Chapter 20.
Photogrammetric Applications in GIS

20-1. Introduction

"**photogrammetry** and **remote sensing** play extremely important roles in the development and implementation of geographic information systems"

- **aerial images** are frequently employed by GIS operators as background frames of reference for performing spatial analyses
- the most important contribution to GIS made by **photogrammetry and remote sensing** is their use in directly generating spatially accurate feature information for databases
- The **digital orthophoto** is another photogrammetric product that has become indispensable in GIS work
- **Layers of information for GIS** are often compiled by simultaneously analyzing photogrammetric products in conjunction with other documents
- **Generating GIS database information by photogrammetry** is almost always faster and more cost-effective than doing so by any other means, and the process enables high orders of accuracy to be achieved

20-2. Land and Property Management

The GIS is the primary site development and analytical tool for informed land management

- To analyze large areas of land **to determine potential sites for new facilities** such as roads, stormwater drainage systems, utilities, and communication towers
- To determine if any existing county property would **be suitable for site selection**
- Data organized in a GIS readily enable queries to be made **to eliminate many inappropriate parcels** based on design constraints and legal considerations
- **GIS spatial analysis** facilitates overlaying imagery, parcels of land, storm surge prediction areas, flood zones, National Wetland Inventory estimates, land cover, elevation, zoning, address points, and utility lines along with the remaining county-owned parcels
- Search buffers and road network routing support **efficient site selection**

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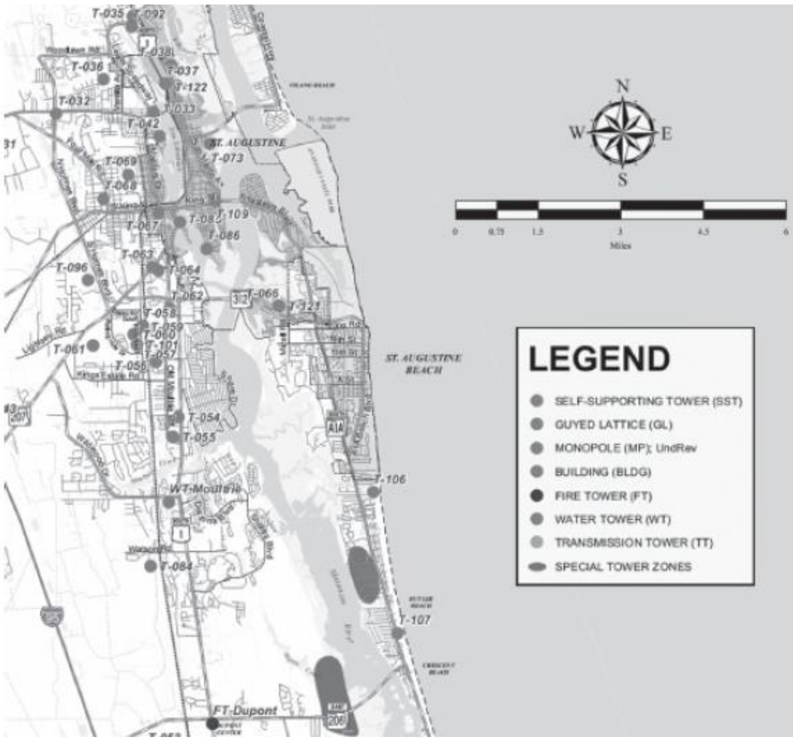

Figure 20-1. Telecommunication tower sites for a portion of St.Johns County, Florida

- As shown in Fig.20-1, these **site analysis tools** and data supported the design of ten sites for the county intergovernmental radio system
- **Telecommunications engineering and modeling** determined approximate locations for towers
- Using **GIS layers** for research and **spatial analysis** helped ensure a full review of land was performed and the best available sites were selected

20-3. Floodplain Rating

With Community Rating System(CRS) program, it is possible to reduce flood damage losses, provide proper regulation for construction, increase public awareness of flood zone locations and impacts, and prepare for flooding situations

