BIG CYPRESS BASIN WATERSHED MANAGEMENT PLAN

Hydrologic-Hydraulic Assessment for Replacement and Relocation of Golden Gate Canal Weir #3

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

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Big Cypress Basin

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

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Acronyms and Initialisms

BCB	Big Cypress Basin
COE	Corps of Engineers
DHI	Danish Hydraulic Institute
EPA	Environmental Protection Agency
FLUCCS	Florida Land Use Cover Complex System
FU-1	Faka Union Weir Number 1
GG-1	Golden Gate Weir Number 1
GG-2	Golden Gate Weir Number 2
GG-3	Golden Gate Weir Number 3
H&H	Hydrologic & Hydraulic
LIDAR	Light Detection and Ranging
MIKE SHE/ MIKE 11	Integrated Surface Water\Groundwater Modeling System Developed By DHI
NAVD	North American Vertical Datum
NGGE	Northern Golden Gate Estates
NGVD	National Geodetic Vertical Datum
SFWMD	South Florida Water Management District
SGGE	Southern Golden Gate Estates
SWMM	Storm Water Management Model
UNET	Unsteady Network Hydraulic Model
USACE	United States Army corps of Engineers
USGS	United States Geological Survey

EXECUTIVE SUMMARY

The existing Golden Gate Canal Weir No. 3 (GG-3) is a fixed crest weir with two small bottom opening sluice gates (5ft x 6ft). The structure is inadequate to meet the current water management objectives of dry season storage for water supply, and control of fresh water discharges for water quality protection of Naples Bay. A modification of this weir, including provisions for a more efficient system of operable control gates, will provide management flexibility for water conservation and flood control. Replacing and relocating this structure is an element of the Big Cypress Basin (BCB) Five-Year Plan (2006-2010).

Surface and groundwater hydrologic assessment of the Golden Gate Canal basin and hydraulic evaluation of the conveyance capacity of the canal and structures were conducted using the BCB integrated surface water and groundwater model developed by the application of Danish Hydraulic Institute, Inc.'s (DHI) MIKE SHE\MIKE 11 modeling system. After consideration of various types of structural alternatives, a fully gated spillway with OBERMEYER gates was found to be the most efficient configuration for relocating and replacement of GG-3. An assessment of the level of flood protection and general water management functions of existing GG-3 and structural modification of the proposed GG-3 were conducted by continuously simulating the hydrologic-hydraulic responses for an average hydrologic year and for the design storm event. The proposed GG-3 is designed to convey the 25-year, 5-day storm event discharge with no impact on wet season high water levels beyond the existing conditions while being able to store additional water in canal and recharge the groundwater during the dry season, and reduce the load of fresh water discharge to Naples Bay.

1.0 INTRODUCTION

1.1 BACKGROUND AND WATER MANAGEMENT PROBLEMS

The Big Cypress Basin (BCB) operates and maintains 169 miles of primary canals and 46 water control structures in western Collier County. These facilities provide avenues for flood protection, enhancement of water supply and improved environmental quality. Since the early 1980s, the BCB has adopted an aggressive program to modify the water control structures in the Golden Gate Canal and its tributaries to achieve better water management objectives. The Golden Gate Canal Weir No. 3 (GG-3) has been found to be deficient in providing the desired levels of service for flood protection and conservation storage. A full-scale retrofit of the structure is outlined in the Big Cypress Basin Five-Year Plan (2006-2010).

The present Golden Gate Canal Weir No.3 structure (GG-3) is located approximately 6 miles upstream from Golden Gate Canal Weir No.2 (GG-2) at the easterly terminus of 17^{th} Ave. SW in Golden Gate Estates. The existing GG-3 is a fixed crest weir with two bottom opening sluice gates (Figures 1-1, 2 & 3). The structure was retrofitted from a V-notch weir to a gated structure in 1986. The current GG-3 is incapable of meeting the current water management objectives of dry season storage for water supply, as well as control of fresh water discharges for water quality protection of Naples Bay. Modification of this weir, with provisions for a more efficient system of operable control gates, will provide better management flexibility for water conservation and flood control.

The BCB's Five-Year Plan (2006-2010) has outlined a regional plan to assess the feasibility of diverting a portion of the Golden Gate Canal flows to Henderson Creek to reduce damaging freshwater discharges to Naples Bay, and also to provide regulated freshwater release to Henderson Creek Estuary of Rookery Bay. In order to facilitate adequate hydraulic head for such diversion, a new water control structure will be required at a location of approximately two miles downstream from the present location of GG-3. The purpose of this assessment is to evaluate the hydraulic performance of a relocated GG-3 under alternative structural configurations and estimate the size of an economically feasible water control structure that will achieve the water management objectives of the Golden Gate Canal basin.

The analysis will incorporate present BCB integrated surface and groundwater systems modeling of the existing hydrologic and hydraulic (H&H) conditions of Golden Gate.

Golden Gate Canal Weir #3 Drainage Area

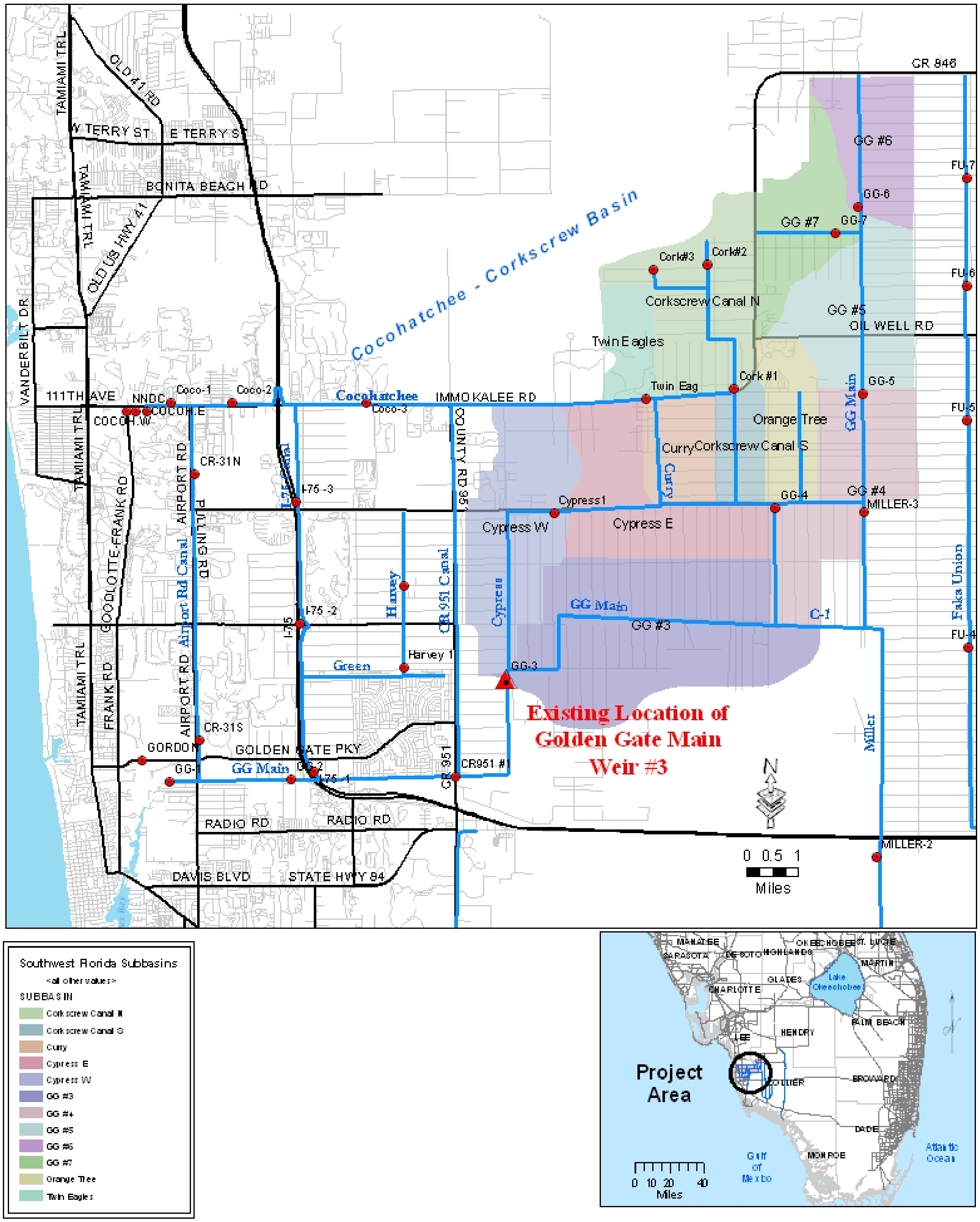


Figure 1-1 Existing Golden Gate Canal Weir No. 3

Figure 1-2 Aerial View of Existing Golden Gate Weir # 3

Figure 1-3 Existing Golden Weir # 3

Canal watershed and simulate different scenarios to evaluate hydraulic performance for the development of an economically and environmentally sound plan to replace and retrofit GG-3. The H&H analysis will provide information on the responses of improved GG-3 structure to average hydrologic conditions, to design flows in terms of flood control and environmental quality protection.

1.2 OBJECTIVES

The objectives for this H&H study are as follows:

- Evaluate hydraulic performance of the existing GG-3
- Evaluate hydraulic performance of the proposed GG-3
- Demonstrate the impact on flood protection in the Golden Gate Canal watershed
- Evaluate the change of fresh water discharge to the Naples Bay Estuary
- Evaluate the increase in conservation storage for aquifer recharge during the dry season
- Develop an economically and environmentally sound configuration of the weir

2.0 HYDROLOGIC & HYDRAULIC MODELING

2.1 BASIN PHYSICAL FEATURES

The Golden Gate Main Canal is located in the west-central portion of Collier County. The canal system in the Golden Gate basin was built in 1960s to drain the lands for residential development in the rural area known as Golden Gate Estates. The canal drains approximately 120 square-miles, with primary land uses of agriculture, rural and urban residences and commercial development. The Golden Gate Main Canal basin is bounded by the Corkscrew-Cocohatchee basin to the north, the Gordon River Extension basin to the northwest, the District VI basin to the south, the Henderson Creek basin to the southeast, and the Faka Union Canal basin to the east (Figure 2-1). The canal flows generally southwest into Naples Bay. Presently, seven water control structures in the Golden Gate Main Canal provide a controlled step-down of the water level to prevent overdrainage of the interior lands. In addition, many canals of its tributary network, namely Golden Gate side branch, Cypress, Harvey, I-75, Corkscrew, CR 951, and Airport Road Canals, also have operable water control structures.

The current GG-3 structure captures runoff from approximately 109 square miles. Despite the low-relief terrain of the Golden Gate Canal basin, natural surface drainage is controlled by topography. The Immokalee Rise provides the high point for the basin where drainage begins to flow towards the southwest, and then flows in a more southerly and then westerly direction towards the Naples Bay. Ground elevations range from approximately 23 feet NGVD, in the northeastern end, to nearly 6 feet NGVD near GG-1.

2.2 MODELING METHODOLOGY

The Golden Gate Canal watershed is typical of Southwest Florida hydrology, with low relief and high water table conditions. An extensive network of drainage canals and water control structures regulate the surface and groundwater flow patterns.

Golden Gate Canal Weir #3 Drainage Area

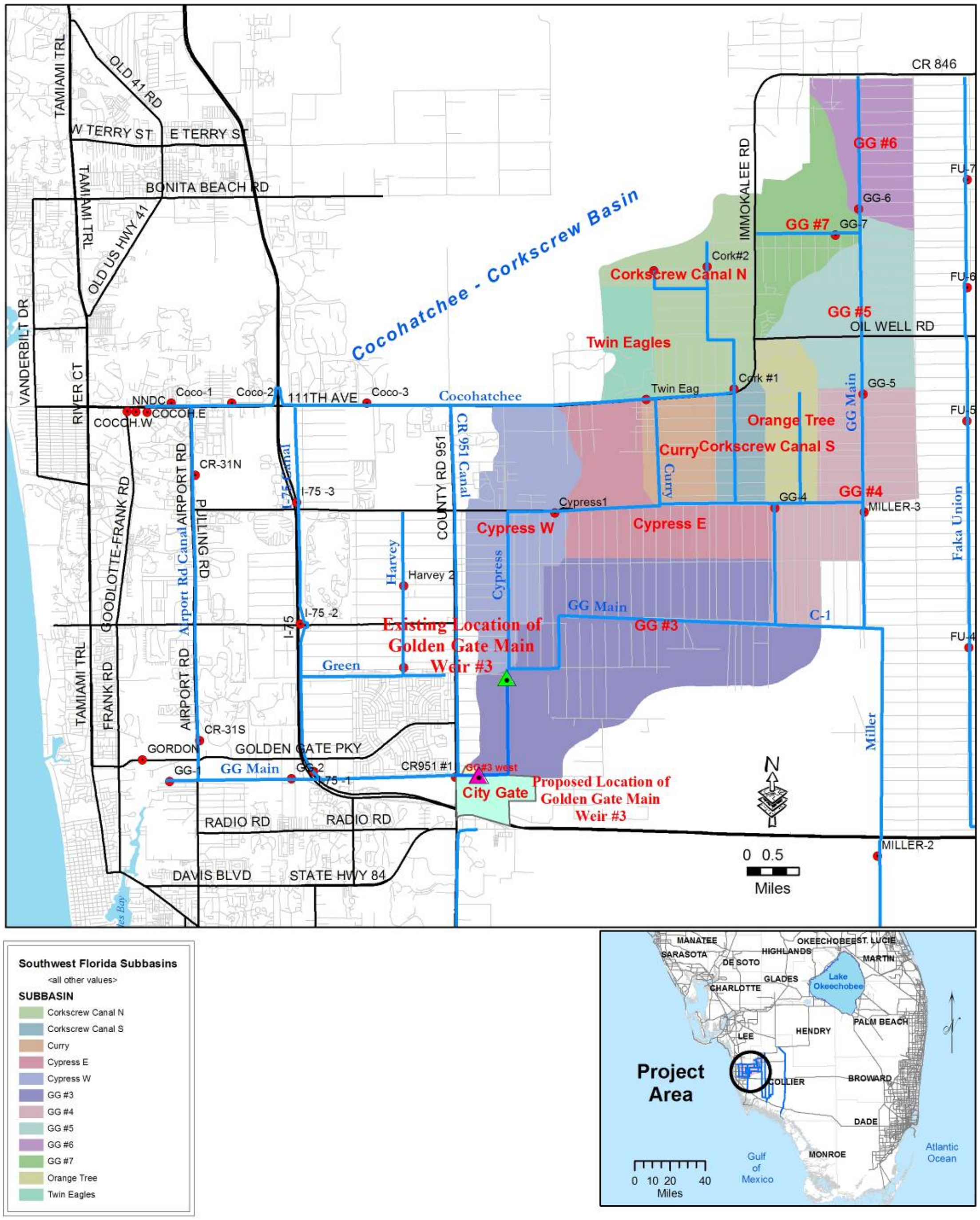


Figure 2-1 Golden Gate Canal Weir #3 Drainage Area

There is significant interaction between surface water and groundwater. A set of regional hydrologic-hydraulic models were previously developed by applying the United States Environmental Protection Agency's (USEPA) Storm Water Management Model (SWMM) and the U.S. Army Corps of Engineers' unsteady state hydraulic network model (UNET) (Dames & Moore, 1998). However, the SWMM-UNET combination of models is primarily geared toward simulating the rainfall-runoff process and flood routing in open channels. Their effectiveness in assessing the effects on water supply, groundwater recharge and wetland functions are limited without the application of an integrated surface water/groundwater model.

An integrated hydrologic-hydraulic model for the BCB regional watershed was developed by DHI Inc. to assess the impact of water management strategies on flood dynamics, wetland water levels and water supply (Christierson, 2002; DHI, 2004). The model is based on an integrated, physically distributed hydrologic modeling system – MIKE SHE, which simulates overland flow, unsaturated zone flow and groundwater flow dynamically, coupled with a river hydraulics model, called MIKE 11. The domain of the BCB model covers an area of 1194 square miles. The model is defined in State Plane 1983 Florida East coordinates and NAVD 1988, and it further subdivided spatially into 15,060 cells, with a grid dimension of 1500 feet by 1500 feet (Figure 2-2).

The integrated modeling approach provides a physical representation of the flow processes as opposed to the lumped parameter rainfall-runoff simulation process. The H&H components included in the BCB model are as follows:

- Overland sheet flow and depression storage
- Infiltration and storage in the unsaturated zone
- Groundwater flow, storage and potential heads
- Open channel flow and water levels
- Drainage effects
- Irrigation water allocation distribution
- Dynamic exchange between the unsaturated zone-groundwater (recharge)

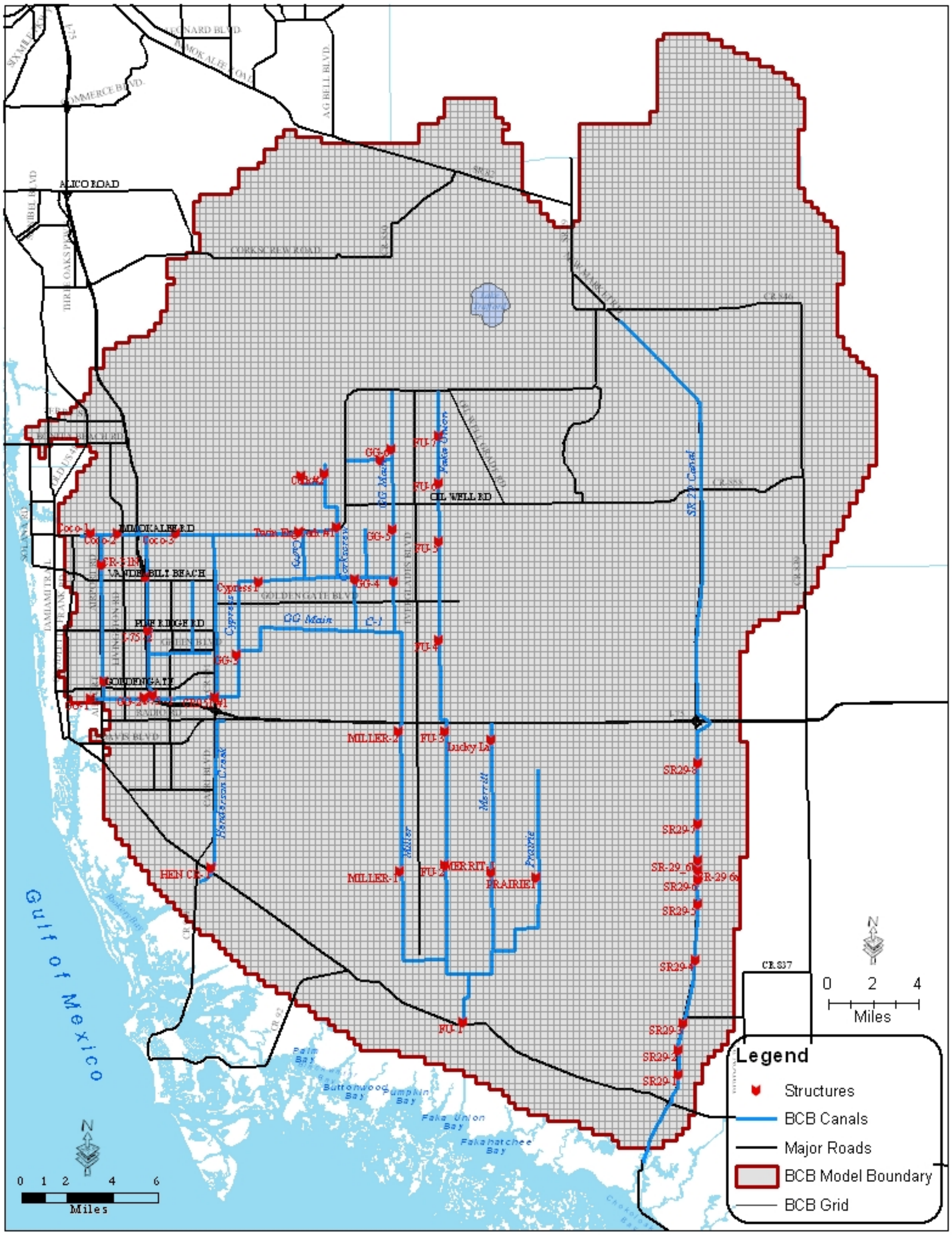


Figure 2-2 BCB Model Boundary and Major Canal System in the Model

The MIKE SHE/MIKE 11 modeling system couples several partial differential equations that describe flows in the overland, channel, the saturated zone and unsaturated zone to simulate the integrated process of all the principal components of the hydrologic regime, including the correlation between ground and surface waters. The physically-based flow equations to be solved include the following: (1) one-dimensional Saint-Venant flow equations for surface flow processes; (2) two-dimensional diffusive wave for overland flow; (3) one-dimensional Richard equation for unsaturated vertical infiltration; and (4) three-dimensional Boussinesq equation for saturated groundwater flow. Different numerical solution schemes are then used to solve the partial differential equations for each process. A solution to the system of equations associated with each process is found iteratively by use of different numerical solves. A schematic representation of the complete water resources system that is represented by MIKE SHE/MIKE 11 interaction model is shown in Figure 2-3.

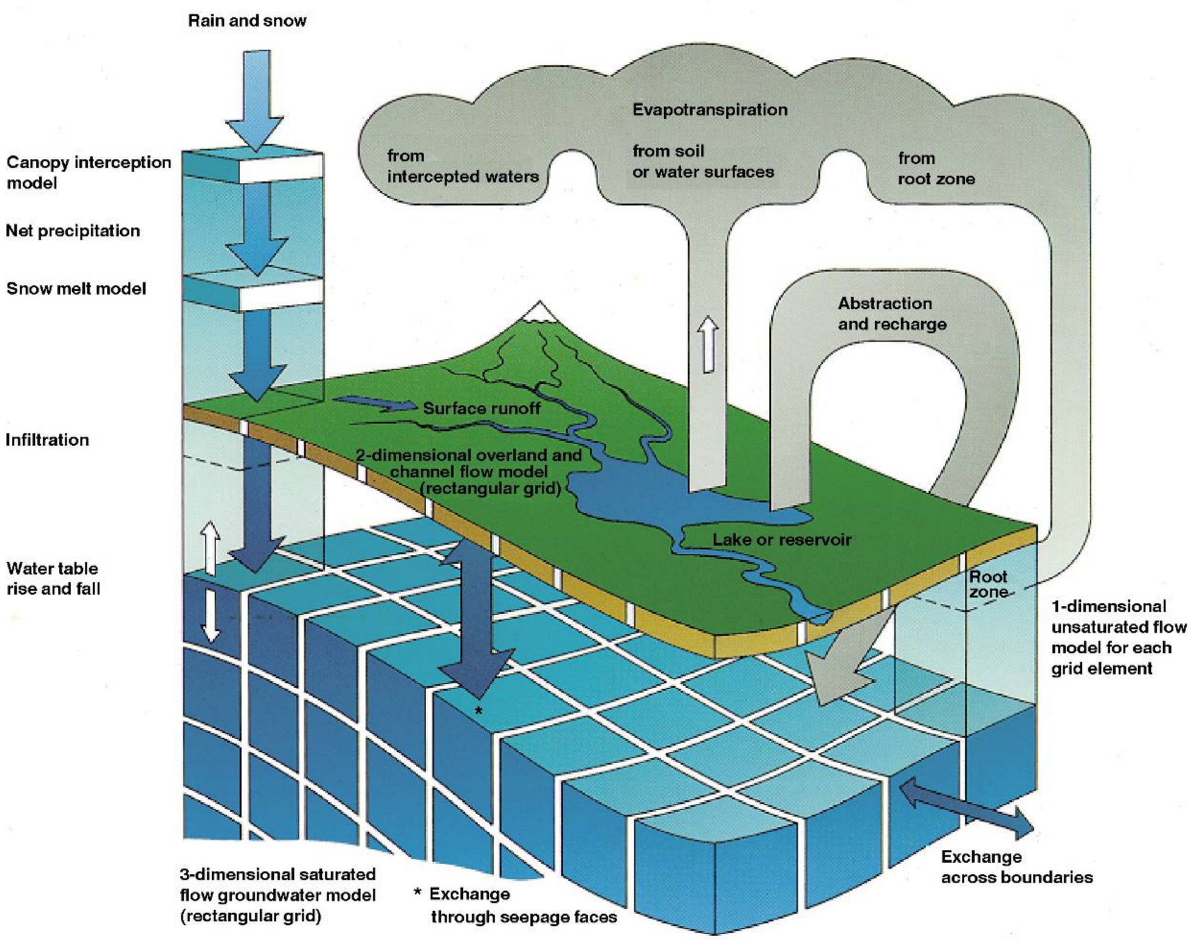


Figure 2-3 A General Configuration at Integrative Groundwater-Surface Water

2.3 SURFACE WATER HYDROLOGIC MODEL

The overland flow component of the MIKE SHE model represented the rainfall-runoff processes, including the unsaturated zone and the interaction between groundwater and surface water. The BCB overland flow model was set up to simulate both surface water runoff and groundwater influence for drainage areas located in the BCB. The ground surface elevation was interpolated to 1500 feet grid based on topography generated from USGS quadrangle data and further enhanced by topographic data obtained by aerial photogrammetry, LIDAR data (2000) from Collier County and USACE cross section surveys gathered in the Golden Gate Estates (2003). The interpolated topographic digital grid input map was used to develop the conceptual model for the overland flow simulated using MIKE SHE. The topographic coverage of the BCB area describes the overland flow processes in MIKE SHE. The MIKE SHE generated overland flows acted as distributed sources for the MIKE 11 channel routing model. The topographic map used in the MIKE SHE model is shown in Figure 2-4.

In the MIKE SHE model, surface runoff occurs when water starts ponding on the surface, due to insufficient infiltration capacity of the underlying soil, proximity of the groundwater table near the ground surface, or existence of drainage flows from low-lying areas. The overland flow in MIKE SHE uses a 2-D diffusive wave approximation for computing hydrologic components, dependent on ground surface slope, surface roughness, and detention storage. These parameters are described in detail in the reports prepared by DHI, Inc. (2001, 2004).

The driving forces for the integrated hydrologic model are rainfall and evapotransporation. Rainfall on the west coast of Florida, including the BCB, is typically dominated by local weather phenomena. Continuous records of rainfall for the BCB and neighboring area are available at 20 rainfall stations (Figure 2-5) for a 13-year period (1988-2000). The measured rainfall from the 20 stations (Figure 2-5) was spatially distributed using the triangulation method, Triangular Irregular Network – 10 (TIN –10). This method divides daily rainfall estimates into 2 mile by 2 mile grid cells, and then 10 by 10 sub-cells, thus the sub-cell size becomes 1056 feet by 1056 feet, as illustrated in Figure 2-6.

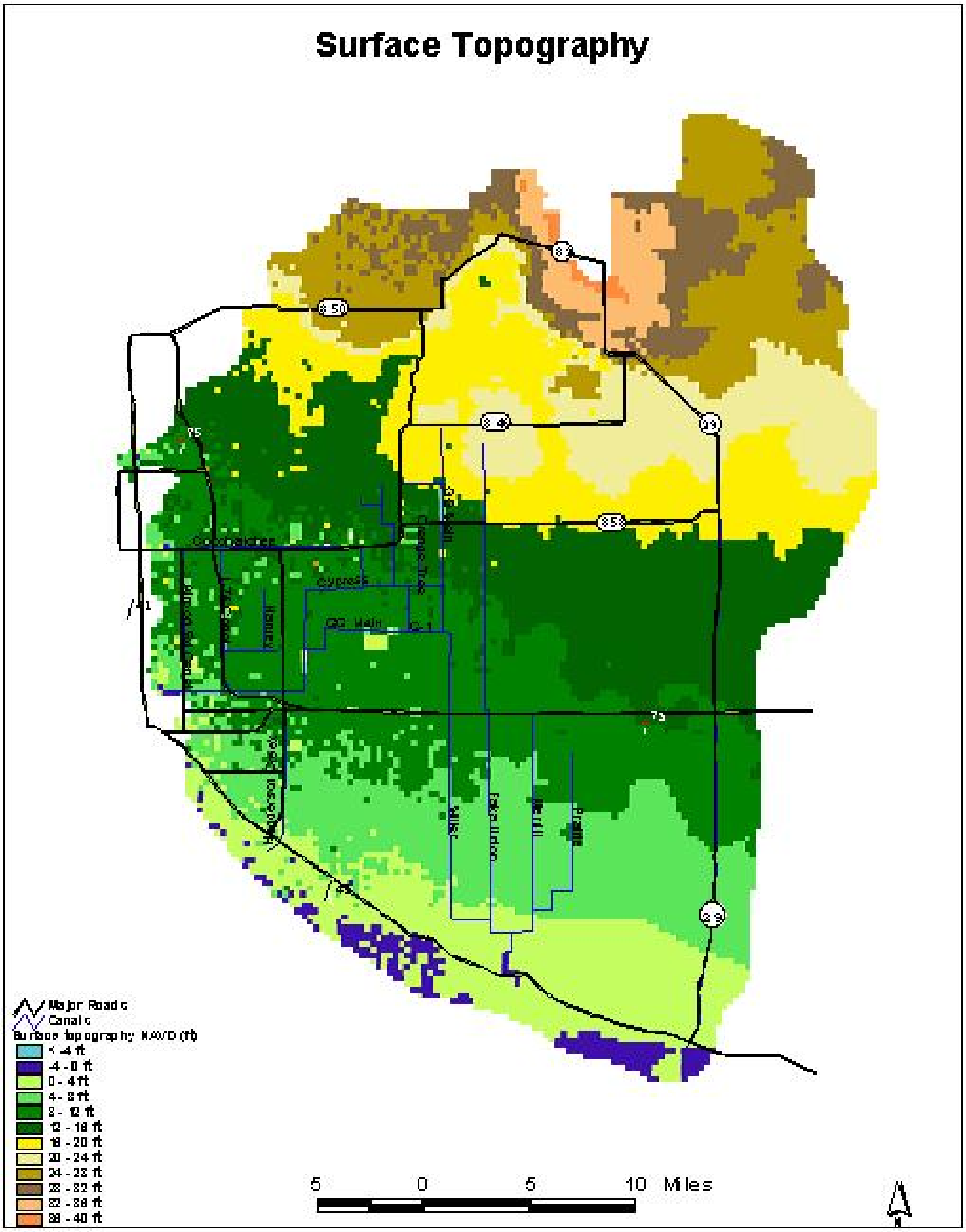


Figure 2-4 Surface Topography

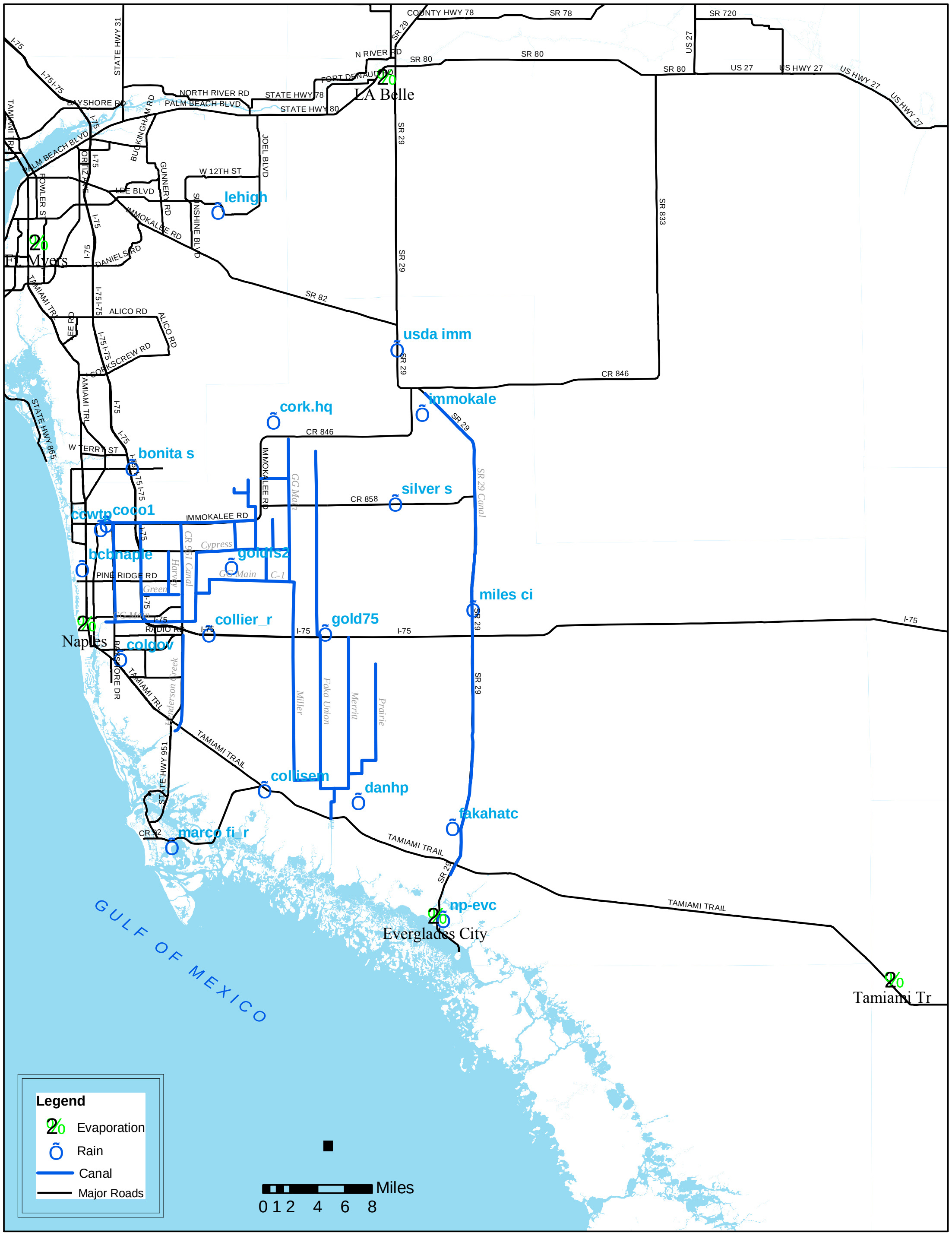


Figure 2-5 Rainfall and Evaporation Stations

Spatial Distribution of Rainfall using TIN-10

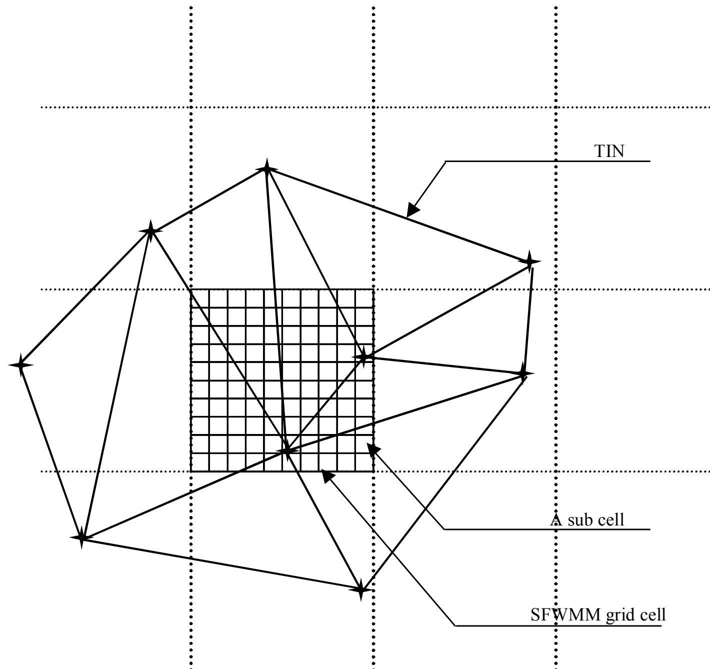


Figure 2-6 Spatial Distribution of Rainfall using TIN-10

For a given day, a TIN is built whose vertices are rain gauge locations with non-missing values. For a given 2 mile by 2 mile grid cell, the above TIN is used to interpolate rainfall at the centroids of each of the 100 sub-cells covering that cell. The average of the 100 rainfall values is represented as the daily rainfall for a 2 mile by 2 mile cell. The operation is repeated to generate daily rainfall records for the entire model period.

Evapotranspiration (ET) accounts for the bulk of water loss from the modeling area. Water is lost to the atmosphere by evaporation from plant surfaces, free water surfaces, soil evaporation, and through transpiration from the plant root zone thereby reducing water available for runoff and groundwater flow. Table 2-1 gives vegetation parameters used by MIKE SHE to calculate actual evapotranspiration.

The potential ET for the BCB model was calculated by the SFWMD Simple Method, which computes the long-term historical (1965-2000) wet marsh potential ET from the evaporation stations in the model domain (Figure 2-5). Due to the difference in the roughness characteristics between marsh and grass surfaces, the crop coefficients developed were modified for use with wet marsh potential ET. Additionally, five National Oceanic and Atmospheric Administration (NOAA) stations with long-term (1965-2000) daily temperature data were thoroughly checked and patched to correct systematic errors, trends and missing values with the purpose of producing the best possible temperature dataset for ET estimates. The spatial distribution of the wet marsh potential ET values for the model domain was estimated by the TIN-10 method across the five evaporation stations. A summary of the statistics of the wet marsh potential evapotranspiration for those NOAA stations is shown on Table 2-2.

Table 2-1 Vegetation Parameters

Model Land Use Type	Growth Period	Leaf Area Index (-)	Root Depth (mm)	Crop Coef. Kc (-)	AROOT
Citrus	All year	4.5	1250	0.77-0.9047	0.25
Pasture	All year	3-4	750	0.7	0.5
Sugar Cane	All year	1-6	500-1500	0.665-1	0.25
Urban Low Density	All year	1-2	200	0.552-0.777	0.5
Urban Medium Density	All year	0.5-1	200	0.552-0.777	0.5
Urban High Density	All year	0.1-0.2	200	0.552-0.777	0.5
Truck Crops	All year	3-4.5	152-750	0.561-1	0.5
Golf Course	All year	2-3	750	0.552-0.777	0.75
Bare Ground	NA	0	0	1	0.25
Mesic Flatwood	All year	1.5-3	1219	0.246-0.82	1
Mesic Hammock	All year	2.5-4	610	0.246-0.82	1
Xeric Flatwood	All year	1-2	1219	0.221-0.738	0.5
Xeric Hammock	All year	2-3	610	0.221-0.738	0.5
Hydric Flatwood	All year	1.5-3	1219	0.237-0.79	1.5
Hydric Hammock	All year	2.5-4	610	0.237-0.711	1.5
Wet Prairie	All year	1.5-3	152	0.225-0.75	2
Dwarf Cypress	All year	1-2	152	0.22-0.734	1
Marsh	All year	2-4	152	0.254-0.845	2
Cypress	All year	2-4	1524	0.237-0.79	1
Swamp Forest	All year	3-5	1524	0.237-0.79	1
Mangrove	All year	3-4	1524	0.271-0.904	1
Water	NA	0	0	1	0.25

Table 2-2 Annual Time Series and Summary Statistics of Wet Marsh Potential Evapotranspiration in Inches Estimated at 5 NOAA Stations

Year	La Belle	Ft Myers	Naples	Everglades City	Tamiami Trail
1965	56.57	57.96	59.53	62.05	60.80
1966	54.92	56.94	57.94	60.51	56.16
1967	58.40	56.46	59.36	60.73	63.63
1968	57.37	57.70	58.36	60.22	59.78
1969	56.72	53.86	58.11	60.46	56.65
1970	58.85	55.86	60.22	58.52	53.54
1971	61.77	57.34	61.43	60.25	61.22
1972	59.76	59.32	60.88	58.41	58.83
1973	57.06	59.23	61.91	60.27	59.57
1974	58.07	59.90	62.95	60.58	60.10
1975	58.97	59.61	62.70	58.42	59.04
1976	57.73	59.14	62.31	60.21	56.12
1977	58.69	57.89	61.44	59.61	57.40
1978	58.38	57.57	59.82	59.58	55.98
1979	56.35	57.93	60.48	57.97	58.29
1980	57.67	58.56	60.36	58.80	59.75
1981	59.41	60.05	63.16	60.43	62.67
1982	55.33	56.76	60.70	57.69	60.47
1983	54.48	54.26	59.79	57.51	57.95
1984	55.53	56.73	58.12	60.35	56.93
1985	56.87	58.30	57.75	60.30	61.93
1986	56.85	59.85	58.34	61.27	57.20
1987	55.08	58.74	56.96	60.21	56.57
1988	56.33	60.61	58.36	63.59	57.99
1989	57.56	61.41	58.70	56.99	64.46
1990	56.37	60.83	58.71	56.90	63.73
1991	55.61	58.12	56.90	59.62	59.45
1992	54.66	58.23	57.35	57.69	59.79
1993	54.35	57.82	57.95	60.45	54.22
1994	56.24	57.11	55.85	59.39	56.36
1995	54.83	55.46	55.62	58.75	54.22
1996	54.60	57.27	58.11	62.45	58.31
1997	55.18	59.45	56.89	59.47	57.63
1998	53.60	56.51	56.33	56.20	56.44
1999	56.08	57.63	56.67	57.31	56.16
2000	55.22	58.85	57.49	58.12	56.67
Ann Ave	56.71	58.04	59.10	59.48	58.50
Stdev	1.81	1.71	2.07	1.63	2.70
Max	61.77	61.41	63.16	63.59	64.46
Min	53.60	53.86	55.62	56.20	53.54
Kr	0.158	0.179	0.176	0.190	0.179

Table 2-3 Land Use Types in the Model and Corresponding FLUCCS Codes

Model Land Use Type	MIKE SHE Code	FLUCCS Code (Level)
Citrus	1	220
Pasture	2	210 (3), 242
Sugar Cane	3	2156
Urban Low Density	41	110 (2), 180 (2), 192, 193, 240 (3), 241, 243, 245, 246, 250 (2)
Urban Medium Density	42	1009, 120 (2), 144, 833, 834
Urban High Density	43	130 (2), 140 (2), 150 (3), 151, 155, 170 (2), 810 (2), 820 (2), 830 (2), 152, 153, 154, 159
Truck Crops	5	214, 215
Golf Course	6	182
Bare Ground	7	160 (3), 161, 162, 163, 182, 230 (2), 261, 740 (3), 742, 744, 835
Mesic Flatwood	8	190 (3), 191, 194, 260 (3), 310 (2), 321, 330 (2), 410 (3), 411, 414, 429, 435, 440 (3), 441, 443, 710 (2), 720 (2), 741
Mesic Hammock	9	420 (3), 422, 423, 426, 427, 434, 437, 438, 439
Xeric Flatwood	10	412, 413
Xeric Hammock	11	322, 421, 432
Hydric Flatwood	12	4119, 419, 624
Hydric Hammock	13	329, 424, 425, 428, 433, 610 (3), 611, 743
Wet Prairie	14	643, 6439
Dwarf Cypress	15	6219
Marsh	16	6171, 6172, 640 (3), 641, 6411, 6412, 644
Cypress	17	620 (3), 621, 6218, 745
Swamp Forest	18	613, 614, 615, 616, 617, 630 (2)
Mangrove	19	612, 642
Water	20	166, 500 (1)

2.4 UNSATURATED ZONE MODEL

The unsaturated zone extends from the ground surface to the groundwater table. The depth is dynamic and varies throughout the year with groundwater fluctuations and rainfall. During periods of the year, the unsaturated zone may occasionally disappear in depression areas, such as wetlands, where the water table rises above ground, e.g. in wetland areas. Unsaturated flow in MIKE SHE is computed based on a simplified Richard's equation and infiltration rates depend on a number of soil parameters including hydraulic conductivity of the soil, soil retention, residual soil moisture, and water content at field capacity etc. The model computes infiltration rates and soil moisture, which in turn affect evapotranspiration losses from the root zone and irrigation demands. Input for the model consists of soil property parameters and a soil column distribution map. The soil parameters in MIKE SHE are specified in a database and a number of soil profiles are defined using soil types from the database. The MIKE SHE soil distribution map is shown in Figure 2-8. Various physical soil parameters entered into the unsaturated zone database are given in Table 2-4.

2.5 GROUNDWATER MODEL

The geology of the area consists of a Water Table Aquifer, Lower Tamiami Aquifer and the Sandstone Aquifer. The Surficial Aquifer system includes the Water Table Aquifer and a portion of the Lower Tamiami Aquifer, extending down approximately 80 feet. The Water Table Aquifer, which is well connected with the canal systems and responds rapidly to rainfall, is the only source of recharge, and canal drainage. The Surficial Aquifer System is separated from the lower aquifers by an aquiclude. The Lower Tamiami Aquifer is the primary source of regional public water supply. However, the rapid urban development in Collier County has stressed this aquifer to its safe yield limits, and a lower Mid-Hawthorne formation is now being tapped for supplemental public water supply using reverse osmosis treatment.

