

# Gateway Canal/Treeline Avenue Culvert System

(Water Management Easement OR 2558 Page 2002)

## Analysis Report

Prepared for:

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Dated: April 2014

# **GATEWAY CANAL CULVERT SYSTEM**

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## **Introduction**

RWA, Inc. was contracted by WCI Communities, LLC to analyze the Gateway Canal Culvert System (Strap No. 35-44-25-P3-037GC.0010) that conveys water underneath Treeline Avenue in Fort Myers, Florida. It is our understanding that some Pelican Preserve residents are concerned that the culverts have not been sized properly and may cause flooding upstream within Pelican Preserve.

The Gateway Canal is a stormwater management conveyance system that bisects the southern portion of Pelican Preserve. The canal was permitted with the South Florida Water Management System (SFWMD) in 1985 and designed to convey stormwater run-off for build-out of all of the Pelican Preserve land south of Veneto Drive and also the majority of the Gateway Community to the east. Subsequent SFWMD permit modifications over the years that have been done for any reconfiguration of lakes or streets within Pelican Preserve and Gateway have not increased the previously designed stormwater discharge into the Gateway Canal and have been within the originally permitted limits. The Gateway Canal ultimately discharges into the Six Mile Slough on the west side of Interstate 75. The culvert that conveys water under Treeline Avenue is located on the west boundary of Pelican Preserve. Please see **Exhibit 1** for the culvert location. The conveyance system currently in place is a dual culvert system. There are two 11'x6' box culverts 165' long underneath Treeline Avenue. Please see **Exhibit 2** for a culvert diagram and a picture of the west headwall.

The Pelican Preserve Stormwater Management system is comprised of several interconnected lakes wetlands. Stormwater runoff within the community is collected by an internal storm sewer system that discharges into the on-site water management lakes. A series of control structures limit discharge from the lakes into the Gateway Canal. The road and finished floor elevations for the community are designed to be constructed above the anticipated peak stages of the calculations and storm routings permitted with the SFWMD. The road and finished floor elevations of the constructed portion of Pelican Preserve were set based on the build-out condition of the entire Pelican Preserve and Gateway Communities and the resulting stage of the Gateway Canal.

## **Approach**

One of the most important research items for this project was canal stage data. In order to model the culverts properly, the original design stage data was needed. There were several resources that were used to obtain this data.

The first step in the research process was searching for the original Treeline Avenue Environmental Resource Permit (ERP) on the South Florida Water Management District (SFWMD) ePermitting website. The search uncovered the original Treeline Avenue extension

permit (application: 030625-5, permit: 36-02899-S), which included roadway plans. A letter modification (application: 041018-5, permit: 36-02899-S) included more recent plans. Treeline Avenue was widened and utilities added in several phases over the course of a few years. Phase 1 construction included the building of the culvert system. According to the approved construction plans (dated November 12, 2004, completed by Community Engineering Services, Inc.), the culvert system is “11’x6’ double barrel concrete box culvert.” The profile shows a culvert invert elevation of 12.00 ft NGVD 29. Please see **Exhibit 3** for backup permit information. Unfortunately, no backup calculations were found online to support the sizing or placement of the culvert system.

Since no culvert calculations could be found in any Treeline Avenue ERP application documents, Gateway Canal data was obtained through the Pelican Preserve ERP modification (application: 930426-8, permit: 36-00678-S). Control elevation of the Gateway Canal was found to be 19.20 ft NGVD 29. The 25 Year- 3 Day storm event produced a peak stage of 21.2 ft NGVD 29 in the Gateway Canal. A more current ERP permit (application: 120716-1, permit: 36-000678-S-18) confirms these numbers. Calculations from that ERP modification showed the max flow through the culvert is 246.97 cfs. Selected pages from both of the above mentioned ERP permits can be found in **Exhibit 3**.

The next step in the process was surveying the culverts to verify if the culverts were constructed as permitted with SFWMD and Lee County. An RWA, Inc. survey crew surveyed the culvert system on February 28, 2014, and obtained headwall and invert elevations and measured the box culverts. The culvert diagram in **Exhibit 2** was created based on the information obtained from their survey.

The final step in the analysis process was to enter all the culvert information and flow data into CulvertMaster by Bentley Systems, Inc. CulvertMaster is a culvert modeling program that allows users to enter geometry data and will calculate several different culvert parameters. In this way, CulvertMaster was utilized to determine the headwater elevation and headloss (change in water elevation from the entrance to exit of the culverts) through the culverts.