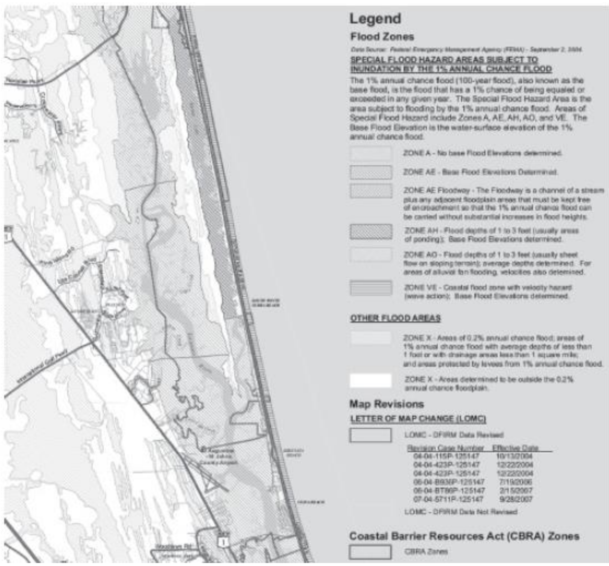

Figure 20-2. Floodplain ratings for areas within St.Johns County, Florida

- **Photogrammetry, remote sensing, and LiDAR products incorporated in the county GIS** are used to more accurately delineate floodplains and identify potential improvements (See Fig. 20-2.)

- The GIS can be used to efficiently determine how much open space exists within the regulatory floodplain areas

- In addition to identifying the floodplain areas and open space, the GIS incorporates private land ownership, public lands, and land uses in order to maintain an effective CRS

- Water bodies were delineated and land uses updated from orthophotography

- Structures including roads and buildings were also reviewed and removed, and designation as conservation lands increased the value of the preserved open space4

20-4. Water Quality Management

"Geographic information systems have been successfully applied to the solution of many problems in water quality management"

Figure 20-3. Location of Sugar River water quality management GIS project. (Courtesy Dane County Land Conservation Department, M. S. Robinson and A. Roa-Espinosa.)

- **GIS** that was developed for the Sugar River watershed in south-central Wisconsin (see Fig. 20-3)
- **The objectives of the GIS** were to provide a cost-effective means for assisting in preventing soil erosion and to improve and preserve the water quality in the Sugar River and its tributaries, as well as in Belle Lake which exists at the lower end of the watershed
- A GIS was developed to provide the information necessary for a computer modeling program to identify areas of high sediment and phosphorus delivery within the watershed
- **Improved management** practices could then be implemented in these areas

20-4. Water Quality Management

The major layers of information developed for the GIS database included topography, hydrography, soils, and land use/land cover Photogrammetry played a major role in the development of each of these layers

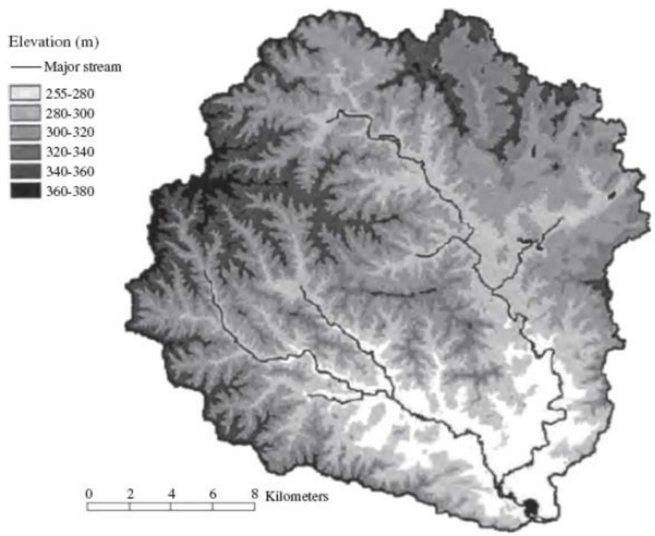

Figure 20-4. Elevation model prepared from DEM of Sugar River watershed. (Courtesy Dane County Land Conservation Department, M. S. Robinson and A. Roa-Espinosa.)

