

Rapid Stormwater Feature Data Collection--Experience in Automation

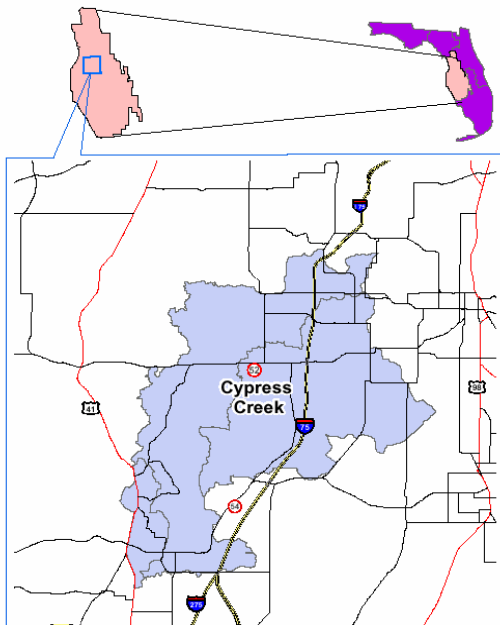
¹Prachee Gupta, ¹Yoav Rappaport and ²David Arnold, P.E

Abstract

The Southwest Florida Water Management District is performing watershed management plan for several watersheds within its jurisdiction, including the Cypress Creek Watershed. Several engineering consulting firms have been retained to develop the plans, including Parsons for the Cypress Creek watershed plan. This watershed is currently a mostly rural watershed but with a rapidly growing population. Hydrologic and Hydraulic (H&H) characterization of the watershed is necessary to establish current conditions and make recommendations for future development. In order to speed up data collection of Stormwater features, ArcPad 6 has been customized, placed on a Trimble GeoXM handheld GPS. Customized Visual Basic Scripts have been created to automatically capture location data and create a unique structure ID. Other scripts perform data validation and automatically move between tabs. VBA code in Access then automates the report generation which combines photographs taken in the field with the GIS data. These individual reports are then hyperlinked to structure locations in ArcMap. Automation in the field and office allow for rapid H&H model development with rich content.

Introduction

Half of Florida (15 million acres) is covered in diverse forest ecosystems that contribute over \$16 billion per year to the State's economy. Forested landscapes and wetlands play a critical role in aquifer recharge and fresh water, marine and estuarine ecology. The forest,



agricultural and marine industries in Florida, including recreation and tourism, are significantly impacted by hydrologic cycles. Acknowledging the importance of water quality and quantity, the state created Water Management Districts (WMD) to better manage Florida's water resources. The WMD's and other state agencies now manage nearly three million acres of land. Among Florida's five districts, Southwest Florida Water Management District (SWFWMD) manages about 10,000 square miles of south western region of Florida (6,400,000 acres). The water resource management responsibilities issues include water supply, flood protection, water quality and Natural Systems. In this effort SWFWMD has established comprehensive watershed

management plans that employ the watershed based approach to water and related resource management. In this paper, Cypress Creek watershed is used as a case study

(Figure 1). The watershed is primarily rural and encompasses approximately 102,400 acres. A preliminary step towards completion of a watershed management plan is to identify the existing hydraulic structures within the watershed. A field reconnaissance survey is conducted for this purpose. Field reconnaissance consists of driving and/or walking the accessible hydraulic drainage features of the watershed to record drainage patterns, map drainage facilities, measure facility dimensions, inspect the condition of the drainage facility in the field, and assemble a photographic log of the drainage facility. Upgrade and management of the photographic log, and documentation and representation of the data collected are the challenges that are faced during this task completion. To augment these issues, Parsons developed visual basic application in ArcPad and Microsoft Access for data collection and representation respectively.

This paper provides an overview of how the integration of ArcPad and Microsoft Access with GIS geodatabase is used to facilitate these procedures. Minimizing the manual errors and time consumption for creating and managing databases are the key features of these applications. The paper concludes with the advantages, disadvantages and limitations of the application and future enhancements that can be provided to the script.