## **Results**

CulvertMaster requires the input of several different parameters, which were mostly obtained through the survey that was performed on the culverts. The parameters entered were:

1. Discharge: 247.00 cfs
2. Maximum Allowable Headwater: 21.44 ft
3. Tailwater Elevation: 21.20 ft
4. Shape: Box
5. Material: Concrete

6. Size: 11 x 6 ft
7. Number: 2
8. Mannings: 0.013
9. Entrance: 90° headwall with 45° bevels
10.  $K_e$ : 0.20
11. Invert Upstream: 11.99 ft
12. Invert Downstream: 11.69 ft
13. Length: 165.00 ft

The value used for the tailwater elevation is the 25 year - 3 day storm elevation for the normal (rainy) season. However, during the dry season, the canal stage can drop to elevations that are two or three feet below the control elevation. For example, the picture in **Exhibit 2** shows the west headwall of the culvert system. The picture was taken on February 28, 2014 by our survey crew, and shows the water level at approximately 1.5 feet below control elevation. Control elevation, which is evidenced by the staining on the headwall, is only maintained during the few rainy months out of the year. Since the majority of the staining is at control elevation it can be concluded that that maximum water level of the canal does not get much higher than the staining or control elevation. This calculation makes following assumptions for the worst case scenario:

1. It is the rainy season
2. The rainy season is wet enough to maintain control elevation
3. The 25 year – 3 day storm event occurs (there is a 1/25, or 4% probability of this storm event happening each year)

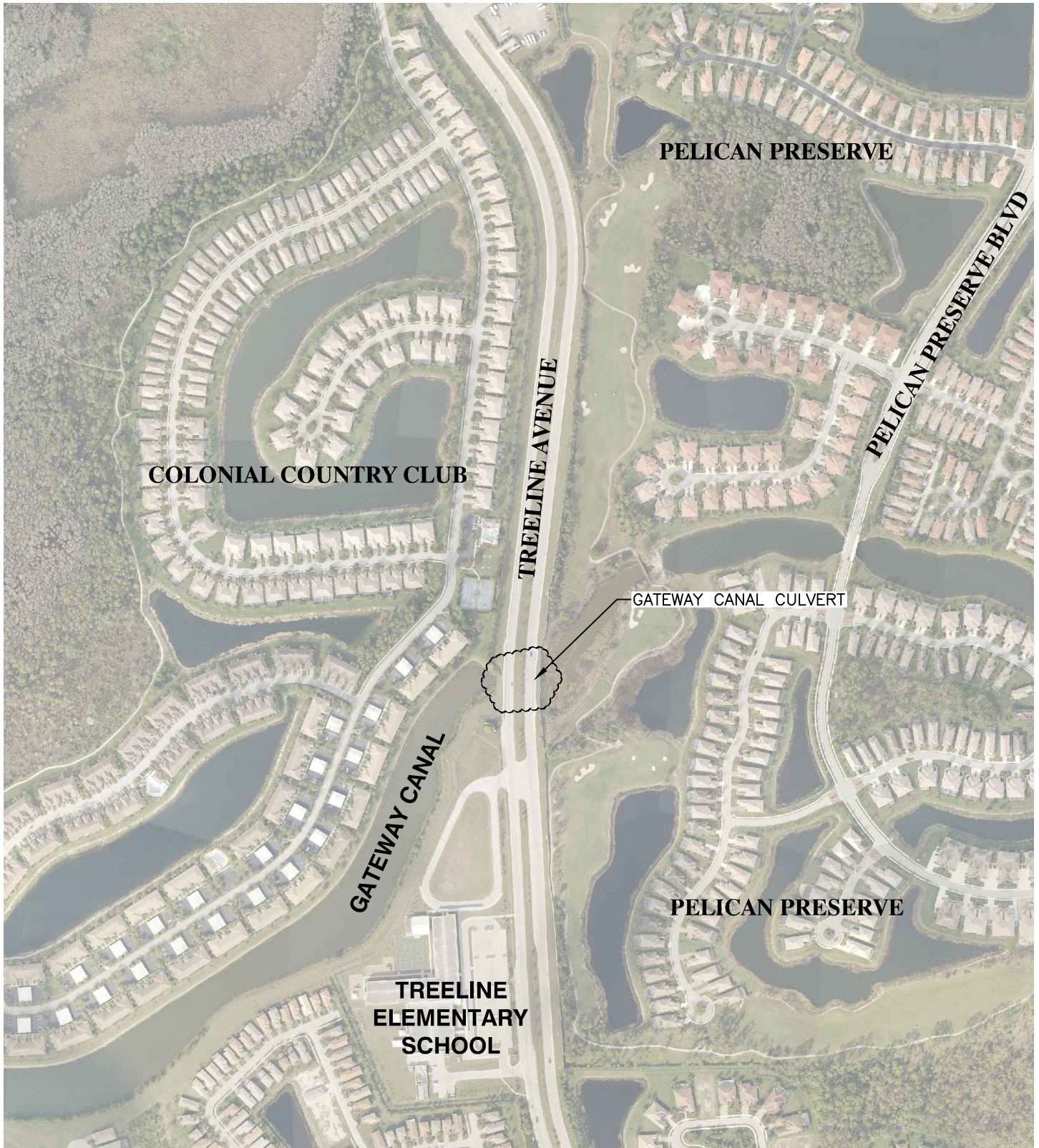
Using the parameters listed above, CulvertMaster was run. For the parameters entered, the program calculated an increase in the canal stage of 0.08 ft, or less than 1 inch. The 0.08 ft change in water elevation from the entrance to exit of the culvert indicates that the culvert has an insignificant impact on the canal elevations upstream of the culvert. For a complete calculation output, see **Exhibit 4**. This calculation was done based on the 25 year – 3 day storm, which is the storm even that SFWMD requires for Storm Water Management permitting and calculations.

