Gator Slough
Storm Water Model

Model Construction and Phase 2 Calibration Report

by

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DRAFT Model Construction and Calibration Report

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1. Project purpose and Scope

The City of Cape Coral proposes to raise the crest elevations of some of the several weirs in the Gator Slough fresh water secondary canal system to create additional storage availability for wet season storage and dry season drawdowns. One potential problem associated with this concept is increasing tailwater elevations in the drainage system, which may increase the potential for flooding.

The objective of this storm water modeling is to evaluate the canal system enhancement plan of raising weir elevation (Weir numbers 19, 15, 14, 13 and 11) under design storm events.

As agreed at the planning meeting between the South Florida Water Management District and City of Cape Coral on October 16, 2000, the Storm Water Management Model developed by XP-Software (XP-SWMM2000) was used in this study to simulate a scenario of one foot higher elevation for the selected weirs. The simulated water levels then will be compared to the elevations of the existing structures such as roads, septic tanks, and residential houses to determine whether the elevated weirs cause any flooding. The three design storm events designated for this project are the 5-year 1-day, 25-year 3-day, and 100-year 3-day storm events.

This draft report provides the results of the model calibration.

Cape Coral is located in western Lee County on a peninsula bounded on three sides by waters of the Caloosahatchee River and Matlacha Pass and is bounded on the north by undeveloped land.

The analyzed area is one of the defined watershed basins within Cape Coral located north of Pine Island Road, S.R. 78, and west of U.S. 41. It covers an area extending north to the Lee County line and 7 miles beyond. It is all part of the same drainage basin as a result of the North Spreader Waterway, which receives the discharge from all canals north of Pine Island Road (see Figure 1).

Eight recharge basins (1, 2, 3, 4, 6,7, 9, and 10) will be considered in the model.

The Gator Slough watershed basins encompass a thirty three square mile undeveloped drainage basin located northeast of the city limits which was not a part of the project but is included in the hydrologic simulation model.

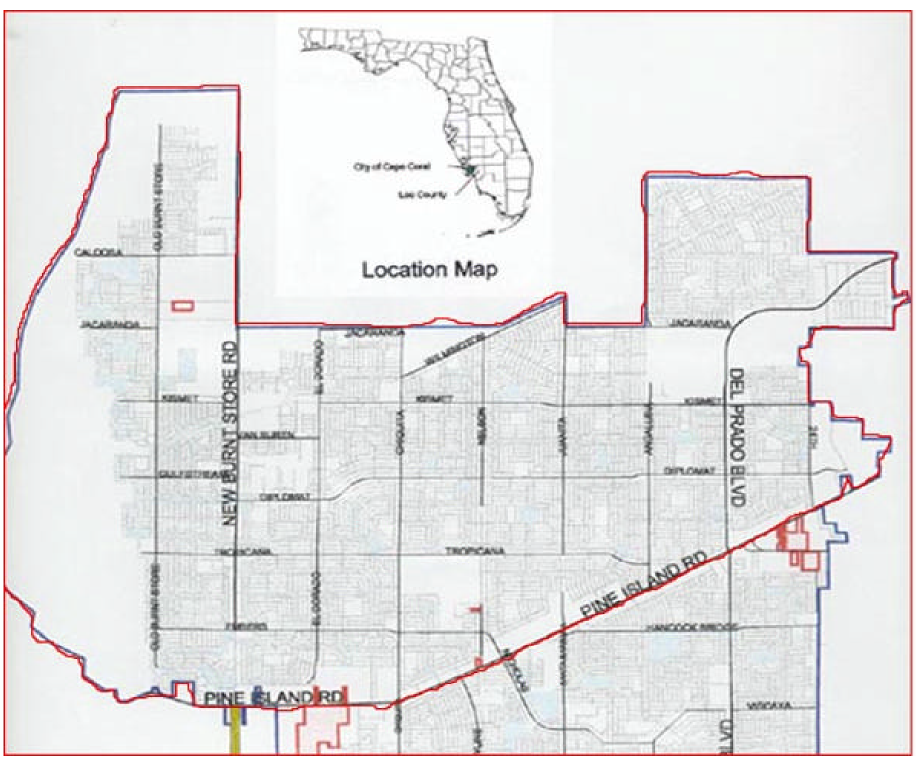


Figure. 1 Map of the Watershed

2. Scope of work Revision

The original Phase I scope of work included the model construction, calibration, and design storm runs for the portion of Gator Slough upstream of Weir 19 (Andalusia Boulevard). The design storm component of the work plan was predicated on the assumption that this event could be modeled independently of the downstream reaches. This assumption thus requires free-flow conditions at Weir 19. Upon inspection of the references cited below, it was determined that backwater conditions would prevail at Weir 19 for any event larger than the one-year design storm. Therefore for the model to be properly implemented on the designated design storms (5, 25, and 100 year) first requires construction of the Phase 2 model (downstream of Weir 19) and the linkage of the two systems. Thus, the revised Phase 1 scope of work was limited to the *model construction* and the *calibration* of the model using a *one-year event*. This Phase 2 report includes construction and calibration of the model representing the entire watershed. Then Phase III will simulate the continuous system for the 5, 25, and 100-year design events.

3. Literature Survey

<u>Canal Dimensions/ Field Info/ Hydraulics Structures</u>

I. *Lee County Surface Water Management Plan (LCSWMP)*. Johnson Engineering, Inc., Camp Dresser & McKee Inc., Hole, Monte & Assoc., and W. Dexter Bender & Assoc. (1991).

II. *A Water Management Study of the Cape Coral Networks, Lee County*. Connell, Metcalf, and Eddy (1979).

III. *City of Cape Coral – Road Design Maps*. *Water Independence For Cape Coral (WICC) Master Plan, City of Cape Coral*, Boyle Engineering Corporation (1988).

IV. *City of Cape Coral Utility Master Plan Update, Final Report*. Dames and Moore in association with Black and Veatch (August 1999).

Soil Data

V. *Soil Survey of Lee County, Florida.* United States Department of Agriculture, Soil Conservation Service (December 1984).

Discharge Data

VI. *Water Data Reports: South Florida Surface Water* Gauging Stations: 264437081550100 "Gator Slough at U.S. 41 near Ft. Myers, Fl"; 264139082022100 "Gator Slough at S.R. 765 near Ft Myers, Fl." United States Geological Survey.

Rainfall Records

VII. *"Lake Fairway" rain gage station, historical data.* Lee County Environmental Services-Natural Resources Division Southwest Florida.

4. Project Data

4.1. Watershed and Area Hydrology

The Gator Slough canals system watershed is located in the northwest area of Lee County and covers an area of approximately fifty-two square miles in the counties of Lee and Charlotte. An additional thirty-three square miles are within Charlotte County (mostly within the Webb Wildlife Management Area). As agreed in the planning meeting with SFWMD, this modeling study focused mainly on the Lee County portion of watershed (starting west of US Highway 41). Data from the U.S. Geological Survey gauging station US Hwy 41 were used to represent runoff water entering into Lee County from the Webb Wildlife Area. The east boundary in Lee County is along portions of an abandoned railroad and U.S. 41, the south boundary is Pine Island Road, The west boundary is the Cape Coral perimeter canal. This perimeter canal outfalls to a mangrove marsh, which in turn outflows to Matlacha Pass (Data source: *Lee County Surface Water Management Plan*, Johnson Engineering, Inc., Camp Dresser & McKee Inc., Hole, Monte & Assoc., and W. Dexter Bender & Assoc., 1991). The Lee County portion of the main Gator Slough canal watershed, utilized for the calibration of the model, is relatively narrow, varying from one to three miles in width.

The complete drainage basin is then composed by other three main canals, Horseshoe, Hermosa, and Shadroe, and their secondary branches. It is about six miles in width.

The watershed is channelized for its complete length from the Lee-Charlotte County Line to the perimeter spreader waterway system in Cape Coral adjacent to the salt marsh/mangrove estuary. This spreader system was built by the developer of Cape Coral to help reduce the impact of direct flow out of the canals to the estuary in the 1970's (Data source: *A Water Management Study of the Cape Coral Networks*, Lee County. Connell, Metcalf, and Eddy, 1979). It was not part of the official scope of the Modeling as assigned in the planning meeting with SFWMD (October 16, 2000), but has been taken into account to have more realistic boundary conditions downstream of the weirs under analysis.

The spreader system is a canal that parallels the salt/marsh mangroves zone with the purpose of causing the water to sheet flow into the wetlands. It also provides additional salinity control for the canals which discharge into it. According to previous literature on the subject, the presence of the north spreader may cause backwater conditions with a considerable amount of nuisance type flooding in several of the developed units under the design storm conditions (Data source: *A Water Management Study of the Cape Coral* Networks, Lee County. Connell, Metcalf, and Eddy, 1979).

Most of the Cape Coral area in this watershed has been previously cleared for future residential area. However, the only developed property is adjacent to U.S. 41. More water can be expected to enter the system as northern Cape Coral builds out. This study's simulation has been kept consistent with current conditions. All of the existing natural wetlands on the west sides of

U.S. 41 are north of the main Gator Slough canal flow-way. The City of Cape Coral's canal system could be used to divert and store fresh water from the main flow-way. The final purpose of this study is to verify and quantify the opportunity of raising two weirs in the main flow-way as well as in the others main canals to hold runoff water. Diverting water into more of the Cape Coral canal system by raising weir elevations would be consistent with several Lee County Plan policies and would likely increase estuarine productivity, decrease the impacts of excessive fresh water discharge and increased fresh water storage.

The type of development and the general canal conditions affects the hydrology of the basin. The watershed has experienced growth in the eastern portion of its Lee County area since the late 1970's, and currently it is estimated to be about 30% developed. The majority of the watershed in Lee County is just north or within the City of Cape Coral. The area within the city consists entirely of single–family residential development. The remainder of the watershed in Lee County is shown in the Lee County Comprehensive Plan as "Open Lands" with some "Resource Protection-Transition Zone" and "Suburban". The majority of the unincorporated area within the watershed is sparsely developed. Most of the single-family residential development within the watershed has little or no surface water detention (Data source: *City of Cape Coral, Water Independence For Cape Coral WICC Master Plan*, City of Cape Coral, Boyle Engineering Corporation, 1988).

The topography within the watershed varies in elevation from about +7 ft NGVD at the western boundary of Cape Coral to about +10 ft NGVD at Chiquita Boulevard, then to about +17 ft NGVD at Andalusia Boulevard, with about +24 ft NGVD at the north end of the Lee County portion of the watershed. Certain areas around U.S. 41 experience over bank flooding in the medium to large storm events. The average ground slope in both Lee and Charlotte Counties is about one foot per mile.

The majority of the upper reaches of the watershed must convey runoff via overland flow. Runoff from the remainder of the watershed is over large sheet flows areas or from residential areas noted above, directly to the channel. The runoff from the developed area is directed to the conveyance via overland flow or through ditches and/or culverts.

There are several tributary canals directly outfalling to Gator Slough. These canals convey much of the northern portion of Cape Coral's surface water runoff. There are no water control structures on most of these tributary canals; therefore runoff is fairly rapid from developed areas. Canals that connect further downstream have some controls (Data source: *City of Cape Coral, Water Independence For Cape Coral WICC Master Plan*, City of Cape Coral, Boyle Engineering Corporation, 1988). Dependent on the canal water levels, water can flow in or out of the main canal. Therefore the links created to mimic the canal system include no flap gates. Bypassing of water control structures in the main canal is also possible. The watershed boundary was set to be reasonably consistent with the canal system design. Uneven rainfall pattern and/or other hydrological events and conditions could cause flow differences in the main canal. Due to the fact that multiple cases are beyond the scope of this study, it was assumed that runoff would not be diverted in or out of the watershed.

In order to fully analyze the hydrologic characteristics of this watershed, it is necessary to consider the portion of watershed in Charlotte County. It extends into the Webb Wildlife Management Area up to three miles north of Tucker's Grade and is about five miles wide at this location (see Figure.2). This area is the headwaters for the Gator Slough Watershed. By its very nature, the Webb Wildlife Management Area has not been and will not be developed. It is a natural flat prairie area that historically has sheet flowed south into Lee County and Gator Slough (Data source: *Lee County Surface Water Management Plan*, Johnson Engineering, Inc., Camp Dresser & McKee Inc., Hole, Monte & Assoc., and W. Dexter Bender & Assoc., 1991). Monthly discharge coming from this portion of the watershed located north and east at Hwy U.S. 41 has been statistically evaluated and established as inflow data for the Gator Slough at its most upstream point (node 31) of the simulated canal system, just before the quadruple 10 ft x 6 ft box culvert under U.S. 41. Data obtained from United States Geological Survey gauging station located 0.5 miles west of US 41, named “Gator Slough at US 41 near Ft. Myers, Fl” were used to represent runoff water entering into Lee County.

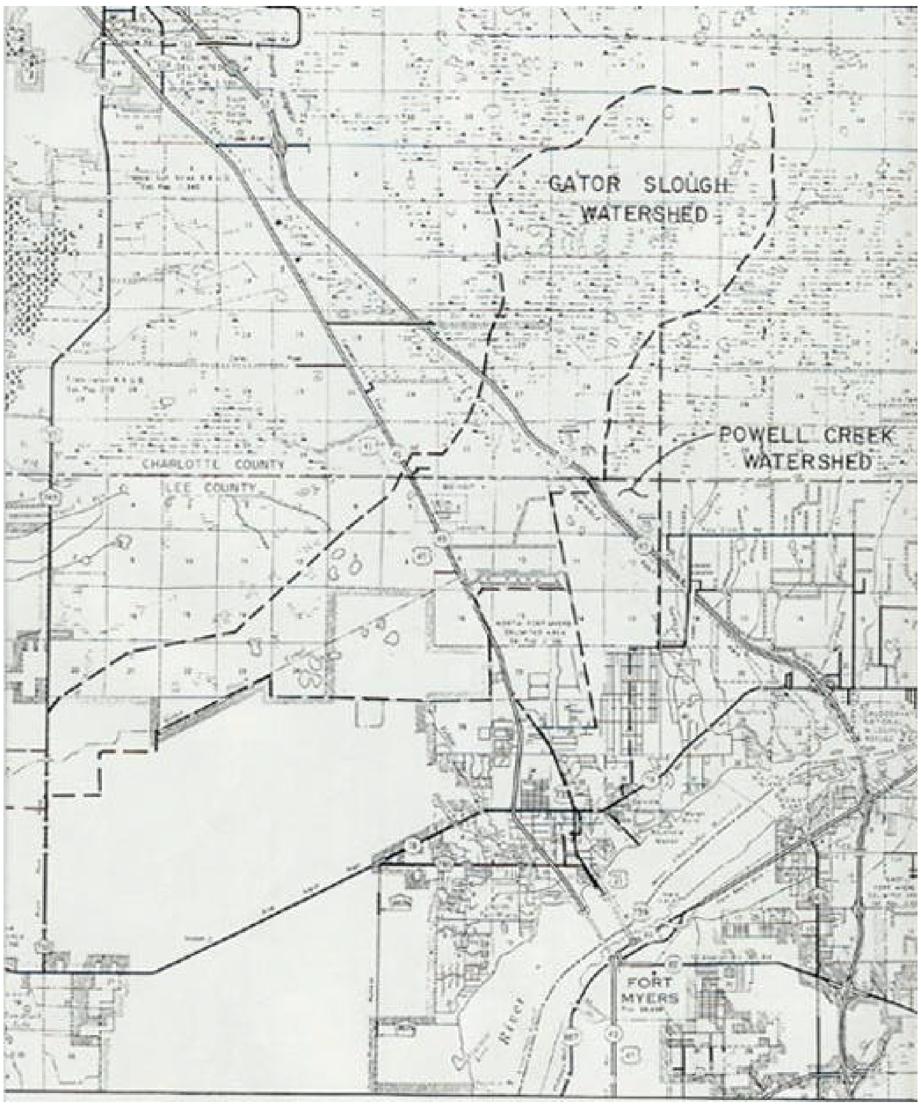


Figure 2. Gator Slough Watershed

4.2. Conveyance Elements

<u>Gator Slough</u>

The conveyance elements within Lee County for the Gator Slough Watershed consist of a main channel length of a little over ten miles, with an associated upstream sheet flow area. There are several culverts, bridges and weirs along the primary conveyance.

During the development of the City of Cape Coral, the canal was constructed to replace the broad sheet flow that was the original cross section. The conveyance is an excavated channel from its outflow into the City of Cape Coral's western perimeter canal to about 4,500 feet upstream of U.S. Hwy 41. The Gator Slough main channel is approximately 200 feet wide in the reach from Burnt Store Road to a point one-half mile west of U.S. 41. In this last one-half mile it narrows considerably to about 30 feet wide with several with several shallow areas in this vicinity.

In its downstream reaches, Gator Slough is interconnected with the City of Cape Coral's canal system. The canals connected to Gator Slough convey water to and from it. Some of the connecting canals have no water control structures at their confluence with the Gator Slough channel, others are culvert connection and some have weirs for control of elevation and quantity of flow (Data source: *Lee County Surface Water Management Plan*, Johnson Engineering, Inc., Camp Dresser & McKee Inc., Hole, Monte & Assoc., and W. Dexter Bender & Assoc., 1991).

At its downstream origin, Gator Slough has a bottom elevation of about – 6.5 ft NGVD. This elevation rises to about – 4 ft NGVD at Burnt Store Road. From Burnt Store Road east, the bottom elevation rises from – 4 ft NGVD to about +4 ft NGVD at Nelson Road. The channel bottom remains at a relatively constant elevation up to a point about one-half mile west of U.S. 41. At that point, the bottom rises sharply to about +11 ft NGVD.

The bottom elevation at the upstream end of the Lee County portion of the watershed is approximately +21 ft NGVD.

Downstream of Burnt Store Road, the conveyance is controlled by tidal conditions. The Burnt Store Road weir was installed in 1972 and provides a salt-water barrier. It also helps to maintain higher groundwater elevations upstream during the dry season.

Most of the channel downstream of Burnt Store Road is relatively clear of debris and aquatic vegetation. The side slope vegetation varies depending on location. There are very few seawalls along the conveyance. Most of the channel side slopes are vegetated, some being maintained by the property owners while other areas are covered with Brazilian pepper and scrub vegetation (Data source: *City of Cape Coral Utility Master Plan Update, Final Report*, Dames and Moore in association with Black and Veatch, August 1999).

The excavated channel upstream of Burnt Store Road to Chiquita Boulevard is of a fair uniform cross section. The channel from Chiquita Boulevard to Juanita Boulevard is about half the width of the channel downstream and upstream. After widening again, the channel is consistent in width to the northeast limit on U.S. 41 An existing layer of rock that maintains the channel shape and inhibits erosion protects the bottom. The shallow depth channel, with extensive cattail growth, continues east of U.S. 41.

The channel contains excessive amounts of vegetation along most of its length from Burnt Store Road weir to the Lee County / Charlotte County line. In many places, this vegetation completely blocks the channel. The side slopes are covered with scrub brush and sporadic pepper trees. Most of the vegetation in the channel consists of cattail and other plants attached to the bottom (Data source: *Lee County Surface Water Management Plan*, Johnson Engineering, Inc., Camp Dresser & McKee Inc., Hole, Monte & Assoc., and W. Dexter Bender & Assoc., 1991).

Thirty percent of the non-Charlotte County portion of this watershed consists of single-family residential development within the City of Cape Coral. About half of the watershed in Lee County is undeveloped with the remainder in mobile home parks or sparse residential. Since most of the residential development along the channel occurred prior to current regulations, much of the flood plain in Lee County has been encroached upon and filled in the developed areas. There has been very little development in this watershed within Charlotte County. Most of the Charlotte County area is within the Cecil Webb Wildlife Preserve.

A description of the major canal components in Gator Slough and the modifications currently in progress or proposed is presented as follows (Data source: *City of Cape Coral Utility Master Plan Update, Final Report*, Dames and Moore, August 1999):

Gator Slough is being dredged to clear weeds and promote flow. The profile from where the Slough enters the City to 8 feet below the top of Weir 9 is being cleared of rock to provide unimpeded drainage flow. This is anticipated to increase the flow to Cape Coral from the Slough. However, flow records show that there is little flow in the Slough during the dry season. Therefore, the change in profile would only allow some water into the Cape Coral system during the rainy season or after rain events.

Basin 1, the first canal basin that the Slough enters, contains a substantial amount of canal surface area in addition to the Slough. Weir 19 (elevation 10.37 feet) discharges from Basin 1 to Basin 2, which contains only Gator Slough and no additional canals. Weir 19 is a notch weir and addition of a sluice gate is proposed to provide flexibility and lower the effective weir elevation when desired. Lowering the weir will provide access to additional surface water to Gator Slough and to the groundwater flow available from the canals in Basin 1; it can be diverted to Basin 4 and be accessed for use in the secondary water system.

The water from Gator Slough in Basin 2 can flow over Weir 9 (elevation 8.5 feet) continuing over Gator Slough or flow over Weir 58 (elevation 8.35 feet) entering Basin 4. Weir 58 is a notch weir and addition of a sluice gate is to lower the effective weir elevation and direct more water to Basin 4. Weir 9 is a rectangular weir that zigzags diagonally across the channel. Hence it is know as the Zigzag weir. The Zigzag weir is currently being repaired and the elevation will remain unchanged.

A large flat area of scrub vegetation north of the lower position of Gator Slough (called the "Yucca Pen") drains into Gator Slough just below the Zigzag weir during rain events. The City is looking into redirecting the drainage flow so that it flows into Gator Slough above the Zigzag weir.

Downstream from Basin 2, a balance structure in Gator Slough transfers water by gravity flow through four 36-inch culverts from Basin 4 to Gator Slough. This is counterproductive to the goal of augmenting the storage in Basin 4 and the structure is proposed to be blocked to eliminate the loss of water from Basin 4.

Gator Slough flows through Basins 1,2,4 and 6, eventually discharging to North Spreader Canal System. In the dry season, it is possible that due to the diversion of water to Basin 4 there will be little or no surface water flow in the Slough downstream of Weir 9 (Basin 2).

The overflow weirs in Basin 4 should be raised to provide greater storage capacity. This would impact Weir 16 (elevation 6.27 feet), Weir 17 (elevation 6.33 feet) and possibly Weir 4. This will be considering the impact of raised groundwater levels on raising weir elevation in canals.

Based on the above, Gator Slough is currently being enhanced to provide additional water to the City.

There were several sources of information for structural details. These include the *Lee County Surface Water Management Plan* (LCSWMP, 1991), prepared by Johnson Engineering, Inc. The following is a brief synopsis of each structure along the conveyance:

Structure #1

The most downstream structure is located at Old Burnt Store Road, east of the perimeter canal outfall. The structure consists of a pair of concrete bridges, each 102 ft long with a load elevation of +12.3 ft NGVD. There are two sets of concrete support pilings at this structure.

Structure #2

This is a 156 ft long concrete bridge at Burnt Store Road. The road elevation is about +10.8 ft NGVD. There are five sets of concrete support pilings in the channel.

Structure #3

This is the Burnt Store Road weir. It is a reinforced concrete weir, which has a crest elevation of +2.4 ft NGVD with a length of 175 ft. There is no notch in the crest. There is one slide gate on the south end of the weir.

Structure #4

El Dorado Boulevard crosses over a 27 ft x 14 ft concrete box culvert. The top of road elevation over the structure is about +13.4 ft NGVD. The invert elevation of the culverts is –3.1 ft NGVD. There is no center column.

Structure #5

This is the Chiquita Boulevard weir. It is a reinforced concrete weir that has a crest elevation of +6.3 ft NGVD with a length of 230 ft. This is a polygonal weir resembling interconnected boxes. There is no notch in the crest. There are no gates at this structure.

Structure #6

Two 27 ft x 9 ft concrete box culverts provide the Chiquita Boulevard crossing. The top of road elevation over the structure is about +12 ft NGVD. The invert elevation of the culverts is +0.4 ft NGVD.

Structure #7

This is the Nelson Road weir. It is a reinforced concrete weir that has a crest elevation of +8.5 ft NGVD with a length of 220 ft. The weir shape resembles a set of stairs across the canal. There is no notch in the crest. There are no gates at this structure.

Structure #8

This is the structure at Andalusia Boulevard. It is a double 24 ft x 10 ft concrete box culvert, which incorporates a 46 ft long (92 ft of total length) weir structure located diagonally inside each box culvert. The weir crest elevation is

+10.1 ft NGVD. The top of road elevation over the box culvert is approximately +16.7 ft NGVD. The invert elevation for this box culvert is +4.7 ft NGVD.

Structure #9

A single 20 ft x 14.6 ft concrete box culvert at West Gator Circle is the next structure upstream from Andalusia. The top-level elevation over the culvert is about +21.0 ft NGVD. The invert elevation of the culvert is about +4.4 ft NGVD.

Structure #10

This is a single 15 ft x 14 ft concrete box culvert at East Gator Circle. The top of road elevation over the culvert is about +20.4 ft NGVD. The invert elevation of the culvert is +4.5 ft NGVD.

Structure #11

The Garden Boulevard crossing is a single 15 ft x 14 ft concrete box culvert. The top of road elevation over the culvert is about +20.6 ft NGVD. The invert elevation of the culvert is +4.1 ft NGVD.

Structure #12

This is a quadruple 10 ft x 6 ft concrete box culvert at U.S. Hwy 41. The top of road elevation over the culvert is about +23.1 ft NGVD. The invert elevation of the culvert is about +13.1 ft NGVD.

