INLET CAY DRAINAGE INVESTIGATION

Prepared for
Town of Ocean Ridge

Prepared by
Higgins Engineering, Inc.

September 2018

17-14

INLET CAY DRAINAGE INVESTIGATION

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I. Introduction

On December 12, 2017, Higgins Engineering, Inc. was asked to perform a drainage investigation specifically on Inlet Cay. Inlet Cay is an island in the intracoastal west of the barrier island that contains the Town of Ocean Ridge. The investigation was to include certain items such as existing drainage system capacity, analysis of soil borings to determine a cause of existing settlements, perform a groundwater analysis on the land locked irritant within Inlet Cay to determine the cause of water seeping into the adjacent roadways, and to develop alternatives to improving drainage. The results from each individual task are provided in the following.

II. Existing Drainage System Capacity

The Inlet Cay stormwater system consists of approximately fourteen (14) drainage easements and pipes which carry runoff from approximately 15.6 acres of developed residential properties. The condition of these pipes has been well-documented through video techniques which show the stability and flow-through condition of each piping unit.

A review of recent within-pipe videos shows areas in which the storm pipes have partially collapsed and or cracked due to settling, age and selected strength of materials. The existing capacity analysis assumes that the pipes can function under normal flow conditions in order to ascertain the hydraulic ability of the system to convey storm waters without localized surface flooding and pounding between inlets on the roadways.

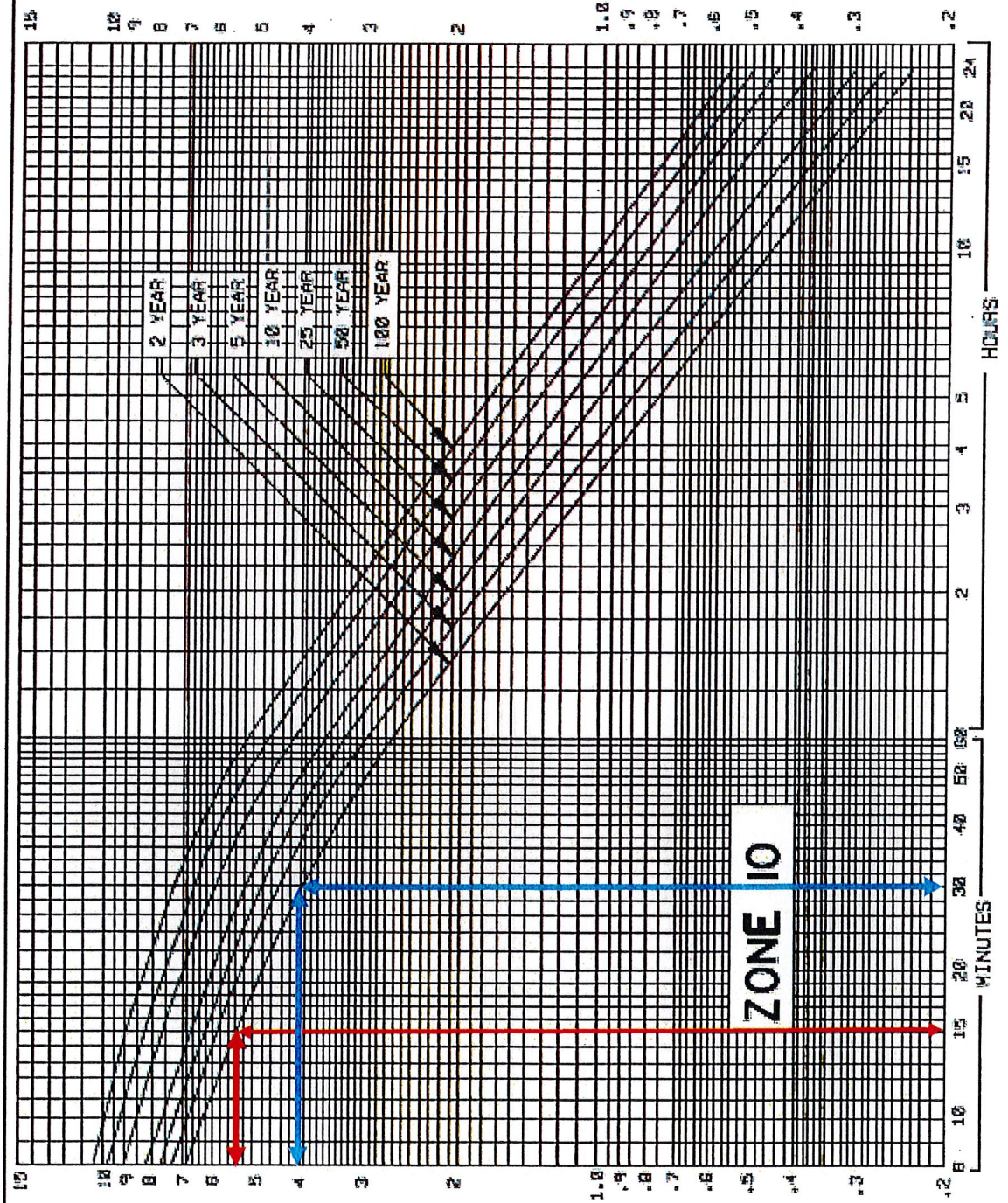
Doing a hydraulic capacity computation considering the relatively small diameters of the pipes in the 8 to 24 inch range, with most in the 15 inch category, shows an installed capacity of between 2 to 3 cfs (cubic foot per second of water flow) per pipe-length at one-half foot of head (meaning a likely water level difference of 6 inches during peak flow conditions).
The computed total peak capacity between 28 and 42 cfs overall is expected overall. To compare this flow rate to expected flows generated on-site during a normal heavy rainfall event the

Rational Method can be utilized. This method is commonly used by the Florida Department of Transportation for the design of roads and storm sewer systems throughout the state.

