3.0 PHYSICAL INVENTORY AND DESCRIPTION OF CANAL SYSTEMS IN THE MONROE COUNTY

3.1 INTRODUCTION

The second task performed as part of this study consisted of developing a spatial database that includes residential canal physical attributes that could potentially impact water quality. Spatial datasets have been widely used in the Florida Keys, especially with the development of the Florida Keys National Marine Sanctuary. The Florida Departments of Transportation and Environmental Protection have extensive basemaps, data sets and data standards for Geographic Information Systems (GIS) used in resource management, inventory and regulation. The residential canal project needed first to identify those canal systems that were developed *mostly* for private homes and residences. Large marinas and harbors that are not part of a canal system were not included, though these areas may also contribute to nearshore water quality problems. The database was focused specifically on developments under the jurisdiction of greater Monroe County, and included single family homes, trailer parks, condominiums, duplexes, apartment complexes and some businesses that reside along canals that are mostly residential. The GIS maps in the attached CD ROM highlight the identified canal systems.

The goal of database development was to bring as much information as possible into a single GIS database on the characterization, history and potential pollution sources for residential canals. The scope of work called for incorporation of information that was readily available in an electronic format. The database is viewed as dynamic, and should be improved with new information (e.g better canal depth information).

3.2 EXPLANATION OF DATA SOURCES AND THEME DEVELOPMENT

The 1998 aerial photographs for the Florida Keys, derived from Florida Department of Transportation (FDOT) District 6 and available as part of the Florida Geographic Data Library (FGDL from 1:24,000 black/white aerial photography), were utilized to digitize all the water bodies observed during the desktop aerial interpretation. The aerials were selected due to their relatively high resolution and their extensive coverage of the study area. A GIS based water body layer was created by delineating the footprint of each water body observed as a separate polygon within the one layer. Upon completion, a quality assurance phase was then implemented, and through select field verifications, interviews with local homeowner associations, and distribution of the water body layer to local agencies for comments, the layer was refined to include only the residential canals located within the Florida Keys, the Residential Canal Layer. The final residential canal layer is enclosed on the CD ROM.

The majority of the supporting database associated with the residential canal layer was collected from existing sources. The sources varied from GIS based layers (ex. topographical map layer, parcel layer, county boundary layer) to hard copy information obtained through agency file review and homeowner questionnaires. Please refer to **Appendix A** for a detailed list of all sources utilized. When needed, the existing GIS source layers were re-projected to the canal layer projection and spatially analyzed through customized programming to populate each individual canal with the associated attribute.

In addition to the existing information obtained, the physical canal attributes, such as the canal area, width, length, number of mouths, orientation of mouths, degree of convolution, and latitude and longitude of the centroide of the canals, was derived through GIS, spatially analyzing the polygons and documenting the individual canal attributes. For instance, to get the overall area and dimensions of the canals, the aerial photographs were utilized. The length of the canal (presented in feet and meters) is a characteristic describing the greatest distance from the mouth of the canal to the furthest end of the canal system. **Figures 3-1** through **3-3** shows how several of the major attributes were determined.