## **Conclusions**

As identified in this report, the box culvert at the Gateway Canal under Treeline Avenue has an insignificant impact on the canal elevations upstream of the box culvert. In addition to the Gateway Canal Elevations, no evidence could be found that indicate the lake elevations for the portion of the Pelican Preserve that drain into the Gateway Canal are outside of the peak design stages permitted with SFWMD. The Pelican Preserve wetland monitoring data that is monitored in accordance with the SFWMD permit was reviewed for peak water levels over a period starting

at the initial construction of Pelican Preserve around 2001 to present. Since the Pelican Preserve wetlands are designed to be interconnected to the Pelican Preserve lakes, the water level elevations from the wetland monitoring would coincide with the lake levels. Any future development of Pelican Preserve on the undeveloped portions of the community is not expected to have an adverse impact on the existing Pelican Preserve lake elevations or Gateway canal outside of their peak design stages; as long as the peak stormwater discharge amounts for the future areas are within the SFWMD previously permitted allowable amounts.

**EXHIBIT 1**  
**Culvert Location**



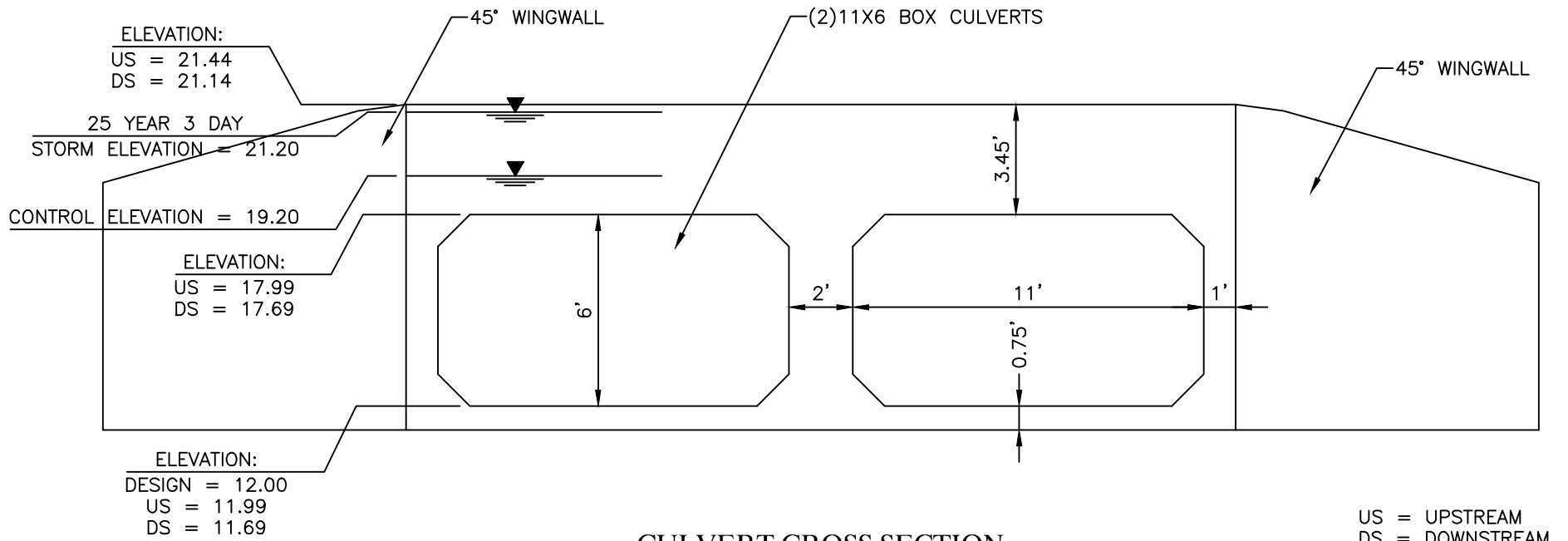
**RWA** INC.  
**CONSULTING**  
 6610 Willow Park Drive, Suite 200  
 Naples, Florida 34109  
 (239) 597-0575 FAX: (239) 597-0578  
 www.consult-rwa.com  
 Florida Certificates of Authorization  
 EB 7663 LB 6952