- The elevation layer (see Fig. 20-4) was based upon a digital elevation model that was produced photogrammetrically The **DEM**, which consisted of a 10-m grid with accuracies to within ±0.3 m, <u>provided slope information that was critical in the computer modeling</u>
- **The hydrography layer**, which consisted of the rivers and streams within the watershed, was digitized from orthophotos

- **By combining the elevation and hydrography layers**, small individual hydrologic drainage areas that were needed for the computer modeling were identified

20-4. Water Quality Management

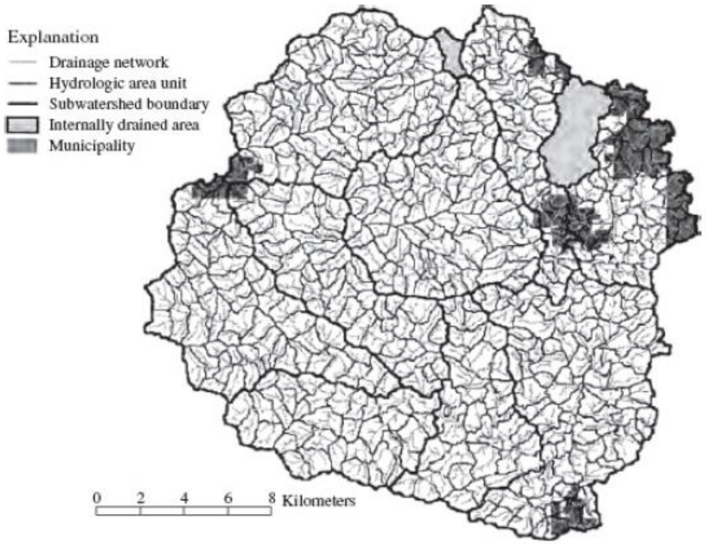

Figure 20-5. Hydrologic area units within the Sugar River watershed obtained by combining elevation and hydropraphy layers (Courtesy Dane County Land Conservation Department, M. S. Robinson and A. Roa-Espinosa.)

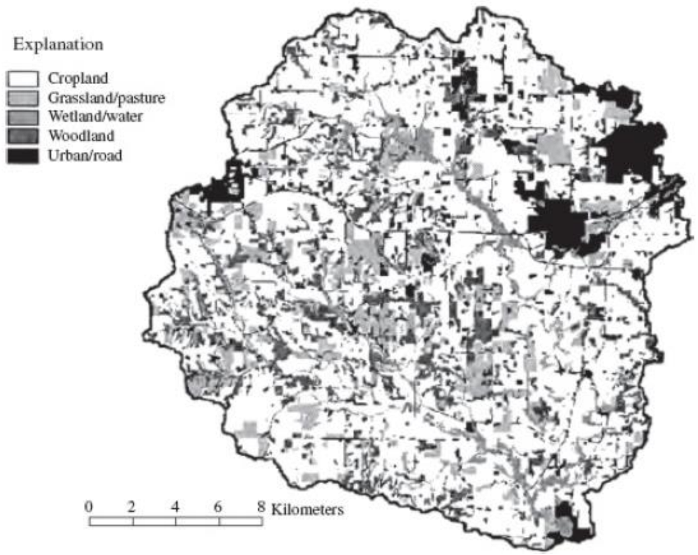

Figure 20-6. Land use/land cover layer of the Sugar River GIS database. (Courtesy Dane County Land Conservation Department, M. S. Robinson and A. Roa-Espinosa.)

