Utilities Focused Asset Management & Mapping for Parks

Penn State University
Masters in GIS - Capstone Project
596B – Spring 1, 2014

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Introduction & Background

The Muskingum Watershed Conservancy District (MWCD) owns and operates campground facilities at five of our fourteen reservoirs. This project will focus on Tappan Lake Park (http://www.mwcd.org/places/parks-and-campgrounds/tappan-lake-park) (figure 1). Tappan Lake Park (figure 2) is in Harrison County, Ohio and includes nearly 600 campsites and hundreds of acres. This project encompasses the process of planning, data collection, Geographic Information System (GIS) development and finally implementation of a utility data retrieval system for field and office staff. I have met with stake-holders for the individual "layers" (Storm, Sewer, Natural Gas, etc.) and have determined their priorities. End-user applications will vary by computer skills work location (park or office).

The recreation program for the MWCD started in the 1960's and has been through many modifications (Jenkins 1976). Like cities with aging infrastructure, the MWCD has many utilities (water, gas, electric, and sewer) that need to be documented and repaired on a frequent basis. Older data vary in age and quality including hand drawings and Computer Aided Design (CAD) maps that show various areas with little consolidation or consistency. Campsites in Tappan Lake Park range from primitive to full utility hook-up (water, sewer & electric). We have recently completed a Park Master Plan that will involve significant upgrades and additional amenities. Without knowledge of our facilities, we will experience increased downtime and costs during construction (Barnhart 2013).

The park infrastructure is similar to a city or municipality with two specific differences: one is the park layout; cites are often developed on a grid that has a systematic expansion process. While the individual campsite areas do have a grid-like parcel pattern, there are outlying support buildings such as the Activities Center, Park Office, Maintenance Buildings and Cabins that do not follow this layout. Many of these regions are linked together with a random cross-country approach of utility placement. While not convenient, proximity dictates this type of layout.

The second difference is city construction projects are typically surveyed, designed and installed with planning and record keeping done by a Planning or Engineering Department. The MWCD Engineering Department has fluctuated in size over the past thirty years. These staff changes have resulted in an inconsistency of record keeping. Many design projects were contracted out over the years and keeping the park running has been paramount over maintaining utility records. Prior to 2005, there were several technicians in charge of these updates, but as staff retires much institutional knowledge has left the organization.

The current trends in record keeping for the park utilities are inconsistent. Many of the parks maintain on-site hard copies of the utility maps. These records are infrequently updated when a change or repair is performed in the field. The main office in New Philadelphia, Ohio has a CAD Technician in the Engineering Department that maintains an AutoCAD version of a utility base map that has been assembled from various projects and surveys. However, it is not 100% complete and cannot be accessed by anyone outside of the engineering staff in the main office.

A GIS evaluation committee existed in the District from 1997-2004. This group was created to perform a feasibility study of how GIS could be implemented into the MWCD. During this time ESRI's ArcView (ESRI 2013) was growing as the primary GIS software and Autodesk was promoting their AutoCAD Map and MapGuide GIS products (Autodesk 2013). Much of the discussion in the group centered upon which software to use. The Engineering Department was using Autodesk products and there was a strong resistance to changing software. In 2001 MWCD staff performed a partial survey of Tappan Lake Park with the intent of implementing a utility focused GIS (Schreiner 1997-2004). Soon after this was completed, budgets were trimmed and several key members of the Engineering staff that were involved with the GIS Team retired.

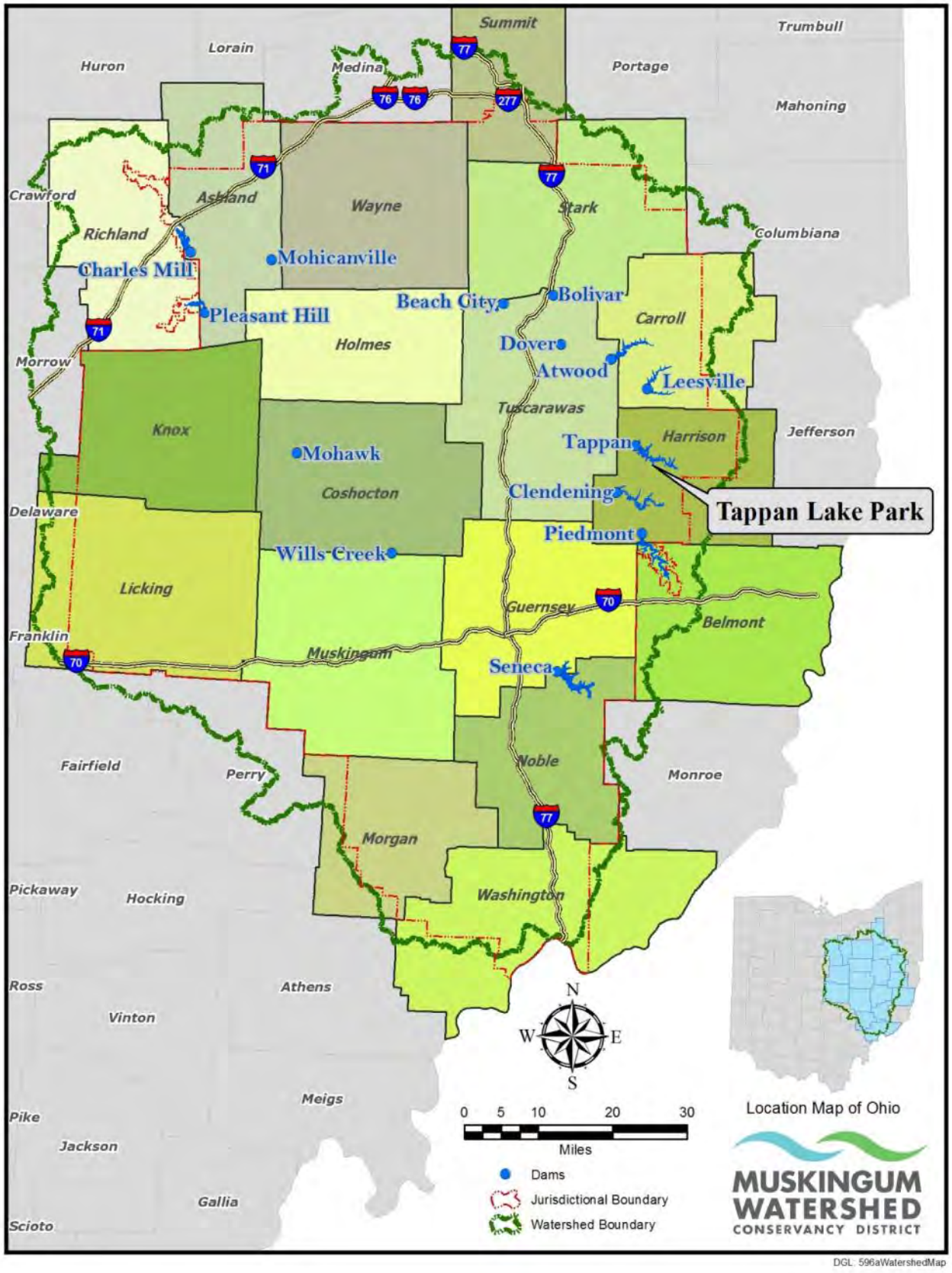

Figure 1: Muskingum Watershed Conservancy District watershed and jurisdictional areas with park and dam locations. Map by Author (December 2013).

