Section 2 Stormwater Analysis

2.1 Existing Drainage

Natural drainage patterns within the watershed were drastically altered in the early 1960's when new land was created on the east side of Lake Shore Drive. The newly created land was built at elevations higher than the road, effectively cutting off the natural sheetflow from the road to the Intracoastal Waterway, also known as the Lake Worth Lagoon. To maintain drainage, three 30-inch diameter outfall pipes were installed spanning the new land from the roadway to the new coastline of the Lake Worth Lagoon. The southern end of the roadway discharges runoff into an existing 60-inch outfall pipe that serves a large portion of the Town.

Most of the created land drains to the Lake Worth Lagoon and does not discharge to the roadway. The road, however, accepts drainage from the west extending to US 1 where the coastal ridge begins. US 1, also known as Federal Highway and Broadway Avenue, includes a drainage system that does not drain into the watershed. Land immediately east of US 1 sheetflows via parking lots and side-streets to Lake Shore Drive. Existing swales and limited inlets and pipes assist in directing the water to the four existing outfalls.

The overall watershed and internal basin boundaries were determined based on topography, existing drainage infrastructure and field visits. ***Figure 2-1*** shows the existing drainage including elevations of the most recent, available LiDAR (Light Detection and Ranging) data (2017), basin boundaries and the locations of existing drainage pipes.

Flooding has been observed at low lying areas and ponding occurs frequently. In 2012, major flooding occurred due to a large storm event that was estimated to exceed 7-inches in magnitude (***Photo 1***). Frequent ponding also occurs due to grading issues where runoff is trapped. ***Photo 2 and Photo 3*** illustrate examples of this. Severe flooding occurred in October 2016 when low lying areas were flooded by a king tide event that pushed water from Lake Worth Lagoon into the street (***Photo 4***).

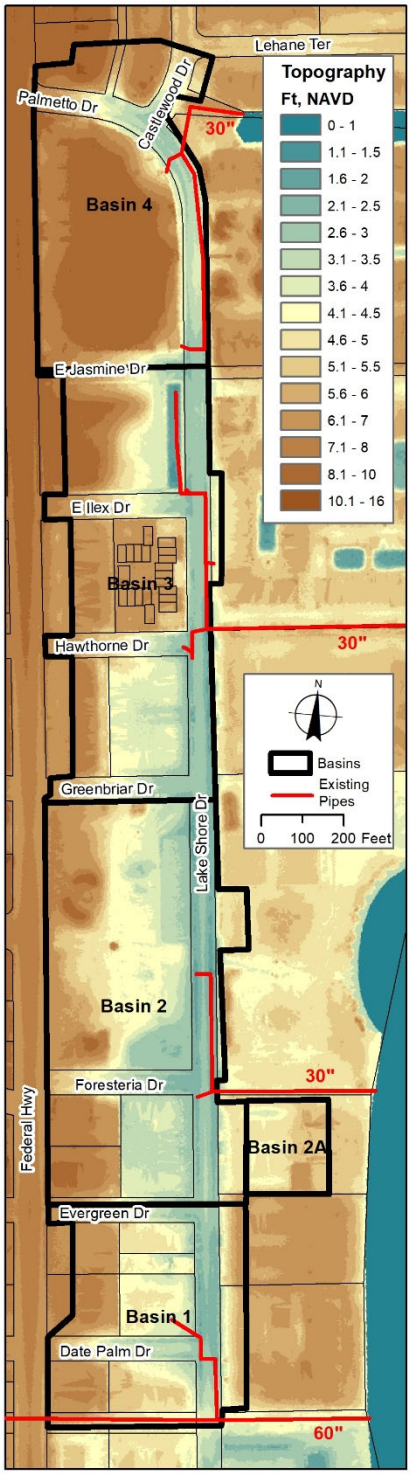


Figure 2-1: Existing Drainage

The existing drainage infrastructure only exists in certain locations. Most of the infrastructure is decades old and in fair to poor condition (see ***Photo 5***). Televising was not part of the project scope, but based on the estimated age of the structures and visual condition, it appears that the system is near the end of its service life. It is recommended that the existing structures not be considered for reuse in the new drainage design with the exception of the outfall pipes.

Photo 1: Pictures taken during flood of 2012 in vicinity of Hawthorn Drive

Photo 2: Intersection of Lake Shore Drive and Evergreen Drive, looking southwest.

Photo 3: Lake Shore Drive, looking south.

Photo 4: King tide flooding at Lake Shore Drive and Date Palm Drive (Oct 2016) looking north

Photo 5: Existing inlet near entrance to Lake Harbour Towers, South.

2.3 Regulatory Requirements

The South Florida Water Management District (SFWMD) is the controlling agency in regard to regulation and enforcement of construction related activities that effect Waters of the State. Lake Worth Lagoon is considered Waters of the State. SFWMD imposes a pre versus post requirement for peak discharge rates associated with a 25-year, 3-day storm event and also requires water quality treatment of a determined volume of runoff based on the amount of impervious area. Treatment is usually accomplished via lakes or dry detention/retention areas.

Since the project area was developed before these rules existed, SFWMD will primarily be concerned with water quality treatment of runoff from any *new* impervious areas. SFWMD requires treatment for up to 2.5 inches of runoff over the new impervious area. Since the road will be widened to provide parallel parking, the new impervious area will need to be treating in some manner. Typical water quality treatment mechanisms for roadways include exfiltration trenches and swales. However, these methods would have limited effectiveness because of the short depth to the water table.

The primary criteria that SFWMD will use to evaluate the project will be the pre vs. post 25-year, 3-day flood stages and peak discharge rates into the Lake Worth Lagoon. Aboveground flood stages cannot be increased as a result of the improvements. Lowering flood stages in one area while increasing flood stages in other areas is not permissible. It is also not allowed to increase the peak discharge rates into the Lake Worth Lagoon. Large watershed scale modeling is sometimes needed to make these assessments.

SFWMD also regulates wetlands including seagrass which may exist in the Lake Worth Lagoon. A seagrass survey will be performed at any locations where changes are proposed such as new outfall pipes. Impacts to seagrass will need to be avoided or mitigated.

2.4 Stormwater Modeling

A flood routing model was set up to simulate the existing drainage systems using Inter-connected Pond Routing ver. 4 (ICPR4) software. This model can simulate various storm events to verify the benefits of potential improvements while verifying the permitability of systems. Specifically, flood stages and peak discharge rates cannot be increased. These criteria are evaluated for a 25-year, 3-day storm event. A 3-year, 1-day storm is used to evaluate the Level of Service (LOS) relative to street flooding.

2.4.1 Hydrology

Subbasins were delineated, as shown in ***Figure 2-1***, to define individual catchment areas that collect runoff and discharge it at determined locations. LiDAR data was used along with locations of existing stormwater infrastructure to determine the hydrologic divides.

Land use and soils have a significant influence over the runoff characteristics within the watershed (see ***Figure 2-2*** and ***Figure 2-3***). The majority of the soils within the project area are classified as Arents-Urban Land Complex, 0 To 5 Percent Slopes (Arents) which is defined by the Natural Resources Conservation Service (NRCS) as "somewhat poorly drained" meaning that there is a lower than average ability to absorb stormwater runoff. Soils in the higher elevations of the watershed include St. Lucie-Paola-Urban Land Complex (St. Lucie), which is defined as "very well drained" with relatively high percolation rates.