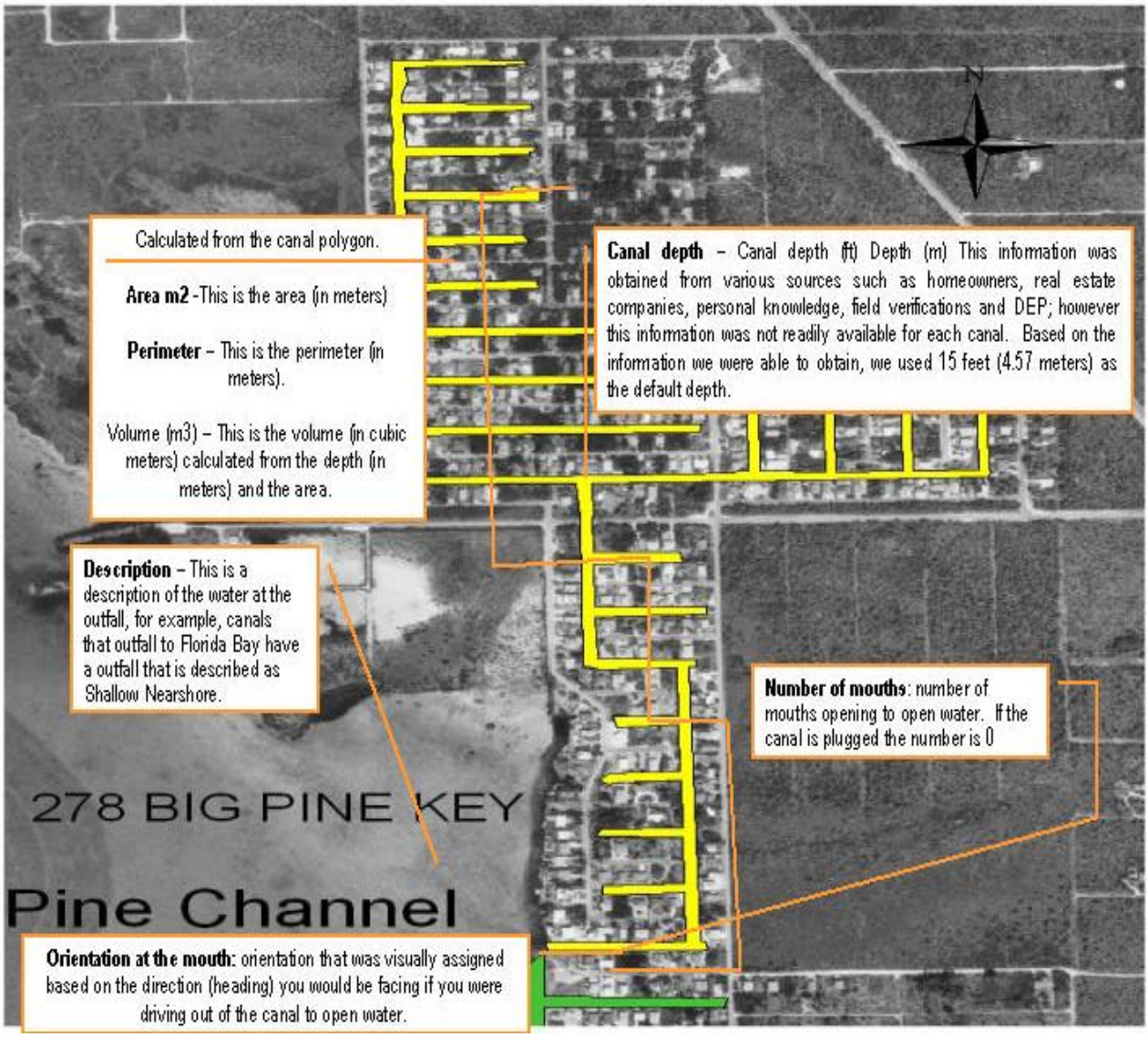

Figure 3-1: Summary of physical canal attributes

The number of convolutions was determined by measuring the number of 90 degree turns, or fractions of 90 degree turns, in the canal. This value is a proxy for ease of circulation with adjacent nearshore waters. **Figure 3-2** illustrates the number of convolutions using Port Largo Canal as an example. There are 11 convolutions in this canal system.

Figure 3-2: Measurement of the number of convolutions in the Port Largo Canal (Key Largo 60)

In general, the greater the length of a canal, the greater the restrictions to circulation with adjacent nearshore waters. **Figure 3-3** of Port Largo Canal (Key Largo 60), a canal of maximum length, illustrates how this was measured. The length of this canal was measured at 5,271 feet (1,607 meters).

Figure 3-3: Measurement of length in the Port Largo Canal (Key Largo 60)

A classification model was then developed to group canals that exhibit similar physical characteristics. The goal of this task was to collect sufficient information, through desktop analysis on the physical attributes, to evaluate potential impacts to water quality, without the cost of a large-scale field effort. The results of this task provided Monroe County with a basis upon which future studies, monitoring, planning and evaluation of canal systems can be performed. This comprehensive database can be expanded upon and drawn upon as needed particularly for, but not limited to, future canal studies.

The following GIS layers/shape files were developed and are included within the attached CD ROM:

1. 1998 FDOT aerials (FGDL 3.0)
2. Residential Canal Layer (Mactec)
3. Point file of existing water quality monitoring station locations (Mactec)
4. Surrounding land use, County boundary layers and numerous other layers as part of the FGDL version 3.0.