- There were approximately 500 individual areas in the watershed, as shown in Fig. 20-5, and they averaged about 1 km in size
- The soils layer was digitized from 2 NHAP aerial photos

- The land use/land cover layer consisted of the combination of many individual layers as shown in Fig. 20-6
- It included categories of cropland, grassland, pasture, woodland, wetland, water, roads, residential areas, industrial areas, and commercial areas

20-4. Water Quality Management

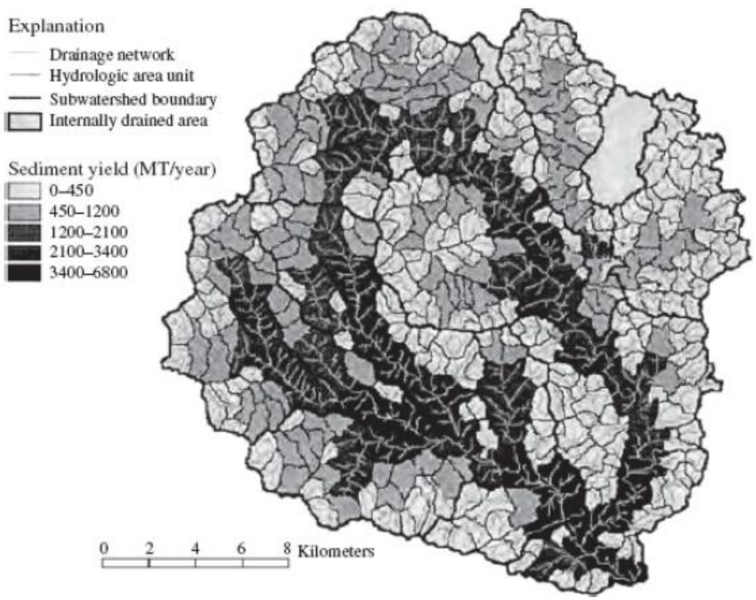

Figure 20-7. Sediment yield within the Sugar River wastershed obtained through GIS analysis. (Courtesy Dane County Land Conservation Department, M. S. Robinson and A. Roa-Espinosa.)

- Figure 20-7 is a graphic which shows **the sediment yield of each of the hydrologic units** in the watershed
- A similar graphic was developed for **phosphorus yields**
- **Areas with high yields** could be examined in the field and <u>targeted for improved field and management practices</u>
- These practices could include such measures as practicing conservation tillage, using soil binders, establishing buffer strips, constructing terraces, or installing water and sediment control basins

20-5. Wildlife Management

Not only has **photogrammetry** enabled the work to be completed more rapidly and efficiently, but also it has permitted greater amounts of data to be collected, analyzed, and managed, thereby improving the overall end results

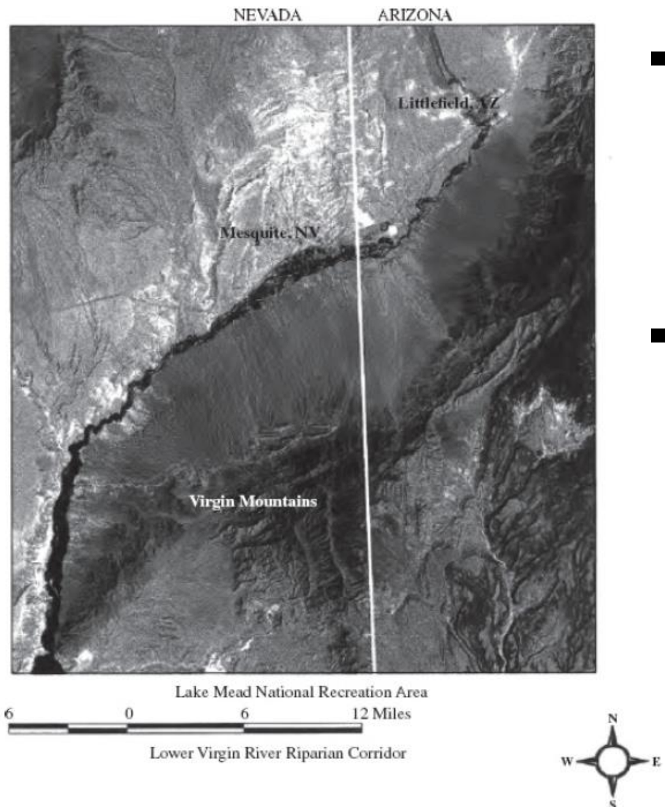

Figure 20-8. Study area of Virgin River wildlife management GIS project. (Courtesy Southern Nevada Water Authority.)