The Rational Method uses a formula of Q=CIA, where Q = peak flows in cfs, I = rainfall intensity in inches per hour, and A is the contributing watershed. The required runoff capacity for this site based upon an expected Time of Concentration between 15 and 30 minutes (for DOT Rainfall Zone 10) with the state **Intensity Duration Frequency Curves** yields expected design rainfalls between 4 and 5.4 inches per hour for the most common (frequent) storm events. See the attached DOT IDF curves for Zone 10 (see Exhibit 1), which is the southeast coast of Florida.

A rough runoff capacity for 4 inches of rain per hour yields a required hydraulic capacity of 31 cfs and for 5.4 inches per hour a needed capacity of 42.1 cfs. These values correspond with a once in 2-year design storm, which is the same as an annual event (the most frequent).
Most local roadways are designed for once in 3-year and once in 5-year storm capacities. In addition public roadways which are maintained by governmental agencies such as cities and counties will be designed for 10-year and 25-year storm events.

Drainage Manual
IDF Curves



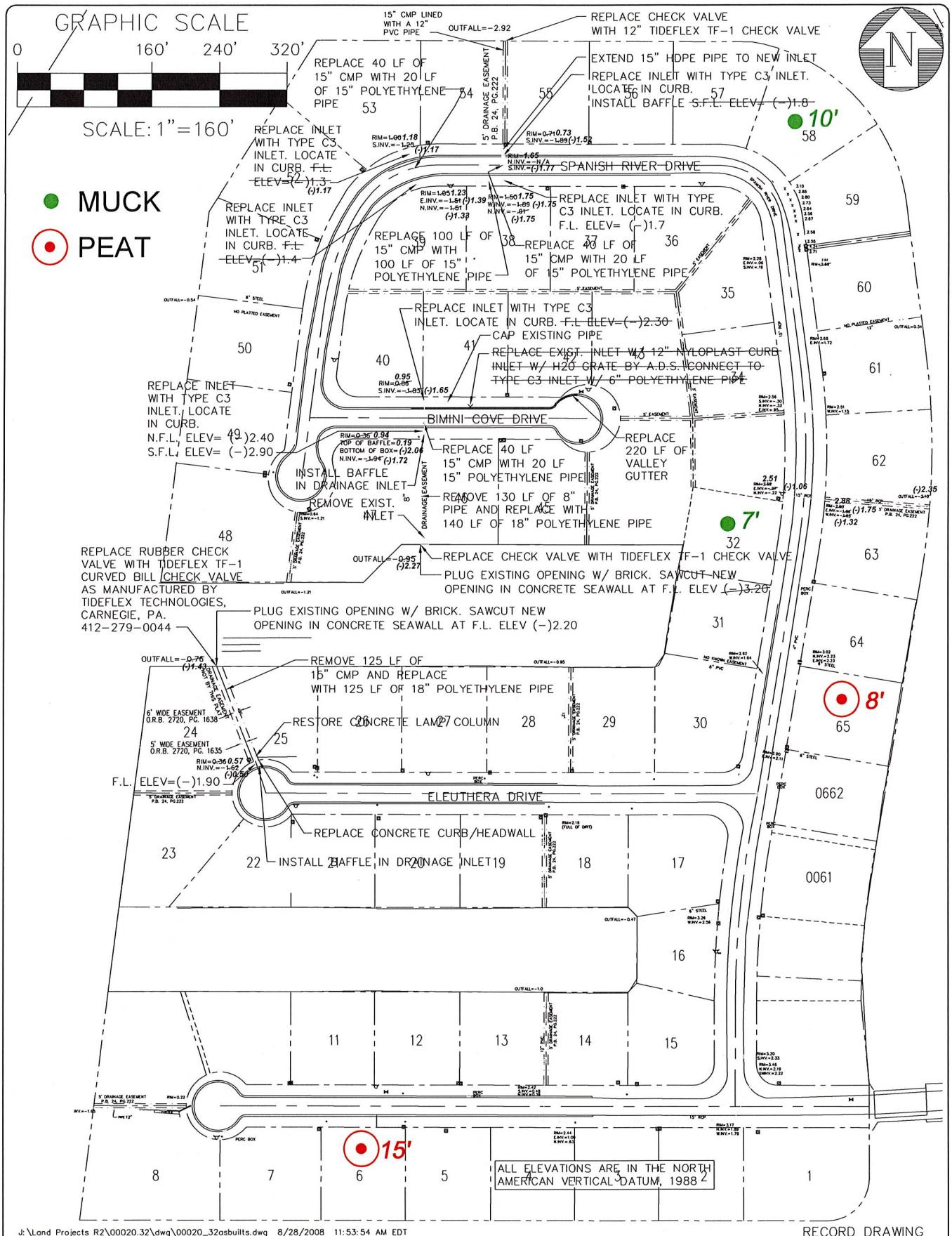
RAINFALL INTENSITY-DURATION-FREQUENCY CURVES
ZONE 10

EXHIBIT 1

III. Soil Boring Analysis

Pursuant to the scope of work, Higgins Engineering have worked with the building department to locate records for any lots with deep soil borings and associated geotechnical reports. We did find four lots with deep soil borings (see Exhibit 2). All four borings recognized a layer of muck or peat lying approximately 5 feet below grade down to as much as 22 feet below grade. This equates to a compressive layer ranging from 7 to 15 feet. Two of the boring listed the layers as peat while the other two are listed the layer as muck. The difference between peat and muck, peat has organic materials and muck consists of fully decomposed organic material. Both peat and muck compress over time when loads are applied to it. An example would be a driveway settling due to the weight of the slab. A map from the Inlet Cay showing the four borings and the thickness of the muck/peat layer is attached. This layer of muck/peat is likely to be made from thousands of years of leaf litter from mangrove trees. Once the layer is fully submerged in groundwater, there is no oxygen to continue the decaying process of peat. It is evident that the original developers of Inlet Cay created this subdivision by excavating the canals and filling the lots over the mangroves. Because of this layer, most of, if not all of the homes have been constructed on pilings including pools. The geotechnical report gave recommendations on piles for the structures which prevent the structures from settling. However, the roadways and driveways will settle with time until the layer reaches its compressibility limit.