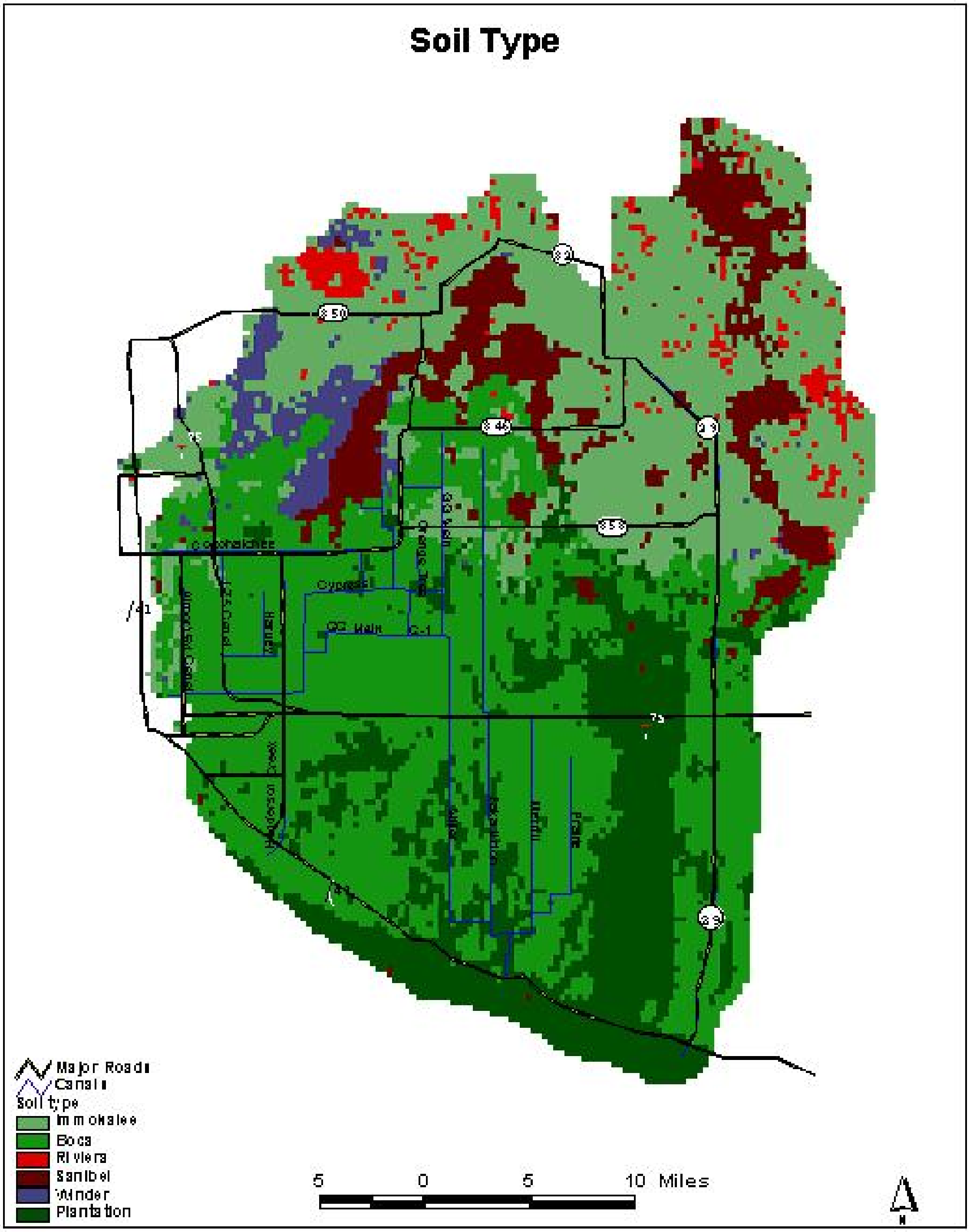


Figure 2-7 Soil Type

Table 2-4 Soil Profile Definition and Soil Physical Parameters Entered into the Unsaturated Zone Database

Profile No. and MSHE Code	Soil Type and Depth	Saturated Hydraulic Conductivity Ks [m/s]	Saturated Water Content □ s	Water Content at Field Capacity □ fc	Water Content at Wilting Point □ w	Residual Water Content □ r
1	Immokalee A1 (0.0-0.1 m)	2.0e-4	0.42	0.15	0.013	0.01
	Immokalee AE (0.1-0.23 m)	1.1e-4	0.42	0.15	0.02	0.031
	Immokalee E1 (0.23-0.41 m)	8.6e-5	0.39	0.14	0.02	0.015
	Immokalee E2 (0.41-0.91 m)	1.0e-4	0.38	0.14	0.01	0.01
	Immokalee Bh1(0.91-1.27 m)	1.2e-6	0.38	0.33	0.057	0.031
	Immokalee Bh2 (1.27-1.4 m)	6.1e-6	0.38	0.28	0.05	0.043
	Immokalee Bw/Bh (1.4-30 m)	7.5e-5	0.38	0.20	0.03	0.02
2	Boca A (0.0-0.08 m)	1.1e-4	0.487	0.11	0.04	0.029
	Boca E1 (0.08-0.23 m)	9.7e-5	0.46	0.11	0.034	0.023
	Boca E2 (0.23-0.36 m)	8.0e-5	0.408	0.09	0.024	0.015
	Boca Bw (0.36-0.64 m)	5.4e-5	0.396	0.10	0.009	0.006
	Boca Btg (0.64-30 m)	8.3e-7	0.347	0.33	0.122	0.071
3	Riviera Ap (0-0.15 m)	1.2e-6	0.38	0.23	0.049	0.031
	Riviera A (0.15-0.28 m)	4.2e-5	0.52	0.22	0.047	0.02
	Riviera E1 (0.28-0.41 m)	5.0e-5	0.46	0.12	0.022	0.01
	Riviera E2 (0.41-0.64 m)	5.5e-5	0.4	0.06	0.003	0.001
	Riviera Bw (0.64-0.74 m)	3.5e-5	0.38	0.06	0.004	0.001
	Riviera Btg (0.74-30 m)	2.5e-7	0.38	0.32	0.102	0.08
4	Sanibel Oa1 (0-0.12 m)	2e-5	0.752	0.72	0.207	0.2
	Sanibel Oa2 (0.12-0.15 m)	7.8e-5	0.73	0.69	0.205	0.1
	Sanibel A1 (0.15-0.23 m)	9.4e-5	0.51	0.39	0.025	0.01
	Sanibel A2 (0.23-0.3 m)	1.7e-4	0.41	0.17	0.013	0.01
	Sanibel C1 (0.3-0.66 m)	1.4e-4	0.37	0.09	0.013	0.01
	Sanibel C2 (0.66-30 m)	1.1e-4	0.38	0.08	0.011	0.01
5	Winder A1 (0.0-0.08 m)	3.6e-5	0.374	0.26	0.024	0.014
	Winder E (0.08-0.33 m)	5.7e-5	0.37	0.15	0.008	0.004
	Winder B/E (0.33-0.41 m)	1.6e-6	0.328	0.23	0.048	0.027
	Winder Btg (0.41-0.58 m)	7.4e-6	0.43	0.40	0.153	0.101
	Winder BCg (0.58-0.74 m)	7.4e-6	0.34	0.26	0.05	0.028
	Winder C1 (0.74-0.89 m)	4.1e-6	0.332	0.27	0.038	0.021
	Winder C2 (0.89-1.04 m)	5.0e-6	0.347	0.23	0.042	0.024
	Winder C3 (0.89-30 m)	1.9e-6	0.355	0.31	0.107	0.062
6	Plantation Oap (0-0.23 m)	1.6e-4	0.86	0.56	0.164	0.1
	Plantation A/E (0.23-0.48 m)	8.4e-5	0.491	0.19	0.029	0.022
	Plantation Bw (0.48-30 m)	1.2e-4	0.392	0.10	0.003	0.002

The deeper Floridian Aquifer system is not considered to be recharged or add to the water available in the overlying aquifer systems. According to geological surveys in the area, negligible exchange occurs between the Mid Hawthorn and the underlying Floridian aquifers. Figures 2-9 through 2-13 are elevation maps for each layer. Figures 2-14 through 2-18 are vertical and horizontal hydraulic conductivities distribution maps for those three aquifer layers.

Groundwater flow and potential heads are computed using a 3-D finite-difference groundwater model. A conceptual geological model representing the major layers, including aquitards and aquifers, was initially set up for the watershed to adequately represent flows in the groundwater system. A number of hydrogeological parameters, e.g. hydraulic conductivity and storage coefficients, were specified and appropriate boundary conditions were established. The delineation of boundary conditions was essential for obtaining a correct water balance for the groundwater basin. Moreover, water allocation from groundwater wells will affect the water balance significantly and impact groundwater levels locally. Similarly groundwater drainage will affect water levels and the dynamics of groundwater levels, primarily in the shallow aquifers.

Some of the groundwater simulation parameters were adapted from the Collier County MODFLOW model developed earlier. A specific yield of 0.2 was used for the surficial aquifer and the storage coefficient was set at 1 . 10-5 m-1 for the combined lower Tamiami and Sandstone aquifers. The final soil properties were determined through calibration of the model.

The boundary conditions for the confining layers were defined as an impermeable boundary. A combination of constant and variable head boundary conditions were applied for simulating the integrated surface and groundwater flow in the BCB MIKE SHE model (Figure 2-19). A constant head boundary was applied along the

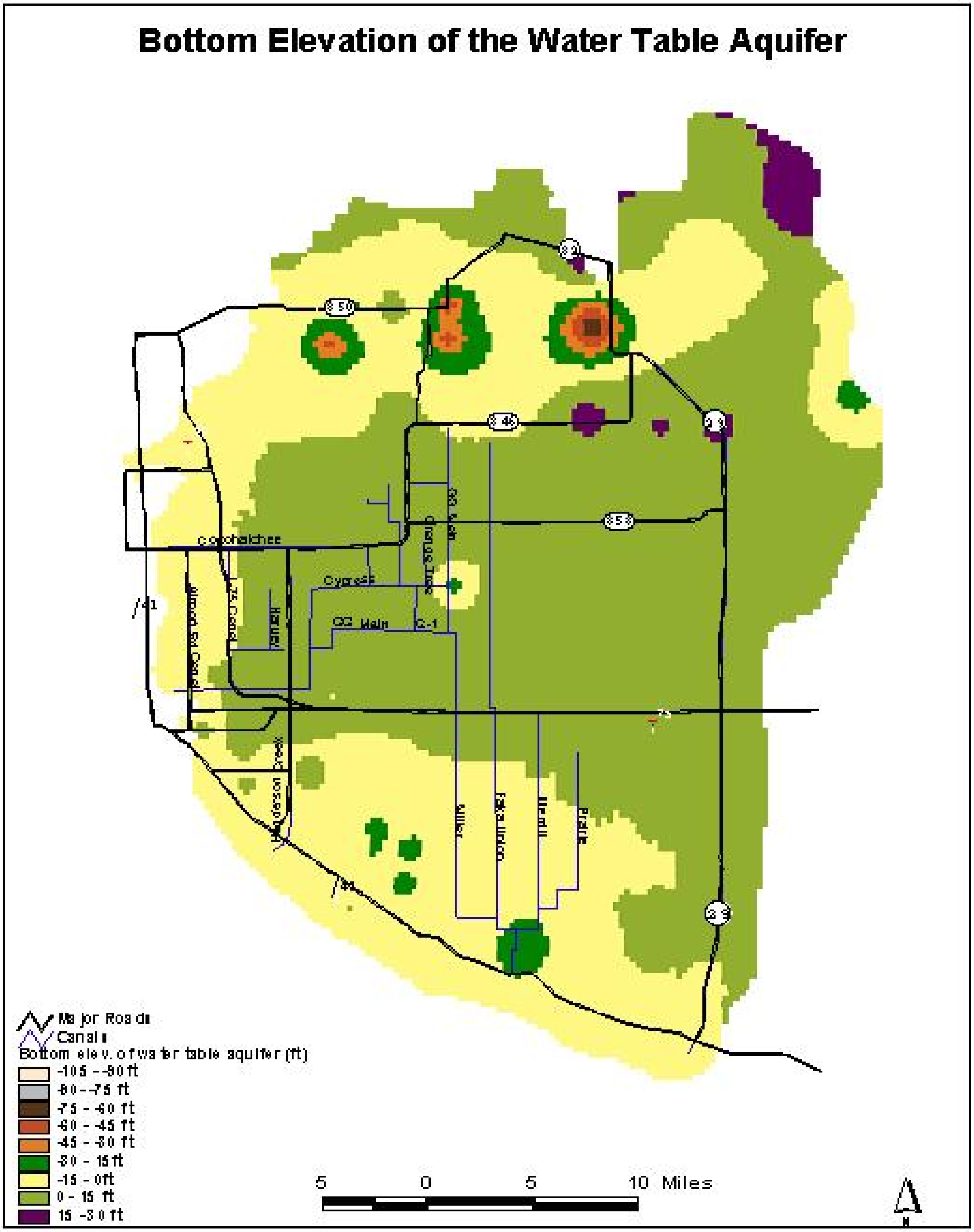


Figure 2-8 Bottom Elevation of the Water Table Aquifer

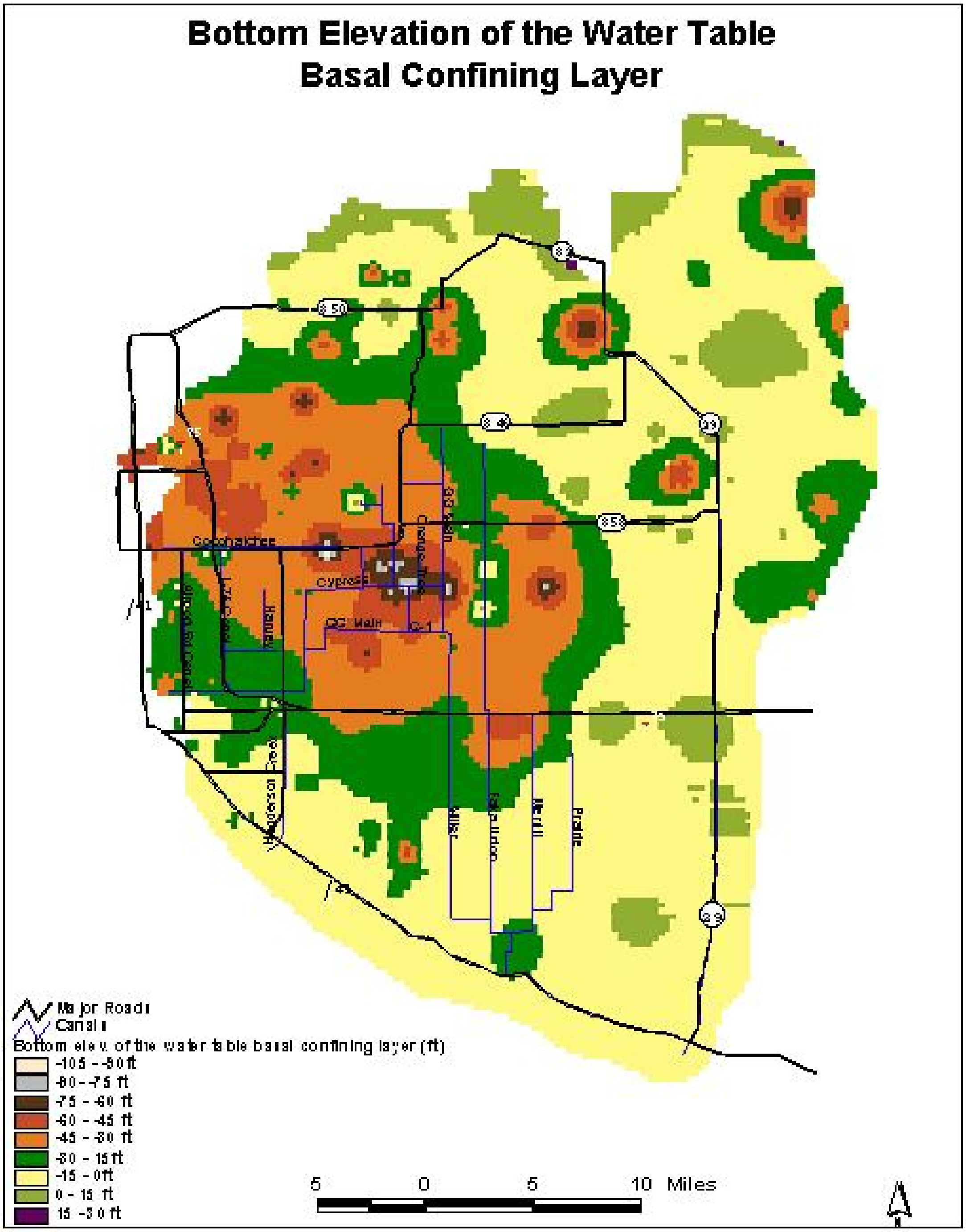


Figure 2-9 Bottom Elevation of the Water Table Basal Confining Layer

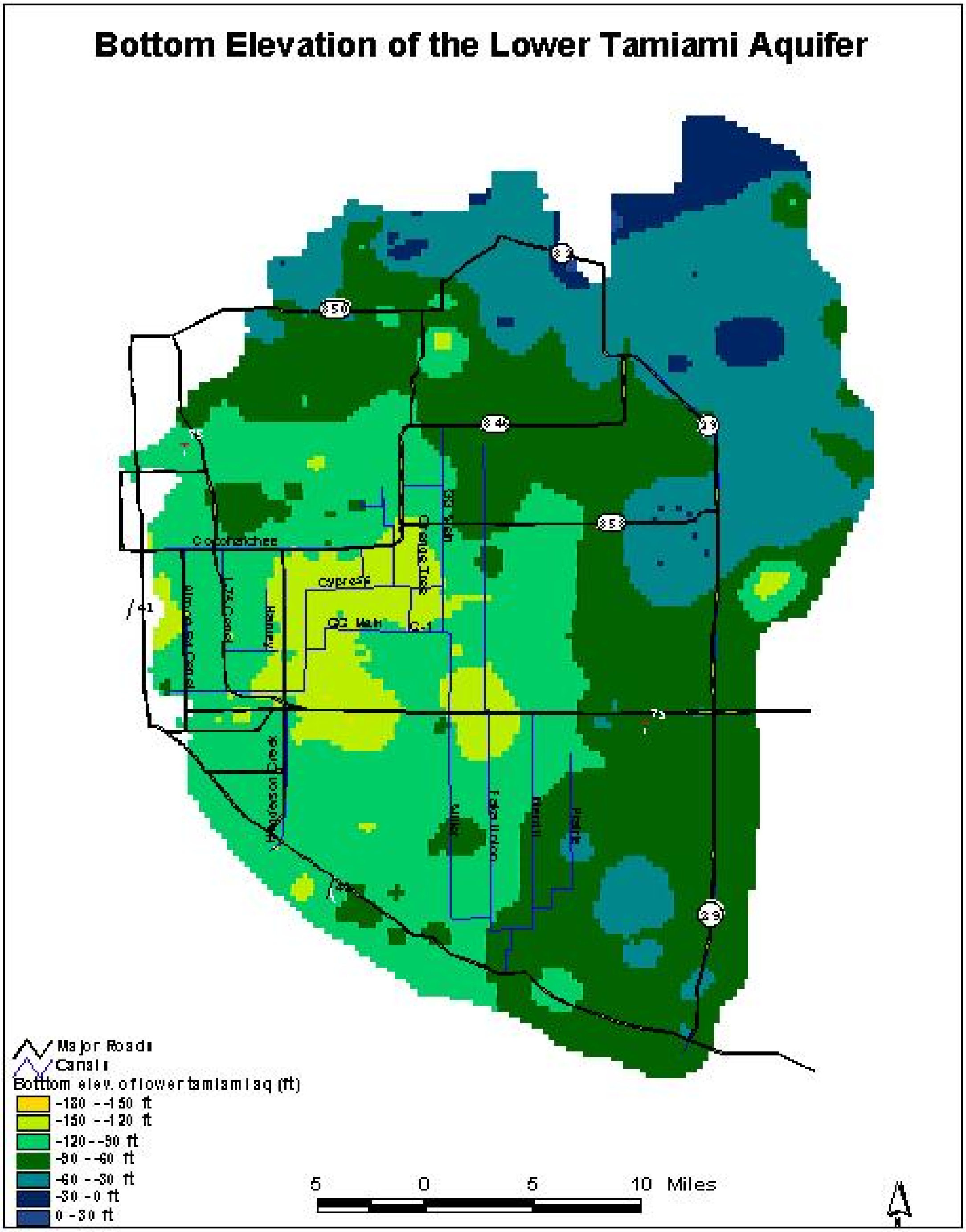


Figure 2-10 Bottom Elevation of the Lower Tamiami Aquifer

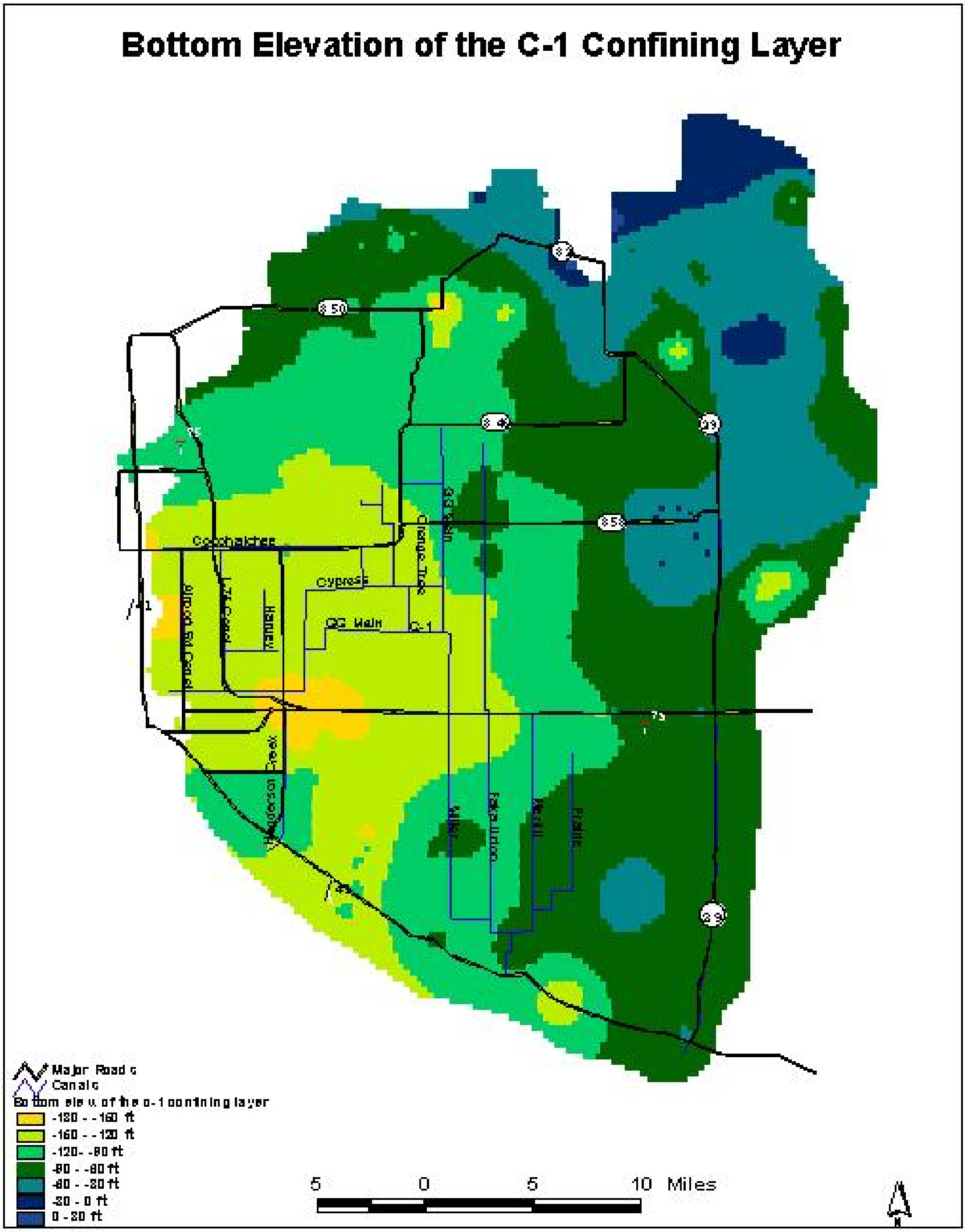


Figure 2-11 Bottom Elevation of the C-1 Confining Aquifer

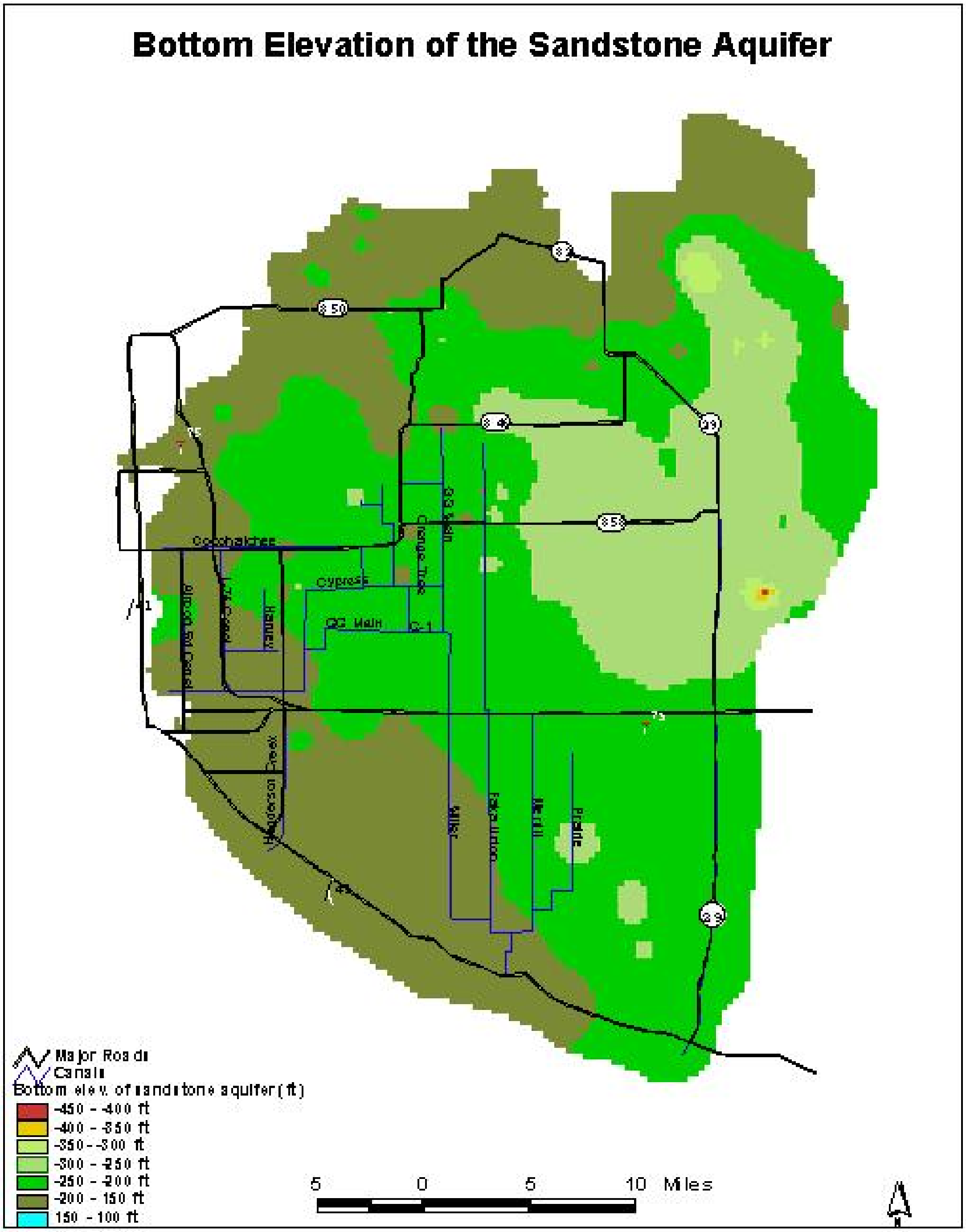


Figure 2-12 Bottom Elevation of the Sandstone Aquifer

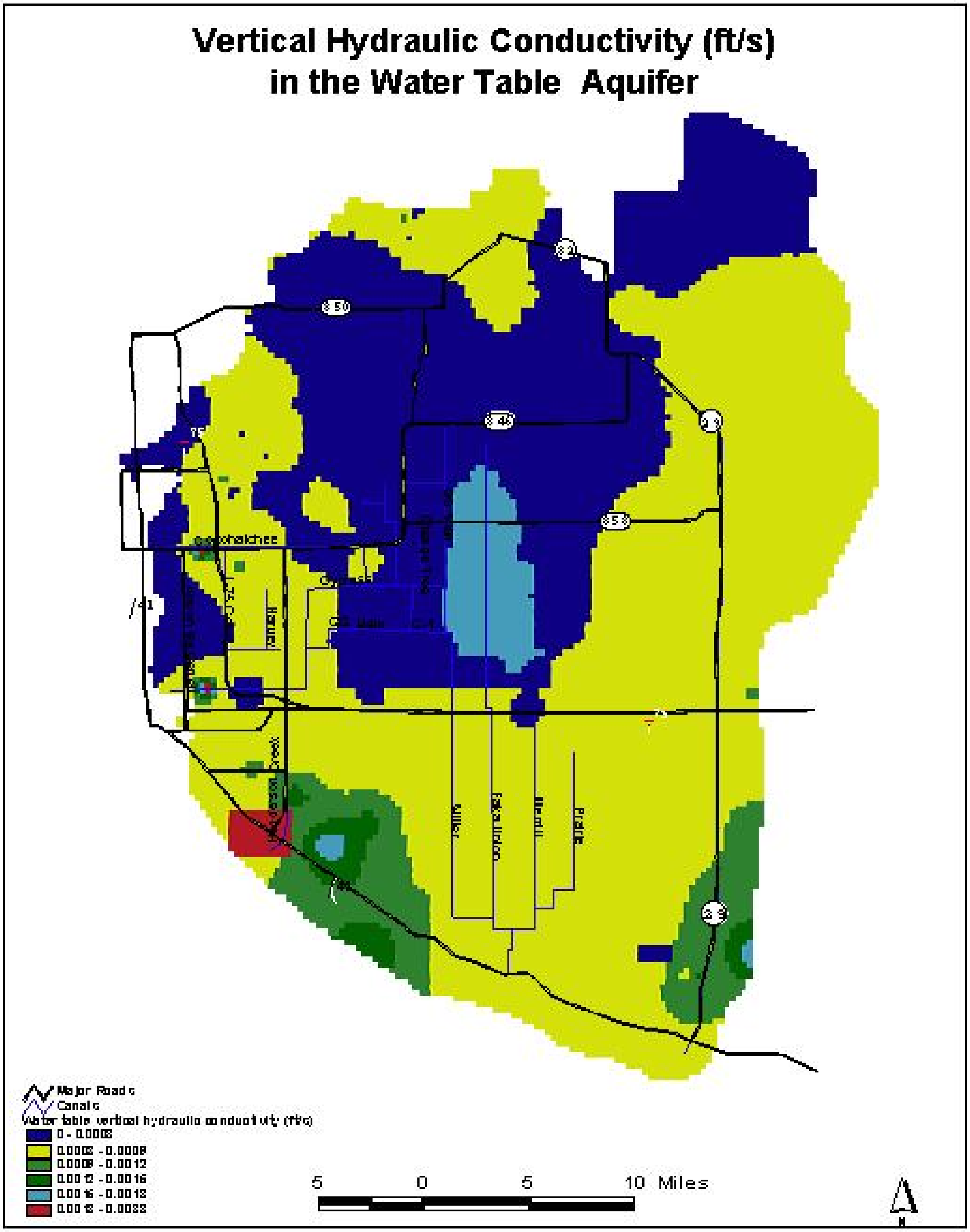


Figure 2-13 Vertical Hydraulic Conductivity (ft/s) in the Water Table Aquifer

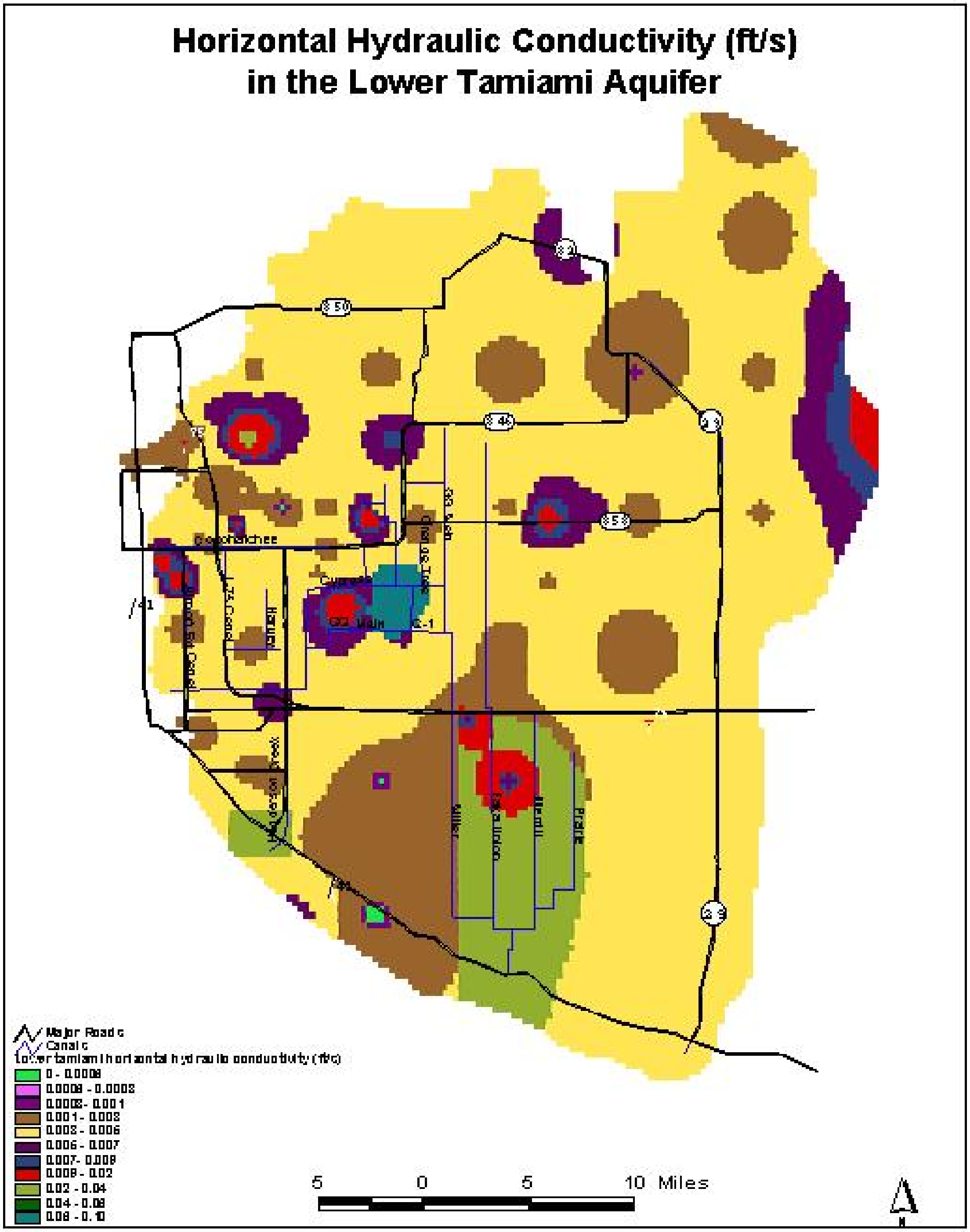


Figure 2-14 Horizontal Hydraulic Conductivity (ft/s) in the Lower Tamiami Aquifer

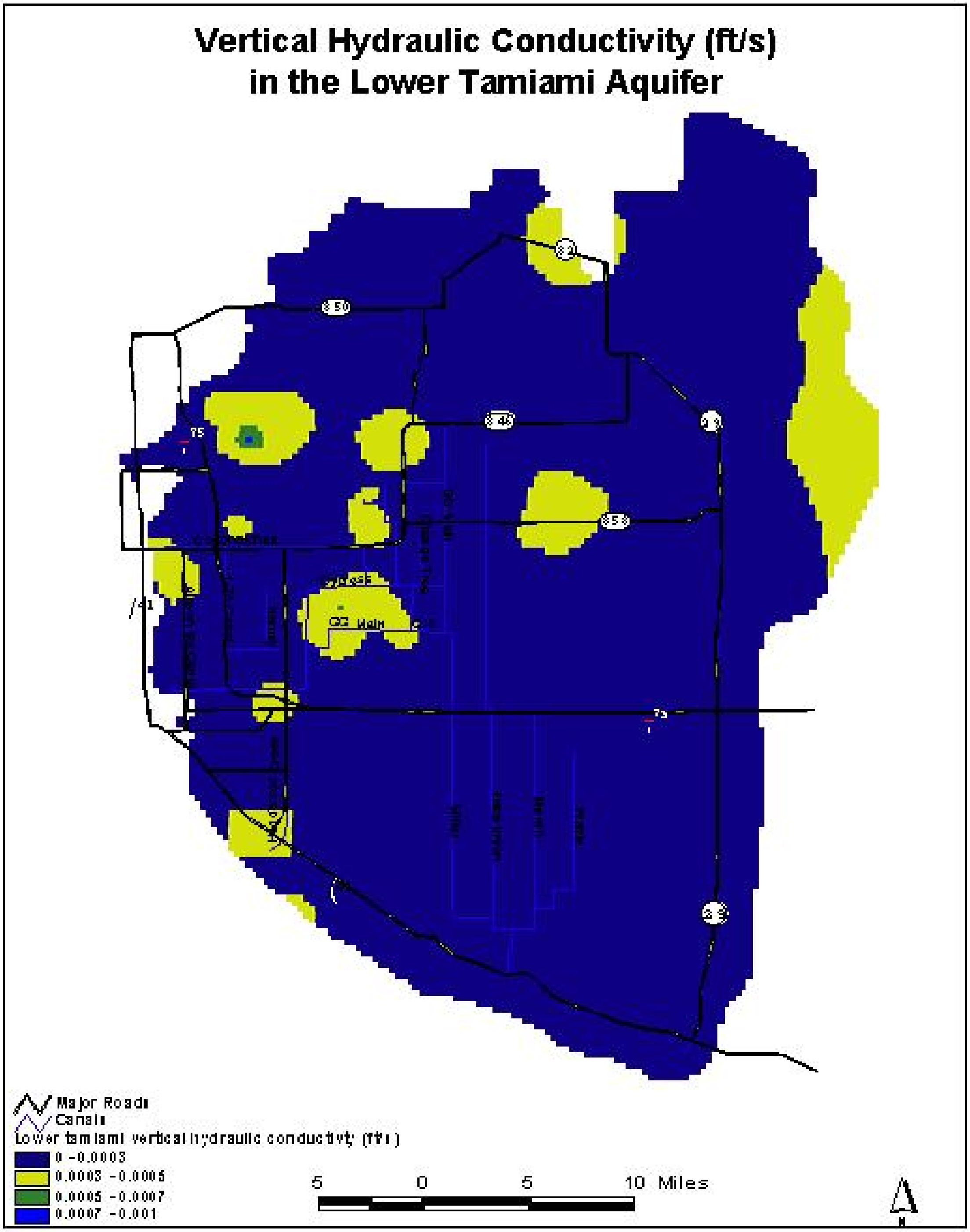


Figure 2-15 Vertical Hydraulic Conductivity (ft/s) in the Lower Tamiami Aquifer

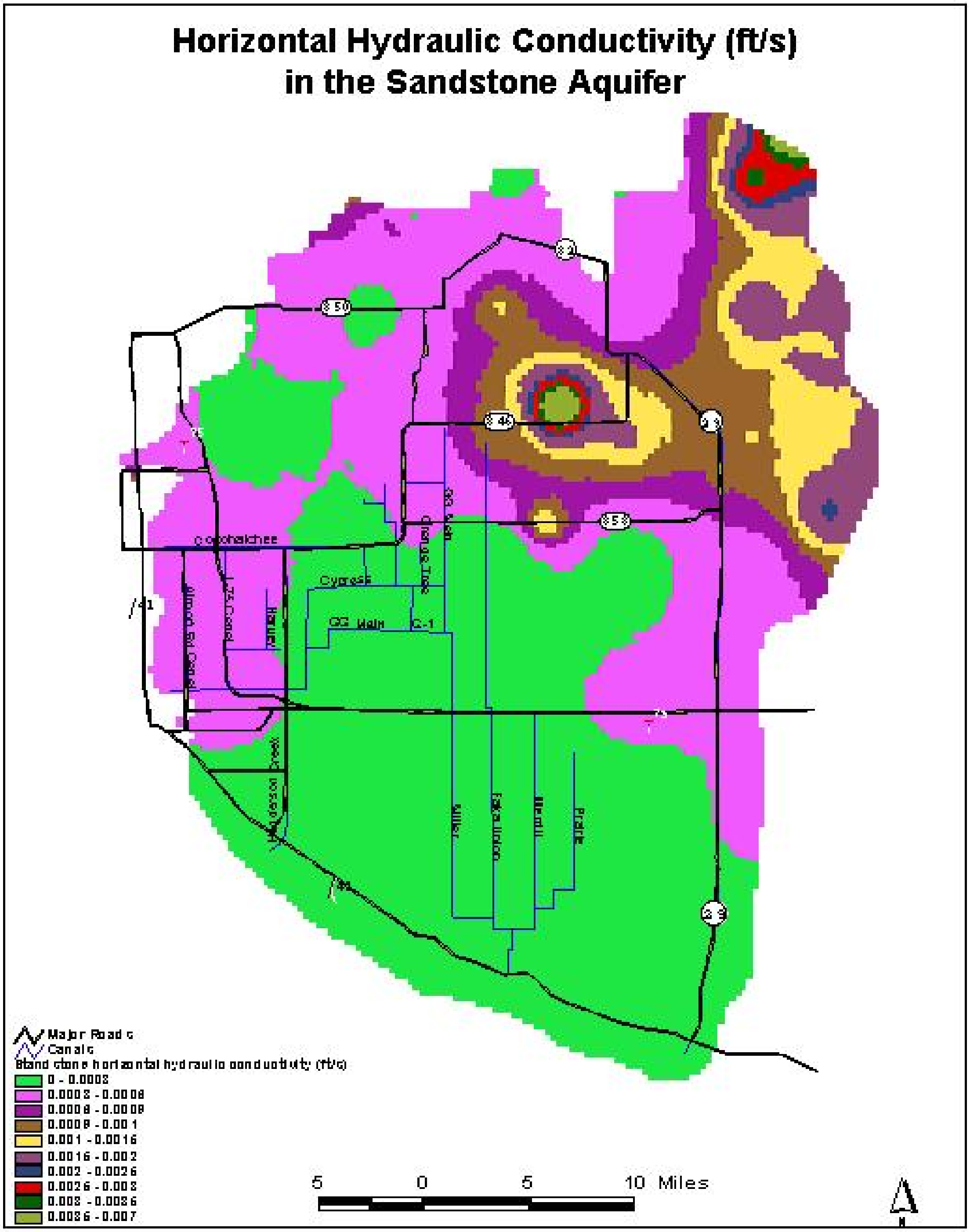


Figure 2-16 Horizontal Hydraulic Conductivity (ft/s) in the sandstone Aquifer

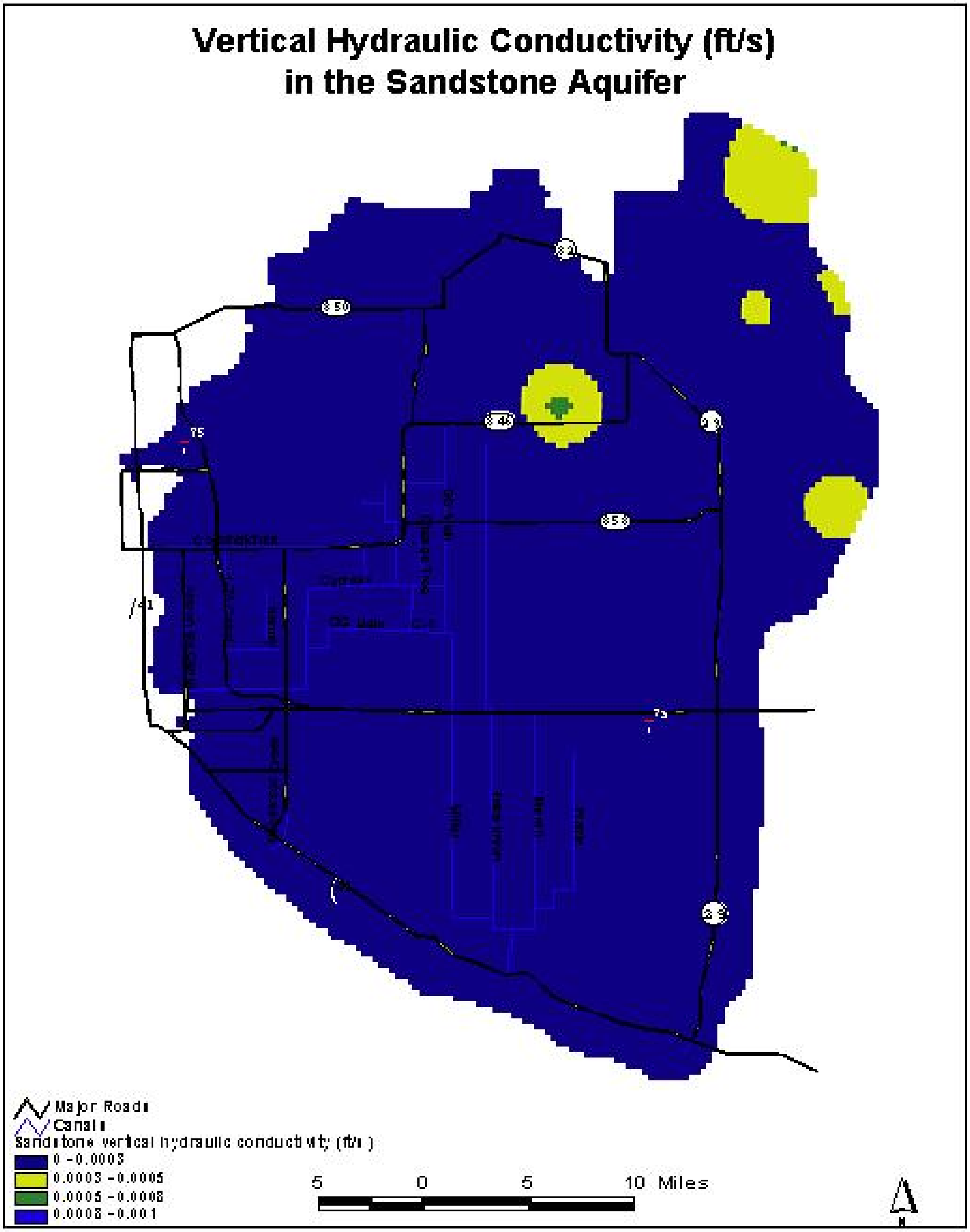


Figure 2-17 Vertical Hydraulic Conductivity (ft/s) in the Sandstone Aquifer

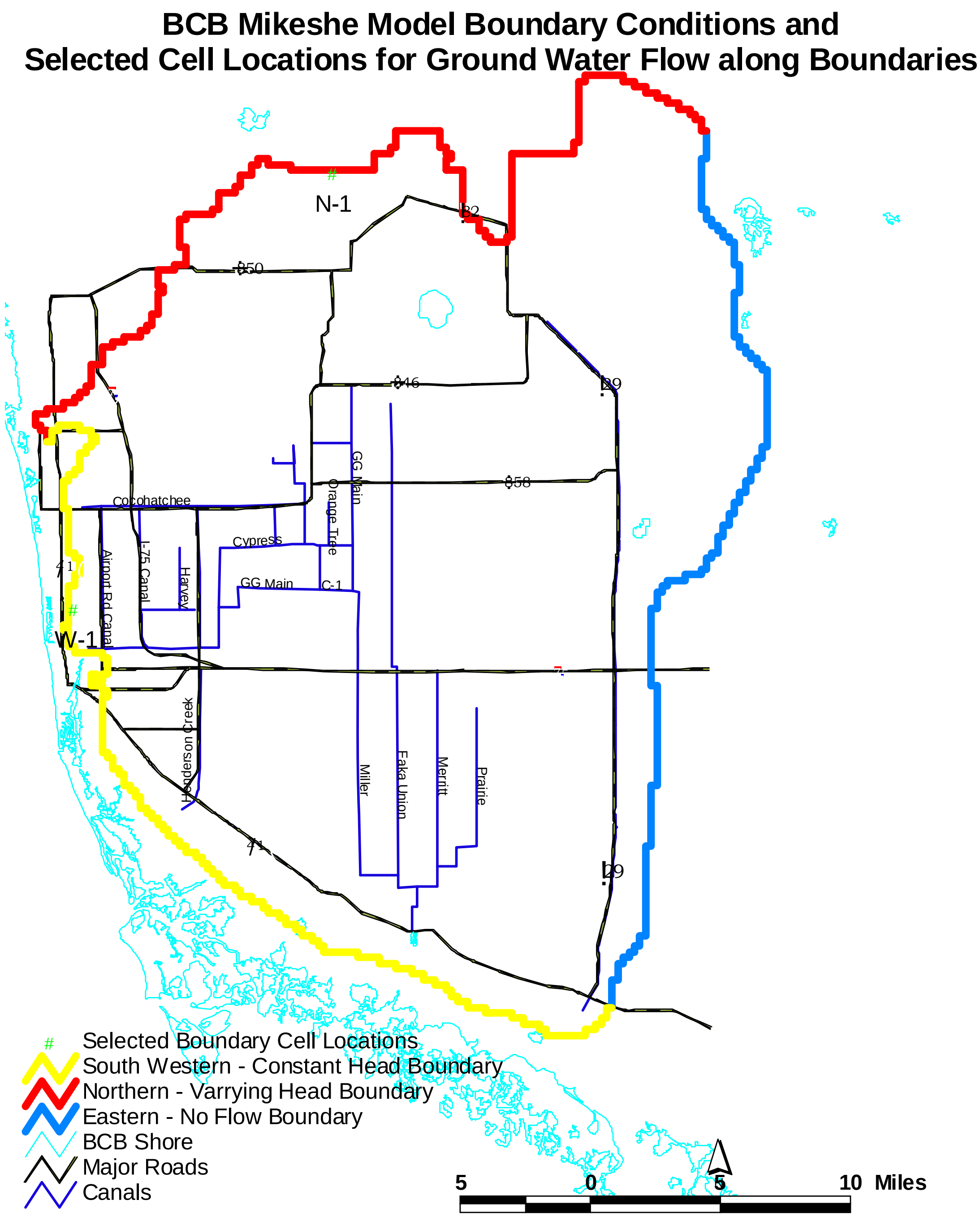


Figure 2-18 BCB MIKE SHE Model Boundary Conditions and Selected Cell Locations for Groundwater Flow along Boundaries