DATE: 3/24/14  
 SCALE: 1" = 500'  
 DRAWN BY: JBB  
 CHECKED BY: MCP  
 SEC: 2 TWP: 45S RGE: 25E

CLIENT: WCI COMMUNITIES, LLC  
 TITLE: PELICAN PRESERVE FLOWWAY  
 GATEWAY CULVERT LOCATION (EX 1)  
 PROJECT NUMBER: 130077.00.00 SHEET NUMBER: 1 OF 1 FILE NUMBER: 1300770000

**EXHIBIT 2**  
**Culvert Cross Section and Picture**  
**Of West Headwall**

# EXHIBIT 2



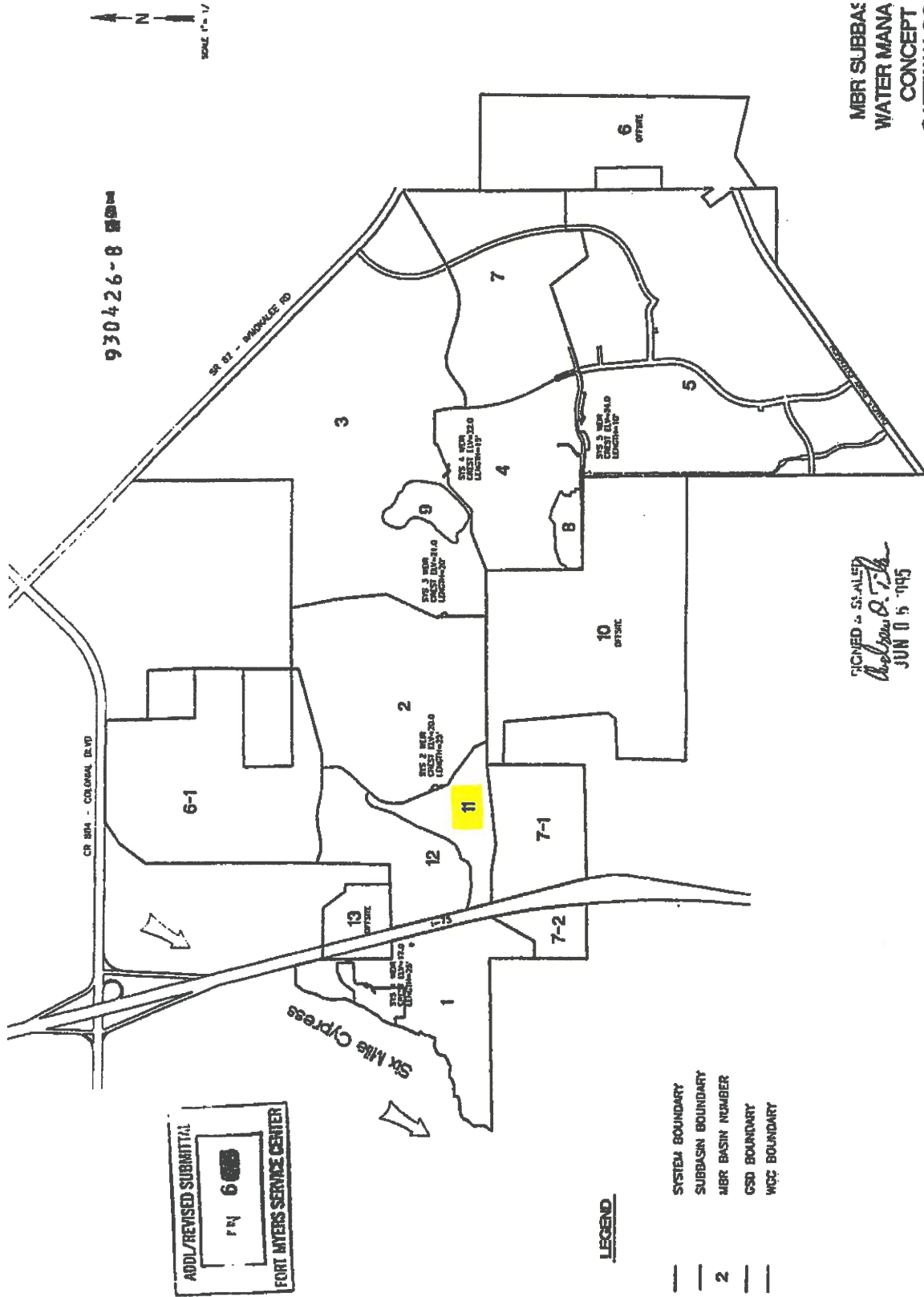
**CULVERT CROSS SECTION**  
CROSS SECTION DRAWN BASED ON SURVEY  
DATA OBTAINED FROM RWA, INC ON 2/28/14