All soils are compressible to some extent which is widely variable. There is an index called a Compression Index which measures the compressibility of various soils. For comparison, typical clays have a compression index of 0.3 to 0.9. Peat soils have a compression index of 10 to 15. The amount of settlement that can occur within Inlet Cay varies considerable depending on location, thickness of the layer and how much compression has occurred to date. The only way to get an accurate indication of remaining compressibility is to have a geotechnical firm perform a deep soil boring and analyze the peat/muck in the lab.



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RECORD DRAWING

NO	REVISIONS	BY	DATE
1	ADDED RECORD INFO	MCB	8/12/08

INLET CAY DRAINAGE IMPROVEMENTS

PROJECT ENGINEER:	MRH
DRAWN BY:	STAFF
CHECKED BY:	
CHECKED BY:	

Y:\Engenuity logo\EG-LOGO-RGB-Subtag.tif

1201 BELVEDERE ROAD, WEST PALM BEACH, FLORIDA 33405 (561) 655-1151

DATE:	03-12-08
JOB NO:	00020.32
SCALE:	1"=100'
SHEET:	1 OF 7

EXHIBIT 2

IV. INLET CAY MOUNDING ANALYSIS

Temporary "mounding" of the water table can occur after a severe rainfall event or with other sources of water (effluent from septic tanks), rising the water table locally until the water is infiltrated laterally after a few days. This analysis estimates the rise of the water table under the 10 non-waterfront lots located in Inlet Cay by Bimini Cove drive and Spanish River drive. Local residents speculate that this area overlies a spring. However, this area overlies 10 to 15 feet of peat/muck which can be assumed to be impervious.

A total rainfall of 4.26 inches in a 4-day period (May 25 to May 28, 2018 recorded at the SFWMD station ST-41R) was used for this particular analysis:

Date	Rainfall depth (inches)
May 25, 2018	0.16"
May 26, 2018	1.17"
May 26, 2018	1.69"
May 26, 2018	1.24"
Total	4.26"

The daily average rainfall rate was 1.07 inches per day, or 0.09 ft/day. It was assumed that all the rainfall was infiltrated in pervious areas (i.e. lawns). The infiltration area under the ten lots is approximately 150,000 square feet, 500 feet x 300 ft or 3.4 acres. To estimate the potential impact of additional water sources such as septic tanks, it was assumed 100 gallons per day for each lot; thus a total of 4,000 gallons (535 cubic feet) would be contributing to the water table mounding. This amount was distributed over the 3.4 acres, which is equivalent to 0.01"/day. This amount was considered negligible compared to the daily average rainfall rate.

The following soil properties were assumed for the analysis:

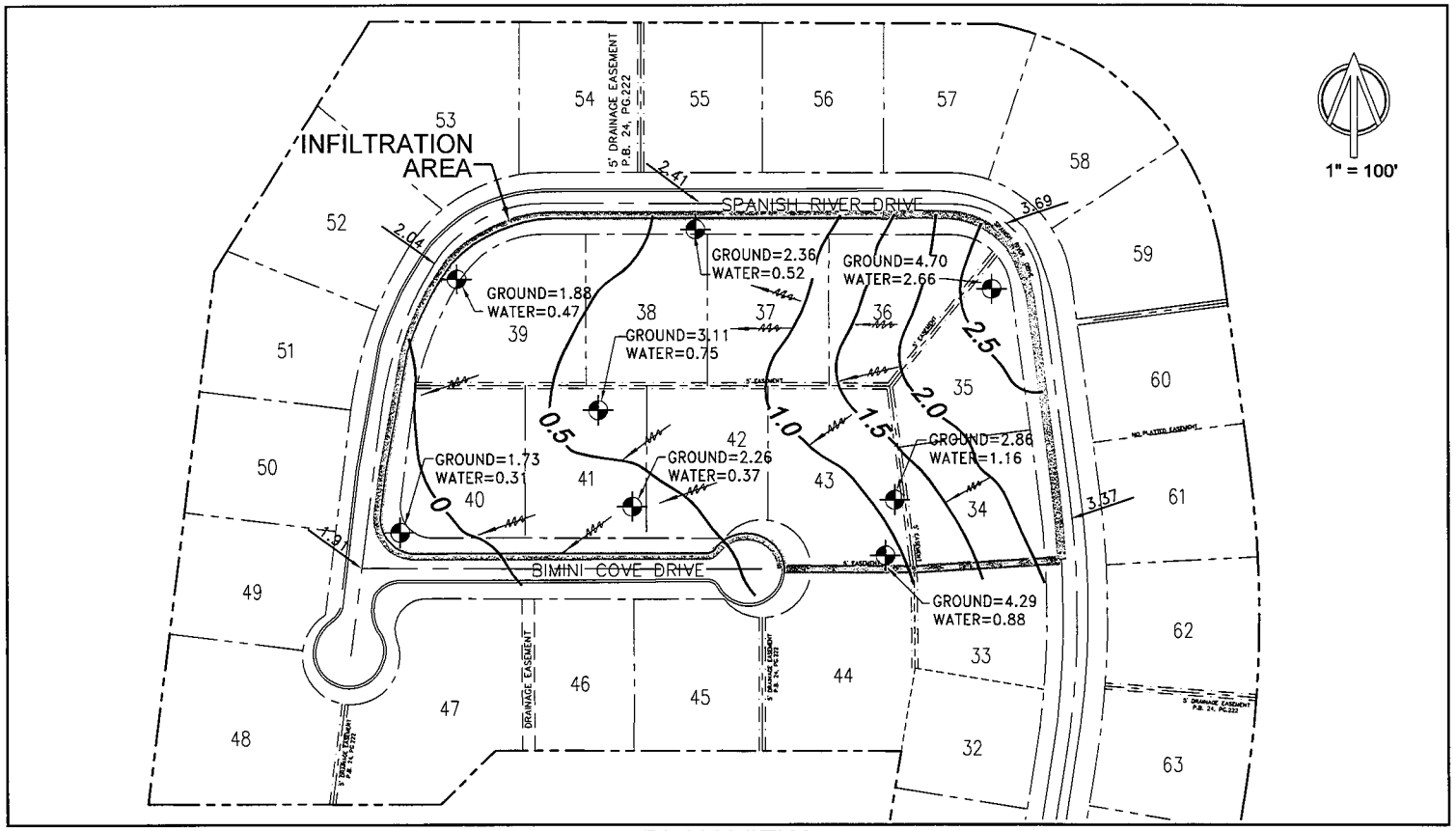
Specific yield (or porosity) S_y: 0.2 which is typical for unconsolidated sandy sediments and a hydraulic conductivity of $K_x = 2 \times 10^{-5}$ m/s = 5.7 feet/day.