The complete list of all GIS layers included in the Canal Inventory and Assessment Layer and the Water Quality Station Locations Layer are included in **Appendix B.1**.

A separate GIS layer was provided as a Point file of existing water quality monitoring station locations (refer to **Figure 3-4)** for the water quality monitoring station location map). Water quality sampling stations from all known sources and studies are indicated on this Keys-wide map of the residential canal systems. The sources varied from existing GIS based layers (ex. Baywatch, Florida Keys National Marine Sanctuary, and the Islamorada sampling locations layer) to hard copy information obtained through the Data Compilation and Review Task, previously conducted (refer to Section 2 and **Table 2-1**). The map illustrates the clustered nature of water quality monitoring stations: some canals have been extensively studies for water quality problems, other canals have been monitored as part of a volunteer sampling program (Florida Bay Watch). There has been no systematic monitoring of canal water quality in the Florida Keys.

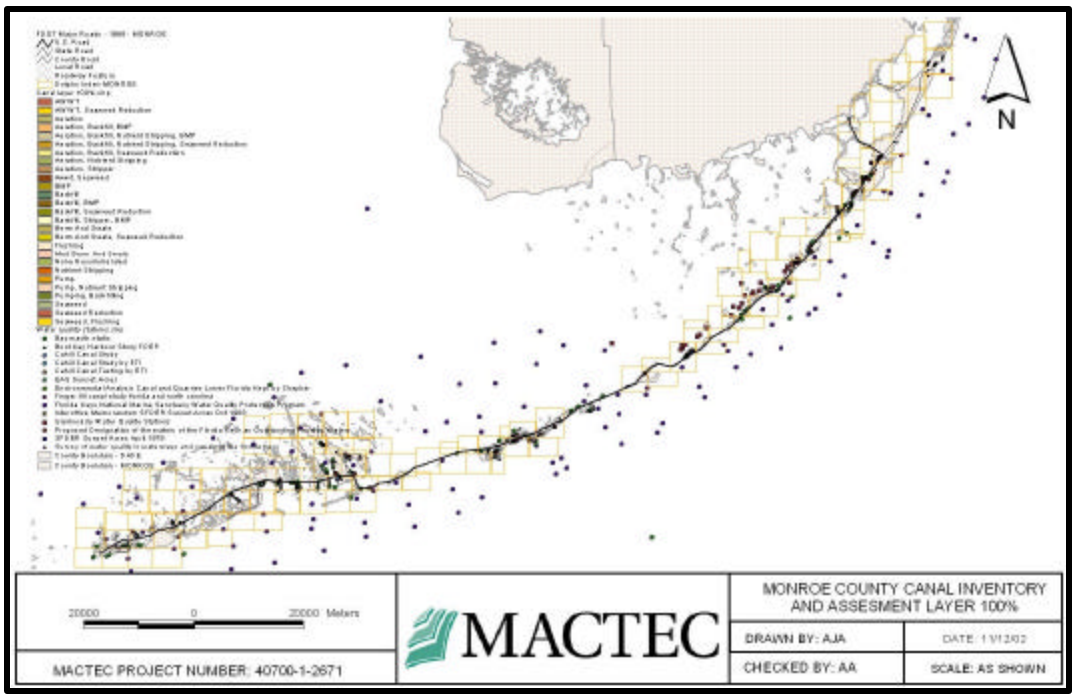

Figure 3-4: Map of water quality monitoring station locations

When needed, the existing GIS source layers were re-projected to the canal layer projection. Hard copy reports containing monitoring stations were manually digitized and joined to the master water quality monitoring stations location layer. The layer's supporting database contains the source documentation, longitude and latitude, and a reference field to the bibliography. Water quality sampling data was collected over the past 40 years, and many of the datasets lacked a complete metadata record of the methodologies and instrumentation used. Although the historical water quality data were of value to see general trends in parameter variability, it was impossible to compare many data sets that were collected using different (or undocumented) methods. The data quality control review included a review of methodologies, and documentation. Only data with comparable methods, and documented protocols could be confidently compared between different monitoring stations and over time. The goal of this task was be to provide Monroe County with a comprehensive GIS monitoring station layer of all monitoring stations discovered during the Data Compilation and Review Task.