## EXHIBIT 3

### Backup Permit Information

Exhibit 3



ADD./REVISED SUBMITTAL  
 PN 6  
 FORT MYERS SERVICE CENTER

**LEGEND**

- SYSTEM BOUNDARY
- SUBBASIN BOUNDARY
- 2 MBR BASIN NUMBER
- CSD BOUNDARY
- WCC BOUNDARY

MBR SUBBASIN  
 WATER MANA  
 CONCEPT  
 GATEWAY CO

DESIGNED BY ST. ALLEY  
*Robert D. Alley*  
 JUN 05 1995

Exhibit 3

BASIN INFORMATION:

Basin	Area Acres	WSWT Elev (ft, NGVD)	Normal/Dry Ctrl Elev (ft, NGVD)	Method of Determination
1 SYSTEM 1	303.00	18.00	17/17	WETLAND INDICATOR ELEVATION
2 SYSTEM 2	542.00	21.00	20/20	WETLAND INDICATOR ELEVATION
3 SYSTEM 3	1176.00	22.00	21/21	WETLAND INDICATOR ELEVATION
4 SYSTEM 4	354.00	23.00	22/22	WETLAND INDICATOR ELEVATION
5 SYSTEM 5	1294.00	25.00	24/24	WETLAND INDICATOR ELEVATION
6 SYSTEM 5 OFFSITE	508.00	25.00		WETLAND INDICATOR ELEVATION
7 SYSTEM 4	439.00	24.00	23/23	WETLAND INDICATOR ELEVATION
8 SYSTEM 4	36.00	23.00	23/23	WETLAND INDICATOR ELEVATION
9 SYSTEM 3	50.00	22.00	22.93/22.93	WETLAND INDICATOR ELEVATION
10 SYSTEM 2 OFFSITE	719.00	21.00		WETLAND INDICATOR ELEVATION
11 SYSTEM 1	124.00	19.00	19.2/19.2	WETLAND INDICATOR ELEVATION
12 SYSTEM 1	212.00	19.00	19.5/19.5	WETLAND INDICATOR ELEVATION
13 SYSTEM 1 OFFSITE	70.00	18.00		WETLAND INDICATOR ELEVATION
1 SYSTEM 6	650.00	19.70	18.7/18.7	WETLAND INDICATOR ELEVATION
1 SYSTEM 7	200.00	20.00	18/18	WETLAND INDICATOR ELEVATION
2 SYSTEM 7	42.00	19.50	18/18	WETLAND INDICATOR ELEVATION

Receiving Body:

Basin	Str. #	Receiving Body
1 SYSTEM 1	1	SIX MILE CYPRESS SLOUGH
2 SYSTEM 2	1	BASIN 1
3 SYSTEM 3	1	BASIN 2
4 SYSTEM 4	1	BASIN 3
5 SYSTEM 5	1	BASIN 4
6 SYSTEM 5 OFFSITE	1	BASIN 5
7 SYSTEM 4	1	BASIN 4
8 SYSTEM 4	1	BASIN 4
9 SYSTEM 3	1	BASIN 3
10 SYSTEM 2 OFFSITE	1	BASIN 2
11 SYSTEM 1	1	BASIN 1
12 SYSTEM 1	1	BASIN 11
13 SYSTEM 1 OFFSITE	1	BASIN 12
1 SYSTEM 6	1	SIX MILE CYPRESS SLOUGH
1 SYSTEM 7	1	SYSTEM 7 BASIN 2
2 SYSTEM 7	1	SIX MILE CYPRESS SLOUGH

III. PROJECT EVALUATION

**Discharge Rate:**

The allowable discharge for the entire project is 37 csm as stated in the Lee County Six Mile Cypress Slough Study.