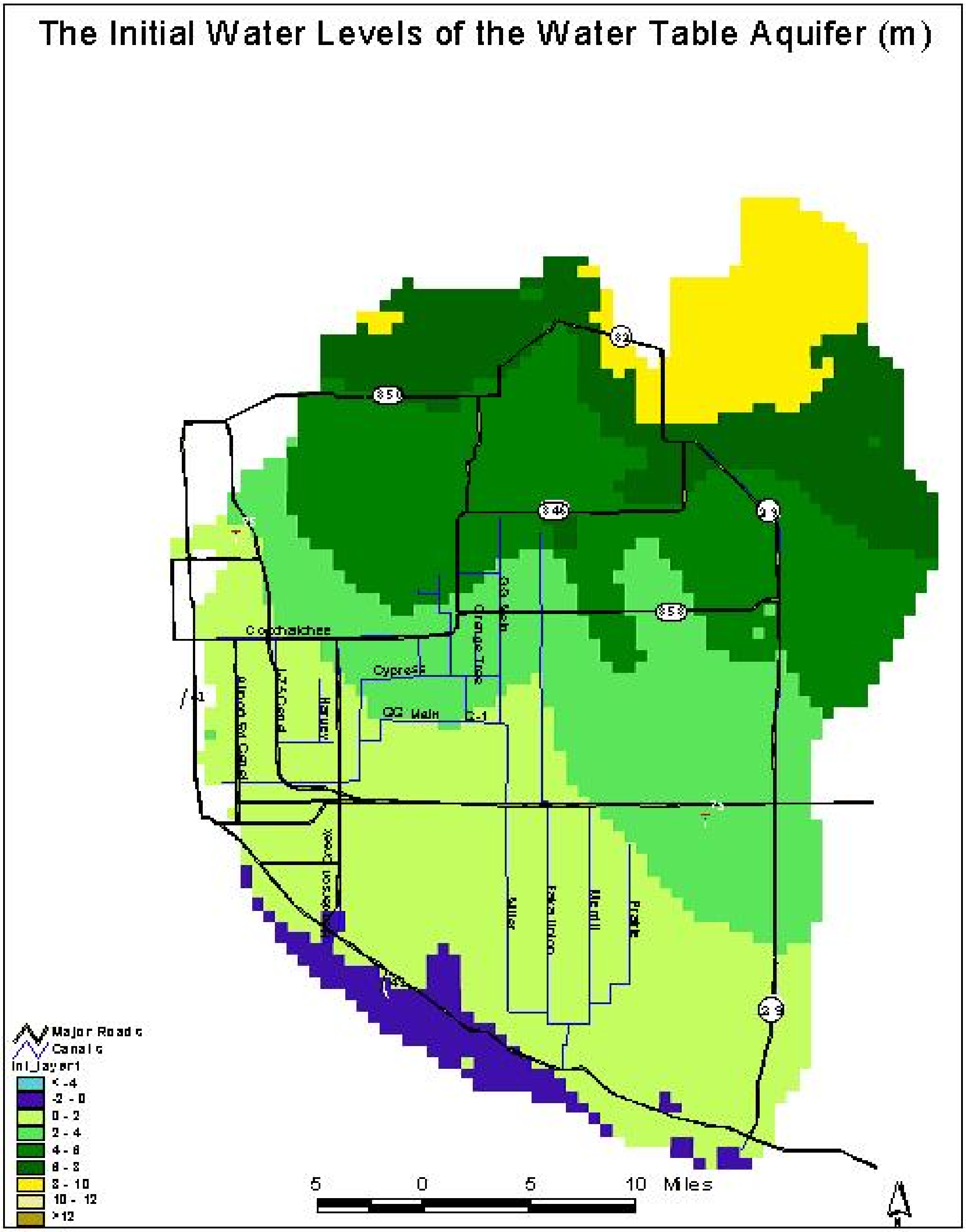


Figure 2-19 The Initial Water Levels of the Water Table Aquifer (m)

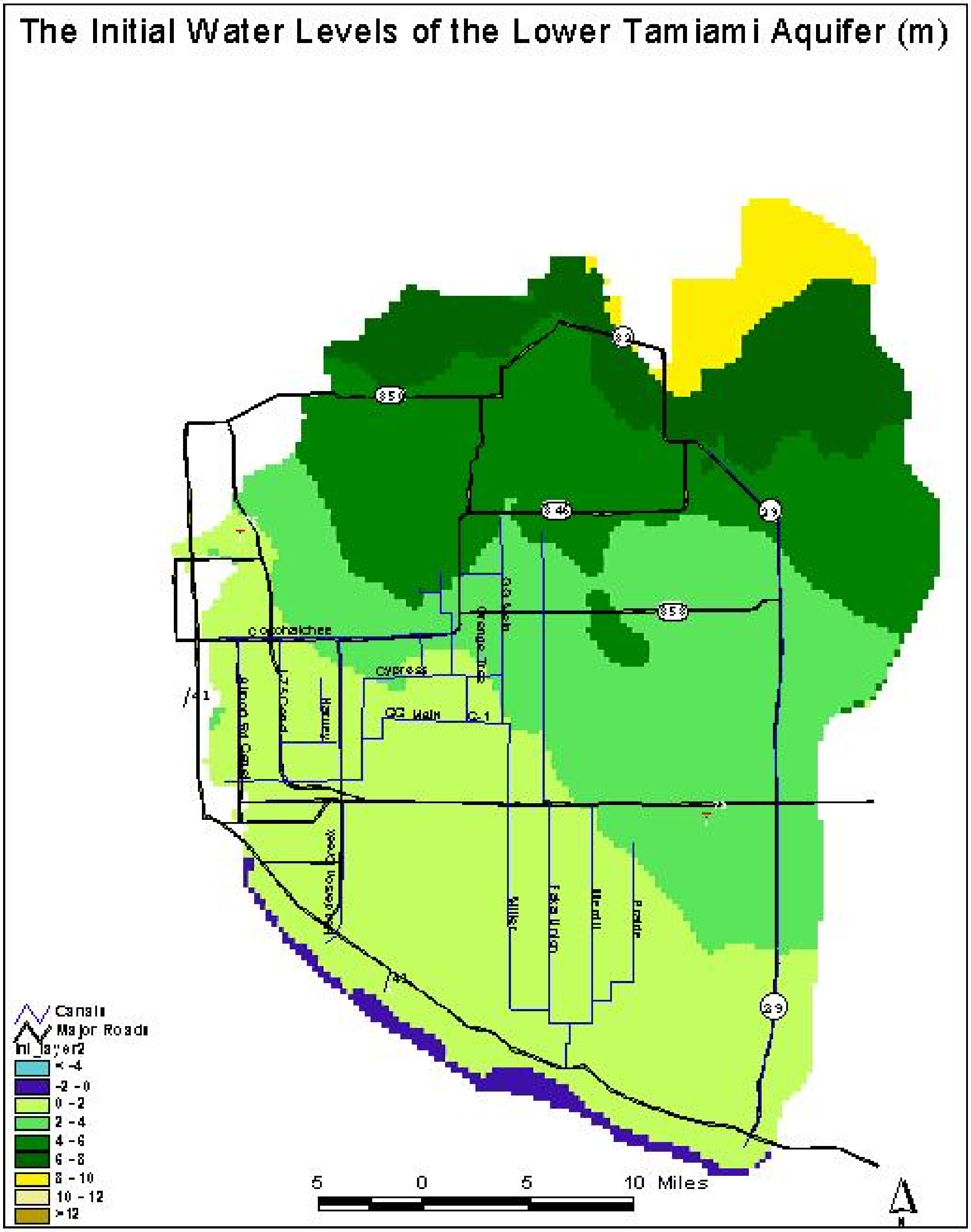


Figure 2-20 The Initial Water Levels of the Lower Tamiami Aquifer (m)

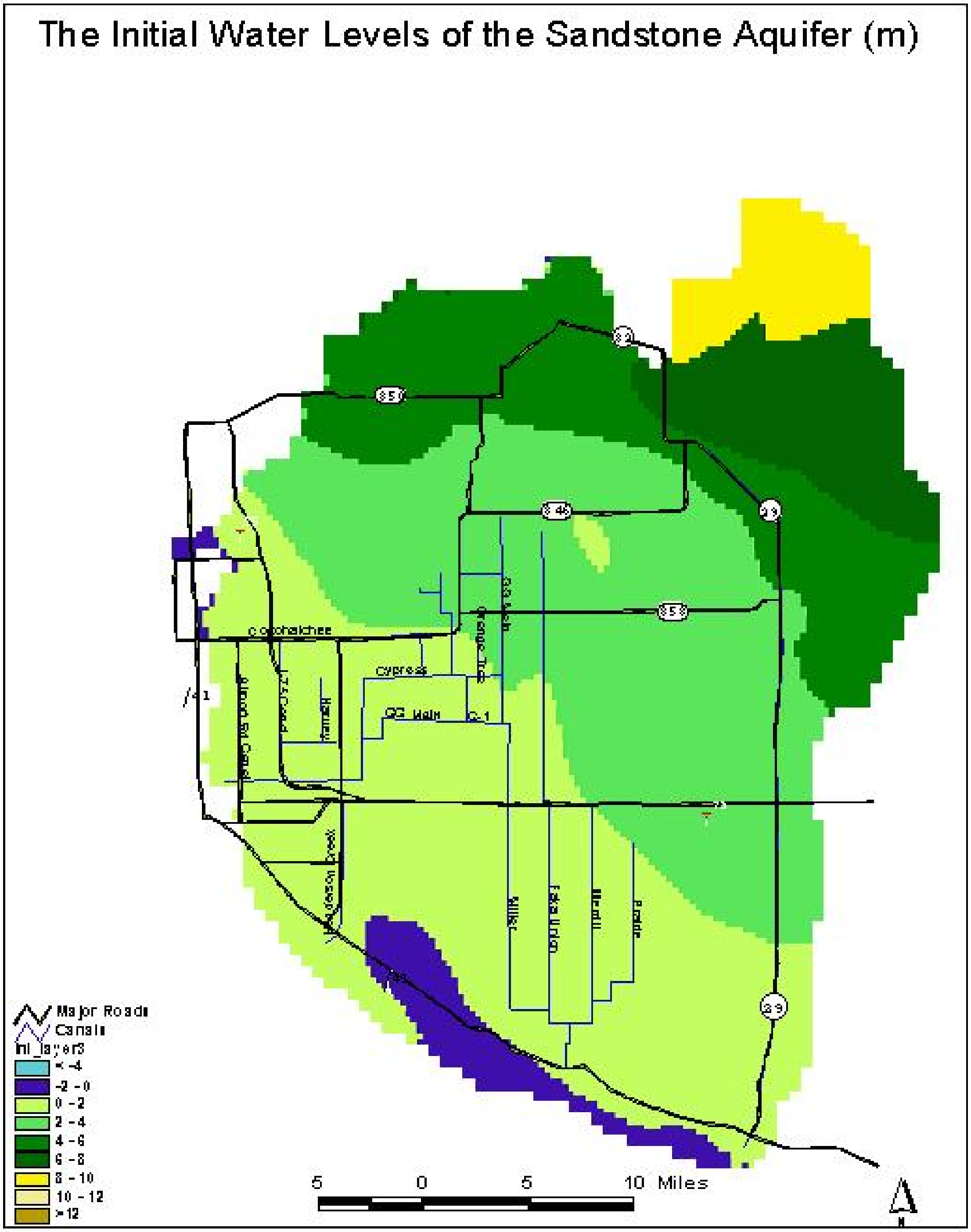


Figure 2-21 The Initial Water Levels of the Sandstone Aquifers (m)

southwestern coastline. A tidal boundary condition would, in principle provide more accurate results in assessing the impacts on tidal wetlands. However, sufficient information on groundwater levels along the coastline was not available to generate transient head boundary conditions. Time-varying head boundary conditions were applied along the northern boundary generated from available groundwater level data from monitoring wells. The time series of variable heads for cells between locations with measured data were generated using triangular linear integration. A no-flow boundary condition was specified for the eastern boundary.

Initial water levels for the aquifer layers are illustrated in Figures 2-20 through 2-22.

2.6 HYDRAULIC ROUTING MODEL

Channel flows in the watershed are described by the 1-D fully hydrodynamic river/flood routine model MIKE 11, which couples dynamically to the integrated hydrological MIKE SHE model. All surface flowways are accounted for by the model, including canals, and natural sloughs - except overland surface runoff, which is handled by the MIKE SHE overland flow component.

Input for the model consists of the channel network, and surveyed cross-sections of canals and floodplains, as well as appropriate boundary conditions consistent with actual surface boundaries and bed resistance. Moreover, flow regulating structures, such as culverts, weirs and control gates that may significantly alter or modify channelized flows and stages, are specified as input to the model. Finally, the channels exchange water with the underlying aquifer. This may either be described entirely by the aquifer material properties or by a channel lining leakage coefficient as specified in MIKE 11.

The major flowways in the BCB consist of a number of natural sloughs and an intricate system of manmade channels. The major flowways in the BCB are shown in Figure 2-23. The main channels defined in Figure 2-23 were included in the

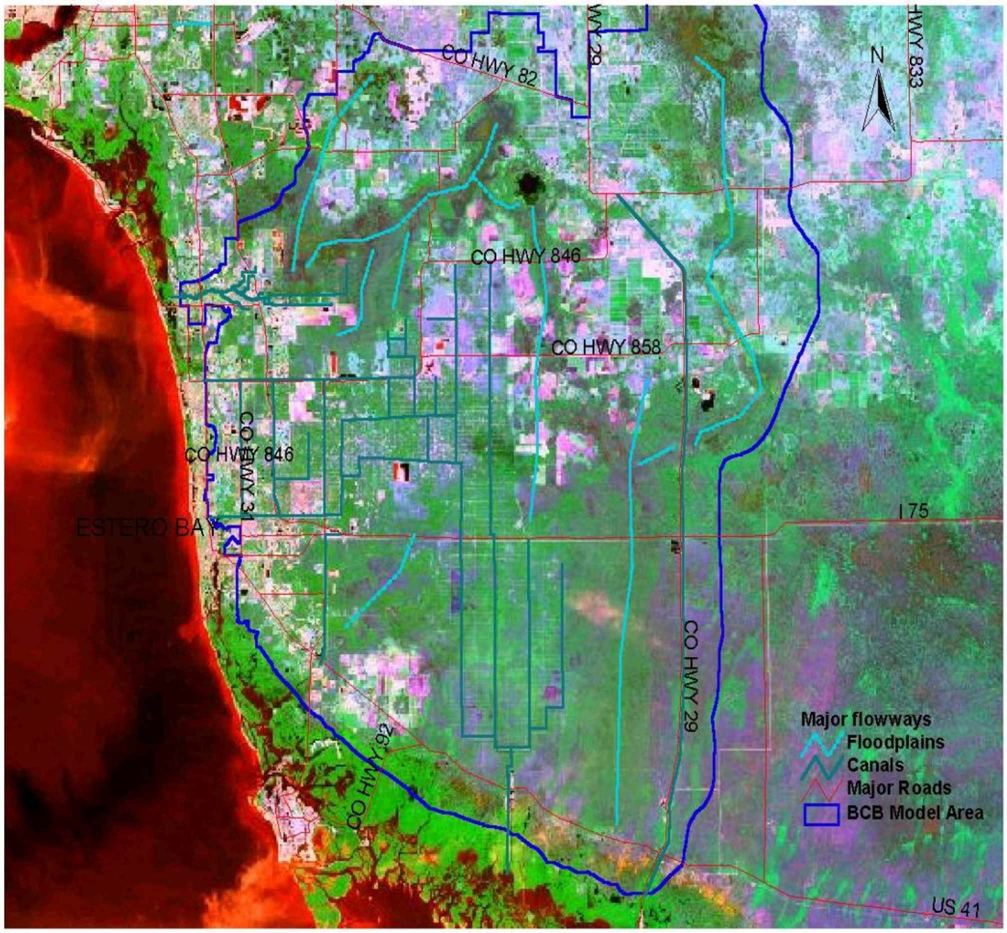


Figure 2-22 Major Flowways in the BCB Watershed

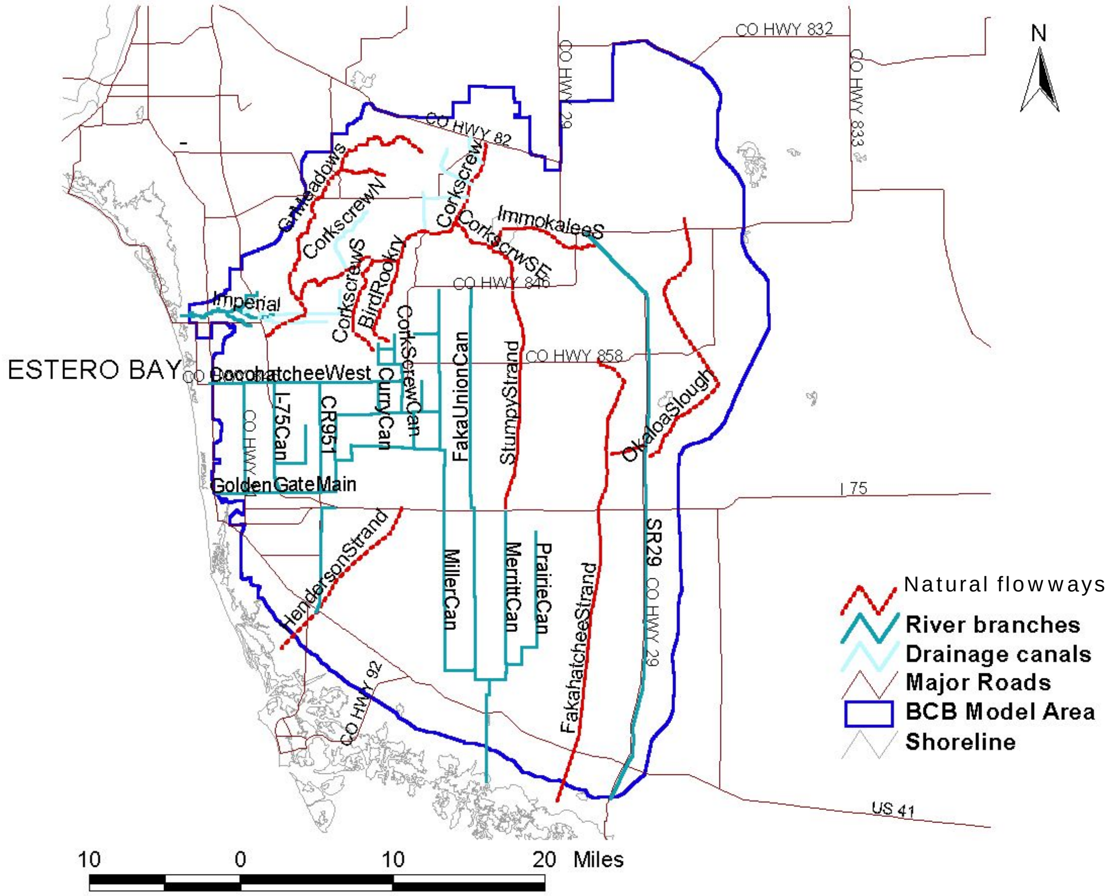


Figure 2-23 MIKE 11 Channel Network for the BCB Watershed

model, totaling 28 MIKE 11 branches. Moreover, a number of prominent natural flowways and sloughs were defined in MIKE 11, a total of 14 branches. The final MIKE 11 branch system is presented in Figure 2-24. The conveyance and storage capacity of the channel system is described by the cross-sectional geometry of the channel branches. Cross-sections are preferably entered into the model at regular intervals of approximately 600-1600 ft (200- 500 m), if available, and as a minimum, at up and downstream ends of each channel branch. Surveyed channel cross-sections with limited extent of the flood plains for the entire BCB channel system were available in an existing UNET model set up by Dames & Moore (1998). The cross-sections were converted to MIKE 11 format and imported directly into the model (2000). Some additional survey was carried out by COE and also incorporated in the Mike 11 model.

The BCB channel system is characterized by an intricate network of channels with a large number of control structures, culverts and bridges. In total 44 control structures are located in the BCB major canal system as outlined in Figure 2-1. Five different types of control structures are found in the BCB channel system: fixed crest weirs with underflow gates, movable crest weirs, fixed crest weirs with V-notches, fixed crest weirs with steel sheets and amil gate weirs. The structures generally prevent over-drainage from the watershed and minimize tidal effects, as well as saltwater intrusion in the canals. The dimensions and operation of the control structures are described in the operation manual, Water Control Structures, BCB (2005), and a pamphlet with operating water elevations, BCB (2006). Based on this information, the MIKE11 structure module was used for setting the structure operation in the model and, since the module is very flexible, the gates are operated close to the description in the operation manual.

2.7 CALIBRATION

The integrated surface water-groundwater management model for BCB was calibrated and validated so that the model represents actual H&H conditions prevalent in the domain. A well calibrated and validated model ensures better performance in evaluating scenarios associated with different water resources management projects. The performance of this type of integrated model will depend on a number of factors including:

- Model conceptualization
- Quantity and quality of input data
- Model parameters
- Accuracy, availability and distribution of field observations
- Mathematical/numerical model application

The model conceptualization and other factors involved in analyzing the performance of the model were described in the DHI's reports (2002, 2004). Table 2-5 summarizes major model input and parameters in MIKE SHE model. The model was initially calibrated and validated for a period from 1990-1995, and further calibrated and validated to the period of 1995-2000 (DHI, Inc. 2004). These calibrated time durations cover a number of dry, wet and average meteorological condition years. The model calibration and validation demonstrated that the calibrated model was capable of reproducing field data with a reasonable confidence. A number of key calibration parameters were identified for the model, with parameters adjusted during calibration and their ranges given in Table 2-6.

The main calibration data comprise canal flows and stages at a number of gauging stations and a number of monitored groundwater wells in both the shallow and deep aquifers. Stream flow records at four stations located at the outlets of the canals were utilized for calibration. The stage and discharge station locations are outlined in Figure 2-25. Groundwater observations consist of 38 records of monitored potential head in the watershed. The wells generally cover most of the watershed and, as such, constitute a good basis for the calibration. The well locations are presented in Figure 2-26.

The rigorous calibration and validation for both surface water and groundwater system in the BCB area are illustrated in the modeling report (DHI 2002, 2004). The comparisons of observed data and simulated results at several representative locations and groundwater monitoring wells are presented in Appendix A.

Table 2-5 List of Model Input and Parameters for MIKE SHE

Model Component	Model Input	Model Parameters
MIKE SHE SZ Saturated zone flow	Geological model (lithological information Boundary conditions Drainage depth (drain maps) Wells and withdrawal rate	Kh, Horizontal hydraulic conductivity Kv, Vertical hydraulic conductivity S, confined storage coefficient S , unconfined storage coefficient Drainage time constant
MIKE SHE UZ Unsaturated zone flow	Map of characteristic soil types Hydraulic Conductivity Curves Retention curves	Ks, saturated hydraulic conductivity □s Saturated water content □res Residual water content □eff Effective saturation water content pFc, Capillary pressure at field capacity pFw, Capillary pressure at wilting point n, Exponent of hydraulic conductivity curve
MIKE SHE ET Evapotranspiration	Time series of vegetation Leaf Area Index Time series of vegetation root depth	C1, C2, C3 : Empirical parameters Cint : Interception parameter Aroot :Root mass parameter Kc : Crop coefficient
MIKE SHE OC Overland and river/canal flow (MIKE11)	Topographical map Boundary conditions Digitized river/canal network River/canal cross sections	M, Overland Manning no. D , Detention storage L, leakage coefficient M, River/canal Manning no.
MIKE SHE IRR Irrigation module	Irrigated areas Irr. sources (pumps/canals/reservoirs) Distribution method (sheet, sprinkler, drip) Source capacity	Eact/Epot, crop water stress factor (target ratio between actual and potential evapotranspiration rates) Well threshold

Table 2-6 Primary Parameters Adjusted During Calibration

Model component	Calibration parameters	Parameter range
MIKE SHE SZ – Saturated zone flow	Kv: Vertical hydraulic conductivity (m/s) KH/Kv Drainage time constant (s-1) Drain level (m) Boundary head conditions: Northern Boundary (-) Eastern Boundary Tidal Boundary	9.7 . 10-11- 1 . 10-3 1 - 1000 2.9 . 10-6- 0.00 -1.62 – 13.30 Time Varying No Flow Fixed Head
MIKE SHE OC – Overland and river/canal flow (MIKE11)	M, Overland Manning no. m1/3/s D , Detention storage (mm) L, leakage coefficient (s-1) Canal M (Reverse of Manning's n) (m1/3/s) Floodplains M (m1/3/s)	0 - 2 50 - 100 9.9 . 10-7 – 9.9 . 10-5 2 - 35 2 - 35

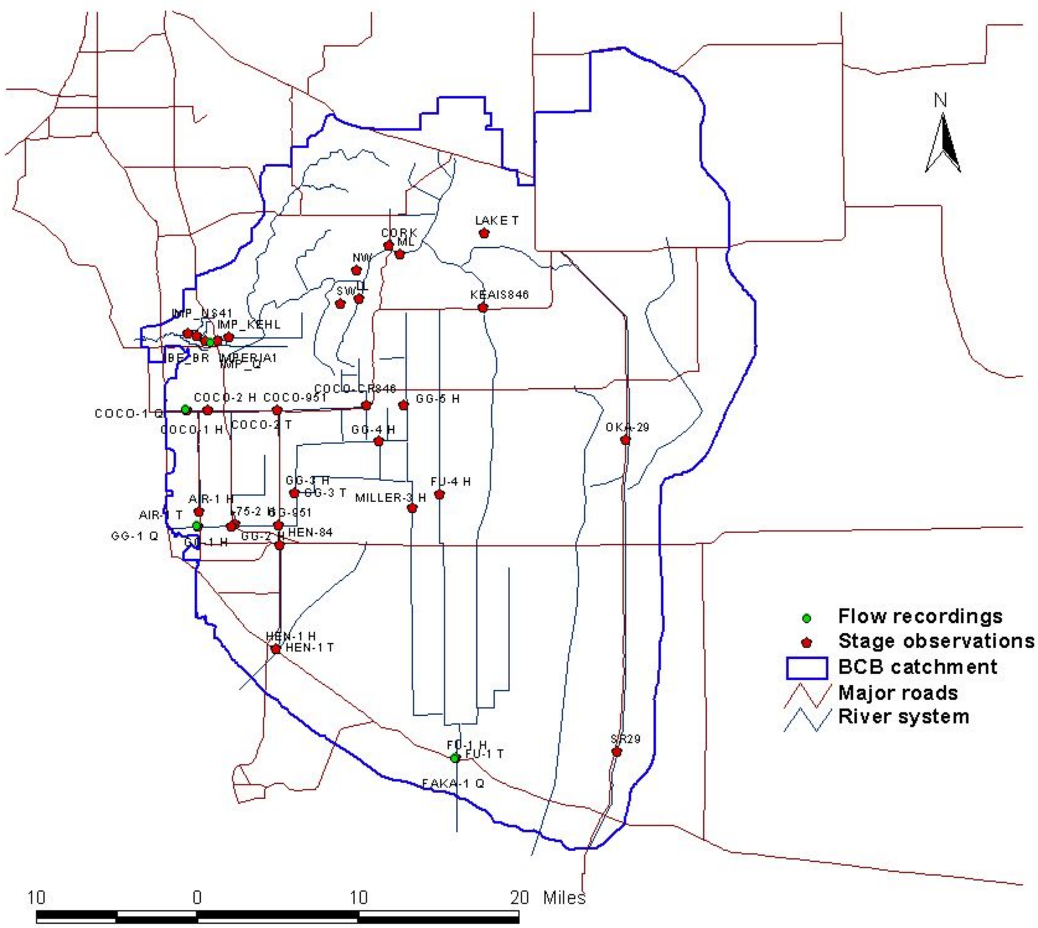


Figure 2-24 Locations of Flow and Stage Observations for 1990-1995

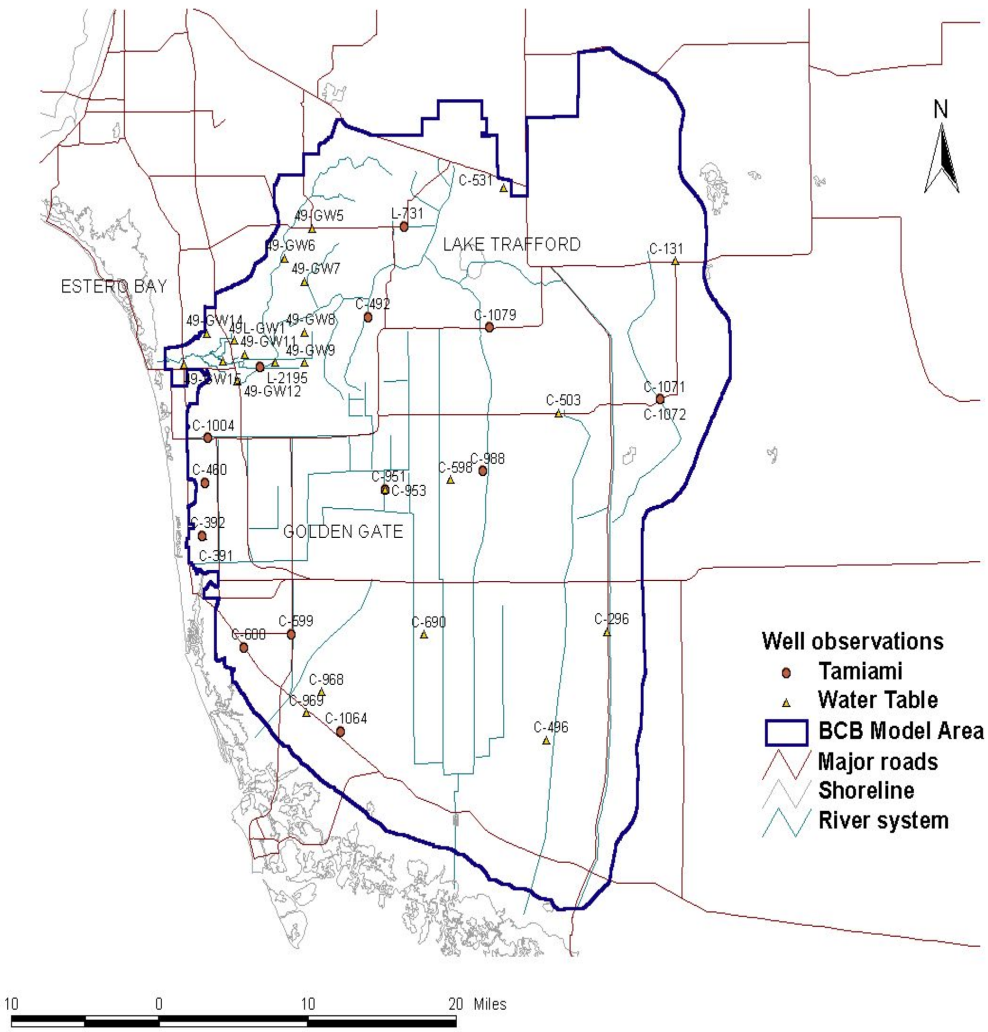


Figure 2-25 Groundwater Well Observations for 1990-2000 in the Big Cypress Basin Watershed

3.0 PROPOSED GG-3 STRUCTURE IMPROVEMENTS

Since the basic purpose of this assessment is to formulate a conceptual design for replacement of the inefficient water control structure, only structural configuration alternatives were investigated. Conveyance capacity enhancement measures like channel modification were not explored due to limitations of economic and environmental feasibility of the project. Presently the Golden Gate Main canal has very limited right-of-way. Due to rapid urban growth and high real estate prices, acquisition of additional Right-of-Way for widening the canal, particularly for the critical reach of the canal west of CR-951, is not economically feasible.

The major feature of proposed GG-3 improvements includes two portions:

1. Remove the current GG-3 weir and gates at retrofit at the existing location.
2. Relocate the new structure GG-3 approximately two miles downstream of current location

For replacement of the present structure three different configurations of gated control structures presently utilized by the District were investigated:

- Vertical lift gates with side spillways (similar to COCO #1)
- Hinged crest radical gates (similar to GG-1)
- OBERMEYER spillway gates (similar to S381 structure and GG-2 structure)

All of the above three types of gated structures are operable by automated control to achieve the desired range of objectives for flood control and maintenance of conservation pools. However, based on SFWMD and COE experience on installation, operation and overall project cost, a gated structure with OBERMEYER type of gates has been proposed as the effective replacement of Golden Gate Canal Weir #3.

The OBERMEYER Spillway Gate system is simply described as a row of steel gate panels supported on their downstream side by inflatable air bladders. By controlling the pressure in the bladders, the pond elevation maintained by the gates can be infinitely adjusted within the system control range (full inflation to full deflation) and accurately maintained at user-selected set-points (Figure 3-1).

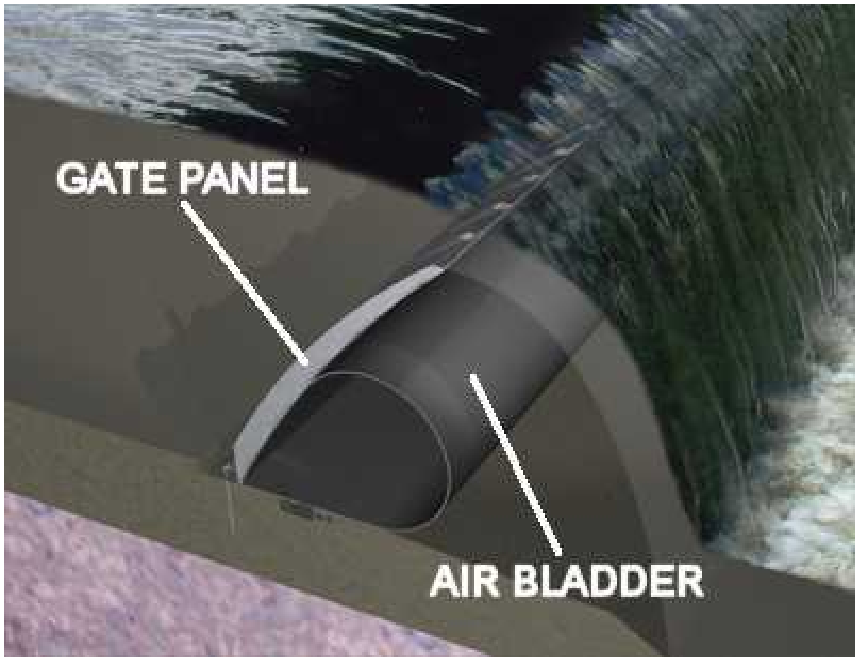


Figure 3-1 The OBERMEYER Spillway Gate System

The spillway gate system is attached to the foundation structure by stainless steel anchor bolts (epoxy or non-shrink cement grout, as design dictates). The required number of bladders are clamped over the anchor bolts and connected to the air supply pipes. When the bladder hinge flaps are fastened to the gate panels, the installation of the strong, durable and resilient crest gate system is complete.

The gaps between adjacent panels are spanned by reinforced EPDM rubber webs clamped to adjacent gate panel edges. At each abutment, an EPDM rubber wiper-type seal is affixed to the gate panel edge. This seal rides up and down the stainless steel abutment plate, keeping abutment plate seepage to a minimum. Alternatively, rubber seals may be fixed to the abutments or piers which engage the raised gate panels.

The OBERMEYER Spillway Gates can be custom designed to conform to any existing or desired spillway cross-section with a minimum profile when in the lowered position. The wedge-shaped profile of the OBERMEYER Gate System causes stable flow separation from the downstream edge of the gate without the vibration-inducing vortex shedding associated with simple rubber dams during overtopping. This results in vibration-free operation and excellent control throughout a wide range of head water elevations and gate positions.

The proposed structure will consist of three automated OBERMEYER spillway gates. Each gate is 26 ft and 8 in. wide. The total spillway width is 80 feet. The top of the hinge when the gates are down is at elevation 2 ft NGVD (0.73 ft NAVD). When the gates are fully raised, the top of the gates are at 9.0 ft NGVD (7.73 ft NAVD). Each gate can open independently, as needed, to maintain the target water surface elevation upstream of the proposed structure. Table 3-1 gives a summary of existing GG-3 structure and proposed structure. The operating schedule has both a wet season setting, dry season setting, and special event setting. These settings are described in later sections of the report. Figures 3-2 gives a three dimensional layout of proposed Golden Gate structure GG-3.