- **An example illustrating a GIS application in wildlife management** involves a portion of the Lower Virgin River in the southwestern United States
- The study area, shown in Fig. 20-8, includes the entire riparian corridor of the river from the Virgin River Gorge near Littlefield in northwest Arizona, to the Lake Mead National Recreation Area in southeast Nevada

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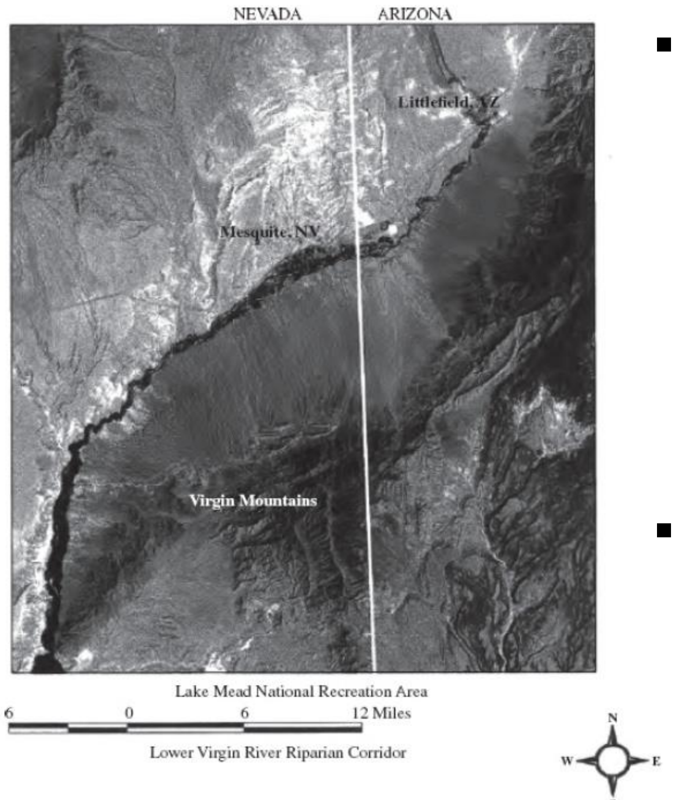

Figure 20-8. Study area of Virgin River wildlife management GIS project. (Courtesy Southern Nevada Water Authority.)

- Its **objectives** were to delineate the vegetation communities and other habitat types within the riparian corridor of the river, determine how the different vegetation species are used by wildlife, and predict how the distribution and composition of vegetation and wildlife change with varying flow levels in the river

- **The base map**, or frame of reference for performing GIS analyses, was prepared **from color infrared aerial photos**
  - These photos, taken at a scale of 1:24,000, were scanned, rectified, and joined digitally to form a mosaic of the study area

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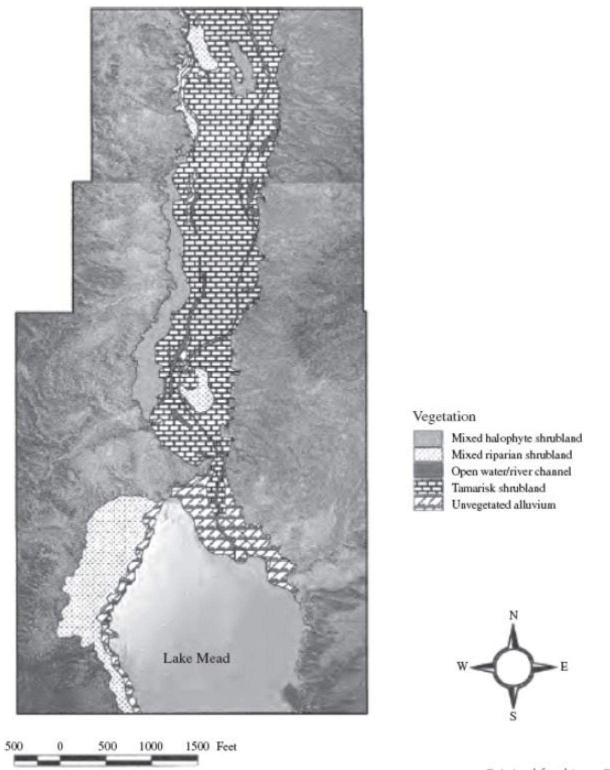