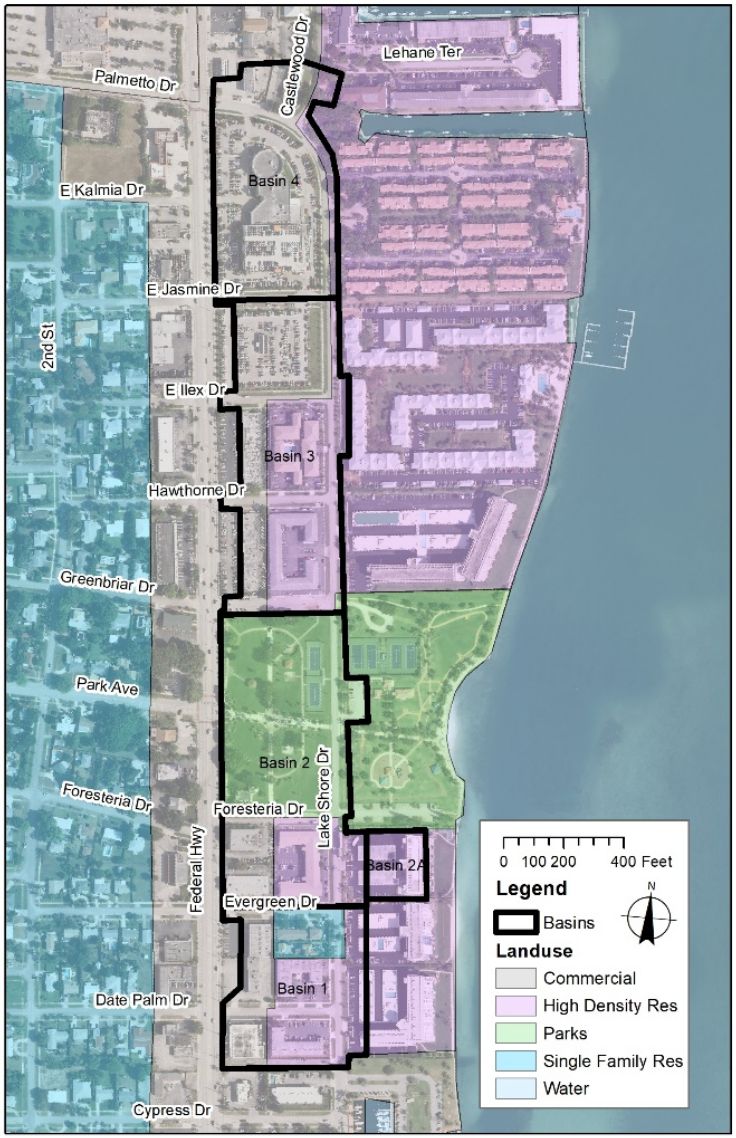


Figure 2-2: Land Use

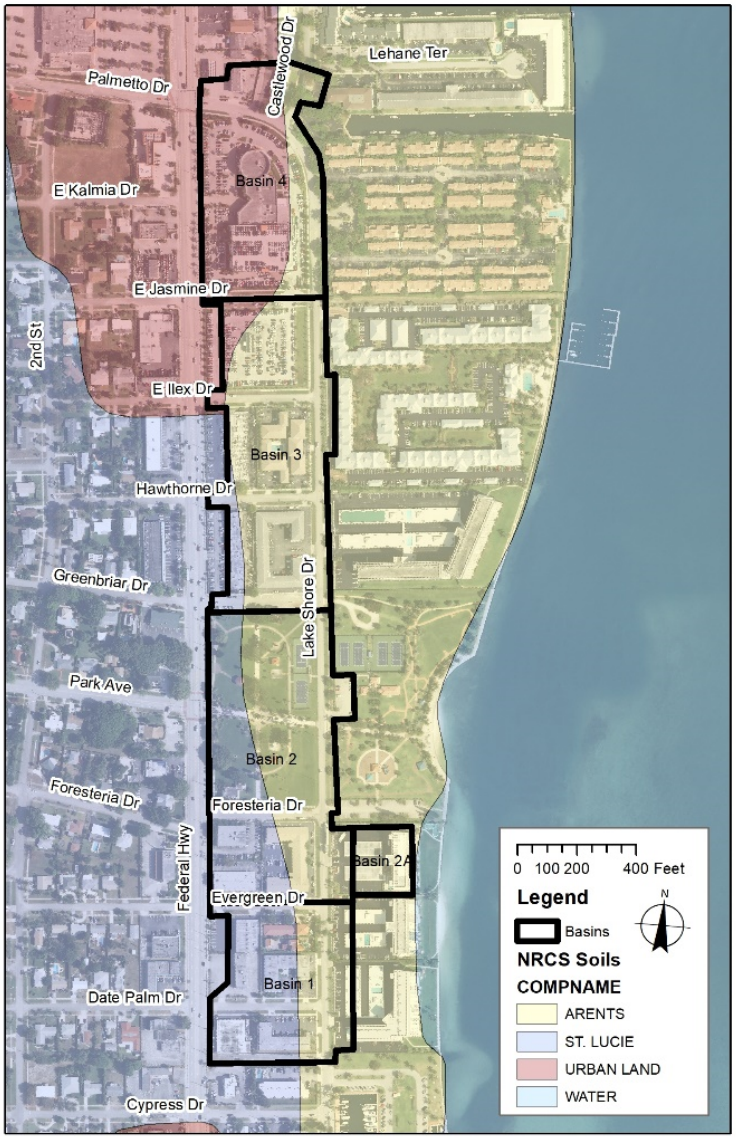


Figure 2-3: Soils

The average depths to the wet season water table varies from 2 to 6 feet. According to SFWMD, the maximum soil storage is 8.18 inches which corresponds to a Curve Number (CN) of 55 for coastal, well drained soils (St. Lucie). Arents soil is considered poorly drained and was designated with a higher CN value of 66 to 84 indicating more runoff and less available soil storage.

These values were used throughout the watershed and were adjusted in the model by impervious values that were applied based on land use. Land use within the area is a mix of high density residential, commercial, park and a small amount of single family residential. Percentages of impervious area per land use range from 25 and 90 percent.

The land use and soils spatial datasets were intersected with the subbasins to create an areal list of land use and soil combinations for each basin. This information is presented in ***Table 2-1*** and was entered into the model's basin parameters. Look-up tables were added for impervious (based on land use) and CN values (based on soils) which the model used to determines each basin's overall soil capacity. These values are also shown in ***Table 2-1***.

Table 2-1: Hydrologic Parameters of Land Use and Soil Combinations

Basin	Landuse	Soil	Area (ac)	CN	Impervious
Basin 1	Commercial	ST. LUCIE	1.70	55	90%
Basin 1	High Density Res	ARENTS	1.77	84	90%
Basin 1	High Density Res	ST. LUCIE	1.14	84	90%
Basin 1	Single Family Res	ARENTS	0.46	84	50%
Basin 1	Single Family Res	ST. LUCIE	0.46	55	50%
Basin 2	Commercial	ST. LUCIE	1.18	55	90%
Basin 2	High Density Res	ARENTS	1.49	84	90%
Basin 2	High Density Res	ST. LUCIE	0.52	55	90%
Basin 2	Parks	ARENTS	4.62	84	25%
Basin 2	Parks	ST. LUCIE	2.20	67	25%
Basin 2A	High Density Res	ARENTS	1.05	84	90%
Basin 3	Commercial	ARENTS	3.01	84	90%
Basin 3	Commercial	ST. LUCIE	0.66	55	90%
Basin 3	Commercial	URBAN LAND	0.56	55	90%
Basin 3	High Density Res	ARENTS	4.42	84	90%
Basin 3	Parks	ARENTS	0.04	84	25%
Basin 4	Commercial	ARENTS	1.33	84	90%
Basin 4	Commercial	URBAN LAND	5.05	55	90%
Basin 4	High Density Res	ARENTS	0.72	84	90%

Time of Concentration (Tc) values were also calculated for each basin based on travel distances, slopes and types of surfaces. Most of the values were less than 10 minutes, which is typically the minimum value used for modeling. For those basins, a value of 10 minutes was used. A value of 12 minutes was used for Basin 3.

The design storm used for the roadway LOS is a 3-year, 1-day storm event which has an associated rainfall amount of 5.8 inches distributed over a 24-hour statistical hydrograph. The design storm used by SFWMD to establish flood stage and discharge criterial is a 25-year, 3-day storm event which has an associated rainfall amount of 13.0 inches distributed over a 72-hour statistical hydrograph. A 10-year, 3-day storm was also run which consists of 9.0 inches distributed over a 24-hour statistical hydrograph.

2.4.2 Hydraulics

The primary drainage features used to convey stormwater during smaller storm event consist of drainage culverts that collect runoff via inlets and transport the water to the Lake Worth Lagoon via four existing outfall pipes. In addition to these inlets and pipes, larger storm events also rely on overland flow between the basins. This occurs when the drainage infrastructure becomes overwhelmed by the amount of runoff. To simulate this in the model, broad crested weirs were placed at subbasin divides. The locations and "irregular" geometry for each weir were determined by producing cross-sectional profiles from the LiDAR information along the subbasin boundaries. These hydraulic features are shown as model elements in ***Figure 2-4*** which was produced from the ICPR4 interface.

A downstream boundary condition node was created to represent tidal conditions in the Lake Worth Lagoon. An average high tide elevation of 1.0 foot, NAVD was used based on monitoring data maintained by SFWMD.