Table 3-1 Summary of Existing GG-3 Structure and Proposed GG-3 Structure

Structure Description	**Existing GG-3**	**Proposed GG-3**
Structure Type	Fixed crest weir with two bottom opening sluice gate	Obermeyer Spillway Gates
Length of Weir	100 feet	80 feet
Crest Elevation	7.50 feet NGVD	Movable crest, top of weir can be moved within 2.00 ft – 9.0 ft NGVD
Number and Size Gate Type	Two Rodney Hunt (5 ft by 4 ft)	Three Obermeyer gates, 26.6 ft wide by 7.0 ft high
Type of Control	Manually operated sluice gate	Automatic & Manual
Structure Location	Golden Gate Canal	Golden Gate Canal

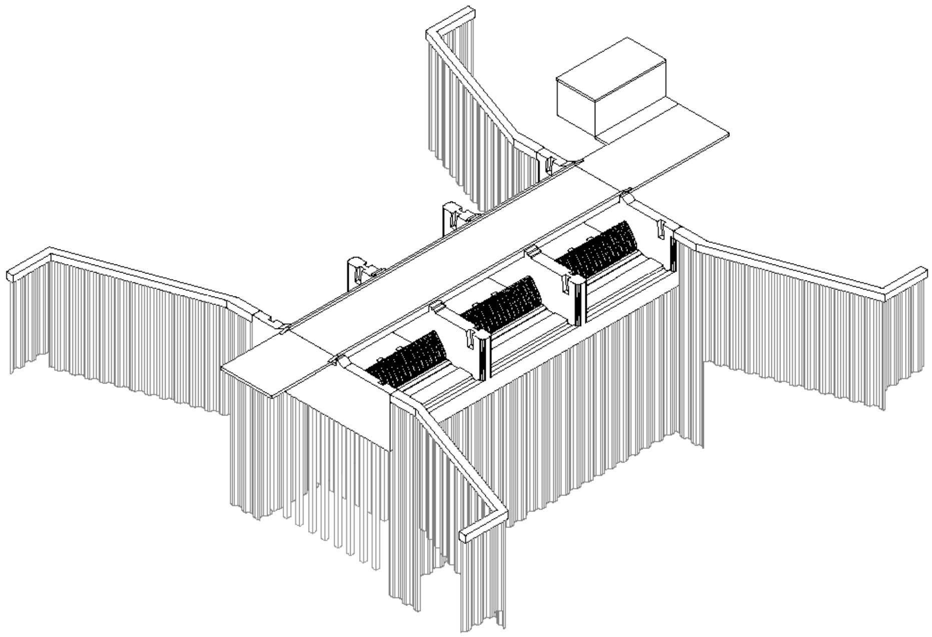


Figure 3-2 Three Dimensional Layout of Proposed Golden Gate Structure GG-3

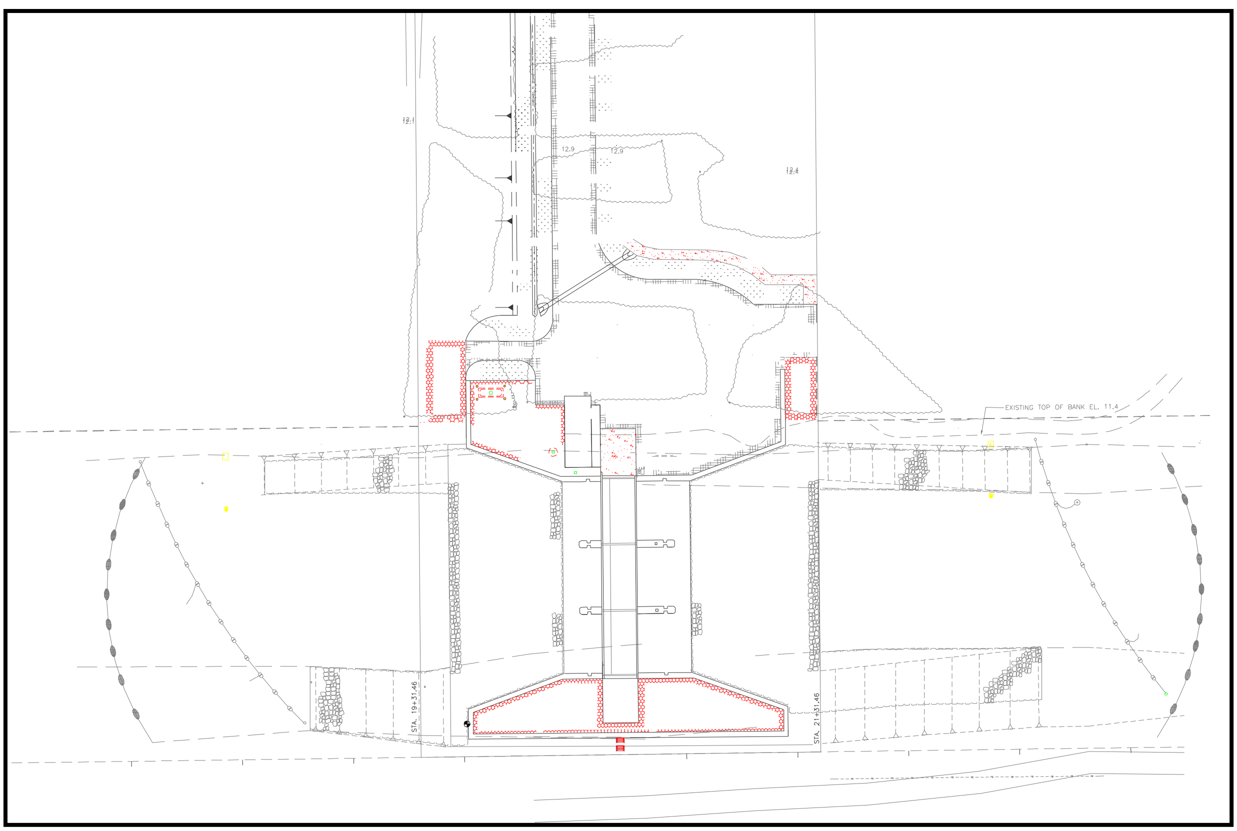


Figure 3-3 Plan view of proposed GG-3 weir

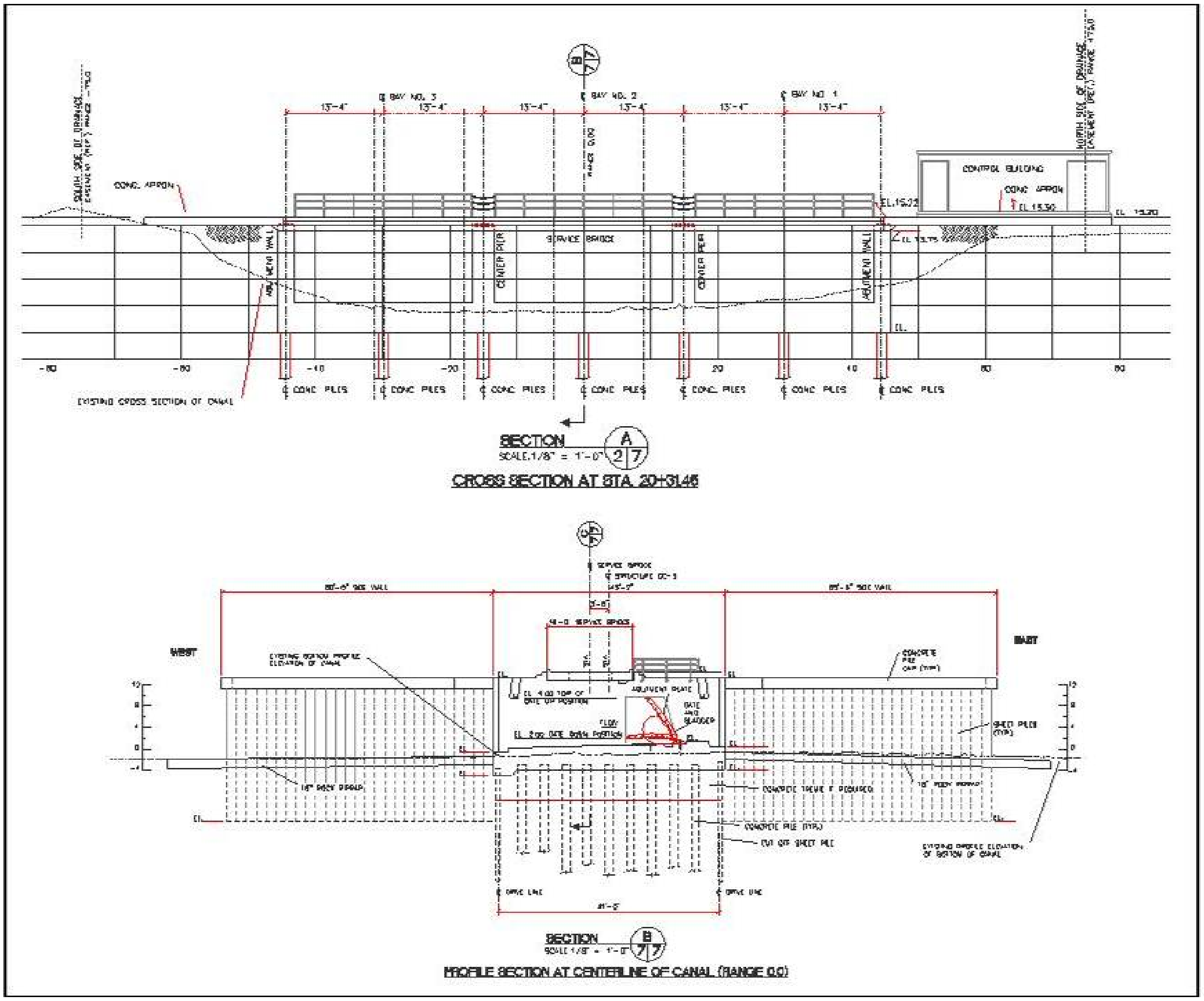


Figure 3-4 Elevation of proposed GG-3 weir

4.0 H&H ASSESSMENT FOR AVERAGE HYDROLOGIC CONDITION

The calibrated surface and groundwater integrated MIKE SHE/MIKE 11 modeling information of the BCB watershed was used to simulate the existing GG-3 and modified GG-3 scenarios. Both existing and proposed structures were simulated continuously for a two year period between 6/1/1993 and 7/31/1995. The hydrologic performance of a one year period between 5/1/1994 to 4/30/1995 (a complete cycle of wet season and dry season) was selected as the average meteorological condition of the Golden Gate Canal basin.

For normal hydrologic condition, the operating control elevations for the wet season, dry season for the proposed GG-3 structure are set as follows:

- Wet season: At the beginning of the wet season, set the top of the gates at 7.5 ft NGVD.
    - When the upstream water level higher than 8.0 ft NGVD, start open (or lowering the OBERMEYER spillway) gates.
    - When the upstream water level lower than 7.2 ft NGVD, close gates to 7.5 ft NGVD
- Dry season: At the beginning of the dry season, set the top of the gates at 9.0 ft NGVD.
    - When the upstream water level higher than 9.2 ft NGVD, start open (or lowering the OBERMEYER spillway) gates.
    - When the upstream water level lower than 8.5 ft NGVD, close gates to 9.0 ft NGVD

The existing GG-3 and proposed GG-3 gate operating schedule for normal hydrologic condition are summarized in Table 4-1

The comparison of channel flow and stage between existing and proposed condition has been conducted at structure locations of GG-1, GG-2, GG-3 existing, GG-3 proposed, GG-4, CY-1, Airport Road Bridge, in the Golden Gate Canal system. The features of those structures are summarized in Table 4-2.

Comparison and investigation of the change of surface and groundwater levels between the existing and proposed structure modification provides a measure of whether the proposed improvements impact the water levels in the project adjacent area. The effect on surface and groundwater resources of the area under this average condition, resulting from the proposed modification and operation of the structure, are described below.

4.1 AVERAGE ANNUAL SURFACE AND GROUNDWATER CHANGE

4.1.1 Groundwater

The effects of water level change in the water table aquifer caused by the structural improvements can be visualized by comparing the groundwater head difference between the existing and proposed improvement conditions. The effects of groundwater level changes are examined by comparing the time series of groundwater levels at eleven (11) selected locations listed in Figure 4-1. Figures 4-2-A through 4-2-K represents water table hydrographs from 5/1/1994 through 4/30/1995 at those selected locations identified in Figure 4-1.

Table 4-1 GG-3 Operating Schedule for Normal Wet & Dry Season

<table>
<tr><th rowspan="3"></th><th colspan="4">Elevation in NGVD</th></tr>
<tr><th colspan="2">Wet season water level
(ft NGVD)</th><th colspan="2">Dry season water
level
(ft NGVD)</th></tr>
<tr><th>Open
Elevation</th><th>Close
Elevation</th><th>Open
Elevation</th><th>Close
Elevation</th></tr>
<tr><td>Existing GG-3
(Manual Operating)</td><td>8.0</td><td>7.5</td><td>8.5</td><td>7.75</td></tr>
<tr><td>Proposed GG-3
(Automated with
manual override)</td><td>8.0</td><td>7.2</td><td>9.2</td><td>8.2</td></tr>
</table>

Table 4-2 Summary of Existing Canal Crossings in the BCB Canal System

Structure Name	Location	Structure Description	Structure Invert Elevation	
			NAVD in ft	NGVD in ft
GG-1	Golden Gate canal	Three 26.8' movable crest spillway	Crest elevation: 3.73' NAVD Invert of gate: -2.27' NAVD	Crest elevation: 5.0' NGVD Invert of gate: -1.0' NGVD
GG-2	Golden Gate canal	Three 26.67' Obermeyer spillway	Movable crest: -1.27' to 5.03' NAVD	Movable crest: 0' to 6.3' NGVD
GG-3 Proposed	Golden Gate canal	Three 26.67' Obermeyer spillway	Movable crest: 0.73' to 7.73' NAVD	Movable crest: 2' to 9.0' NGVD
GG-3 Existing	Golden Gate canal	One 100' fixed crest weir, two 6'x5' gates	Crest elevation: 6.23' NAVD Invert of gate: -1.57' NAVD	Crest elevation: 7.5' NGVD Invert of gate: -0.5' NGVD
GG-4	Golden Gate canal	One 100' fixed crest weir, two 6'x5' gates	Crest elevation: 8.27' NAVD Invert of gate: 1.27' NAVD	Crest elevation: 9.5' NGVD Invert of gate: 2.5' NGVD
CY-1	Cypress Canal	One 42' fixed crest weir, two 5'x4' gates	Crest elevation: 8.23' NAVD Invert of gate: 1.27 NAVD	Crest elevation: 9.5' NGVD Invert of gate: 2.5 NGVD

4.1.2 Surface Water

Figures 4-3-A through 4-3-G are simulated flow hydrographs and Figures 4-4-A through 4-4-G are simulated stage hydrographs at selected locations. Table 4-3 lists the simulated total volume of flow to pass through the GG-1 structure for existing and improved GG-3 conditions.

4.2 SURFACE AND GROUNDWATER LEVEL CHANGES DURING WET SEASON

4.2.1 Groundwater

Figures 4-2A through 4-2H represents the average ground water level difference between proposed condition and existing condition during the average wet season (May 1-Oct 14, 1994. The operation of the structure under the proposed operating schedules would have insignificant change to groundwater levels during wet season, and would have no impact on functioning of septic tanks in North Golden Gate Estates.

4.2.2 Surface Water

Figure 4-5 compares the water surface profiles of Golden Gate Canal between existing and proposed GG-3 structures in the middle of wet season, of an average year (May 1-October 15) in the stage of canal water during the middle of the wet season 9/1/1994. The detailed simulated flow and stage hydrographs for both existing and proposed GG-3 conditions at selected points in the Golden Gate Canal system can be found in Figures 4-3-A through 4-4-F.

4.3 SURFACE AND GROUNDWATER LEVEL CHANGES DURING DRY SEASON

4.3.1 Groundwater

During the simulated dry season of 10/15/94 through 4/30/95, the proposed GG-3 structure will enhance groundwater storage between the upstream of GG-3 and downstream GG-3, as illustrated in groundwater level hydrographs at selected locations presented in Figures 4-2-A through 4-2-I.

4.3.2 Surface Water

Figure 4-6 compares the water surface profiles between existing and proposed GG-3 structures in the middle of dry season. The reduction in the total volume of runoff at GG-1 during simulated dry season is illustrated in Table 4-3. Figures 4-3-A through 4-4-F are simulated flow and stage hydrographs at selected points in the BCB canal system.

Table 4-3 Simulated Total Volume of Flow Discharge through Structure GG-1

	Existing GG-3 Condition (Million Gallons)	Proposed GG-3 Condition (Million Gallons)
Average Year (5/1/94 – 4/30/95)	89,211	87,650
Wet Season (5/1/94 – 10/15/94)	54,912	54,687
Dry Season (10/16/94-4/30/95)	34,299	32,963

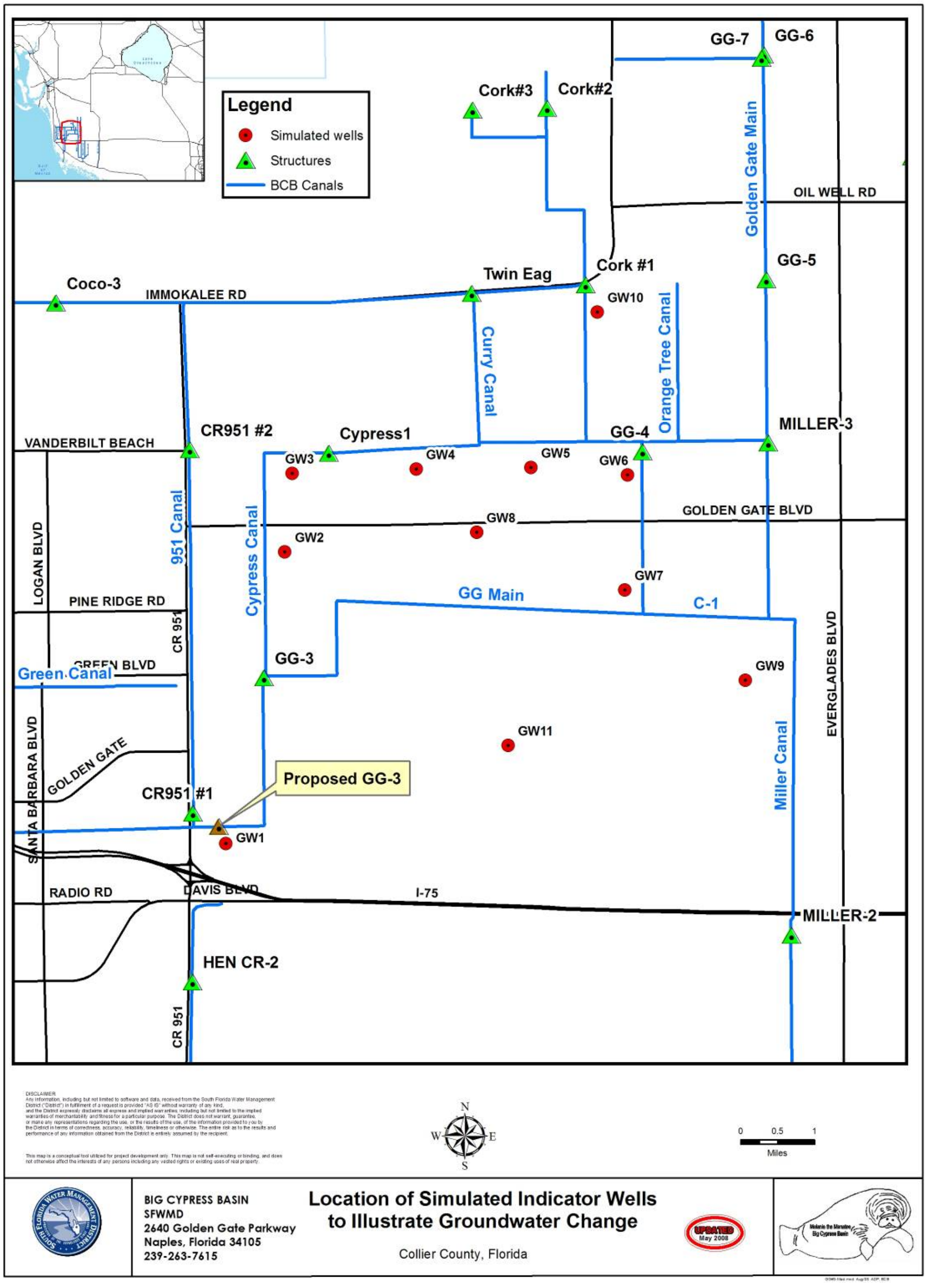


Figure 4-1 Location of Simulated Indicator Wells to Illustrate Groundwater Level Change