Field Reconnaissance

Potential places where hydraulic features may exist are identified before the field visit, using the available information such as topographic images, contours and spot elevations, roads and existing network coverages. The field reconnaissance is conducted with GPS receiver that records the horizontal coordinates of the hydraulic feature as they are identified and examined. The information received in the field reconnaissance is assembled and incorporated into the hydraulic inventory database. ESRI ArcPad 6.0 has been customized to aid in this process. It facilitates the collection of Stormwater features including feature type such as culvert or weirs, related approximate dimensions, structure condition like vegetation growth and maintenance requirement. A unique hydraulic ID is assigned to each unique hydraulic feature location with respect to the Section Township and Range it falls in and the survey point number within that section (this section ID number is assigned by the user). For example, if in Section-Township-Range 12-21-20 and, ArcPad is performing hydraulic inventory for the first structure, the hydraulic ID that ArcPad application assign to the point would be 122120_001 ([Section]-[Township]-[Range] _00 [Structure Number]). A complete description of this application is explained in details in later sections.

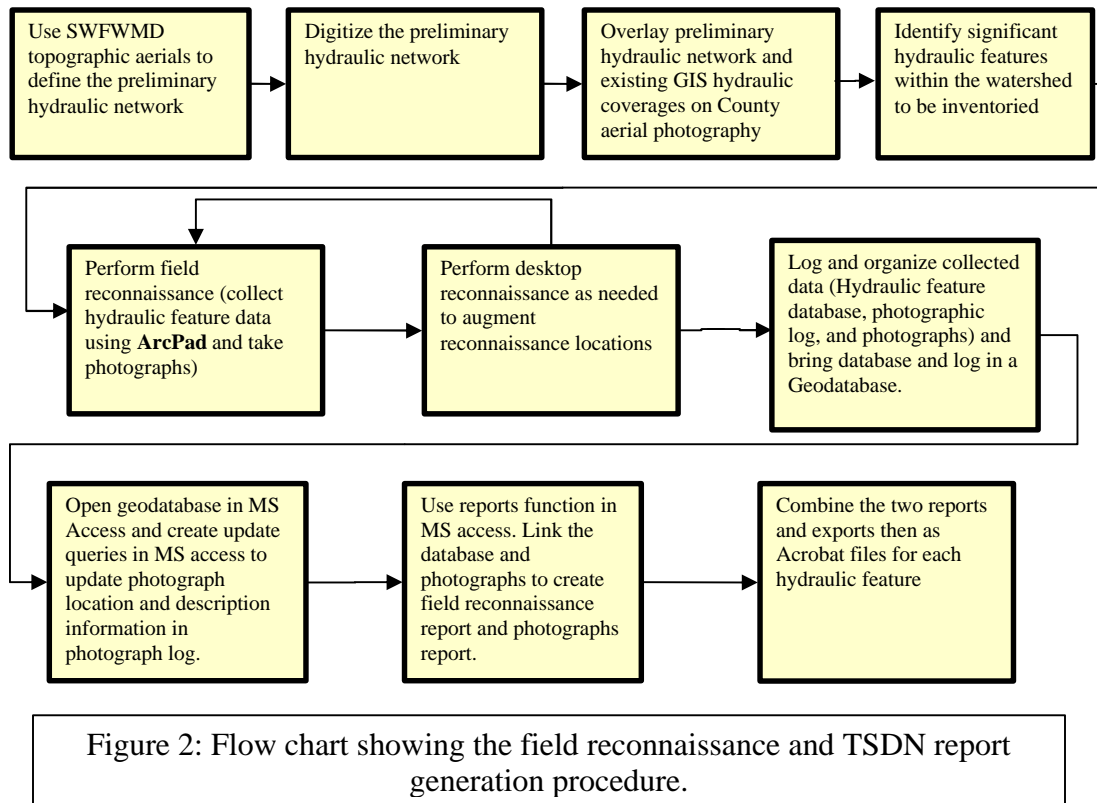


Figure 2: Flow chart showing the field reconnaissance and TSDN report generation procedure.