The surface water management system is a cascading system with outfalls off-site at Basin 1 System 1, Basin 1 System 6 and Basin 2 System 7. Systems 1 - 5 all flow into Basin 1 System 1, allowable discharge of 336.83 cfs, design discharge of 336.9 cfs. System 6 has one basin. System 7 has two basins with Basin 1 discharging to Basin 2, allowable discharge 13.99 cfs and design discharge 14.2 cfs.

Total allowable discharge from the site is 388.39 cfs and the total design discharge is 387.4 cfs.

Design Storm Frequency: 25YR-3DAY

Design Rainfall: 10.20 inches

Basin	Allow Disch (cfs)	Method of Determination	Design Disch (cfs)	Design Stage (ft. NGVD)
1 SYSTEM 1	17.52	CONVEYANCE LIMITATION	336.9	20.1
2 SYSTEM 2	31.33	CONVEYANCE LIMITATION	n/a	22.6
3 SYSTEM 3	67.99	CONVEYANCE LIMITATION	n/a	23.5
4 SYSTEM 4	20.47	CONVEYANCE LIMITATION	n/a	24.6
5 SYSTEM 5	74.79	CONVEYANCE LIMITATION	n/a	26.3
6 SYSTEM 5 OFFSITE	29.36	CONVEYANCE LIMITATION	n/a	26.5

Exhibit 3

Basin	Allow Disch (cfs)	Method of Determination	Design Disch (cfs)	Design Stage (ft, NGVD)
7 SYSTEM 4	25.37	CONVEYANCE LIMITATION	n/a	24.7
8 SYSTEM 4	2.08	CONVEYANCE LIMITATION	n/a	24.8
9 SYSTEM 3	2.89	CONVEYANCE LIMITATION	n/a	24.2
10 SYSTEM 2 OFFSITE	41.56	CONVEYANCE LIMITATION	n/a	23.6
11 SYSTEM 1	7.17	CONVEYANCE LIMITATION	n/a	21.2
12 SYSTEM 1	12.25	CONVEYANCE LIMITATION	n/a	21.2
13 SYSTEM 1 OFFSITE	4.05	CONVEYANCE LIMITATION	n/a	20.1
1 SYSTEM 6	37.57	CONVEYANCE LIMITATION	36.3	21.3
1 SYSTEM 7	11.56	CONVEYANCE LIMITATION	n/a	21.3
2 SYSTEM 7	2.43	CONVEYANCE LIMITATION	14.2	21.3

**WATER QUALITY:**

The original approved conceptual plans intended to use open road side swales for pretreatment. The first portion of Gateway Boulevard uses this design. Later designs have used closed conduits with the pollutant retardant basins within the water management systems. This is the proposed method for future roadway projects pretreatment.

Basin	Treatment Method	Vol Req'd. (ac-ft)	Vol Prov'd (ac-ft)
1 SYSTEM 1	78.3 acres WET DETENTION	25.25	25.25
2 SYSTEM 2	136 acres WET DETENTION	45.17	45.17
3 SYSTEM 3	266 acres WET DETENTION	98.00	98.00
4 SYSTEM 4	61 acres WET DETENTION	29.50	29.50
5 SYSTEM 5	323.4 acres WET DETENTION	107.83	107.83
7 SYSTEM 4	124 acres WET DETENTION	36.58	36.58
8 SYSTEM 4	11.7 acres WET DETENTION	3.00	3.00
9 SYSTEM 3	17.2 acres WET DETENTION	4.17	4.17
11 SYSTEM 1	30 acres WET DETENTION	10.33	10.33
12 SYSTEM 1	103 acres WET DETENTION	17.67	17.67
1 SYSTEM 6	162.7 acres WET DETENTION	54.17	54.17
1 SYSTEM 7	47.5 acres WET DETENTION	16.67	16.67
2 SYSTEM 7	15.8 acres WET DETENTION	3.50	3.50

**ROAD DESIGN:**

As shown in the following table, minimum road center lines have been set at or above the calculated design storm flood elevation.