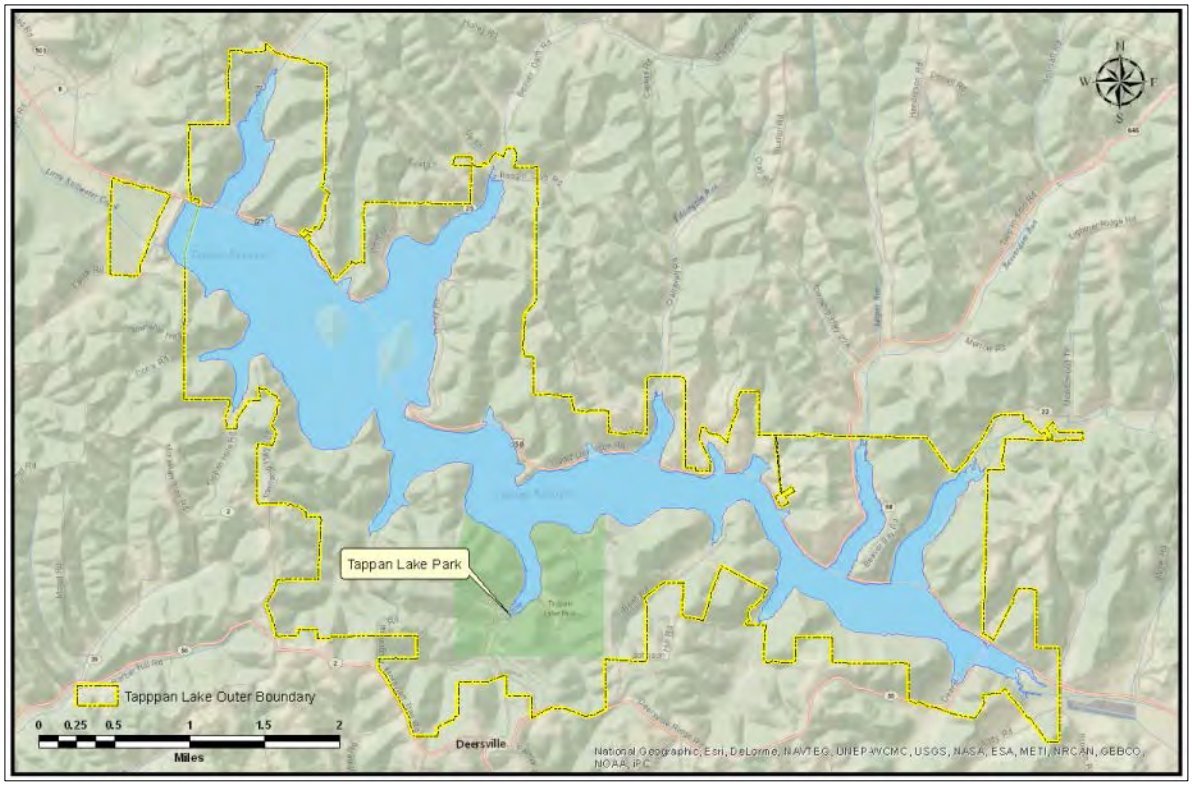

Figure 2: Map of Tappan Lake region in Harrison County, Ohio. Tappan Lake Reservoir property and Tappan Lake Park identified. Map by Author (December 2013).

Past Practices

There are a variety of options when determining the best GIS software for your particular use or organization. Autodesk, Google and ESRI all have platforms with varying capabilities. There are many options both fee based and open-source, depending on your needs. The following examples discuss several of these software choices.

AutoCAD is a leader in Civil Engineering software and is commonly used by surveyors and engineers for data collection and design (Carpenter 2013). Autodesk, Inc. considered AutoCAD Map a quasi-GIS but it had limited querying capabilities and an unfriendly user interface (Carpenter 2013). AutoCAD is suitable in a surveying and engineering environment when working with raw survey data, but the record retrieval is limited. Also, annotation can be when difficult when hard copies are required at multiple scales (Carpenter 2013). AutoCAD files can also be difficult due to lack of coordinate systems and various standards when using a variety of contracted engineering firms (Mayo 2013).

Google Earth or Google Earth Pro was also an option for this project. The use of Keyhole Markup Language (KML/KMZ) files has become increasingly popular in the non-GIS community (Carpenter 2013). It allows less tech savvy users to take advantage of the data on a familiar platform. This option was used in 2010 for the Timken Steel Company based out of Canton, Ohio (Carpenter 2013). The original data was developed in an AutoCAD format and the conversion to ESRI was underway. However, GIS staff changes occurred and the new GIS Coordinator preferred the Google platform. Google is a web format, easy to deploy to a large amount of users in a short amount of time, and is less difficult than setting up ArcServer. Google Earth Pro was used because of its additional measuring and map making capabilities for end-users. This platform worked for these basic operations, but lacked the complexity needed for the utility network analysis and additional capabilities from the ESRI products. The Google platform was utilized for a couple years until the decision was made to return to the ESRI platform with ArcServer to deploy to the web (Carpenter 2013).

The U.S. National Park Service has embraced the use of incorporating their Facilities Management Software System (FMSS) with GIS as early as 2005. Each asset has a unique ID that was coupled with a photograph and incorporated into the GIS for asset visualization. All assets had a specified location from a Global Positioning System (GPS) location to be recorded (figure 3). Files were also linked to work order tracking (Diethorn 2005).

The City of Cocoa in eastern Florida was similar in approach to the Tappan project when mapping their potable water assets. They started by digitizing existing records and then later supplemented with additional surveyed data (Turner 2008-9). Data are now available for use on Panasonic Toughbooks for portability with ESRI's ArcPAD software (Turner 2008-9). Record drawings that were used for some of the original creation of the mapping system are hyperlinked to features so that more detail can be accessed if needed (Turner 2008-9).

The Tappan Park database will use images to increase the end-user's familiarity with the utilities by including the attachment option that is found in the database software. This allows digital images to be linked with individual assets such as manholes, valves, hydrants, etc. In addition to attaching photos taken during the survey, scanned historical utility maps and engineering drawings will be attached as well. The Tappan Lake project has combined past experiences and current trends to develop an easy to use and beneficial product for the MWCD staff.

Waypoint Collection Positions for each Park Asset

Roads	Record the GPS coordinates at the beginning and end of each route.
Parking Areas	Record GPS coordinates at the approximate center.
Bridges	Record the GPS coordinates at the beginning and end of the Bridge.
Tunnels	Record the GPS coordinates at the beginning and end of each Tunnel
Trails	Record the GPS coordinates at the beginning and end of each Trail.
Maintained Landscapes	Record GPS coordinates at the approximate center.
Campground	Record GPS coordinates at the approximate center.
Picnic Area	Record GPS coordinates at the approximate center.
Buildings	Record GPS coordinates near the primary entrance.
Water / Waste Water Systems	Record GPS coordinates at the approximate center.
Heating & Cooling Plants	Record GPS coordinates at the approximate center.
Electrical, Radio, Phone, Computer Systems	Record GPS coordinates near the primary entrance.
Fuel Systems	Record GPS coordinates at the approximate center.
Dams	Record GPS coordinates at the approximate center.
Constructed Waterways	Record the GPS coordinates at the beginning and end of each.
Marina/Waterfront System	Record GPS coordinates near the primary entrance.
Tower/Missile Silo	Record GPS coordinates near the primary entrance.
Outdoor Sculptures/Monuments/Plaques	Record GPS coordinates near the approximate center of this unique asset.
Ruins	Record GPS coordinates near the primary entrance.
Fortification	Record GPS coordinates near the primary entrance
Lighthouse	Record GPS coordinates near the primary entrance
Railroad System	Record the GPS coordinates at the beginning and end of each track.
Aviation System	Record the GPS coordinates at the approximate center.
Amphitheater	Record GPS coordinates near the primary entrance

Figure 3: Features to be collected with layers and proposed data collection locations for National Park Service assets. (Diethorn 2005).

Goals and Objectives

GOALS:

- *Develop a system that multiple departments can easily access utility data*
  - Maintain data in one location and make available to all staff via the Internet
- *Increase the amount of sharing of data throughout the MWCD*
  - Once the advantages of GIS are realized, a more sharing and open philosophy will be adopted
- *Increase efficiency for Utilities and Construction Crews*
  - Make the information not typically available to field staff by implementing tablets and handheld GPS units, allowing problems to be resolved faster and generating a self-sufficient environment

OBJECTIVES:

- *Survey all Tappan Lake Park utility components*
  - Select survey consultant and have work completed by August 31st
  - All utility components to be located: Storm, Sewer, Water, Electric and Gas
- *Compile the most recent water and sewer utility records*
  - Review data from engineering construction and design records
  - Review records kept on-site by park staff
- *Implement a method of data retrieval via ArcGIS ONLINE*
  - Utilize Web applications such as ESRI's ArcGIS ONLINE or ArcGIS Explorer ONLINE

As we head into 2014 we are in a better financial state (see appendix A) and plan to increase our project workload to include asset management using GIS. Recent funding has helped the MWCD initiate this project and it will likely serve as the pilot project and template for all MWCD parks.