Digital photographs were also taken of each of the inventoried hydraulic feature. These photographs are renamed according to the SWFWMD Guidelines & Specifications (G&S) and logged into a database for cross referencing. For each photograph taken, the Hyd_ID, feature type, location/description and orientation are all recorded in the photograph database. This database along with photographs and ArcPad hydraulic feature database is used to create the structure documentation data sheets in support of FEMA's TSDN (Technical Support Documentation Notebook) per SWFWMD G&S. To create these documents, first the inventory database obtained from ArcPad is synchronized with the existing shapefile. This shapefile is brought into a geodatabase feature class using simple Arc Catalog functions. The advantage of working in a geodatabase is that it provides relational database functionality to the feature classes. Geodatabase can also be opened in Microsoft Access, which enables use of Access functionalities like simple and update query functions and reporting tool for managing and documenting the database. Similarly, a photographic log manually created can also be imported into the same geodatabase to enable link between the hydraulic feature information, photographic log and photographs.

Figure 2 shows the flowchart describing the field reconnaissance and TSDN report creating procedure. An application is created in Microsoft Access that uses feature class data and access queries to generate SWFWMD specified report formats (TSDN) and export them as individual Acrobat files per hydraulic ID. These TSDN reports consist of the hydraulic feature information collected using ArcPad and the photographs associated

with it. An example of the report created is shown in *Figure 3*. These Acrobat files can be directly hyperlinked with the hydraulic inventory shapefile in an Arc Map.

Hydraulic Feature Evaluation Form (07/2002)

Date: 2/2/2005 Firm: Parsons Corporation

Evaluator: Daniel

HYD_ID 102619_014

General Hydraulic Feature Type: Reinforced Concrete Pipe System Scale: _____

Location: STR 102619 Horizontal Datum HARN83 Vertical Datum NAVD88

Horizontal Units Feet ; Vertical Units Feet ;

Coordinate System HARN State Plane ; Northing 1418891 ; Easting 530277

Location Description:
Lexington Oaks Rd., 1 mi W. of Wesley Chapel Blvd.

Notes: _____

Plastic Culverts: Number ___ Height (Approx.) _____ (in) Width(Approx.) _____ (in)
End Treatment _____ Silted _____ Crushed _____
 Reverse Flow Control Need Maintenance Wing Walls Headwall

Metal Culverts: Number ___ Height (Approx.) _____ (in) Width (Approx.) _____ (in)
End Treatment _____ Silted _____ Crushed _____
 Reverse Flow Control Need Maintenance Wing Walls Headwall Rusted

Concrete Culverts Number 1 Height (Approx.) 30 (in) Width (Approx.) 30 (in)
End Treatment Mitered Silted Mild
 Reverse Flow Control Need Maintenance Wing Walls Headwall

Channel or Ditch: Type _____ Location _____
Vegetation _____ Bank _____ Accessibility _____
 Erosion Lined Slough Need Maintenance Trees

Bridge Vegetation _____ Silted _____
 Slough Wing Walls Need Maintenance Scour

Weirs: Weir Type _____ Need Maintenance

Lake, Pond, or SMA: Storage Type _____ Water _____
 Need Maintenance Vegetation

DESCRIBE REQUIRED MAINTENANCE AND ACCESS REQUIREMENTS:








Figure 3: The TSDN for Hydraulic ID 102619_014 showing ‘Hydraulic feature’ properties and photographs.

ArcPad 6.0 Customization

ESRI ArcPad 6.0 has been customized to aid in the collection of stormwater features based on the SWFWMD G&S for the watershed management program. The application resides on the Trimble GeoXM handheld GPS with meter horizontal accuracy, using WAAS GPS real time position correction technology. The unit is suitable for rapid field reconnaissance, though not for surveys requiring good vertical control.