Water quality data available in electronic format were evaluated, summarized and linked to the associated canal system in the GIS. The Excel spreadsheets containing the water quality summaries, as well as the raw data sets obtained from each source, are also included on the attached CD ROM.

3.3 ABBREVIATED METADATA

Development of the canal layer involved incorporation of an extensive amount of data and a formalization of a method of association to specific canals. Every continuous canal system (not just one leg) in the Keys was outlined and assigned a number starting from the Lower Keys and extending along US 1 to the Upper Keys (1 – 481) (**Figure 3-5**). Each numbered canal has an associated list of physical attributes. A summary of the major canal attributes that are included in the GIS are presented in **Table 3-1.** A complete attribute table of the attributes in the GIS database is presented in **Appendix B.4**. A description of the attributes, along with the source of the data and known data limitations are presented in the Metadata included in **Appendix B.2**. The attached CD ROM contains the Final 100% Residential Canal GIS layer.

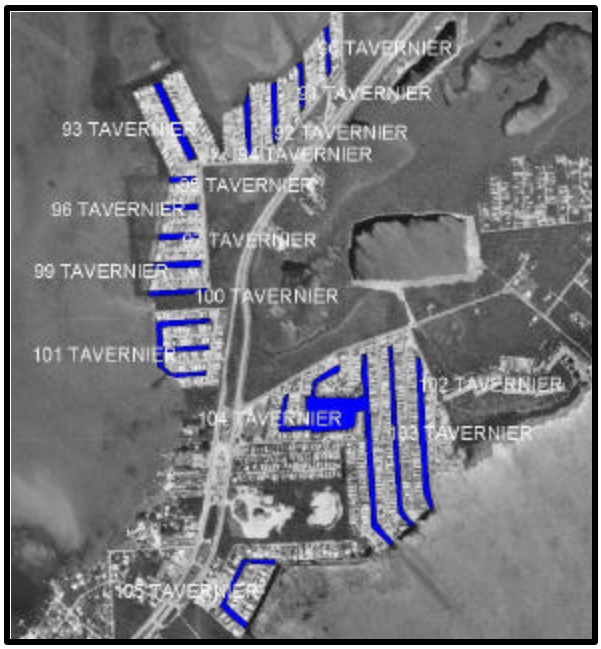

Figure 3-5 Example of the numbering system for the canals

3.4 FIELD VERIFICATION AND DATA ACCURACY

As part of the GIS database development field verification was conducted to verify the characteristics of canals. Numerous days were spent driving to specific canals, and inspecting the aerial interpretation of canal mouth, construction, and the existence of culverts.

The main problems in data accuracy are related to the ability to use aerial photography to attribute the canals. The field verification identified several deviations which included:

- Changes to canals since the aerial photography was taken (1998), especially small changes in culverts or additional inlets/outlets to the canal system
- Dredging or changes in the depth or entrance to the canals
- The status of plugged canals, which residents in some areas have breached to allow at least limited circulation
- Some very small canals or canal extensions may have been missed because of mangroves or tree overhang obscuring canal dimensions, and
- Addition of storm water treatment systems adjacent to canal systems.

All of these potential deviations were addressed in a systematic field verification of different canal types and locations. People involved in the field verification exercise had local knowledge of the Florida Keys, and interviewed residents as well as county officials for up to date information. Corrections and annotations were made on "hard copy" maps of the dataset, and then entered into the final GIS database.

3.5 ANALYSES AND QUERY FUNCTIONS

The database was established to allow canals to be grouped by common attributes. This can be useful in applying particular design criteria to canals for application of treatment technologies. Section 4 presents a detailed discussion of the grouping of canals into canals classifications based upon physical attributes contained in the GIS database.

An additional tool was found to be extremely useful in selecting the most applicable and cost effective treatment technologies for each canal. That is the query function in Access. The query function is used to select features with a logical expression such as 'select all the canals with areas greater than or equal to a certain size'. The query function uses the existing fields from the attribute table and the selected logical functions. Combinations of fields and logical functions can be used to generate a resultant table of the query that best fits the optimum attributes for a particular treatment technology. Section 5 presents the results of the queries that were performed to select the treatment technologies that were best suited to each type of canal based upon the canal attributes in the GIS database. An example of the use of the query function is shown below.