Outline for the project is as follows:

I. GIS Database development

a. Determine needs with staff – review necessary data requirements (fields/features) to be incorporated into project

b. Database – create ESRI geodatabase incorporating staff comments

II. Survey and Data collection fieldwork

a. Survey scope development – determine required items to be collected in field

b. Field survey and GPS monumentation – perform fieldwork and establish monumentation for future survey work

III. GIS development

a. ArcGIS Desktop – populate ArcGIS geodatabase with survey data and existing records

b. ArcGIS ONLINE – develop web tools using existing apps to make online interface user-friendly to staff, thus promoting use

c. Utilities – Water, Sewer, Roadways and Buildings

IV. Implementation

a. Training/Release: Main Office – train in groups by department and release beta version to sample of users for initial review

b. Training/Release: District Wide (Parks, etc.) – utilize Main Office remarks prior to full District release

c. Tablet use – have data available in portable form for utility and construction crews

d. Maintenance – Plan method of maintaining system in-house with Survey Technicians (2) and GIS Specialist

V. Benefits/Conclusions and Lessons learned

a. Benefits

b. Communications

c. Project Schedule

d. Future Option

I. GIS Database Development

It is important to provide a brief overview of GIS or Geographic Information Systems prior to reviewing this paper. GIS is the connection of graphic data (maps) and non-graphic data (databases, tables, etc.). This information is then made available to the end-user via a PC or alternate device. Depending on required security measures, the data can be put on a network for local users such as a government office or placed on the internet (i.e. Internet Cloud) for access by utility company field crews with a tablet or smart phone. Managing data in one central location provides all users up-to-date information. In addition to the utility needs we will discuss in this paper, another common use for GIS is the mapping of parcel data in county government offices. Parcel maps can be represented in the graphic portion of the program while the owner and home data can be accessed and queried by multiple departments such as planning, building, engineering or even the public.

There are several database options for this project. Shapefiles and Geodatabases are options that are native to GIS. The shapefile is a widely accepted format in the GIS community and was developed by ESRI. A shapefile consists of multiple files that include graphics, tabular data and positional data (ESRI 1998). Due to the complexity of this project, ESRI's Geodatabase format was selected for data architecture instead of shapefiles. A geodatabase format provides more flexibility in the design and therefore better suits this project. This includes additional space for naming conventions and domains for data consistency (figure 4). These features are not available when using shapefiles. Also "attachments" will be used with this database format. This allows an image (scanned map, photo, etc.) to be imbedded in the actual database. This eliminates the need to maintain file locations when using hyperlinks.

Database design and creation was completed with the end-users input to provide insight of what the day-to-day needs would be for the field staff. Meetings were held with members of the Engineering and Utilities Group for the development of the geodatabase. The Utilities Group is a subset of the Engineering Department and consists of five people that operate and maintain MWCD owned water and wastewater systems, including the Water Treatment Plants and water and sewer line infrastructure (Taylor 2013). Park Managers were consulted for the roadway and building portions of the database. This was accomplished over several months during the monthly meetings that included Park Managers and the Chief of Recreation (Barnhart 2013). Each database field was discussed in detail along with domains and standards. Once complete, all database schemas were provided in Excel format for a final review and approval before the geodatabase was created (figure 4).

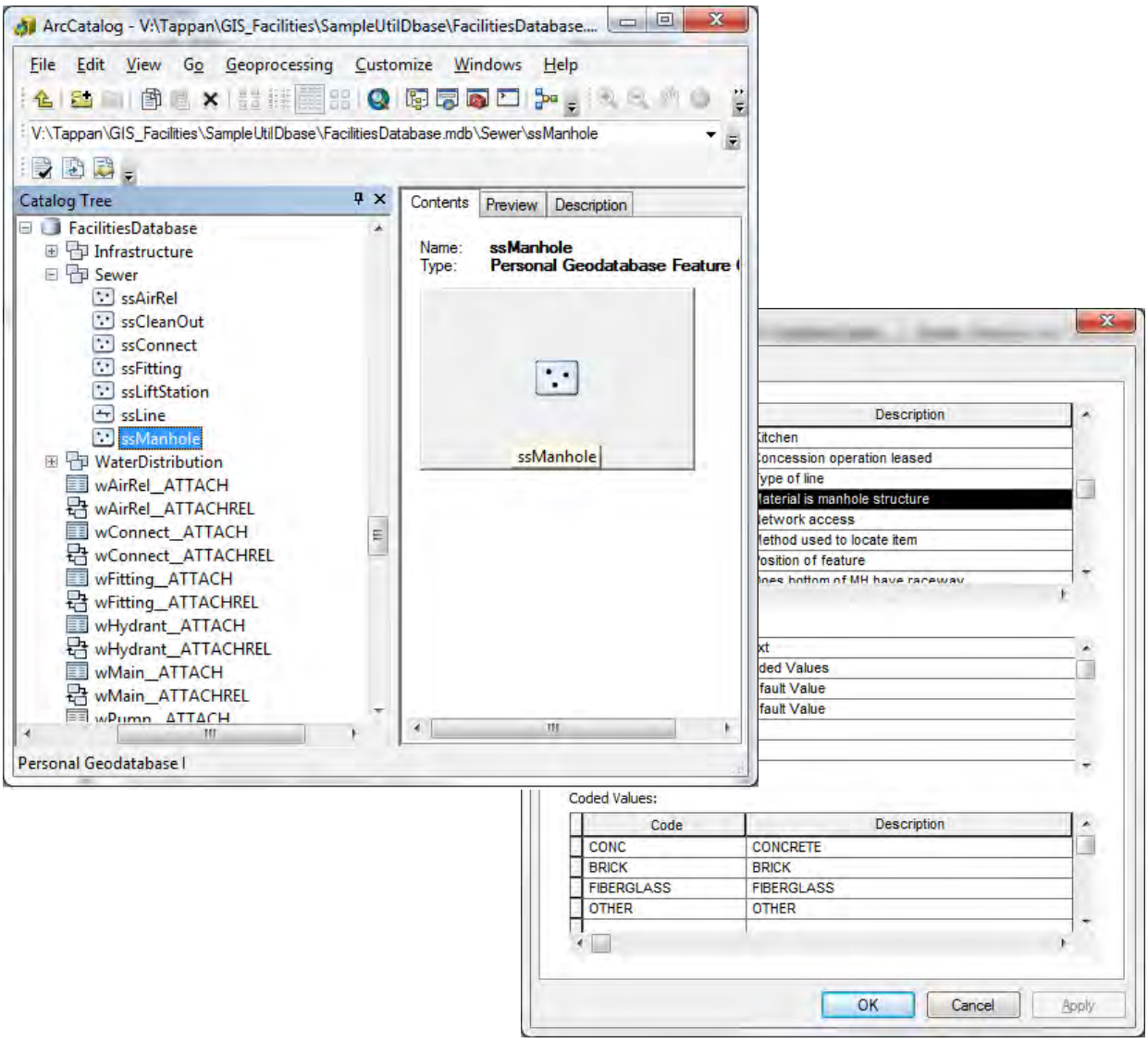

Figure 4: Tappan Lake Park geodatabase – Sanitary Manhole feature class with material domains. In this example the sanitary manhole material options are CONCRETE, BRICK, FIBERGLASS or OTHER. This is done to maintain consistency throughout the database during data entry and for future queries. By Author (November 2013).

II. Field Survey/Data Collection

The field surveying portion of this project was contracted to a local surveying consulting firm. Several firms provided a Letter of Interest (LOI) stating they have the personnel and abilities to perform the work. The firms that provided a LOI were then invited to provide a Request for Proposal (RFP) for the contract of performing the data collection. These RFPs were reviewed by the engineering staff and selected on predetermined criteria. This included items such as understanding of project, project approach, proximity to project location, staff availability and past experience with the MWCD. Bodo and Associates, Inc. of Carrollton, Ohio were selected for this project. See appendix B for original project scope and ranking criteria used during LOI and RFP review.

