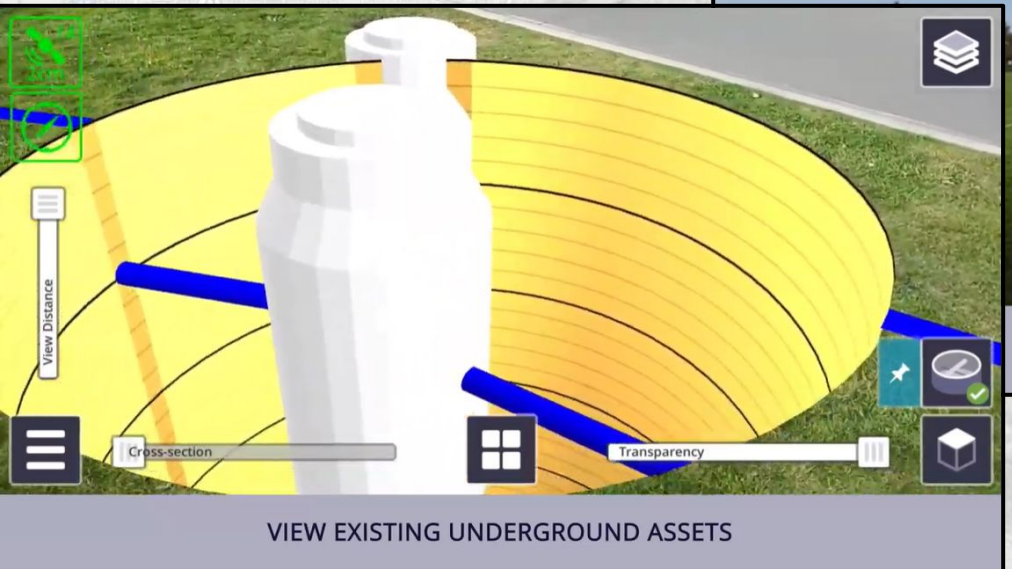


[Trimble SiteVision](), [construction]()



Common GIS Tasks and Applications

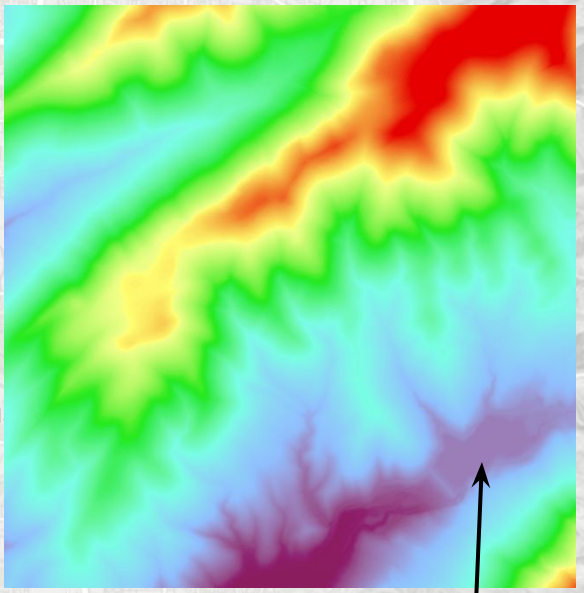
- **Augmented Reality (AR) applications**
  - **View underground utility infrastructure**
  - **View proposed infrastructure**



[Trimble SiteVision]

Common GIS Tasks and Applications

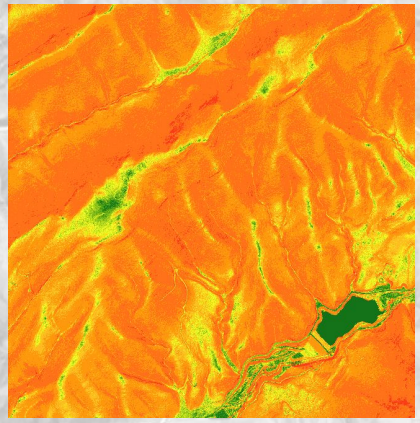
- **Elevation: data models and analysis**