Figure 20-9. Vegetation layer of Virgin River wildlife management GIS project. (Courtesy Southern Nevada Water Authority.)

- One of the critical layers of information compiled was **vegetation**
- To assist in preparing this layer, portions of the base map in selected areas were enlarged to 1:6000 scale
- These **large-scale photomaps** were used during field surveys to identify and delineate the locations of vegetation classifications in several key areas of the river corridor
- Based upon these "ground truth" samples, the remaining images in the corridor were interpreted and classified, using the heads-up digitizing process

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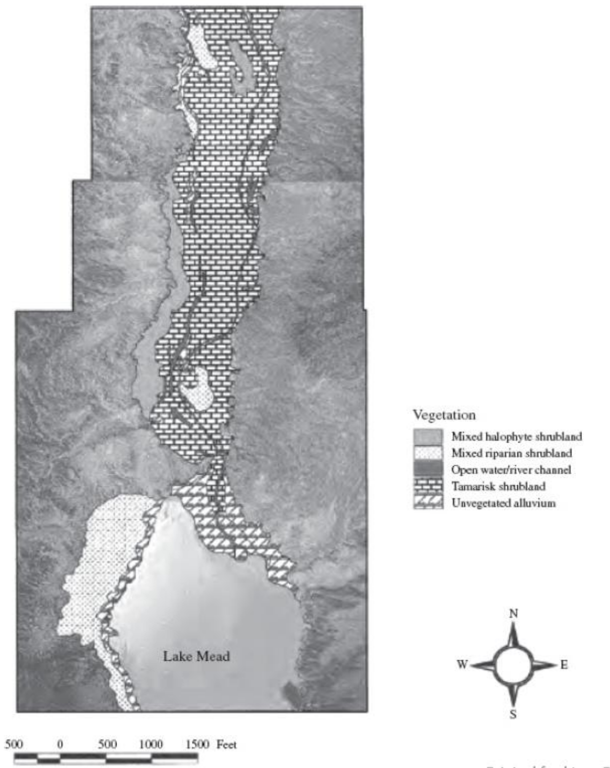

Figure 20-9. Vegetation layer of Virgin River wildlife management GIS project. (Courtesy Southern Nevada Water Authority.)

- GPS was also used in some cases to check visual analyses and to locate certain features that were not visible on the base map, such as special habitat areas and nesting grounds
- Next **the resulting vegetation map** was utilized to select representative areas for evaluating wildlife and their use of the resources within the riparian corridor
- A total of 11 vegetation classifications were included on the map
- Figure 20-9 shows **the portion of the vegetation map** at the location where the Virgin River corridor enters Lake Mead

20-5. Wildlife Management

Not only has **photogrammetry** enabled the work to be completed more rapidly and efficiently, but also it has permitted greater amounts of data to be collected, analyzed, and managed, thereby improving the overall end results

- **The vegetation/habitat layer** was used as a guide in selecting areas for conducting wildlife surveys in the field
- In addition to vegetation types, **the topography, floodplain characteristics, and stream gradient** were also considered in selecting the wildlife survey areas
- **GPS** was used to control the placement and mapping of the transect lines for data capture within the GIS model
- A great deal of valuable data have been gathered to further existing knowledge of the wildlife in this southwest habitat, and to aid in understanding the dependence these wild creatures have upon the different vegetation communities and other habitat types that exist in the river corridor
- This method of study has the added advantage that the information collected can conveniently be shared with other agencies having overlapping or common interests and goals