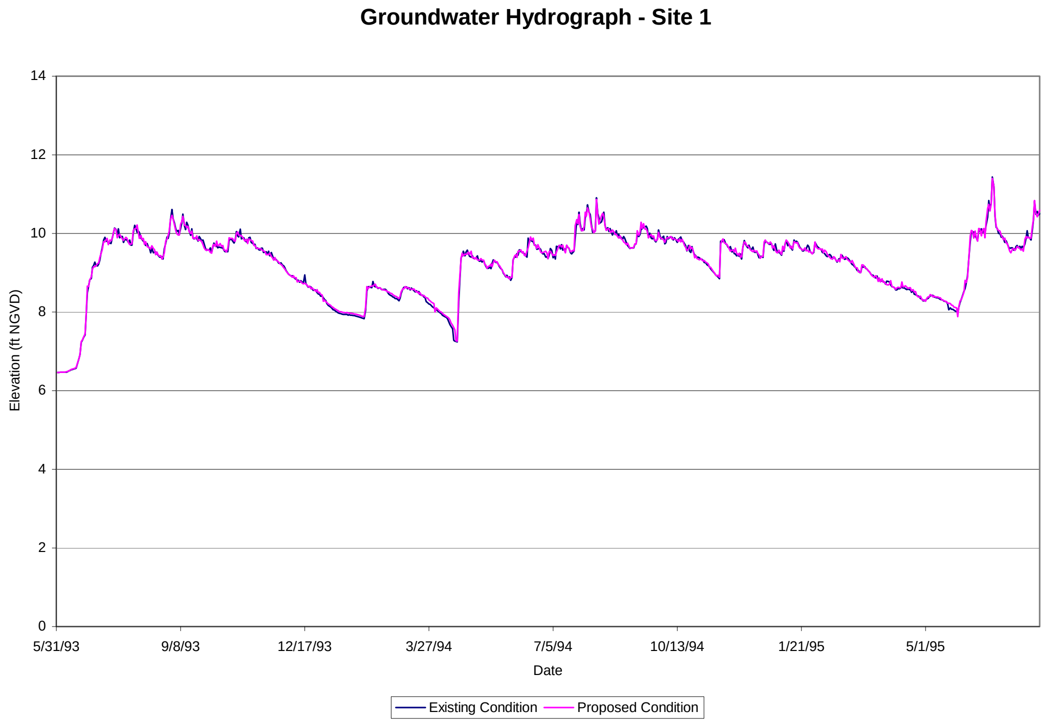


Figure 4-2-A Groundwater Hydrograph – Site 1

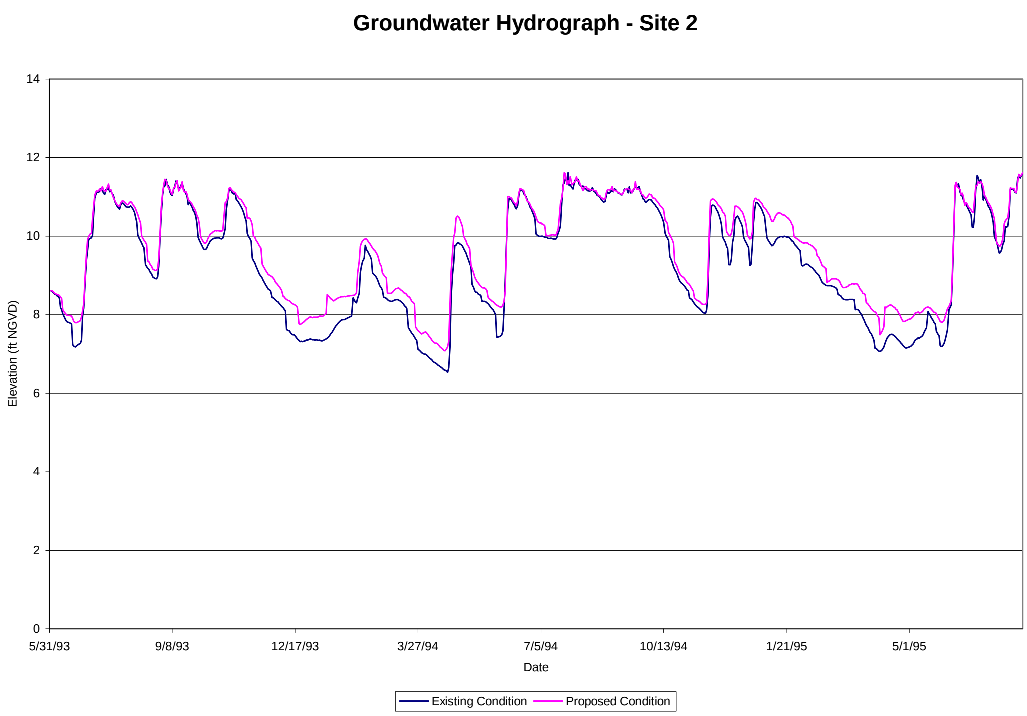


Figure 4-2-B Groundwater Hydrograph – Site 2

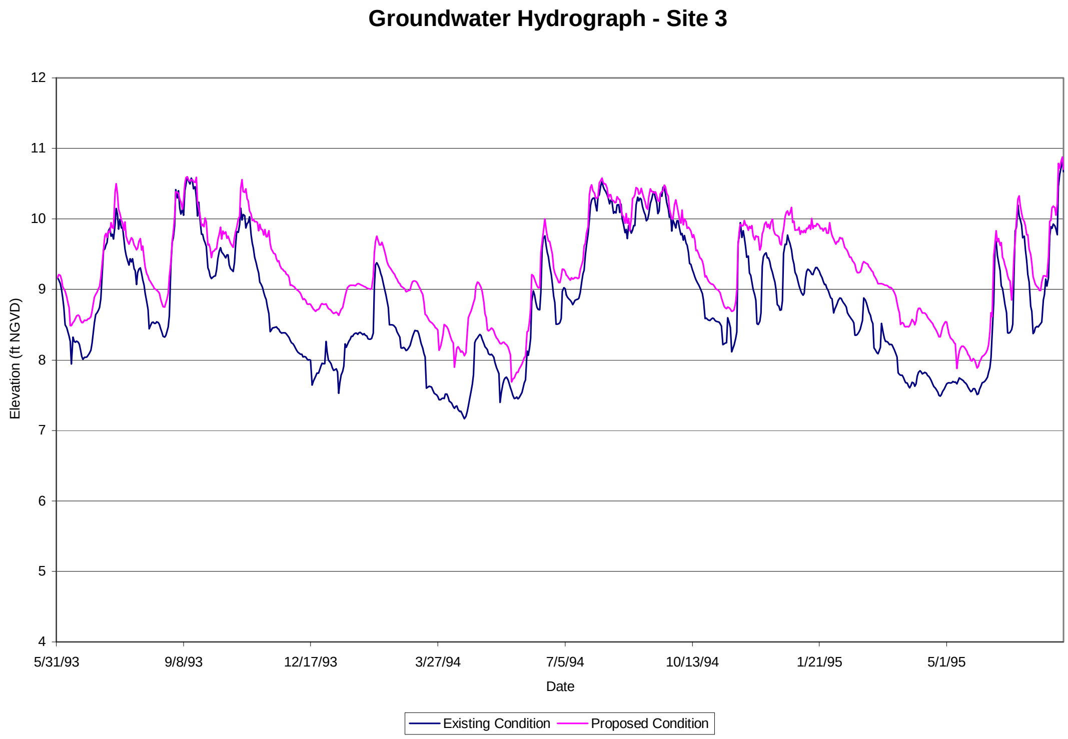


Figure 4-2-C Groundwater Hydrograph – Site 3

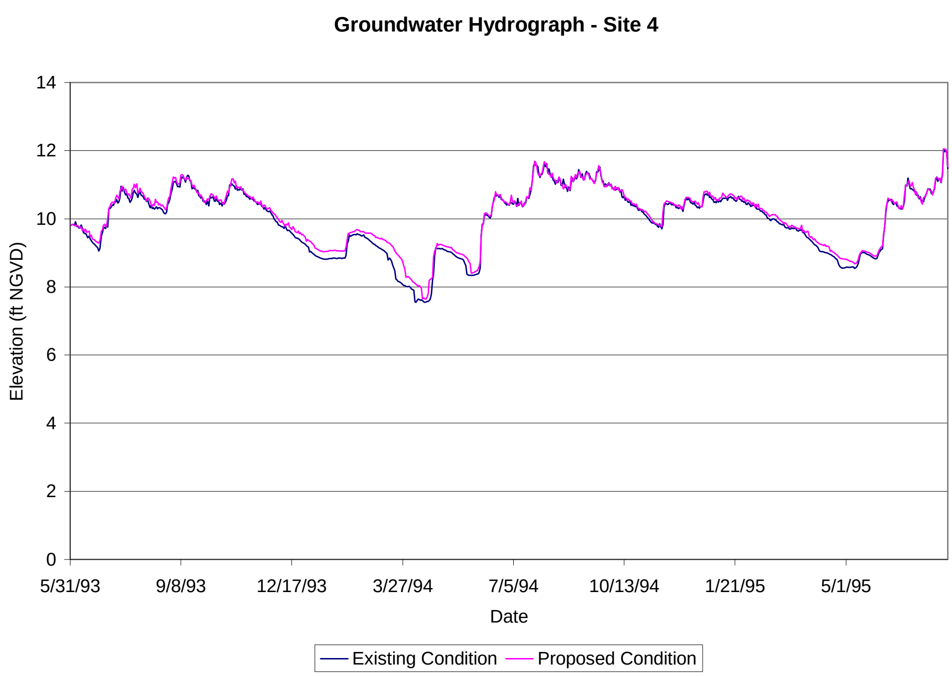


Figure 4-2-D Groundwater Hydrograph – Site 4

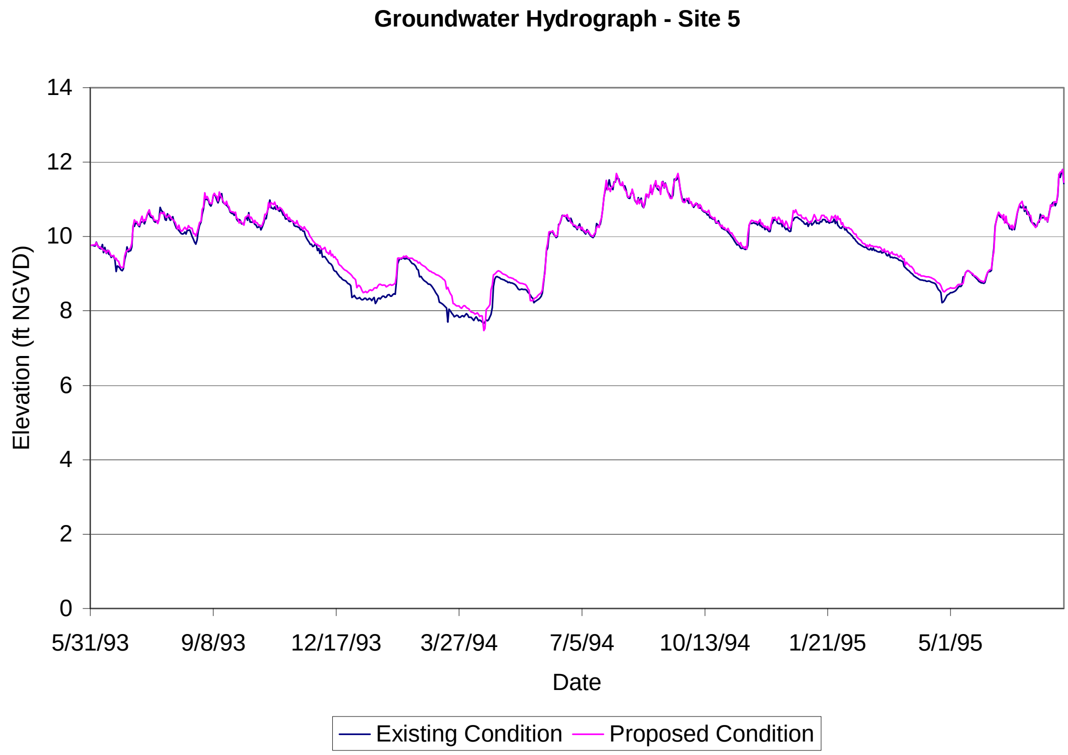


Figure 4-2-E Groundwater Hydrograph – Site 5

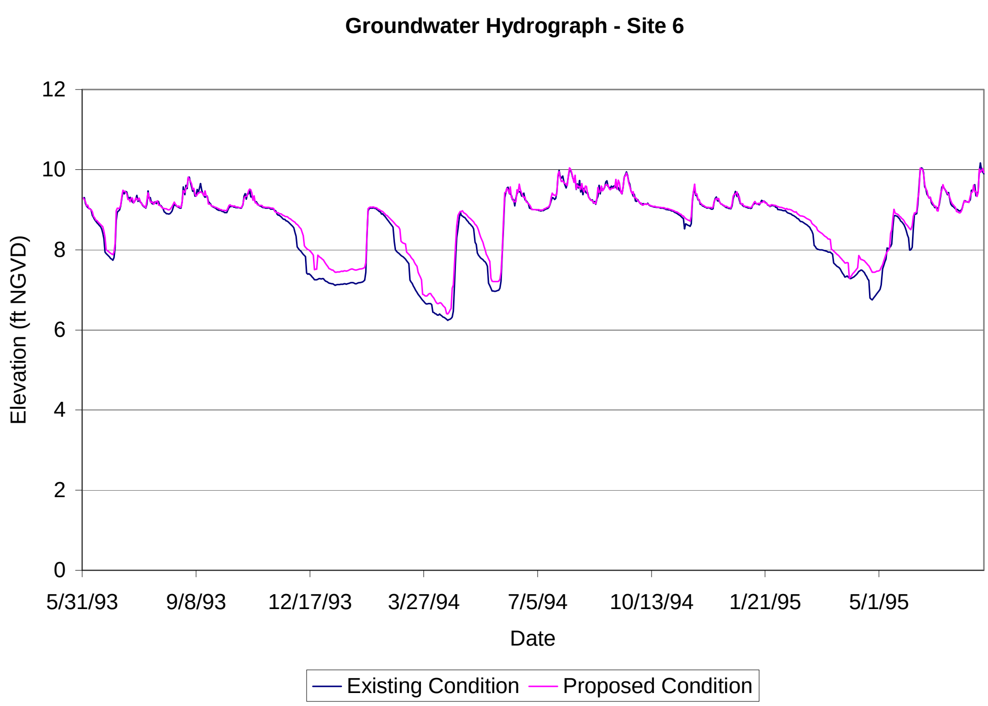


Figure 4-2-F Groundwater Hydrograph – Site 6

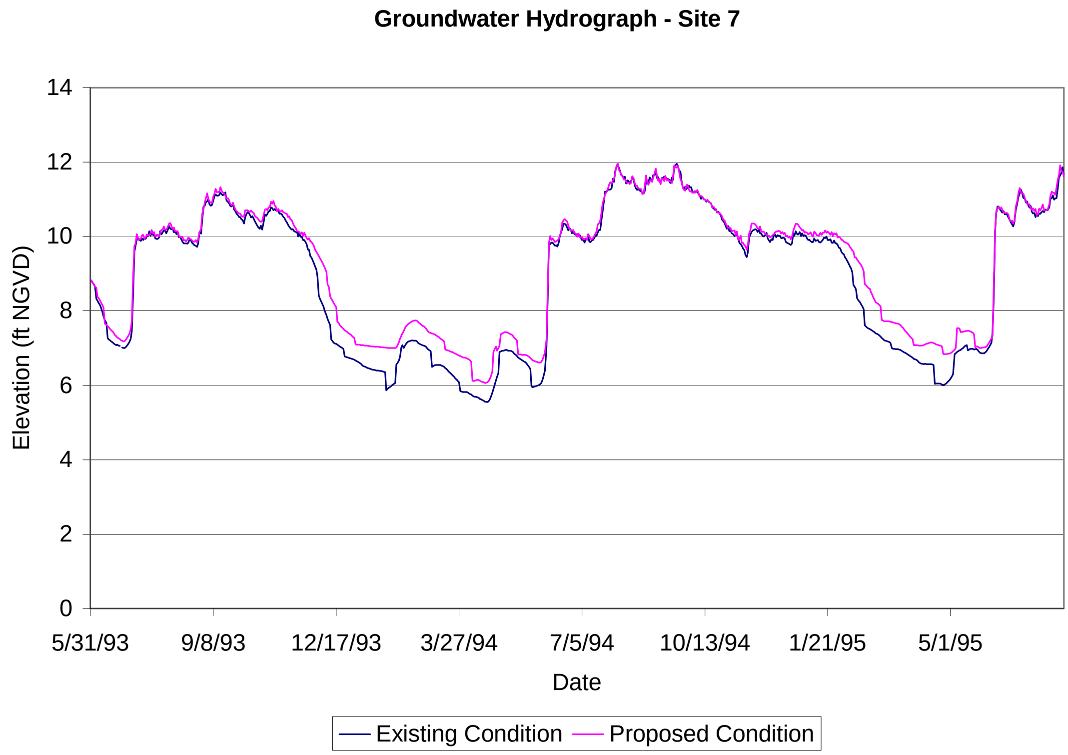


Figure 4-2-G Groundwater Hydrograph – Site 7

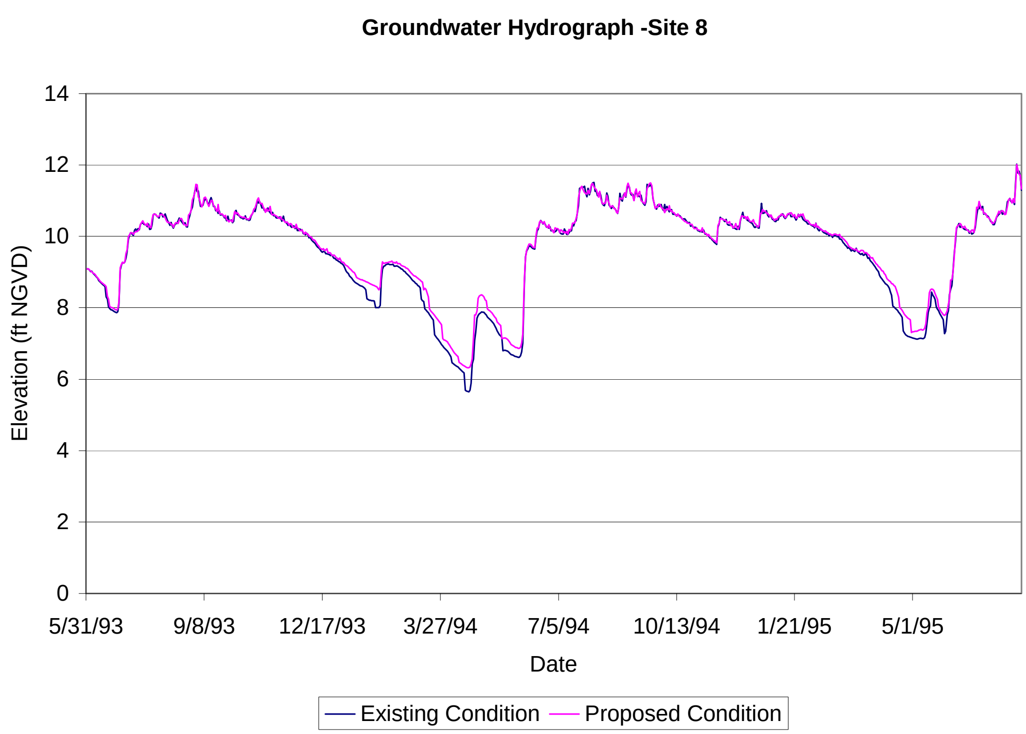


Figure 4-2-H Groundwater Hydrograph – Site 8

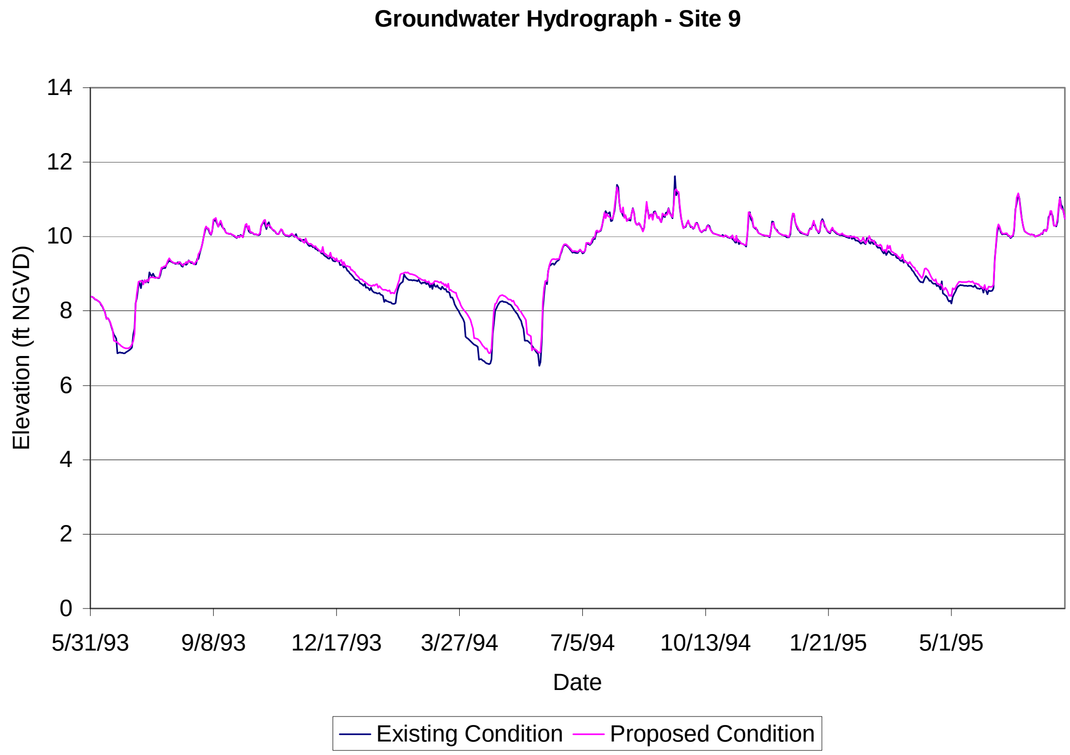


Figure 4-2-I Groundwater Hydrograph – Site 9

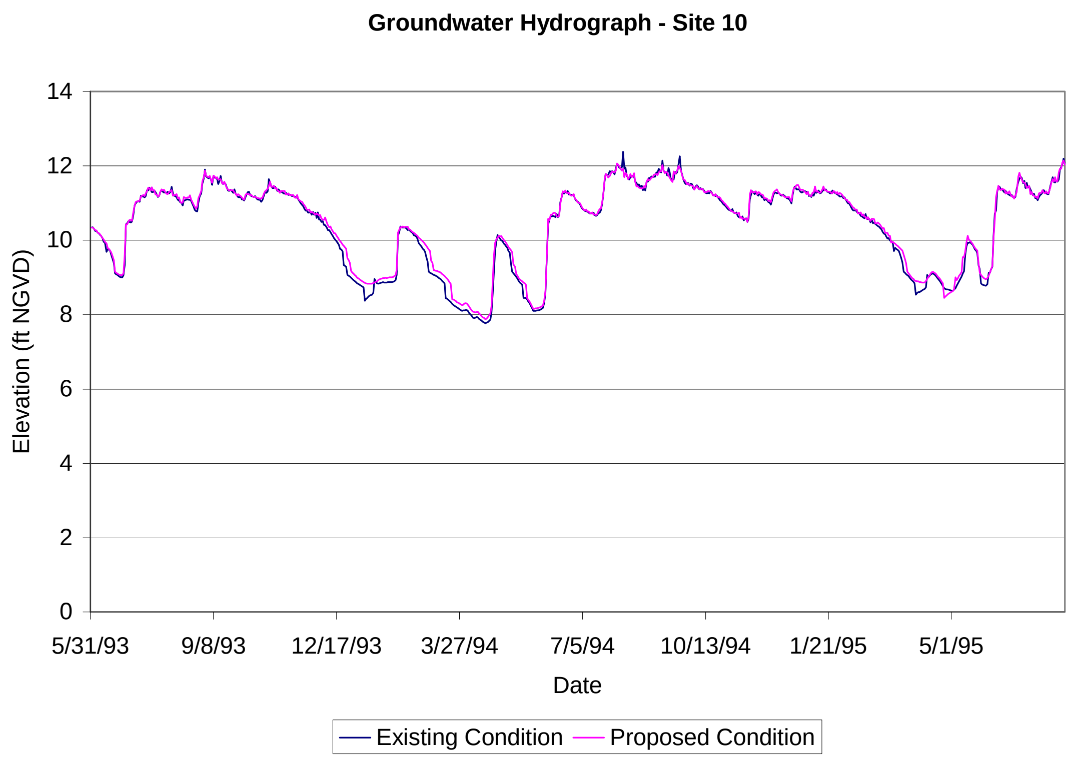


Figure 4-2-J Groundwater Hydrograph – Site 10

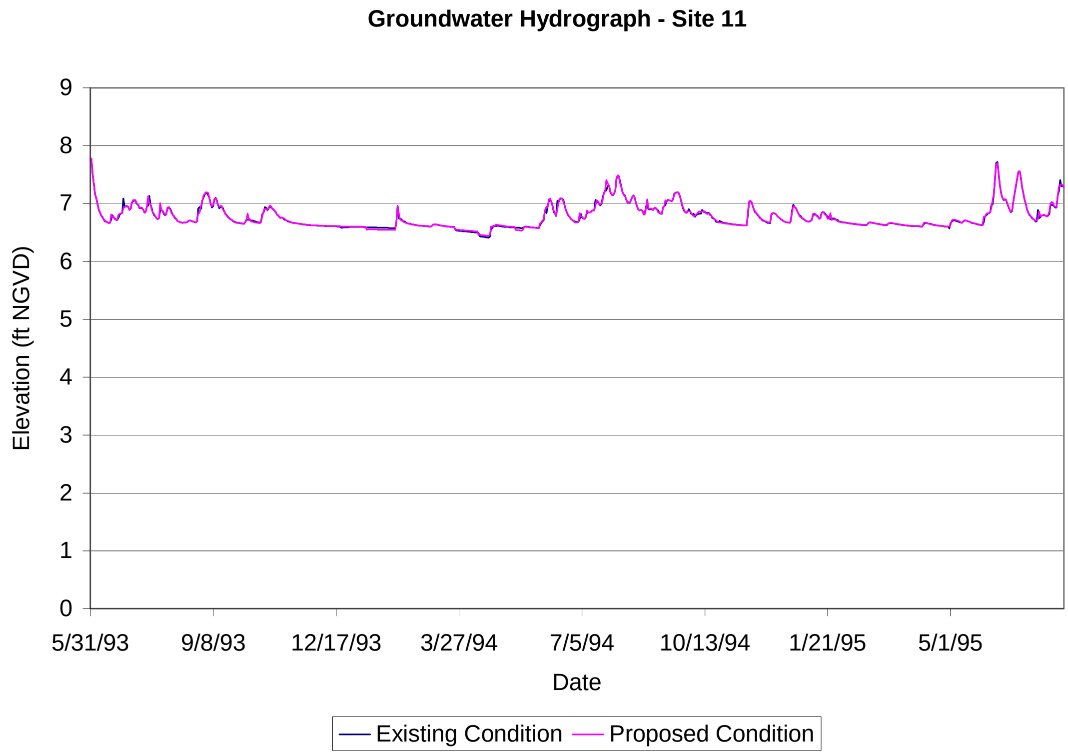


Figure 4-2-K Groundwater Hydrograph – Site 11

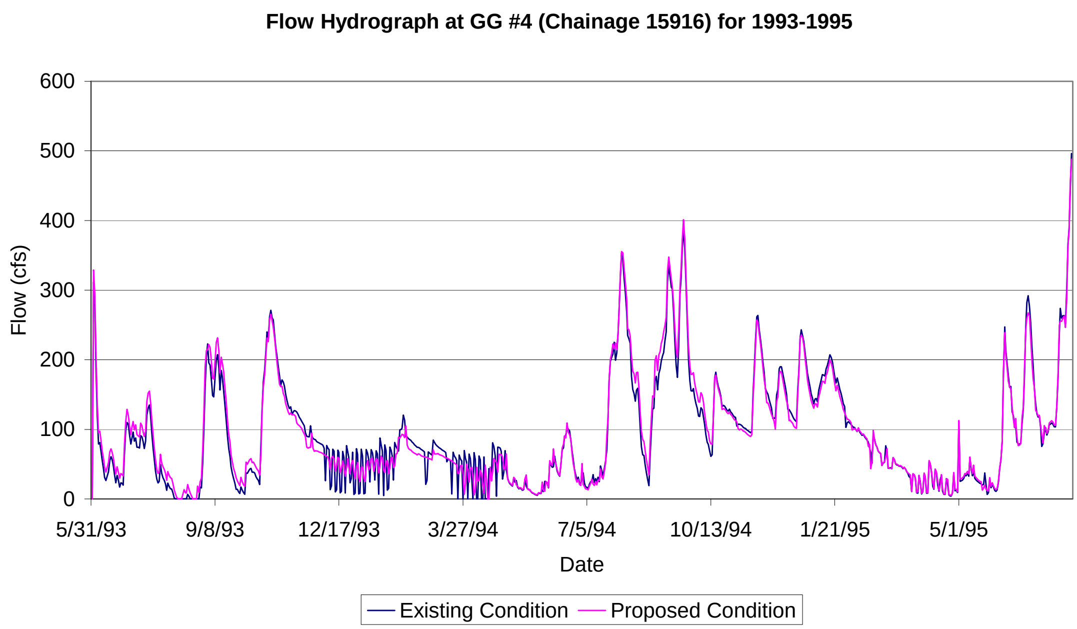


Figure 4-3-A Flow Hydrograph at GG#4 (Chainage 15916) for 1993-1995

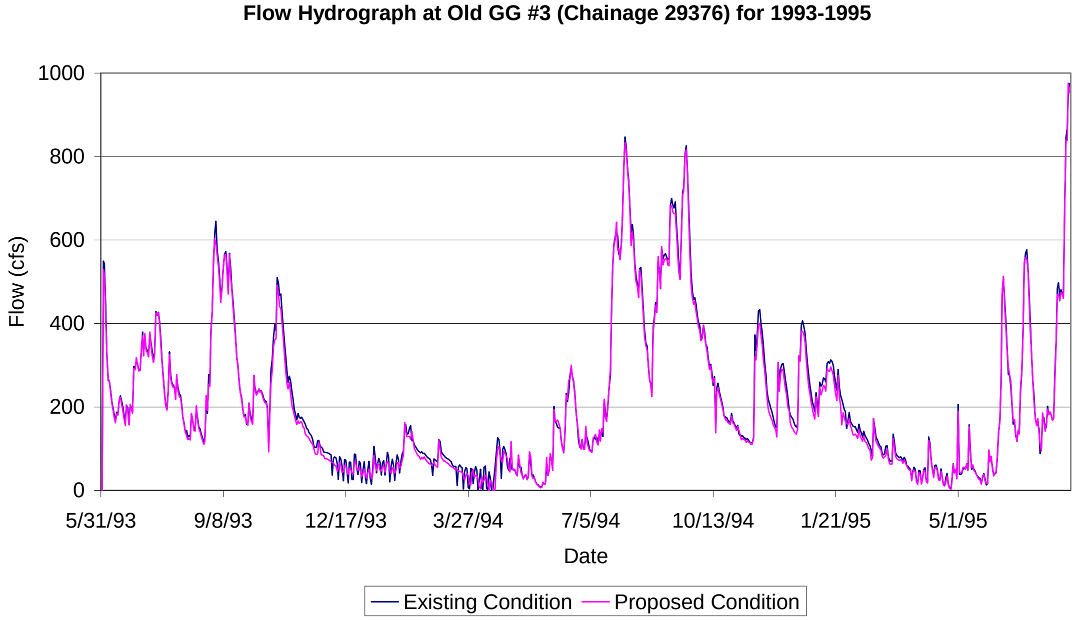


Figure 4-3-B Flow Hydrograph at Old GG #3 (Chainage 29376) for 1993-1995

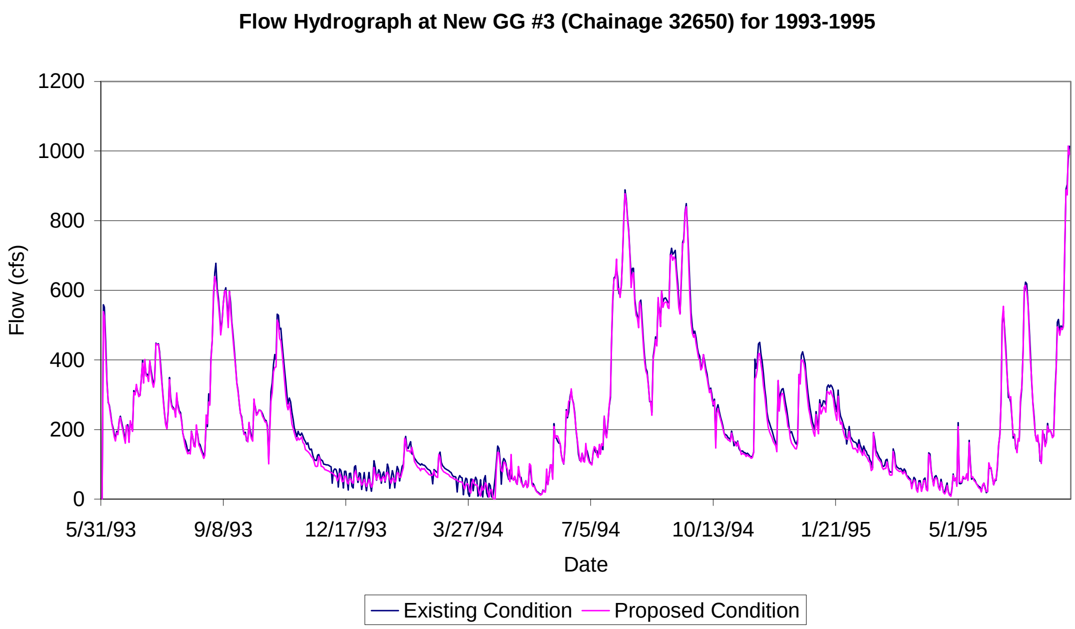


Figure 4-3-C Flow Hydrograph at New GG #3 (Chainage 32650) for 1993-1995

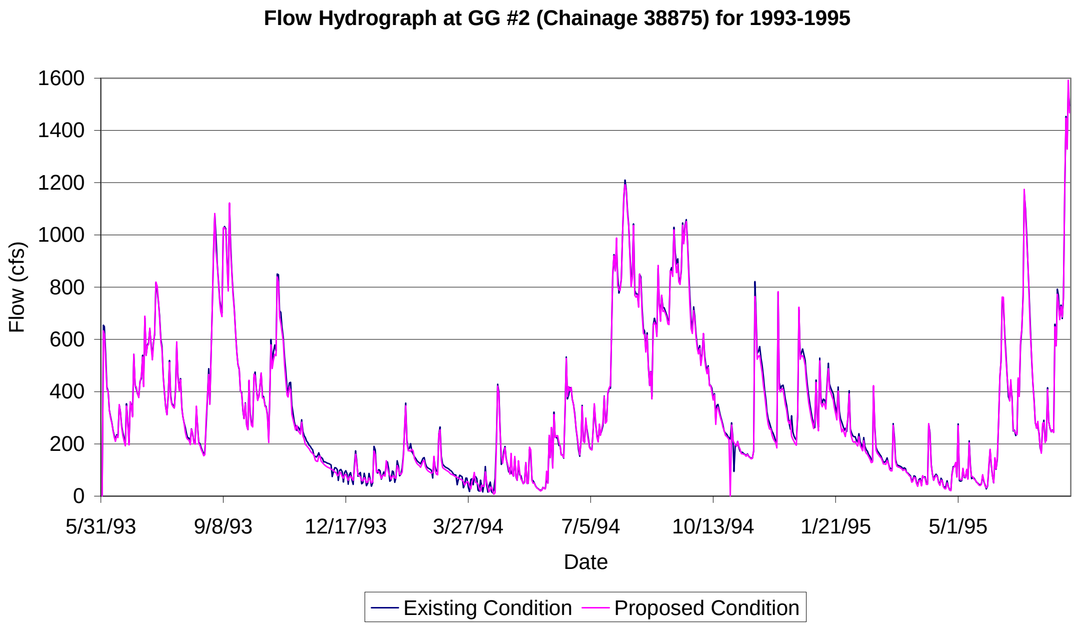


Figure 4-3-D Flow Hydrograph at GG #2 (Chainage 38875) for 1993-1995

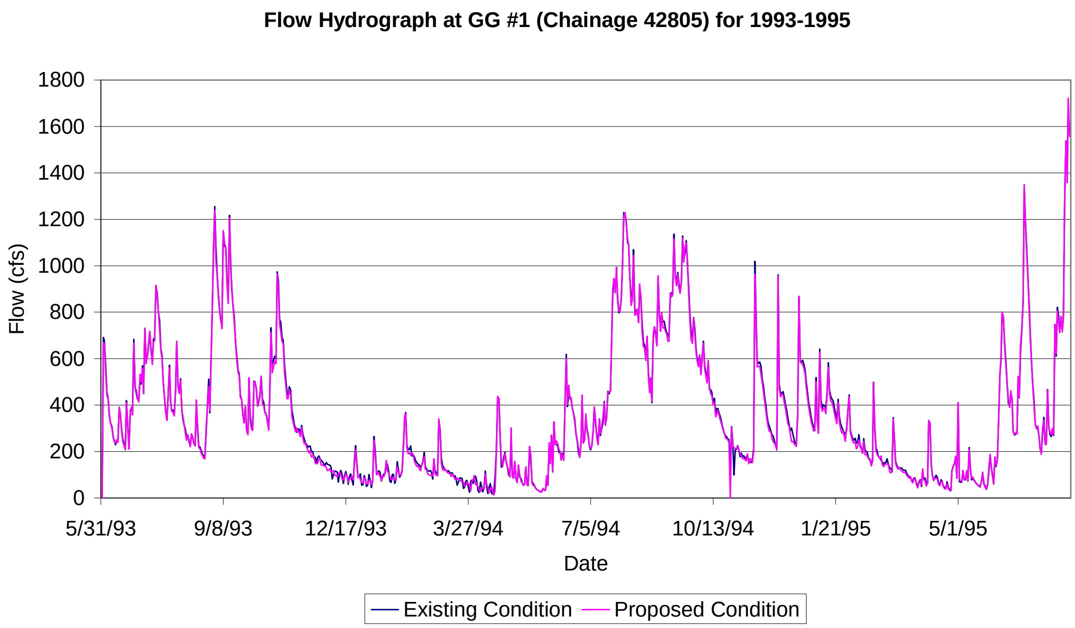


Figure 4-3-E Flow Hydrograph at GG #1 (Chainage 42805) for 1993-1995

Flow Hydrograph at CYP #1 (Chainage 6749) for 1993-1995

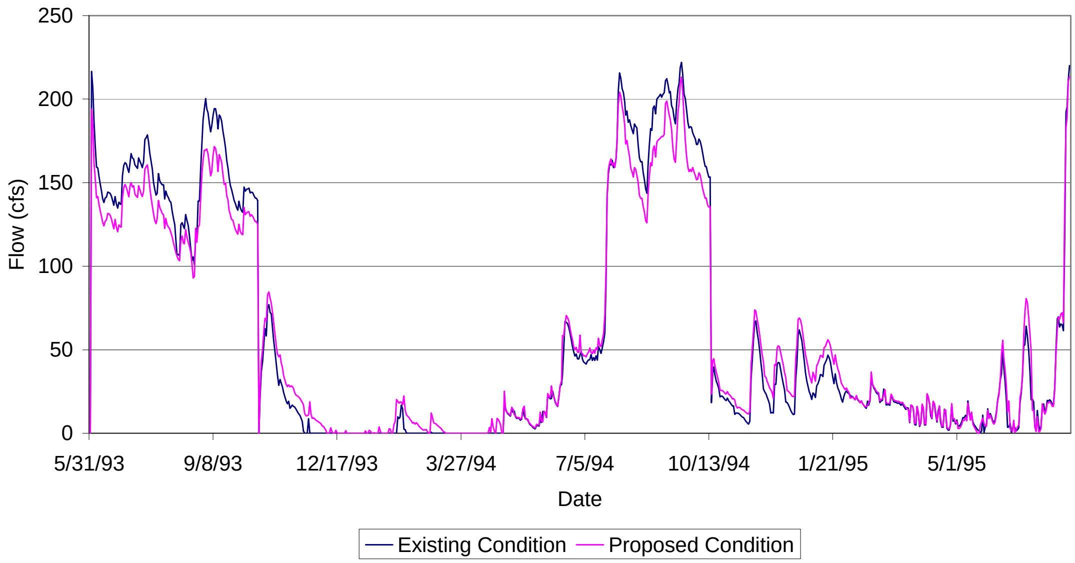


Figure 4-3-F Flow Hydrograph at CYP #1 (Chainage 6749) for 1993-1995

Flow Hydrograph at I-75 #1 (Chainage 12201) for 1993-1995

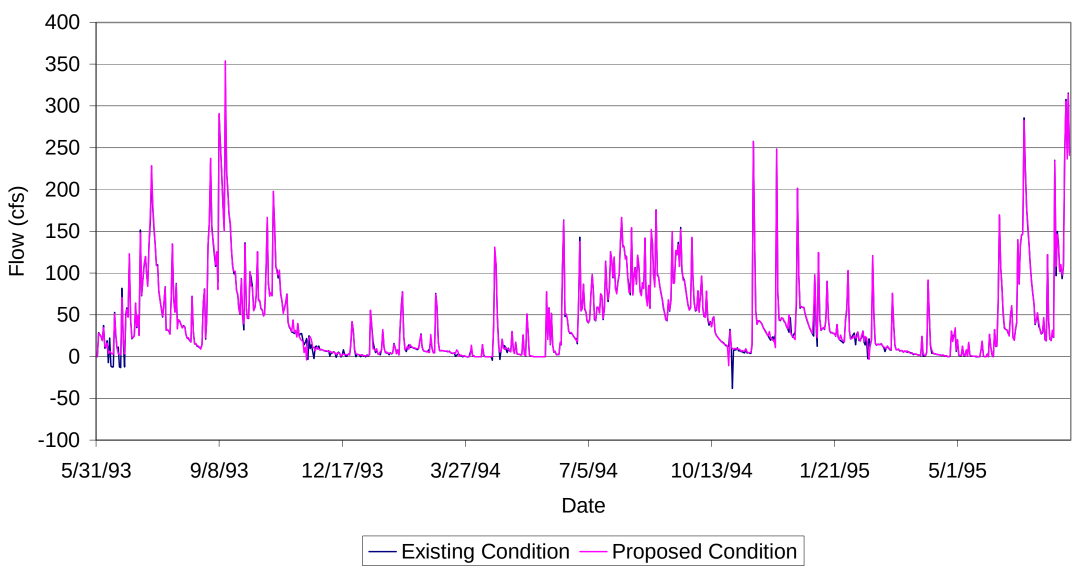


Figure 4-3-G Flow Hydrograph at I-75 #1 (Chainage 12201) for 1993-1995

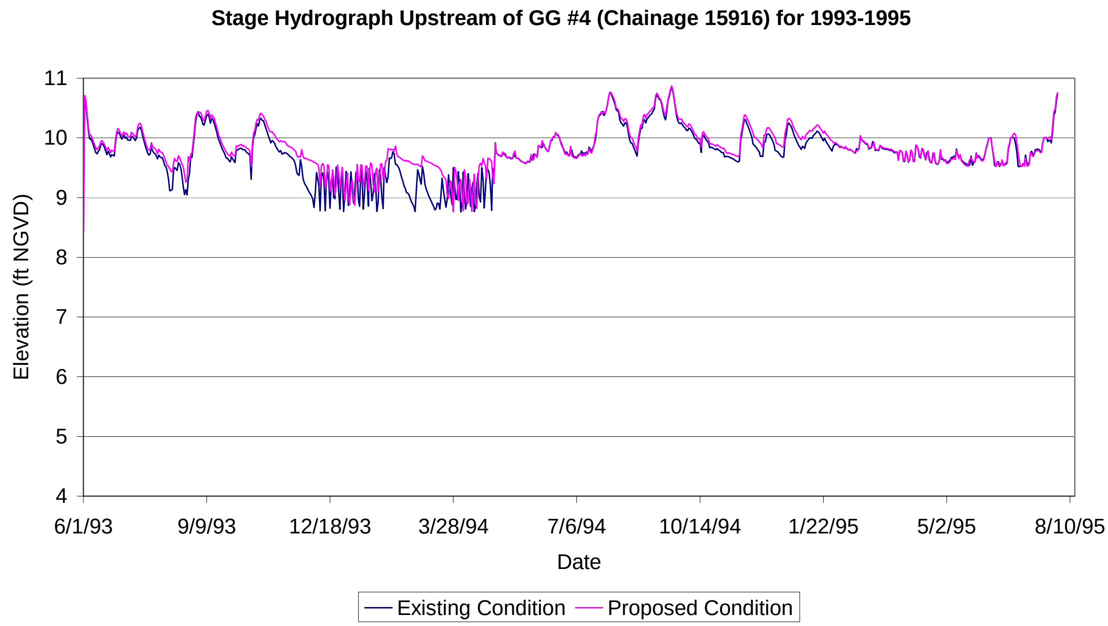


Figure 4-4-A Stage Hydrograph Upstream of GG #4 (Chainage 15916) for 1993-1995

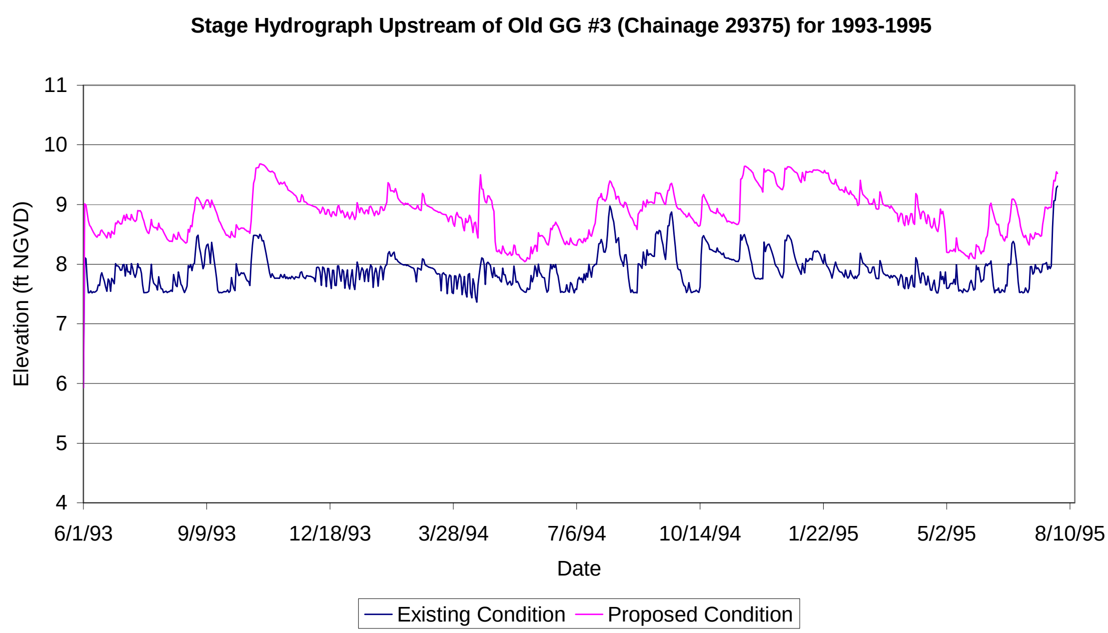


Figure 4-4-B Stage Hydrograph Upstream of Old GG #3 (Chainage 29375) for 1993-1995

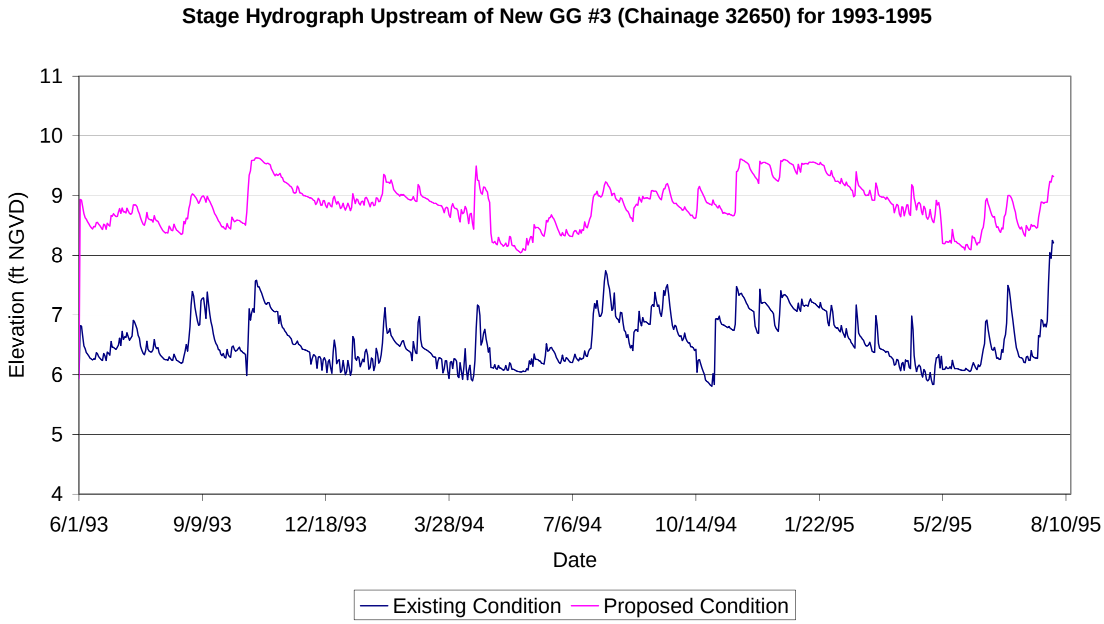


Figure 4-4-C Stage Hydrograph Upstream of New GG #3 (Chainage 32650) for 1993-1995

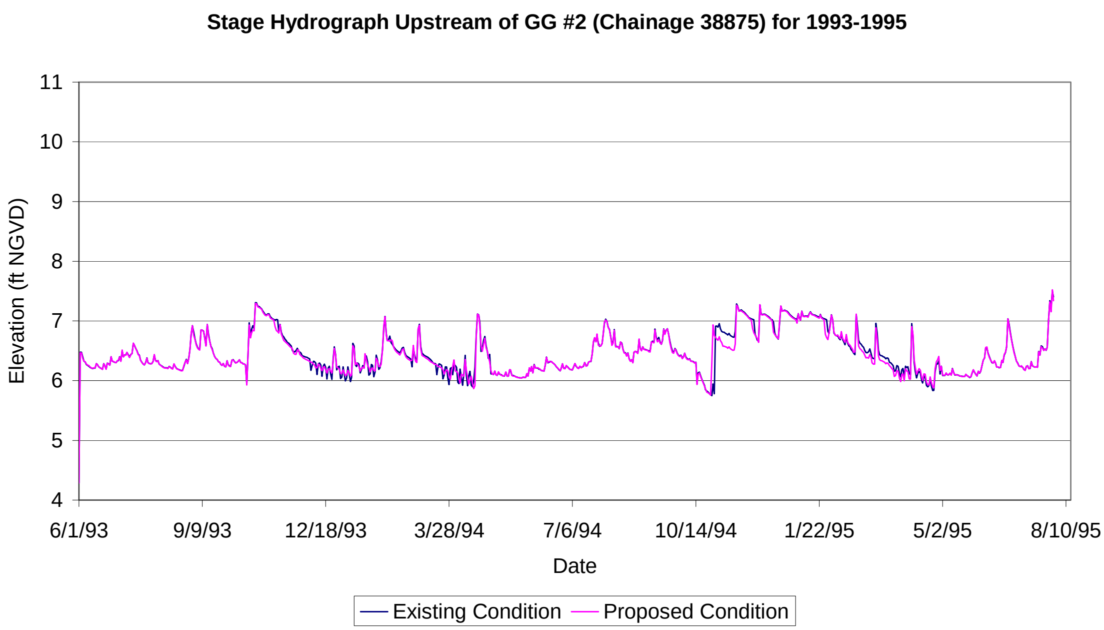


Figure 4-4-D Stage Hydrograph Upstream of GG #2 (Chainage 38875) for 1993-1995

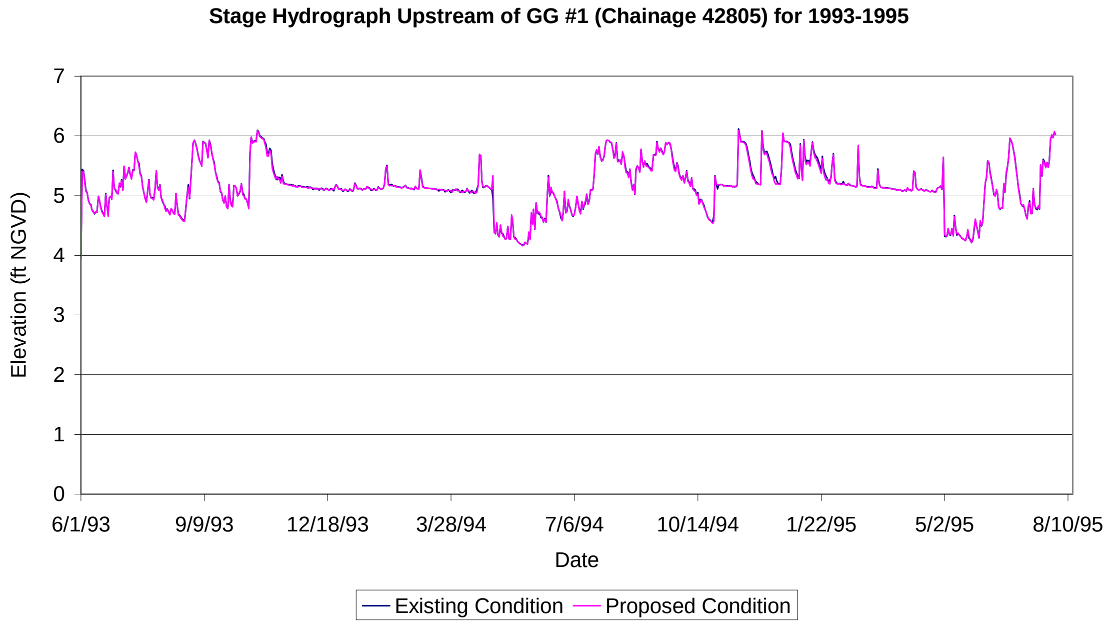


Figure 4-4-E Stage Hygrograph Upstream of GG #1 (Chainage 42805) for 1993-1995

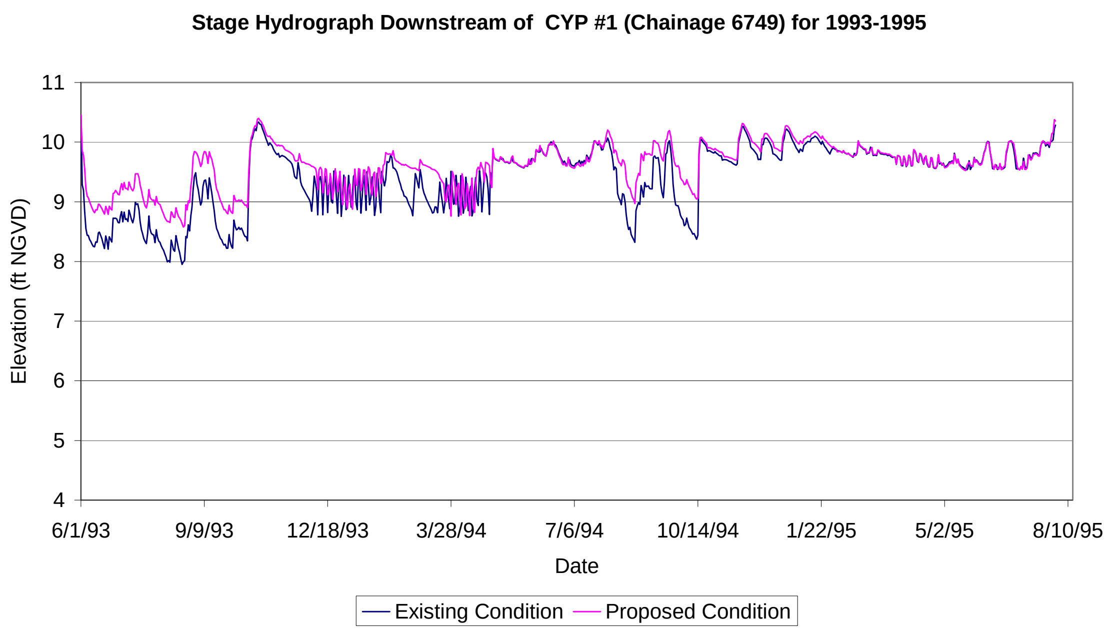


Figure 4-4-F Stage Hydrograph Downstream of CYP#1 (Chainage 6749) for 1993-1995

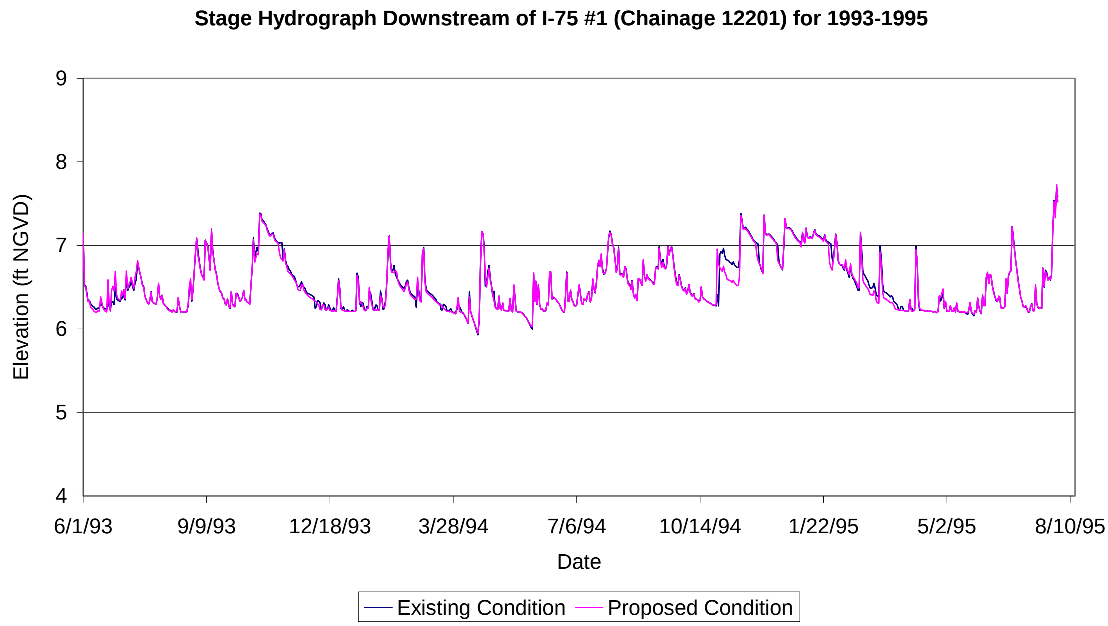


Figure 4-4-G Stage Hydrograph Downstream of I-75 #1 (Chainage 12201) for 1993-1995

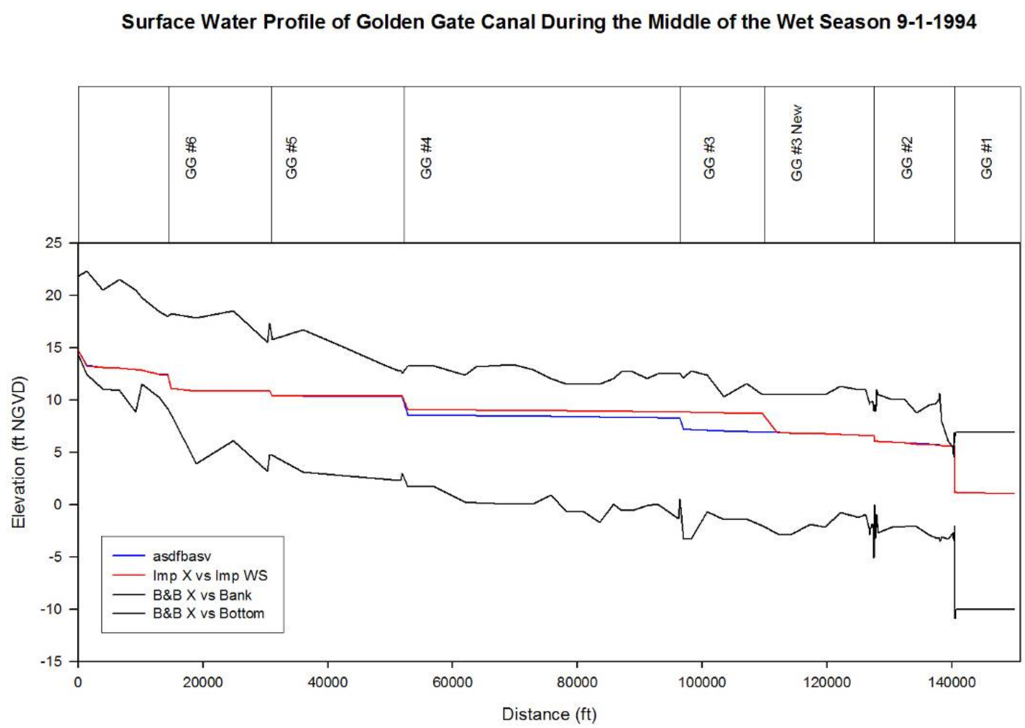


Figure 4-5 Surface Water Profile of Golden Gate Canal During the Middle of the Wet Season 9-1-1994

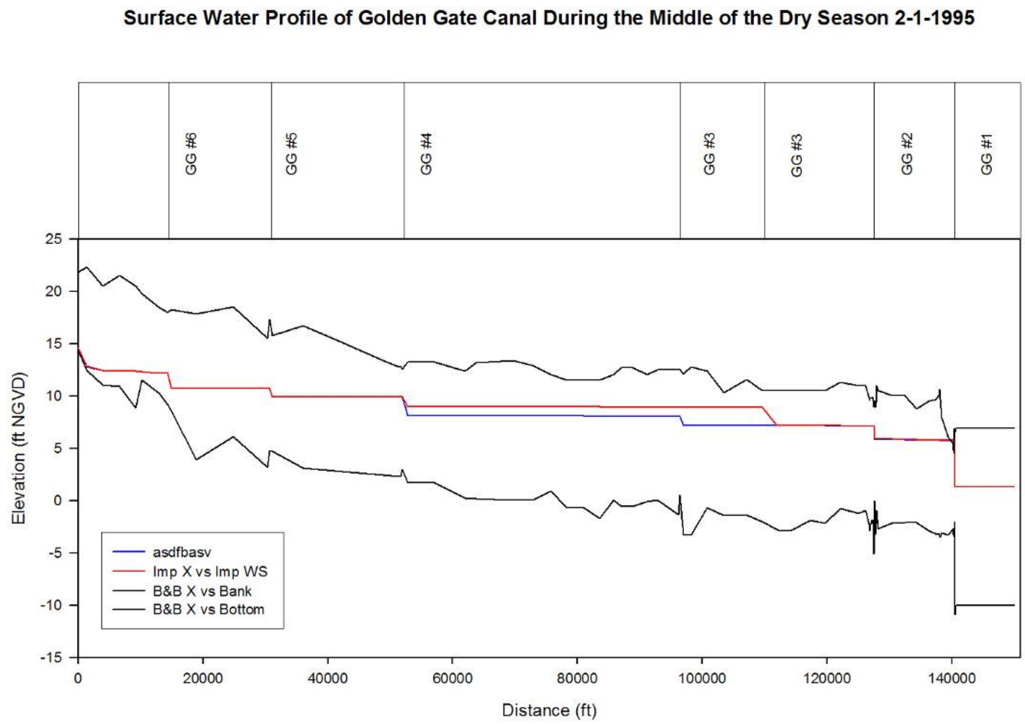


Figure 4-6 Water Surface Profile of Golden Gate Canal During the Middle of the Dry Season 2-1-1995

4.4 IMPACT ANALYSIS ON SEPTIC TANK DRAINED SYSTEM

The potential impact of the proposed GG-3 structure on the septic tank drainfield system of the Northern Golden Gate Estates was evaluated on the basis of groundwater level changes resulting from the relocation of GG-3. The analysis found that the proposed structure GG-3 and its operation schedule will have no negative impacts to the septic tank drainfield system. This conclusion is based on the following results and analysis.

The wet season is the time with high ground water level. A higher than normal groundwater level can impact the functionality of septic tank system of waster disposal. Collier County requires the drainfield of septic tanks to be more than 2 feet above the seasonal high groundwater levels in order to allow the septic tank system to function properly. Eleven locations (Figure 4-1) were selected in the Golden Gate Canal Basin to address this problem. Figures 4-2-A through 4-2-K compare the groundwater hydrographs between the existing GG-3 and proposed GG-3 conditions. By comparing the ground elevation to the highest water levels for both the existing and proposed GG-3 conditions during wet season, we found that the minimum water table depths at all selected locations remains approximately the same for existing and proposed conditions; and most importantly, most of those depths are larger than 2 feet. Table 4-4 has been generated to address the detailed impact analysis of proposed structure GG-3 to the septic tank drain-field system in Golden Gate Canal Basin, which illustrates that the improvement of the GG-3 will not have adverse impact on the functioning of the septic tanks in the area.

Table 4-4 The Impact Analysis of Proposed Structure GG-3 to the Septic Tank Drained System in Golden Gate Canal Basin

Location	Ground Surface Elevation	Highest Ground Water Elevation During Wet Season of Year 1994		Depth from Ground Surface to Peak Water Table		Adverse Impact To Septic Tank
		Existing GG-3	Proposed GG-3	Existing GG-3	Proposed GG-3	
Well 1	11.63	9.6	9.6	2.03	2.03	No
Well 2	14.36	11.58	11.57	2.78	2.79	No
Well 3	12.73	10.49	10.5	2.24	2.23	No
Well 4	13.40	11.60	11.60	1.8	1.8	No
Well 5	13.70	11.53	11.60	2.17	2.2	No
Well 6	12.52	10.0	10.0	2.52	2.52	No
Well 7	12.92	10.15	10.11	2.77	2.81	No
Well 8	13.49	11.39	11.39	2.1	2.1	No
Well 9	12.50	11.61	11.33	0.89	1.17	No
Well 10	13.50	12.38	12.38	1.12	1.12	No
Well 11	9.61	7.47	7.47	2.14	2.14	No

5.0 H&H ASSESSMENT FOR FLOOD PROTECTION

5.1 Design Storm Event

The flood modeling for this project was performed in accordance with the technical guidelines proposed recently for the Project Implementation Report (PIR) of the Picayune Strand Restoration Project (June, 2003, Guidelines for Design Storm Depth - Duration-Frequency; Temporal Distribution of Storm Rainfall Depth; and Antecedent Moisture Conditions Assessment for Design Storm Simulation by MIKE SHE/ MIKE 11). A 5-day, 25-year return period rainfall event was used as the design storm for H&H evaluation.

5.1.1 Spatial Distribution of Design Storm

The spatial design storm depth-duration-frequency analysis is outlined in the SFWMD Technical Publication EMA#390 (2001) Frequency Analysis of Daily Rainfall Maximum for Central and South Florida. These methods are based on extensive frequency analysis of local rainfall data tested with several widely used probability distribution methods. The BCB staff has refined the spatial GIS coverage of three design storms for incorporating those data with BCB MIKE SHE model. Figure 5-1 represents the spatial distribution map for a 25 year storm.

5.1.2 Temporal Distribution of Design Storm

For the one and three-day temporal distribution of design rainfall event, the applicable distribution is recommended in the SFWMD Basis of Review. This distribution is generally used for all storm water management regulatory functions in South Florida. The Basis of Review document does not specify a 5-day temporal distribution. The BCB staff reviewed the local rainfall distribution pattern of three major tropical storms affecting Collier County in the recent past at five recording rainfall stations. A composite distribution curve (Figure 5-2) was developed based on the local storm patterns and recommended for use in the BCB project.

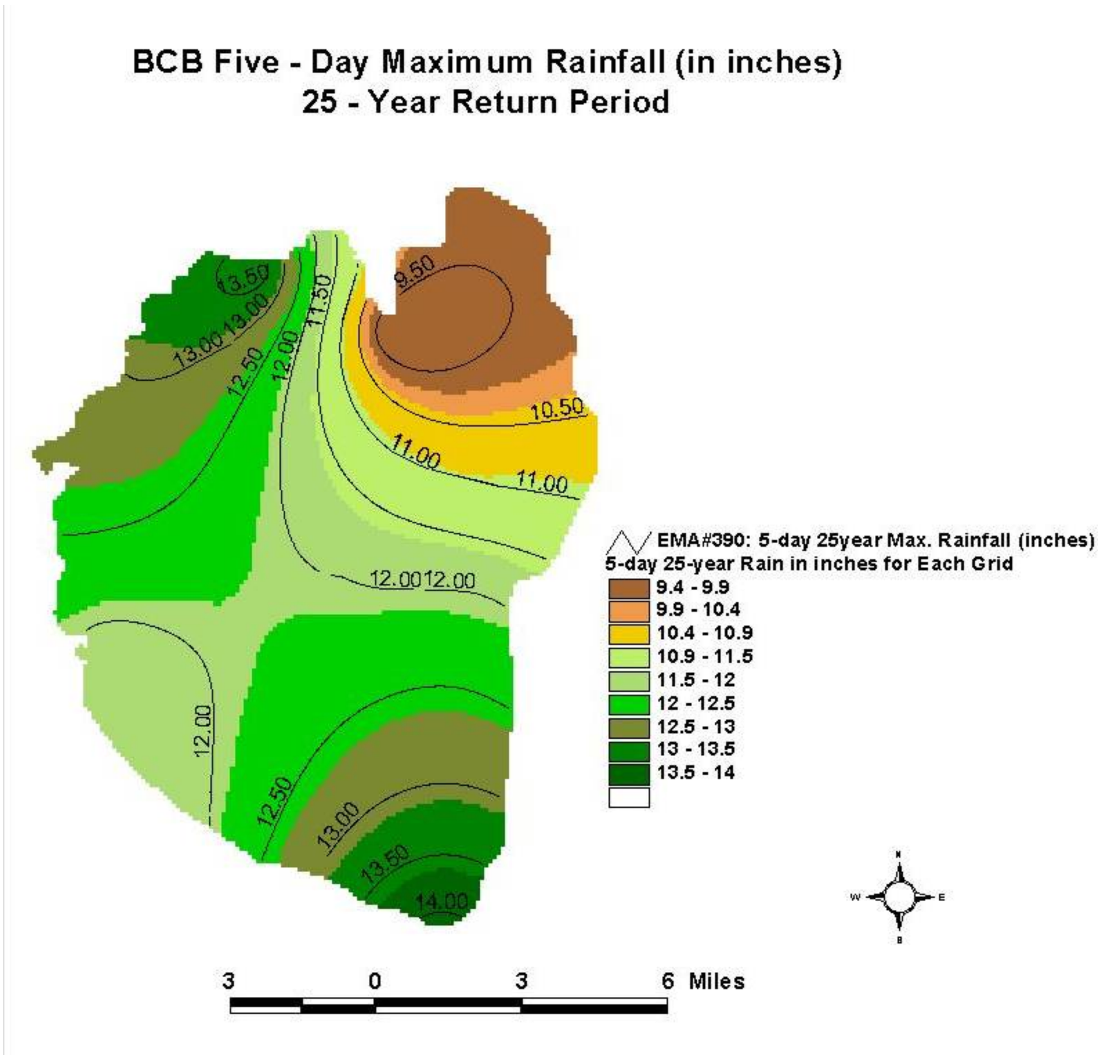


Figure 5-1 BCB Five-Day Maximum Rainfall (in inches) 25-Year Return Period

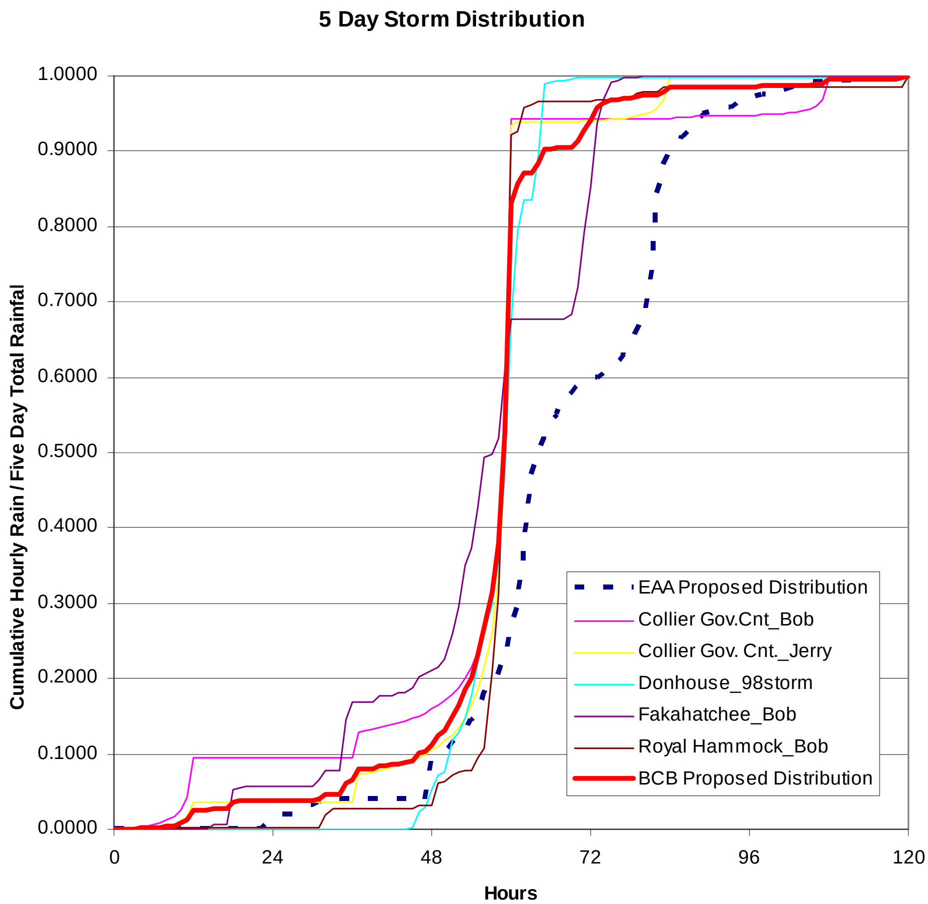


Figure 5-2 5 Day Storm Distribution

5.2 Antecedent Moisture Conditions (AMC) for Continuous Process Hydrologic-Hydraulic Simulation by MIKE SHE/MIKE 11

The SFWMD Basis of Review recommends the use of normal (long-term) wet season water table conditions to determine the AMC and that is used along with the design storm in designing the storm water management facilities. This method could generally be used for all design storms for the runoff curve number methods of runoff computation. These standard runoff curve numbers are based on AMCII conditions. However, for continuous process simulation by MIKE SHE/MIKE 11, it is necessary to simulate the design storm starting at a point in time where the proper soil moisture conditions are achieved.