A hydraulic inventory point shapefile that consists of the potential hydraulic feature locations is created before the field visit. These locations are identified on the basis of available information including roads, contours, spot elevations, existing network and subbasin coverages and USGS Digital Ortho Quarter Quadrangles (DOQQs). This point shapefile is placed in the ArcPad along with the roads, existing network shapefiles and DOQQs that help in recognizing the location of the hydraulic feature. On locating the feature in the field, the field reconnaissance point associated with the location is edited using a toolbar that has been added to the standard ArcPad application (*Figure 4*). The new tool is an aid for GPS data capture in the field to populate the feature table. The data entry form has seven tabs: Storm Feature, CMP, RCP/RCBC, Channel, Bridge, Storage, and Weir (*Figure 4*). A series of pick-lists radio buttons, and text entry windows have been programmed to help with automation, data standards and speed of field data acquisition. Customized VBS (Visual Basic Scripts) have been created to

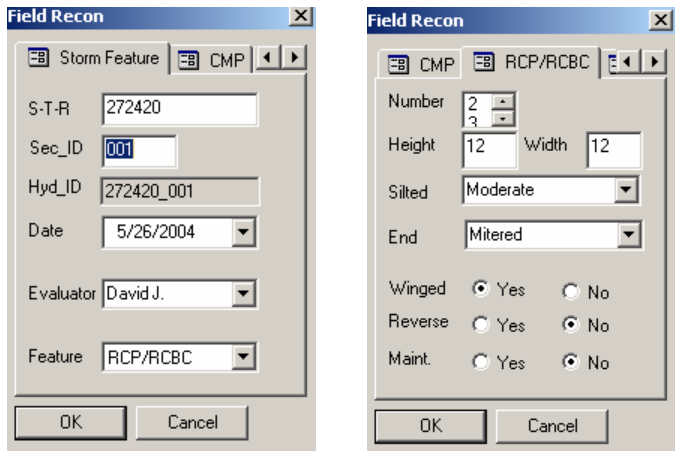
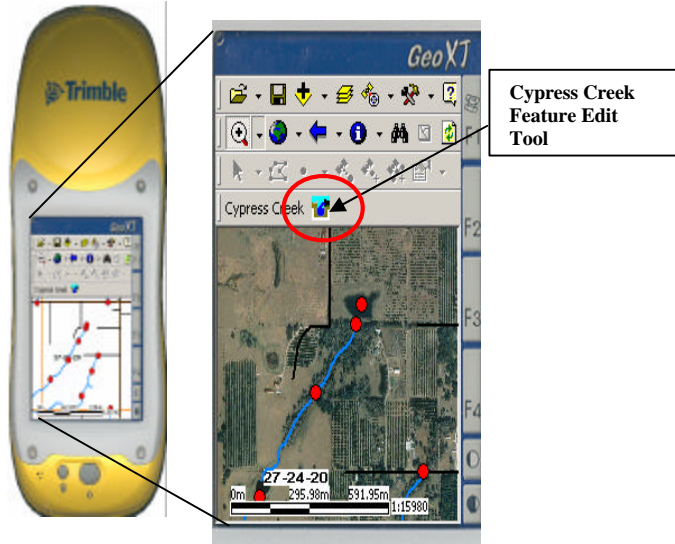


Figure 4: Tool created in ArcPad 6.0 for GPS data capture. RCP/RCBC feature type is shown as an example.

automatically capture the Section, Township, Range and combine with user defined ID to form the Hydraulic ID (Hyd_ID). Also scripts perform data validation and automatically move between tabs.

Creation of Microsoft Access Database and Report Generation

The shapefile with the hydraulic inventory information and Hyd_IDs are imported into a Geodatabase feature class using Arc Catalog export function. This Geodatabase is opened in Microsoft Access to enable standard and update query functions, and reporting tools. Microsoft Access update queries are created for each structure type to add additional fields and update the information to satisfy the specifications of SWFWMD. This information includes the photograph description for each structure type that is included with pictures in the TSDN reports (*Figure 3*) and the location of photographs on desktop

(jpg files). This hydraulic structure information and photograph log is used to create Microsoft Access reports for hydraulic structure information and photographs information. The hydraulic structure information report contains a page for each row (each hydraulic structure of field reconnaissance point) and photographs report contains one to three pages (depending on the number of photographs) for each row. A Visual Basic script has been written to enable the report generation for each hydraulic structure (or hydraulic ID, Hyd_ID). This script reads each row, one at a time, in the field reconnaissance database and extracts the related information from the access. The common attribute among the two databases is the hydraulic ID (Hyd_ID). These extracted reports are combined by the program using the acrobat distiller to generate acrobat files (.pdf) for each hydraulic ID. It then renames each of these files with respect to the individual Hyd_IDs they are associated with.