20-6. Environmental Monitoring

- **The Southern Nevada Water Authority (SNWA)** has been looking for other sources helping supplement existing water supplies to meet the water needs of nearly 2 million people while maintaining natural habitat and minimizing negative impacts to the environment through environmental monitoring for the large area of interest to SNWA
- **Large-scale monitoring** has become easier over the past few decades, as the advent of commercial airborne imagery allows companies to view and analyze thousands of square miles in a much shorter timeframe
- Satellite imagery can be periodically acquired over the same areas, allowing for analysis to detect changes that have occurred over time
- As part of the monitoring efforts in basins where groundwater could be pumped, SNWA has collected **baseline data** over areas of eastern Nevada ⇨ multispectral imagery and LiDAR elevations
- Once acquisition of imagery and LiDAR was completed, statically collected GPS control and checkpoint targets were compared against AGPS's kinematic positions

20-6. Environmental Monitoring

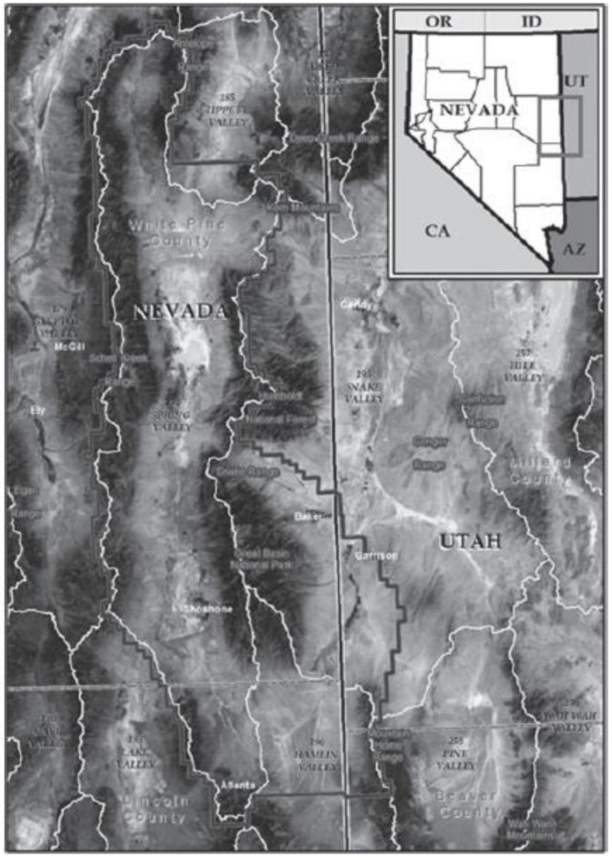

Figure 20-10. Groundwater resource area in eastern Nevada being monitored for environmental effects. (Courtesy Southern Nevada Water Authority.)

- These datasets have been instrumental in different aspects of the monitoring program, **including GIS mapping and analysis for hydrology, biology, and ranch management**
- Spring locations, property boundaries, plant identification, soil analysis, slope analysis, animal grazing allotments, and determining the volume of small drainage basins are just some of the items that have been determined or benefitted from the more accurate datasets that were collected
- Figure 20-10 depicts **the imagery produced for the project area**

20-7. Wetland Analysis

"A GIS can be a useful tool to aid the wetland scientist in finding general locations for analysis"

- When delineating wetlands on a parcel of county-owned land, **the starting point is always** GIS
- Elevation data often refines the search area for wetland delineation when combined with aerial imagery
- Some of the **key layers in refining the analysis** and **directing ground analysis** include: land cover, national wetlands inventory (NWI), soils, true color imagery, color infrared imagery, and LiDAR elevation data
- Starting with the land cover, soils, and NWI layers, the nominal habitat type and potential hydric indicators (particularly hydric soils or hydrophytic vegetation) are checked to indicate the possible presence of wetlands