Results:

The Hantush (1967) equation was solved with these parameters, to obtain the groundwater mounding beneath the infiltration area. There are several available calculators that can perform this task. The calculated temporary height above the water table was 1.8 feet.

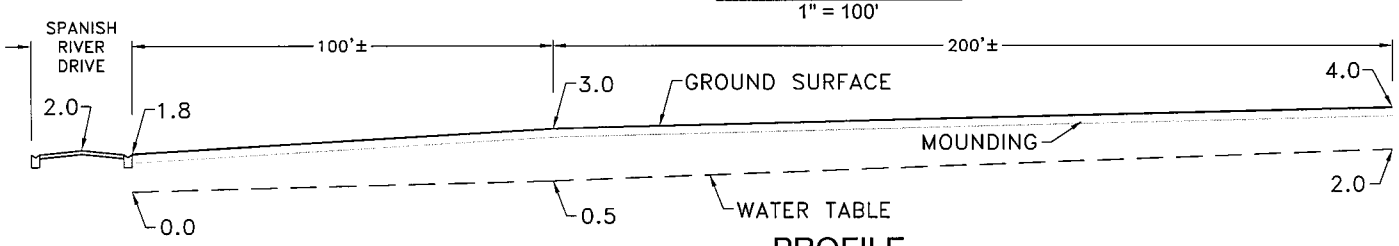
Exhibit 3 shows the "static" water table based on boreholes situated in different parts of the infiltration area. The predominant flow is from east to west; the average ground elevation is 3 feet NAVD, and the average water table is about 1 foot NAVD. When water mounding occurs as during an intense or concentrated rainfall event, the water table can reach up to 2.8 feet NAVD. This excess water will seep laterally to the roadways in a few days, especially to the west on Spanish River Drive and to Bimini Cove Drive (which are at or below elevation 2.0 feet NAVD), even after the rainfall has stopped.

As a comparison, during the total rainfall between May 13 and May 16, 2018 for the area was 6.2", or a daily average of 1.54". The calculated water table elevation for this storm event was 2.6 ft, which saturated the ground and raised the water table to 2.6 ft NAVD at the roadway at the west side of Spanish River Drive (elevation at the curb side is around 2.0 ft NAVD). The peat/muck layer found at approximately 5 feet below ground is below the water table and fully saturated, and is practically impervious. All flow is laterally in the sands overlying the peat layer. The conclusion that can be reached is there is no artesian spring; all the water that seeps laterally is from local rainfall.



PLAN VIEW

1" = 100'



PROFILE

N.T.S.

1714-0 Exhs Report\1714_32asbits Wtr Table-5E.dwg

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INLET CAY
DRAINAGE IMPROVEMENTS
GROUNDWATER MOUNDING ANALYSIS
TOWN OF OCEAN RIDGE, FLORIDA

DESIGNED	DRAWN	CHECKED	JOB NO.
F.J.P.	D.A.B.		17-14
DATE	SCALE	APPROVED	SHT. 1 OF 1
6/18	1"=100'		

EXHIBIT 3

V. Drainage Improvement Alternatives

It is clear that Inlet Cay needs additional drainage improvements. A continuation of the ongoing outfall pipe inspection, cleaning, and repairs are certainly an effective near term improvement to the drainage system issues. SFRN (Now Engenuity) also recommended a cleaning/maintenance program in the Flood Control Study Task D (2000). The program should include ongoing cleaning of the entire infrastructure. The drainage lines were cleaned and televised to determine the integrity of the pipes. If outfall pipes are cracked or corroded, "slip lining" may be necessary. Installing Tideflex valves TF-1 at the end of the outfall pipes should continue to be implemented to eliminate backflow associated with high tides. The addition of this type of fitting also requires routine maintenance. Permitting with SFWMD is not necessary for this program option, unless increased outfall capacity is proposed (which requires water quality improvement). The estimated cost to initially clean, televise, valve and slip line the outfalls ranges from $125,000 to $175,000 (ongoing). Annual maintenance of the drainage infrastructure can range from $10,000 to $20,000.