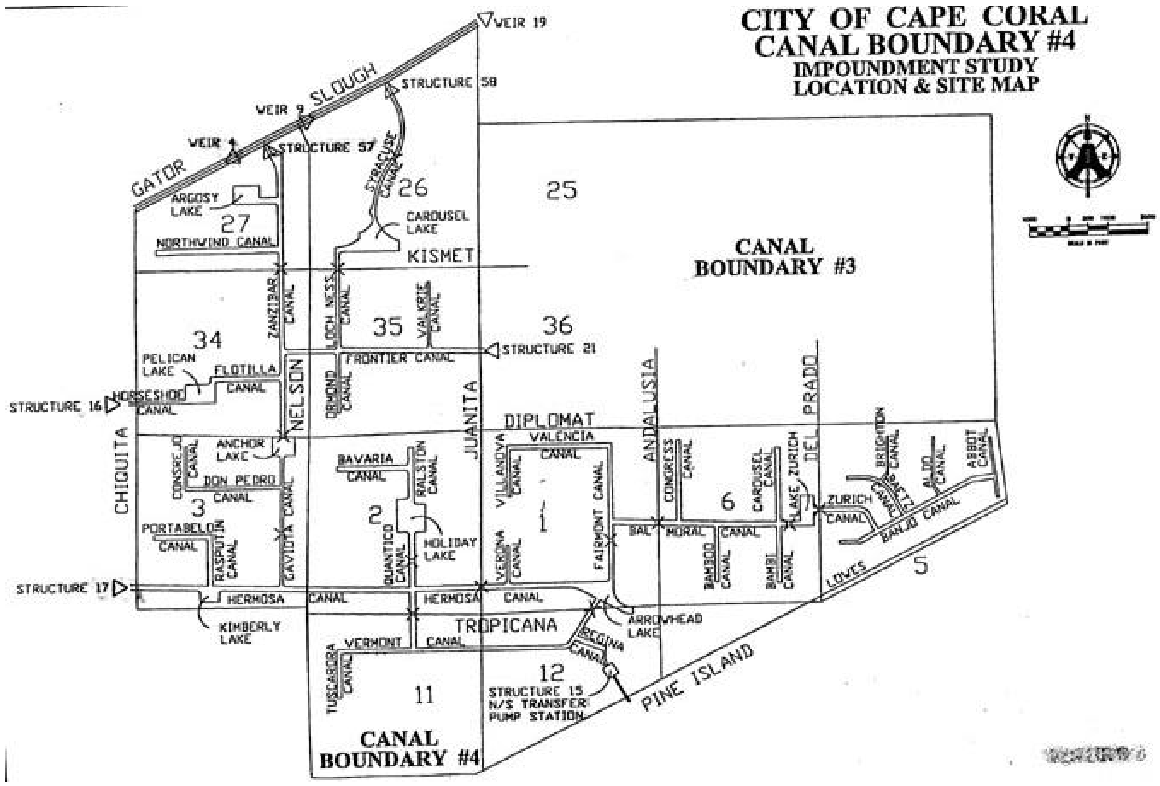


Figure 3. City of Cape Coral Canal Boundaries

Table 1. Summary table of weirs located in the entire watershed

Weir #	Location	Length (ft)	Crest elevation (ft)
4	Gator Slough - Chiquita Boulevard	230	6.5
9	Gator Slough - Nelson Road	220	8.5
11	Gator Slough - Burnt Store Road	178 / 175**	2.4
12	Gator Slough - Burnt Store Road	36	2.4
19	Gator Slough- Andalusia Boulevard	92 / 120*	10.5 / 10.1**
58	Gator Slough - Syracuse Canal	62	8.5 / 8.25*
13	Horseshoe Canal-Burnt Store Road	101	2.4
16	Horseshoe Canal-Chiquita Boulevard	100	6.5
21	Horseshoe Canal – Juanita Boulevard	52	8.5
14	Hermosa Canal - Burnt Store Road	83	2.4
17	Hermosa Canal - Chiquita Boulevard	85	6.5
15	Shadroe Canal - Burnt Store Road	99	2.4
18	Shadroe Canal - Chiquita Boulevard	35	5.0

Reference - unless otherwise stated: *A Water Management Study of the Cape Coral Canal Networks, Lee County, Florida*, Connell, Metcalf & Eddy, January 1979.

**Environmental Resource Permit Staff Review Summary – Gator Slough Enhancements*. Boyle Engineering Corporation, March 2000.

***Lee County Surface Water Management Plan* (LCSWMP). Johnson Engineering, Inc, 1991.

When data where not consistent, preference was given to the most current publication.

The following are the drawings of several of the weir described above:

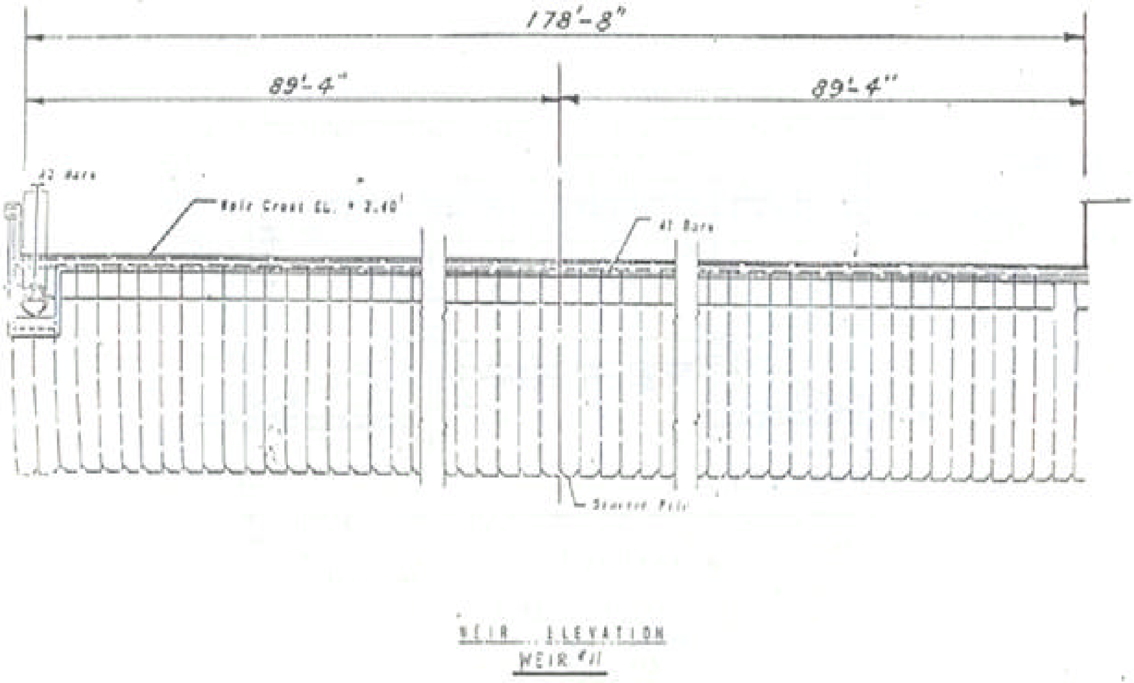


Figure 4. Gator Slough Weir #11.

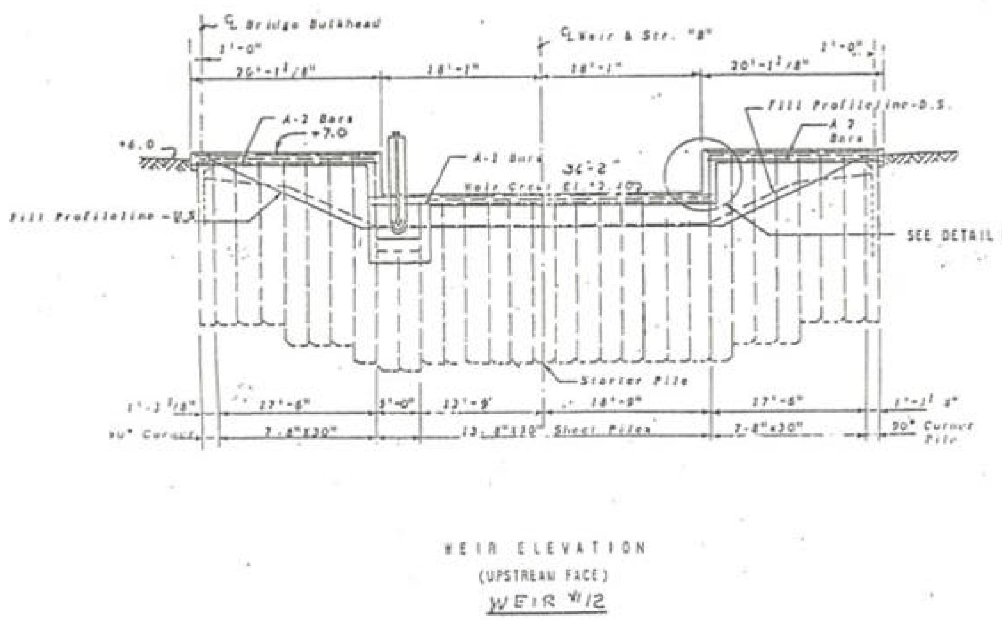


Figure 5. Gator Slough Weir #12.

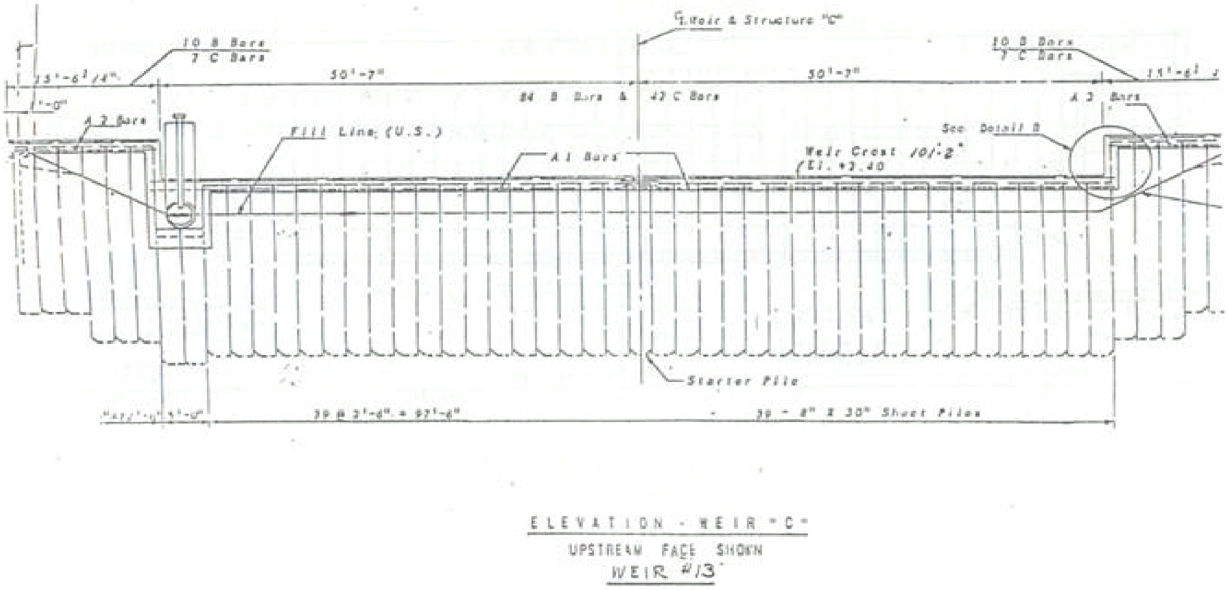


Figure 6. Horseshoe Canal Weir #13.

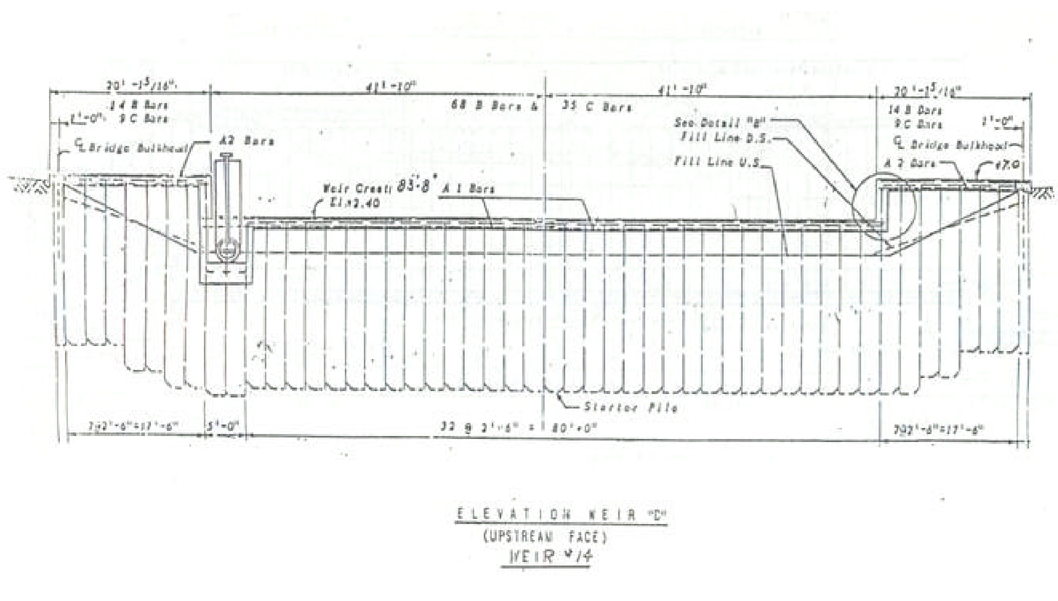


Figure 7. Hermosa Canal Weir #14.

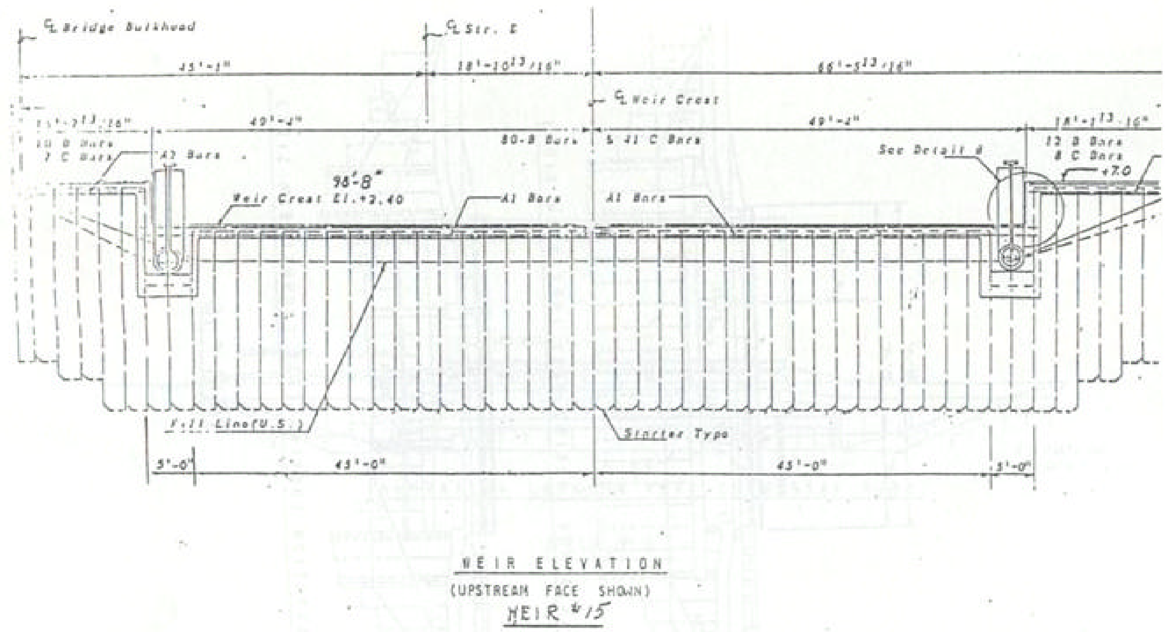


Figure 8. Shadroe Canal Weir #15.

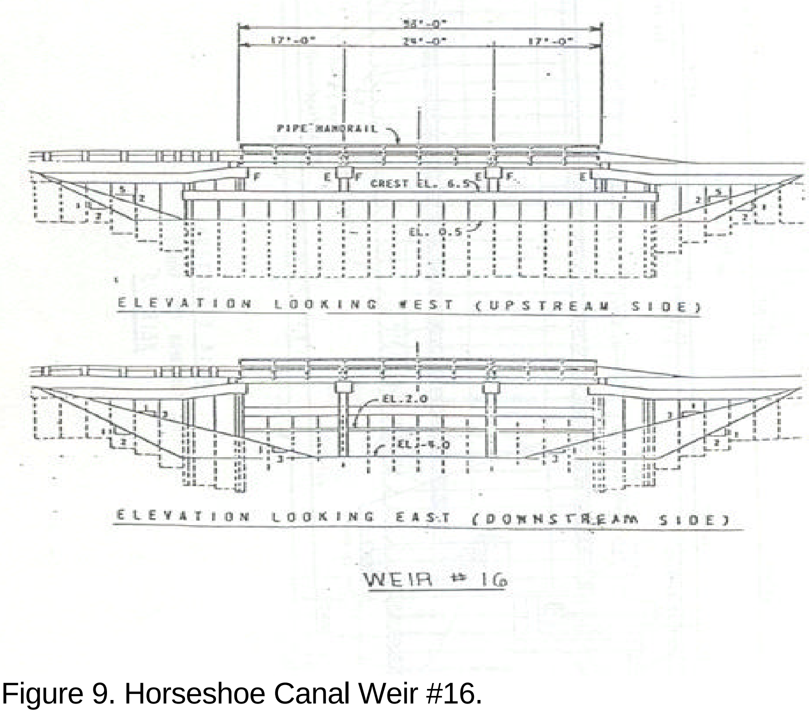


Figure 9. Horseshoe Canal Weir #16.

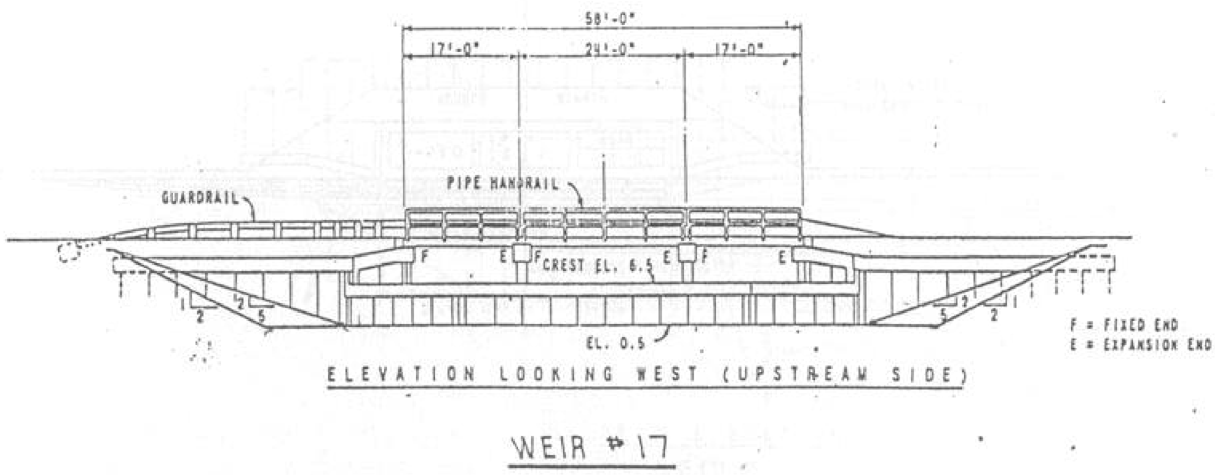


Figure 10. Hermosa Canal Weir #17.

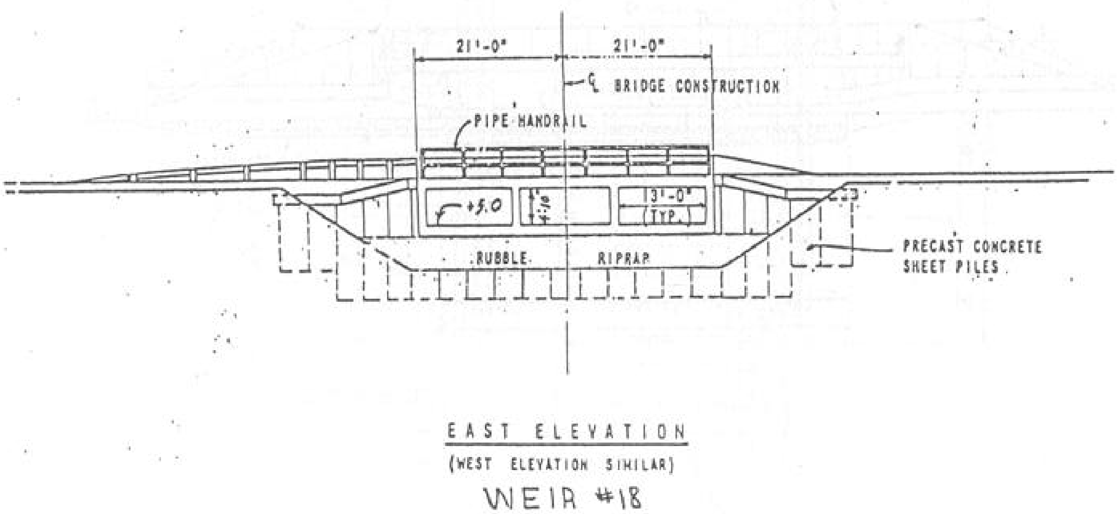


Figure 11. Shadroe Canal Weir #18.

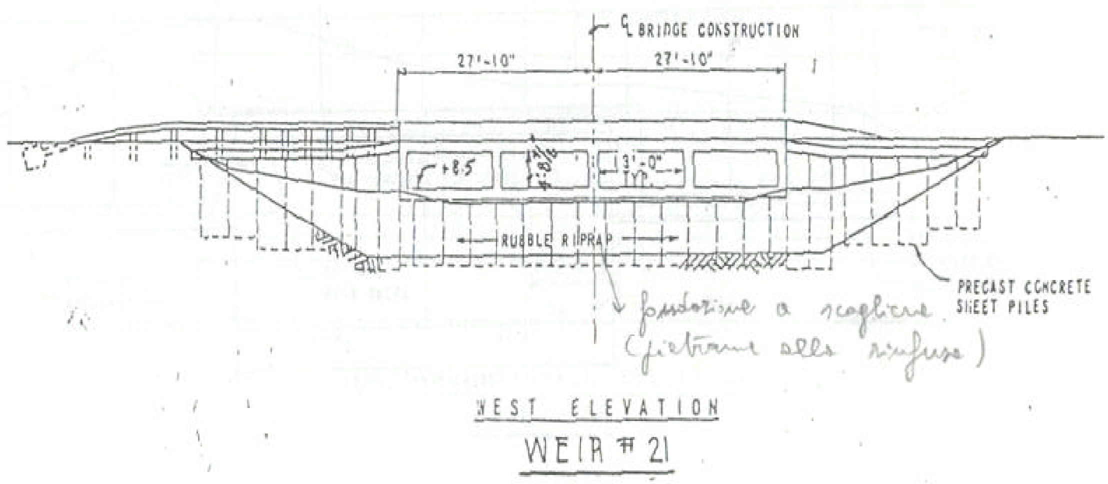


Figure 12. Shadroe Canal Weir #21.

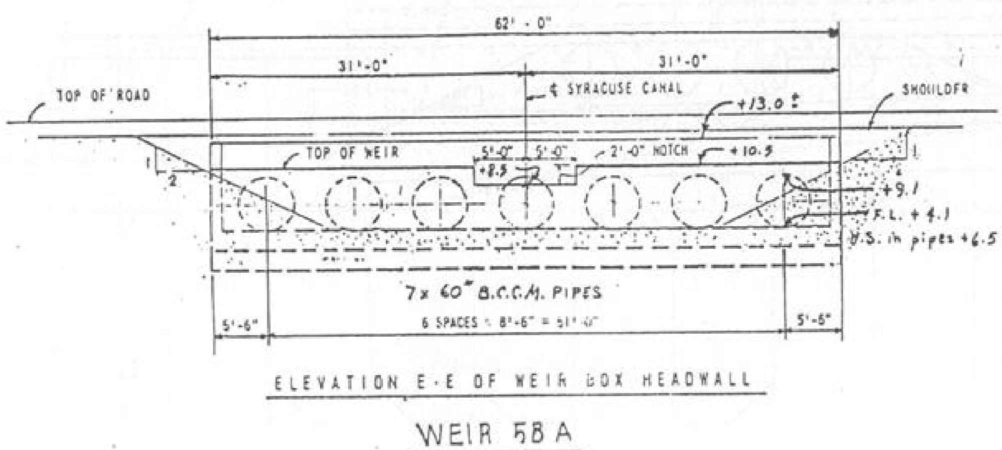


Figure 13. Gator Slough Weir #58.

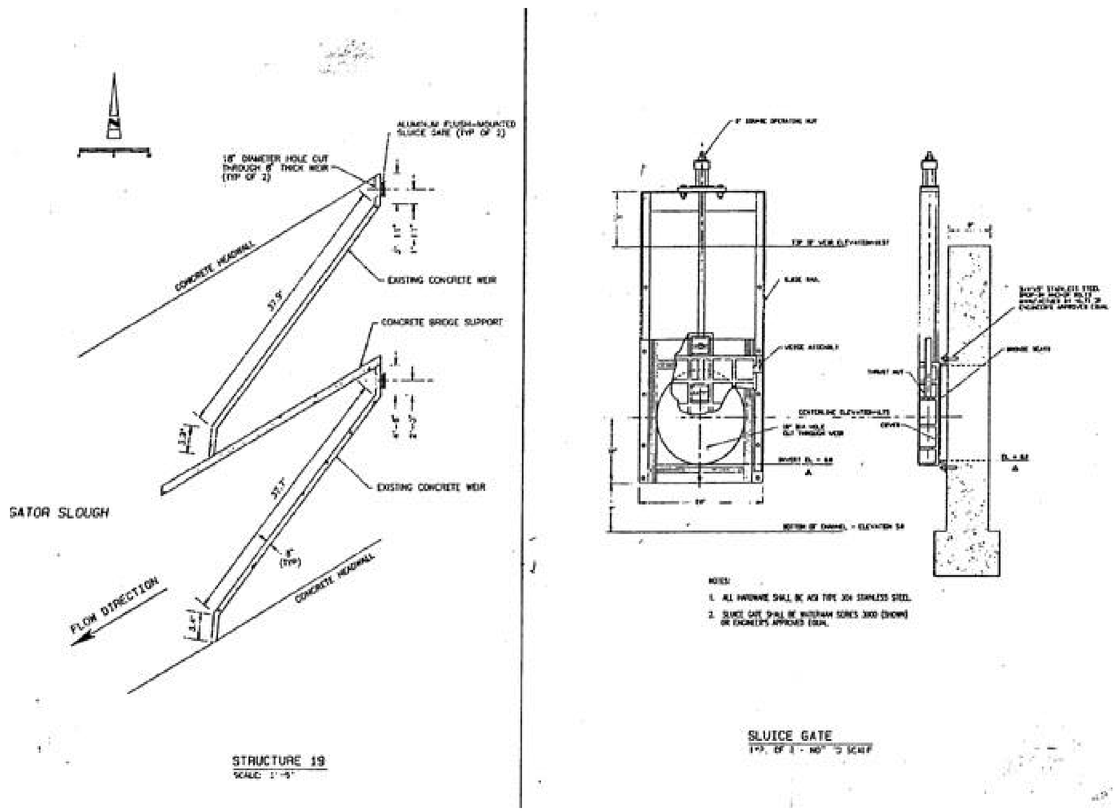


Figure 14. Structure #19.