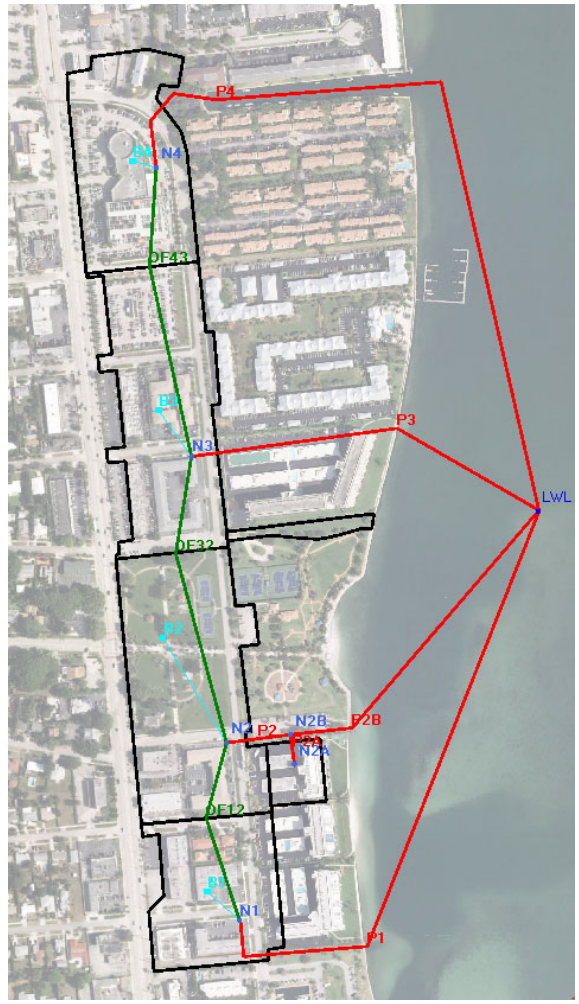


Figure 2-4: ICPR4 Model Network (Basins = Black, Nodes = Blue, Pipe Links = Red, Overland Flow Weirs = Green)

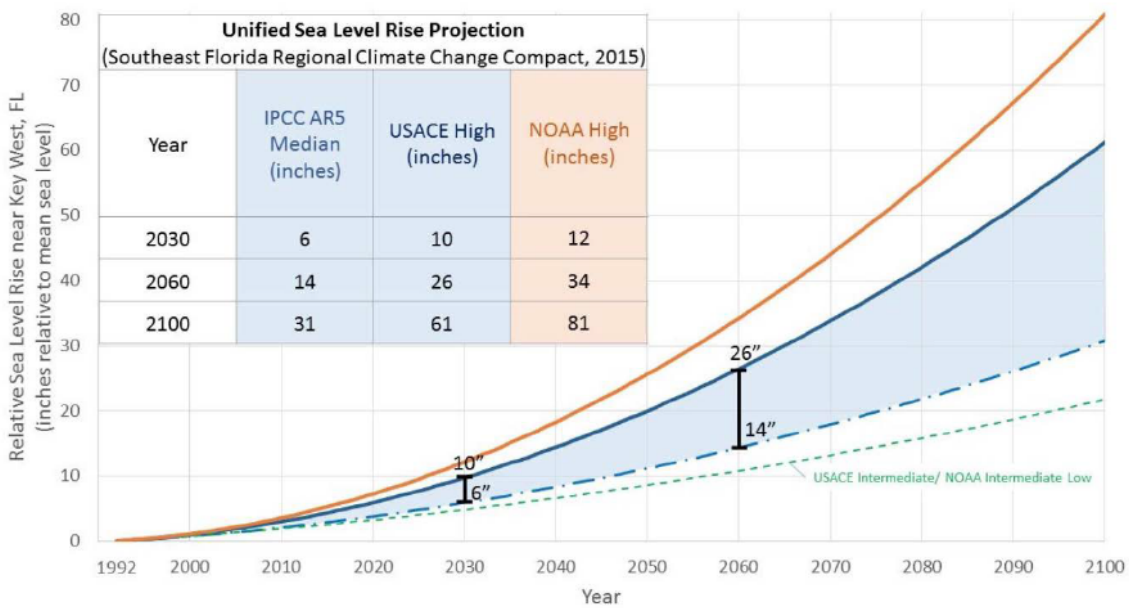
2.5 Sea Level Rise Assessment

SLR events consist of storm surges, king tides and the effects of climate change. All of which can have adverse impacts on gravity-based drainage systems. Storm surges are usually associated with hurricanes and can vary widely depending on the strength and timing of the storm. The effects are two-fold because the events are accompanied by heavy rains. King tides, however, are predictable and rare enough that they usually do not coincide with a major rain

event. Their impacts, however, can be severe. In October of 2016, a king tide event occurred that flooded Lake Shore Drive. It is estimated that the tide associated with that event was 1.4 feet above normal high tide.

The Unified Sea Level Projection was published in October 2015 by the Southeast Florida Regional Climate Change Compact (SEFRCCC) with regional projections for the period from 1992 through 2100 based on projections and scientific literature released since 2011. This publication is being used by local municipalities for SLR planning purposes. The unified projections include three global mean curves that were regionally adapted to account for observed acceleration in SLR in South Florida as shown in ***Figure 4***. The three curves consist of an adjusted "NOAA High" curve, U.S. Army Corps of Engineers (USACE) "High" curve (same as the "NOAA Intermediate-High"), and the median of the Intergovernmental Panel on Climate Change Fifth Assessment Report Representative Concentration Pathway 8.5 scenario (i.e. "IPCC AR5 Median" curve). The "USACE Intermediate", which is equivalent to the "NOAA Intermediate-Low" curve, was also included to reflect the projection based on a significant reduction in greenhouse gas emissions, which is not likely given the current emission trends. The "USACE Intermediate/ NOAA Intermediate-Low" curve is not part of SEFRCCC's recommendations.

SEFRCCC Unified Sea Level Rise Projection (SEFRCCC Sea Level Rise Work Group, 2015)



Unified Sea Level Rise Projection (Southeast Florida Regional Climate Change Compact, 2015)

Year	IPCC AR5 Median (inches)	USACE High (inches)	NOAA High (inches)
2030	6	10	12
2060	14	26	34
2100	31	61	81

Figure 2-5: Sea Level Rise Projections

For this project, the 2060 USACE High prediction was used. According to the graph in ***Figure 2-5***, the change in sea level between 2018 and 2060 is approximately 20 inches for that prediction. This corresponds to 2060 average high tide elevation of 2.7 feet, NAVD. The model was modified to reflect a sea level rise of 1.7 feet corresponding to the year 2060.

2.6 Drainage Improvement Alternatives

2.6.1 Model Scenarios

Several alternatives were developed to improve and maintain positive drainage for the project area for SLR events. The elements were considered as described below:

- Check valves at pipe outlets
- Raise road elevations
- Pump station
- Detention basin
- Combinations of the above
- Sea level rise assessment

In consideration that the Town's Vision Lake Park plans for the roadway include additional impervious area, it will be necessary to provide water quality treatment of runoff for the new impervious area with methods approved by SFWMD. Acceptable treatment methods include dry detention, swales, lakes or exfiltration trenches. Because of the low depths to the water table, these methods become problematic. An offsite dry detention area is the most practical method and was incorporated in many of the modeling scenarios as described below:

Scenario	Description
Existing	Existing drainage system with no SLR events
Existing Past SL	Existing drainage system with past sea level (-0.5 feet) prior to 1992
Existing w/SLR	Existing drainage system with SLR of 1.7 feet (2060)
Valve Only w/SLR	Add inline check valves to the four existing outfall pipes
Pump and Detention	Add collection system and pump water to a dry detention area located in Kelsey Park with no SLR events. Station includes 1-10 cfs duty pump and 1-20 cfs primary pump and check valves on existing outfall pipes.
Pump & Detention w/SLR	Add collection system and pump water to a dry detention area located in Kelsey Park with SLR of 1.7 feet. Station includes 1-10 cfs duty pump and 2-20 cfs primary pumps and check valves on existing outfall pipes.
Raised Rd & Detention w/SLR	Raise road by 1.5 to 2 feet. Add collection system and drain water via gravity to a dry detention area located in Kelsey Park with SLR of 1.7 feet.
Raised Rd & Det & Pump w/SLR	Raise road by 1.5 to 2 feet. Add collection system and pump water to a dry detention area located in Kelsey Park with SLR of 1.7 feet. Station includes 1-10 cfs duty pump and 2-20 cfs primary pumps and check valves on existing outfall pipes.

A controlling factor in the design of the drainage improvements is the allowable discharge rate which is mandated by SFWMD to not exceed the existing peak discharge rate for a 25-year, 3-

day storm event. The 'Existing' model scenario establishes the allowable discharge rate of 57.8 cubic feet per second (cfs). The 'Existing Past SL' scenario was run to assess whether the discharge rate was higher when the current drainage system was original constructed. The results suggest that an allowable peak discharge rate of 62.6 could be supported.

Because of the limitation of the peak discharge rate, the 'Pump and Detention' scenario was developed using only one primary pump and turning off the duty pump before the peak of the storm. Otherwise, the combined pumps and outfall pipes would have exceeded the allowable discharge rate. The plan for the pump station would be to construct it to accommodate an additional pump in the future. As SLR continues to occur, diminishing the capacity of the pipes to discharge via gravity, the need for the additional pump will likely be required in 15 to 20 years.

The 'Raised Rd' scenarios were developed by modifying the LiDAR dataset to fill any areas in the roadway up to elevation 4.0 feet, NAVD which would account for a combined SLR due to climate change and king tides. The detention area was retained in these scenarios because it was assumed that the road would be widened if raised, per the Vision Lake Park plan.