Several other drainage improvements and solutions are discussed in the following:

1. "Stormceptor"
   This system removes and retains sediments (TSS), free oils, and other pollutants such as nutrients (bound to sediments) and metals from stormwater runoff at higher flow rates. This solves the problem of water quality allowing an increase in discharge to the Intracoastal Waterway (after permitting). For this option, installation of the stormceptor would allow for an increase in the outfall pipe size which increases the discharge from any given area. The tradeoff of increased discharge, from a regulatory perspective, is the improvement in water quality that is being discharged to tide; there is a precedent for this type of approval.

   The 3.4-acre drainage area of Bimini Cove Drive was used for purposes of cost estimation and size. The stormceptor model STC450i with inlet grate (see Exhibit 4 and 6) is suitable with a minimum surface to outlet invert variable to match existing grade, and peak conveyance flow rate of 15 cfs. The cost of the 4-foot diameter precast concrete structure with fiberglass insert is approximately $15,000 dollars (Rinker Materials), and

installation cost of $10,000 will be needed to increase the outfall pipe diameter from 12 inches to 18 inches.

2. Exfiltration Trench.

An exfiltration trench can be installed along the roadside since there is approximately 5 feet of beach sand and shells overlying the peat/muck layer, with potential storage capacity. A 12-inch perforated pipe can be installed with a filter cloth rapped trench filled with rock (see Exhibit 5). The exfiltration trench not only provides extra flood storage but also increases the ability to exfiltrate excess runoff, which improves water quality. Estimated cost based on $100 per linear foot is approximately $30,000. Add an additional $10,000 for an increased outfall pipe totals $40,000.

3. Permeable Pavers

Geotextile fabrics can replace the existing cul-de-sac pavement (such as Gravelpave2 from Invisible structures or similar products from Pave drain). They provides heavy load bearing support and containment of gravel to create a porous surface. This alternative may be a good candidate for Bimini Drive because of low traffic and low speed conditions; the entire street transforms into a pervious area. Gravelpave2 consists of a geotextile fabric injection molded to the ring and grid structure. Gravelpave2 requires a base course.

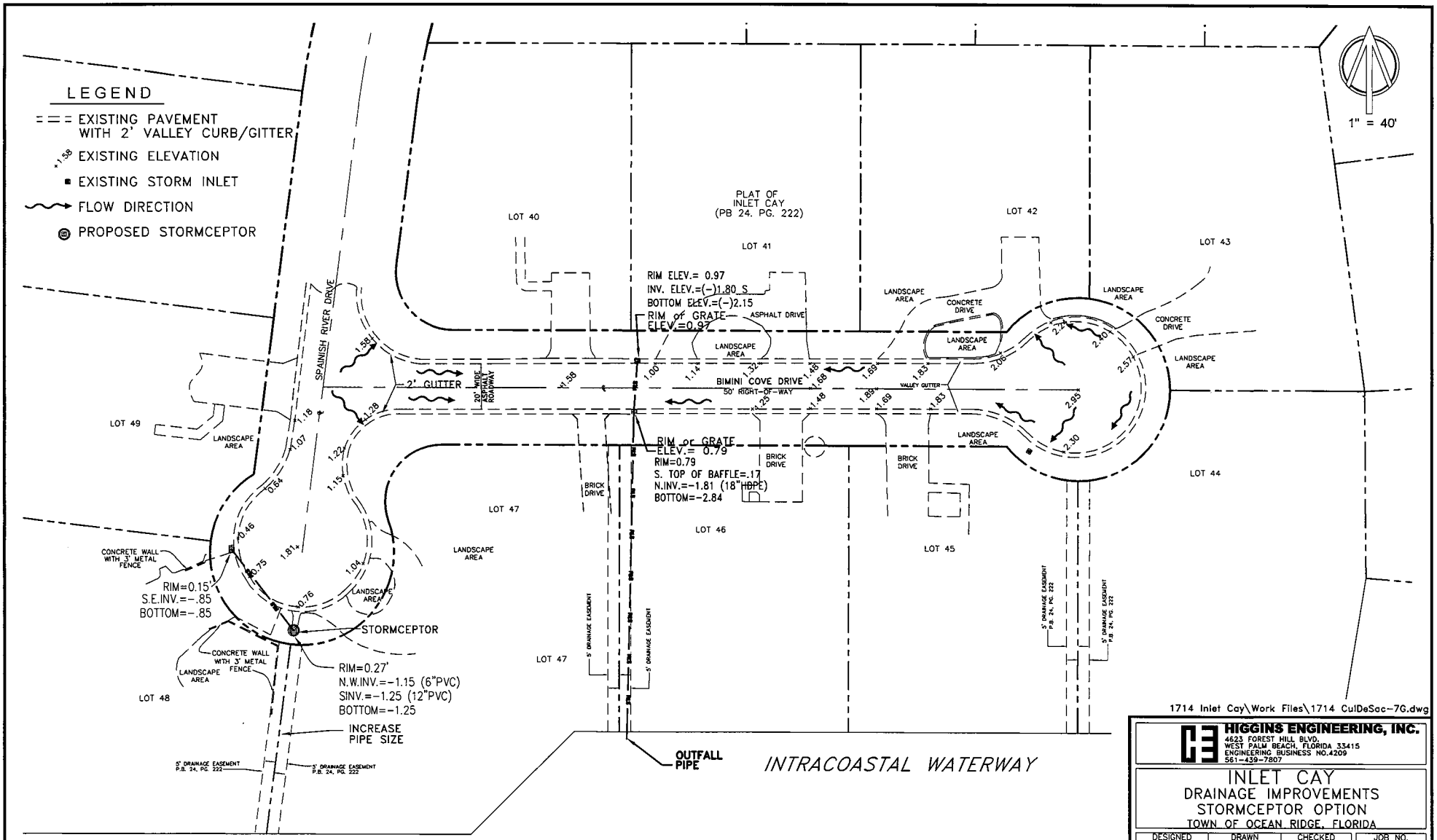
The subsoil needs to infiltrate at least 0.5 inches per hr to be considered permeable and recommended soils would be loam, sandy loam, or loamy sand. The system could deliver 2.63 to 38.55 inches of water per hour to the subsoil.