The following table gives the bridge numbers and corresponding bridge types for all the bridges located in the entire watershed of this work:

Table 2. Summary of all the bridges located in the watershed.

Gator Slough Watershed		*Hermosa Canal*	
Bridge No.	Bridge Type	Bridge No.	Bridge Type
71	D	76	B
74	B	68	*
94	D	52	*
95	C	53	*
99	D	51	*
Horseshoe Canal		49	D
Bridge No.	Bridge Type	50	D
75	B	46	C
70	C	47	D
69	*	48	D
72	C	17	*
54	*	18	*
55	*	16	D
56	D	24	D
57	D	59	C
60	C	*Shadroe Canal*	
19	D	Bridge No.	Bridge Type
61	D	92	A
62	*	93	B
63	*	65	*
20	D	66	*
21	D	67	*
22	C	64	*

The following are the drawings of bridges described above:

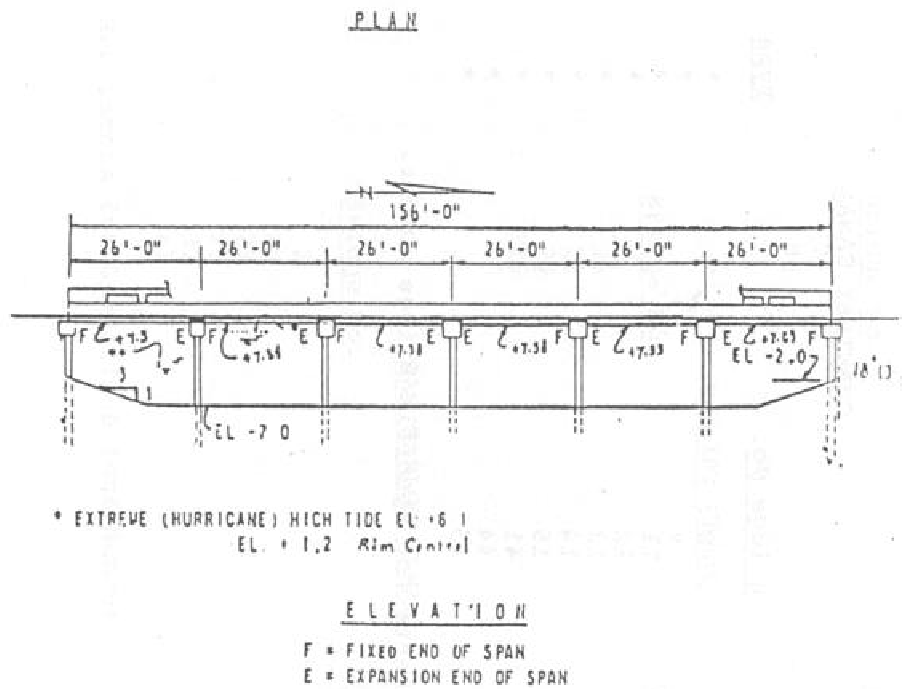


Figure 15. Bridge type 'A'.

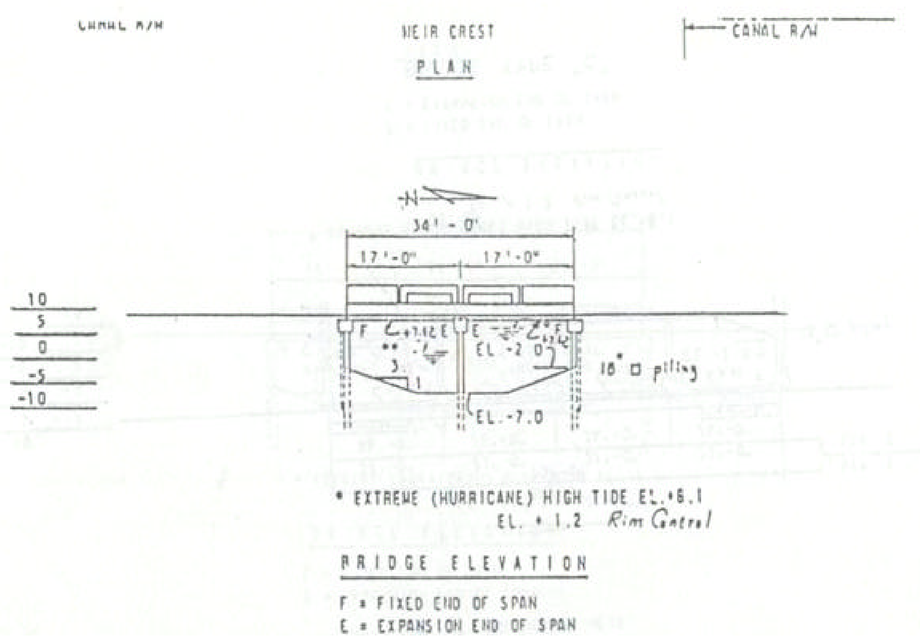


Figure 16. Bridge type 'B'.

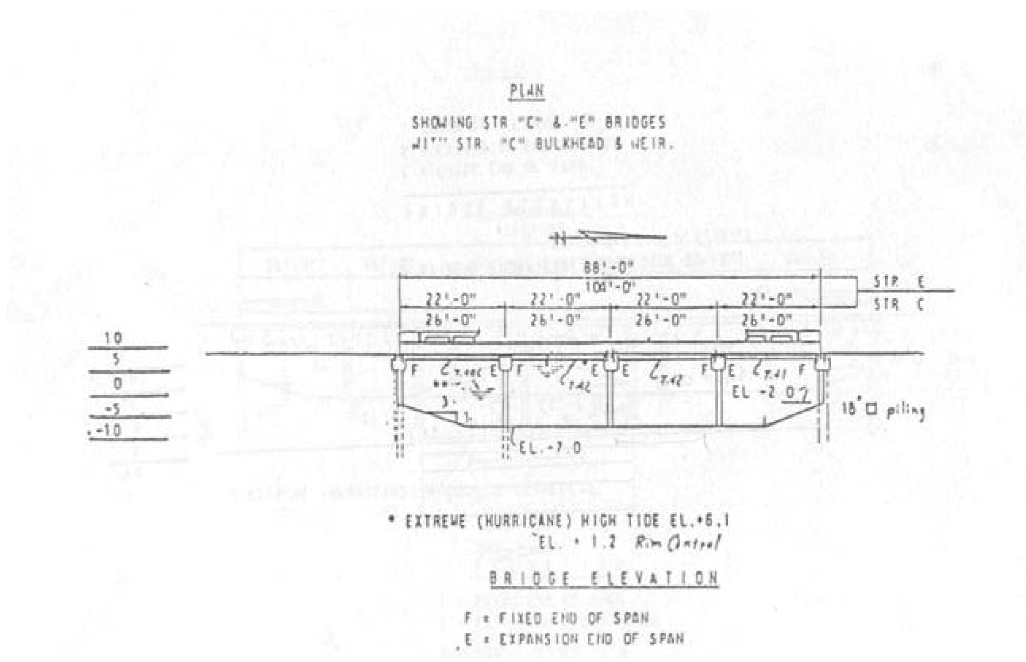


Figure 17. Bridge type 'C'.

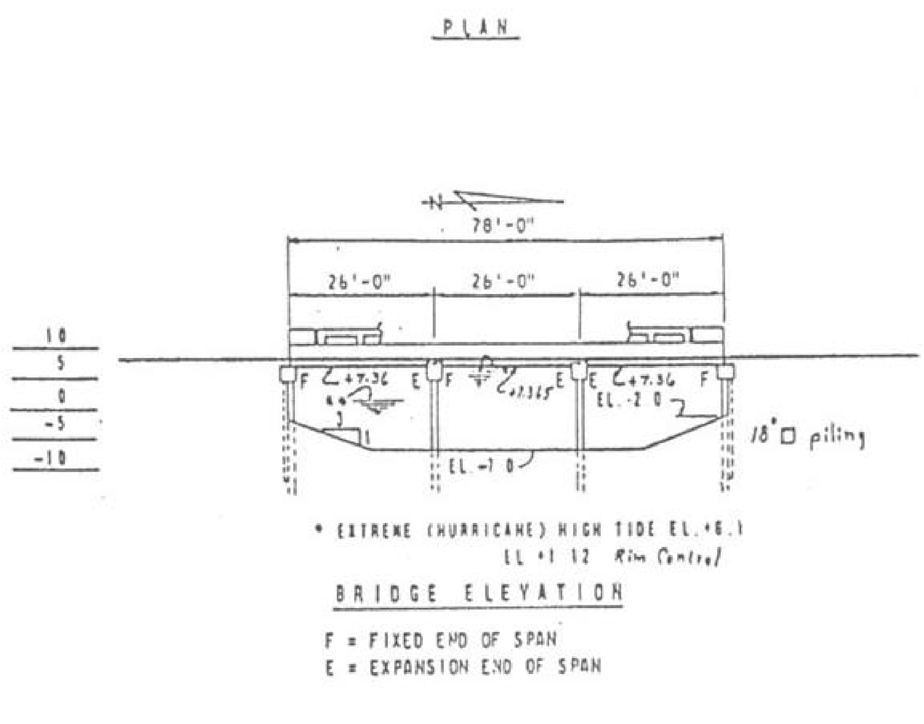
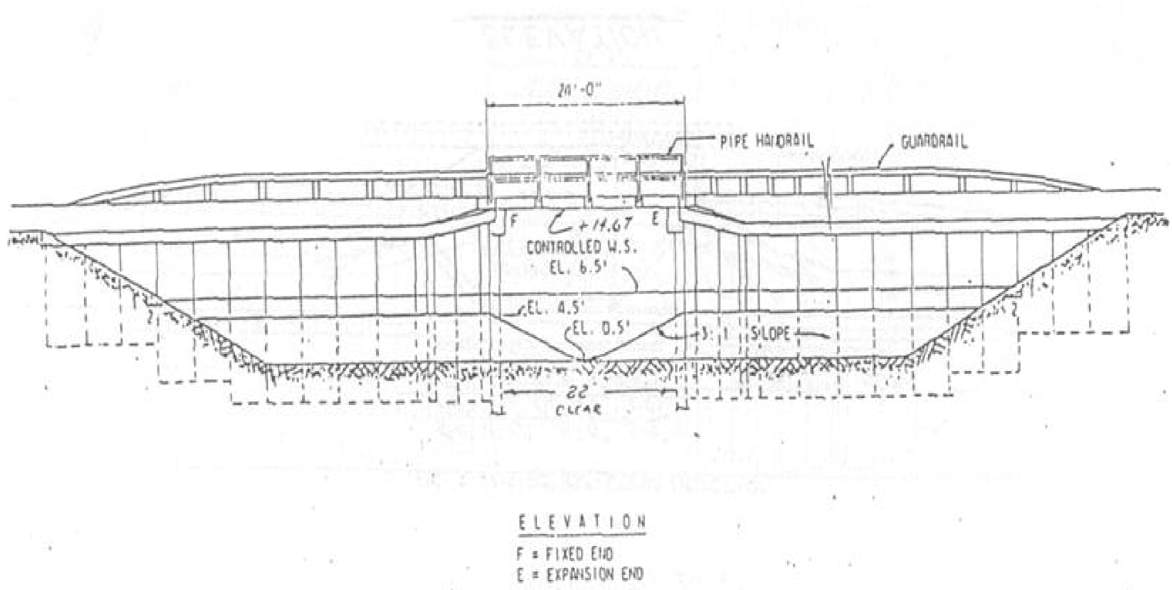


Figure 18. Bridge type 'D'.



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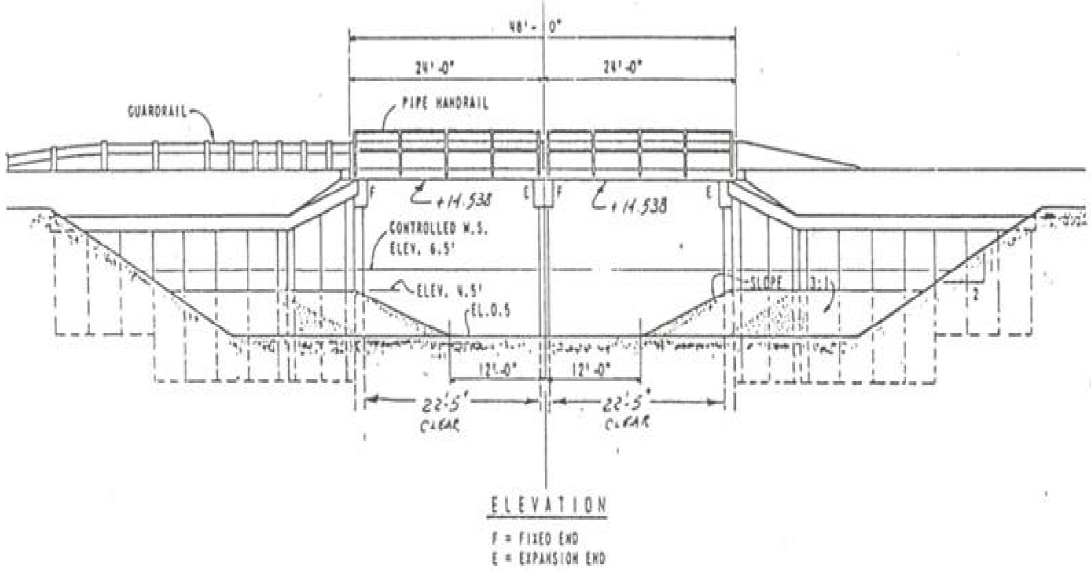

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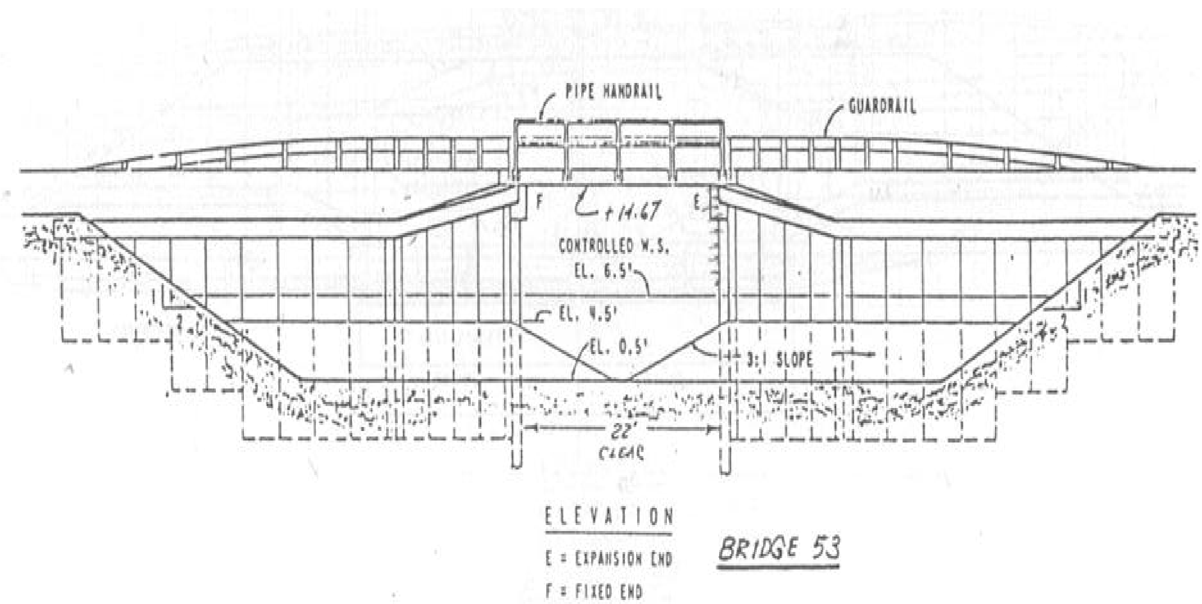

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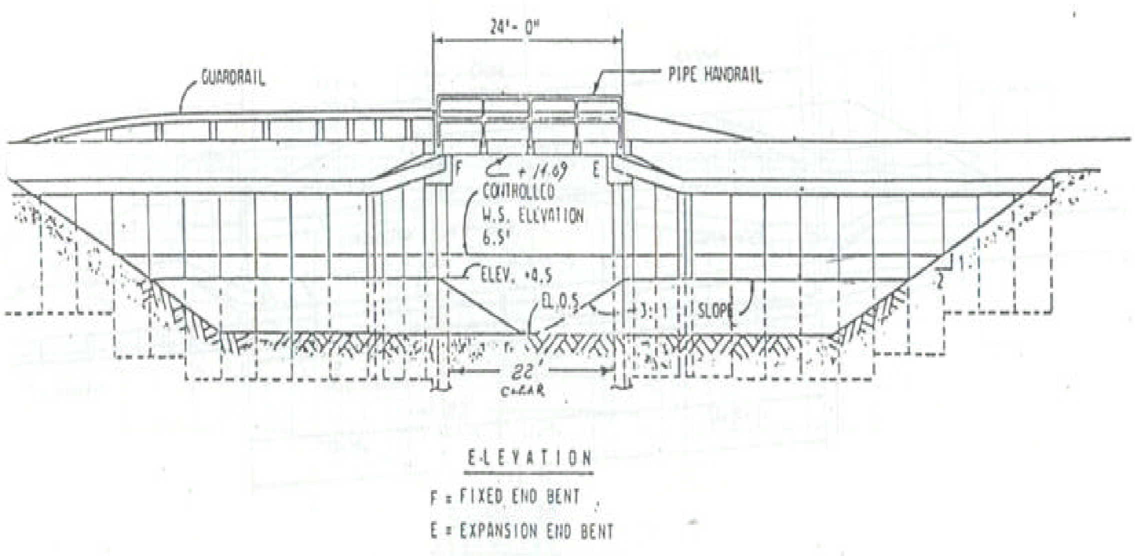

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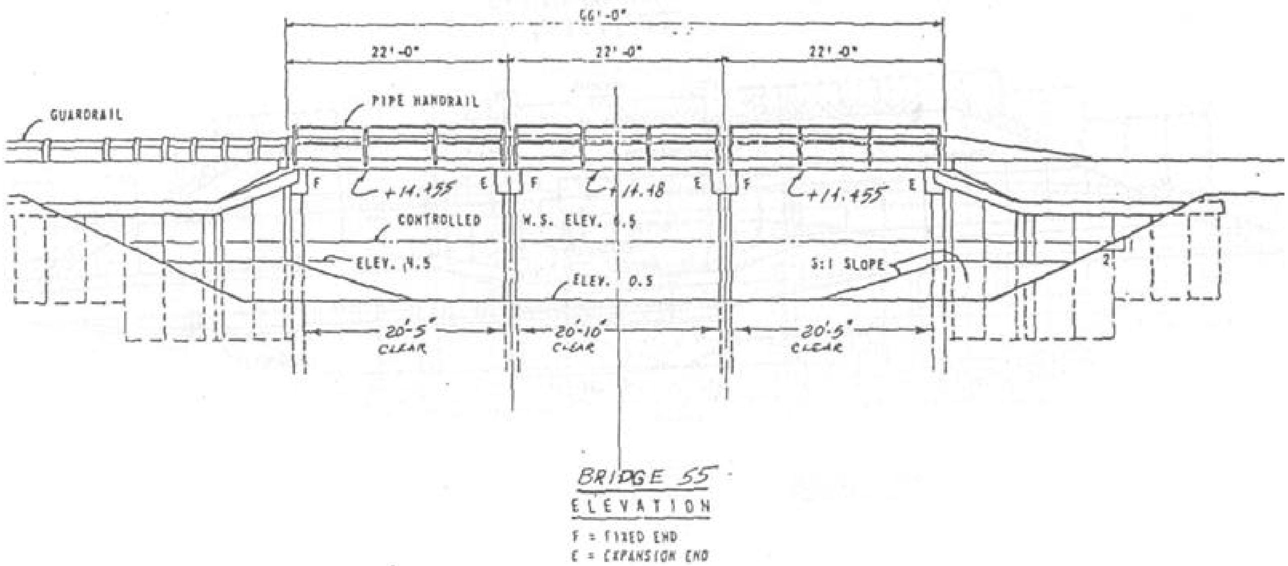

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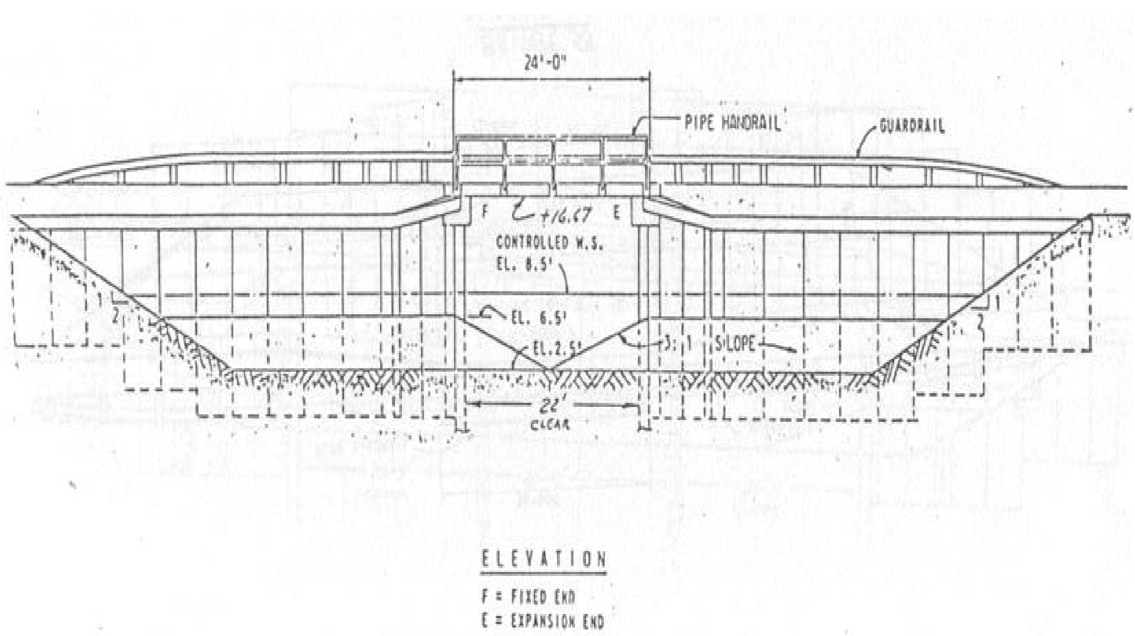

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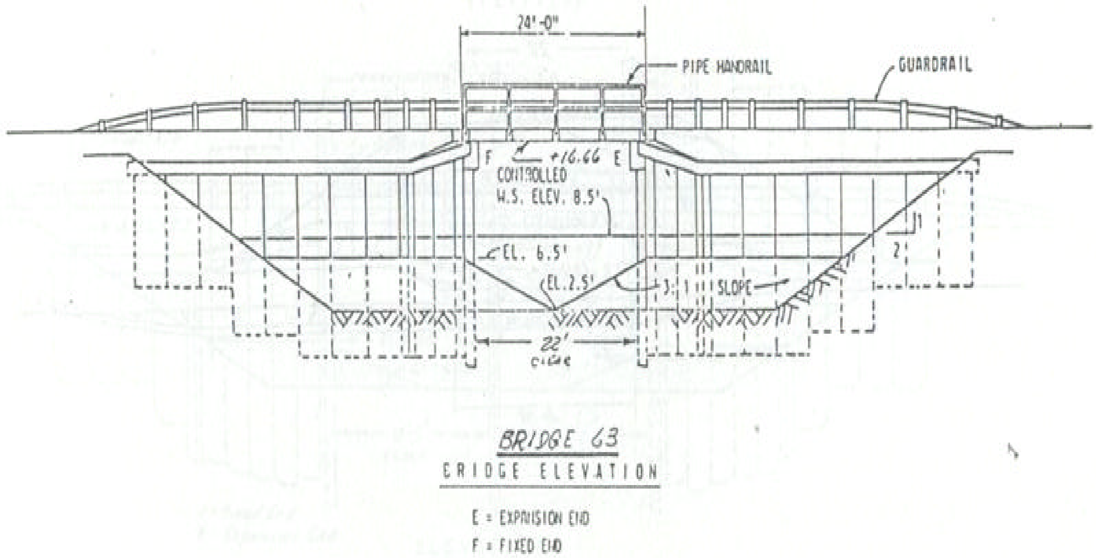

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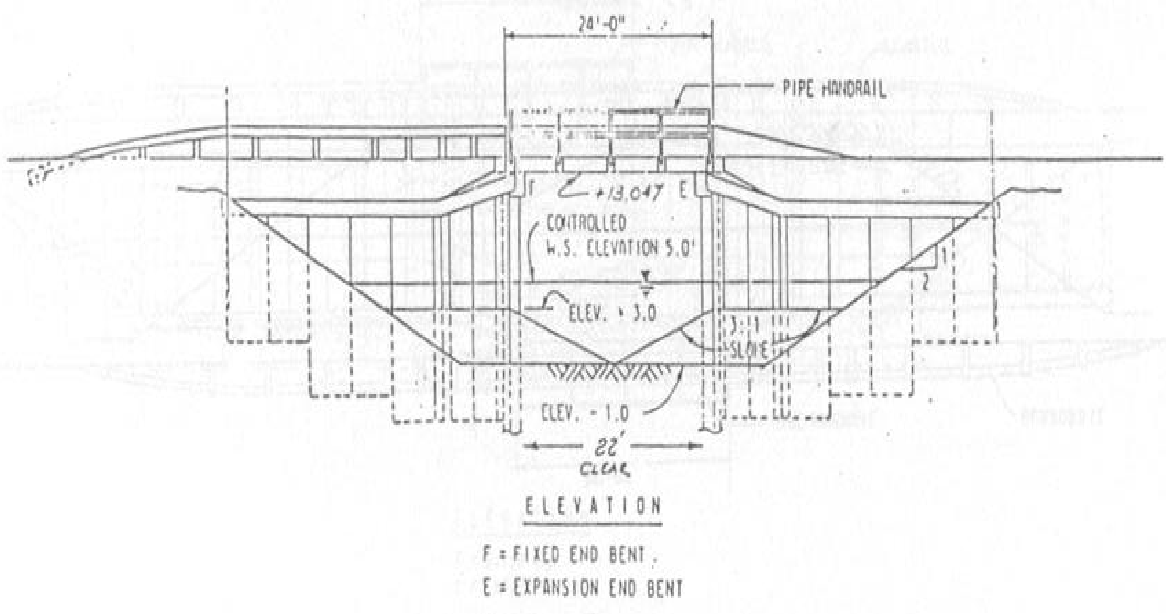