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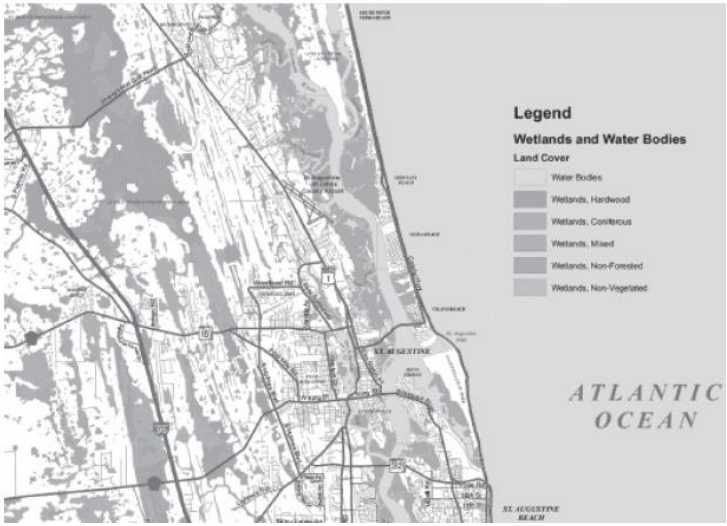

Figure 20-11. A portion of the wetlands layer from the St. Johns County, Florida, GIS database.

- With **a preliminary GIS review of the parcel**, time in the field is directed to the areas needing further scrutiny and the field process of wetland delineation is much more efficient and accurate
- By measuring the spatial location of the boundary in the field, a more accurate representation can be input into the GIS database, which will improve the accuracy of the information
- Figure 20-11 shows **a portion of the wetlands layer** in the St. Johns County GIS

20-8. Transportation

- **The Roadway Characteristics Inventory (RCI)** is a **GIS database** which contains information about signs, pavement, drainage structures, bridges, etc., along highways in Florida
- First introduced as a pilot project, the RCI was developed to facilitate pavement maintenance, accident cataloging, replacement or repair of damaged structures (guardrails, signs, fences, etc.), and other items related to highway issues
- **The GIS replaced manual inventory methods** in which facilities were located by driving along the highways and noting the positions of inventory features from odometer readings (dead reckoning)
- **Aerial photography** was acquired along the highway at a flying height of 600 m above terrain ⇨ This photography was used to compile planimetric features such as road centerlines and edges of pavement
- **Digital orthophotos** were also produced, at a resolution of 10 cm, to provide a spatially accurate visual base map

20-8. Transportation

Figure 20-12. Selection from the Roadway Charateristics Inventory GIS showing relevant information for a specific feature. (Courtesy 3001, Inc.)

- Figure 20-12 shows a portion of the GIS along a stretch of highway
- When a user selects a feature by pointing and clicking, a table pops up, giving detailed information about the particular item
- In Fig. 20-12, the box culvert was selected, giving a table showing its position, diameter, type of material, and other information

- The plan calls for **5-year updates** to be performed to keep the information in the GIS current
- Due to the **high accuracy of the GIS database** and its **completeness**, it is anticipated that the RCI will provide for better decision making now and in the future

20-9. Multipurpose Land Information System

The city of Sulphur, Louisiana, established a high-accuracy GIS to provide spatial information for a variety of needs

- Additional data layers, created through photogrammetric techniques, were tied to the GPS control to achieve **high-accuracy**
- These include a topographic map, digital orthophotography, and a digital elevation model
- The system also includes **parcel boundaries** based on tax assessor data, utility information, stormwater facilities, fire hydrants, and crime incident locations

Figure 20-13. Sanitary sewer facility map from the Sulphur, Louisiana, GIS showing addresses affected by pipe maintenance. (Courtesy 3001, Inc.)

- Figure 20-13 shows a portion of the GIS with parcels, buildings, streets, stormwater facilities, water lines, and sanitary sewer lines
- A section of sewer pipe was selected, and the table lists the affected addresses

This illustrates just one of the many uses of this multipurpose GIS