The system can be used for storage and filtration of stormwater runoff. For example, a cross-section with a 12-inch deep base course (at 20% void space) and one inch of Gravelpave2 (at 35%) can store 2.75″ of rain. Permeable pavers clean stormwater of pollutants from vehicle drippings prior to reaching the water table. The EPA and other organizations recognize permeable pavers as a pre-treatment option for stormwater. This would allow for a larger outfall pipe.

Estimated cost is as follows: $23,000 for materials and $30,000 to scrape and dispose of the existing pavement, and conditioning of the base course (assumed at $7.50 per square foot), for an approximate cost of $53,000. Add an additional $10,000 for the outfall pipe, results in a total cost of $63,000.

4. Raise Roadway

Raising of the cul-de-sacs and roadways has been done in Inlet Cay before. This approach could continue to be used in Inlet Cay. Raising of the roadways and cul-de-sacs would likely require the raising of the adjacent lots to prevent Ponding. An example of one previously done by Engenuity Group on Bimini Cove Drive has provided as Exhibit 7. Raising the roadways is also a costly option, since based on the mounding analysis it would have to be raised about six inches, and the green areas of the lots would have to be filled to match grade or convert to swales at the curbside.



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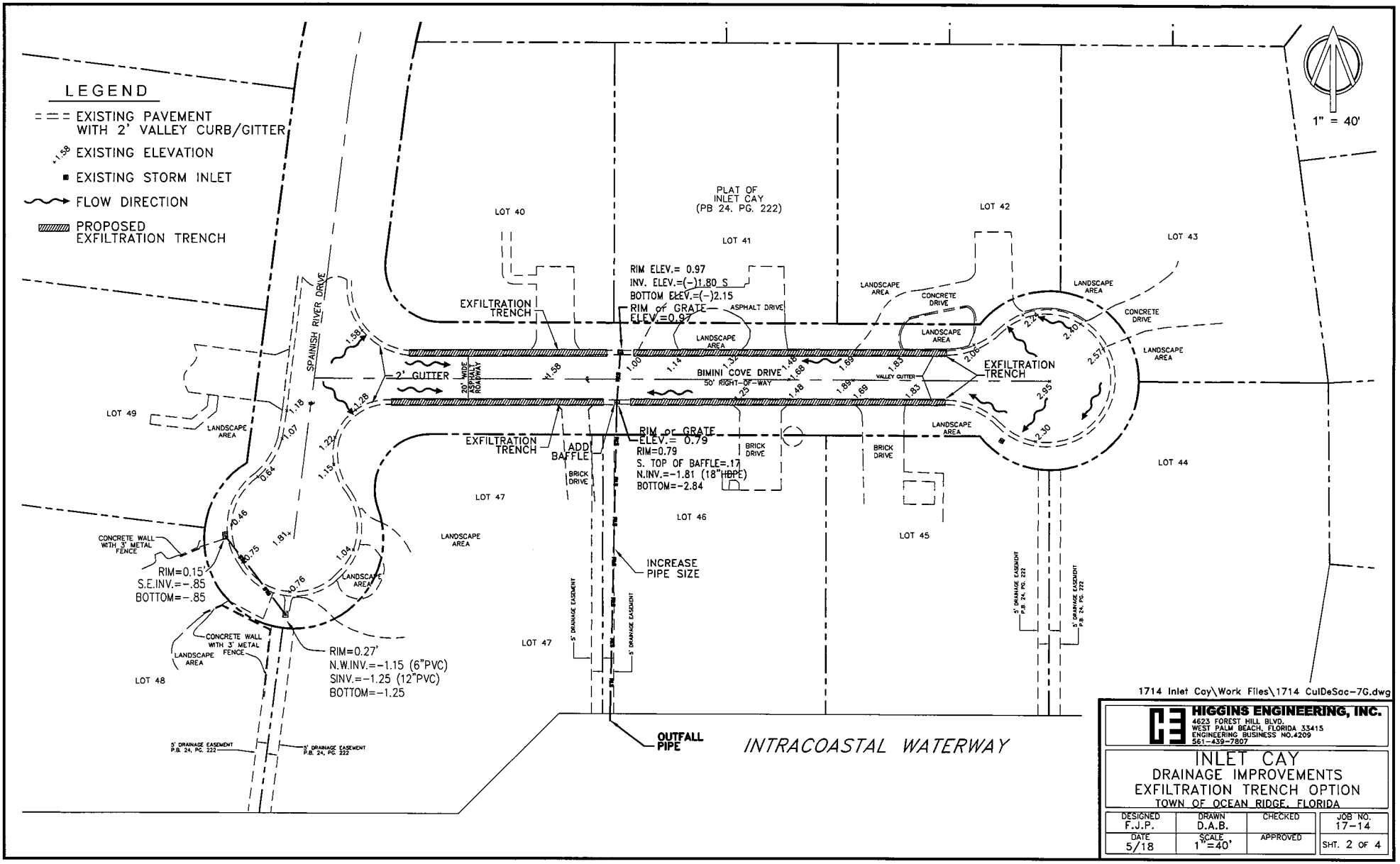
INLET CAY
DRAINAGE IMPROVEMENTS
STORMCEPTOR OPTION
TOWN OF OCEAN RIDGE, FLORIDA