Query: Jumbo and Large size canals, with High Development, of Fill Construction, with an Area to Length Ratio (A/L) < 8

Select the attribute for size classification from the query function and create a new attribute table by selecting the values Jumbo, then by querying the field again for Large and adding the results to the previously selected table. Query the database table again for High Development, Fill and A/L < 8 by selecting from the existing attribute table previously generated. The final results table is the result of the query.

Query functions illustrate the complexity of the problem in addressing canal water quality – there is a great deal of diversity in canals. The GIS database, queries and linked water quality data are a tool that can be used by a broad array of government agencies, as well as homeowner associations, to assist in future planning for the management of the canals in the Florida Keys.

TABLE 3.1
MAJOR CANAL ATTRIBUTES INCLUDED IN GIS DEVELOPED FROM DATA SOURCES

ATTRIBUTE	DESCRIPTION	DATA SOURCE	LIMITATIONS
Water Quality Summary	Assigned as "POOR", "FAIR" and "GOOD" based on canal size, design and existing water quality data for all canals	Based on historical reports and studies of canal water quality as well as the long-term water quality monitoring program for the Florida Keys National Marine Sanctuary and Everglades National Park, see Table 2-1	Certain assumptions about water quality were made, and there may be some exceptions in individual canals – this information is sufficient to identify demonstration projects and critical information gaps
Canal Depth	Depth of the canal	Homeowners, real estate companies, personal knowledge, DEP and field verifications	Default depth = 15 feet. Often was used due to lack of actual depth data. The information was taken from permits, and some field-verified depths were added. There are likely deeper canals in the Keys than indicated on the permit because of the need for fill.
%Natural	Percentage of the shoreline that was left natural. Provides information about the nature of the canal bank.	1998 DOT photo map 1:24,000 ortho-rectified digital images	Visual observations on the aerial map.
%Developed	Percentage of the shoreline that was developed. Provides information about the nature of the canal bank.	1998 DOT photo map 1:24,000 ortho-rectified digital images	Visual observations on the aerial map.
Area	Calculated by the digitizing of individual canal polygons	1998 DOT photo map 1:24,000 ortho-rectified digital images	Given in both ARCES and HECTARES
Volume	Calculated value from estimated depth and calculated areas measured by digitizing individual canal polygons	Combine data in AREA and DEPTH datasets	Depth not available for each canal.
Modification	Information about the physical improvements made to a canal that affects water quality. Includes culverts, weedgates, etc.	This came f rom county permits, interviews and field verification	Limited data available.
Perimeter	Calculated value from the digitizing of the individual canal polygons minus distance of mouth	1998 DOT photo map 1:24,000 ortho-rectified digital images	

TABLE 3.1
MAJOR CANAL ATTRIBUTES INCLUDED IN GIS DEVELOPED FROM DATA SOURCES

ATTRIBUTE	DESCRIPTION	DATA SOURCE	LIMITATIONS
Maximum Distance to Mouth	This is the longest distance from the mouth to the furthest end of the canal	1998 DOT photo map 1:24,000 ortho-rectified digital images	
Number of Convolutions	This is the numerical value that was assigned (visually) based on number of 90 degree turns. A full 90 degree turn has a value of 1; a 45 degree turn has a value of 0.5	1998 DOT photo map 1:24,000 ortho-rectified digital images	
Filled Mangrove/Dredged Rock	Combination of original geologic setting which influences energy and the canal construction which influences composition of material adjacent to the canals. In the Keys there are two general categories: filling coastal mangrove or dredging of limestone bedrock	Based on pre-development maps indicating location of mangrove wetlands, permits, and use of bulkheads along canals and the 1998 DOT photo map 1:24,000 ortho-rectified digital images	Many canals are a combination of both filling of coastal wetlands and dredging into upland areas. Classification is based on the shoreward half of canal systems. Assumption that filled mangrove materials have a higher percolation rate and leach contaminants faster than dredged rock.
Canal Outfall	Name of the outfall at the canal systems mouth	Charts of the Florida Keys	
Outfall Description	Outfalls were described by either being shallow nearshore, natural channel or dredged channel.	1998 DOT photo map 1:24,000 ortho-rectified digital images	Canal outfall type can be utilized to indicate the energy at the mouth of the canal system.