2.6.2 Model Results

The results for the modeled scenarios are presented in ***Table 2-2*** which provides a comparison of the results with the existing conditions model. The basins referred to in the table are shown in ***Figure 2-1*** through ***Figure*** 2-4. LWL refers to Lake Worth Lagoon. Results for three storm events are provided (3-year, 1-day; 10-year, 1-day and 25-year, 3-day events). For each of the scenarios, the peak stage is reported along with the change in the stage compared to the existing conditions models. Color coding has been applied to the table to illustrate the magnitude of increases or decreases in peak stages. The change shown for the past and future sea level scenarios ('Existing' system) was compared to the current sea level condition which includes an average high tide of 1.0 feet NAVD. The change shown for LWL, for example, reflects the change in sea level that was assumed. The design alternative scenarios were compared to the version of the 'Existing' with the matching sea level conditions. Models denoted with 'w/SLR' include storm surge and king tide events as well as the eventual effects of climate change.

Based on the results, the following observations can be made:

- A comparison of current versus past sea levels shows that peak flood stages were moderately lower prior to 1992 when SLR effects were first perceived. The change, however, associated with the predicted levels in 2060 is much greater with an average rise in flood stages of 6-inches. It is important to note that other SLR events such as storm surges and king tides have, and will occur again, prior to 2060.

Table 2-2: Model Results – Comparison of Peak Stages (Feet, NAVD)

Basin	Storm	Existing	Existing Past SL Pre-1992	Change	Existing w/SLR	Change	Valve Only w/SLR	Change	Pump & Detention	Change	Pump & Detention w/SLR	Change	RaisedRd & Detention w/SLR	Change	RaisedRd & Det & Pump w/SLR	Change
LWL	3Y1D	1.00	0.50	-0.50	2.70	1.70	2.70	1.70	1.00	0.00	2.70	0.00	2.70	0.00	2.70	0.00
N1	3Y1D	2.79	2.68	-0.11	3.33	0.54	3.32	0.53	2.69	-0.10	2.72	-0.61	3.70	0.37	3.44	0.11
N2	3Y1D	2.79	2.69	-0.10	3.33	0.54	3.32	0.53	2.67	-0.12	2.70	-0.63	3.69	0.36	3.44	0.11
N2A	3Y1D	4.31	4.31	0.00	4.33	0.02	4.33	0.02	4.31	0.00	4.30	-0.03	4.36	0.03	4.30	-0.03
N3	3Y1D	2.83	2.74	-0.09	3.33	0.50	3.32	0.49	2.69	-0.14	2.72	-0.61	3.69	0.36	3.44	0.11
N4	3Y1D	2.82	2.73	-0.09	3.32	0.50	3.32	0.50	2.71	-0.11	2.74	-0.58	3.69	0.37	3.44	0.12
LWL	10Y1D	1.00	0.50	-0.50	2.70	1.70	2.70	1.70	1.00	0.00	2.70	0.00	2.70	0.00	2.70	0.00
N1	10Y1D	3.28	3.21	-0.07	3.70	0.42	3.71	0.43	3.21	-0.07	3.19	-0.51	3.99	0.29	4.00	0.30
N2	10Y1D	3.28	3.21	-0.07	3.71	0.43	3.72	0.44	3.21	-0.07	3.18	-0.53	3.99	0.28	4.00	0.29
N2A	10Y1D	4.64	4.64	0.00	4.67	0.03	4.67	0.03	4.64	0.00	4.64	-0.03	4.69	0.02	4.63	-0.04
N3	10Y1D	3.28	3.21	-0.07	3.71	0.43	3.71	0.43	3.21	-0.07	3.18	-0.53	3.99	0.28	4.00	0.29
N4	10Y1D	3.28	3.20	-0.08	3.70	0.42	3.71	0.43	3.22	-0.06	3.19	-0.51	3.99	0.29	4.01	0.31
LWL	25Y3D	1.00	0.50	-0.50	2.70	1.70	2.70	1.70	1.00	0.00	2.70	0.00	2.70	0.00	2.70	0.00
N1	25Y3D	3.38	3.31	-0.07	3.78	0.40	3.80	0.42	3.35	-0.03	3.29	-0.49	4.05	0.27	4.09	0.31
N2	25Y3D	3.38	3.32	-0.06	3.78	0.40	3.80	0.42	3.35	-0.03	3.28	-0.50	4.04	0.26	4.08	0.30
N2A	25Y3D	4.69	4.69	0.00	4.72	0.03	4.72	0.03	4.69	0.00	4.69	-0.03	4.74	0.02	4.68	-0.04
N3	25Y3D	3.38	3.31	-0.07	3.78	0.40	3.80	0.42	3.35	-0.03	3.28	-0.50	4.04	0.26	4.08	0.30
N4	25Y3D	3.38	3.31	-0.07	3.78	0.40	3.79	0.41	3.35	-0.03	3.29	-0.49	4.04	0.26	4.09	0.31

DT	25Y3D								4.34	N/A	4.82	N/A	3.93	N/A	4.07	N/A
Discharge (cfs)		57.8	62.6		45.4		41.3		57.7		65.7		69.2		51.8	

- Adding only valves will not improve drainage during a storm event. This was expected because storm events create positive head on the system that would maintain an open valve, essentially functioning the same as having no valve. The valves, however, are still considered to be an important feature considering their ability to prevent dry-weather flooding due to SLR events such as king tides.

- The scenarios involving raising the road resulted in higher flood stages within the watershed. Although the road would not be flooded, the higher stages would have an adverse impact on existing developments adjacent to the road. This occurred regardless that a detention area was included. Adding a pump station helped to reduce the increases, but the increased stages would still occur – in addition to the increases due solely to SLR. This is due to a net loss of storage in the system.

- The pump and detention area scenario provides a moderate improvement compared to the existing system without SLR. However, there is a significant improvement when run with SLR conditions. This is illustrated in Figure 2-6 which shows the flood depths for the 3-year, 1-day storm with a SLR event. Another factor to consider is the reduction in the duration of flooding. This is shown with time-series graphs in Figure 2-7 for all three storm events. The fluctuations shown in the 'Proposed' stages reflect the on and off activations of the pumps.

Figure 2-6: Flood Depths for Existing vs. Proposed (Pump & Detention) System during 3-Year, 1-Day Storm Event