The BCB and DHI staff has analyzed the measured water table elevations of eleven monitor wells in the model domain to determine the beginning time frame of high average annual wet season during the simulation period of 1988-2000. The seasonal water table levels were also correlated with rainfall records. Based on this analysis, the beginning of August 1995 has been found to be a representative time frame of average annual high water table conditions. Therefore, the design flood analysis in MIKE SHE/MIKE11 model was simulated by inserting the design storm distribution beginning August 1, 1995.

5.3 Structure Operation under Extreme Event

In an emergency situation, e.g. hurricane, tropical storm etc., the operation criteria for the water control structures will follow the directives of the District and the Collier County EOC, and will be adjusted accordingly. Since the BCB water control structures are not remotely operated by the district control room, the common practice under an extreme storm event is to monitor canal stages very closely be telemetry and by field visit and manually open to their full capacities so that the flooding levels can be minimized.

5.4 Flood Protection Simulation

The simulated channel flows and stages with the proposed structure were compared with those under the existing condition to evaluate the performance for flood control. The comparison of the existing and proposed condition has been conducted at structure locations of GG-1, GG-2, proposed GG-3, existing GG-3, GG-4, CY-1 in the BCB canal system.

The flood profile along Golden Gate Canal for the 25-year storm runoff under existing and proposed GG-3 conditions simulated by MIKE 11 model is presented in Figure 5-3. The water surface profile indicates that the 25-year stages in the large part of the canal do not stay within the banks. Although the elimination of the fixed crest weir and addition of large gates will provide larger draw-down capabilities, the conveyance capacity of the canal is limited by the existing size of the canal. However, with larger storms, like a 25-year storm event, the hydraulic analysis indicates that the weir modification will not result in significant reduction of flood stage from the existing levels. The modified GG-3 will not have adverse impact on the current levels flood protection in the Golden Gate watershed.

Figures 5-4-A through 5-5-1 are the stage and flow hydrographs for 25-year design storm at some key structure locations. The peak flow and stage at selected locations are also summarized in Table 5-1.

Table 5-1 Summary of Maximum Flow and Stage During a 5-Day, 25-Year Design Storm

Canal Crossings	Mike11 Chainage	Existing GG-3 Condition		Proposed GG-3 Condition	
		Peak Flow (cfs)	Stage NGVD (feet)	Peak Flow (cfs)	Stage NGVD (feet)
GG#1	42805	4625	7.00	4660	7.05
GG#2	38875	4122	10.46	4121	10.47
GG#3 New	32650	2148	11.61	2232	11.72
GG#3 Old	29376	2067	12.07	2146	12.01
GG#4	15916	809	12.80	842	12.81
CY #1	6749	481	13.11	499	13.14
FU-1	45922	3113	5.86	3116	5.87
COCO-1	15212	1338	9.81	1411	10.14

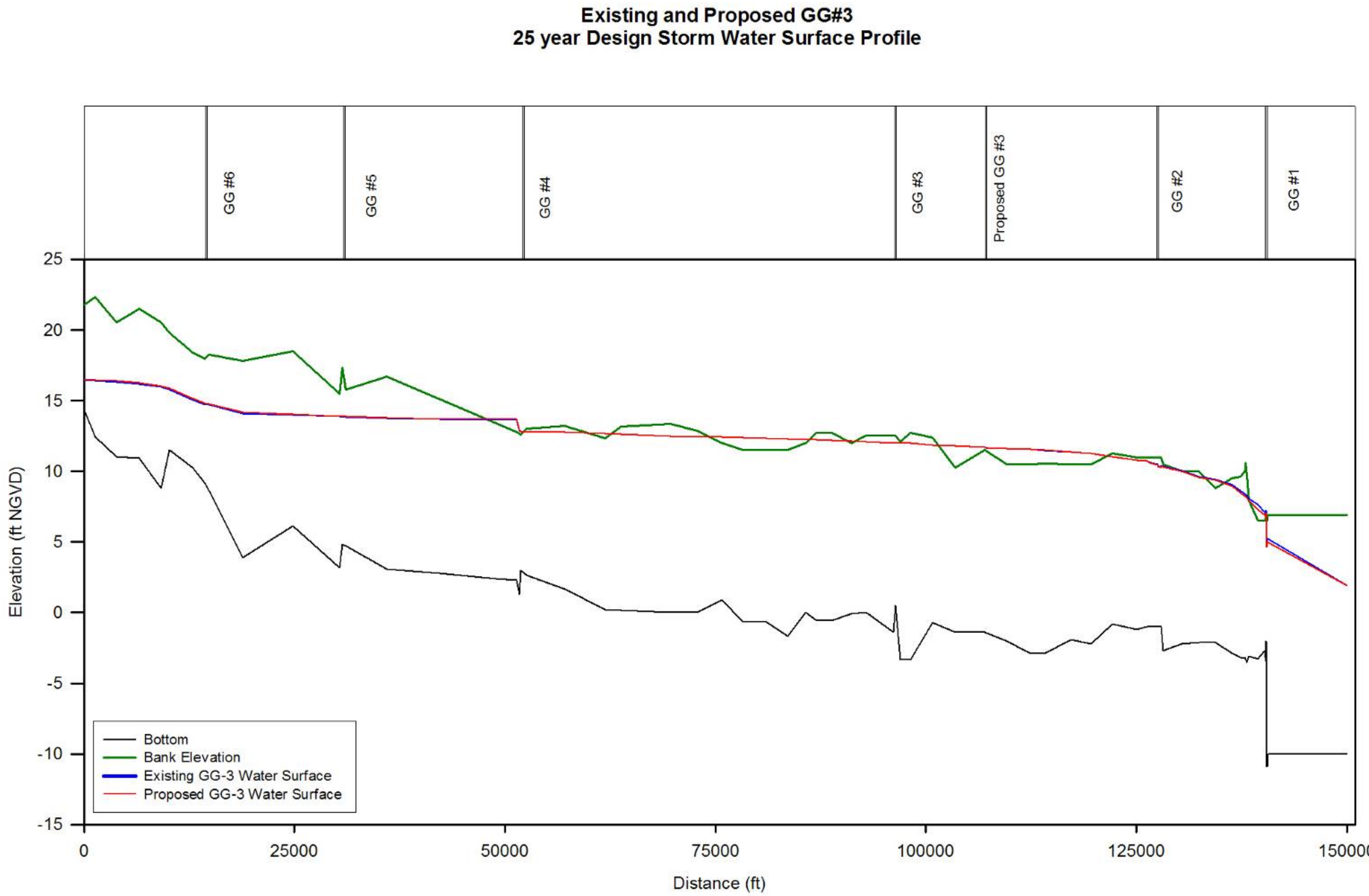


Figure 5-3 Existing and Proposed GG #3 5 Day 25 year Design Storm Water Structure Profile

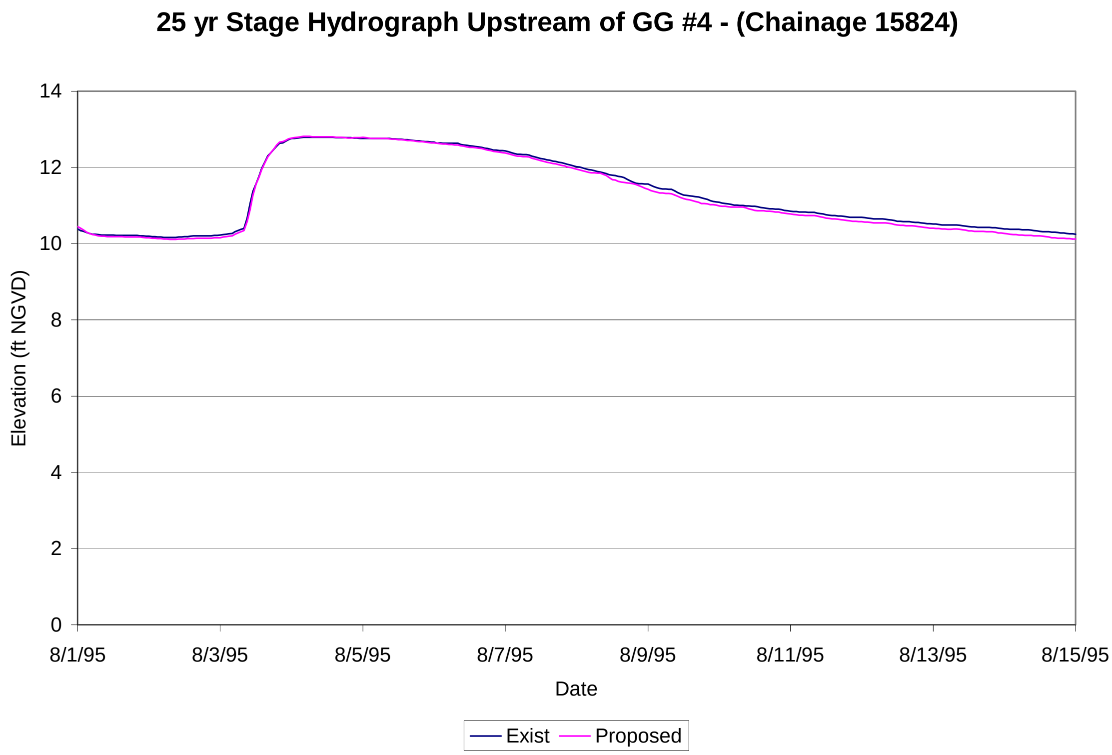


Figure 5-4-A 25 yr Stage Hydrograph Upstream of GG #4 – (Chainage 15824)

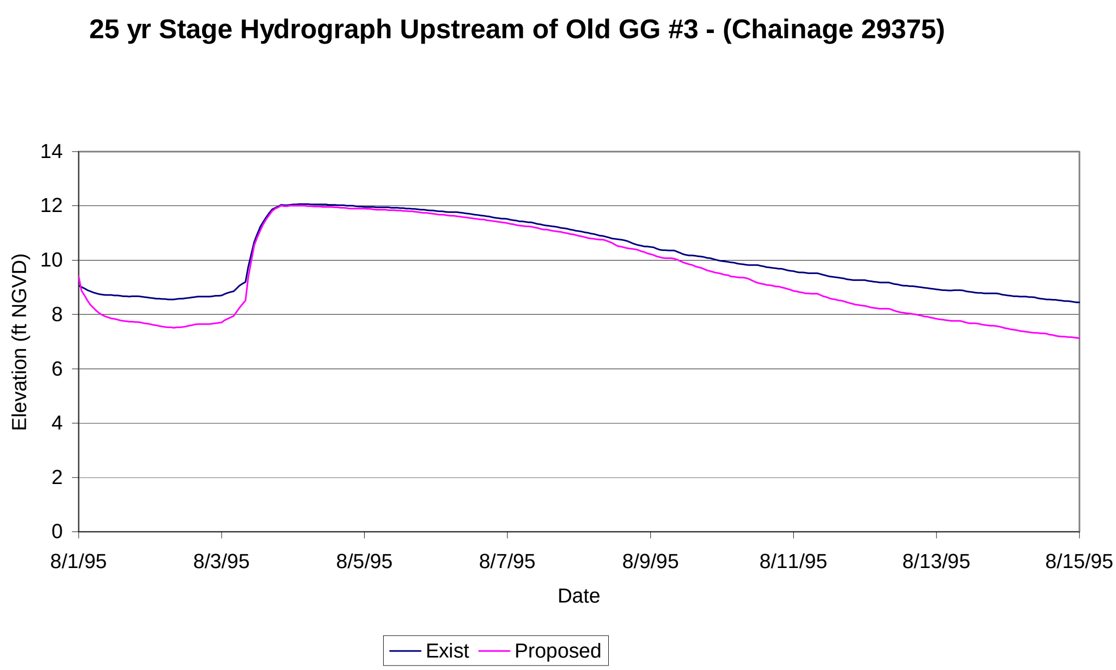


Figure 5-4-B 25 yr Stage Hydrograph Upstream of Old GG #3 – (Chainage 29375)

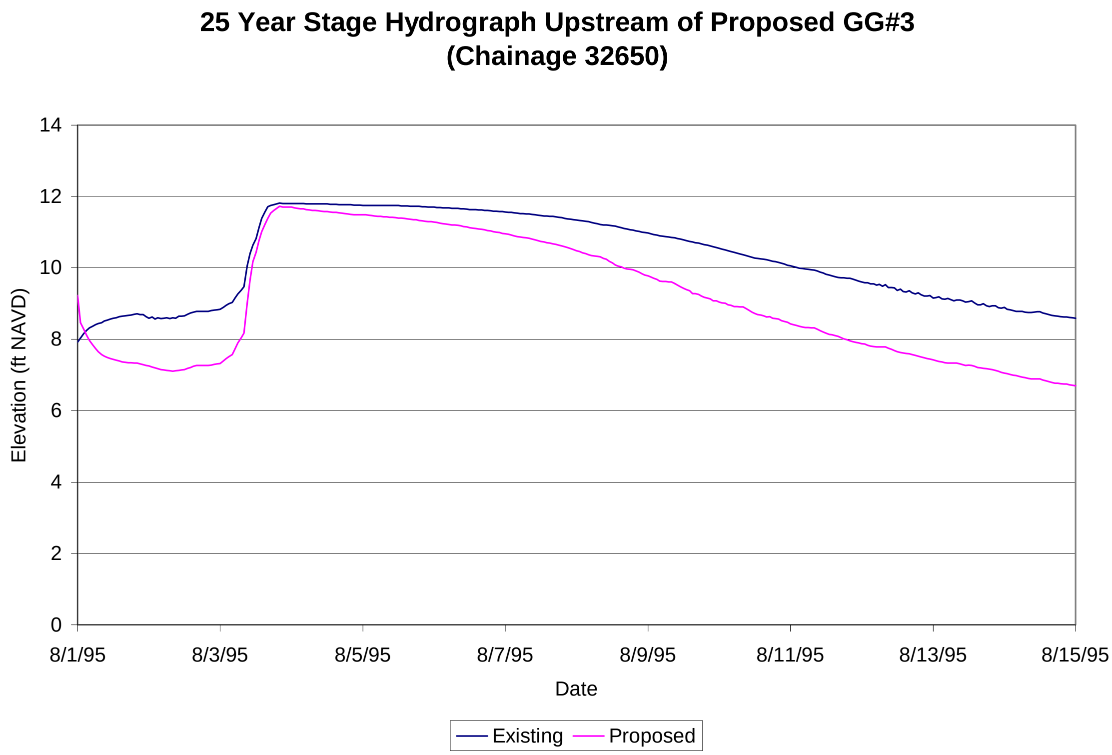


Figure 5-4-C 25 yr Stage Hydrograph Upstream of Proposed GG #3 – (Chainage 32650)

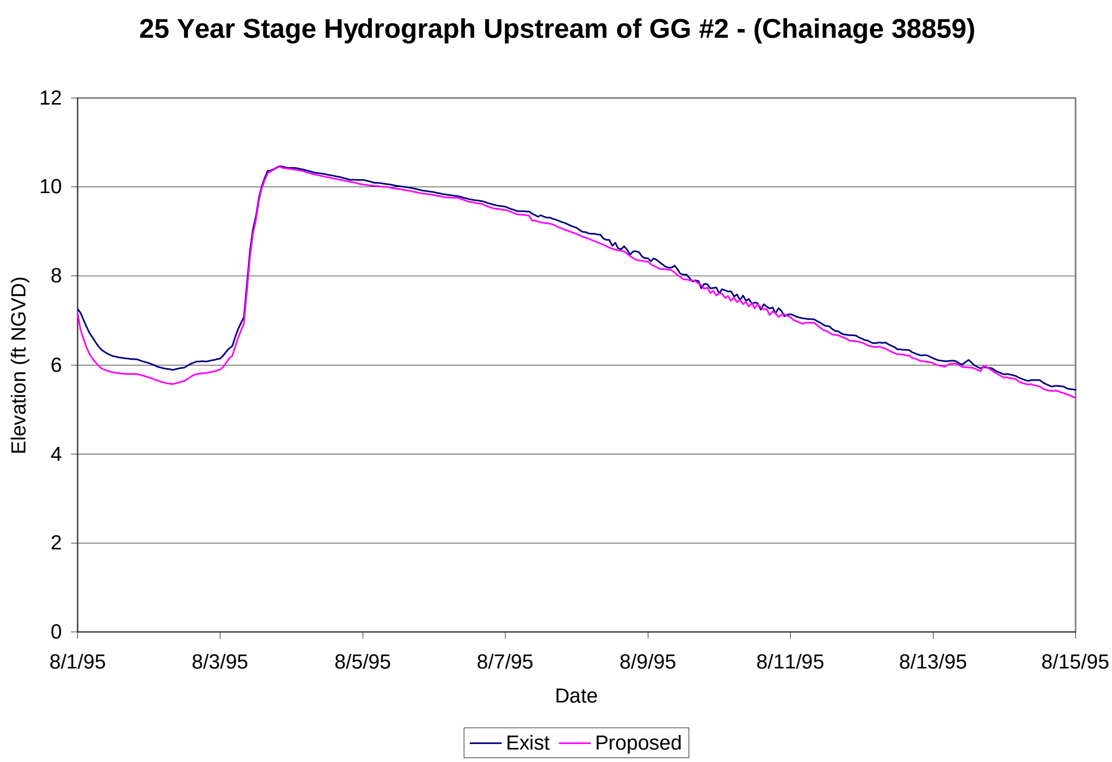


Figure 5-4-D 25 Year Stage Hydrograph Upstream of GG #2 – (Chainage 38859)

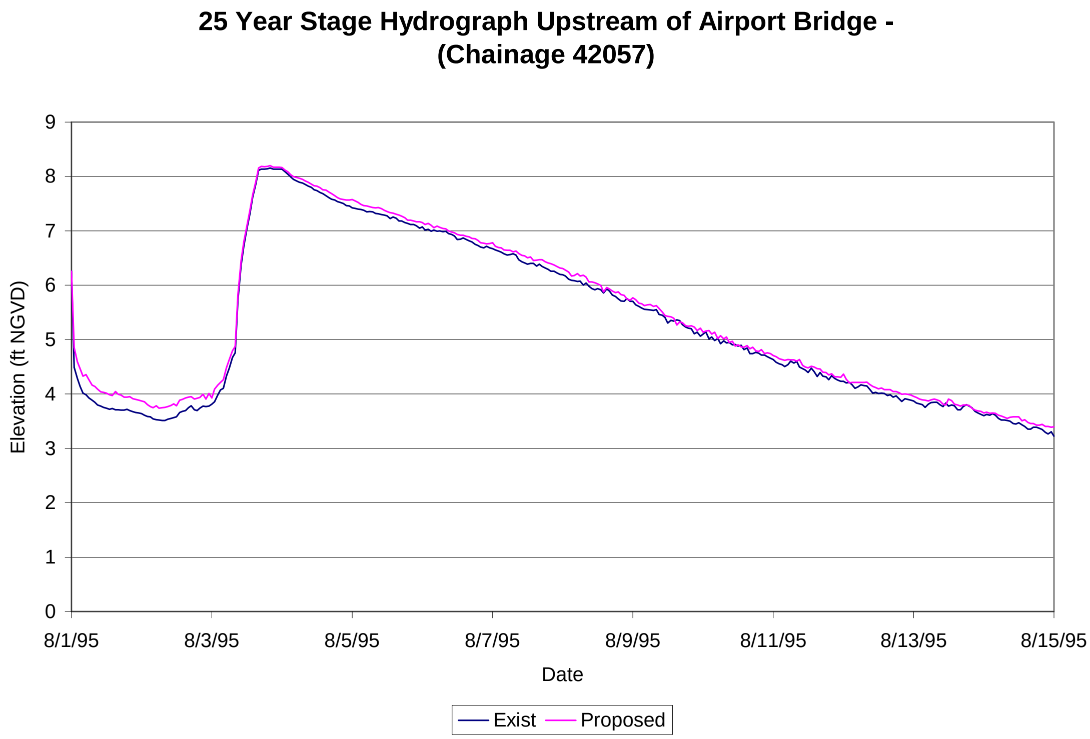


Figure 5-4-E 25 yr Stage Hydrograph Upstream of Airport Bridge – (Chainage 42057)

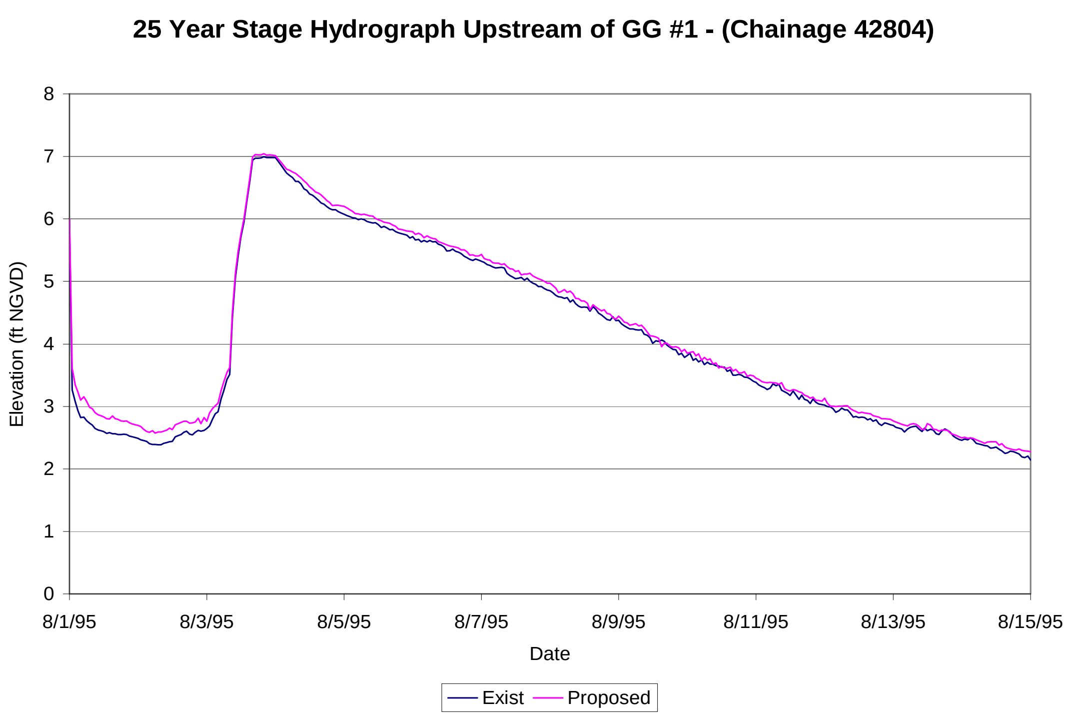


Figure 5-4-F 25 yr Stage Hydrograph Upstream of GG #1 – (Chainage 42804)

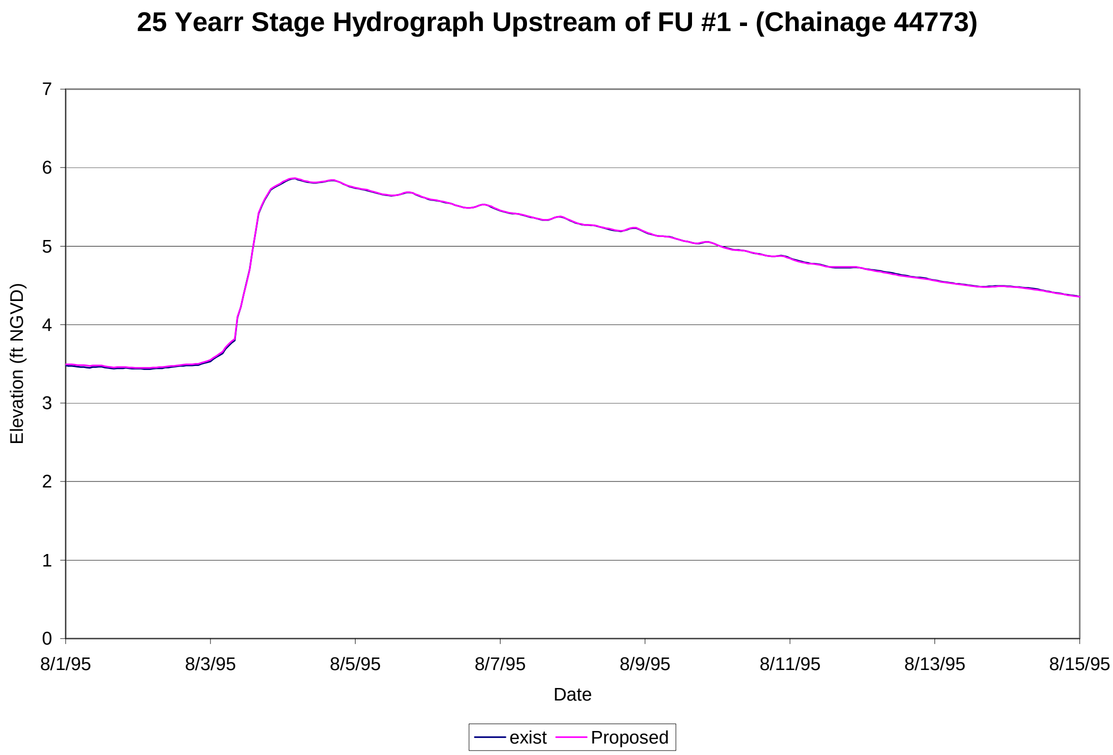


Figure 5-4-G 25 yr Stage Hydrograph Upstream of FU #1 – (Chainage 44773)

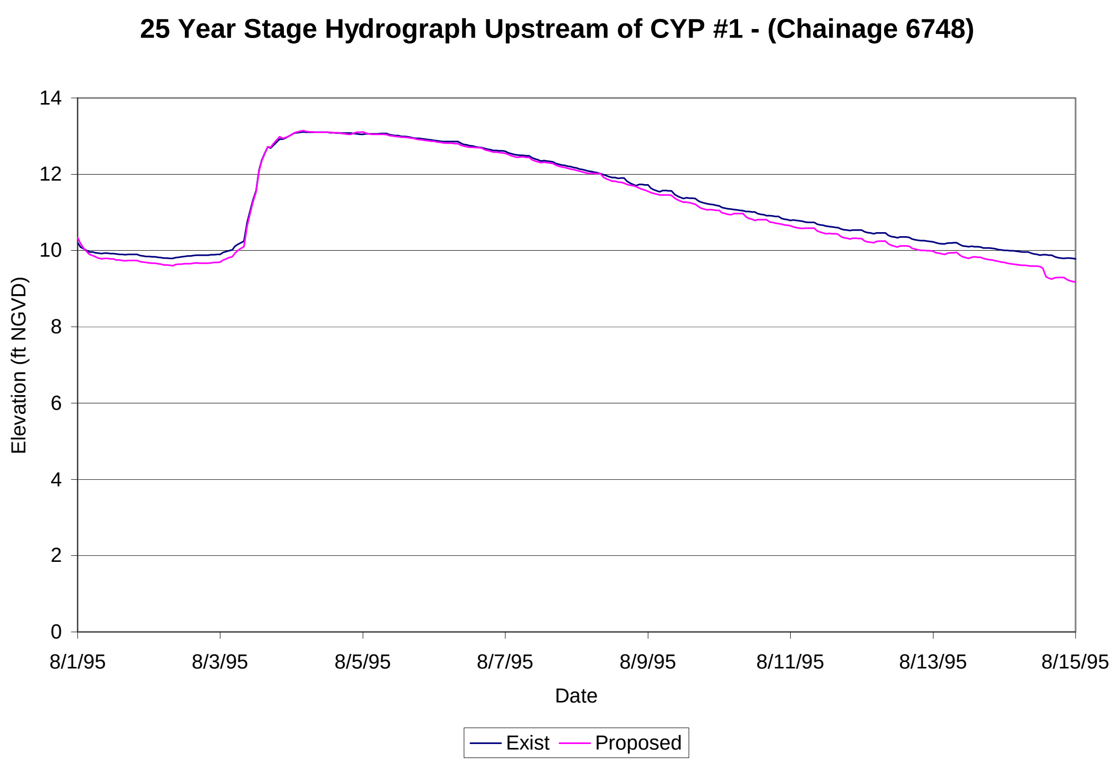


Figure 5-4-H 25 yr Stage Hydrograph Upstream of CYP #1 – (Chainage 6748)

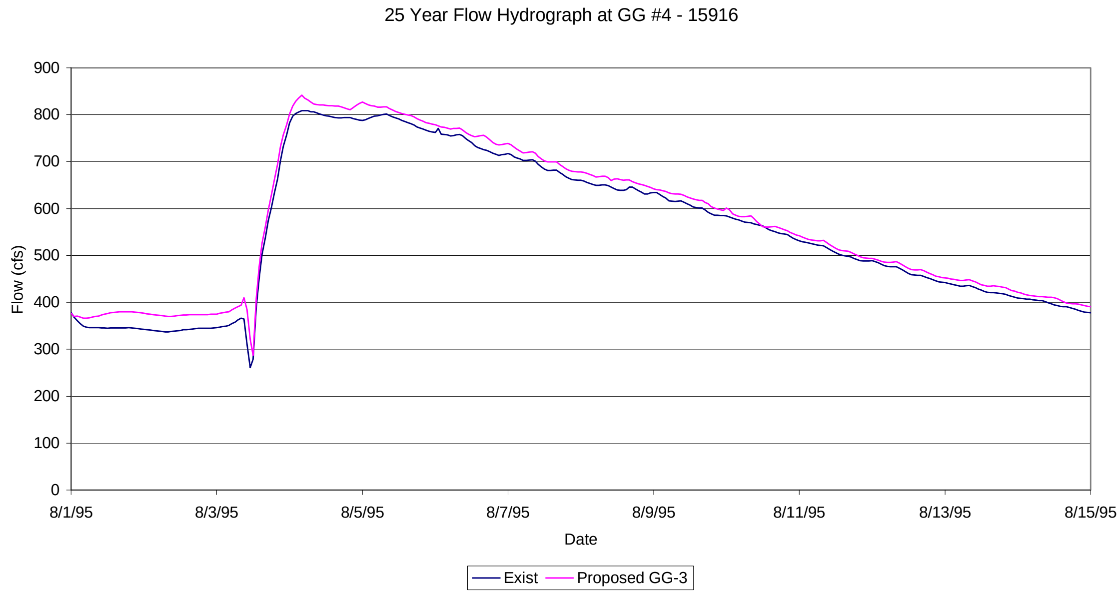


Figure 5-5-A 25 Year Flow Hydrograph at GG#4 – 15916

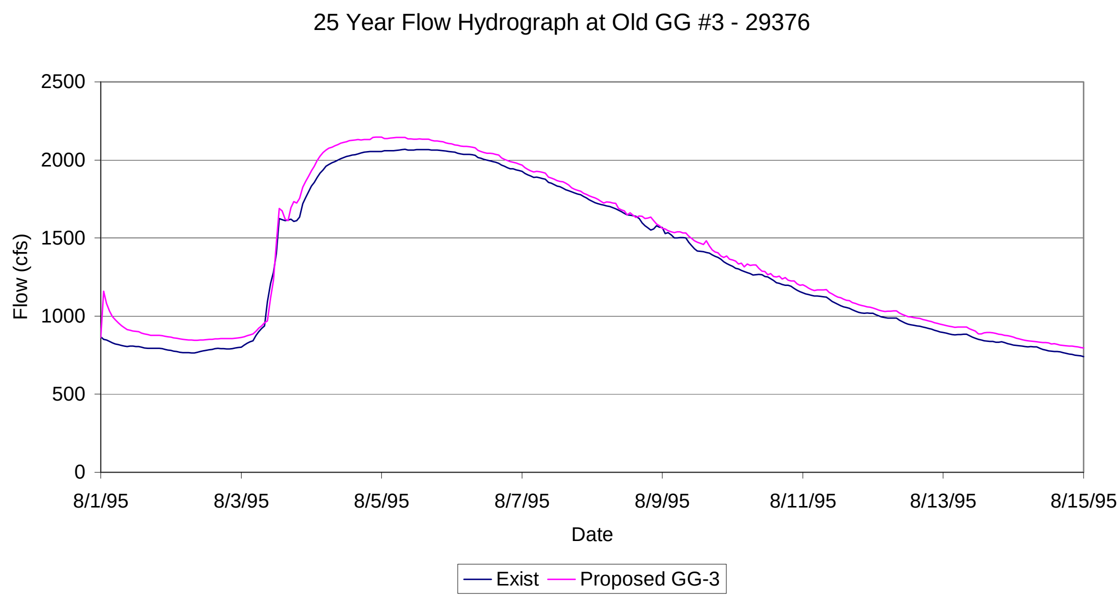


Figure 5-5-B 25 Year Flow Hydrograph at Old GG #3- 29376

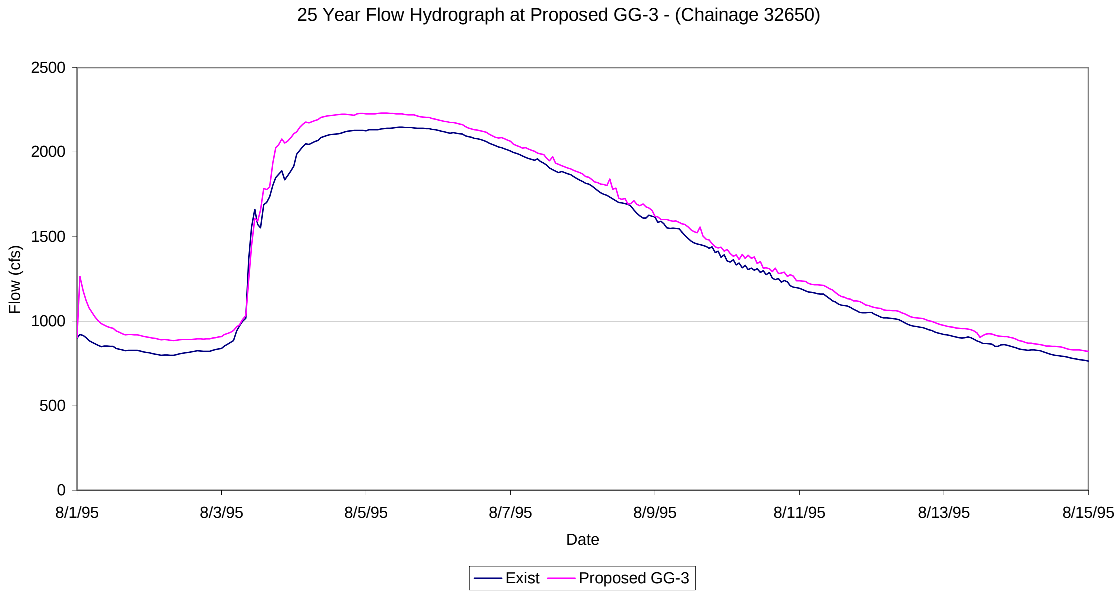


Figure 5-5-C 25 Year Flow Hydrograph at Proposed GG-3- (Chainage 32650)

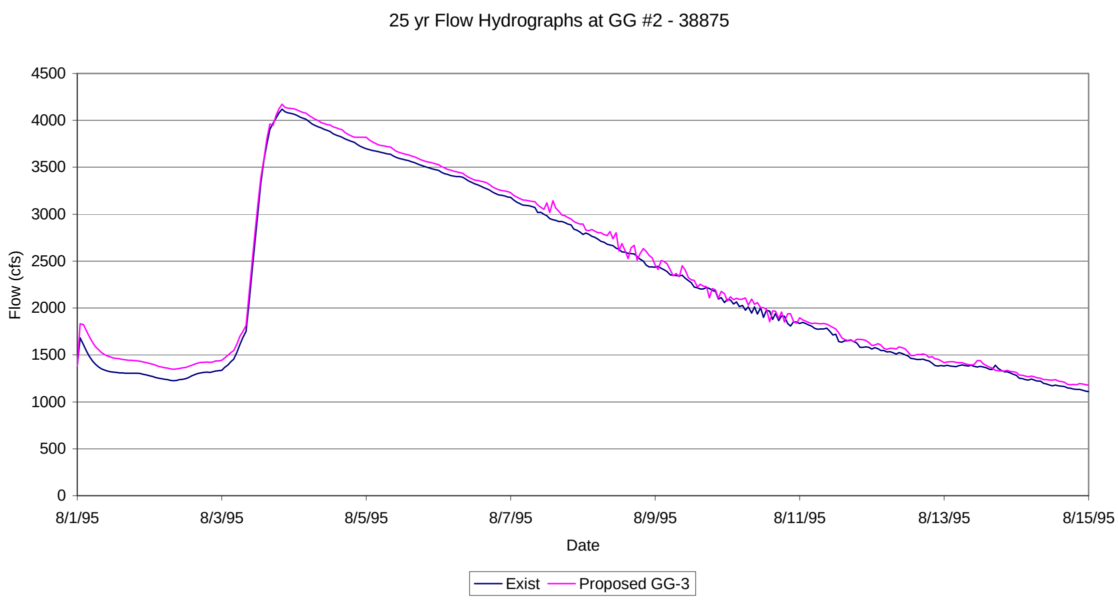


Figure 5-5-D 25 Year Flow Hydrograph at GG#2 – 38875

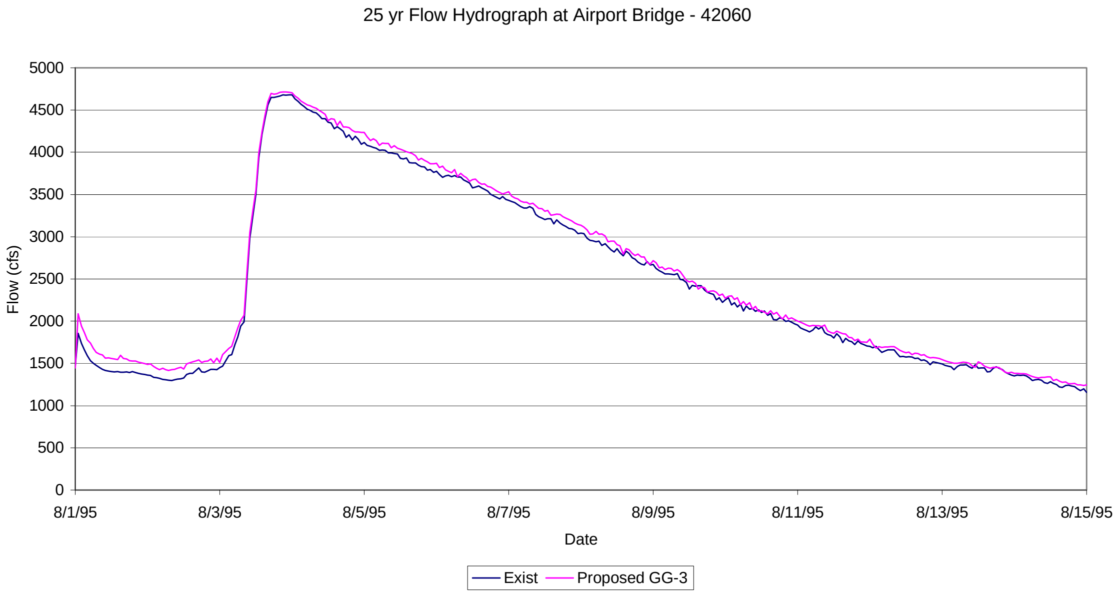


Figure 5-5-E 25 Year Flow Hydrograph at Airport Bridge – 42060

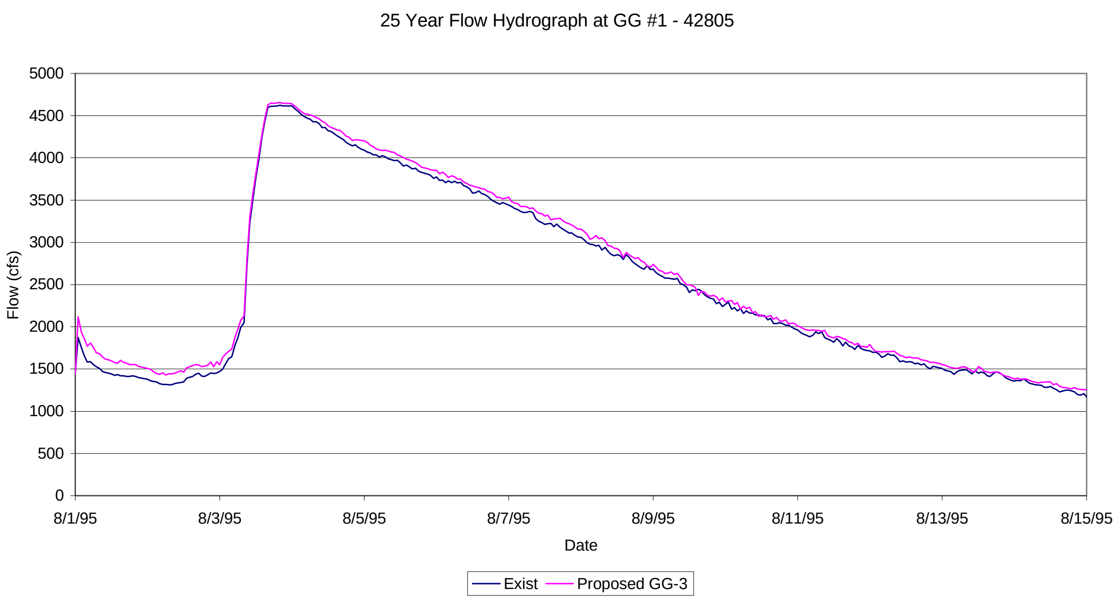


Figure 5-5-F 25 Year Flow Hydrograph at GG#1 – 42805

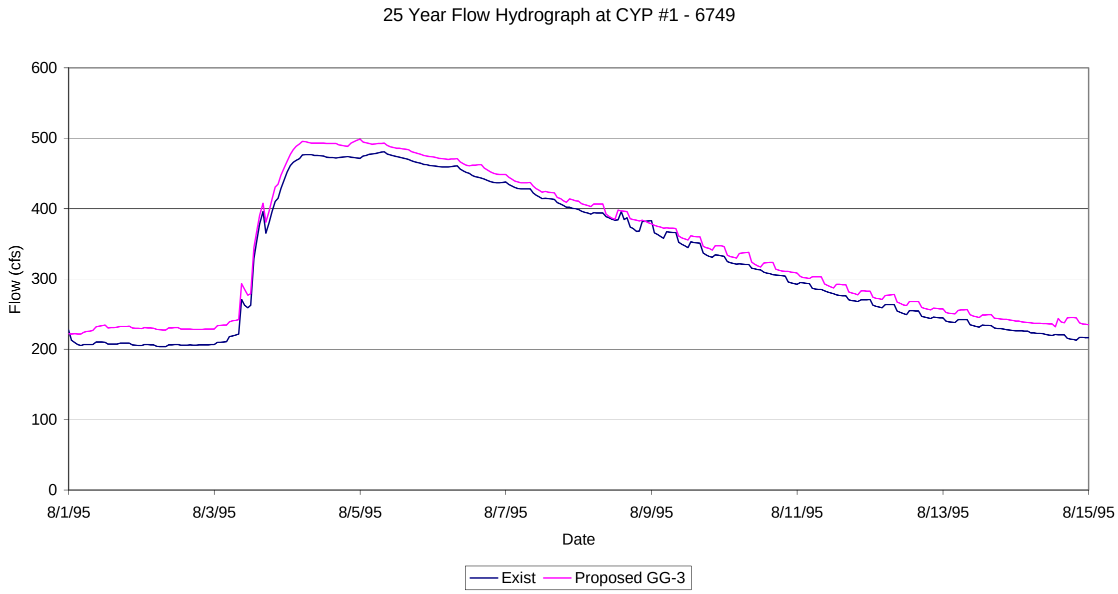


Figure 5-5-G 25 Year Flow Hydrograph at CYP#1 – 6749

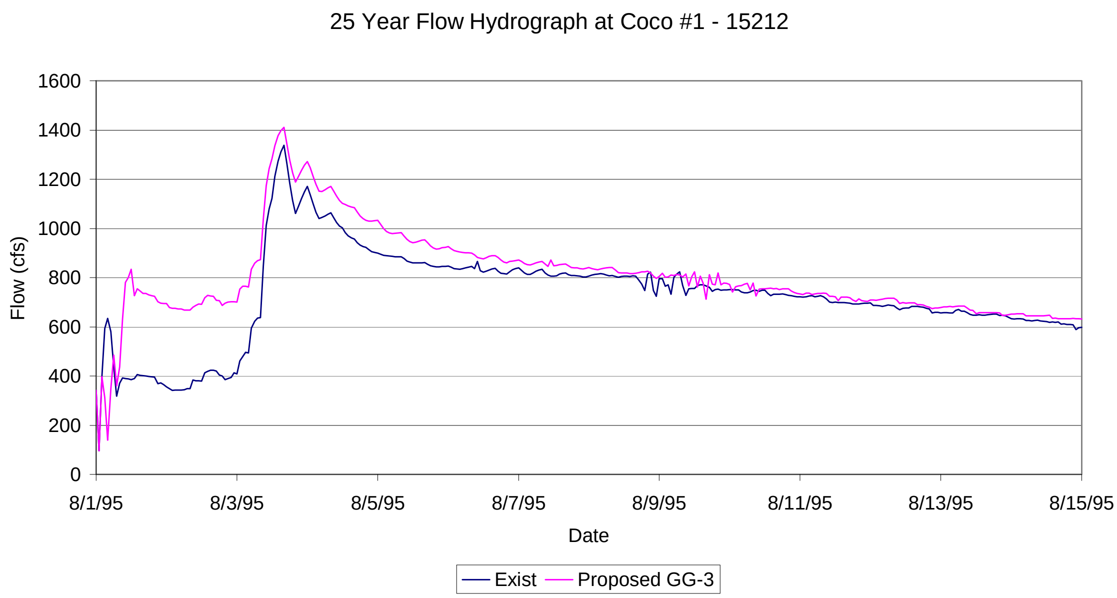


Figure 5-5-H 25 Year Flow Hydrograph at Coco #1 – 15212

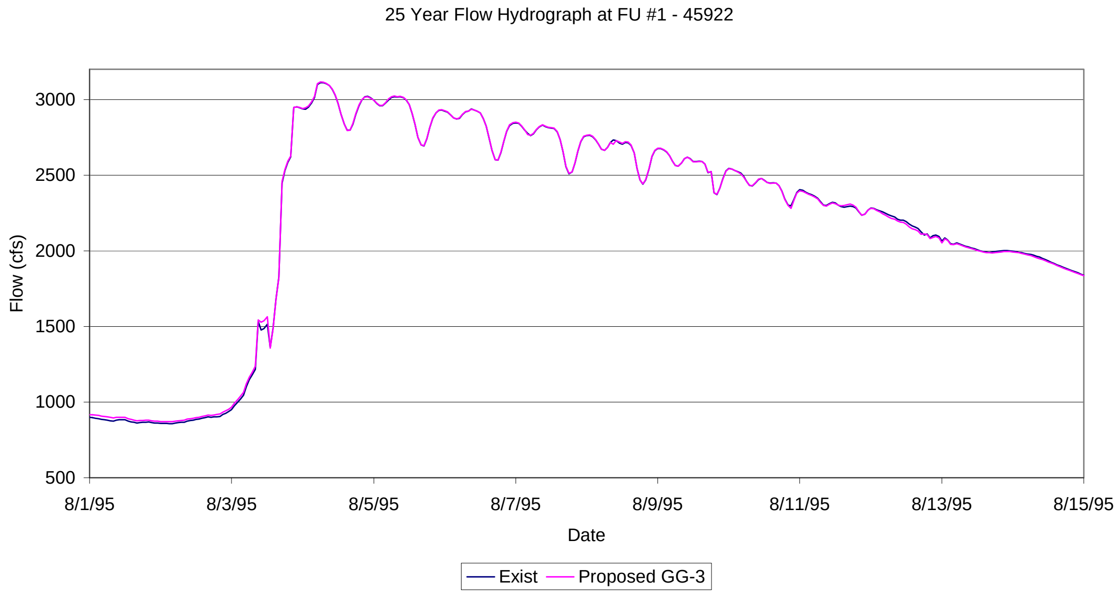


Figure 5-5-I 25 Year Flow Hydrograph at FU #1 - 45922

5.5 Flood Impact Analysis with Future Planed Capital Improvement Projects

The BCB Five Year Plan 2006-2010 (April, 2006), has outlined an array of water management strategies for regional water management enhancement. Two of these projects are related to the implementation of GG-3 relocation and were included in flood simulation scenario analysis of this project.