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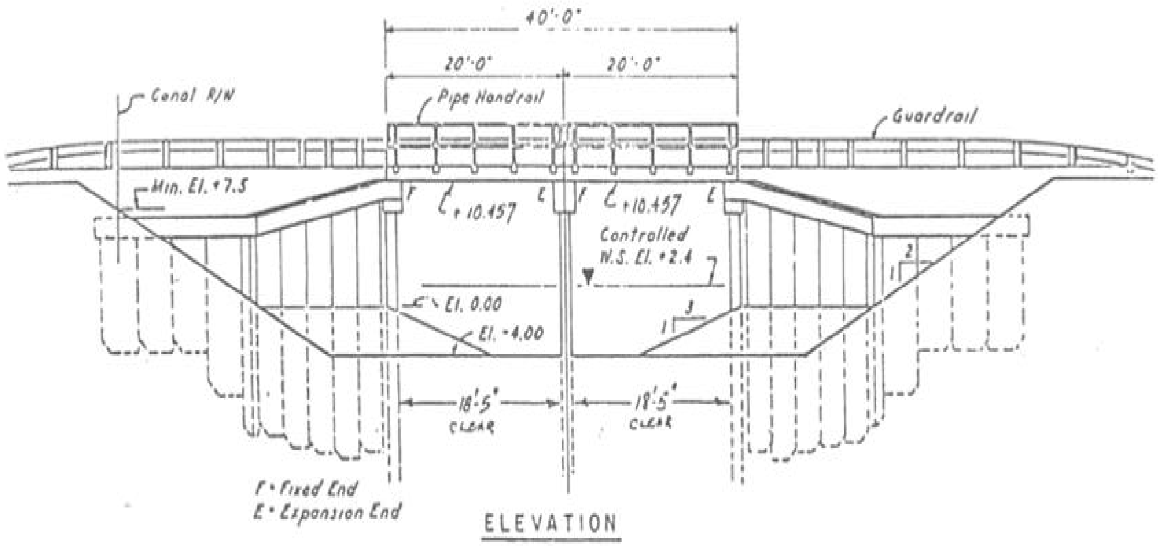

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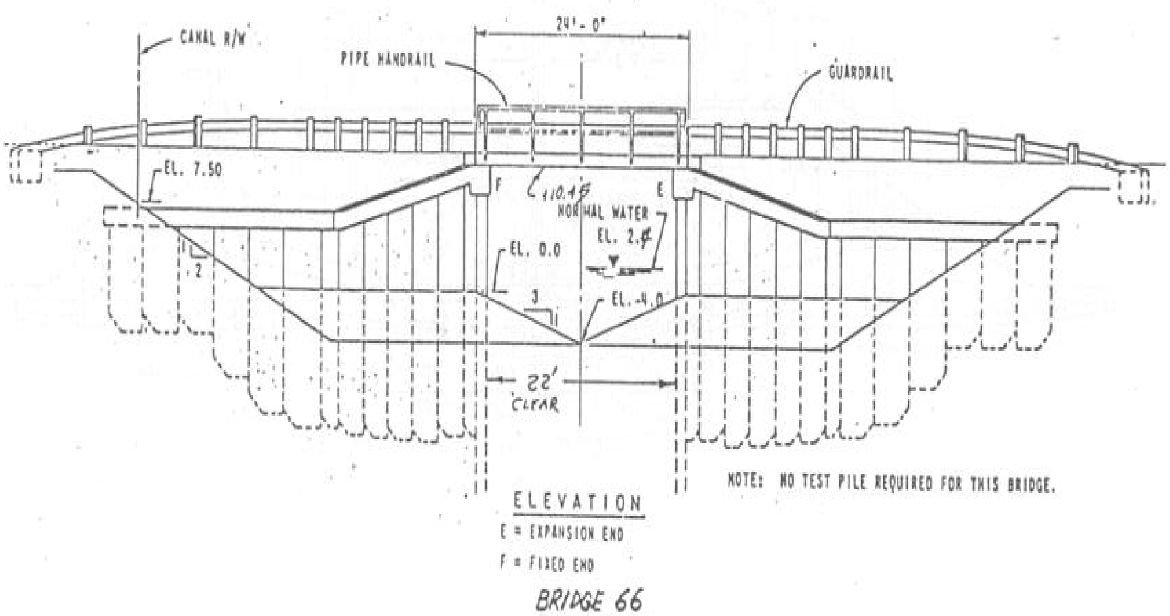

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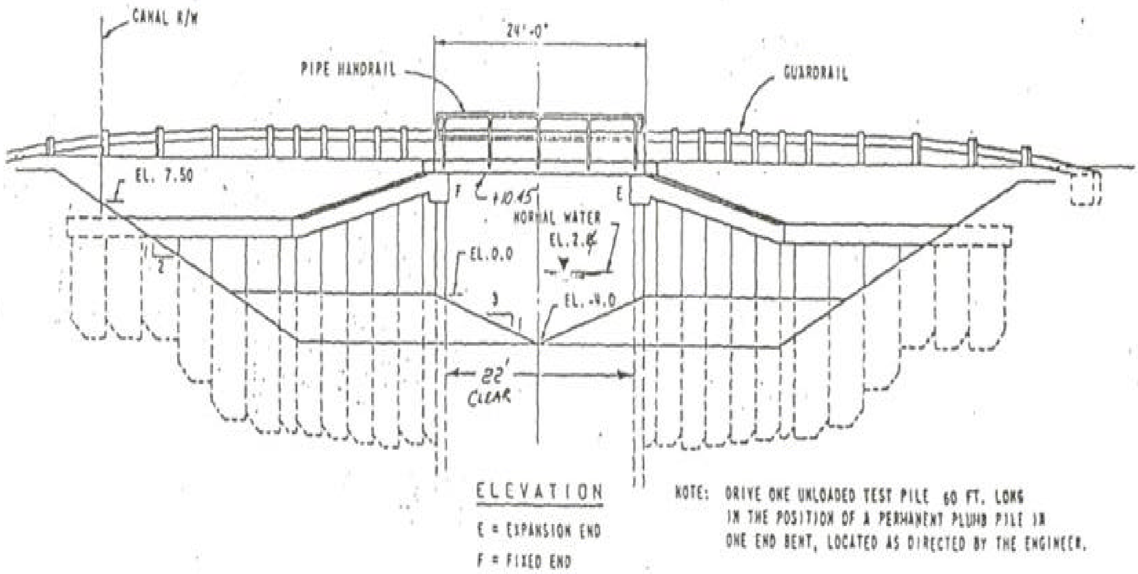

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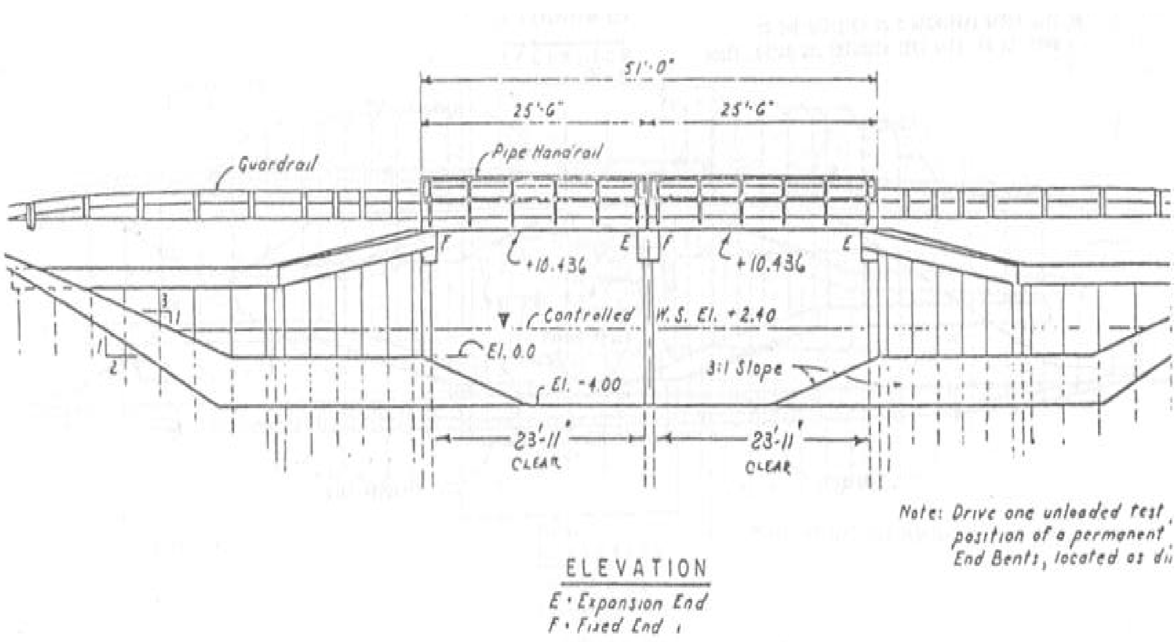

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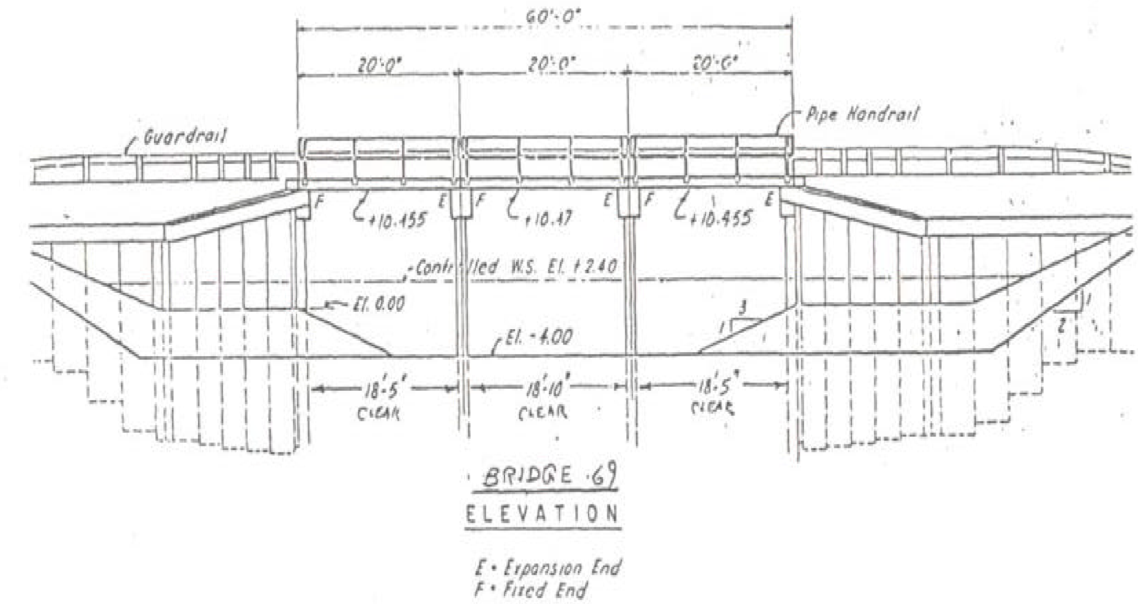

Figure 31. Bridge #69.

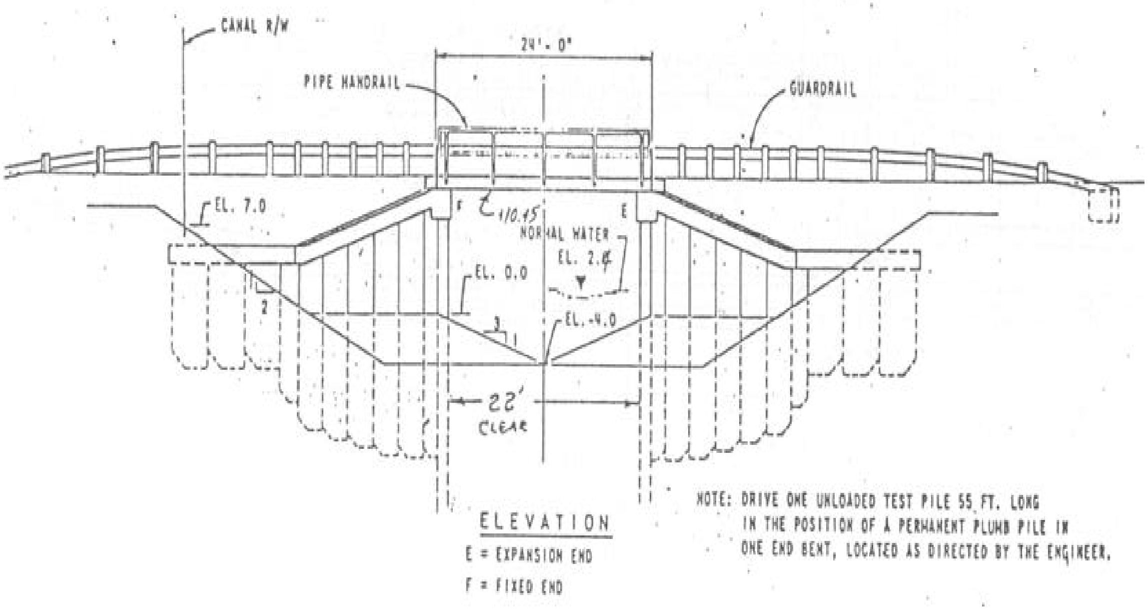

Figure 32. Bridge #71.

4.3. Soils Classification

The majority of Gator Slough Watershed has soils from the following groups: Boca, Matlacha gravely fine sand, Oldsmar, Pineda and Wabasso. These soils are all in the B/D hydrologic group except the Matlacha gravely fine sand, which is hydrologic group C. The B classification is for those areas that are well drained. The D classification refers to those areas with a high water table. The C classification has a water table two to three feet below the land surface. Most of this soil group is within the Cape Coral where the land has been reshaped and filled during the development (Data source: *A Water Management Study of the Cape Coral Networks*, Lee County, Connell, Metcalf, and Eddy, 1979). The measured water elevations in 1990 were similar to the information provided in the SCS Soil Survey of Lee County, Florida.

The soil conditions of the Cape Coral area were taken from soil borings and data furnished by the U.S. Soil Conservation Service. Soil borings taken on different sites scattered throughout Cape Coral indicate that in general the uppermost 25 to 40 feet of soil is mostly silica sand, with an estimated porosity of 30%. About half of the sites had thin layers of restrictive material such as sandy silt, silty sand or sand with traces of silt occurring at shallow depths. At the depth of 25 to 40 feet there is a layer of marl, or green clay (Data source: *Lee County Surface Water Management Plan*, Johnson Engineering, Inc., Camp Dresser & McKee Inc., Hole, Monte & Assoc., and W. Dexter Bender & Assoc., 1991), (Data source: *City of Cape Coral, Water Independence For Cape Coral WICC Master Plan*, City of Cape Coral, Boyle Engineering Corporation, 1988).

According to *The Florida General Soils Atlas*, the soils of Cape Coral are classified as shown in the figures below.

The soil classification numbers indicated in the figure were defined as:

No. 2: Immokalee-Myakka-Pompano association: Nearly level, poorly drained sandy soils with weakly cemented sandy subsoil and poorly drained soils, sandy throughout.

No. 3: Adamsville-Pompano association: Nearly level, somewhat poorly and poorly drained soils, sandy throughout.

No. 5: Keri - Ft. Drum - Hallandale association: Nearly level, somewhat poorly drained soils with thin sandy layers over loamy marl under-laid by sandy and poorly drained soils with thin sandy layers over porous limestone.

No. 6: Pompano-Charlotte association: Nearly level, poorly drained soils, sandy throughout.

No. 7: Bradenton-Wabasso-Felda association: Nearly level, poorly drained soils with thin, sandy layers over loamy subsoil; poorly drained sub soils with a weakly cemented sandy subsoil layer under-laid by loamy subsoil and poorly drained sandy soils with loamy subsoil.

No. 8: Salt Water Marsh and Swamp Dunes association: Nearly level, very poorly drained soils subject to frequent flooding by tidal waters and deep droughty sands.

(Data source: *A Water Management Study of the Cape Coral Networks*, Lee County, Connell, Metcalf, and Eddy, 1979)

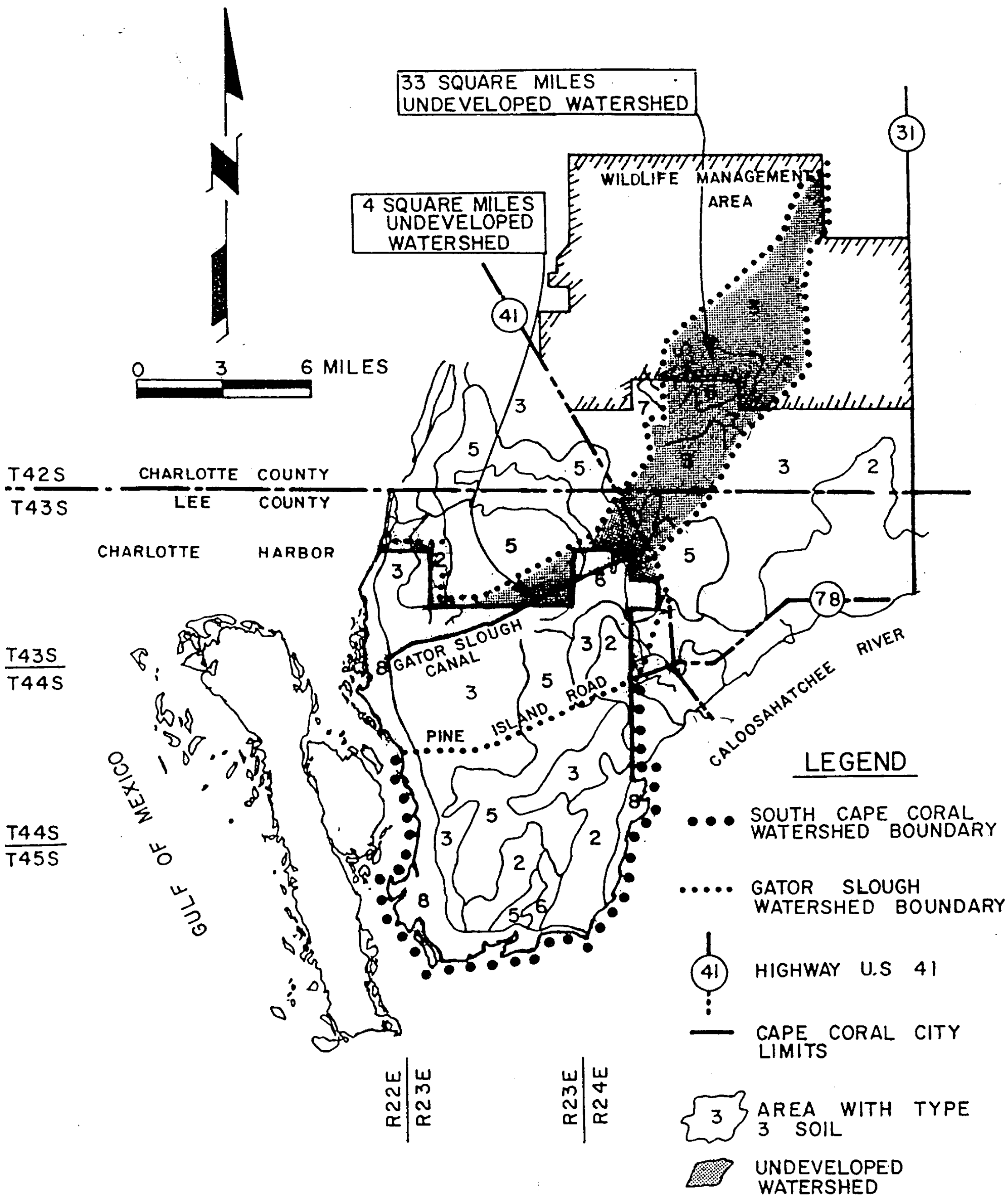

Figure 33. Soil Atlas of Cape Coral.

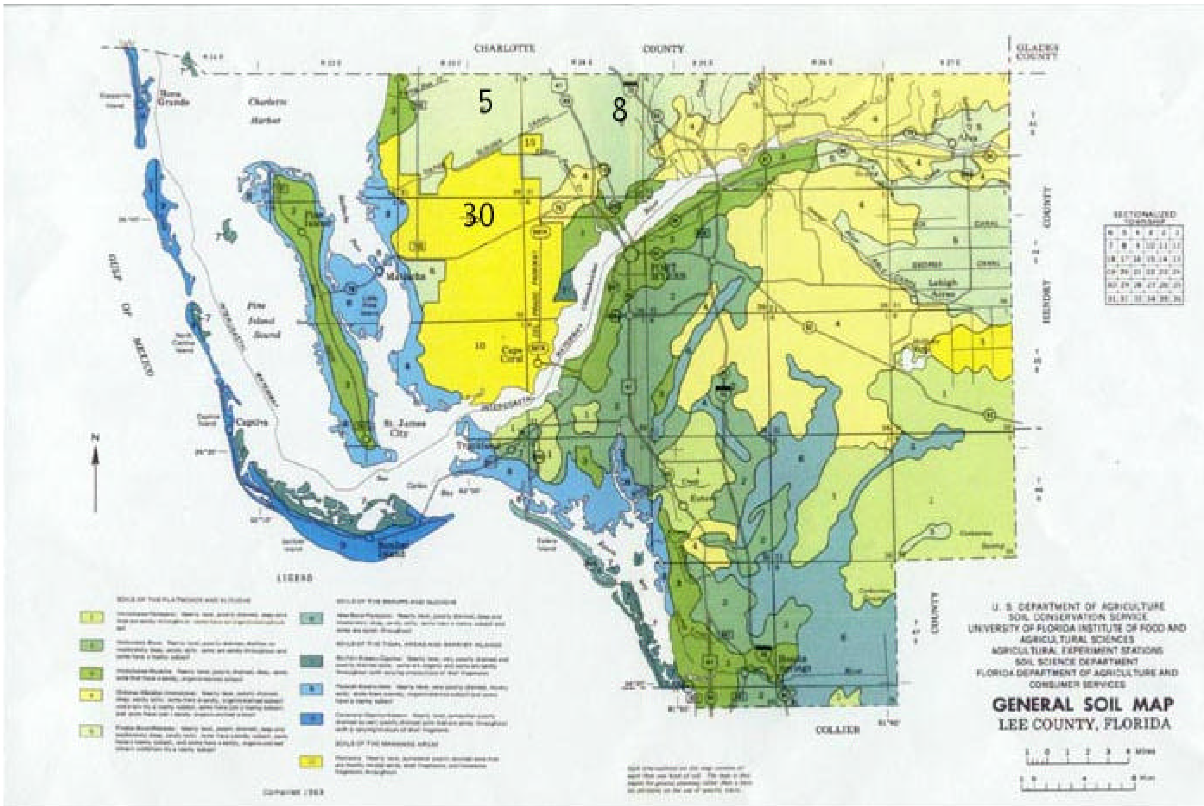

Figure 34. Lee County General Soil Map.

4.4. Groundwater Flow

As agreed in the Pre-Scope Meeting with the City of Cape Coral on October 2, 2000, the detailed simulation of the proposed horizontal wells to evaluate the well capacity, and the hydraulics of the canal and ground water interaction will be part of a subsequent study, using a MODFLOW simulation. The XP SWMM Groundwater option in the present study will be used in a less detailed analysis to evaluate its hydrology, focusing overall on the correct evaluation of the interflow/base flow contribution in the outflow hydrograph shape and total volume.

In the City of Cape Coral the surficial aquifer system is comprised of unconsolidated sand or silty sand deposits interbedded with sandy limestone, shell fragments, and sandy clay. It is not under artesian pressure (Data source: *Lee County Surface Water Management Plan*, Johnson Engineering, Inc., Camp Dresser & McKee Inc., Hole, Monte & Assoc., and W. Dexter Bender & Assoc., 1991), (Data source: *A Water Management Study of the Cape Coral Networks*, Lee County, Connell, Metcalf, and Eddy, 1979). The aquifer is reported to be approximately 20 feet thick and is under-laid with a thick (59 feet or more) layer of sandy clay. Its hydraulic conductivity varies due to lithologic changes. Results found in literature indicate that the hydraulic conductivity ranges from 10^{-5} and $2*10^{-2}$ feet/sec. The higher values would indicate sand deposits, while the lower values would indicate limestone (Data source: *City of Cape Coral Utility Master Plan Update, Final Report*, Dames and Moore in association with Black and Veatch, August 1999). The large range of this parameter has been an important factor as for the calibration of the groundwater flow contribution.

The water level in this aquifer rises in response to recharge by local rainfall and seepage from the extensive network of drainage canals and the levels falls in response to losses by evapotranspiration and seepage into the canals, the Caloosahatchee River, and the Bay. Recharge of this aquifer by vertical percolation of rainwater is inhibited in many of the undeveloped and undisturbed parts of Cape Coral because of layer of silt and clay, which exist in places at very shallow depths. This results in areas with locally perched water tables from which much of the rainfall is lost to evapotranspiration rather than infiltration to the Water Table Aquifer.

Groundwater movement is generally radial flow in the Cape Coral area, with flow moving to the west towards Matlacha Pass, and flow directions to the south and east towards the Caloosahatchee River, the canal system, and again Matlacha Pass (Data source: *City of Cape Coral Utility Master Plan Update, Final Report*, Dames and Moore in association with Black and Veatch, August 1999).

Groundwater elevations vary within the watershed. Adjacent to the main canals and their tributaries, water levels are low. This provides for well-drained soil conditions. This well-drained condition is evident from the dry conditions near the canals. Localized ponding of water is often attributable to the fine grain soils rather than an overall high water table. The localized ponding is usually of short duration, typically less than six hours. Wet season water levels farther from the canal, including the area east of U.S. 41, are close to the ground surface as expected. This is especially true in the areas that are not developed with canals and have not had land elevations raised (Data source: *Lee County Surface Water Management Plan*, Johnson Engineering, Inc., Camp Dresser & McKee Inc., Hole, Monte & Assoc., and W. Dexter Bender & Assoc., 1991).