OVFL W53	Undefnd	Undefnd	Undefn	19.2699	60	36
W51.1	Undefnd	Undefnd	Undefn	1.9896	60	14
W51A	Undefnd	Undefnd	Undefn	11.1086	60	26
WEIR CS#4	Undefnd	Undefnd	Undefn	1.9170	70	52
WEIR # 27	Undefnd	Undefnd	Undefn	227.8813	74	36
CS23_BLDR	Undefnd	Undefnd	Undefn	-5.2155	60	23
CS23_TOP	Undefnd	Undefnd	Undefn	-16.6231	61	13
CS16_WEIR	Undefnd	Undefnd	Undefn	2.9298	72	14
52D-CSweir	Undefnd	Undefnd	Undefn	12.8400	62	43
L52B_CS1_W	Undefnd	Undefnd	Undefn	6.5656	69	27
FREE # 1	Undefnd	Undefnd	Undefn	129.6932	82	57
FREE # 2	Undefnd	Undefnd	Undefn	117.2811	82	57

These "FREE" flows are the offsite discharge over the Gateway Canal, System #2 Weir.

The peak offsite discharge =  $\Sigma$ [free flows]

Peak Offsite Discharge =

129.6932 cfs  
+ 117.28.11 cfs  
**246.9743 cfs**

\*\*\*\*\*  
| Table E11. Area assumptions used in the analysis |  
| Subcritical and Critical flow assumptions from |  
| Subroutine Head. See Figure 17-1 in the |  
| manual for further information. |  
\*\*\*\*\*