Scenario 1- Henderson Creek Division Plan: As indicated in Figure 5-6, this plan will divert a portion of the Golden Gate Canal flows to the Henderson Creak Canal. The historic flowways of the Henderson Creek have been disrupted by the road and drainage development. Some of the flow has been intercepted by the Golden Gate Canal. One of the key objectives of the BCB Water Management Plan is to restore this important flowways to reduce flooding and minimize adverse impact to the estuaries. This scenario will include construction of a pump station and diversion channel that will convey flow along a series of water management lakes in the Century Park Industrial development and a culvert under I-75, flowing south to the Henderson Creek Canal. A pump station of 100cfs capacity will be installed upstream of the proposed GG-3.

Scenario 2 – North Belle Meade Rehydration Plan: As indicated in Figure 5-6, this plan will divert flow from the Golden Gate Canal to the North Belle Meade. The detailed H&H and environment assessment has not been finalized at this time, the plan intent is to divert up to 400 cfs flow to North Belle Meade area.

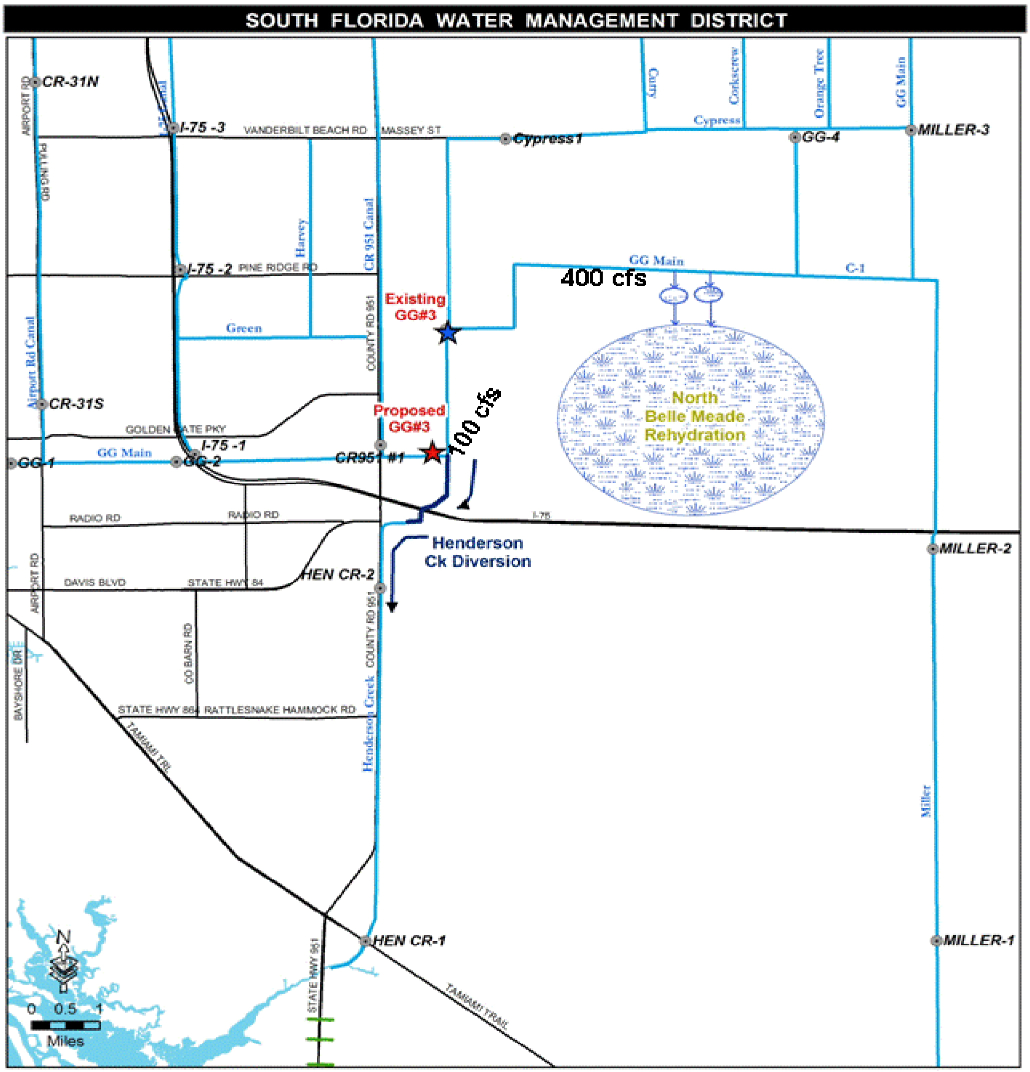


Figure 5-6 Proposed Henderson Creek Diversion and North Belle Meade Rehydration Plan in BCB Five Year Plan

Table 5-2 provides the summary of the hydraulic components of these two scenarios in the flooding modeling:

Table 5-2 Simulation Scenarios 1 and 2

Simulation Scenarios	Plan Name	Plan Feature
Scenario 1	Henderson Creek Division	Proposed GG-3 plus 100-cfs pump to Henderson Creek
Scenario 2	North Belle Meade Rehydration	Scenario 1 plus divert 400 cfs to the North Belle Meade

Figure 5-7 shows the maximum water surface profiles along Golden Gate Canal for the 25-year storm runoff for the conditions of existing GG-3, proposed GG-3, scenario 1 and scenario 2. Since scenario 1 and 2 divert flow from Golden Gate Canal system, the water surface profiles indicate that both scenario 1 and scenario 2 will improve flood protection in the Golden Gate Canal system.

Tables 5-3 and 5-4 give the peak flow and stage at selected locations along Golden Gate Canal system. The stage and flow hydrographs for 25-year design storm are given in Figures 5-8-A through 5-9-D.

Figure 5-7.
25 Year Design Storm Water Surface Profiles for the Conditions of Existing GG-3, Proposed GG-3, Scenario 1 & Scenario 2

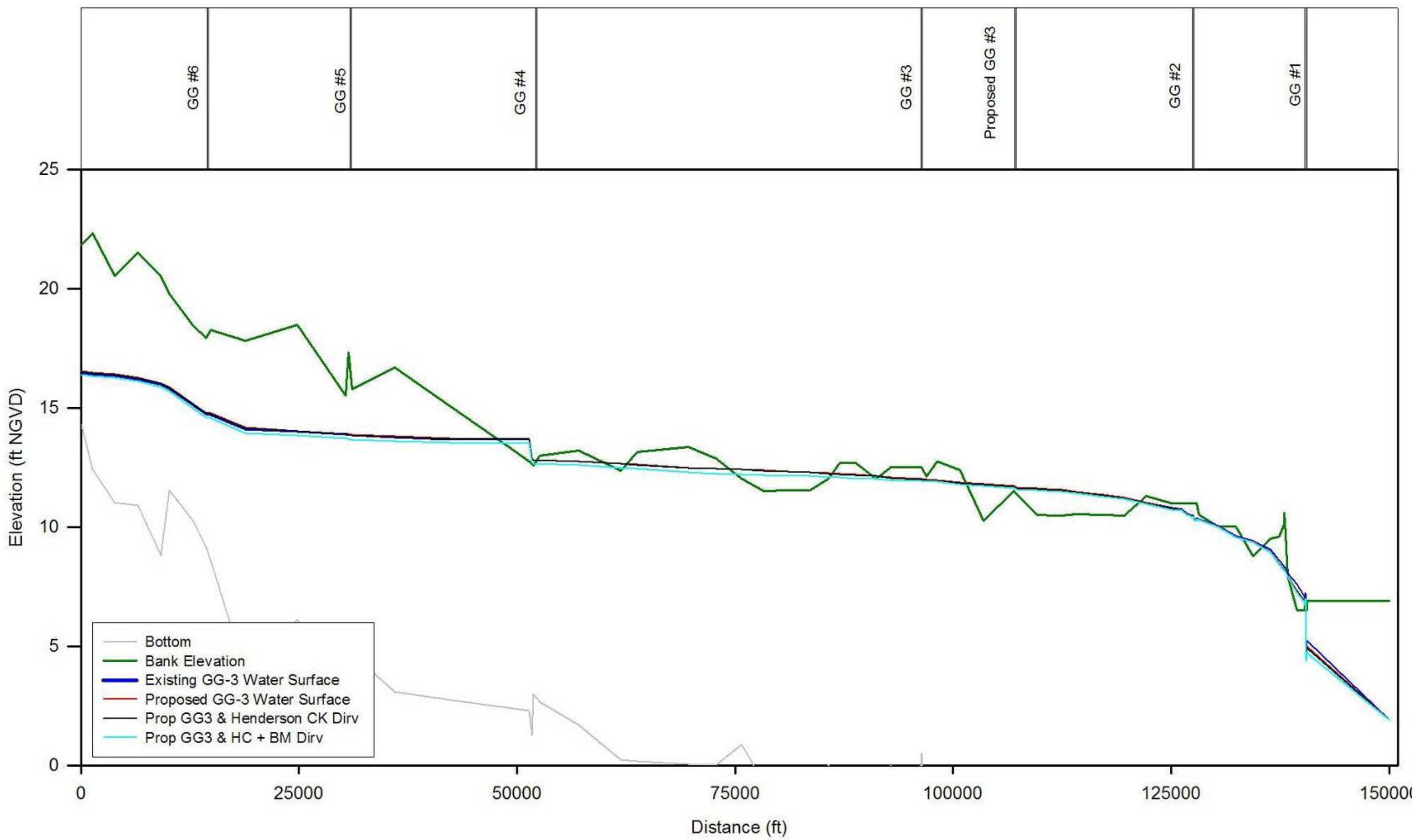


Table 5-3 Summary of Maximum Flow at Selected Locations for a 5-Day, 25-Year Design Storm

Canal Crossings	Mike11 Chainage	Peak Flows For Different Scenarios cfs			
		Existing GG-3	Proposed GG-3	Scenario 1	Scenario 2
GG#1	42805	4624	4660	4645	4630
GG#2	38875	4121	4175	4120	4072
GG#3 New	32650	2148	2232	2155	2001
GG#3 Old	29376	2067	2146	2171	1594
GG#4	15916	808	842	841	851

Table 5-4 Summary of Peak Stage at Selected Locations for a 5-Day, 25-Year Design Storm

Canal Crossings	Mike11 Chainage	Peak Stage For Different Scenarios feet (NGVD)			
		Existing GG-3	Proposed GG-3	Scenario 1	Scenario 2
GG#1	42805	7.00	7.05	7.02	6.99
GG#2	38875	10.46	10.47	10.46	10.44
GG#3 New	32650	11.61	11.72	11.68	11.62
GG#3 Old	29376	12.07	12.01	11.98	11.92
GG#4	15916	12.80	12.81	12.81	12.65

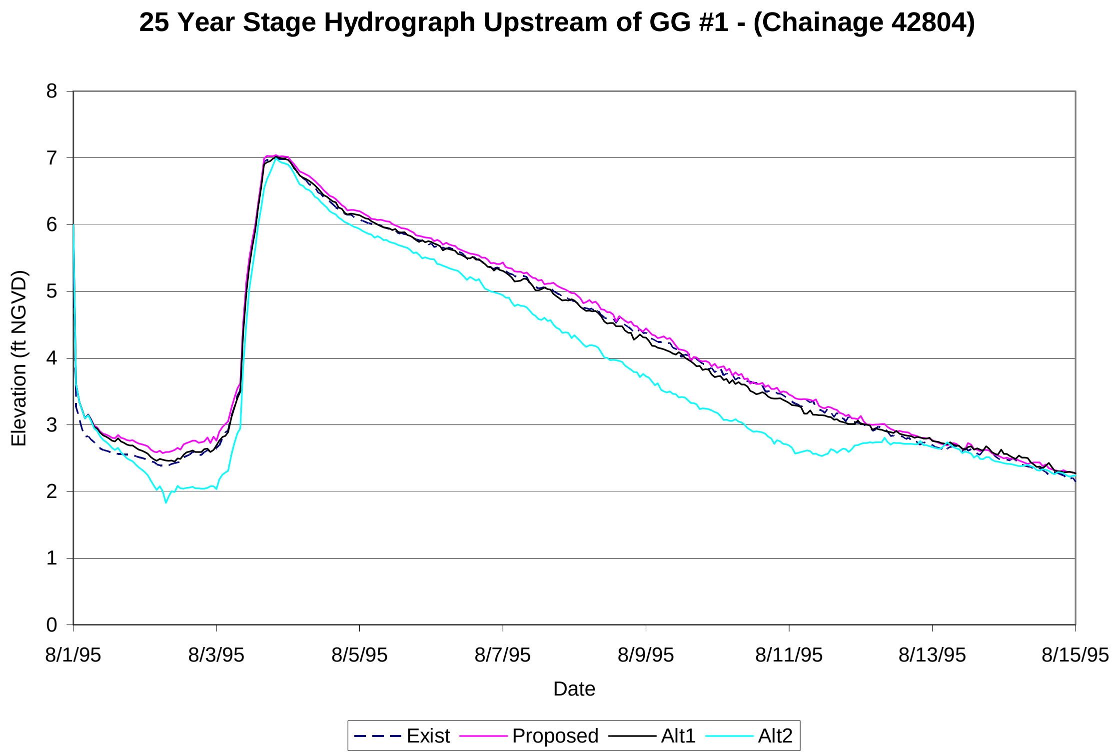


Figure 5-8-A 25 Year Stage Hydrograph Upstream of GG #1 – (Chainage 42804)

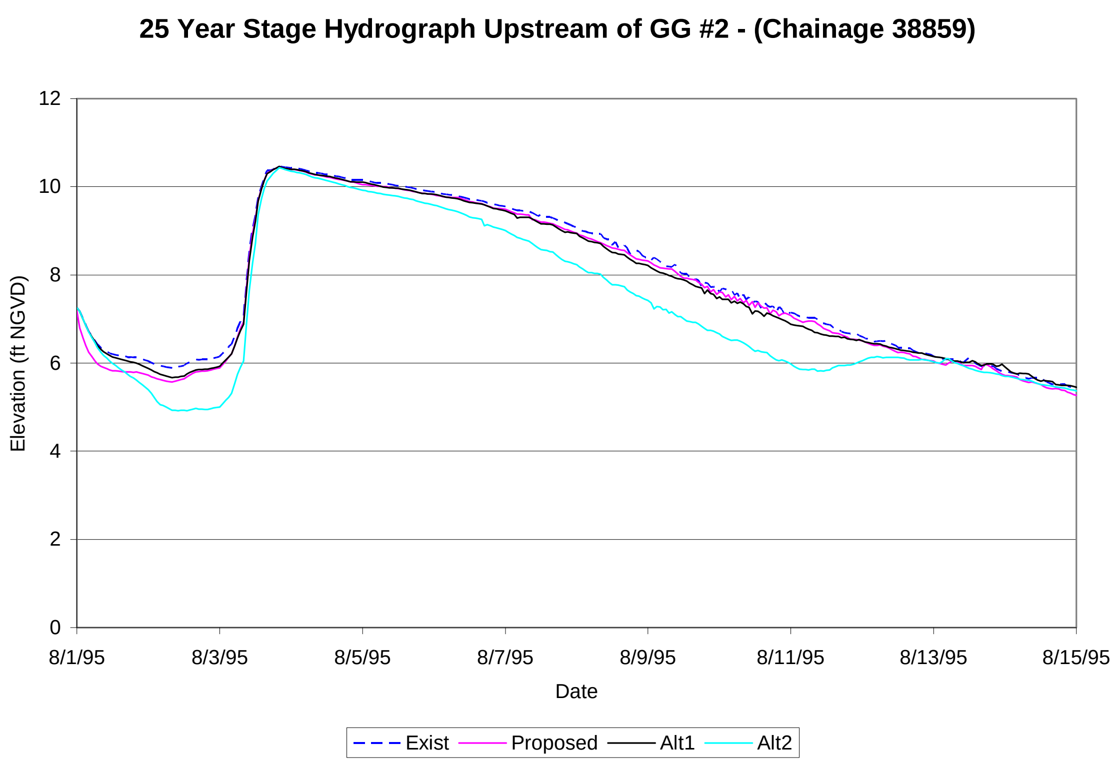


Figure 5-8-B 25 Year Stage Hydrograph Upstream of GG #2 – (Chainage 38859)

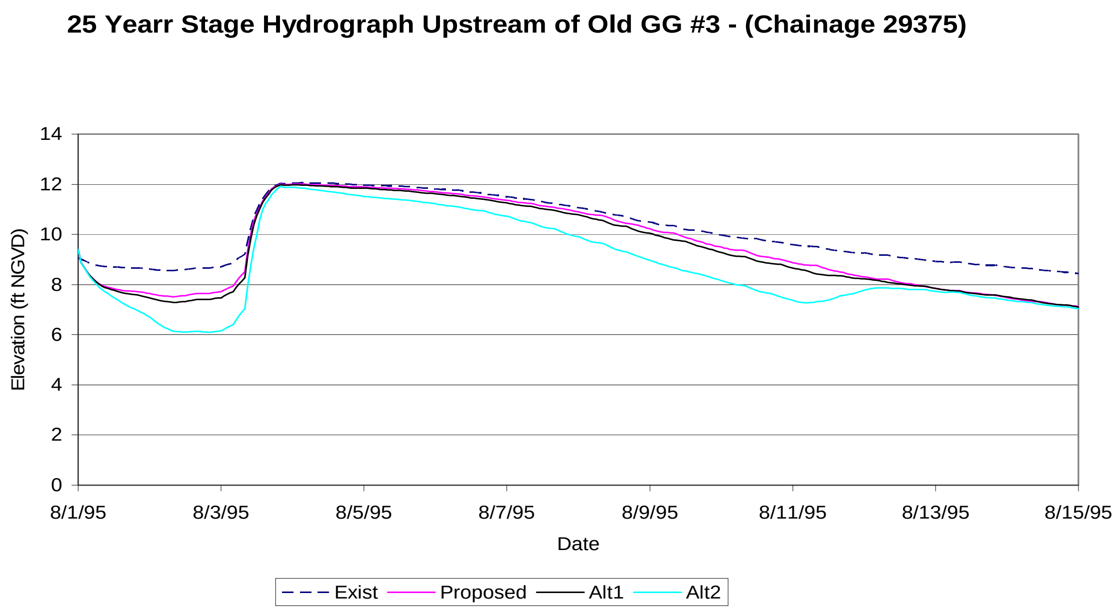


Figure 5-8-C 25 Year Stage Hydrograph Upstream of Old GG #3 – (Chainage 29375)

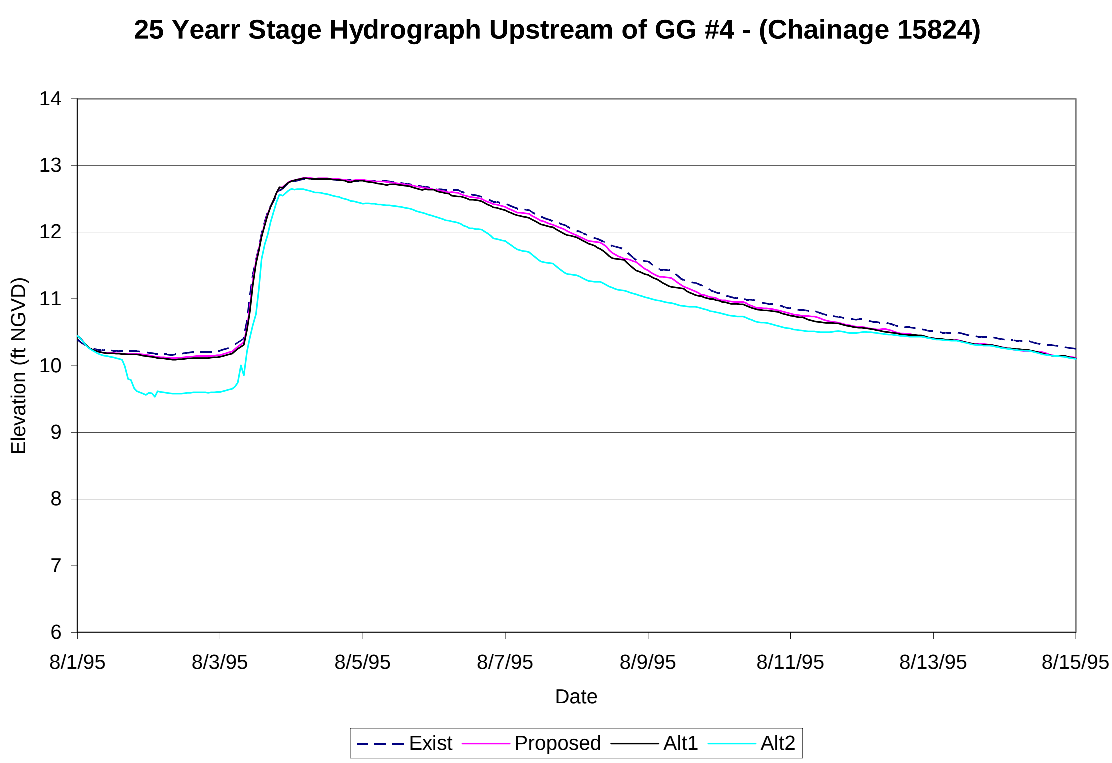


Figure 5-8-D 25 Year Stage Hydrograph Upstream of GG #4 – (Chainage15824)

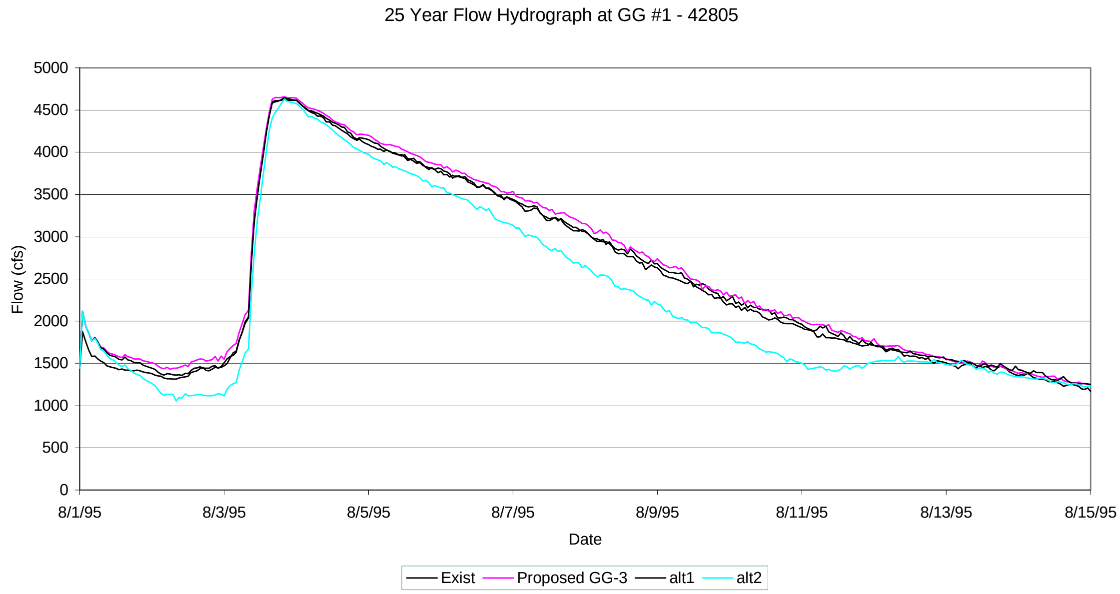


Figure 5-9-A 25 Year Flow Hydrograph at GG #1 – 42805

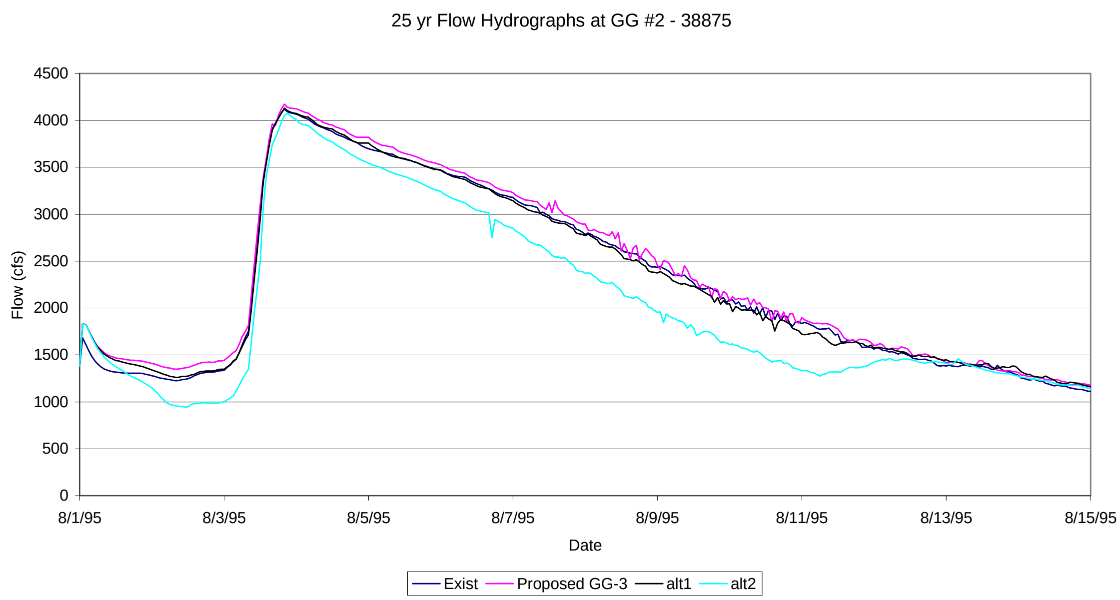


Figure 5-9-B 25 Year Flow Hydrograph at GG #2 – 38875

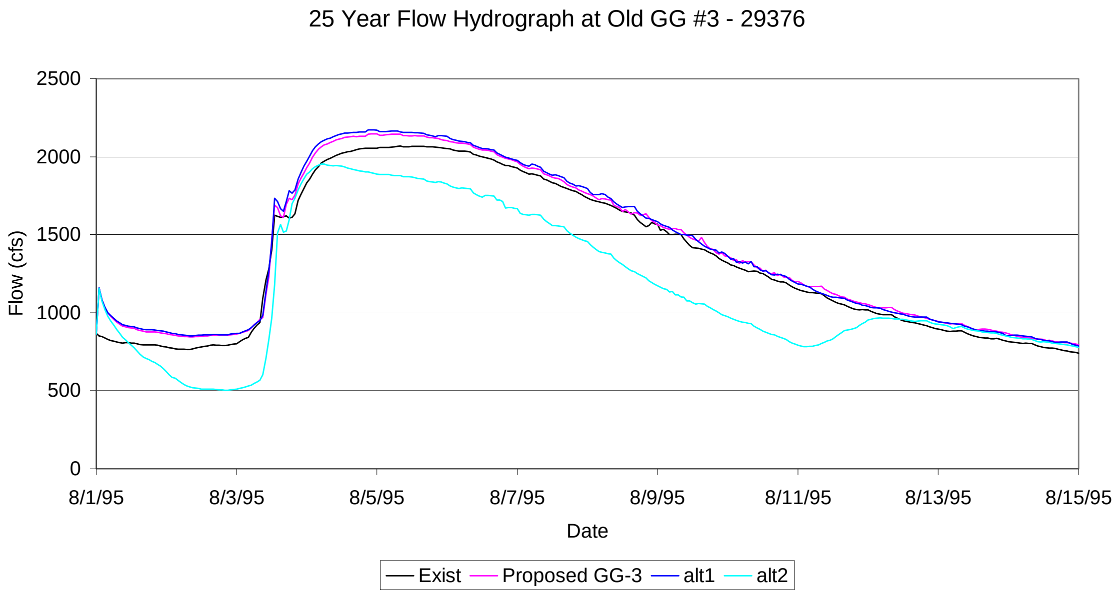


Figure 5-9-C 25 Year Flow Hydrograph at Old GG #3 – 29376

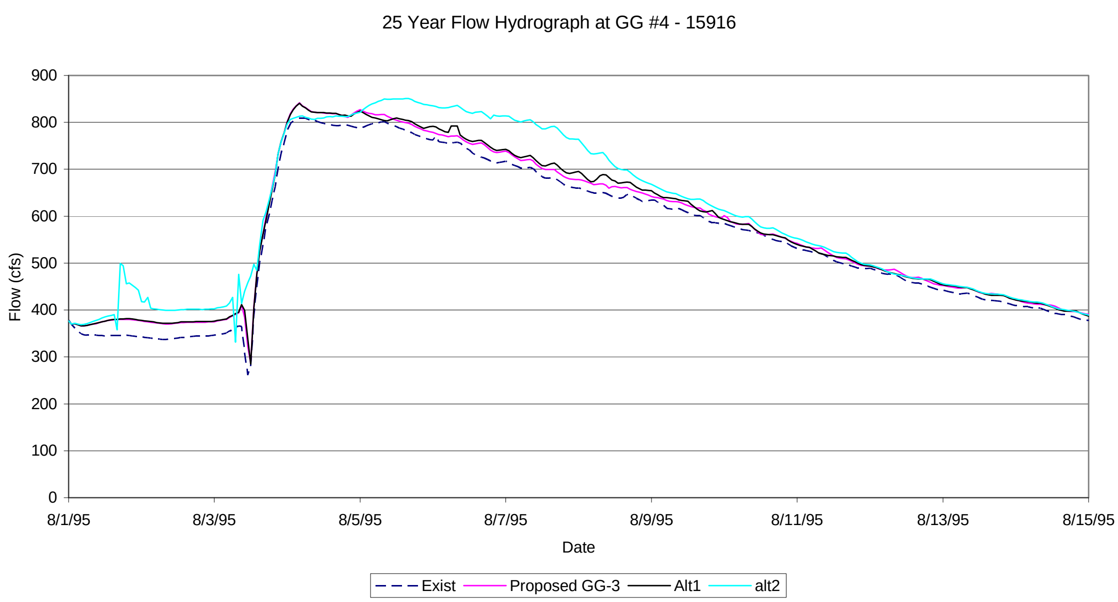


Figure 5-9-D 25 Year Flow Hydrograph at GG #4 - 15916

6.0 SUMMARY AND CONCLUSIONS

This hydrologic-hydraulic assessment recommends an optimized structural configuration for replacement of GG-3 with a three-bay gated automated OBERMEYER spillway with total spillway length of 80 feet. Each gate can be operated with variable top elevations for more versatile hydraulic performance. Operation can be either automatic or manual control. Different operational scenarios of GG-3 were evaluated in terms of their hydraulic performance. The operating control elevations for the wet season, dry season and in the event of extreme conditions are set as follows:

- Wet season: At the beginning of the wet season, set the top of the gates at 7.5 ft NGVD.
  - When the upstream water level higher than 8.0 ft NGVD, start open (or lowering the OBERMEYER spillway) gates.
  - When the upstream water level lower than 7.2 ft NGVD, close gates to 7.5 ft NGVD
- Dry season: At the beginning of the dry season, set the top of the gates at 9.0 ft NGVD.
  - When the upstream water level higher than 9.2 ft NGVD, start open (or lowering the OBERMEYER spillway) gates.
  - When the upstream water level lower than 8.5 ft NGVD, close gates to 9.0 ft NGVD
- Special operation: Under emergency storm events the operation of the structure will follow EOC direction and gates can be operated manually to wide open condition. After the threat of storm has passed, the gates will be reset to the normal automatic operation.

The construction for replacement of the structure has been proposed during the fall of 2008. The major advantages of GG-3 replacement are summarized as:

1. Fixed crest weir replaced with movable automated spillway will greatly enhance the water management flexibility.

2. The proposed structure will not have adverse impacts on the existing levels of flood protection in the Golden Gate Canal watershed.
3. The proposed structure and its operation will reduce the total volume of fresh water discharge to Naples Bay.
4. The proposed structure will increase groundwater storage in the upstream structure area during dry season.

7.0 REFERENCES

1. Dames & Moore, 1998. BCB Watershed Plan, Task D – Model Development. Prepared for SFWMD, BCB Board under Contract no. C-7703, Naples, Florida.

2. SFWMD, 1990. Permit Information Manual Volume IV, West Palm Beach, Florida.

3. Danish Hydraulic Institute, Inc. (DHI), 2002. Big Cypress Basin Integrated Hydrologic-Hydraulic Model

4. BCB, 2000. BCB Watershed Management Plan, Task IIIA Problem Analysis – Flood Control Element. SFWMD, Naples, Florida.

5. BCB, 2002. Five-Year Plan, 2002-2006. BCB of the SFWMD.

6. BCB, 2005. Water Control Structures. BCB of the SFWMD.

7. BCB, 2006. Operation Schedule of Water Control Structures. BCB of the SFWMD.

8. SFWMD, 1999. SFWMD Permit Information Manual, Volume V, Criteria Manual for Use of Works of the District. West Palm Beach, Florida.

9. US Army Corps of Engineers and SFWMD, 2004. Final Integrated Project Implementation Report and Environmental Impact Statement

10. Chandra S. Pathak, 2001. Technical Publication EMA # 390, Frequency Analysis of Daily Rainfall Maxima for Central and South Florida.

11. Ke Feng & Ananta Nath, 2006. Big Cypress Basin Watershed Management Plan, Hydrologic-Hydraulic Assessment for Retrofit of Golden Gate Canal Weir #2.

8.0 APPENDIXES

APPENDIX A - CALIBRATION RESULTS

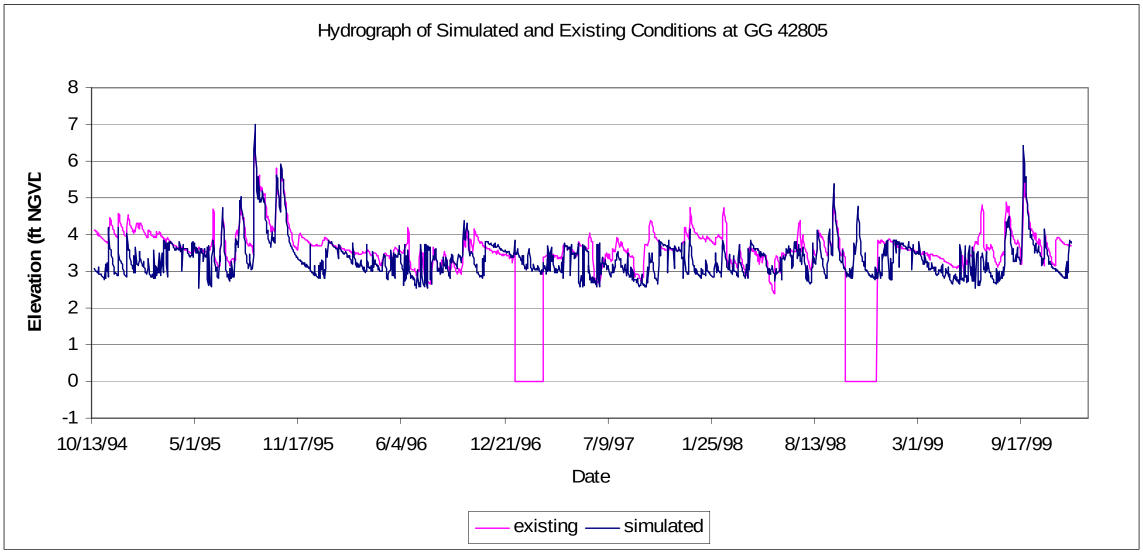


Figure A-1: Simulated and observed headwater at GG #1 from 1995-2000

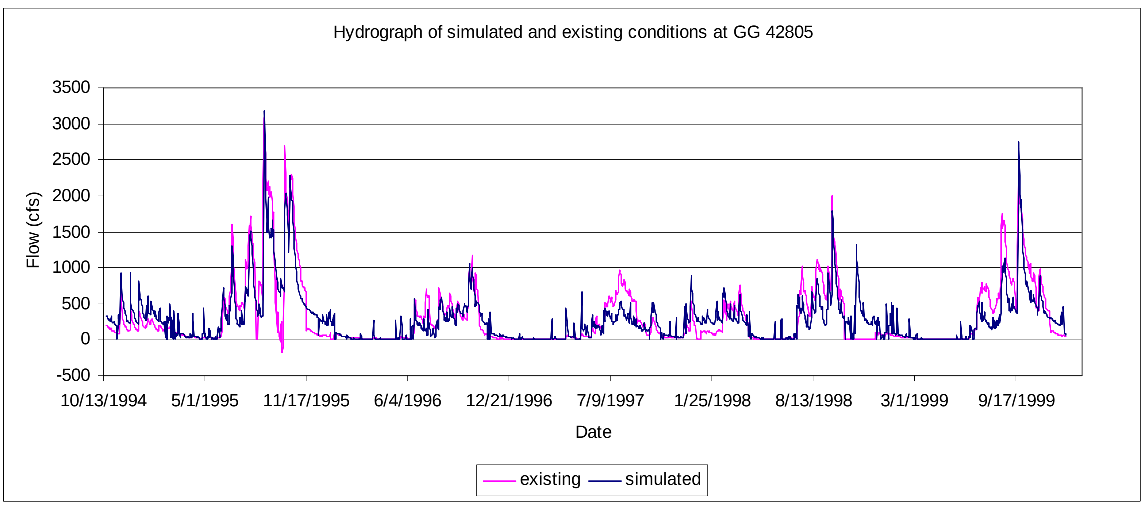
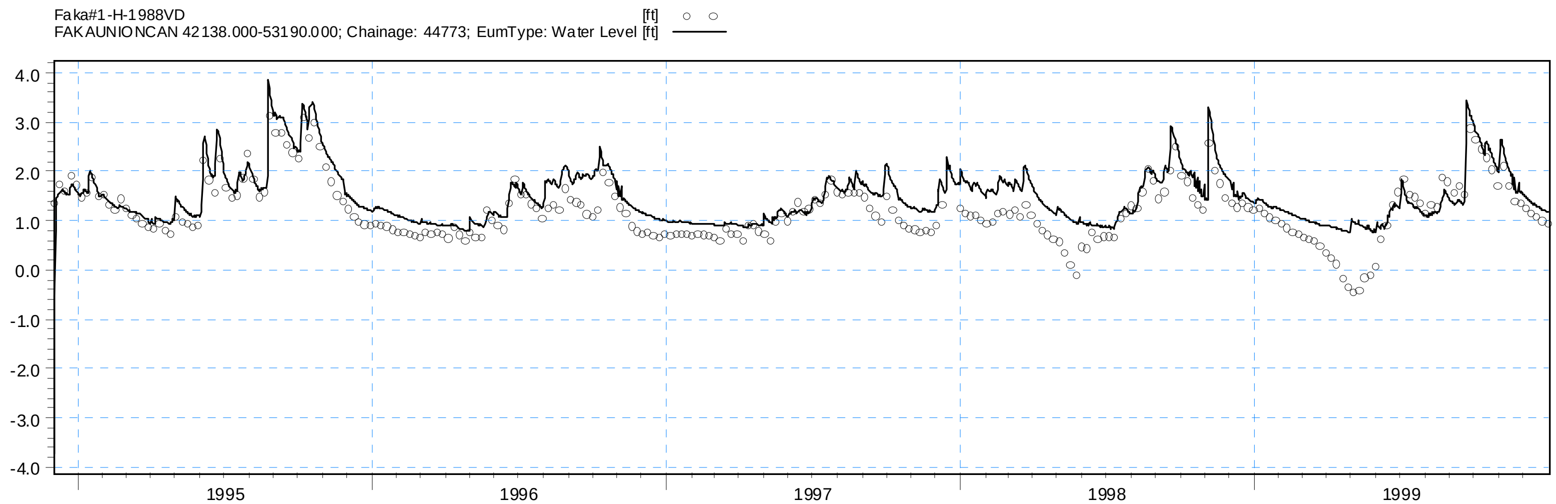
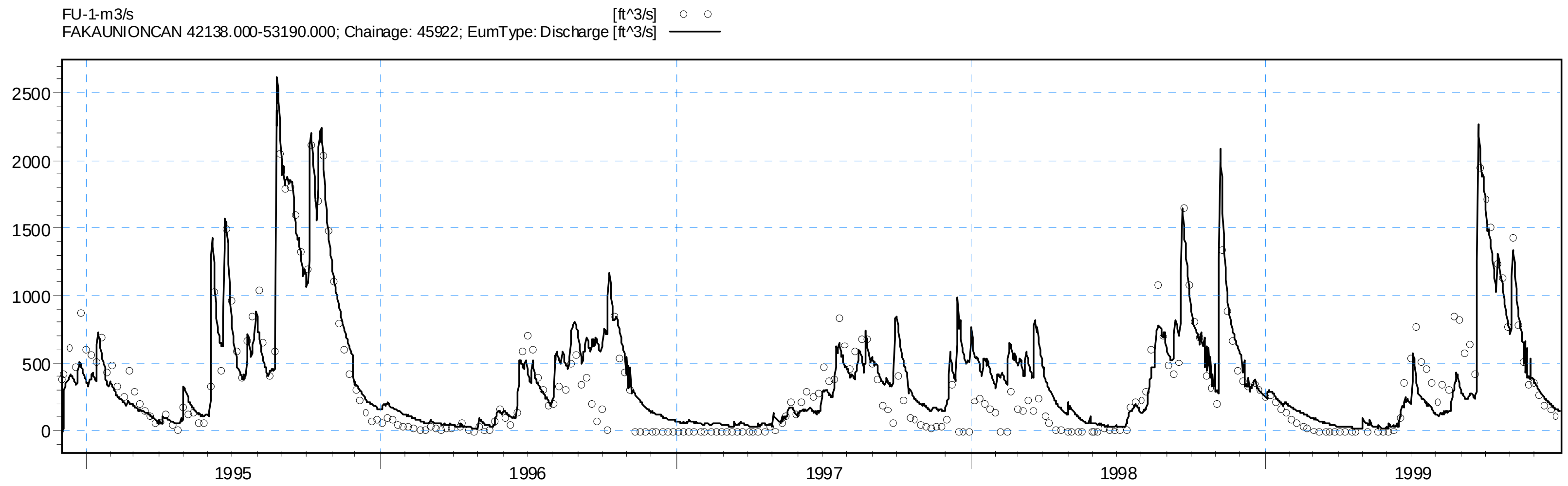