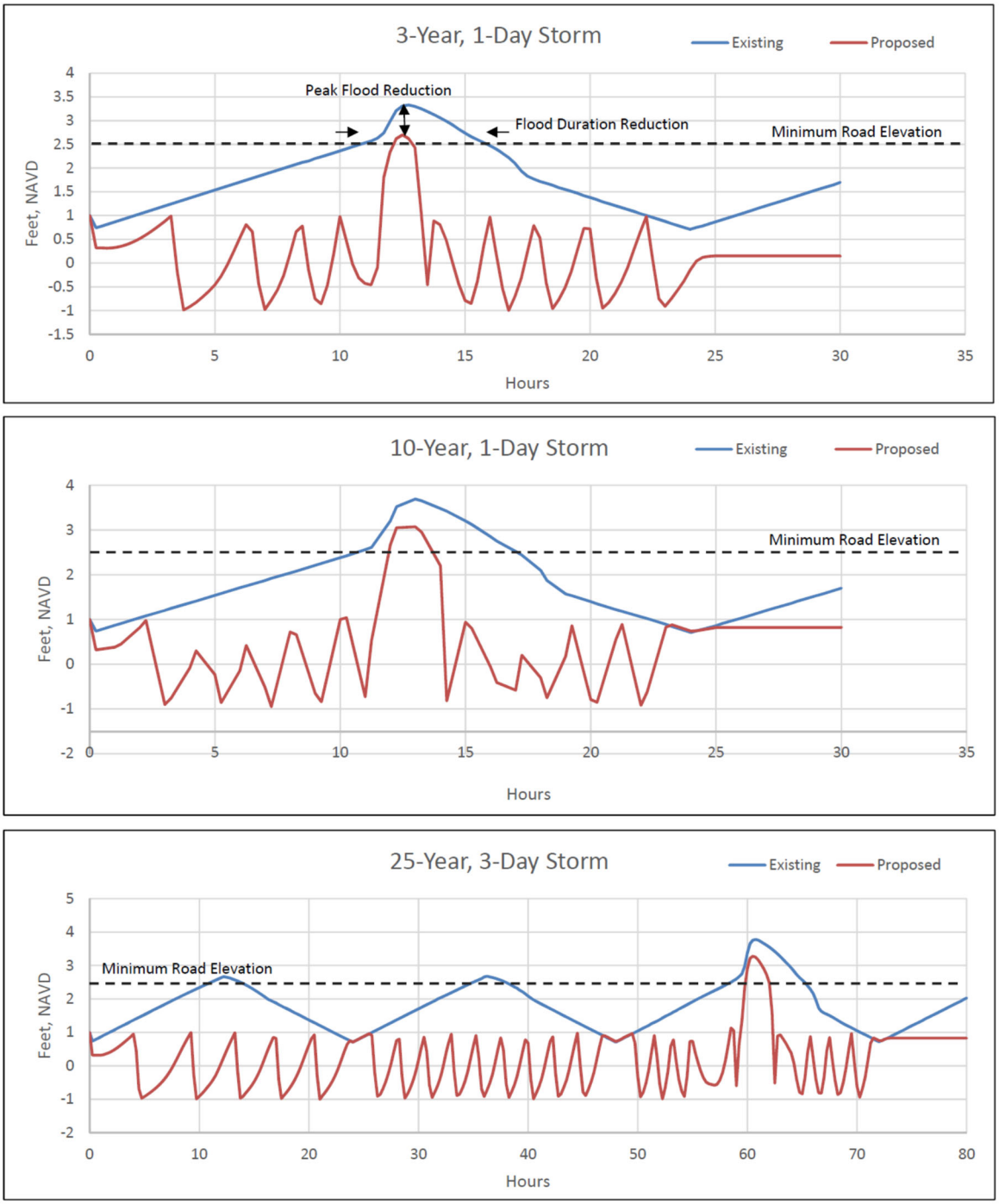


Figure 2-7: Stage vs. Time for Existing and Proposed (Pump & Detention) Systems with SLR

2.7 Stormwater Improvement Recommendations

Based on the Town's Vision Lake Park site plan for this portion of Lake Shore Drive, it is recommended that road runoff be directed to the grassed areas where inlets and pipes will collect and convey the water to its destination. Openings in the curbs can be made corresponding to low points in the road. A swale within each grassed area can direct the runoff to an inlet providing a first flush of water quality treatment within the grassed areas.

The modeling results show that the 'Pump and Detention' alternative would provide the most flood protection for the project area and would extend that protection to 2060 and beyond. Other benefits of this alternative include the addition of water quality treatment to the system and the ability to discharge water at the maximum allowable rate regardless of the downstream water level. It is possible to further enhance the capabilities of the detention area by planting native, salt tolerant plant species in the detention area, essentially producing a large bioswale. The drainage improvements specific to the 'Pump and Detention' alternative are shown in ***Figure 2-8***.

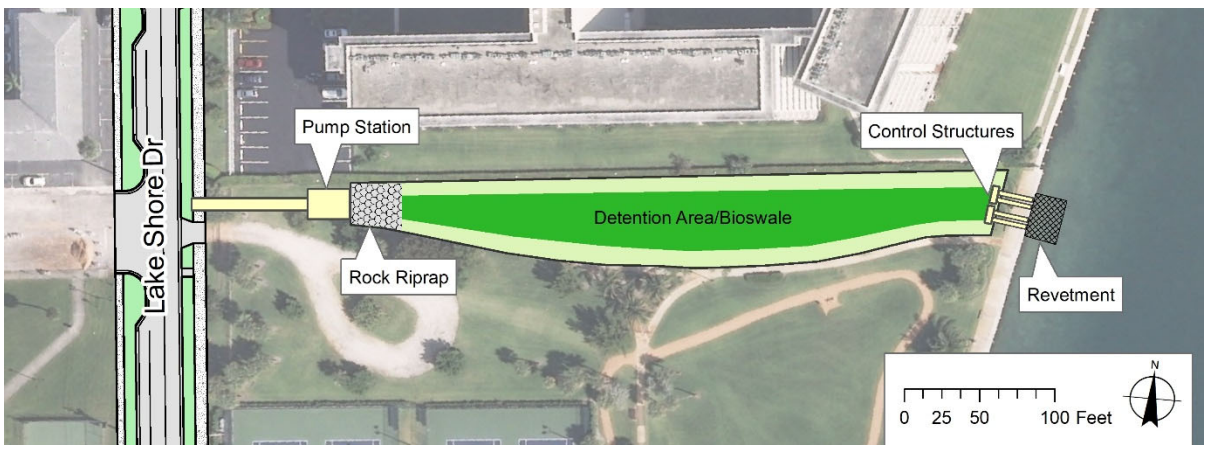


Figure 2-8: Proposed (Pump & Detention) System

The proposed system differs from conventional water management systems which rely internally on gravity to deliver water to a retention/detention area. If pumps are needed for such a system, they would typically be located at the discharge point of the basin. For this project, the road is already at the lowest end of the basin and it is not feasible to create a dry detention area at a lower elevation because of the closeness to the water table. Since a pump station is needed to combat SLR, it would be advantageous to locate the station internally in the system upstream of a dry detention area. Doing so allows the detention area to be raised to a higher elevation, high enough for water to percolate and also high enough for it to discharge via gravity to the LWL. The existing sidewalk on the south side of the detention area will need to be replaced and raised approximately one foot so that stormwater can be entirely contained within the detention area during the 25-year, 3-day design storm event.

Since the effects of climate change will not be fully realized for some time, it is possible to continue utilizing the gravity outfall pipes and partially install the pumps until it becomes

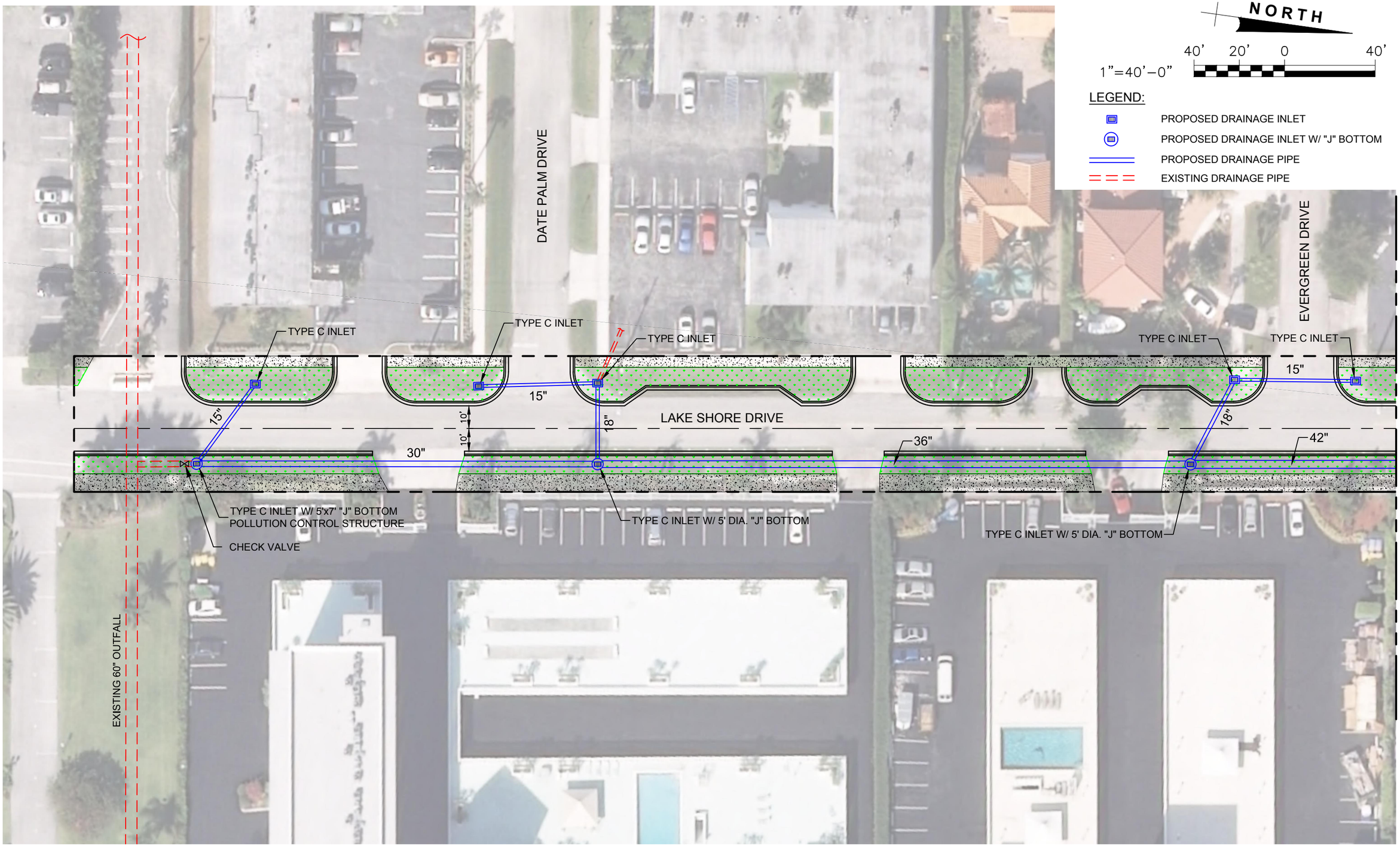
necessary to increase the capacity of the pump station. The station infrastructure, however, should be built to accommodate the ultimate capacity. A temporary combined pump and gravity system has the benefit of lower energy costs while including the ability to pump in the event of SLR due to storm surges or king tides. The gravity system provides a back-up in case of a power failure. Ultimately, however, a generator will need to be installed as the drainage system become more reliant on the pump station.