Conduit Name	Duration of Dry Flow (min)	Duration of Sub-Critical Flow (min)	Durat. of Critical Flow (min)	Durat. of Downstream Critical Flow (min)	Maximum Hydraulic Radius-m	Maximum X-Sect Area (ft^2)	Maximum Vel*D (ft^2/s)
B2-L28-L29	0.0000	7200.0000	0.0000	0.0000	0.5000	3.1859	6.2963
B2-L33-L31	0.0000	7200.0000	0.0000	0.0000	1.0000	12.6573	14.7631
B2-W9-L26	0.0000	7200.0000	0.0000	0.0000	0.5000	3.1758	15.7129
B2-L27-L31	0.0000	7200.0000	0.0000	0.0000	0.7500	7.1350	13.5811
L2VD-LXVD	0.0000	7200.0000	0.0000	0.0000	0.6250	4.9641	7.8055
B2L35A-L31	0.0000	7200.0000	0.0000	0.0000	0.6250	4.9641	15.7669
B2-L29-L25	0.0000	7200.0000	0.0000	0.0000	1.1250	16.0041	11.8610
B2-L26-L28	0.0000	7200.0000	0.0000	0.0000	0.5000	3.1758	6.4954
B2L33A-L31	0.0000	7200.0000	0.0000	0.0000	0.5000	3.1859	15.3797
B2L29AL27A	0.0000	7200.0000	0.0000	0.0000	0.5000	3.1859	9.3900
B2L27AL25A	0.0000	7200.0000	0.0000	0.0000	0.5000	3.1859	5.5942
B2L25A-L25	0.0000	7200.0000	0.0000	0.0000	0.6250	4.9642	21.0592
B2L29B-L29	0.0000	7200.0000	0.0000	0.0000	0.5000	3.1859	9.6552
L67-L65	0.0000	7200.0000	0.0000	0.0000	0.7500	7.1719	8.6843
L63-L62	0.0000	7200.0000	0.0000	0.0000	0.7500	7.1656	2.2493
L64-L62	0.0000	7200.0000	0.0000	0.0000	0.7500	7.1656	14.5037
L62-L61	0.0000	7200.0000	0.0000	0.0000	0.7500	7.1656	8.7969
L68-L67	0.0000	7200.0000	0.0000	0.0000	0.7500	7.1720	8.7842
L71-L70	0.0000	7200.0000	0.0000	0.0000	1.2500	19.7919	11.2457
L27	0.0000	7200.0000	0.0000	0.0000	7.0557	893.1139	2.9271
L61-CHN	0.0000	7200.0000	0.0000	0.0000	0.7500	7.1656	10.4513
L55	0.0000	7200.0000	0.0000	0.0000	7.0573	893.4926	2.8601
L56	0.0000	7200.0000	0.0000	0.0000	8.5837	1661.7197	1.5355
L58	0.0000	7200.0000	0.0000	0.0000	8.9137	1948.4427	1.3090
L59	0.0000	7200.0000	0.0000	0.0000	9.5983	2865.9718	0.8895
L60	0.0000	7200.0000	0.0000	0.0000	8.5836	1661.7052	1.6062
L61	0.0000	7200.0000	0.0000	0.0000	7.0563	893.2607	2.9872
L63	0.0000	7200.0000	0.0000	0.0000	7.0562	893.2236	2.9860
L27.1	0.0000	7200.0000	0.0000	0.0000	7.1459	1172.4697	1.8396
W56-CHN	0.0000	7200.0000	0.0000	0.0000	0.7500	7.1437	12.8237
L66-L65	0.0000	7200.0000	0.0000	0.0000	0.7500	7.1718	2.6768
CS 50- CHN	0.0000	7200.0000	0.0000	0.0000	1.0000	12.9350	128.6479
L58-L50	0.0000	7200.0000	0.0000	0.0000	0.5000	3.1973	10.4267
L65-L62	0.0000	7200.0000	0.0000	0.0000	0.7500	7.1455	5.1412
L59-W55	0.0000	7200.0000	0.0000	0.0000	0.7500	7.1757	12.7069
L69-W57	0.0000	7200.0000	0.0000	0.0000	0.7500	7.1757	14.1389
W57-W58	0.0000	7200.0000	0.0000	0.0000	0.7500	7.1757	9.6478
L69-W56	0.0000	7200.0000	0.0000	0.0000	1.0000	12.7091	19.8393
L57-L56	0.0000	7200.0000	0.0000	0.0000	0.7500	7.1548	3.5325
L25-L50	0.0000	7200.0000	0.0000	0.0000	1.1250	16.2923	24.2213
L70-W56	0.0000	7200.0000	0.0000	0.0000	1.1250	16.0761	32.8717
L118	0.0000	7200.0000	0.0000	0.0000	1.0000	12.7090	24.1710
L120	0.0000	7200.0000	0.0000	0.0000	0.7500	7.1870	33.5190
L125	0.0000	7200.0000	0.0000	0.0000	0.7500	7.1473	13.6496
A-B	0.0000	7200.0000	0.0000	0.0000	8.0969	1603.5156	1.4832
B-C	0.0000	7200.0000	0.0000	0.0000	8.5131	2051.9914	1.1583
sys3cntrl.	0.0000	7200.0000	0.0000	0.0000	7.9594	1488.6978	1.5910
G-H	0.0000	7200.0000	0.0000	0.0000	8.2089	1707.7678	1.3886
E-F	0.0000	7200.0000	0.0000	0.0000	8.4889	2020.6895	1.1747
C-D	0.0000	7200.0000	0.0000	0.0000	8.9002	2688.2186	0.8838
D-E	0.0000	7200.0000	0.0000	0.0000	9.1322	3251.4400	0.7305
F-G	0.0000	7200.0000	0.0000	0.0000	8.3993	1911.1600	1.2413



**EXHIBIT 4**  
**Calculation Output**

# Culvert Calculator Report

## Gateway Canal Culvert System

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	21.44 ft	Headwater Depth/Height	1.55
Computed Headwater Elev:	21.28 ft	Discharge	247.00 cfs
Inlet Control HW Elev.	21.20 ft	Tailwater Elevation	21.20 ft
Outlet Control HW Elev.	21.28 ft	Control Type	Outlet Control

Grades			
Upstream Invert	11.99 ft	Downstream Invert	11.69 ft
Length	165.00 ft	Constructed Slope	0.001818 ft/ft

Hydraulic Profile			
Profile	Pressure Profile	Depth, Downstream	9.51 ft
Slope Type	N/A	Normal Depth	1.85 ft
Flow Regime	N/A	Critical Depth	1.58 ft
Velocity Downstream	1.87 ft/s	Critical Slope	0.002961 ft/ft

Section			
Section Shape	Box	Mannings Coefficient	0.013
Section Material	Concrete	Span	11.00 ft
Section Size	11 x 6 ft	Rise	6.00 ft
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev.	21.28 ft	Upstream Velocity Head	0.05 ft
Ke	0.20	Entrance Loss	0.01 ft

Inlet Control Properties			
Inlet Control HW Elev.	21.20 ft	Flow Control	N/A
Inlet Type	90° headwall w 45° bevels	Area Full	132.0 ft²
K	0.49500	HDS 5 Chart	10
M	0.66700	HDS 5 Scale	2
C	0.03140	Equation Form	2
Y	0.82000		