While generating these reports, the program uses access standard queries to identify the Hyd_IDs for which the associated photograph log does not exist in the photograph log database. Program also identifies missing photographs (.jpg files) by comparing the field reconnaissance Hyd_ID and the photograph names. These checks help user to identify the manual errors and or missing database problems before generating the TSDN files which can save a significant amount of time.

By automating the data collection and documentation requirements of field reconnaissance users can reduce the possibility of human errors such as mixing of information for different Hyd_IDs, incomplete notes on available information, standardization of feature type and condition types, and inaccurate location of hydraulic structure. Automation also generates an easy way to upgrade database and generate reports. Need for manually checking for errors reduces and it enables user to hyperlink the documents with the field reconnaissance shapefile in ArcMap. These TSDN reports also provide the basic information required to identify the location for a subsequent professional survey.

Type	Survey Cost	Field Reconnaissance Performed (Cypress Creek)		Professional Survey Required (Cypress Creek)	
		Locations	Cost Estimate	Locations	Cost Estimate
Structures	\$300 - \$400	812	\$243,600 - \$324,800	287	\$86,100-\$114,800
Ponds	\$700-\$800	123	\$86,100 - \$98,400	0	0
Cross Section	\$700-\$800	100	\$70000 - \$80,000	42	\$29,400-\$33,600
Others	\$300-\$400	41	\$12,300-\$164,00	0	0
	Total	1076	\$412,000 - \$519,600	329	\$115,500-\$148,400

This methodology also identifies appropriate locations for professional survey. For example, in the Upper Cypress creek subwatershed the number of survey locations identified from desktop reconnaissance alone (The process in which survey locations are identified from the available topographic information, road and preliminary network coverages, and other available desktop information like Environmental resource permits (ERP) and roadway plans) were 1,076. These are the locations for which field reconnaissance is performed and TSDN tables are created. Out of these 1,076 locations,

only 329 locations were identified as requiring professional survey locations after field reconnaissance. This represents a significant cost saving for the project. Similarly for another watershed in the SWFWMD area, Eastern Hernando County Withlacoochee watershed, 714 field reconnaissance locations were visited and 239 locations were identified as requiring professional survey. For both these watersheds, field reconnaissance resulted in a 70% reduction in sites identified for field survey versus desktop techniques alone.

For every survey location in the watershed, the cost of professional survey costs range from \$300 to \$800 depending of the survey type (structure, ponds or cross sections) and the survey firm (*Table 1*). For Upper Cypress Creek subwatershed for example, the estimated total saving for survey alone range from \$296,500 to \$371,200.

Conclusions

The new tool created for use with ArcPad 6.0 assists in GPS data capture in the field. This application provides an easy and faster means to update the field reconnaissance information and link related photographs used for locating potential survey locations. This application together with the documentation and data update functions created in Microsoft Access provides a complete data collection, upgrade and documentation requirement of field reconnaissance. The estimated total savings on identifying an efficient field survey plan for Cypress Creek Watershed is in the range of \$296,500 to \$371,200. Since photographs and the field reconnaissance information is linked on the desktop rather than in the field, a possibility of error when naming the photographs and creating a photographic log exists. To reduce these errors the photograph name and photographic log is updated on a daily basis. Also, the Microsoft Access application provides information regarding the missing photographs or incomplete photographic log in the database. The major future enhancement may include integrating a camera with ArcPad. This will eliminate the wasted time in naming and creating the photographs and photographic log respectively, and thus reduce error. The modified ArcPad application should automatically store multiple photographs information with the associated field reconnaissance location, and receive the image from the camera.

Acknowledgement

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Authors

¹Prachee Gupta, Prachee.Gupta@parsons.com

¹Yoav Rappaport, Yoav.Rappaport@parsons.com

²David Arnold, P.E, david.arnold@swfwmd.state.fl.us

¹ Parsons Corporation, 34560 Buschwood Park Dr., Suite 345 Tampa FL 33618, 813-933-4650

² Southwest Florida Water Management District, Resource Management Department, 2379 Broad Street, Brooksville, FL 34604, 1-800-423-1476