DESIGNED	DRAWN	CHECKED	JOB NO.
F.J.P.	D.A.B.		17-14
DATE 5/18	SCALE 1"=40'	APPROVED	SHT. 1 OF 4

EXHIBIT 4



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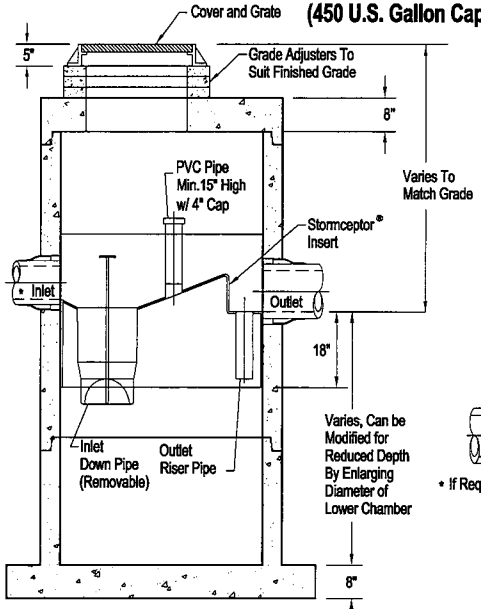
INLET CAY
DRAINAGE IMPROVEMENTS
EXFILTRATION TRENCH OPTION
TOWN OF OCEAN RIDGE, FLORIDA

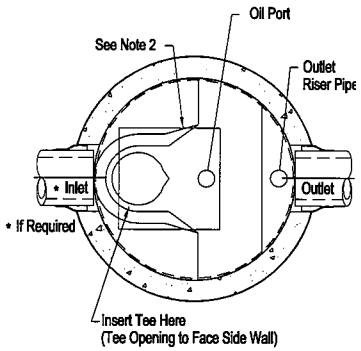
DESIGNED	DRAWN	CHECKED	JOB NO.
F.J.P.	D.A.B.		17-14
DATE	SCALE	APPROVED	
5/18	1"=40'		SHT. 2 OF 4

EXHIBIT 5

STC 450i Precast Concrete Stormceptor®
(450 U.S. Gallon Capacity)



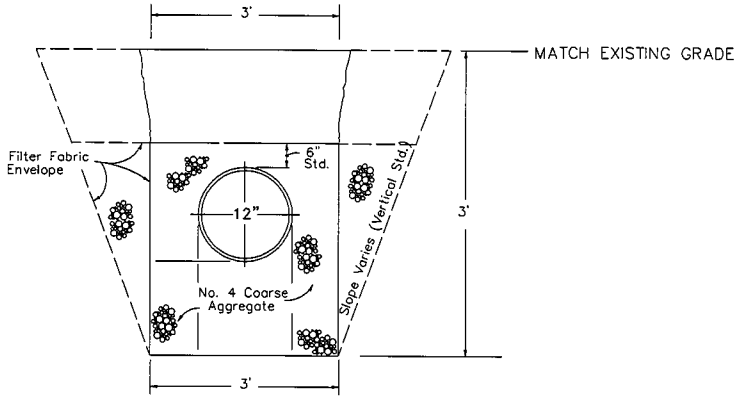
Section Thru Chamber



Plan View

Notes:

1. The Use Of Flexible Connection is Recommended at The Inlet and Outlet Where Applicable.
2. The Cover Should be Positioned Over The Inlet Drop Pipe and The Oil Port.
3. The Stormceptor System is protected by one or more of the following U.S. Patents: #5753115, #5849181, #6068765, #6371690. #7582216, #7666303.
4. Contact a Concrete Pipe Division representative for further details not listed on this drawing. Rinker 027



ROUND PIPE SHOWN

STANDARD CROSS SECTION (ENLARGED)

EXFILTRATION TRENCH
REFERENCE F.D.O.T. INDEX NO. 285
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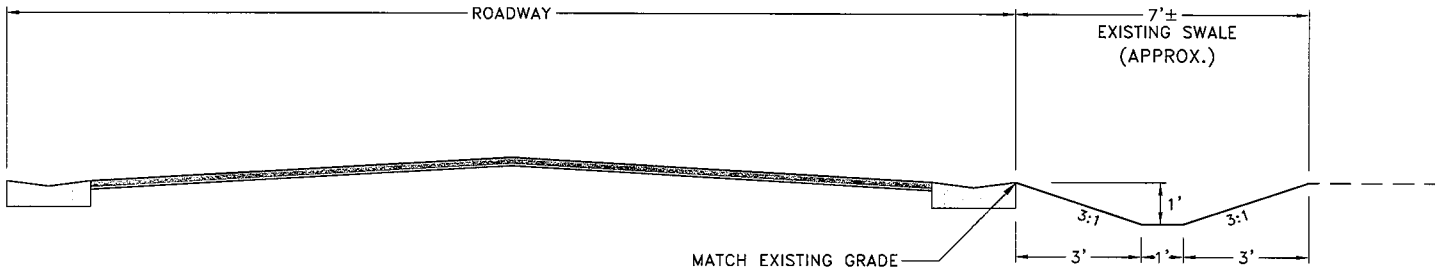

TYPICAL SECTION
N.T.S.