A model was developed for an interim combined system to size the amount of pumping that can occur without exceeding the allowable discharge rate. Based on the model results, a 10-cfs duty pump and 20-cfs primary pump, with restricted levels of operation, can be used in unison with the gravity outfalls. For the full SLR conditions in the future, a second 20-cfs primary pump will need to be installed. The advantage of having two equally sized primary pumps is that they can be alternated in use by the motor control center to distribute even runtimes. Also, having two primary pumps provides some redundancy in case of a pump failure. Preliminary calculation of the total dynamic head indicate that a 20-hp motor will be needed for the duty pump and 30-hp motors will be needed for the primary pumps. The pumps will be axial flow

Rock riprap can be used to dissipate the flows into the detention area. It is recommended that the detention area include a bottom elevation of 3.0 feet, NAVD with an internal meandering swale with an invert elevation of 2.5' NAVD. Twin FDOT Type 'H' inlet structures can be modified to include 4-foot wide weirs and a 3-inch diameter bleeder orifice that will assist in bringing down the water level to maintain a dry system.

Aspects of other model scenarios are also recommended. In-line check valves should be installed at the four gravity outfall pipes. This will protect the road from king tides and other SLR conditions and avoid the potential of activating the pumps and recirculating the water to and from the Lagoon. Also, the portions of the road crowns in the lowest points of the road can be raised by a couple of inches to provide a 3-year LOS for the entire roadway. This produces a minor reduction in storage that is easily compensated by the addition of the detention area.

Conceptual drawings for the entire proposed drainage improvements are provided in ***Figure 2-9*** including the future roadway site plan.



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LAKE SHORE DRIVE DRAINAGE IMPROVEMENTS

PROPOSED STORMWATER SYSTEM

FIGURE: 2.9

SHEET: 1 OF 7

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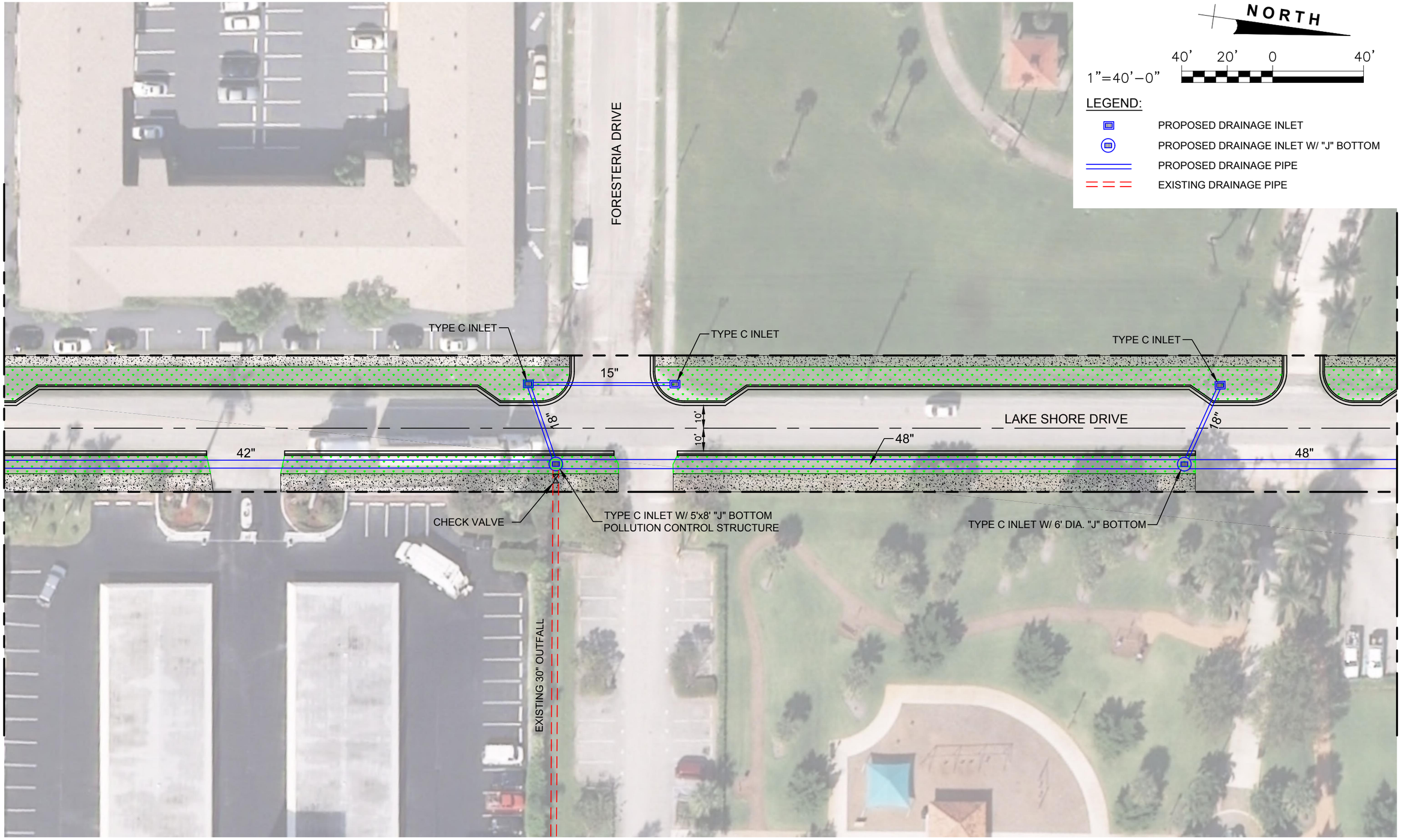

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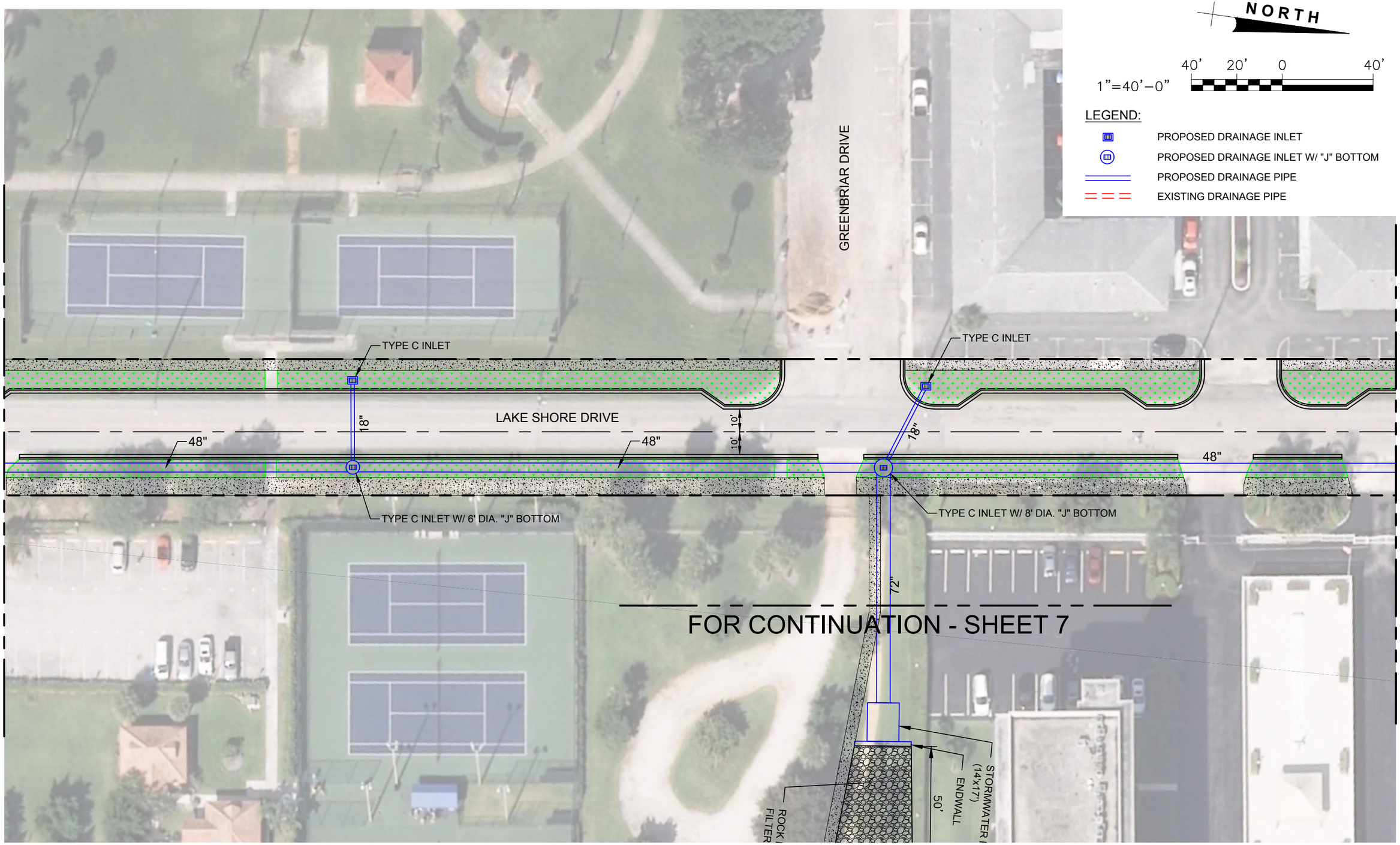
LAKE SHORE DRIVE DRAINAGE IMPROVEMENTS