In addition to the collection of utility components, permanent control monuments were established (figure 5). Carsonite posts were placed near the monuments. Decals with coordinate data were then placed on the posts to provide MWCD surveyors and outside consultants with known control points. Permanent monuments will allow future projects to be easier to plan and document, making it easier to sustain an up-to-date GIS. The horizontal datum is on the Ohio State Plane Coordinate System and vertical datum is the National Geodetic Vertical Datum of 1929 (NGVD29). This vertical datum is still being used by the United States Corps of Engineers for their record elevation datum (Little 2013). All record levels, lake "pool" levels for winter and summer months and flood easements refer to the NGVD29 system.

Figure 5: Left: Installation of survey control monument using a gas powered auger. Monuments were placed 42" deep to be below frost line. Right: Final product of monument and witness post. Photograph by Author (July 2013).

While the survey was underway, MWCD staff collected attribute data for all of the building structures at Tappan Lake Park. An online software product called doForms (http://www.doforms.com/) was used for this portion of the data collection. This software allows the user to create a fillable form that is deployed to an Android, iOS or Windows portable device to collect data. This data is synced in the internet-based cloud and can be exported into an Excel file to be imported or joined to an existing database.

Fieldwork was performed during the summer months. After the initial fieldwork was completed, survey drawings were provided in paper format for an additional Quality Control/Quality Assurance (QC/QA) check by MWCD staff. Several modifications were required and the final product was then provided in AutoCAD format in State Plane Coordinates (figure 6). Prior to receiving the final map, Bodo and Associates, Inc. performed an additional QC/QA check (figure 7).

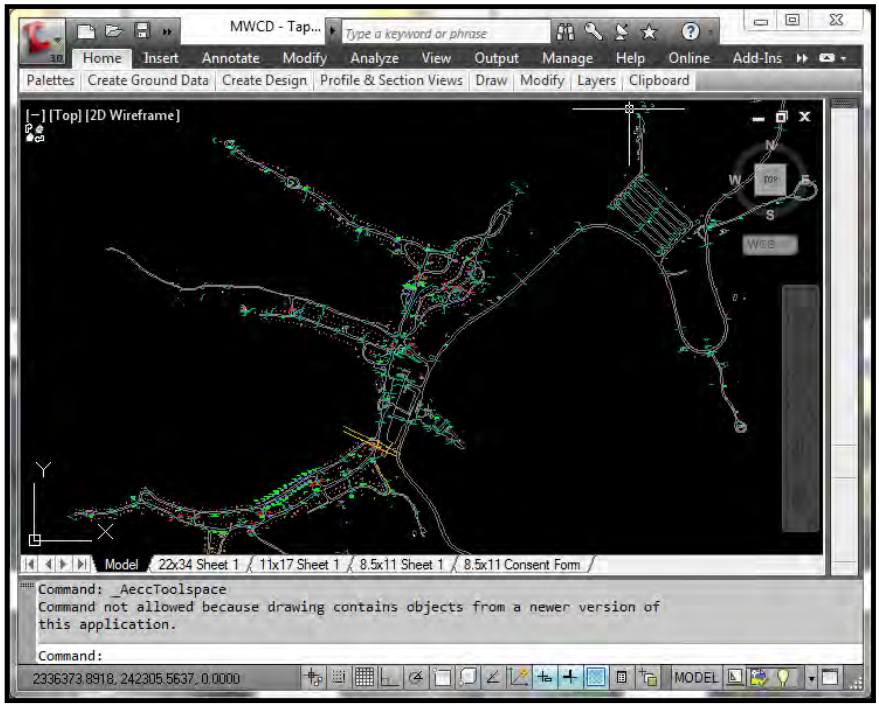

Figure 6: Survey work done at Tappan Lake Park in AutoCAD. Note the random pattern of the campsite layouts. White lines represent roadways. All remaining points are field located utility components (Bodo & Associates, Inc.).

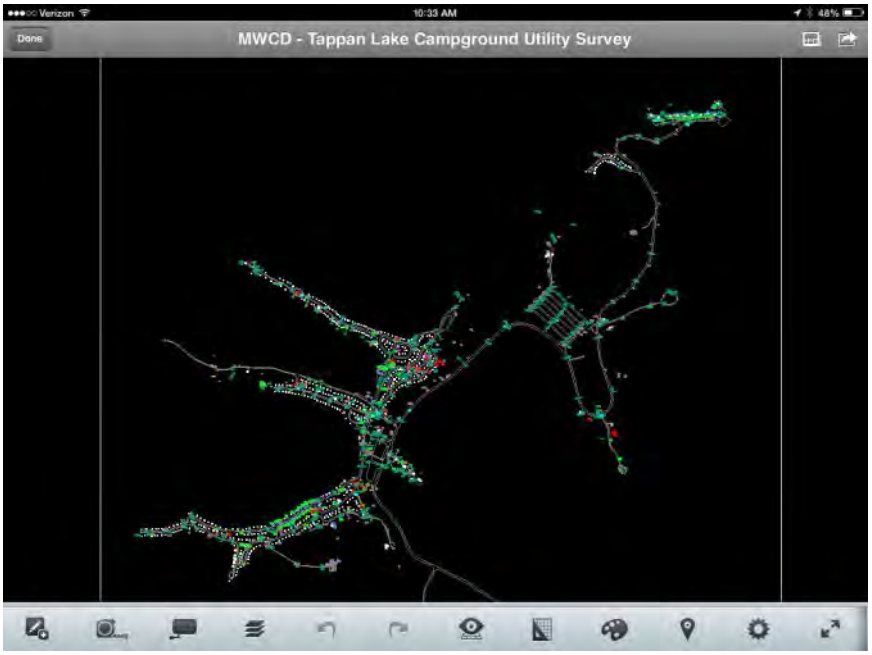

Figure 7: Tappan survey data in AutoCAD 360 software app on an Apple iPAD. This was used during the during on-site QC/QA check by the surveyors (Bodo & Associates, Inc.).

A video recording was taken while driving all of the roads in the park using a GPS enabled video camera called the Contour (Contour 2014). The video and corresponding GPS data is downloaded to the PC and can be viewed via Storyteller software (Bodo 2013). The video (MOV file format) includes a picture in picture screen that shows the location via Google Earth. This was used as part of the QC/QA check and is also another method of reviewing an area when discussing other projects with staff personnel. The software allows you to go directly to a desired location, pause and rewind (figure 8) if necessary.