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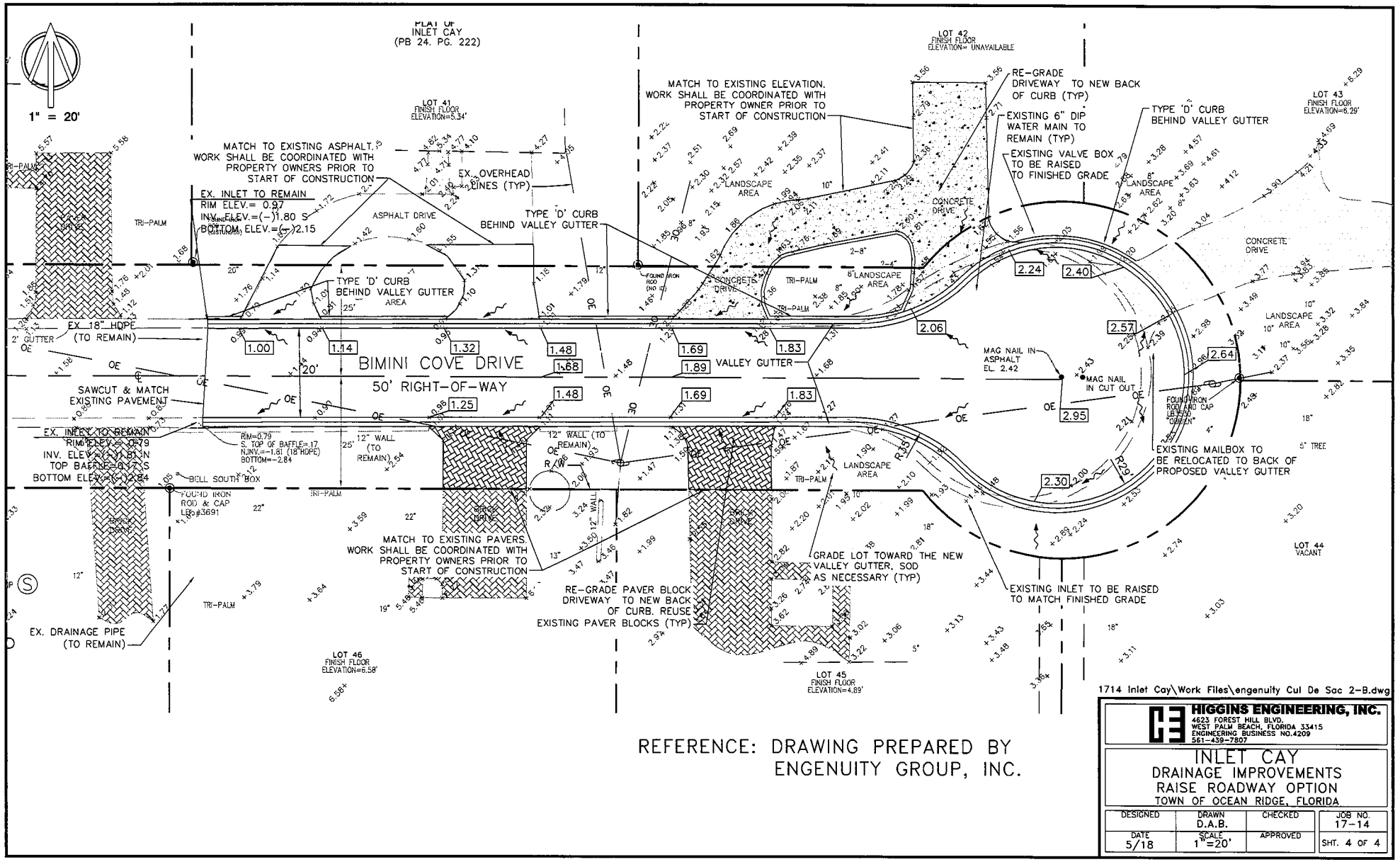
INLET CAY
DRAINAGE IMPROVEMENTS DETAILS
TOWN OF OCEAN RIDGE, FLORIDA

DESIGNED	DRAWN	CHECKED	JOB NO.
F.J.P.	D.A.B.		17-14
DATE	SCALE	APPROVED	SHT. 3 OF 4
5/18	N.T.S.		

EXHIBIT 6



REFERENCE: DRAWING PREPARED BY ENGENUITY GROUP, INC.

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INLET CAY
DRAINAGE IMPROVEMENTS
RAISE ROADWAY OPTION
TOWN OF OCEAN RIDGE, FLORIDA

DESIGNED	DRAWN	CHECKED	JOB NO.
	D.A.B.		17-14
DATE	SCALE	APPROVED	SHT. 4 OF 4
5/18	1"=20'		

EXHIBIT 7

Recommendations

It is recommended that the Town continues its ongoing program for drainage pipe inspections, repair, and replacement. It is also recommended to increase the capacity of the outfall pipes whenever possible.

It is definite that the Town should continue its practice of obtaining soil borings from a site prior to issuance of a building permit. The Town should also continue to recommend the use of piling beneath all foundations and swimming pools.

The drainage alternatives described in this report should be looked at on a case by case basis at individual locations. While these alternatives have varying costs, they are definitely a drainage improvement over existing.