PROPOSED STORMWATER SYSTEM

FIGURE:
2.9
SHEET:
2 OF 7



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LAKE SHORE DRIVE DRAINAGE IMPROVEMENTS

PROPOSED STORMWATER SYSTEM

FIGURE: 2.9

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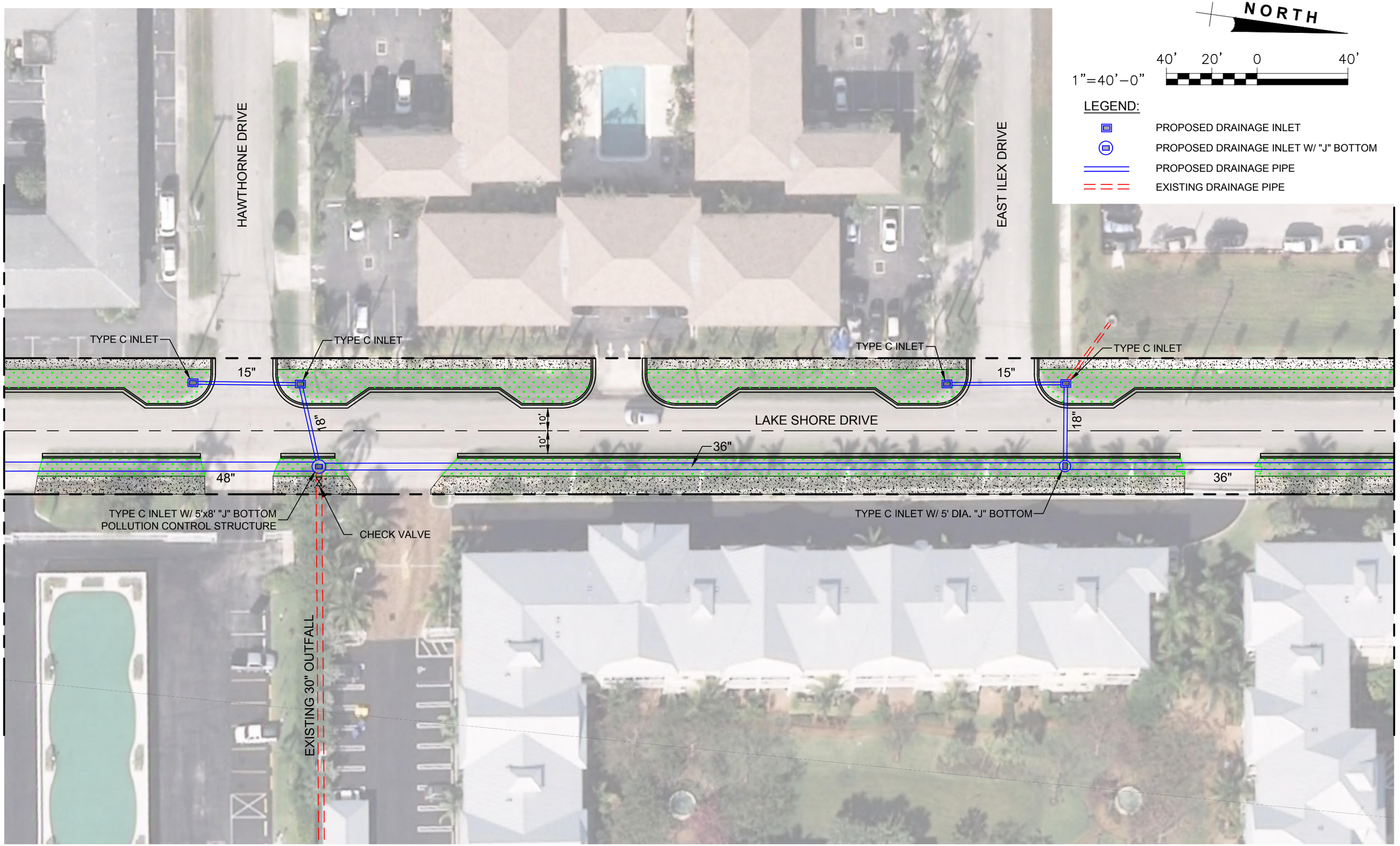

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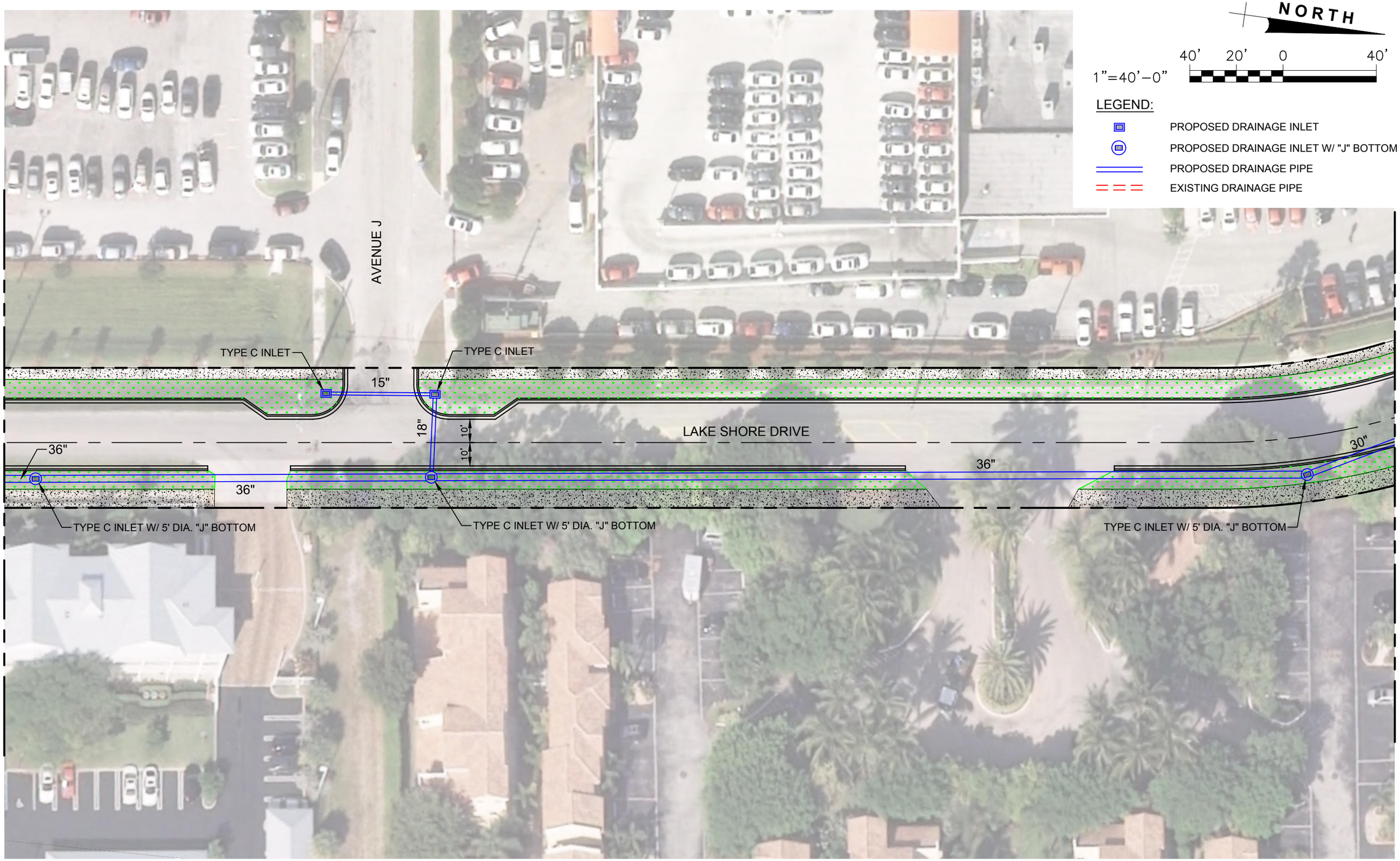
LAKE SHORE DRIVE DRAINAGE IMPROVEMENTS