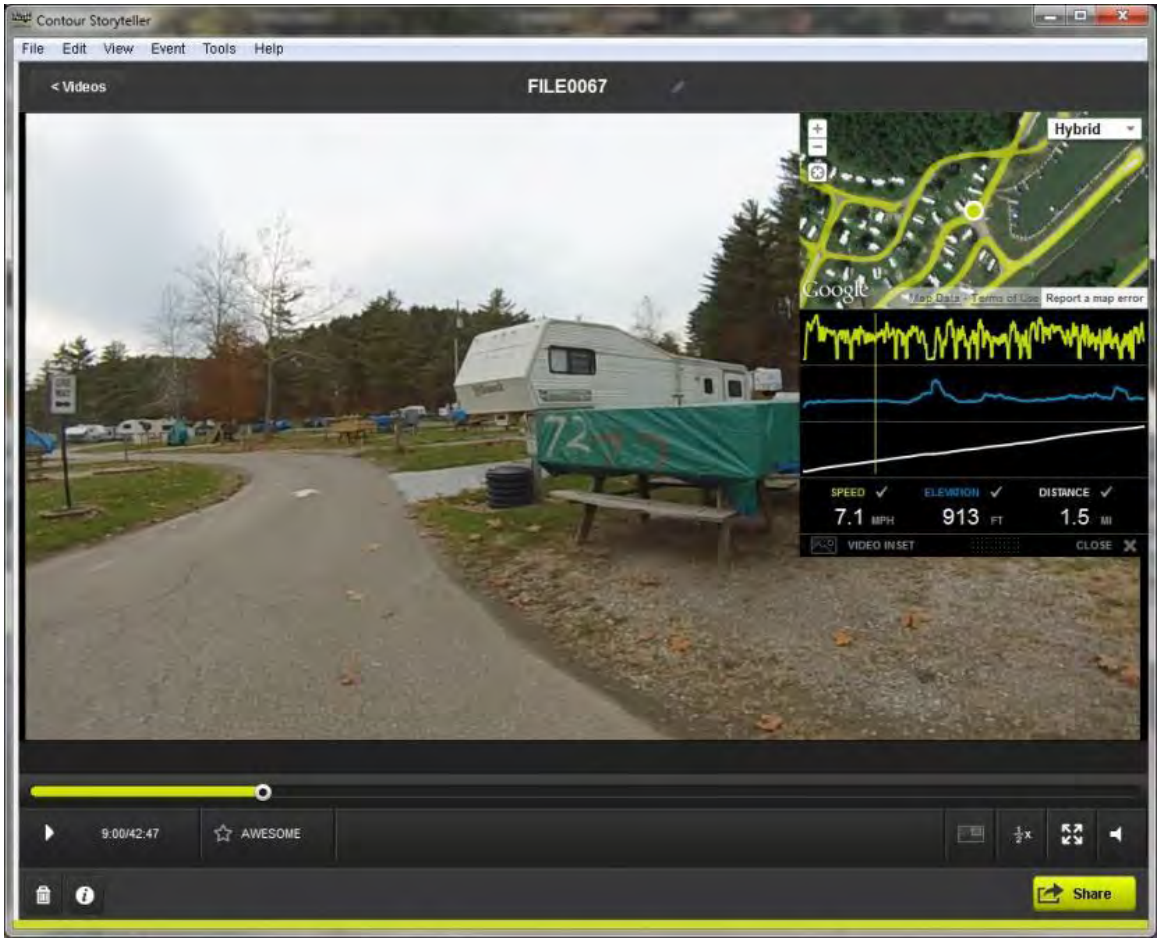

Figure 8: Video of Tappan Lake Park campground taken with Contour camera. The Contour camera has capability to record GPS locations as well. Storyteller software is used to view in office. Video is linked to Google Earth (upper right) to show location of video. By Author (January 2014).

III. GIS Development

Upon delivery of the final survey in AutoCAD, the conversion to a functional GIS began with the creation of the geodatabase. Photographs were taken of the utility components during the survey and the "Attachment" feature was used to link the images in the database (figure 9).

Figure 9: Water service at campsite. Waterline is run into plastic vault and terminated with residential style valve to connect garden hose to a camper. Photograph by Bodo & Associates, Inc.

Individual components and layers were isolated within CAD in preparation for conversion to shapefiles. The shapefiles would then be imported into the geodatabase. Once the data had been converted to a usable GIS format, existing plans were reviewed completing the geometric network. An inventory of all utility related drawing (digital and hard copy) files was performed and existing data from past utility projects and historical plans were scanned and georeferenced. The internal MWCD survey from 2001 was the primary digital file utilized. All of these drawings were reviewed and compared with the final Bodo & Associates survey for final location status. Surveyed components were used in the georeferencing of scanned drawings. This information is used to determine the connectivity among utility features. In addition to using existing utility plans, field verification is sometimes required during this process. Surveyed features are used in conjunction with the existing utility plans to verify line locations from feature to feature (i.e. waterline from valve to hydrant).

The MWCD Utilities Group is tasked with the responsibility of maintaining the water and wastewater systems within the parks. This group has two pieces of equipment useful for locating underground utilities. The first is a utility locator similar to what is used by the Ohio Utilities Protection Service (OUPS), Ohio's "Call Before You Dig" service (OUPS 2014). This will allow the user to connect to a metal pipeline, electric or telephone line and trace the electric current with the detector. This works as long as the operator is able to attach to a metallic component. The second item is a push camera that can be used in any pipe larger than four inches in diameter (figures 10 & 11). The camera unit also gives off a signal that allows the technician to find the location and depth from the surface. Both of these units were used for the survey portion of the project for verification of line locations.

Figure 10: A push style sewer camera in use at a sewer cleanout in Tappan Lake Park. The video camera is linked to a laptop and able to collect images and video. Photograph by Author.

Figure 11: Photograph of 8" vitrified clay sewer pipe taken by MWCD sewer camera. Note the cleanout connection located at the top of the pipe. Photograph by Author.

IV. Implementation

Software

Environmental Systems Research Institute (ESRI) has an extensive suite of GIS programs for use in both the field and office. The MWCD has been using ESRI's ArcGIS products since 2006. It has been the foundation of the parcel mapping portion of the Maintenance Assessment (see appendix A) and has been used on many projects from smaller asset management sub-district projects to simple park maps. ESRI has mobile, desktop and web applications that will be used during this project. The ESRI Desktop programs are more appropriate for generating high quality maps, while the mobile applications are suited for field use during inspections and documentation.

Arc Explorer has been used for several projects in the past by the MWCD. It has an easy to use interface and the software can be downloaded from the web. This is a suitable choice for an end-user with few querying or analysis needs. ArcExplorer users can now use the online version, however Explorer is focused on data exploration and viewing and accepts limited data formats. ArcGIS ONLINE was introduced several years ago as an eventual replacement to ArcExplorer. ArcGIS ONLINE allows many more data formats to be loaded and also incorporates sharing capabilities with other operating systems (Mimami 2011). ArcGIS ONLINE will be the desktop software for the Park Managers.

End-Users - Office

ArcGIS Desktop (figure 12) will continue to be the primary software for the day to day maintenance of the system by the Engineering GIS staff. Implementation for the office end-users such as Design Engineers, Park Managers and non-technical staff in Recreation and Conservation Departments will begin with the use of ArcGIS ONLINE. Custom ArcGIS ONLINE applications will then be developed as needed. Web Applications that are not open to the general public will be placed in the Employee Portal page of the MWCD website that has restricted accessibility. The MWCD website has an ArcGIS ONLINE map imbedded in its shoreline project section (figure 13) for identification of past, present and potential shoreline construction projects. Since the ArcGIS ONLINE platform is cloud based, intranet and IT staffing resources will be reduced as well.

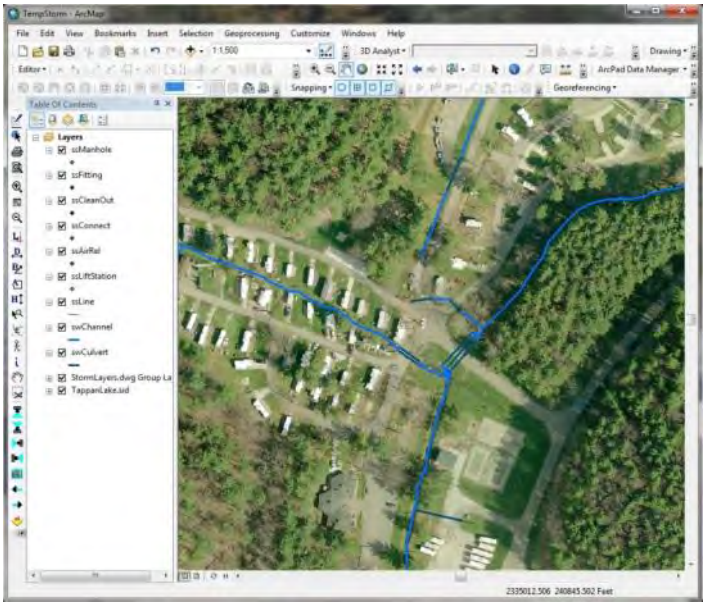

Figure 12: ArcGIS Desktop map of portion of Tappan Lake Park with culverts and drainage channels. Map by Author.