Elevation

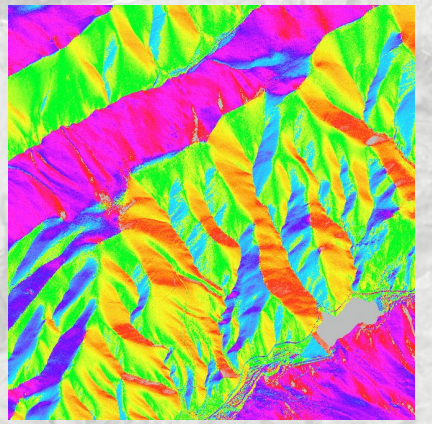
Red Butte Reservoir

Slope

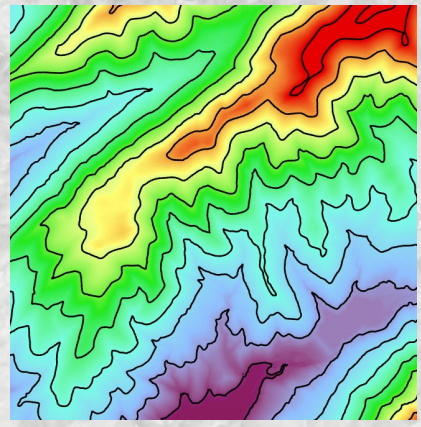


Hillshade

Aspect



Contours



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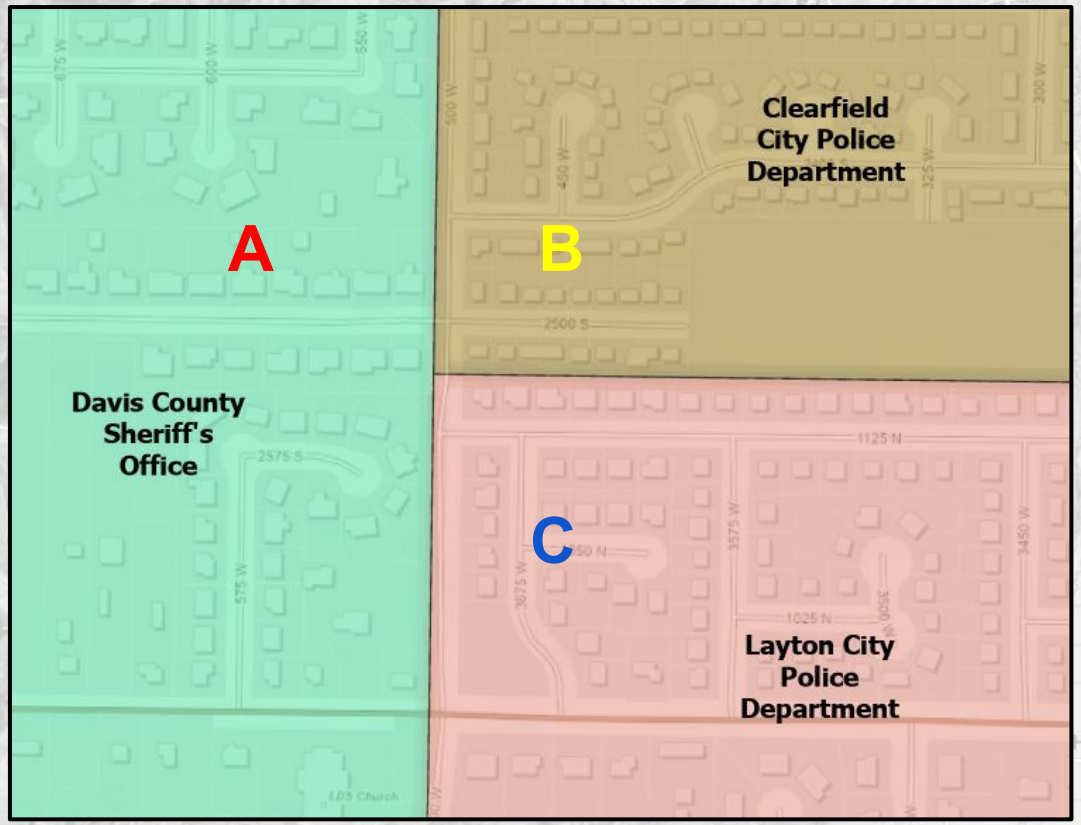
Common GIS Tasks and Applications