In the present study the water table was assumed to be 1.5 feet below the natural ground level, to run a steady state groundwater outflow calibration. The groundwater rate that can be withdrawn from the water table aquifer into the canal system by horizontal seepage has been evaluated according to the Dupuit-Forchheimer formula resulting from a head differential of 2.5 feet between the furthermost area of the aquifer, about ¼mile maximum, and the canals as suggested by literature.

Vertical percolation is more effective than seepage from the canals in reaching the water table aquifer. The potential rate of this vertical percolation is up to 5 cfs/acres. The canal system, however, has a potential recharge rate of less than 0.01 cfs/acre with a head of 1 foot (Data source: *A Water Management Study of the Cape Coral Networks*, Lee County. Connell, Metcalf, and Eddy, 1979).

There are tributary conveyances on the north side of the Gator Slough canal. These conveyances have no control structures to maintain water levels. The effect is to expand the overdrained areas that exist adjacent to the main canal. Control structures on these and future connections to the canal could be designed to minimize the area of overdrainage.

The *City of Cape Coral Utility Master Plan Update, Final Report* prepared by Dames & Moore in association with Black and Veatch August 1999, describes a groundflow simulation performed in the area.

The MODFLOW model results presented in the report have been used as a calibration target to fix the groundwater parameters of the XP SWMM options. The Dames & Moore model showed that the base flow attainable rate would vary from 43 to 62 cfs. The XP SWMM model has finally reached the amount of a constant 50 cfs during the simulated period (September, 1996)

Groundwater outflow data

Groundwater discharge represents lateral flow from the saturated zone to the receiving water. The Dupuit Forcheimer flow equation takes on the following general form (with reference to Figure. 35):

$$Q = K\frac{h_1^2 - h_2^2}{L} \qquad \text{(cfs per linear foot of canal)} \qquad (1)$$

where

K = hydraulic conductivity (range 10^{-5} to $2*10^{-2}$ feet/sec)

L = maximum flow distance at the upstream end of the aquifer

L is determined by the average distance of the canals reaches, and is set to about 0.25 mile

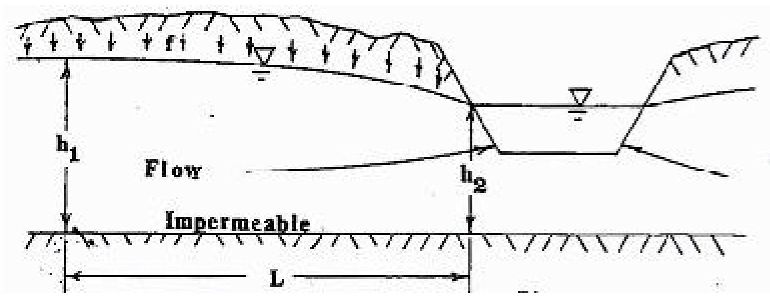

Figure 35. Definition sketch for Dupuit-Forcheimer approximation for drainage to adjacent channel.

The XP-SWMM general groundwater equation takes the form:

$$Q = A1 \cdot (D1 - BO)^{B1} - A2 \cdot BC^{B2} + A3 \cdot D1 \cdot (BO + BC) \qquad (2)$$

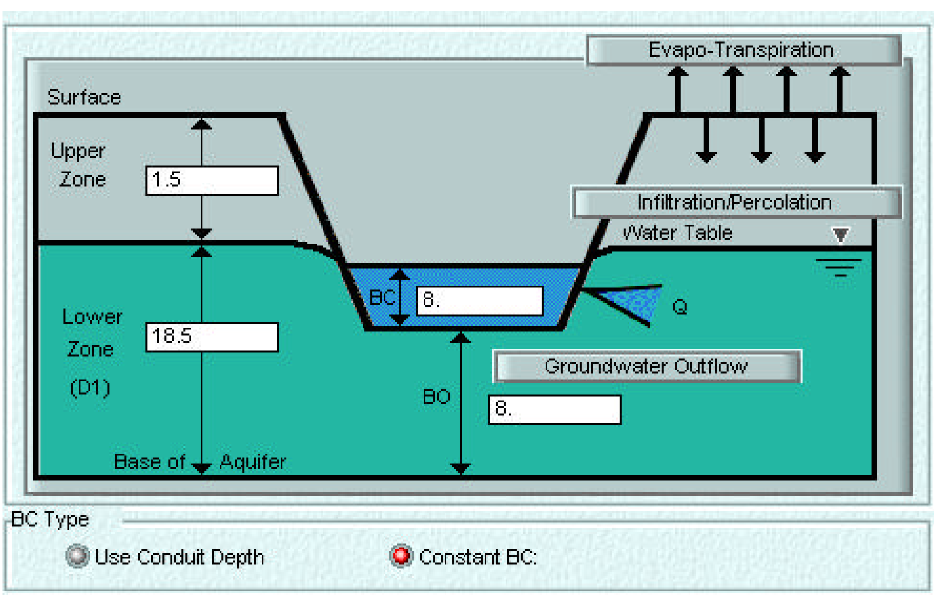

Figure 36. XP SWMM sketch for the groundwater component

Comparison of equation (1) and (2) gives:

$$A1 = A2 = \frac{K}{L}$$
$$B1 = B2 = 2$$
$$A3 = 0$$

To route the groundwater simulation it is necessary to enter the name of the node or conduit to where groundwater from this subcatchment will drain. The drainage name may or may not be the current node name.

In the model the rate of ground flow coming from each single subcatchment (node) is chosen to drain in the subcatchment itself.

A summarizing table with the complete set of groundwater data follows:

Table 3. Groundwater Required Parameters in XP SWMM 2000

Parameter	Unit	Used
Evaporation	in	0.2
Upper zone	ft	1.5
Lower zone D1	ft	18.5
Elevation of channel base BO	ft	8
Water depth BC	ft	8
Ground water flow coefficient A1	-	$5*10^{-5}$
Ground water flow exponent B1	-	2
Channel water influence coefficient A2	-	$5*10^{-5}$
Channel water influence exponent B2	-	2
Ground water/Channel water coefficient A3	-	0
Wilting point	-	0.05
Field capacity	-	0.1
Fraction of max. ET assigned to upper zone	-	0.5
Max. depth of significant lower zone transpiration	ft	3.3
Saturated hydraulic conductivity	in/hr	2
Porosity expressed as a fraction	-	0.3
Curve fitting parameter	-	20
Initial upper zone moisture expressed as a fraction	-	0.29
Coefficient of unquantified losses	in/hr	0
Average slope of tension vs. soil moisture curve	ft/fraction	128

4.5. Tidal Boundary Conditions

The Cape Coral City canals system bounded by the Lee-Charlotte County line on the north limit and by Pine Island road to the south, flows through Basins 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 eventually discharging to the North Spreader Canal System. The spreader system is composed of saltwater canals not used for the City withdraws because of the high salinity and the detrimental impact this type of water has on the vegetation. It originally was a body of fresh water isolated from salt water by a berm between the waterway and the saline Matlacha Pass. However, breaches and channels in the berm currently allow salt water to flow from the Pass to the waterway (Data source: *City of Cape Coral Utility Master Plan Update, Final Report*, Dames and Moore in association with Black and Veatch, August 1999).

The Spreader Canal System was designed to intercept discharge of freshwater from the Cape Coral network. The main objective of the waterway is to prevent point discharge of the canal network into the mangrove fringe along the west and southwest coastline of Cape Coral, distributing the canal discharges over all the existing mangroves. The mangroves were to be maintained by the waterway providing sheet flow through existing tidal wetlands.

Other purposes of the Spreader are to provide additional salinity control for the canals which discharge into it and to maintain higher groundwater elevations upstream during the dry season. (Data source: *A Water Management Study of the Cape Coral Networks*, Lee County. Connell, Metcalf, and Eddy, 1979).

The existing Spreader Canal consists of the North Spreader Waterway to the north of Pine Island Road, taken into account in this study, and the South Spreader Waterway to the south of Pine Island Road. Both systems are physically separated and can be considered to be distinct entities (Data source:

City of Cape Coral Utility Master Plan Update, Final Report. Dames and Moore, August 1999).

Breaks exist in the berm that separates the waterway from the Matlacha Pass. Currently, saltwater flows through these breaks from the pass to the Spreader System. Therefore downstream of Burnt Store Road, in the North Spreader Waterway, the conveyance is controlled by the same tidal conditions of Matlacha Pass, also considering the capacity of the perimeter canal system in the Cape Coral and connections seaward, and it was assumed the water elevations would be similar to those in Matlacha Pass station. Each of the four main canals of the network has a weir along Burn Street Road: Weir 11 (Gator Slough Canal), 13 (Horseshoes Canal), 14 (Hermosa Canal), and 15 (Shadroe Canal).

Matlacha Pass tide level historical information has been furnished by Lee County Environmental Services-Natural Resources Division; the Florida Department of Environmental Protection; and the U.S. Department of Commerce-National Oceanic and Atmospheric Administration National Ocean Service. Unfortunately it has not been possible to find monthly variation of the tide level corresponding to the month under analysis (September 1996). Thus the model has been assigned a constant Mean High Water Level over the full period of the calibration event, approximately equal to the spring high tide. This choice is consistent with many previous modeling efforts in the area. The unique node assigned with the Outfall option and a "User Stage History" is node 1756, located in the last southwest position. The level is taken from the Tidal Bench Mark "Matlacha Pass" (Latitude: 26^{o}37.9'N, Longitude: 082^{o}04.1'W, USGS Quad: Matlacha). The calibration event (1 year Return Interval) has been assigned with a tide elevations of 1.4 ft NGVD. The project events (5, 25, 100 years Return Interval) will been assigned with a tide elevations of 2.5 ft or 2.7 ft NGVD. The backwater analysis only accounts for conditions created by the design rainfall events. Consideration of tidal conditions other than normal is beyond the scope of this simulation.

4.6. Model Geometry and Configuration

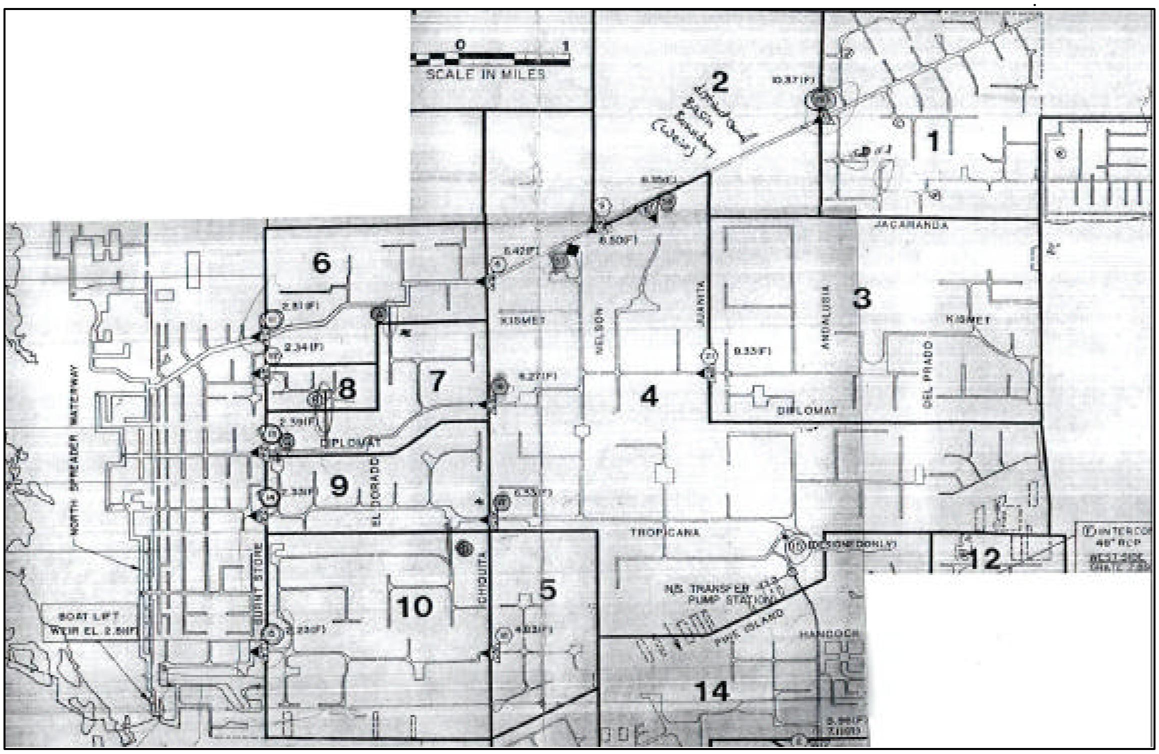

Figure 37. Project canal network area

For the portion of the watershed north and east of U.S. 41 the model utilizes historical data as the input hydrograph to Gator Slough at its easternmost node. Between Burnt Store Road and U.S. 41 a detailed simulation of the existing canal system is performed. West of Burnt Store Road not all the branch canals were included in the model but their storage volumes were considered at corresponding nodes based on the length and width of the reaches.

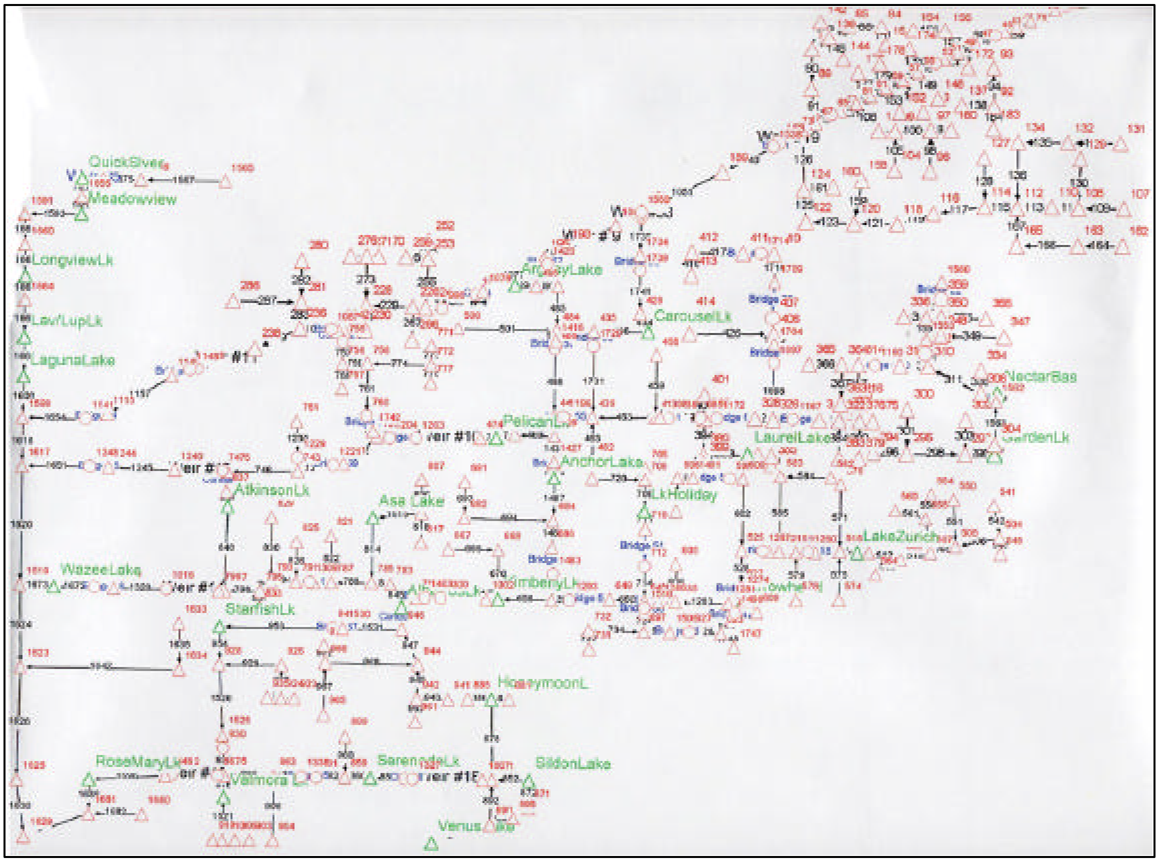

Figure 38. Simulated canal network

<u>Channels Dimension and Lakes</u>

The majority of the channel segments have a relatively uniform cross section with abrupt changes at certain locations. The four main channels, Gator Slough, Horseshoe, Hermosa, and Shadroe have been scaled as reported by the Johnson Engineering & Co., Master Plan; their branch canals have been dimensioned by geometric proportion to the main canals using the City of Cape Coral Drainage Plan maps.

Lakes have been inserted using a constant area storage method or a stepwise linear storage method for those cases where data were available. This second option allows use of trapezoidal section of the lakes in developing a stage-storage function.

Most of the links represent natural channels for which the shape and geometries are described through section coordinates, depth and elevation based on the width of the cross section and on the maximum depth of the canal.

Main canals cross-section main geometric parameters are:

<u>Gator Slough Canal</u>: Bottom width from 30 to 200 feet
Depth 12 feet
Bank Slope 2:1

<u>Horseshoe Canal</u>: Bottom width from 90 to 170 feet
Depth 12 feet
Bank Slope 2:1

<u>Hermosa Canal</u>: Bottom width from 80 to 200 feet
Depth from 10 to 13.5 feet
Bank Slope 2:1

<u>Shadroe Canal</u>: Bottom width from 40 to 220 feet
Depth from 11 to 27.5 feet
Bank Slope 2:1

Data source: *A Water Management Study of the Cape Coral Networks, Lee County*. Connell, Metcalf, and Eddy, (1979).

Nodes are the storage elements corresponding to pipe and channel junctions. The variables associated with a node are volume, head, imperviousness, slope and surface area. Node data are required for every node in the network including regular nodes, storage nodes, pump nodes, and outfall nodes.

Canal Slopes

The channel side slope varies depending on location. For the ground slope for property adjacent to the channels, we assumed a mean value of 1 ft/1 mi = 0.0002 as used in previous Gator Slough studies. Based on the channel elevations found in the City of Cape Coral maps (field information/road design maps) we assumed channel bottom slopes as follows:

Gator Slough Canal (Weir # 9 to Weir # 4)	slope = 0.00100
(Weir # 19 to # 11)	slope = 0.00030
Horseshoe Canal (Bridge # 20 to Weir # 13)	slope = 0.00025
(tributary canals bottom slope)	slope = 0.00100
Hermosa Canal (Bridge # 16 to Weir # 14)	slope = 0.00015
(tributary canals bottom slope)	slope = 0.00016
Shadroe Canal (Weir # 18 to Weir # 15)	slope = 0.000200
(tributary canals bottom slope)	slope = 0.00016

The following is a brief synopsis of the hydraulic structures along the main channels, which include weirs, culverts, bridges, canals interconnections, and balancing structures, based on the information of paragraph 4.2.

Gator Slough Canal

Three water control structures are located downstream of Weir 19; these are Weirs 9, 4, and 11. Downstream of Weir 11 there is one culvert and one bridge (94). Upstream of Weir 11, there are two other bridges (74 and BS). Bridges and culverts are located on both the main channel and the branch canals.

• Weir 9 is a stair steps across the canal. We represent it as a rectangular weir without end contraction. Weir specifications were adapted from the Report by Connell, Metcalf and Eddy (1979).

For flow rate in cubic feet per second, length and head in feet, the discharge equation for a rectangular weir without end contraction is:

$$Q = 3.33 \cdot L \cdot H^{1/5}$$

Weirs of the same shape have a flow defined with the same equation.

• Weir 4 is a reinforced concrete rectangular weir without end contraction. Weir specifications were taken from the Johnson Engineering report (1991).

• Weir 11 is a reinforced concrete rectangular weir without end contraction. There is one slide gate on the south end of the weir. Weir specifications were found in the Connell, Metcalf and Eddy report (1979).

Horseshoe Canal

The three water control structures are Weirs 21, 16, and 13. It has 18 bridges and/or culverts upstream of Weir 13 and one bridge downstream of Weir 13. Bridges and culverts are located on both the main channel and the branch canals.

• Weir 21 is a reinforced concrete drop-inlet culvert. Weir specifications were adapted from the Connell, Metcalf and Eddy report (1979).

• Weir 16 is a reinforced concrete rectangular weir without end contraction and connected to a 4-pilling bridge. Weir specifications were adapted from the Connell, Metcalf and Eddy report (1979).

• Weir 13 is a reinforced concrete rectangular weir with end contraction. Weir specifications were adapted from the Connell, Metcalf and Eddy report (1979).

Hermosa Canal

The two water control structures are Weirs 17 and 14. It has 11 bridges and/or culverts located upstream of Weir 14 and one bridge located downstream of Weir 14. Bridges and culverts are located on both the main channel and the branch canals.

• Weir 17 is a reinforced concrete rectangular weir without end contraction connected to a 4 pilling bridge, type D. Weir specifications were adapted from the Connell, Metcalf, and Eddy report (1979).

• Weir 14 is a reinforced concrete rectangular weir without end contraction. Weir specifications were adapted from the Connell, Metcalf, and Eddy report (1979).

Shadroe Canal

The two water control structures: Weir 18 and 15. It has 3 bridges located upstream of Weir 15. Bridges and culverts are located on both the main channel and the branch canals.

• Weir 18 is a reinforced concrete drop-inlet culvert. Weir specifications were adapted from the Connell, Metcalf, and Eddy report (1979).

• Weir 15 is a reinforced concrete rectangular weir with end contraction. Weir specifications were adapted from the Connell, Metcalf, and Eddy report (1979).

Branch Canals and Spreader Waterway

Three water control structures were inserted in the branch canals: Weir 58, Weir 5 and Weir 15N, which belong to the Spreader Waterway, located at the west extreme of the watershed.

• Weir 58 is a rectangular weir with end contraction and connected to 7 CMP pipes. Weir specifications were adapted from the Connell, Metcalf, and Eddy report (1979).

For flow rate in cubic feet per second, length and head in feet, the discharge equation for a rectangular weir with end contraction is:

$$Q = 3.33 \cdot (L - 0.2 \cdot H) \cdot H^{1/5}$$

Weirs of the same shape have a flow defined with the same equation.

• Weir 5 is assumed as a rectangular weir without end contraction.

• Weir 15N is assumed as a rectangular weir without end contraction.

Other Structures

• Canals Interconnection A: conduit between Gator Slough (Chase Canal) and Horseshoe (Pomeroy Canal): 4 ft reinforced concrete pipe, length 1205 ft, Manning factor 0.014. Specifications found in the *WICC Master Plan, City of Cape Coral*, by Boyle Engineering Corporation (1988).

• Canal Interconnection C: conduit between Horseshoe Canal and Hermosa (Atkinson Canal): 4 ft reinforced concrete pipe, length 800 ft, Manning factor 0.014. Information found in the *WICC Master Plan, City of Cape Coral*, by Boyle Engineering Corporation (1988).

• Canal Interconnection D: conduit between Hermosa (Mohawk Canal) and Shadroe (Albatross Lake): 4 ft reinforced concrete pipe, length 2000 ft, Manning factor 0.014. Information found in the *WICC Master Plan, City of Cape Coral*, by Boyle Engineering Corporation (1988).

• Balancing Structure - Structure # 57: It transfers water by gravity low through by 4 open circular pipes, 5 ft diameter, 100 ft of length, Manning factor: 0.025, from Basin 4 to Gator Slough. Information found in the Connell, Metcalf, and Eddy report (1979).

North South Transfer Pump Station

A canal transfer pump station is present in the study area, the North South Transfer Station, which conveys water from Basin 4 (Regina Canal), north of Pine Road corridor, to Basin 14 (Mackinac Canal) out of the watershed under analysis. It consists of two low head, high volume axial flow pumps and a 36-inch concrete pipeline connecting the two basins. The station is manually operated and is used to replenish basins south of the Pine Island Road Corridor when the system demand is high.

The Pump (model NC 3) manufacturer is M&W; Pump characteristics: 6,600 gpm at 9 feet Total Dynamic Head (Data source: *City of Cape Coral Utility Master Plan Update, Final Report*, Dames and Moore in association with Black and Veatch, August 1999).

Prior modeling assumed the basins south of Pine Island Road were full; therefore the N/S pump station was not activated during the modeling runs. As per information and agreement with Cape Coral City (January 05, 2001) this more conservative approach was used and did not include the N/S pumping station.

Storage Areas

Use of the storage options for each node provides additional surface storage for a canal reach, thus better reflecting the storage of excess runoff. When a canal volume is temporary inadequate, water is allowed to pond in the surrounding overbank area until there is sufficient hydraulic capacity within the canal for it to rejoin the network. To achieve this storage effect the maximum spill crest value in the storage node has been raised from the canal crown to a coordinate location determined from the node area width and slope. Beyond this coordinate, any additional water depth is considered lost from the system (to avoid double counting of the storage volume). The main purpose of this project is to evaluate the flood stage and find out any canal banks overflow risks. To obtain this information from the output file for runoff event, each link data set has been provided with a suitable "Maximum Channel Depth". Combination of raised spill crest in each node and max depth in each link allow us to verify when the canal depth is exceeded by the water level without any loss of flooding area beyond the canal crown.

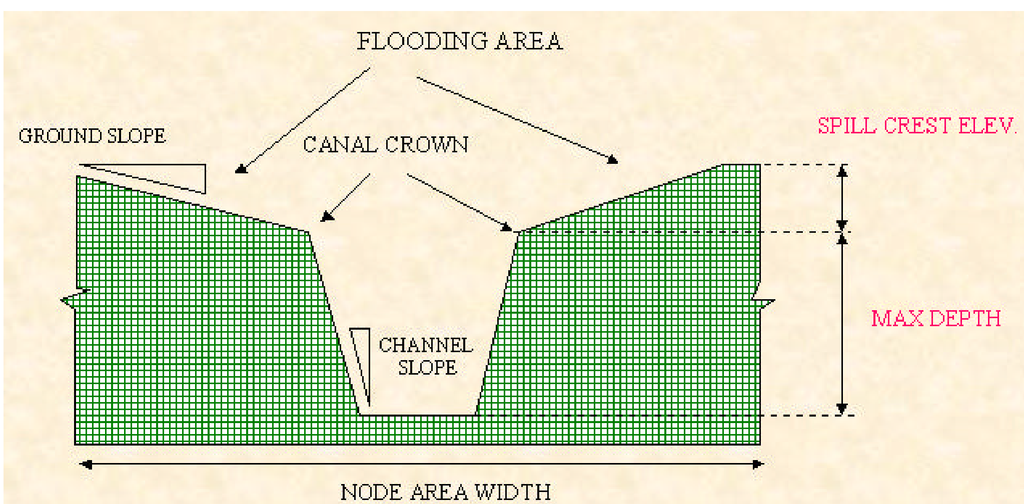

Figure 37. Sketch of a typical canal section

The XP SWMM options for each subcatchment node are:

(1) "Measure depth from node invert", (2) "Use Spill Crest Elevation", (3) "Ponding Allowed", (4) "Max channel depth", and (5) storage definition like stepwise linear.