PROPOSED STORMWATER SYSTEM

FIGURE:
2.9

SHEET:
4 OF 7



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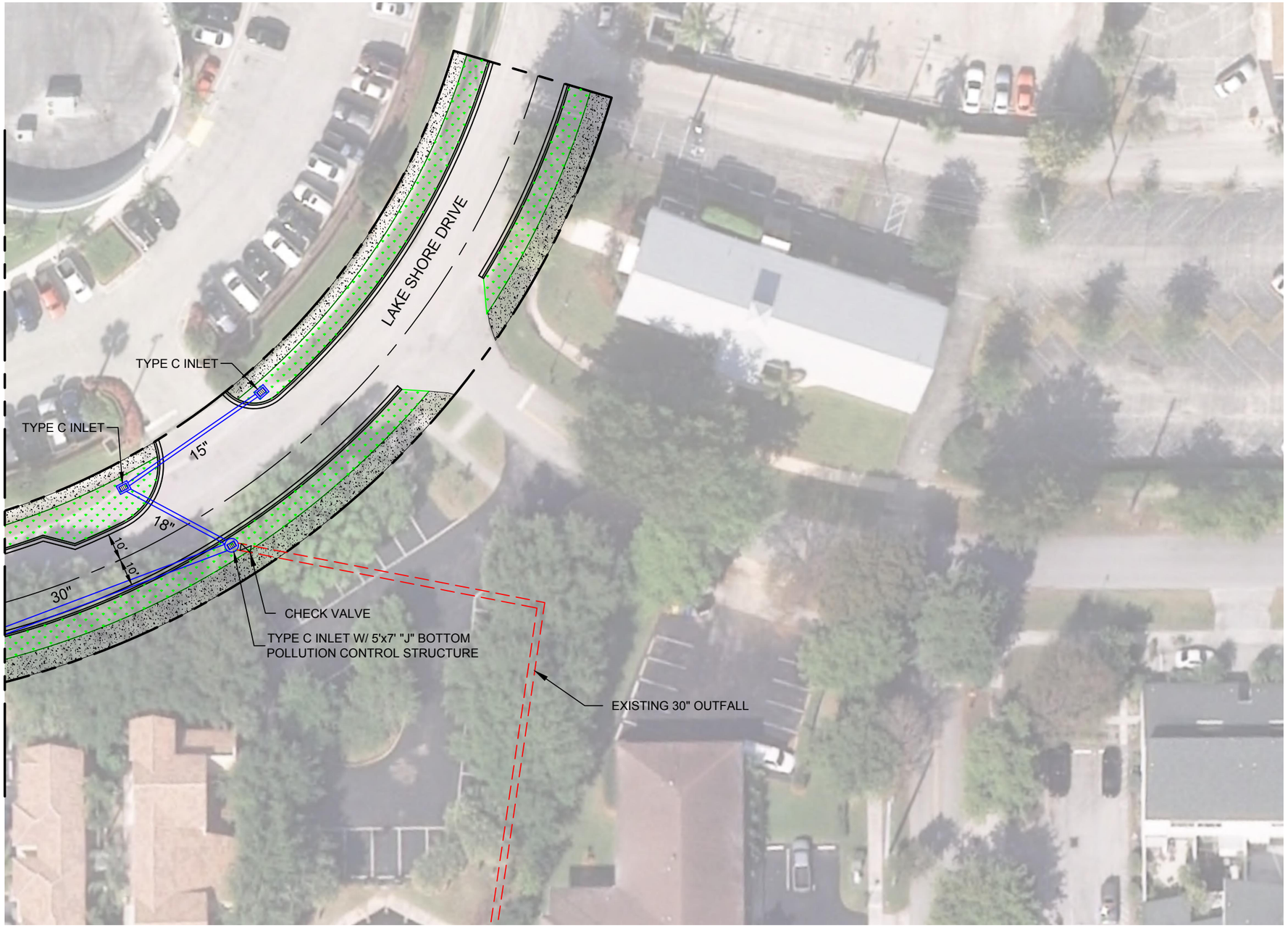
LAKE SHORE DRIVE DRAINAGE IMPROVEMENTS

PROPOSED STORMWATER SYSTEM

FIGURE:
2.9

SHEET:
5 OF 7



NORTH

1"=40'-0"

40' 20' 0 40'

LEGEND:

- PROPOSED DRAINAGE INLET
- PROPOSED DRAINAGE INLET W/ "J" BOTTOM
- PROPOSED DRAINAGE PIPE
- EXISTING DRAINAGE PIPE

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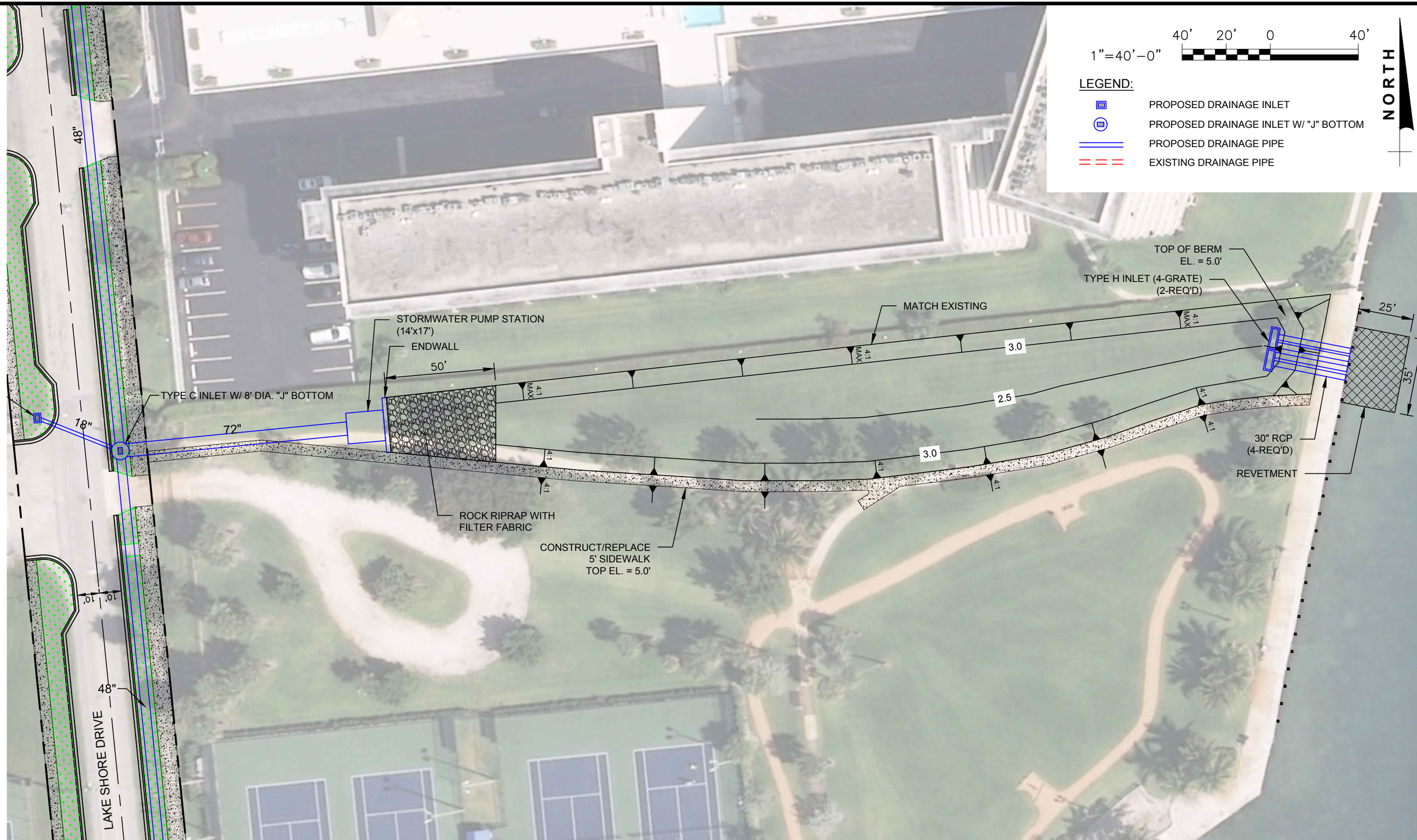
LAKE SHORE DRIVE DRAINAGE IMPROVEMENTS

PROPOSED STORMWATER SYSTEM

FIGURE: 2.9

SHEET: 6 OF 7



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LAKE SHORE DRIVE DRAINAGE IMPROVEMENTS

PROPOSED RETENTION AREA LAYOUT

FIGURE: **2.9**

SHEET: 7 OF 7

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