Figure A-2: Simulated and observed headwater at GG #1 from 1995-2000



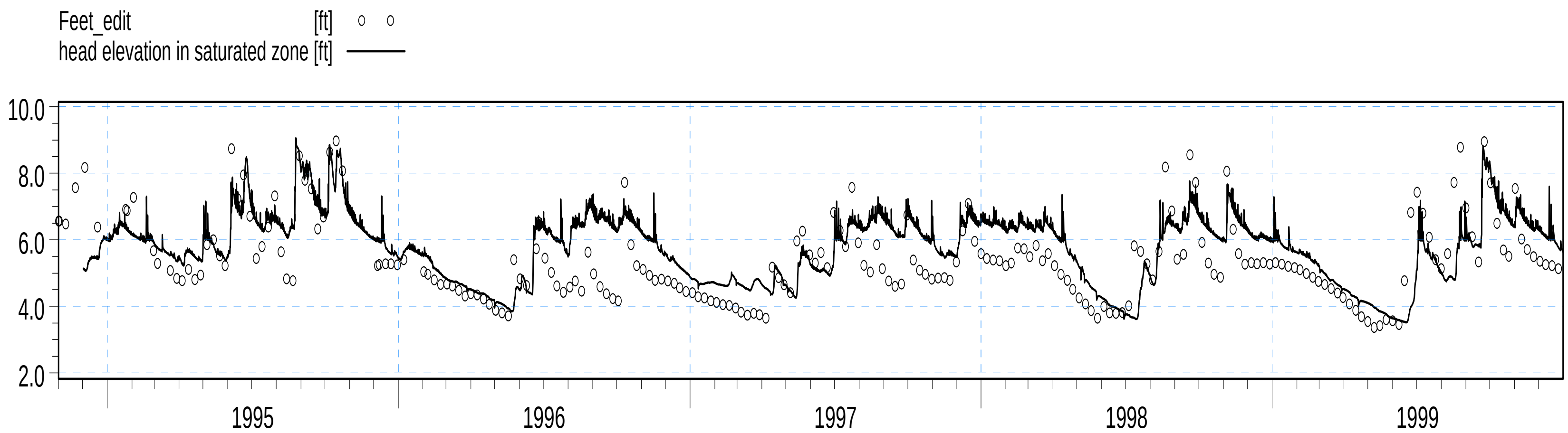
ME=-0.260438
MAE=0.312554
RMSE=0.406389
STDres=0.311968
R(Correlation)=0.860849
R2(Nash_Sutcliffe)=0.553116

Figure A-3: Headwater Stage at FU-1 Weir during Calibration Period



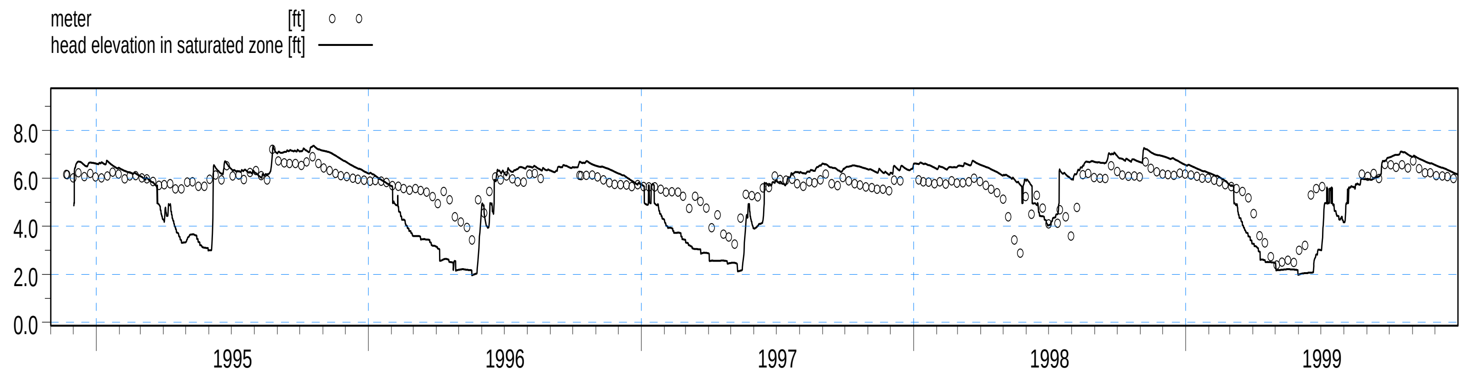
ME=-35.0216
MAE=136.07
RMSE=191.502
STDres=188.273
R(Correlation)=0.908787
R2(Nash_Sutcliffe)=0.817164

Figure A-4: Discharge at FU-1 Weir during Calibration Period



ME=-0.428054
MAE=0.76222
RMSE=0.961212
STDres=0.860638
R(Correlation)=0.6986
R2(Nash_Sutcliffe)=0.305965

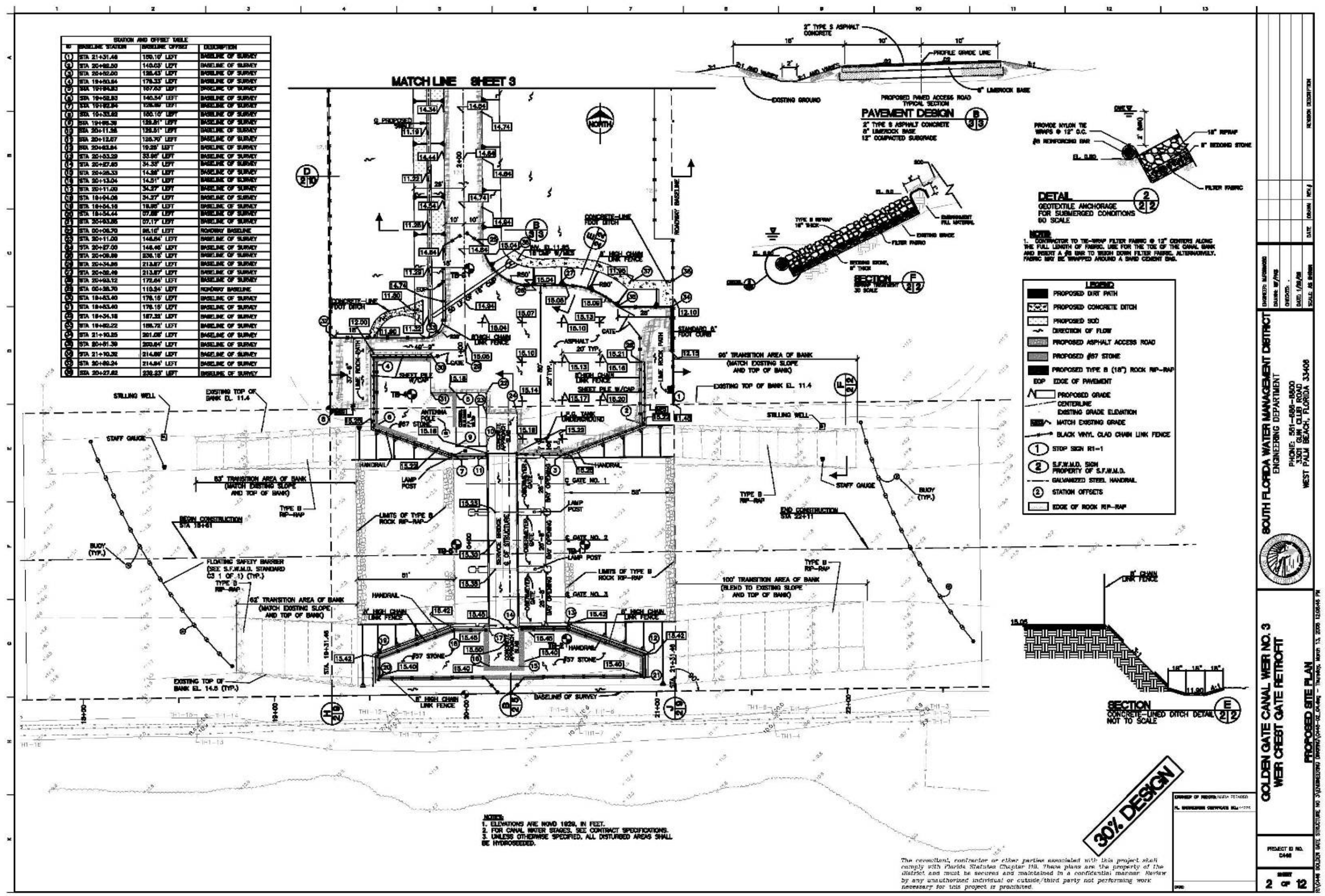
Figure A-5: Simulated and Observed Groundwater Level at Well C-690



ME=0.0847068
MAE=0.790851
RMSE=1.05606
STDres=1.05266
R(Correlation)=0.741699
R2(Nash_Sutcliffe)=-0.440119

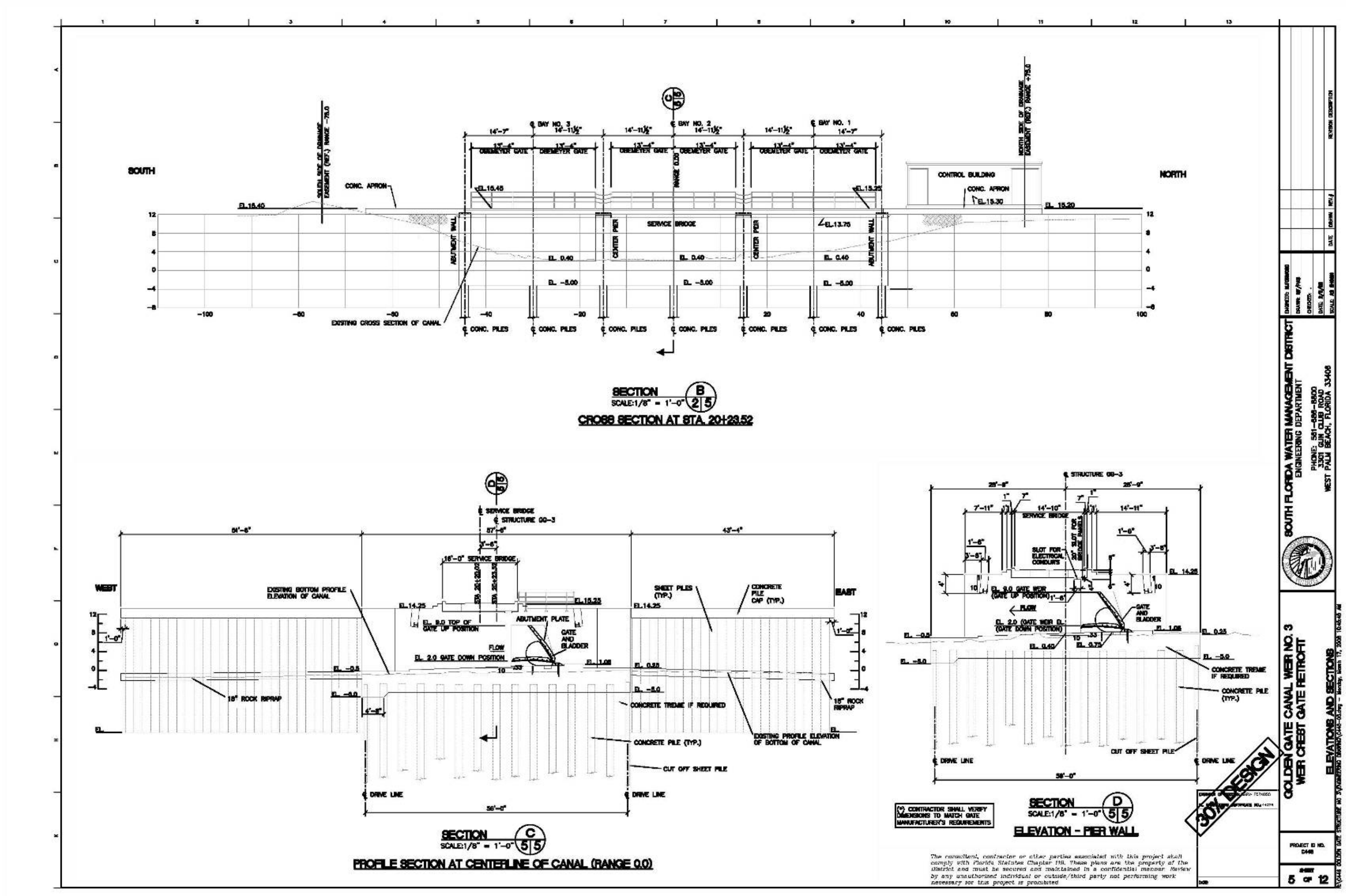
Figure A-6: Simulated and Observed Groundwater Level at Well C-496 (Fakahatchee Strand south of I-75)

APPENDIX B – SKECHES OR GOLDEN GATE STRUCTURE GG#3

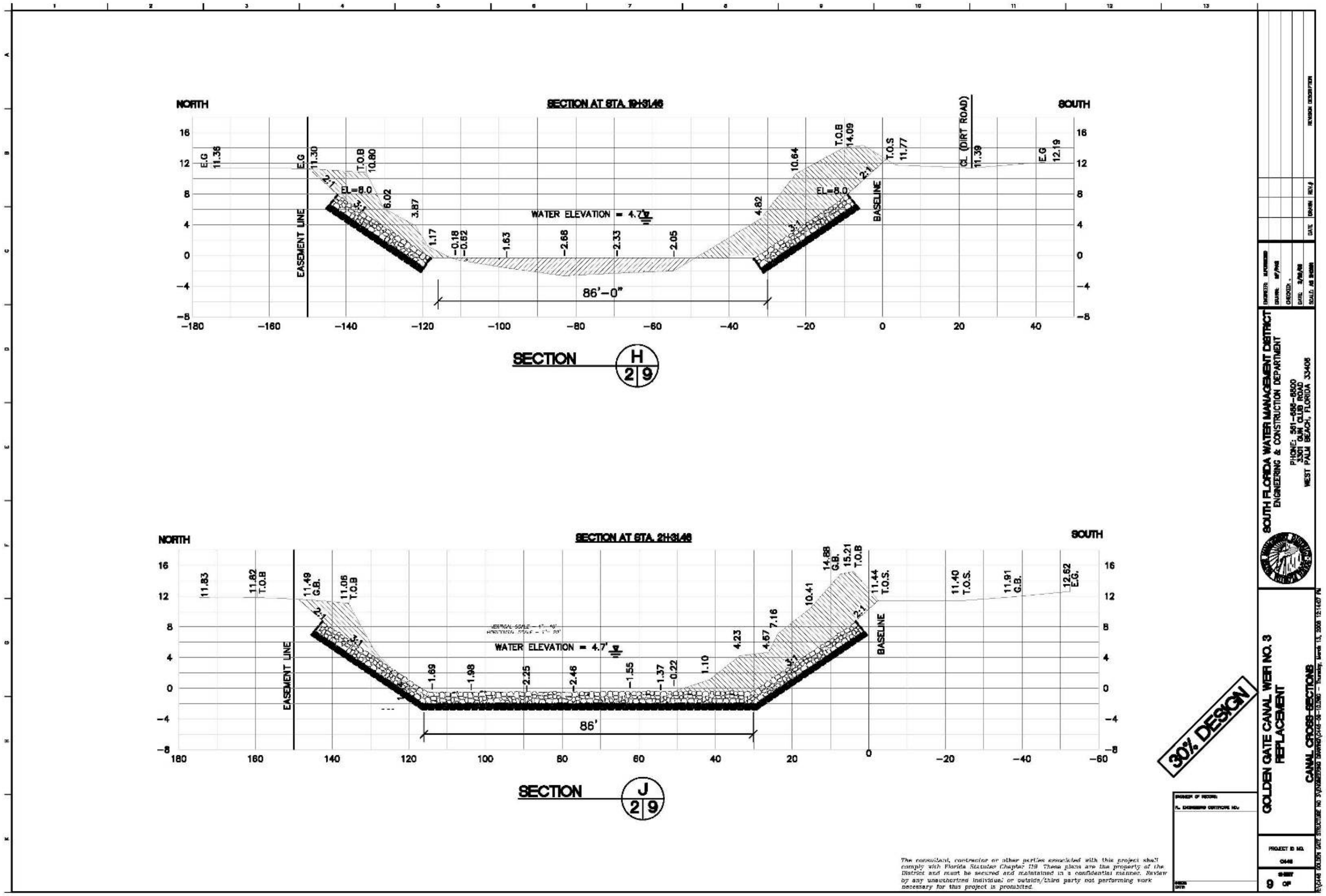


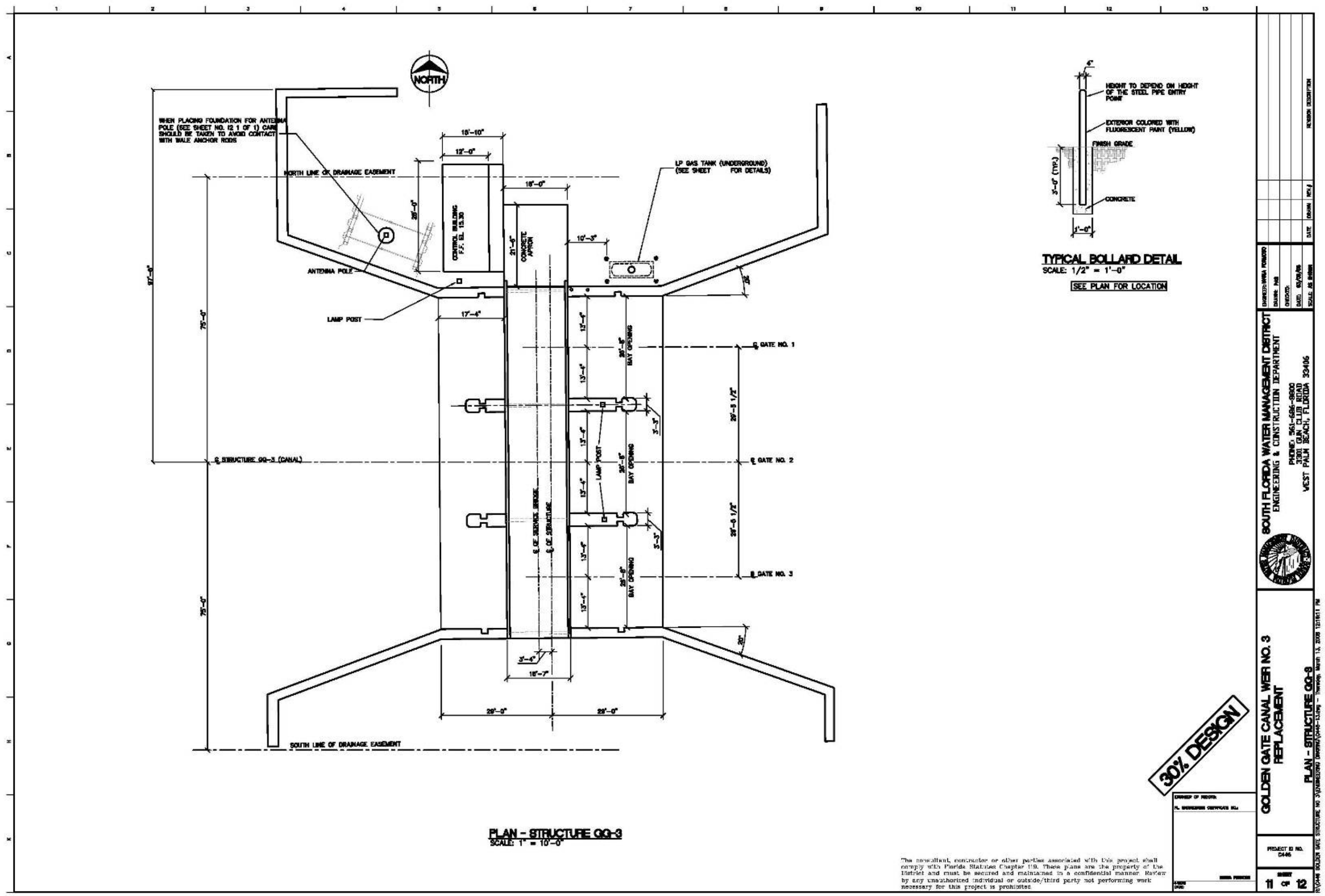
STATION AND OFFSET TABLE

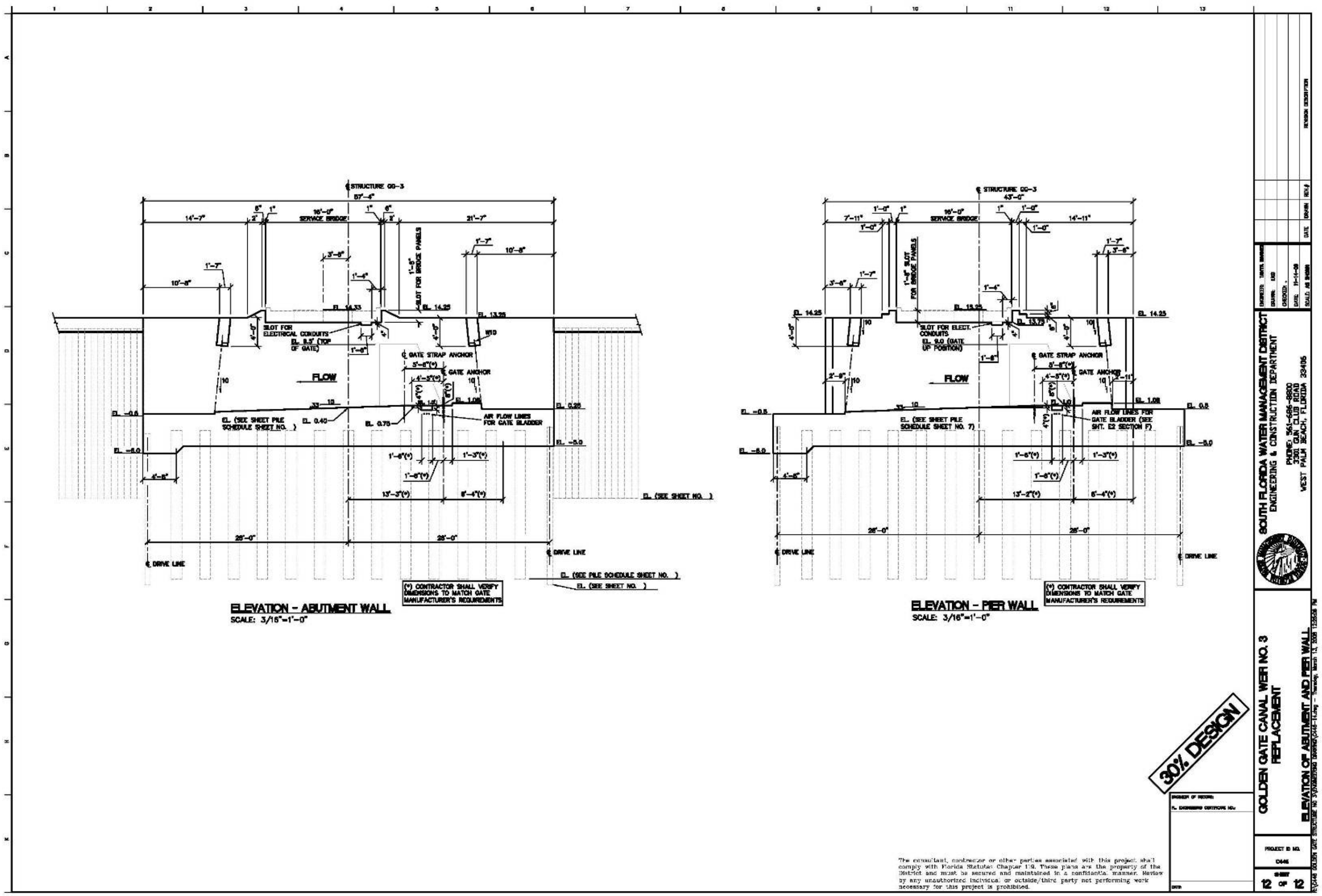
ID	BASELINE STATION	BASELINE OFFSET	DESCRIPTION
1	STA 21+31.46	150.10' LEFT	BASELINE OF SURVEY
2	STA 20+92.50	140.03' LEFT	BASELINE OF SURVEY
3	STA 20+52.00	135.43' LEFT	BASELINE OF SURVEY
4	STA 19+50.64	178.33' LEFT	BASELINE OF SURVEY
5	[illegible]	167.63' LEFT	BASELINE OF SURVEY
6	STA 19+52.93	140.54' LEFT	BASELINE OF SURVEY
7	STA 19+92.94	125.80' LEFT	BASELINE OF SURVEY
8	STA 19+33.92	150.10' LEFT	BASELINE OF SURVEY
9	STA 19+95.39	129.51' LEFT	BASELINE OF SURVEY
10	STA 20+11.38	129.51' LEFT	BASELINE OF SURVEY
11	STA 20+12.07	125.70' LEFT	BASELINE OF SURVEY
12	STA 20+63.84	19.25' LEFT	BASELINE OF SURVEY
13	STA 20+53.29	35.96' LEFT	BASELINE OF SURVEY
14	STA 20+27.65	34.35' LEFT	BASELINE OF SURVEY
15	STA 20+25.33	14.38' LEFT	BASELINE OF SURVEY
16	STA 20+13.04	14.51' LEFT	BASELINE OF SURVEY
17	STA 20+11.00	34.37' LEFT	BASELINE OF SURVEY
18	STA 19+94.06	34.27' LEFT	BASELINE OF SURVEY
19	STA 19+54.16	19.95' LEFT	BASELINE OF SURVEY
20	STA 19+54.44	07.89' LEFT	BASELINE OF SURVEY
21	STA 20+93.86	07.17' LEFT	BASELINE OF SURVEY
22	STA 00+06.70	96.10' LEFT	ROADWAY BASELINE
23	STA 20+11.00	146.64' LEFT	BASELINE OF SURVEY
24	STA 20+27.00	146.46' LEFT	BASELINE OF SURVEY
25	STA 20+08.89	236.16' LEFT	BASELINE OF SURVEY
26	STA 20+34.86	213.87' LEFT	BASELINE OF SURVEY
27	STA 20+52.49	213.87' LEFT	BASELINE OF SURVEY
28	STA 20+93.12	172.64' LEFT	BASELINE OF SURVEY
29	STA 00+35.70	110.24' LEFT	ROADWAY BASELINE
30	STA 19+83.40	176.15' LEFT	BASELINE OF SURVEY
31	STA 19+83.40	176.15' LEFT	BASELINE OF SURVEY
32	STA 19+34.16	187.32' LEFT	BASELINE OF SURVEY
33	STA 19+92.22	186.72' LEFT	BASELINE OF SURVEY
34	STA 21+10.35	201.06' LEFT	BASELINE OF SURVEY
35	STA 20+81.39	200.64' LEFT	BASELINE OF SURVEY
36	STA 21+10.32	214.69' LEFT	BASELINE OF SURVEY
37	STA 20+89.24	214.84' LEFT	BASELINE OF SURVEY
38	STA 20+27.82	232.23' LEFT	BASELINE OF SURVEY



SOUTH
NORTH
BAY NO. 3
BAY NO. 2
BAY NO. 1
OBERMEYER GATE
CONTROL BUILDING
CONC. APRON
SERVICE BRIDGE
ABUTMENT WALL
CENTER PIER
EXISTING CROSS SECTION OF CANAL
CONC. PILES
SECTION B 2 5
SCALE:1/8" = 1'-0"
CROSS SECTION AT STA. 20+23.52
WEST
EAST
SERVICE BRIDGE
STRUCTURE GG-3
EXISTING BOTTOM PROFILE ELEVATION OF CANAL
SHEET PILES (TYP.)
CONCRETE PILE CAP (TYP.)
ABUTMENT PLATE
GATE AND BLADDER
FLOW
18" ROCK RIPRAP
CONCRETE TREMIE IF REQUIRED
EXISTING PROFILE ELEVATION OF BOTTOM OF CANAL
CONCRETE PILE (TYP.)
CUT OFF SHEET PILE
DRIVE LINE
SECTION C 5 5
SCALE:1/8" = 1'-0"
PROFILE SECTION AT CENTERLINE OF CANAL (RANGE 0.0)
STRUCTURE GG-3
SLOT FOR ELECTRICAL CONDUITS
CONCRETE TREMIE IF REQUIRED
CONCRETE PILE (TYP.)
CUT OFF SHEET PILE
DRIVE LINE
(*) CONTRACTOR SHALL VERIFY DIMENSIONS TO MATCH GATE MANUFACTURER'S REQUIREMENTS
SECTION D 5 5
SCALE:1/8" = 1'-0"
ELEVATION - PIER WALL
30% DESIGN
SOUTH FLORIDA WATER MANAGEMENT DISTRICT
ENGINEERING DEPARTMENT
3301 GUN CLUB ROAD
WEST PALM BEACH, FLORIDA 33406
GOLDEN GATE CANAL WEIR NO. 3
WEIR CREST GATE RETROFIT
ELEVATIONS AND SECTIONS
5 OF 12


SECTION AT STA. 19+31.46
NORTH
SOUTH
WATER ELEVATION = 4.7'
86'-0"
EASEMENT LINE
BASELINE
SECTION H 2|9
SECTION AT STA. 21+31.46
WATER ELEVATION = 4.7'
86'
SECTION J 2|9
30% DESIGN
SOUTH FLORIDA WATER MANAGEMENT DISTRICT
ENGINEERING & CONSTRUCTION DEPARTMENT
PHONE: 561-686-8800
3301 GUN CLUB ROAD
WEST PALM BEACH, FLORIDA 33406
GOLDEN GATE CANAL WEIR NO. 3
REPLACEMENT
CANAL CROSS-SECTIONS


NORTH
WHEN PLACING FOUNDATION FOR ANTENNA POLE (SEE SHEET NO. 12 1 OF 1) CARE SHOULD BE TAKEN TO AVOID CONTACT WITH WALE ANCHOR RODS
NORTH LINE OF DRAINAGE EASEMENT
CONTROL BUILDING
CONCRETE APRON
ANTENNA POLE
LAMP POST
LP GAS TANK (UNDERGROUND) (SEE SHEET FOR DETAILS)
℄ GATE NO. 1
℄ GATE NO. 2
℄ GATE NO. 3
℄ STRUCTURE GG-3 (CANAL)
BAY OPENING
LAMP POST
℄ OF SERVICE BRIDGE
℄ OF STRUCTURE
SOUTH LINE OF DRAINAGE EASEMENT
18'-10"
12'-0"
18'-0"
10'-3"
17'-4"
3'-4"
16'-7"
29'-0"
29'-0"
75'-0"
75'-0"
29'-5 1/2"
29'-5 1/2"
TYPICAL BOLLARD DETAIL
SCALE: 1/2" = 1'-0"
SEE PLAN FOR LOCATION
HEIGHT TO DEPEND ON HEIGHT OF THE STEEL PIPE ENTRY POINT
EXTERIOR COLORED WITH FLUORESCENT PAINT (YELLOW)
FINISH GRADE
CONCRETE
1'-0"
30% DESIGN
PLAN - STRUCTURE GG-3
SCALE: 1" = 10'-0"
The consultant, contractor or other parties associated with this project shall comply with Florida Statutes Chapter 119. These plans are the property of the District and must be secured and maintained in a confidential manner. Review by any unauthorized individual or outside/third party not performing work necessary for this project is prohibited.
SOUTH FLORIDA WATER MANAGEMENT DISTRICT
ENGINEERING & CONSTRUCTION DEPARTMENT
PHONE: 561-686-8800
3301 GUN CLUB ROAD
WEST PALM BEACH, FLORIDA 33406
GOLDEN GATE CANAL WEIR NO. 3
REPLACEMENT
PLAN - STRUCTURE GG-3
PROJECT ID NO.
C446
SHEET
11 OF 12
DATE
DRAWN
REV.#

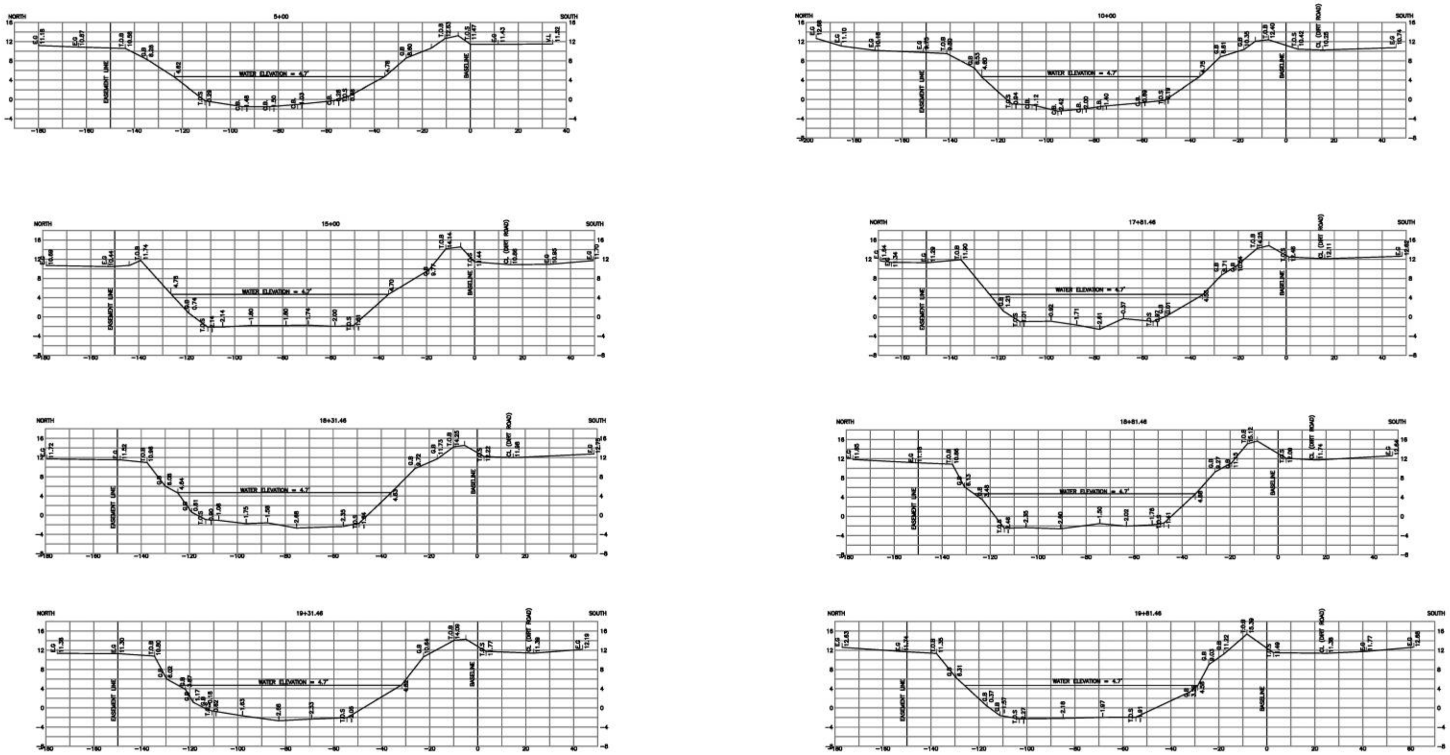


ELEVATION - ABUTMENT WALL
SCALE: 3/16"=1'-0"
ELEVATION - PIER WALL
SCALE: 3/16"=1'-0"
(*) CONTRACTOR SHALL VERIFY DIMENSIONS TO MATCH GATE MANUFACTURER'S REQUIREMENTS
FLOW
30% DESIGN
The consultant, contractor or other parties associated with this project shall comply with Florida Statutes Chapter 119. These plans are the property of the District and must be secured and maintained in a confidential manner. Review by any unauthorized individual or outside/third party not performing work necessary for this project is prohibited.
SOUTH FLORIDA WATER MANAGEMENT DISTRICT
ENGINEERING & CONSTRUCTION DEPARTMENT
PHONE: 561-686-8800
3301 GUN CLUB ROAD
WEST PALM BEACH, FLORIDA 33406
GOLDEN GATE CANAL WEIR NO. 3
REPLACEMENT
ELEVATION OF ABUTMENT AND PIER WALL
12 OF 12

APPENDIX C – CANAL CROSS SECTIONS

LOOKING EAST

LOOKING EAST



VERTICAL SCALE – 1"= 10'
HORIZONTAL SCALE – 1"= 20'

PREPARED BY:
WILSONMILLER, INC.
REG. ENGINEERS AND LAND SURVEYORS
3200 BAILEY LANE, SUITE 200, (239) 649–4040
NAPLES, FLORIDA 34105

SEE SHEET 1 FOR CERTIFICATION, NOTES AND LOCATION SKETCH

LEGEND

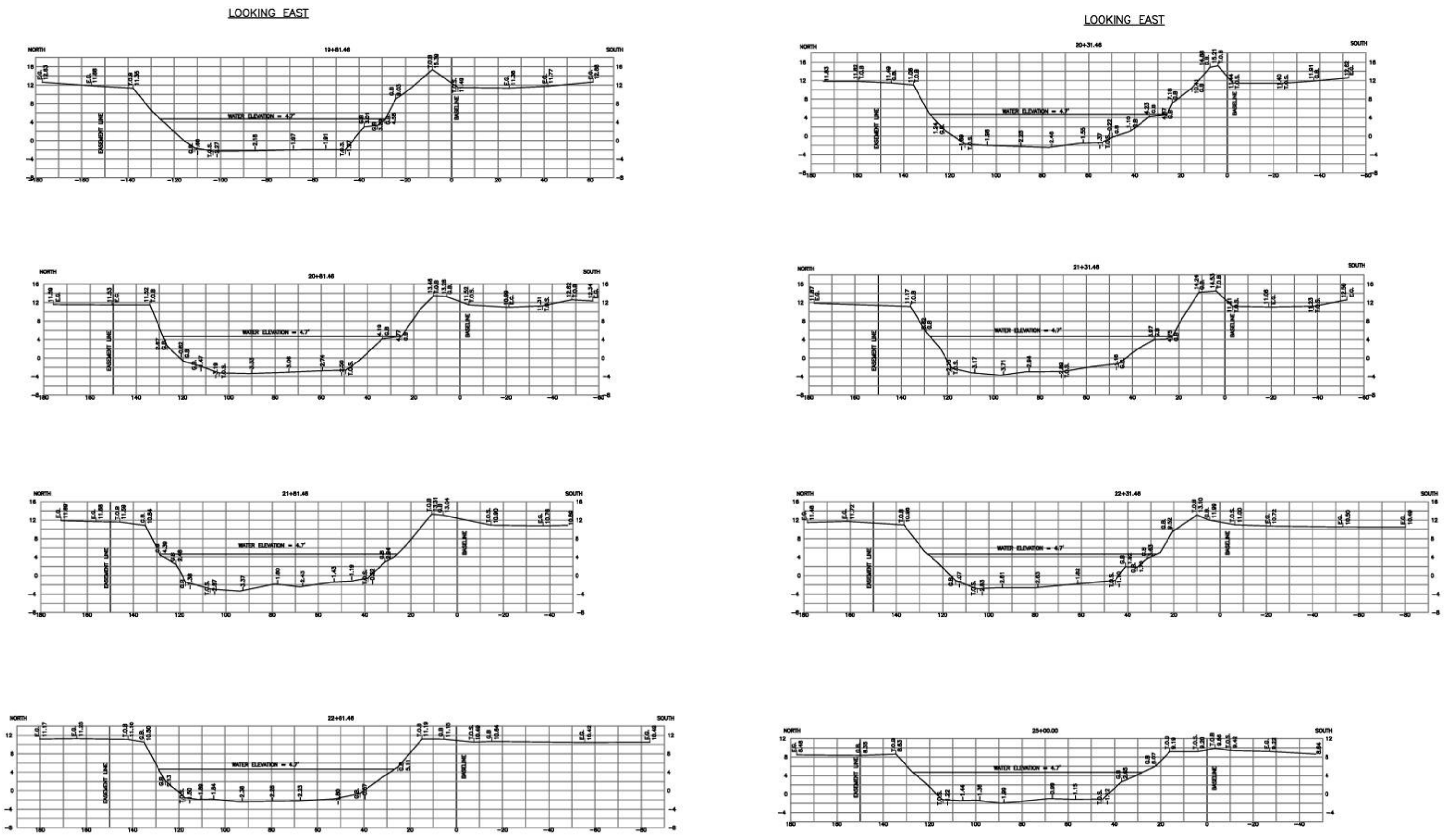
T.O.B = TOP OF BANK
T.O.S = TOE OF SLOPE
G.B = GRADE BREAK
C.B. = CANAL BOTTOM
V.L = VEGETATION LINE
E.G = EXISTING GROUND
E.O.W = EDGE OF WATER
CL = CENTER LINE

WilsonMiller

SOUTH FLORIDA WATER MANAGEMENT DISTRICT
ENGINEERING DEPARTMENT – SURVEY SECTION
P.O. BOX 24680
3301 GUN CLUB ROAD
WEST PALM BEACH, FLORIDA 33416–4680

Golden Gate #3 Replacement Weir
PLAN VIEW SHEET
COLLIER COUNTY, FLORIDA
SECTION – 26 AND 35
TOWNSHIP 49 SOUTH
RANGE 25 EAST

CADD FILE NO.
400-348.DWG
DRAWING NO.
400-348
8 SHEET OF 10



VERTICAL SCALE – 1"= 10'
HORIZONTAL SCALE – 1"= 20'

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WILSONMILLER, INC.
REG. ENGINEERS AND LAND SURVEYORS
3200 BAILEY LANE, SUITE 200, (239) 649-4040
NAPLES, FLORIDA 34105

SEE SHEET 1 FOR CERTIFICATION, NOTES AND LOCATION SKETCH

LEGEND

T.O.B = TOP OF BANK
T.O.S = TOE OF SLOPE
G.B = GRADE BREAK
C.B. = CANAL BOTTOM
V.L = VEGETATION LINE
E.G = EXISTING GROUND
E.O.W = EDGE OF WATER
CL = CENTER LINE

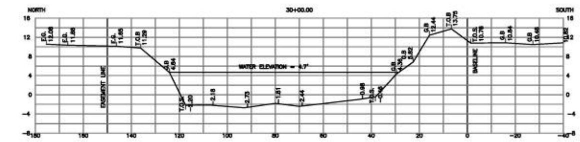
WilsonMiller

SOUTH FLORIDA WATER MANAGEMENT DISTRICT
ENGINEERING DEPARTMENT – SURVEY SECTION
P.O. BOX 24680
3301 GUN CLUB ROAD
WEST PALM BEACH, FLORIDA 33416-4680

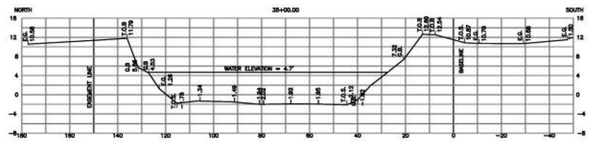
Golden Gate #3 Replacement Weir
PLAN VIEW SHEET
COLLIER COUNTY, FLORIDA
SECTION – 26 AND 35

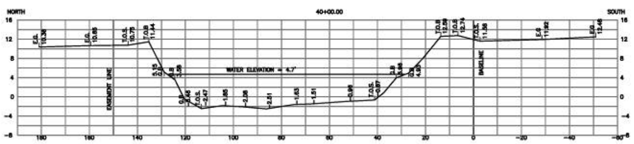
CADD FILE NO.
DRAWING NO.
9 SHEET OF 10

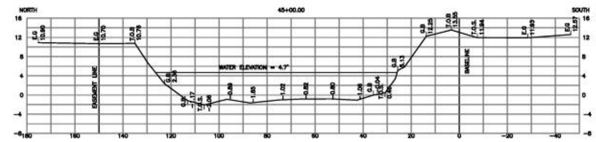
LOOKING EAST

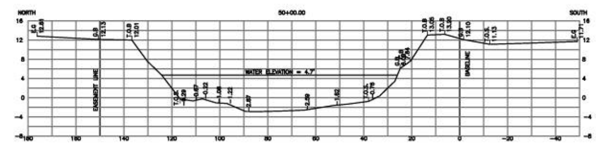


LOOKING EAST









VERTICAL SCALE – 1"= 10'
HORIZONTAL SCALE – 1"= 20'

PREPARED BY:
WILSONMILLER, INC.
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CADD FILE NO.
DRAWING NO.
10 SHEET OF 10