Sub-catchments are modeled as idealized rectangular areas with the slope of the catchment perpendicular to the channel

Manning's factor (*n*)

Based on the information and photo documentation received from Lee County Environmental Services, the canal Manning's factor has been determined as follows. The *n* factors used for the channels in tidal reaches of the conveyances have been set as 0.03. Generally these conveyances are wide with minimal plant growth in the channel. The *n* factors in the freshwater channel portion of the conveyances located east of Nelson Road has been set as 0.07. Fresh water areas tend to be narrower and have more plant growth in the channel than the tidal portions of channels. From Nelson Road due west until Weir 11, 13, 14, and 15 the factors have been set as 0.06 or 0.05. Specifications were also taken from Johnson Engineering report (1991).

For the overland flow within each subcatchment Manning's *"n"* factors are 0.05 for the impervious portion and 0.2 for the pervious portion.

Infiltration

Infiltration from pervious areas is computed using the Horton equation. Its parameters have been set to the following values, based on review of the soil surveys:

Max infiltration rate	2 inch/hour
Min (asymptotic) infiltration rate	0.1 inch/hour
Decay rate of infiltration	0.00115 sec^{-1}

Imperviousness percentages

The project area has been subdivided and assigned six different imperviousness percentages based on the projected 1993 functional population (specifications were taken from *WICC Master plan – City of Cape Coral*, by Boyle Engineering, 1988), computed using the New Jersey equation:

$$I = 9.6\ PD^{(0.53 - 0.0391 \log 10\ PD)}$$

Where:

I = imperviousness [%]

PD = population density in developed portion of the urbanized area [persons/acre]

In addiction to using this formula a more close literature survey the area urban development suggested an imperviousness between 5% and 30%. Only a limited (751 acres) high populated area has been assigned with an imperviousness percentage of 34%

Initial depth

For purposes of initializing the simulation, the water surface profile of the system was assumed to be four feet below local land surface (channel bank) elevation. This assumption generated initial depths in the canal system, ranging from 4 to 8 feet. Final value obtained as for depth of water and starting flow in the canals system have then be used in a Hot Restart options that provides a more realistic and equilibrated initial condition for the final simulation.

The following is a synoptic list of the critical attributes of each subcatchment and conveyance element of the system

Table 4. Node parameters.

Node Name	Area	Imperviousness	Width	Slope	Ground El.	Invert El.
	(acres)	(%)	(feet)	(ft/ft)	(ft)	(ft)
252	22	5	1722	0.0002	8.6	0.3
259	45	5	1722	0.0002	9.1	0.8
253	45.4	5	1722	0.0002	7.7	-0.6
31					24.9	16.5
33	184.3	5	800	0.0002	25	15
37					23	11.5
39	283.4	5	4000	0.0002	23.5	10
75	283.4	5	4000	0.0002	26	11.5
78	283.4	5	4000	0.0002	28.5	13
41	283.4	5	10000	0.0002	24	9
43	10.2	5	200	0.0002	20.6	6
45					20.6	6
137	50	5	800	0.0002	17	6
183	50	5	700	0.0002	17	6
92	76	5	800	0.0002	17	6
93	44.8	5	800	0.0002	18	6
47	92.2	5	700	0.0002	20.6	7
154	23	5	600	0.0002	21.5	7.5
155	23	5	600	0.0002	21.5	7.5
172	23	5	600	0.0002	19.5	7.5
49	23	5	600	0.0002	22.1	7.5
51	42	5	800	0.0002	20.6	6.5
53					20.5	5
148	41.2	5	800	0.0002	17	6
174	31.8	5	800	0.0002	21	6
55	41.2	5	800	0.0002	20.1	5.5
146	29.2	5	800	0.0002	17.5	6.5
57	45	5	800	0.0002	21.1	6.5
152	29.2	5	700	0.0002	17	6
178	20	5	600	0.0002	20.8	6
59	50	5	700	0.0002	20.6	6
176	30	5	700	0.0002	20.7	6
61	109.2	5	800	0.0002	20.9	6
96	46.4	5	800	0.0002	16	6
180	25	5	600	0.0002	16	6
97	50.2	5	1000	0.0002	16	6
104	30.4	5	700	0.0002	17	6
99	46.4	5	800	0.0002	16	6
101	150.4	5	800	0.0002	16	6
81	28.8	5	700	0.0002	21	6
63	39.2	5	600	0.0002	21.5	6
65					20	5.5

Node Name	Area	Imperviousness	Width	Slope	Ground El.	Invert El.
	(acres)	(%)	(feet)	(ft/ft)	(ft)	(ft)
150	14.8	5	700	0.0002	20.7	6
84	30	5	800	0.0002	21	6
85	54.4	5	800	0.0002	21	6
142	10.2	5	600	0.0002	21	6
144	20	5	650	0.0002	20.8	6
139	20	5	700	0.0002	21	6
87	70	5	800	0.0002	21	5.8
89	70.4	5	800	0.0002	20.6	5.4
67	60	5	800	0.0002	19.3	5.5
107	36	5	800	0.0002	17	6
129	54.4	5	600	0.0002	17	6
108	168	5	1000	0.0002	17	6
110	95	5	950	0.0002	17	6
131	20	5	300	0.0002	17	6
132	22	5	500	0.0002	17	6
134	66	5	800	0.0002	17	6
162	51.2	5	500	0.0002	16	6
163	85.4	5	600	0.0002	16	6
165	50	5	500	0.0002	16	6
112	78	5	1300	0.0002	17	6
127	121.6	5	1300	0.0002	17	6
114	278.4	5	2000	0.0002	16	6
116	88	5	1200	0.0002	15.5	6
118	120	5	1000	0.0002	15.5	5.8
158	60.4	5	900	0.0002	15.5	5.8
120	90	5	1000	0.0002	15.1	5.6
122	86.4	5	1000	0.0002	15	5.4
160	60	5	1000	0.0002	15.5	5.4
124	80.8	5	1000	0.0002	15.5	5.2
69	35	5	600	0.0002	18	5
71					17	5
73					17	5
168					17	5
1538					17	5
189	1512	5	4018	0.0002	15.81	3
191	609	5	6314	0.0002	16.65	4
1550					16	4
1409					13	4.1
1042					15.76	3.76
1734	292.7	5	4936	0.0002	15.7	2.8
1739					15.7	2.8
429	211.4	5	3731	0.0002	15.3	2.6
CarouselLk					15.3	2.3
435	142.8	5	2353	0.0002	14.2	1.8

Node Name	Area	Imperviousness	Width	Slope	Ground El.	Invert El.
	(acres)	(%)	(feet)	(ft/ft)	(ft)	(ft)
1729					14.2	1.8
458	120	5	2525	0.0002	14.3	1.81
385	29.6	5	1607	0.0002	15.2	2.9
386	41.1	5	1033	0.0002	14.9	2.7
387	80	5	1894	0.0002	14.9	2.5
LaurelLake					14.9	2.2
399	31.7	5	1607	0.0002	14.4	2.1
389	38.4	5	1664	0.0002	14.2	1.9
401	76	5	2411	0.0002	14.5	2.1
294	65.8	11	1722	0.0002	18.1	5.8
300	65	11	1825	0.0002	18.1	5.8
295	71.4	11	1722	0.0002	17.8	5.5
302	30	11	1263	0.0002	17.4	5.2
297	48.7	11	1722	0.0002	17.3	5
GardenLk					16.8	4.8
304	13.5	11	976	0.0002	16.78	4.6
1562	13	11	975	0.0002	16.48	4.3
NectarBas					16.3	4.3
334	26	11	1062	0.0002	16.5	4.3
308	38	11	1377	0.0002	16.36	4.1
336	334.7	11	4305	0.0002	17.3	4.5
347	65.3	11	1550	0.0002	17.49	5.2
348	31.4	11	1194	0.0002	16.82	4.6
355	65.6	11	1607	0.0002	17	4.7
1560	236.8	11	4132	0.0002	17.38	4.6
359					17.38	4.6
350	22.7	11	861	0.0002	16.56	4.4
337	54	11	1205	0.0002	16.4	4.2
1553	48.4	11	2296	0.0002	16	3.6
342					16	3.6
310	45	11	1435	0.0002	15.9	3.6
312	106	11	2296	0.0002	15.5	3.1
1160					15.5	3.1
314	83.2	11	2296	0.0002	15.43	3
316	23	11	1607	0.0002	15.3	3
375	95.3	11	2009	0.0002	15.8	3.4
379	71.3	11	1865	0.0002	15.95	3.6
376	28.3	11	861	0.0002	15.36	3.2
318	18.4	11	516.6	0.0002	15.1	3
365	72.6	11	1779	0.0002	16	3.7
364	56.7	11	1148	0.0002	15.6	3.4
363	38	11	1521	0.0002	15.4	3.1
320	11.6	11	402	0.0002	15.02	2.95
383	68	11	1665	0.0002	15.6	3.3

Node Name	Area	Imperviousness	Width	Slope	Ground El.	Invert El.
	(acres)	(%)	(feet)	(ft/ft)	(ft)	(ft)
322	15.3	11	804	0.0002	15.09	2.94
324	56.7	11	1722	0.0002	15.2	2.9
1167					15.2	2.9
413	76	5	2296	0.0002	18	5.6
412	60	5	1148	0.0002	17.5	5.3
411	340	5	2583	0.0002	17.3	4.8
1714					17.3	4.7
410	340	5	5740	0.0002	17.7	4.6
1709	166	5	5740	0.0002	16.9	3.8
407					16.9	3.8
414	72.6	5	2296	0.0002	17.1	4.7
415	75.6	5	1435	0.0002	16.7	4.4
406	133	5	4607	0.0002	16.47	3.6
1704	75.6	5	2296	0.0002	15.8	3.4
1697					15.8	3.4
326	108.9	5	1722	0.0002	15.1	2.8
328	25.4	5	1607	0.0002	14	1.7
1172					14	1.7
330	32.9	5	1664	0.0002	13.96	1.65
985					13.6	1.6
1188					13.2	8.5
1181					20.5	8.5
1398	9.2	5	3501	0.0002	13.9	1.3
451	104.8	5	2927	0.0002	13.82	1.27
462	81.7	5	2296	0.0002	13.9	1.5
439	110.6	5	2152	0.0002	13.6	1.2
441	23.4	5	1550	0.0002	13.29	1
1196					15.38	0.9
ArgosyLake					14.33	2.22
495	89.4	5	1578	0.0002	14.33	2.03
1420					16.6	4.25
482	49.2	5	1464	0.0002	14.16	1.89
500	177	5	2985	0.0002	14.89	2.39
484	72.7	5	2985	0.0002	13.99	1.49
1416	118	5	2985	0.0002	13.86	1.36
486					13.86	1.36
443	57.8	5	1578	0.0002	13	0.7
478					13	0.5
AnchorLake					13	0.5
691	81.7	5	2755	0.0002	13.5	1
692	87	5	1406	0.0002	13.14	0.88
684	85.3	5	2698	0.0002	13	0.5
686	127.8	5	3731	0.0002	13.2	0.5
1463					13.2	0.5

Node Name	Area	Imperviousness	Width	Slope	Ground El.	Invert El.
	(acres)	(%)	(feet)	(ft/ft)	(ft)	(ft)
705	108.9	5	2755	0.0002	11	-0.5
719	74	5	2124	0.0002	10.9	-0.5
706	55	5	2985	0.0002	11	-0.5
LkHoliday					11	-0.5
710	65.5	5	3013	0.0002	11.1	-0.5
712					11.1	-0.5
605	115	5	3186	0.0002	11.3	-0.5
609	52.6	5	1607	0.0002	11	-0.5
595	74	5	2612	0.0002	11	-0.5
596	80	5	1320	0.0002	10.7	-0.5
1491	60.9	5	1780	0.0002	10.8	-0.5
598					10.8	-0.5
600	60.9	5	1550	0.0002	10.8	-0.5
578	99.7	11	2612	0.0002	11.3	-0.5
570	77.4	11	1894	0.0002	10.1	-0.5
574	84.7	11	2009	0.0002	10.2	-0.5
541	32.5	11	1234	0.0002	9.7	-0.5
545	38.6	11	976	0.0002	9.65	-0.5
504	23.8	11	976	0.0002	10	-0.5
550	47.2	11	1492	0.0002	9.8	-0.5
505	142.6	11	4764	0.0002	10.7	-0.5
554	83.2	11	2296	0.0002	9.9	-0.5
560	60.13	11	1435	0.0002	9.8	-0.5
555	13.9	11	861	0.0002	9.6	-0.5
507	116	11	4138	0.0002	10.6	-0.5
564	99.3	11	2468	0.0002	10.2	-0.5
509	77.6	11	3386	0.0002	10.4	-0.5
511	37	11	1262	0.0002	10	-0.5
LakeZurich					9.8	-0.5
515	29.9	11	1894	0.0002	10.1	-0.5
517	30.8	11	1952	0.0002	10.2	-0.5
1260					10.9	-0.5
519	57.1	11	2066	0.0002	11.3	-0.5
582	35.2	11	1435	0.0002	11.1	-0.5
583	94.4	11	2239	0.0002	11.2	-0.5
521	43.8	11	1750	0.0002	11.1	-0.5
523	38.1	11	2066	0.0002	11.2	-0.5
1267					11.2	-0.5
525	111.2	5	2009	0.0002	11	-0.5
527	76.5	5	2640	0.0002	11.2	-0.5
1274					11.2	-0.5
731	207	5	2870	0.0002	11.2	-0.5
732	86.7	5	1865	0.0002	11	-0.5
697	339	5	4821	0.0002	11.6	-0.5

Node Name	Area	Imperviousness	Width	Slope	Ground El.	Invert El.
	(acres)	(%)	(feet)	(ft/ft)	(ft)	(ft)
723	54	5	3042	0.0002	11.1	-0.5
1510					11.1	-0.5
1505	185	5	3788	0.0002	11.4	-0.5
627					11.4	-0.5
1747	84.8	5	2239	0.0002	10.9	-0.5
623	27.4	5	1033	0.0002	10.9	-0.5
614	26.5	5	1607	0.0002	11	-0.5
1498					11	-0.5
Arrowhead					10.7	-0.5
1281	18.4	5	775	0.0002	10.85	-0.5
535	82	5	1773	0.0002	11	-0.5
537					10.8	-0.5
1286	35	5	1779	0.0002	10.8	-0.5
645	69.5	5	976	0.0002	10.7	-0.5
649	85.5	5	1779	0.0002	10.8	-0.5
1293					10.8	-0.5
651	56.3	5	1435	0.0002	11.5	-0.5
667	49	5	1435	0.0002	10.8	-0.5
668	41	5	1779	0.0002	10.8	-0.5
KimberlyLk					10.5	-0.5
1002	51.9	5	1607	0.0002	9	-1.5
1300					9.7	-3.5
1403					6.7	-3.5
781	24	5	717	0.0002	6.73	-3.6
AlbatrosLk					6.6	-3.6
783	60.3	5	2411	0.0002	6.95	-3.6
807	34	5	1837	0.0002	7.2	-3.2
817	27.5	5	1492	0.0002	7.2	-3.2
808	101.6	5	1377	0.0002	6.9	-3.4
Asa Lake					6.7	-3.4
785	163.5	5	4138	0.0002	7.2	-3.7
821	70.7	5	1492	0.0002	6.8	-3.6
787	56.9	5	2009	0.0002	6.7	-3.8
789	39.9	5	1779	0.0002	6.4	-4
1309					6.1	-4
825	93.3	5	1865	0.0002	2.3	-8.1
791	50	5	1722	0.0002	2.2	-8.2
829	77.3	5	1894	0.0002	1.9	-8.5
793	63.5	5	1205	0.0002	1.7	-8.6
833	22.7	5	2296	0.0002	1.9	-8.6
795	27.2	5	1722	0.0002	1.7	-8.7
468	215	5	3329	0.0002	12.9	0.3
PelicanLk					12.81	0.21
474	51.7	5	3271	0.0002	12.3	0

Node Name	Area	Imperviousness	Width	Slope	Ground El.	Invert El.
	(acres)	(%)	(feet)	(ft/ft)	(ft)	(ft)
1203					12	0
1204					12	-3.6
266	75	5	2870	0.0002	6.14	-2.4
226	41.6	5	1722	0.0002	8.84	-3.5
270	34	5	1722	0.0002	5.5	-2.8
276	45	5	1722	0.0002	5.9	-2.4
271	22	5	574	0.0002	5.1	-3
228	73	5	1722	0.0002	8.83	-3.5
230	31.7	5	1205	0.0002	8.74	-3.5
232	14.6	5	1205	0.0002	8.24	-4
234	57.6	5	2009	0.0002	10.9	-3.1
1087					10.9	-3.1
280	181	5	4592	0.0002	6.6	-2.3
286	119	5	2000	0.0002	6.6	-1.8
281	79	5	2009	0.0002	5.9	-2.5
236	208	5	3157	0.0002	8.6	-4
238	187	5	2870	0.0002	8	-4.5
1028					8	-4.5
1148					7.5	-5
1145	750	5	4305	0.0002	7.8	-5
1115	750	5	4305	0.0002	5	-7.8
1141					5	-7.8
1565	272.3	5	5166	0.0002	6.48	-4
1566	204.2	5	5166	0.0002	6.48	-4
1574	204.2	5	3000	0.0002	6.48	-4
QuickSlver					7	-5
1655	869.7	5	4592	0.0002	6.37	-6.5
Meadowview					6.37	-6.5
1591	476.5	5	2870	0.0002	6	-6.5
1660	366	5	12628	0.0002	7.9	-6.5
LongviewLk					7.9	-6.5
1664	907.6	5	11480	0.0002	7.67	-6.5
Lav/LupLk					7.67	-6.5
LagunaLake					7.67	-6.5
1599	589.9	5	3444	0.0002	6.8	-6.5
747					7.4	-7.6
1240	189	5	2870	0.0002	6.2	-8.8
1244	189	5	2870	0.0002	4.7	-10.8
1248					4.7	-10.8
1617	491.6	5	7462	0.0002	8.5	-6.5
799	7.5	5	1148	0.0002	3.8	-9
1016					4.5	-9
1319	272.3	5	2296	0.0002	3.9	-10
1323					3.5	-10

Node Name	Area	Imperviousness	Width	Slope	Ground El.	Invert El.
	(acres)	(%)	(feet)	(ft/ft)	(ft)	(ft)
WazeeLake					5.5	-6.5
1619	453.8	5	5740	0.0002	6.5	-6.5
1633	75.6	5	1148	0.0002	6.5	-9
1634	605	5	4592	0.0002	6.3	-9.5
1623	726.1	5	6888	0.0002	8.5	-6.5
1625	317.6	5	3444	0.0002	6.1	-6.5
1680	30	5	2296	0.0002	2.4	-13
903	59.2	5	2497	0.0002	5.6	-5.3
904	116.5	5	2009	0.0002	5.3	-5.6
871	67.9	25	1664	0.0002	9.25	-2.8
SildonLake					8.75	-3
881	300.8	25	4477	0.0002	10.2	-2.4
885	225.6	25	4506	0.0002	10.2	-2.4
HoneymoonL					9.15	-2.6
VenusLake					9.65	-2.1
895	55.2	25	2267	0.0002	9.9	-2.25
890	151.9	25	2353	0.0002	9.69	-2.5
851	201	25	2181	0.0002	9.75	-3
1007	62.2	25	2554	0.0002	9.83	-3
1327					9.83	-4
853					9.83	-4
SerenadeLk					8.75	-4
899	36	5	1320	0.0002	8.45	-3.8
859	17	5	861	0.0002	9.63	-4
861					7.5	-4
1338					5.5	-6
863	244.5	5	2698	0.0002	6	-6
909	42.8	5	2497	0.0002	5.5	-5.5
919	41.1	5	2497	0.0002	5.5	-5.5
910	30.5	5	545	0.0002	5	-5.6
Valmora Lk					4.6	-5.9
923	41.1	5	1837	0.0002	6.1	-4.2
935	56.2	5	1779	0.0002	6	-4.3
924	30.5	5	746	0.0002	5.75	-4.4
926	111	5	1894	0.0002	5.6	-4.7
941	51.5	5	2525	0.0002	7.9	-3.6
961	84	5	2410	0.0002	7.85	-3.6
942	52.7	5	2353	0.0002	8.1	-3.8
965	60.4	5	1578	0.0002	7.9	-3.4
971	27.9	5	2497	0.0002	7.9	-3.6
966	78.9	5	1377	0.0002	7.5	-3.7
944	90.5	5	3272	0.0002	8.1	-4
946	157.3	5	3272	0.0002	7.9	-4.2
1530	190.5	5	1865	0.0002	7.2	-4.6

Node Name	Area	Imperviousness	Width	Slope	Ground El.	Invert El.
	(acres)	(%)	(feet)	(ft/ft)	(ft)	(ft)
948					7.2	-4.6
StarfishLk					6.4	-5.1
928	224.6	5	2583	0.0002	6.7	-5.3
1525	65.6	5	1607	0.0002	5.9	-5.9
930					5.9	-5.9
865	72.8	5	2210	0.0002	5.9	-6
867					5.5	-6
1012					10.5	-8
1348	45.4	5	1722	0.0002	15.5	-12
RoseMaryLk					6.8	-25
1681	242	5	2296	0.0002	2.4	-13
1749	121	5	2296	0.0002	8.5	-6.5
1756					8.5	-6.5
755					8.3	-3.7
767	63.5	5	2698	0.0002	8.7	-3.8
756	38	5	1406	0.0002	8.2	-4
771	69.8	5	2525	0.0002	9.2	-3.3
777	41	5	1779	0.0002	8.9	-3.4
772	44.5	5	1091	0.0002	8.7	-3.5
758	112	5	2296	0.0002	8.2	-4.2
760					7.7	-4.6
1742	73	5	1722	0.0002	7.7	-4.6
739	105	5	1263	0.0002	7.6	-4.6
741	104.7	5	2239	0.0002	6.8	-5.6
1221					6.8	-5.6
751	99.8	5	4592	0.0002	6.6	-6.2
1229					5.7	-6.5
743	85.7	5	1263	0.0002	5.7	-6.5
745	65.3	5	1320	0.0002	5.05	-7.2
837	31.7	5	1607	0.0002	2	-8.4
AtkinsonLk					1.7	-8.4
797	79.4	5	3013	0.0002	3.7	-8.9
1427	116.2	5	2755	0.0002	13	0.5
466	61.9	5	2296	0.0002	12.9	0.5
1060	76	5	2009	0.0002	17.22	5
193					17.22	5
195	270	5	3444	0.0002	12.15	-0.5
1076	579	5	5166	0.0002	13.38	0.4
1068					11.7	-0.3
990					11.7	-0.3
224	64	5	1722	0.0002	9.84	-2.5

Table 5. Link parameters.