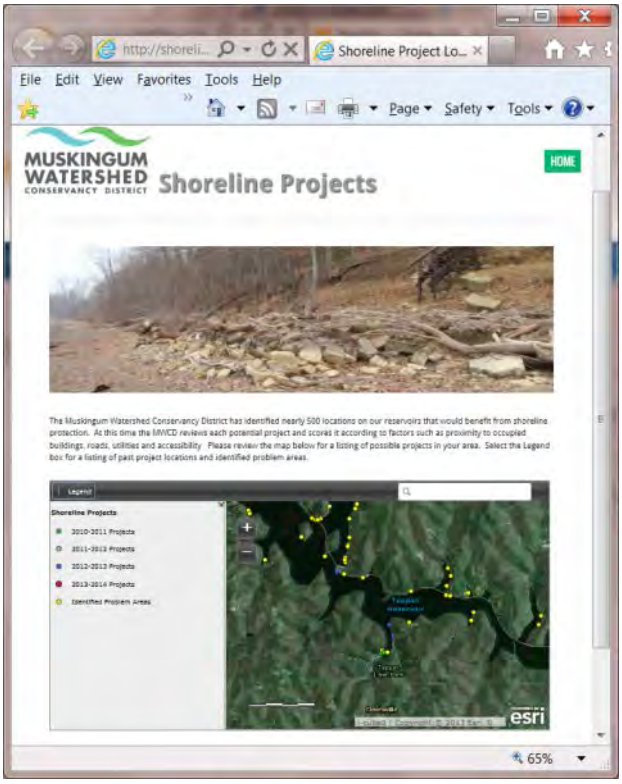

Figure 13: Map created by ArcGIS ONLINE embedded in MWCD website showing portion of Tappan Lake Park shoreline projects. Map by Author (MWCD 2013).

End-Users – Field

End-users in the field will consist of the MWCD Construction Crew, Water and Wastewater Crew and the park maintenance staff. There are several options for locating utilities prior to excavation. The easiest and most widely available will be by smart phone or tablet devices. The ArcGIS Collector app (Android or iOS) works in conjunction with the ArcGIS ONLINE platform (figure 14). Layers and symbology generated in the office (figure 12) are exported to the ArcGIS ONLINE where they can be accessed by the ArcGIS Collector app. The downside of this option is that cell and data service is required. However, cell service and data reliability is improving with additional towers being installed in the rural locations where MWCD parks are located.

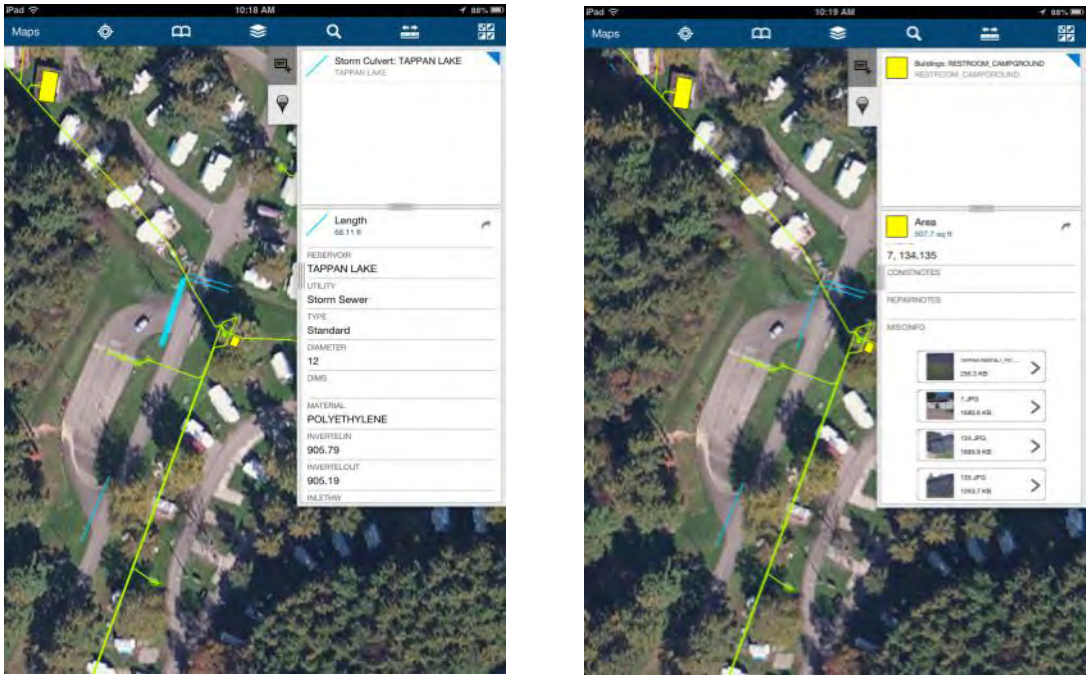

Figure 14: Screen shots of Storm and Building datasets of Tappan Lake Park GIS in ArcGIS Collector app on an iPad. Image on left shows database items. Image on right shows attached photos taken during survey. Map by Author (January 2014).

The ArcGIS Collector app allows the end-user to view and query the data (figure 14) generated in ArcGIS Desktop, allowing access to current and consistent data.

In addition to viewing data, park staff will be able to collect locations and take photographs of any work in progress (figure 15). The data collected by park staff will be for reference only. Photographs and approximate locations will be obtained and uploaded to the ESRI Cloud Server. Once notified, field surveyors will be deployed so precise measurements can be obtained for use in the system.

Figure 15: "Collect a new feature" command in Tappan Lake Park GIS with ArcGIS Collector app on iPad. User can select the item they will add from the list and then select location on screen. Database can then be populated. Map by Author (January 2014).

A second option is the use of a handheld GPS (figure 16) unit capable of 3-5 meter real-time accuracy that will operate ArcPAD or similar software (Painter 2013). These units range in size and accuracy. The data can be installed in the onboard memory which eliminates the need to be connected to the internet. If improved accuracy is desired the unit can be linked to the Ohio Virtual Reference Station (VRS) via a cell phone with digital connection (Painter 2013). This sends Real-Time Kinematic (RTK) corrections to the GPS signal and sub-meter locations can be achieved. This is a better option for the more frequent GIS user that will be collecting data; however the ArcPAD software is less user-friendly and can be intimidating to the casual GIS user.

Figure 16: Trimble GeoExplorer handheld GPS unit. Unit typically has Windows Mobile OS with ESRI ArcPAD. (Trimble USA)

The final and most accurate option will be staking out the utility locations with a survey crew. Utilizing the newly placed control monumentation (figure 5) and utility line coordinates obtained from the GIS, survey crews will be able to stake out locations using GPS or conventional methods (figure 17). If the data are available, depths will also be provided. This will also be the method of choice when collecting data during new projects or when existing utilities are uncovered during an active project.

Figure 17: Surveyor's total station and data collector placed over control point in MWCD campground. Photo by Author.

Training

The office staff at the MWCD is proficient in ArcGIS applications. Additional training will be done in-house for the non-GIS end-users. Training is imperative for the success of this project. End-users must be comfortable with the technology or it will not get used. Engineering and Recreation training sessions at the management level will be done at the Main Office with future sessions at the parks. Training for the parks will include the Park Manager, Assistant Park Manager and Lead Park Technician. An android tablet device with cell/data plan for internet access using ERSI's ArcGIS Collector app will be used for the first park. This is planned during the winter months when there is less demand on park staff. Upon completion of training for the office and park staff, the engineering dirt and utility maintenance crews will then receive training. A user manual is currently being completed for the use of the AcrGIS Collector app.

V. Benefits, Conclusions, and Lessons Learned

Benefits

The benefits of a fully operation GIS program within an organizations are multi-fold. The MWCD's problems focused around knowledge of utility locations and how to not lose that information once it is obtained. Below are three primary benefits that will be realized by the MWCD GIS program.

Limit duplication of data capture and maintenance – Once data is collected and documented, it can be used for additional projects without repetition of survey work. Data will be stored in a central location for all personnel to access. This will provide a cost and time savings for future projects.

Consistency with multiple parks – Standardized layers, symbology and data collection methods will be employed at all five parks. This will allow MWCD staff (Engineering Dirt and Utility crews) that travel to all parks to develop a familiarity with a system once. It is also not uncommon for park staff to transfer or be promoted to positions in other parks. Standardization of this system will help in orientating these employees to new environments and utility systems.