- 911 & Next-Generation call-routing
  - Caller A → Davis County Sheriff's Office
  - Caller B → Clearfield City Police Department
  - Caller C → Layton City Police Department
- Dispatch software can also recommend which fire and medical units should respond to the location

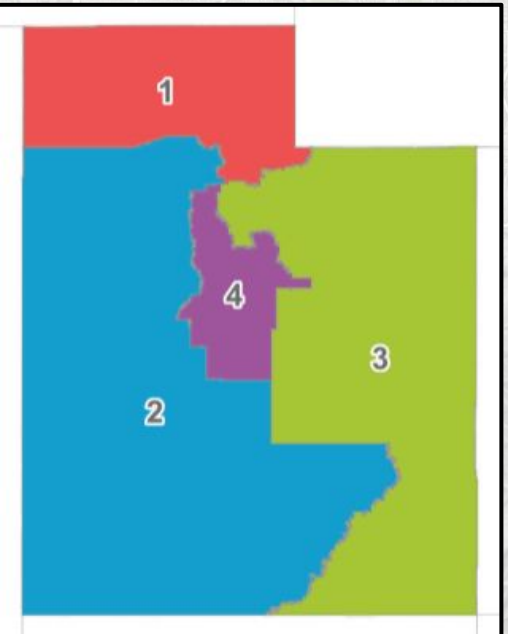


NEXT GENERATION 9-1-1

Utah Geospatial Resource Center

Applications of GIS never end …

- Election Management: Redistricting, drawing precincts, voters and ballots
- Solar potential analysis
- Flood and inundation modeling
- Drone data capture, imagery, and 3D models



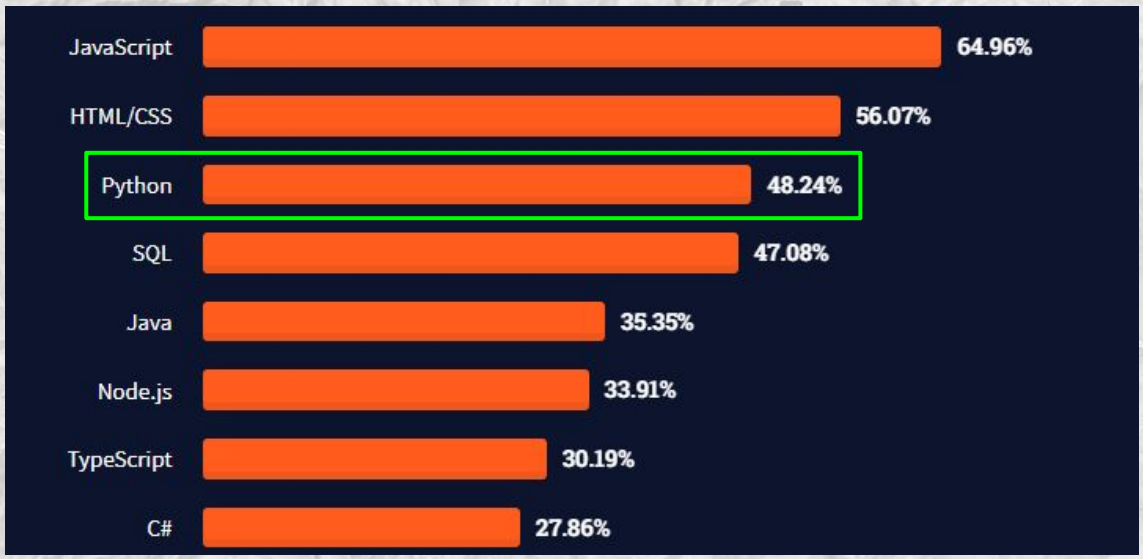
[Google Project Sunroof]

Python and Automation

- Popular, readable, versatile, easy-to-use programming language
- Open source and has a very large community of users and developers
- Tons of packages for a wide variety of uses
- Ubiquitous in GIS, data science, and scientific/academic communities
  - Able to chain tasks together to automate and repeat complex processes
  - Analysis and visualization

StackOverflow [developer survey]:

Most Popular Technologies



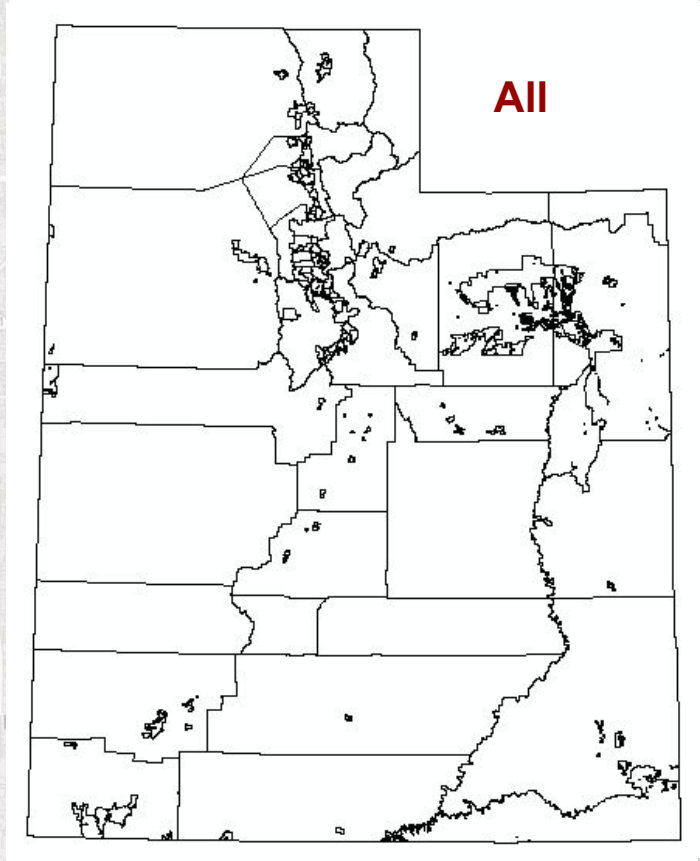
Utah Geospatial Resource Center

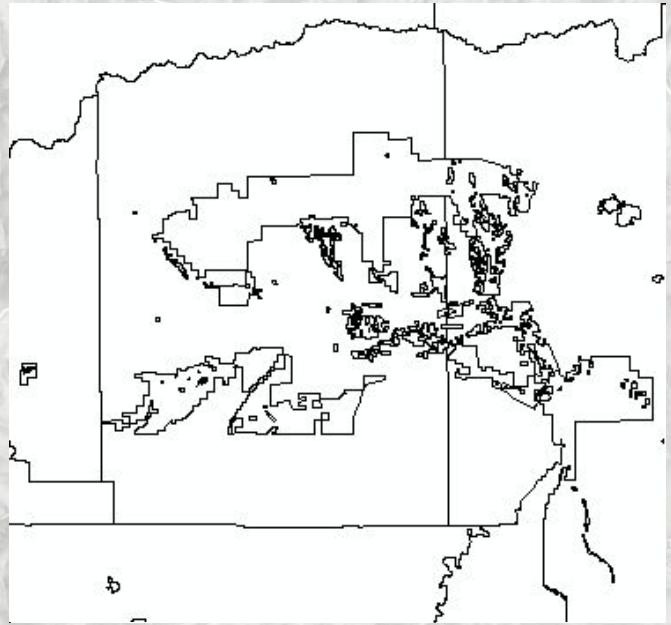
gis.utah.gov

Python and Automation in GIS

- Geospatial packages
  - ESRI: ArcPy, ArcGIS API for Python
  - Open Source: GDAL, PyQGIS, Geopandas, Rasterio, Shapely, Fiona, geemap,
    - too many to list …
- Automate several processes in GIS
  - Perform analysis
  - Create data
  - Edit and update existing data
  - Generate a series of maps
- Specific examples
  - Get all addresses within a 500 ft buffer of a location
  - Real-world example for UGRC: Build 911 law boundaries
    - Combine county, municipal, and special jurisdiction boundaries into a statewide layer
    - Recreate data at the "push of a button" to capture recent municipal annexations
    - Script builds data in less than 2 minutes
    - Don't need to manually edit data or track recent annexations

Utah 911 Law Boundaries





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Final words

- GIS and GIS data can be very useful
  - Storing and managing data with "where" component
  - Answering questions
  - Solving problems
  - Visualizing data
- UGRC has a ton of GIS resources available for *ANYONE* to use
- Python can help automate tasks and improve workflows

Questions?

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