Link Name	Length	Manning's n	Upstream	Downstream	UP Invert El.	DW Invert El.
	(ft)		Node	Node	(ft)	(ft)
809	956	0.05	807	808	-3.2	-3.4
818	956	0.05	817	808	-3.2	-3.4
1515	2583	0.05	808	Asa Lake	-3.4	-3.4
814	1894	0.05	Asa Lake	785	-3.4	-3.7
707	660	0.07	705	706	-0.5	-0.5
720	2267	0.07	719	706	-0.5	-0.5
709	918	0.07	706	LkHoliday	-0.5	-0.5
711	631	0.07	LkHoliday	710	-0.5	-0.5
Bridge 51			710	712		
714	1205	0.07	712	645	-0.5	-0.5
606	1263	0.07	605	535	-0.5	-0.5
610	804	0.07	609	Arrowhead	-0.5	-0.5
597	1435	0.07	595	596	-0.5	-0.5
1495	2078	0.07	596	1491	-0.5	-0.5
Bridge 59			1491	598		
601	1091	0.07	598	600	-0.5	-0.5
602	2411	0.07	600	525	-0.5	-0.5
579	1837	0.07	578	519	-0.5	-0.5
571	2353	0.07	570	515	-0.5	-0.5
575	1837	0.07	574	515	-0.5	-0.5
542	1370	0.07	541	504	-0.5	-0.5
546	631	0.07	545	504	-0.5	-0.5
506	1837	0.07	504	505	-0.5	-0.5
551	2066	0.07	550	505	-0.5	-0.5
508	1400	0.07	505	507	-0.5	-0.5
556	1607	0.07	554	555	-0.5	-0.5
561	1148	0.07	560	555	-0.5	-0.5
557	1263	0.07	555	507	-0.5	-0.5
510	1500	0.07	507	509	-0.5	-0.5
565	1320	0.07	564	509	-0.5	-0.5
512	3100	0.07	509	511	-0.5	-0.5
Bridge 16A			511	LakeZurich		
1746	1200	0.07	LakeZurich	515	-0.5	-0.5
518	850	0.07	515	517	-0.5	-0.5
Bridge 18			517	1260		
1264	1260	0.07	1260	519	-0.5	-0.5
522	1300	0.07	519	521	-0.5	-0.5
584	2526	0.07	582	583	-0.5	-0.5
585	2554	0.07	583	521	-0.5	-0.5
524	560	0.07	521	523	-0.5	-0.5
Bridge 17			523	1267		
1271	1465	0.07	1267	525	-0.5	-0.5

Link Name	Length	Manning's n	Upstream	Downstream	UP Invert El.	DW Invert El.
	(ft)		Node	Node	(ft)	(ft)
528	1200	0.07	525	527	-0.5	-0.5
Bridge 48			527	1274		
1278	980	0.07	1274	Arrowhead	-0.5	-0.5
733	1263	0.05	731	732	-0.5	-0.5
734	2239	0.07	732	697	-0.5	-0.5
724	1521	0.07	697	723	-0.5	-0.5
1507	3886	0.07	697	1505	-0.5	-0.5
Bridge 50			723	1510		
1514	517	0.07	1510	645	-0.5	-0.5
Bridge 46			1505	627		
628	1492	0.07	627	623	-0.5	-0.5
1748	1607	0.07	1747	623	-0.5	-0.5
624	861	0.07	623	614	-0.5	-0.5
Bridge 47			614	1498		
1502	517	0.07	1498	Arrowhead	-0.5	-0.5
1282	1035	0.07	Arrowhead	1281	-0.5	-0.5
1283	2010	0.07	1281	535	-0.5	-0.5
538	860	0.07	535	537	-0.5	-0.5
Bridge 49			537	1286		
1290	2150	0.07	1286	645	-0.5	-0.5
650	3160	0.06	645	649	-0.5	-0.5
Bridge 52			649	1293		
1297	890	0.06	1293	651	-0.5	-0.5
693	1260	0.06	691	692	1	0.88
694	2980	0.06	692	684	0.88	0.5
1466	500	0.06	478	AnchorLake	0.5	0.5
Bridge 54			478	1427		
1431	1195	0.06	1427	466	0.5	0.5
496	861	0.06	ArgosyLake	495	2.22	2.03
497	574	0.06	495	482	2.03	1.89
34	880	0.09	31	33	16.5	15
BC-US41			33	37		
40	830	0.09	37	39	11.5	10
76	830	0.09	39	75	10	11.5
79	830	0.09	75	78	11.5	13
80	830	0.09	78	41	13	9
44	830	0.09	41	43	9	6
BC-GardBlv			43	45		
48	800	0.09	45	47	6	7
138	1607	0.09	137	92	6	6
184	1263	0.09	183	92	6	6
94	1837	0.09	92	93	6	6
95	1547	0.09	93	47	6	7

Link Name	Length	Manning's n	Upstream	Downstream	UP Invert El.	DW Invert El.
	(ft)		Node	Node	(ft)	(ft)
50	800	0.09	47	49	7	7.5
156	1670	0.09	154	155	7.5	7.5
157	1200	0.09	155	49	7.5	7.5
173	1148	0.09	172	49	7.5	7.5
52	800	0.09	49	51	7.5	6.5
BC-GatrCr2			51	53		
56	830	0.09	53	55	5	5.5
149	2181	0.09	148	55	6	6
175	1263	0.09	174	55	6	6
58	830	0.09	55	57	5.5	6.5
147	2411	0.09	146	57	6.5	6.5
60	830	0.09	57	59	6.5	6
153	1722	0.09	152	59	6	6
179	1263	0.09	178	59	6	6
62	830	0.09	59	61	6	6
177	1253	0.09	176	61	6	6
82	840	0.09	61	81	6	6
98	1435	0.09	96	97	6	6
181	1263	0.09	180	97	6	6
100	1867	0.09	97	99	6	6
105	2124	0.09	104	99	6	6
102	976	0.09	99	101	6	6
106	1435	0.09	101	81	6	6
83	840	0.09	81	63	6	6
BC-GatrCr1	70		63	65	6	5.5
68	700	0.09	65	67	5.5	5.5
151	1148	0.09	150	84	6	6
86	1837	0.09	84	85	6	6
140	1000	0.09	85	139	6	6
143	978	0.09	142	139	6	6
145	1607	0.09	144	139	6	6
141	1121	0.09	139	87	6	5.8
90	2062	0.09	87	89	5.8	5.4
91	2070	0.09	89	67	5.5	5.5
70	700	0.09	67	69	5.5	5
109	2411	0.09	107	108	6	6
130	2353	0.09	129	108	6	6
111	1320	0.09	108	110	6	6
113	1665	0.09	110	112	6	6
133	2551	0.09	131	132	6	6
135	2500	0.09	132	134	6	6
136	2885	0.09	134	112	6	6
164	2500	0.09	162	163	6	6
166	2896	0.09	163	165	6	6

Link Name	Length	Manning's n	Upstream	Downstream	UP Invert El.	DW Invert El.
	(ft)		Node	Node	(ft)	(ft)
167	1602	0.09	165	112	6	6
115	2077	0.09	112	114	6	6
128	1894	0.09	127	114	6	6
117	2000	0.09	114	116	6	6
119	1444	0.09	116	118	6	5.8
121	2411	0.09	118	120	5.8	5.6
159	1832	0.09	158	120	5.8	5.6
123	2181	0.09	120	122	5.6	5.4
125	1952	0.09	122	124	5.4	5.2
161	1378	0.09	160	124	5.4	5.2
126	2525	0.09	124	69	5.2	5
72	600	0.09	69	71	5	5
BC-Up			71	73		
Weir #19			73	168		
Bc-Dn			168	1538		
1540	2870	0.07	1538	189	5	3
1051	6199	0.07	189	191	3	4
1061	3042	0.07	191	1060	4	5
1552	100	0.07	191	1550	4	4
Weir #58			1550	1409		
Pipes			1409	1042		
1735	1894	0.07	1042	1734	3.76	2.8
Bridge 58			1734	1739		
1741	1607	0.07	1739	429	2.8	2.6
434	1435	0.07	429	CarouselLk	2.6	2.4
436	2296	0.07	CarouselLk	435	2.3	1.8
Bridge 56			435	1729		
1731	2755	0.07	1729	439	1.8	1.2
459	2181	0.07	458	451	1.81	1.27
390	832	0.07	385	386	2.9	2.7
391	804	0.07	386	387	2.7	2.5
392	1263	0.07	387	LaurelLake	2.5	2.2
393	1205	0.07	LaurelLake	389	2.2	1.9
400	918	0.07	399	389	2.1	1.9
394	1148	0.07	389	330	1.9	1.65
402	1808	0.07	401	330	2.1	1.65
296	1263	0.07	294	295	5.8	5.5
301	1350	0.07	300	295	5.8	5.5
298	2296	0.07	295	297	5.5	5
303	1148	0.07	302	297	5.2	5
299	1148	0.07	297	GardenLk	5	4.8
305	861	0.07	GardenLk	304	4.8	4.6
1563	1263	0.07	304	1562	4.6	4.3
1564	50	0.07	1562	NectarBas	4.3	4.3

Link Name	Length	Manning's n	Upstream	Downstream	UP Invert El.	DW Invert El.
	(ft)		Node	Node	(ft)	(ft)
309	976	0.07	NectarBas	308	4.3	4.1
335	1148	0.07	334	308	4.3	4.1
311	2010	0.07	308	310	4.1	3.6
338	1492	0.07	336	337	4.5	4.2
349	2410	0.07	347	348	5.2	4.6
351	1033	0.07	348	350	4.6	4.4
356	1263	0.07	355	350	4.7	4.4
Bridge 22			1560	359		
360	689	0.07	359	350	4.6	4.4
352	1004	0.07	350	337	4.4	4.2
1557	218	0.07	337	1553	4.2	3.6
Bridge #21			1553	342		
344	574	0.07	342	310	3.6	3.6
313	2296	0.07	310	312	3.6	3.1
Bridge #20			312	1160		
1164	2009	0.07	1160	314	3.1	3
317	1148	0.07	314	316	3	3.05
319	344.4	0.07	316	318	3	3
377	1033	0.07	375	376	3.4	3.2
380	1780	0.07	379	376	3.6	3.2
378	803	0.07	376	318	3.2	3
321	803.6	0.07	318	320	3	2.95
366	1320	0.07	365	364	3.7	3.4
367	1263	0.07	364	363	3.4	3.1
369	689	0.07	363	320	3.1	2.95
323	688.8	0.07	320	322	2.95	2.94
384	1780	0.07	383	322	3.3	2.94
325	1377.6	0.07	322	324	2.94	2.9
Bridge 19			324	1167		
1171	1435	0.07	1167	326	2.9	2.8
416	1263	0.07	413	412	5.6	5.3
417	2353	0.07	412	411	5.3	4.8
Bridge 63			411	1714		
1716	918	0.07	1714	410	4.7	4.6
1710	3272	0.07	410	1709	4.6	3.8
Bridge 62			1709	407		
420	918	0.07	407	406	3.8	3.6
425	1263	0.07	414	415	4.7	4.4
426	3243	0.07	415	406	4.4	3.6
1705	861	0.07	406	1704	3.6	3.4
Bridge 61			1704	1697		
1698	2583	0.07	1697	326	3.4	2.8
329	2296	0.07	326	328	2.8	1.7
Bridge 60			328	1172		

Link Name	Length	Manning's n	Upstream	Downstream	UP Invert El.	DW Invert El.
	(ft)		Node	Node	(ft)	(ft)
1176	900	0.07	1172	330	1.7	1.65
986	1000	0.07	330	985	1.65	1.6
Weir #21			985	1188		
Clvrt 21			1188	1181		
1401	150	0.07	1181	1398	8.5	1.3
1402	1400	0.07	1398	451	1.3	1.27
453	2950	0.07	451	439	1.27	1.2
463	2009	0.07	462	439	1.7	1.2
442	1005	0.07	439	441	1.2	1
bridge 55			441	1196		
1200	750	0.06	1196	443	0.9	0.7
Weir # 9			1060	193		
196	1435	0.06	193	195	5	-0.5
1077	3042	0.06	195	1076	-0.5	0.4
Struc 57			195	1420		
Clvrt 4			1076	1068		
Weir #4			1068	990		
1084	1263	0.05	990	224	-0.3	-2.5
254	920	0.05	252	253	0.3	-0.6
260	1378	0.05	259	253	0.8	-0.6
255	1923	0.05	253	224	-0.6	-2.5
227	689	0.05	224	226	-2.5	-3.5
267	1435	0.05	266	226	-2.4	-3.5
229	2009	0.05	226	228	-3.5	-3.5
272	603	0.05	270	271	-2.8	-3
277	1350	0.05	276	271	-2.4	-3
273	1952	0.05	271	228	-3	-3.5
231	1148	0.05	228	230	-3.5	-3.5
233	803.6	0.05	230	232	-3.5	-4
235	545.3	0.05	232	234	-4	-3.1
Connect. A			232	755		
Bridge 94			234	1087		
1089	1394	0.05	1087	236	-3.1	-4
282	1550	0.05	280	281	-2.3	-2.5
287	3444	0.05	286	281	-1.8	-2.5
283	976	0.05	281	236	-2.5	-4
239	4477.2	0.05	236	238	-4	-4.5
Weir #11			238	1028		
1151	130	0.05	1028	1148	-4.5	-5
Bridge BS			1148	1145		
1157	6000	0.03	1145	1115	-5	-7.5
Bridge 74			1115	1141		
1654	6888	0.03	1141	1599	-7.8	-6.5
1567	4018	0.03	1565	1566	-4	-4

Link Name	Length	Manning's n	Upstream	Downstream	UP Invert El.	DW Invert El.
	(ft)		Node	Node	(ft)	(ft)
1575	6888	0.03	1566	1574	-4	-4
Weir #5			1574	QuickSlver		
1656	1722	0.03	Quicksilver	1655	-5	-6.5
1657	1722	0.03	1655	Meadowview	-6.5	-6.5
1592	4018	0.03	Meadowview	1591	-6.5	-6.5
1661	2870	0.03	1591	1660	-6.5	-6.5
1663	1148	0.03	1660	LongviewLk	-6.5	-6.5
1665	6314	0.03	LongviewLk	1664	-6.5	-6.5
1667	1492	0.03	1664	Lav/LupLk	-6.5	-6.5
1668	7462	0.03	Lav/LupLk	LagunaLake	-6.5	-6.5
1600	15498	0.03	LagunaLake	1599	-6.5	-6.5
1618	4018	0.03	1599	1617	-6.5	-6.5
471	975	0.05	468	PelicanLk	0.3	0.21
475	1320	0.05	PelicanLk	474	0.21	0
Weir #16			474	1203		
Bridge 16			1203	1204		
1217	3150	0.05	1204	739	-3.6	-4.6
757	1894	0.05	755	756	-3.7	-4
768	1263	0.05	767	756	-3.8	-4
759	1292	0.05	756	758	-4	-4.2
773	1291	0.05	771	772	-3.3	-3.5
778	631	0.05	777	772	-3.4	-3.5
774	2670	0.05	772	758	-3.5	-4.2
761	2238	0.05	758	760	-4.2	-4.6
Bridge 72	75		760	1742	-4.6	-4.6
1744	40	0.05	1742	739	-4.6	-4.6
742	2580	0.05	739	741	-4.6	-5.6
Bridge 69			741	1221		
1223	2870	0.05	1221	743	-5.6	-6.5
1230	1895	0.05	751	1229	-6.2	-6.5
Bridge 70			1229	743		
746	2296	0.05	743	745	-6.5	-7.2
748	574	0.05	745	747	-7.2	-7.6
Connect.C	800		745	837	-7.2	-8.4
839	50	0.05	837	AtkinsonLk	-8.4	-8.4
840	2755	0.05	AtkinsonLk	797	-8.4	-8.9
826	631	0.05	825	791	-8.1	-8.2
822	1205	0.05	821	787	-3.6	-3.8
790	920	0.05	787	789	-3.8	-4
Bridge 68			789	1309		
1313	832	0.05	1309	791	-4	-8.2
794	2240	0.05	791	793	-8.2	-8.6
830	1837	0.05	829	793	-8.3	-8.6
796	631	0.05	793	795	-8.6	-8.7

Link Name	Length	Manning's n	Upstream	Downstream	UP Invert El.	DW Invert El.
	(ft)		Node	Node	(ft)	(ft)
834	689	0.05	833	795	-8.6	-8.7
798	1320	0.05	795	797	-8.7	-8.9
800	545	0.05	797	799	-8.9	-9
Weir #14			799	1016		
1320	5650	0.03	1016	1319	-9	-10
Bridge 76			1319	1323		
1672	33	0.03	1323	WazeeLake	-10	-6.5
1673	1377	0.03	WazeeLake	1619	-6.5	-6.5
1624	8036	0.03	1619	1623	-6.5	-6.5
1635	1952	0.03	1633	1634	-9	-9.5
1642	32718	0.03	1634	1623	-9.5	-6.5
1626	6888	0.03	1623	1625	-6.5	-6.5
1753	4592	0.03	1625	1749	-6.5	-6.5
1682	14350	0.03	1680	1681	-13	-13
905	1205	0.05	903	904	-5.3	-5.6
906	2411	0.05	904	863	-5.6	-6
872	1091	0.05	871	SildonLake	-2.8	-3
852	2066	0.05	SildonLake	851	-3	-3
882	918	0.05	881	HoneymoonL	-2.4	-2.6
886	1119	0.05	885	HoneymoonL	-2.4	-2.6
878	2296	0.05	HoneymoonL	851	-2.6	-3
891	1780	0.05	VenusLake	890	-2.1	-2.5
896	1205	0.05	895	890	-2.25	-2.5
892	1894	0.05	890	851	-2.5	-3
1008	1693	0.05	851	1007	-3	-3
Weir #18			1007	1327		
Clvrt 18			1327	853		
858	3444	0.05	853	SerenadeLk	-4	-4
860	803.6	0.05	SerenadeLk	859	-4	-4
900	918	0.05	899	859	-3.8	-4
862	1378	0.05	859	861	-4	-4
Bridge 65			861	1338		
1342	1492	0.05	1338	863	-6	-6
866	2726	0.05	863	865	-6	-6
911	608	0.05	909	910	-5.5	-5.6
920	344	0.05	919	910	-5.5	-5.6
1521	1852	0.05	910	Valmora Lk	-5.6	-5.9
916	746	0.05	Valmora Lk	865	-5.9	-6
925	746	0.05	923	924	-4.2	-4.4
936	631	0.05	935	924	-4.3	-4.4
927	1665	0.05	924	926	-4.4	-4.7
929	3157	0.05	926	928	-4.7	-5.3
943	1550	0.05	941	942	-3.6	-3.8
962	918	0.05	961	942	-3.6	-3.8

Link Name	Length	Manning's n	Upstream	Downstream	UP Invert El.	DW Invert El.
	(ft)		Node	Node	(ft)	(ft)
945	1148	0.05	942	944	-3.8	-4
967	2009	0.05	965	966	-3.4	-3.7
972	631	0.05	971	966	-3.6	-3.7
968	2870	0.05	966	944	-3.7	-4
947	1062	0.05	944	946	-4	-4.2
1531	3903	0.05	946	1530	-4.2	-4.6
Bridge 67			1530	948		
953	4477	0.05	948	StarfishLk	-4.6	-5.1
954	1435	0.05	StarfishLk	928	-5.1	-5.3
1526	3444	0.05	928	1525	-5.3	-5.9
Bridge 66			1525	930		
932	775	0.05	930	865	-5.9	-6
868	1148	0.03	865	867	-6	-6
Weir #15			867	1012		
1349	700	0.03	1012	1348	-8	-12
1696	6314	0.03	1348	RoseMaryLk	-12	-25
1686	804	0.03	RoseMaryLk	1681	-25	-13
1750	8610	0.03	1681	1749	-13	-6.5
1757	33	0.03	1749	1756	-6.5	-6.5
Weir #13			747	1240		
1245	5300	0.03	1240	1244	-8.8	-10.8
Bridge 75			1244	1248		
1651	3444	0.03	1248	1617	-10.8	-6.5
1620	3444	0.03	1617	1619	-6.5	-6.5
1423	33	0.06	1420	482	4.25	1.89
485	1607	0.06	482	484	1.89	1.49
501	3600	0.06	500	484	2.39	1.49
1418	515	0.06	484	1416	1.49	1.36
Bridge 57			1416	486		
488	2640	0.06	486	443	1.36	0.7
467	805	0.06	443	466	0.7	0.5
469	2125	0.06	466	468	0.5	0.3
1467	1722	0.06	AnchorLake	684	0.5	0.5
1468	1435	0.06	684	686	0.5	0.5
Bridge 53			686	1463		
1470	1722	0.06	1463	651	0.5	-0.5
658	2210	0.05	651	KimberlyLk	-0.5	-0.5
669	1722	0.05	667	668	-0.5	-0.5
670	1665	0.05	668	KimberlyLk	-0.5	-0.5
1003	2813	0.05	KimberlyLk	1002	-0.5	-1.5
Weir #17			1002	1300		
Bridge 17A			1300	1403		
1407	1220	0.05	1403	781	-3.5	-3.6
844	630	0.05	781	AlbatrosLk	-3.6	-3.6

Link Name	Length	Manning's n	Upstream	Downstream	UP Invert El.	DW Invert El.
	(ft)		Node	Node	(ft)	(ft)
845	976	0.05	AlbatrosLk	783	-3.6	-3.6
Conduit D	2000		AlbatrosLk	946	-3.6	-4.2
786	746	0.05	783	785	-3.6	-3.7
788	1607	0.05	785	787	-3.7	-3.8

4.7. Upstream Inflow Data

The only data available for calibration and verification was for the Gator Slough Canal watershed. No data were available for Horseshoe, Hermosa and Shadroe canals. Therefore the conceptual methodology adopted to calibrate the model has been to use one year of data for only one sub watershed, the Gator Slough Canal watershed, and assume that the calibrated parameters are applicable to other basins.

Upstream inflow to Gator Slough originating from the portion of the watershed located north and east at Hwy U.S. 41 (33 square miles undeveloped watershed of wildlife management area) are inserted as a “User Inflow” input in node 31 of the model. Data are from gauging station located 0.5 miles west of U.S. 41, named *Gator Slough at US 41 near Ft. Myers, FL.*

The period selected for model calibration includes 24 days from September 5th to 28th, 1996. This is consistent with the 1-year RI event selected based on Gumbel statistical analysis performed over the outflow historical period of record for Weir 11, downstream of Gator Slough Canal. The peak Gumbel 1-year RI flow for this section is 42 cfs (daily average value)

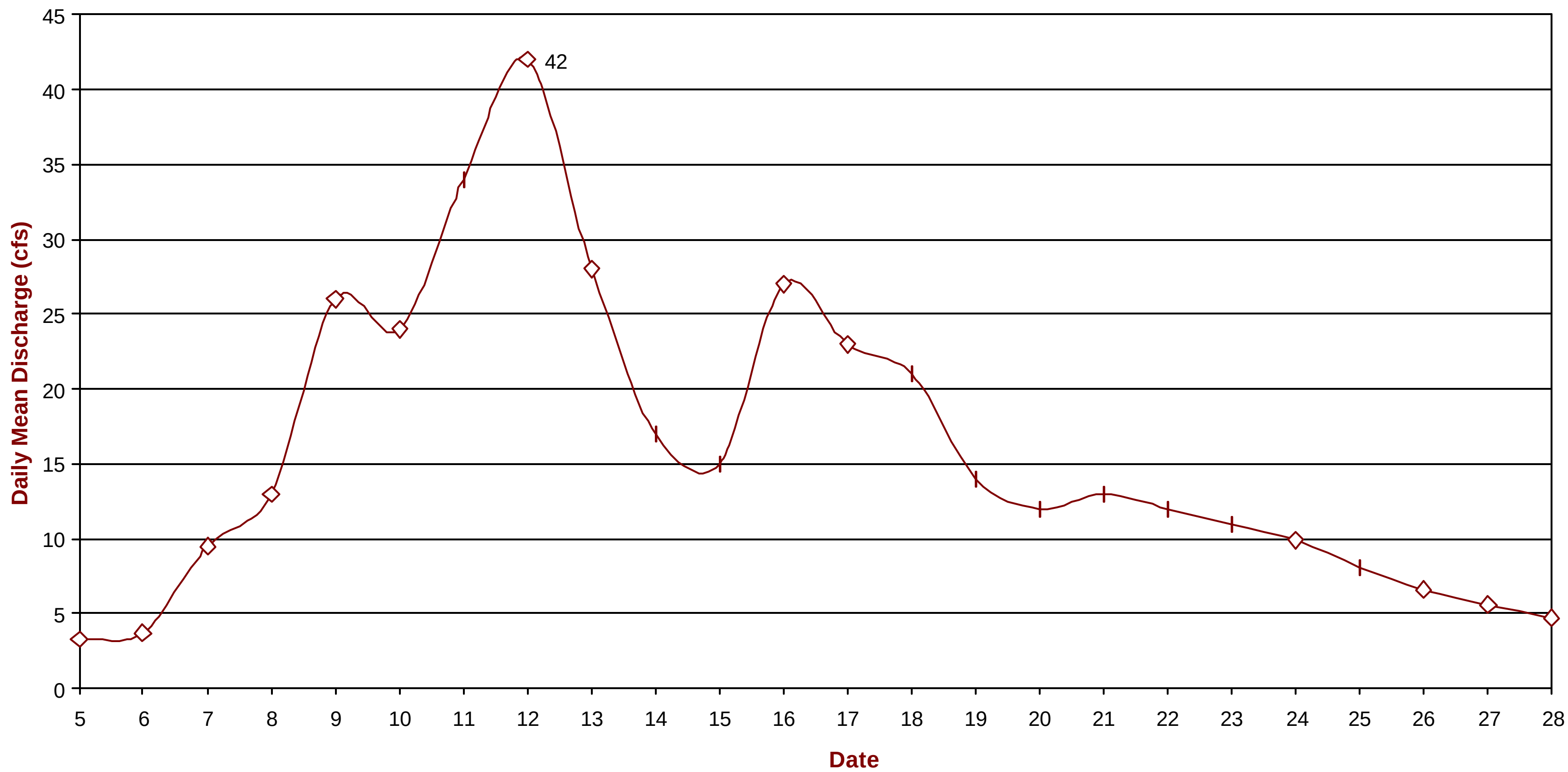

Figure 38. Input Hydrograph node 31 - 1 year event: September 5-28, 1996.

4.8. Evaporation and Rainfall Data

The Southwest Florida Research and Education Center, part of the University of Florida's Institute of Food and Agricultural Sciences, presents information on both the Total Pan Evaporation and the total Penman Evaporation, in the form of average monthly values for each month of the period from 1989 to 1997. Evaporation data requested as an input by the Runoff mode of the model act also as an upper bound for Evapo-Transpiration losses from groundwater and soil moisture. The Total Penman ET values inserted are summarized in the following Table:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3.49	4.20	5.56	5.37	5.77	5.46	5.71	5.45	5.02	4.69	4.04	3.59

Table 5. Total Penman ET (inches). Monthly values.

Rainfall data used for the calibration come from the gauging station of Lake Fairaway (0.5 miles west of the bridge of Hwy 41 on the Gator Slough provided by Lee County, see figure 39). The period of record covers 24 days from September 5th to 28th, 1996, to be consistent with the 1-year RI event selected based on the Gumbel statistical analysis run over the outflow historical data of Weir 11, downstream of Gator Slough Canal. Data on storm paths is not readily available for the Cape Coral area. The local storms for the most part travel inland from the coast. The rain has been considered homogeneous over the whole watershed. The total amount of rain over the 24 days period is 8.39 inches.