Education and transfer of Knowledge – The MWCD suffered from tight financial constraints from the late 1990's until 2011 when the oil and gas revenues began (see appendix A). The Engineering Department did not have the ability to rehire staff that had been with the organization for decades. This resulted in a large loss of institutional knowledge followed by a slow recovery for existing staff. The development and maintenance of this system, along with steady funding, will ensure the information will be around for future employees.

Survey Consultant Communication

As this project progressed there were several items identified for improvement. One area for improvement was to better review the final intended use of system with the survey consultant. Even though the client, MWCD, was taking the AutoCAD data from the consultant and manipulating it into a more user-friendly GIS format, the method of data collection needed to be reviewed closely. Deliverables need to be well defined such that the conversion from drawing files into shapefiles or geodatabase is seamless. Consistent use of symbology and layer naming can aid in the conversion process. This is also important when determining identification methods while collecting photos for a project of this magnitude.

Internal Communication

Communication between Engineering and Recreation Departments was maintained during this project; however, it could be improved. Park staff should receive updates on the project progress. They will be the primary users and will have useful ideas and opinions. In addition to planning, success of a GIS project relies heavily on the satisfaction of the end-users. It has been the author's experience that increased use equals increased chances of success for a GIS project.

The park staff will utilize this system more than any other department and technical skills vary by individual. As the online options are developed recreational staff will play a vital role. This will occur during the off-season when the demand decreases on their schedules.

Project Schedule

Fieldwork for this project was conducted in the summer. Future survey work in the parks will be completed in the late fall or early spring when less campers are present. Some of these problems were avoided by scheduling fieldwork to be performed only during Monday-Thursday to avoid disruption to campers.

Future Option

A future option for the MWCD Enterprise GIS will be the incorporation of work order management software to be linked with the GIS. Work orders can be generated and issued to appropriate staff. Repairs can be tracked and reviewed by managers. Equipment purchases can also be documented for review and approval by the Finance Department and the Engineering Project Accountant.

References

Publications

Jenkins, H. (1976) *A Valley Renewed, The History of the Muskingum Watershed Conservancy District.* The Kent State University Press.

Saine, A. (2012, Fall) Town Sharpens Proactive Sewer System Management. *ArcNews,* vol. 34, p. 37.

Buckley, A. (2012 Summer) Designing Great Web Maps. *ArcUser,* vol. 15, p.50.

Internal MWCD documents

Burke, T. (2000) *Needs Assessment and Feasibility Study for Muskingum Watershed Conservancy District,* Peak Geo-Design, Inc.

Schreiner, B. *1997-2004 GIS Group files*, former Docks and Marinas Coordinator – MWCD, Retired 2011.

Websites

Autodesk. (2013) *Home Page*, Retrieved Dec. 15, 2013 from http://www.autodesk.com/

Contour. (2014) *Home Page*, Retrieved Mar. 4, 2014 from http://contour.com/

Diethorn, B. (2005) *Coordinating National Park Management with GIS.* Retrieved Sept. 2, 2013 from http://www.nps.gov/gis/odyssey/2006/thursday.html

Environmental Systems Research Institute (ESRI). (1998) *ESRI Shapefile Technical description*, Retrieved Dec. 15, 2013 from http://www.esri.com/library/whitepapers/pdfs/shapefile.pdf

Environmental Systems Research Institute (ESRI). (2013), Retrieved Dec. 15, 2013 from http://www.esri.com/

Turner, T. (2008-9) *Mapping and Managing Potable Water Infrastructure Assets.* ArcNews Retrieved Oct. 15, 2013 from http://www.esri.com/news/arcnews/winter0809articles/mapping-and-managing.html

Minami, M. (2011) *ARCGIS ONLINES VS ARCGIS EXPLORER ONLINE,* ArcGIS Resources Retrieved Nov. 18, 2013 from http://forums.arcgis.com/threads/36353-ARCGIS-ONLINES-VS-ARCGIS-EXPLORER-ONLINE

Mayo, M. (n.d.) *Enhancing Water Department Efficiency - Using GIS and GPS to produce quality maps of rural water system features*. ArcUser Retrieved Oct. 15, 2013 from http://www.esri.com/news/arcuser/0408/bamah2o.html

Muskingum Watershed Conservancy District (MWCD). (2013) *Shoreline Projects.* Retrieved Dec. 10, 2013 from http://www.mwcd.org/pages/flood-reduction-and-conservation-stewardship/conservation/shoreline-projects/interactive-shoreline-project-map

Ohio Utilities Protection Service (OUPS). (2014), Retrieved Jan. 10, 2014 from http://www.oups.org/

Hamil, D. (n.d.) *Your Mission, Should You Choose To Accept It: Project Management Excellence.* GeoCommunity Retrieved Oct. 15, 2013 from http://spatialnews.geocomm.com/features/mesa1/

Projects 2009 - GPS/GIS Asset Inventory Chippewa Subdistrict – Muskingum Watershed Conservancy District Retrieved Oct. 10, 2013 from http://chippewa.mwcd.org/html/at_work/2009_cap_inv_GIS.htm

GIS Program – Role & Function. National Park Service – U.S. Department of the Interior. Retrieved Oct. 10, 2013 from http://www.nps.gov/gis/gis_program/role.html

Interviews

Barnhart, S. Chief of Recreation – MWCD. Personal Interview. June 13, 2013

Bodo Jr., D. Survey Chief – Bodo and Associates, Inc., Personal Interview. November 7, 2013

Carpenter, R. – President Accurate Technologies, Inc. Personal Interview. August 7, 2013

Hoffer, J – Tappan Park Manager – MWCD, Personal Interview. June 20, 2013

Little, D. – Project Engineer – MWCD, Personal Interview. May 7, 2013

McGlothlin, J. – Seneca Park Manager- MWCD, Personal Interview. June 13, 2013

Painter, M. – Trimble Sales – Precision Laser and Instrument, Inc. June 18, 2013

Rekstis, M. – Assistant Chief Engineer – MWCD, Personal Interview. May 7, 2013

Slogar, B. - Assistant Chief Engineer – MWCD, Personal Interview. May 6, 2013

Taylor, G. – Utilities Coordinator – MWCD, Personal Interview. May 7, 2013

Warner, J. – Utilities Technician – MWCD, Personal Interview. May 7, 2013

Appendix A - Project Funding

Maintenance Assessment: In 2009 an assessment was levied to the property owners in the MWCD jurisdictional region. This assessment is based on storm water runoff calculated by impervious and pervious areas. Monies generated by this are used as the local cost-share with the Corps of Engineers for Dam rehabilitation and various MWCD managed water quality and shoreline rehabilitation projects. None of this money can be used for recreational projects.

Oil and Gas: The development of Marcellus and Utica Oil and Gas reserves has reached our region of the United States. The signing of several oil and gas leases have allowed us to address our aging park facilities and deferred maintenance projects. This will include items such as updating electrical service to 50 amp service for larger RV's and adding activities such as water features and zip lines to attract a larger audience.

These two financial impacts to the MWCD over the past five years have allowed us to increase our projects. We have expanded our projects list and started updating park infrastructure. These projects are called our “Deferred Maintenance” projects. The mapping of park utilities is one of those projects. We have been working with a large engineering design firm to work on a Master Plan for the expansion of all our parks. The mapping of our facilities will play a large part in the success of these future developments.

Additional funding and projects bring new problems. Staffing has increased and projects are being completed at a much faster rate. We now have to closely monitor all the work being done. The Engineering Department has expanded to thirteen full-time staff (Chief Engineer, Assistant Chief Engineer, Program Manager, Project Engineer, Surveying/Facilities GIS Manager, GIS Specialist, Construction Project Manager, Project Coordinator, Lead Inspector, Project Accountant, Survey Technician, Cad Technician and Administrative Assistant) in the Engineering Department. This does not include the Dirt Crew (four people), the Water Utilities personnel (five people), a Survey Intern and one part-time Construction Project Inspector.

Appendix B – Survey Scope, Letter of Interest (LOI) and Request for Proposal (RFP)

TO: Prospective Surveying Firms

FROM: David G. Lautenschleger, P.S., GISP, Surveying/Facilities GIS Coordinator
Muskingum Watershed Conservancy District

DATE: 5/10/13

RE: Request for Letter of Interest / Proposals
Surveying Services
Tappan Lake Park Utility Surveying

RESPONSE DUE: 5/17/13 (LOI)
5/31/13 (RFP)

The Muskingum Watershed Conservancy District (MWCD) Engineering Department is soliciting a surveying firm for the above referenced project. We have reviewed the consultant qualifications on file, and your firm meets the criteria required for this project. This solicitation consists of 2 steps:

1. Letter of Interest (LOI) – Indicate in writing you firms' interest in the project, and your availability to perform the work. All firms responding positively to the LOI are welcome to submit a proposal.

2. Proposal – Provide a proposal as indicated herein. The District intends to select the surveying consultant based on the content of the proposal and associated evaluation criteria.

Overview

The Muskingum Watershed Conservancy District is beginning the process of surveying and documenting our infrastructure for the implementation of an Enterprise GIS. Tappan Lake Park has been selected for this project. This park is located in Harrison County, Ohio. The survey for this project includes the developed areas of the park which consist of approximately 124 acres. The lake is 7.5 miles west of Cadiz on U.S. 250; take County Rd. 55 (Deersville Rd.) to Tappan Lake Park. Tappan Lake Park has 571 campsites. 25 are full hook-up with electric, water and sewer. 490 have electric only and the remaining sites are primitive without any hook-ups. Waterlines run throughout the park with spigots to be used every several camper lots.

Project Scope

The project will consist of locating all building structures (including pavilions) and utility components within the campground and public areas associated with the park boundary.

Features to be located:

- Approximately 34 permanent structures (park office, maintenance buildings, cabins, etc.)
- Storm drainage structures with inverts
    - Culverts/headwalls
    - Manholes
    - Catch Basins

- Sanitary Structures
    - Manholes (inverts)
    - Clean-outs
    - Camper pad sewer hook-ups(flush with ground)
    - Gray water dump stations
- Water Items to be located at camper pads
    - Fire hydrants
    - Water valves
    - Water hook-ups (flush with ground)
    - Water spigots (a.k.a. stick hydrants)
- Electrical
    - Meter boxes/satellite boxes (elevations not required)
    - Camper electrical hook-ups (elevations not required)
- Natural Gas
    - Valves
    - Markers
    - Meters

Available Information:

- Maps in digital format with the following information:
    - Survey boundary and Campsites (shapefiles or dwg)
    - Aerial Photography (Pictometry from 2010)
- MWCD CAD file with title block and layer naming standards
- List of campsites with utility service types

See end of document for sample images of features to be located.

Concrete Monument Specifications

Survey monuments to be placed in 12-14 locations as agreed upon by consultant and MWCD staff. The following datum will be used on all mapping and/or location data provided to MWCD: Horizontal: State Plane Coordinates – Ohio North Zone 1983(86) US Survey Foot, Vertical: *NGVD29*. Closure standards for both Horizontal and Vertical shall meet NGS, Second–Order, Class II. Monuments shall follow the following specifications.

Aluminum Concrete Monument

- Berntsen International, Inc. part no. C35D
    - "MUSKINGUM WATERSHED CONSERVANCY DISTRICT" on top rows and "DO NOT DISTURB" and "SURVEY MONUMENT" on bottom.
    - Triangle with point in center
- Mounted in 10" diameter hole, 42" deep as per attached diagram.

Carsonite Witness Post

- Berntsen International, Inc. part no. CBM7204SM110
  - "MUSKINGUM WATERSHED CONSERVANCY DISTRICT" on top rows and "DO NOT DISTURB" and "SURVEY MONUMENT"on bottom.
- Witness post to be placed within three (3) feet of monument. Locations of witness posts to be determined by surveyor and MWCD.

Working Limitations

Due to the nature of this project we recommend for the safety of your personnel working on Monday thru Thursdays, 10 hours day. This will eliminate the problems from additional traffic on Fridays and weekends. Survey crews wear reflective vests and place "SURVEY CREW WORKING" signs on roadways where work is being performed.

The MWCD does not allow or have designated ATV trails. Due to the nature of the project, we will permit UTV or Side by Side vehicles to be used. While using said vehicle please remain on MWCD property.

Contract Type To be determined

Deliverables and Schedule

Once the survey is complete and the first draft map is provided, 90% of the agreed upon fee will be paid. MWCD personnel with perform a walk-through of the project and create a punch-list of any remaining items to be located. Remaining 10% to be paid upon completion.

1. Technical Proposal / Selection: May, 2013
2. Authorization to Proceed: June, 2013
3. Data sheets with all monument coordinate information in MS Excel format.
4. Digital (AutoCAD ver. 2010 or newer) file to be referenced to Ohio State Plane Coordinates (NAD83/86) with MWCD layering conventions.
5. AutoCAD file to have elevation labels for manhole and culvert inverts.
6. Raw data file in comma delimited text file format.
7. FIRST DRAFT ITEMS TO BE DELIVERED ON OR BEFORE AUGUST 2nd, 2013.
8. PUNCH LIST ITEMS TO BE COMPLETED BY AUGUST 27th, 2013.

Sample Items

Electrical Junction boxes

Electrical Pedestals at Campsites

Stick-built Frost free
Hydrant w/drain

EPA Approved Frost free
hydrant with valve

Murdoch Style Frost free
Hydrant w/drain

Dump station

"Gray water" dump station

Water hook-up "vault" at campsite

Sewer hook-up at campsite

A. Instructions for preparing and submitting a Request for Proposal

1. Provide the information requested for the Request for Proposal content, in the same order that they are listed below

2. Proposals shall follow the Request for Proposal Content format specified herein and consist of no more than six (6) one sided 8 1/2" x 11" pages. Minimum 11-point font.

3. A signed cover letter may be included exclusive of the page limit. A cover page is also permitted in addition to the signed letter (exclusive of the page limit).

4. Include a copy of the firm's current Professional Liability statement (exclusive of the page limit).

5. Include 3 copies of the Proposal in the submission.

B. Request for Proposal Content

1. Background: Provide a brief and concise history of the firm listing corporate officers, general experience and specific capabilities. Indicate any qualifications that may apply to this project. State the location of the office in which each component of work for this project will be accomplished or originate. (1 page maximum)

2. Project Team Experience: Identify the project manager, project team and any technical specialty personnel. Include education and expertise for the technical lead performing the work. List relevant experience of the project manager and technical lead. (2 page maximum)

3. Project Experience: Provide a listing and description of similar projects performed by the project team within the past 5 years. Include critical project elements and applied solutions relevant to this project. Provide 3 client references other than the MWCD with which your firm has completed similar services in the last 3 years. (2 page maximum)

4. Project Understanding and Approach: Identify your understanding of the project. Discuss your methodology for solving project issues such as data collection and your approach. Indicate your survey team's availability and approach to meeting the project schedule. (1 page maximum)

C. Selection Criteria

Submittals will be ranked according to the following criteria:

1. Background: (20 Points)
    a. Company services applicable to project (scoring 1-10)
    b. Location of office where majority of work will be performed within Muskingum Watershed

Yes	5
No	0

    c. MWCD staff experience with firm (1-5)

2. Project Team Experience: (20 Points)
    a. Project Manager (scoring 1-10)
    b. Survey Crew (scoring 1-10)

3. Project Experience: (20 Points)
    a. Similar Project Experience (scoring 1-10)
    b. Client References (scoring 1-10)

4. Project Understanding and Approach: (20 Points)
    a. Understanding of Surveying Conditions (10 points)
    b. Methodology (10 points)

D. Proposal Submittal

Proposals shall be submitted no later than 4:00 PM on the response due date listed above. Submittals and questions shall be made to the attention of:

David G. Lautenschleger, P.S., GISP
Surveying/Facilities GIS Coordinator
Muskingum Watershed Conservancy District
1319 Third St. NW
PO Box 349
New Philadelphia, Ohio 44663-0349
330-343-6647 x2246
davidl@mwcd.org

Firms not interested in being considered for this project are requested to respond in writing. Responses received after the above deadline will not be considered.