Data source: Lee County

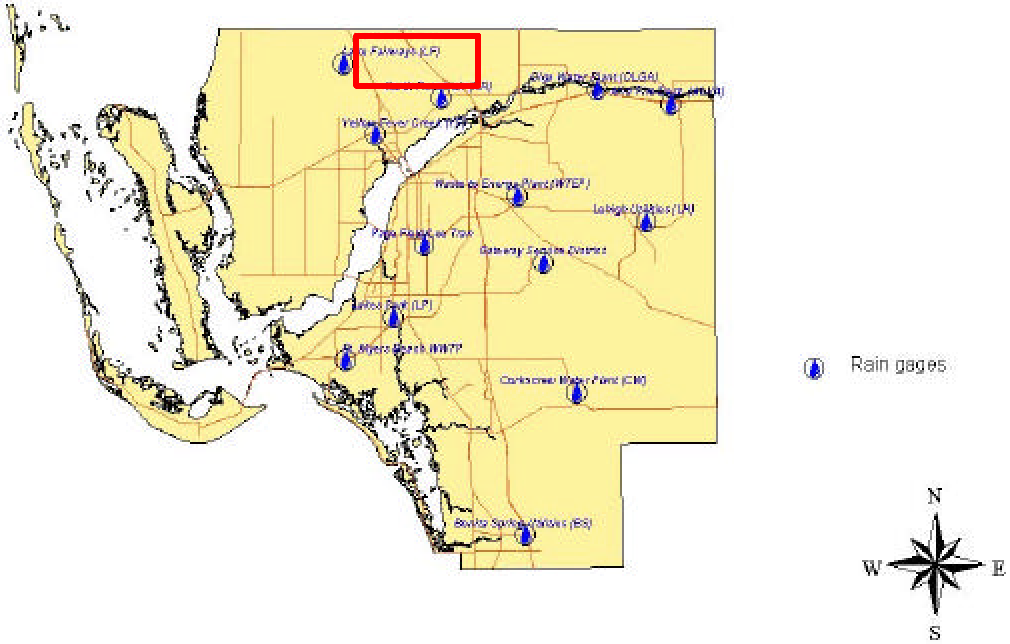

Figure 39. Lee County Rain Stations

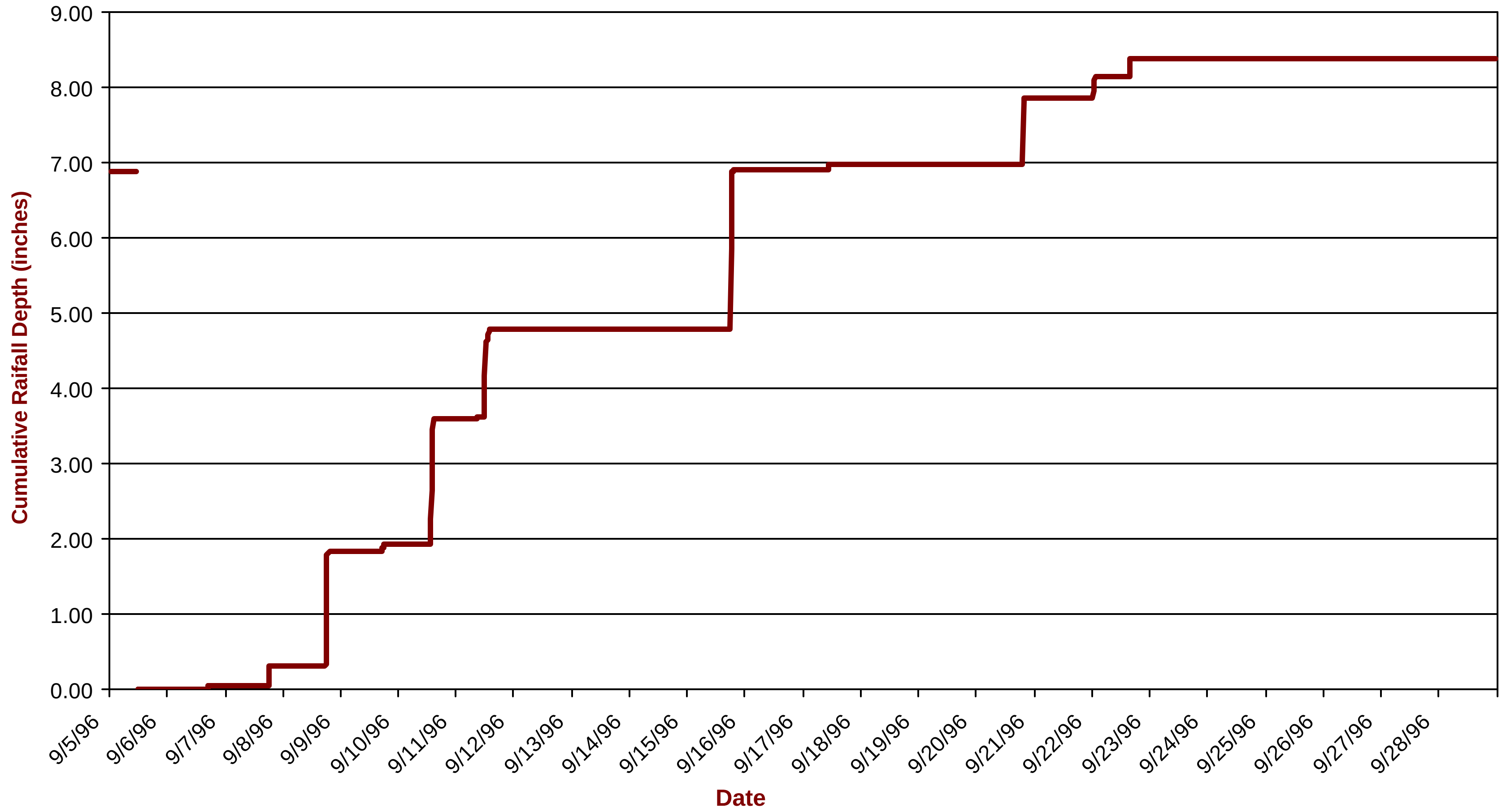

Figure 40. Cumulative Rainfall: September 5-28, 1996 (Gauge Station: Lake Fairaway, 0.5 mile west of U.S. Hwy 41).

4.9. Outflow Data and Statistical Analysis

The main criteria used in selecting the calibration period of record was the Gumbel statistical analysis applied to the outflow data for the station located near SR 765, corresponding to Weir #11.The analysis was conducted for Weir #11 outflow data to identify that period of record most closely marching a 1-year RI runoff event and for which a concurrent rainfall record and upstream inflow record were also available.

<u>Gumbel Statistical Analysis</u>

The annual maximum flood flow value, in daily mean series, detected in a water stream section, is an extreme event. Since the watershed was not submitted to relevant hydrologic modifications during the period of years under analysis, those series can be treated as homogeneous and independent values. These conditions allow us to associate the probable frequency and then the return interval to a given discharge event and to apply those values to the statistical analysis methods. Gumbel analysis has been proved to be one of the most reliable methods for hydrologic series. A double exponential probability distribution allows assignment of an expected flow rate for all return periods.

This following table shows data provided by the U.S. Geological Survey on monthly maximum values of daily average discharge on SR 765 corresponding to weir #11.

Table 6. USGS monthly maximums of discharge (cfs) for location:
264139082022100 Gator Slough at SR 765 Near Fort Myers, FL.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Max**
1984					86	236	290	191	89	60	35	10	**290**
1985	11	8	8	2	0	2	88	154	286	139	182	16	**286**
1986	16	5	27	8	5	478	114	842	407	72	34	39	**842**
1987	108	22	172	147	152	143	308	185	131	595	77	28	**595**
1988	13	12	33	17	10	5	262	273	507	47	77	11	**507**
1989	27	8	22	5	10	118	245	504	204	54	18	4	**504**
1990	7	10	8	5	175	135	97	173	54	30	8	3	**175**
1991	139	25	24	13	177	359	604	133	91	117	16	7	**604**
1992	5	20	30	21	9	740	378	321	165	108	10	12	**740**
1993	29	29	279	30	23	191	145	121	126	101	117	14	**279**
1994	14	16	24	118	40	14	123	136	443	84	29	21	**443**
1995	42	15	19	43	70	633	951	1240	499	594	81	4	**1240**
1996	46	6	18	15	61	167	125	160	346	573	100	29	**573**
1997	0	0	0	19	27	73	301	531	781				**781**

Some of the annual series were not populated with all monthly values. In these cases an annual event maximum value was taken into account only when the values for the whole period between June and October were available. This is because the peak flow rates for all years occurred in this interval. A return period was then associated to each of the extreme values as shown in the following table.

Table 7. Event with Gumbel associated return time.

Order	Event Q (cfs)	Tr
1	1240	15.00
2	842	7.50
3	781	5.00
4	740	3.75
5	604	3.00
6	595	2.50
7	573	2.14
8	507	1.88
9	504	1.67
10	443	1.50
11	290	1.36
12	286	1.25
13	279	1.15
14	175	1.07

After the Gumbel analysis it is possible to find out a discharge value for every given return period as an independent variable (Table 5.)

Table 8. Return period with associated discharge values.

Interval	Q expected (cfs)
1	332
1.5	400
2	523
5	826
10	1027
15	1140
20	1220
25	1281
30	1330
35	1372
40	1409
45	1440
50	1469
55	1495
60	1518
65	1540
70	1560
75	1578
80	1596
85	1612
90	1627
95	1642
100	1656

Given the logarithmic nature of the final Gumbel equation, the 1-year event is obtained from an interpolation trend line of the other data. Figure 41 shows the data distribution and the logarithmic trend line used to associate the discharge value to 1 year.

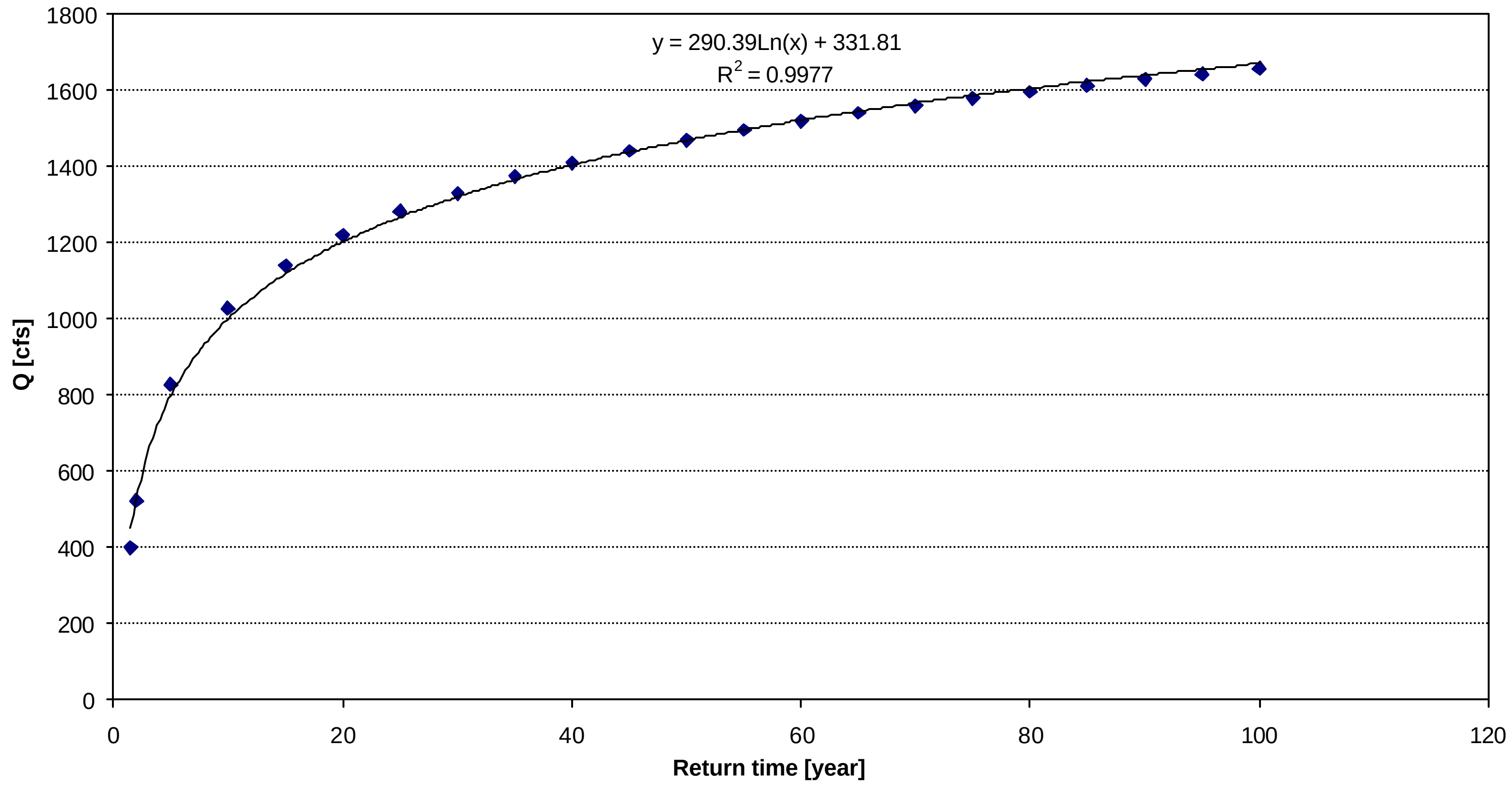

Figure 41. Discharge as a function of Return time (Gumbel Analysis)

4.10. Design Storms

The canal system was calibrated using comparison with Johnson Engineering design water surface profiles and Gator Slough at S.R. 765 USGS gauge station historical hydrograph for the one-year flood event. The three design storm events designated for this project are the 5-year 1-day, 25-year 3-day, and 100-year 3-day storm events. The rainfall depths and distributions for the three storm events were determined based on the *Surface Water Management Design Aids (SWMDA)*, published by SFWMD.

5-year 1-day: 5.2 inches. From Figure C-I-3 of SWMDA, the rainfall depth near Fort Myers, Florida.

25-year 3-day: 10.6 inches. From Figure C-I-5, the rainfall depth for 25-year 1-day as 7.8 inches. This value was modified for 25-year 3-day by multiplying by a factor of 1.359. Therefore, the rainfall depth for 25-year 3-day was determined as 7.8 x 1.359 inches.

100-year 3-day: 12.91 inches. Similar to the above, the rainfall depth from Figure C-I-6 as 9.5 inches and modified by designated multiplication factor i.e. 9.5 x 1.359 inches.

5. Model Calibration Results and Conclusions

September 1996 was selected as the period of record to calibrate the Cape Coral canals model. This was the only period for which all of the following basic data sets for a one-year recurrence interval storm event were available: (1) Inflow data for the Gator Slough at Hwy 41 USGS station, (2) Outflow data for the Gator Slough at Hwy 765 USGS station, and (3) Rainfall data at the Lee County Lake Fairaways station.

The one-year recurrence interval event was selected based on Gumbel statistical analysis of discharge data at Hwy 765. Thus, the period of record used for the calibration run represents a documented flow event with a peak near to the statistical one-year recurrence interval flow magnitude. The calibration event was not selected on the basis of the one-year rainfall magnitude.

The historical outflow hydrograph presents the same flow amount on September 5 and September 28 after rising up to a double peak value and going down to the completion of the complex event The duration of the one-year event used for calibrations purposes was limited to 24 days (from 5 to 28 Sep 1996) to be consistent with the assumption that the system presents the same conditions at the end of the event as it had at the beginning. The runoff data for September 1-4 and September 29-30 included either a falling or rising hydrograph limbs and therefore were eliminated from consideration.

The canal system calibration was also verified using design water surface profile along the Gator Slough Canal for the one-year event (*Lee County Surface Water Management Plan* (LCSWMP). Johnson Engineering, 1991). The mass balance is summarized in the following table:

Table 9. Mass balance table

Gator Slough Canal Watershed		
1 year event Sep 5-28, 1996		
Total Area	396,657,360	ft^2
South of Hwy 41	9,106	acres
	14.23	sq. miles
	volume	depth over total area
	(cubic feet)	(inches)
Tot. Inflow	32,719,680	1.0
from North of Hwy 41		
Tot. Rain	277,329,604	8.4
Lake FairAway station		
Tot. Infiltration	177,162,896	5.4
Tot. ET	130,799,266	4.0
Ground Flow	107,381,486	3.2
Tot. outflow	238,055,396	7.2
link weir # 11		
Tot. outflow		
of USGS data	263,260,800	8.0
Missing Runoff	25,205,404	0.8
Percent error	9.6	

Figures 42 - 44 describe the current model calibration results.

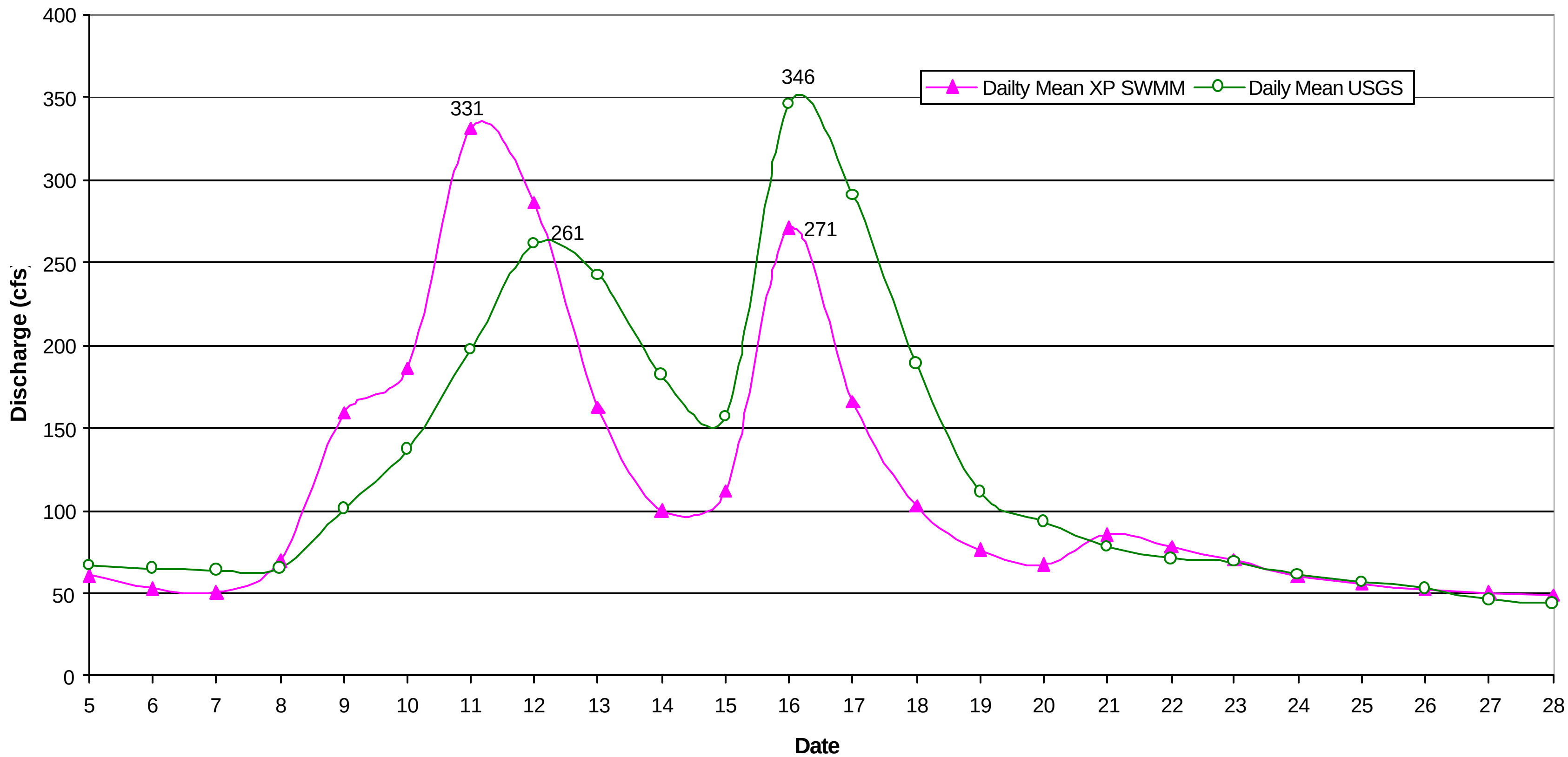

Figure 42. Outflow hydrograph comparison for September 1996.

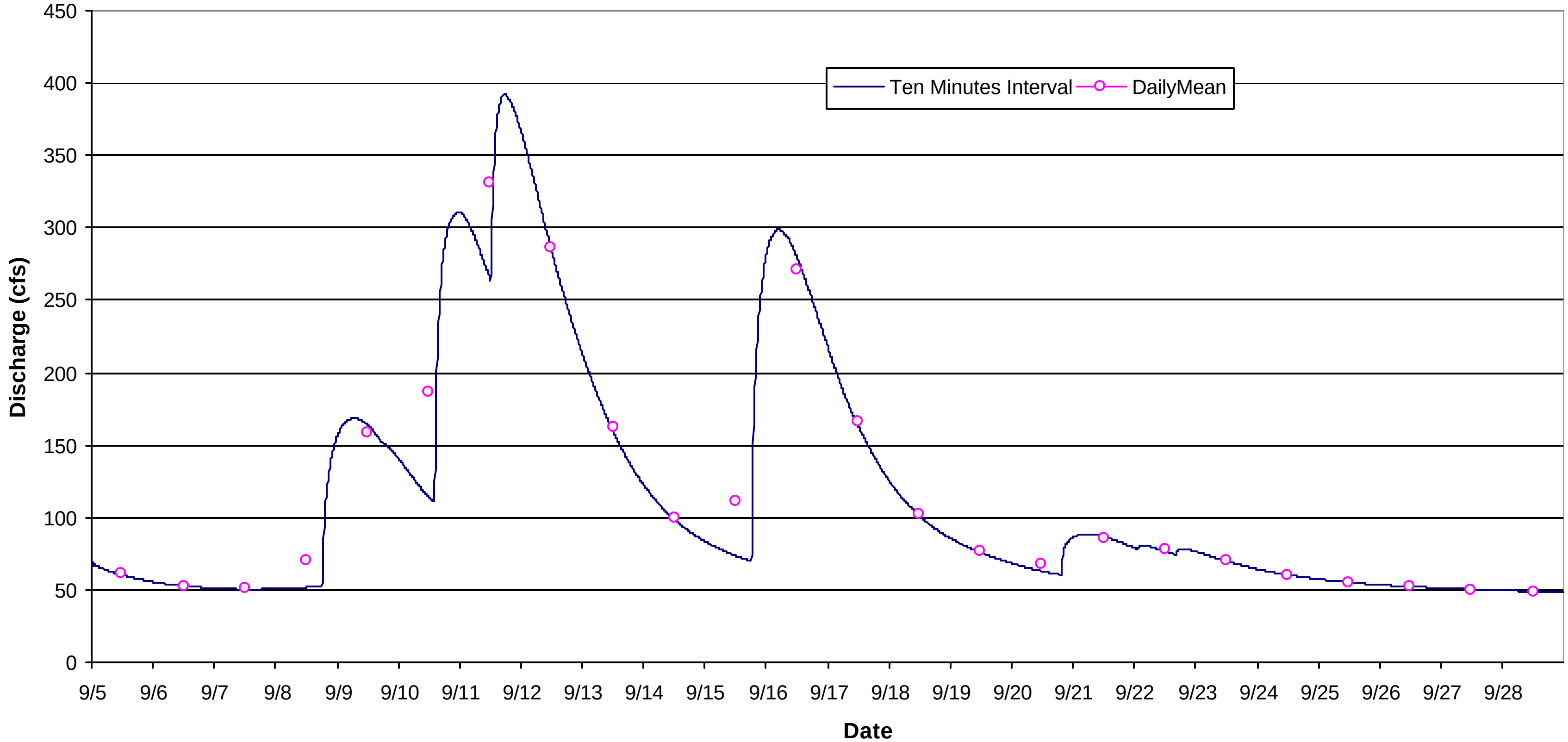

Figure 43. Outflow hydrograph Sept '96 XP-SWMM.

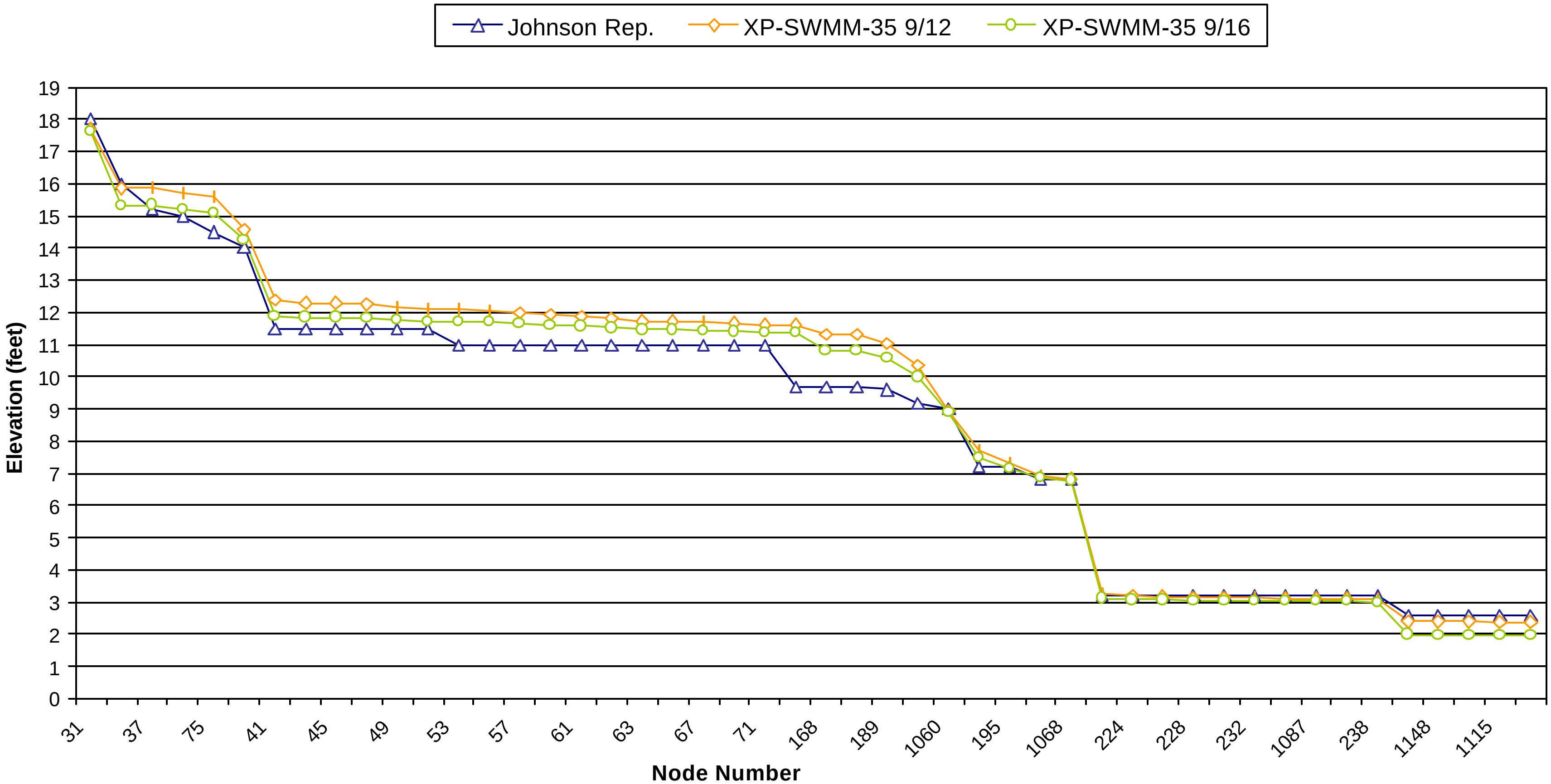

Figure 44. One-year Event Water Elevation comparison - Gator Slough.

Flow Peak: USGS = 346 cfs Model = 331 cfs Deviation = 69 cfs (4.3%)
Flow Volume: USGS = 8 inches Model = 7.2 inches Deviation = 0.8 inches (10%)
Base Flow: USGS = 50 cfs Model = 50 cfs

As these distilled results show, the model appears to be performing reasonably well considering limitations of the rain data set. The record of a single rain station is applied to the whole model area whereas much of the regional rainfall occurs as thunderstorms, which strike unpredictably and locally. Is therefore reasonable to consider acceptable the 20% error in some points of the outflow hydrograph comparison and the mismatch of the two main event peaks. The fact that the first event is over predicted and the second event under predicted suggests that the model performance is correct, on average, and is limited by rainfall data.