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Replacing Critical Force Mains Using HDD Methods in Coastal Areas of the City of Sarasota

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ABSTRACT

In 2010, Stantec assisted the City in taking proactive steps to keep its utility infrastructure up-to-date. An evaluation was conducted to prioritize the replacement of force mains during the period from 2010 to 2020. The prioritization of replacing the force main elements was developed using a weighted scoring matrix that identified the risk of force main failure or loss of operational capacity. The criteria evaluated for the prioritization matrix included age, material, pipeline velocities, redundancy, and critical location.

The results of this evaluation indicated multiple aging cast iron and asbestos concrete force mains as high-priority, largely due to their proximity to the marine waters of Sarasota Bay. These critical replacements were designed for installation using horizontal directional drill (HDD) methods due to the need for subaqueous crossings and the proximity to City park spaces, commercial areas, and high-end residential neighborhoods. An emphasis was placed on the construction challenge associated with minimal space and Maintenance of Traffic plan for pipe layout and equipment during drilling operations.

The replacements were bid as two projects: the Keys Force Main Replacement Project and the Gulfstream/Alderman Force Main Replacement Project. As a means of reducing construction costs, both projects included bid alternates, allowing the contractor to select Fusible PVC (FPVC) pipe or HDPE pipe of an equal inner diameter (one nominal size larger). Total, the projects included approximately 18,000 feet of HDD installation of pipelines ranging from 4-inch to 24-inch in diameter, use of HDPE and FPVC, and nine subaqueous crossings of environmentally sensitive marine waters.

1. INTRODUCTION

Stantec was retained by the City of Sarasota to conduct an evaluation and prioritize the replacement of force mains for the period from 2010 to 2020. Stantec first developed an inventory of 183 force main elements which comprise the City's entire force main system; over 175,000 feet of pipeline. Our final inventory identified the force main segments by age, type, material and size. Stantec also conducted a hydraulic analysis of the force main system, which resulted in recommendations to upsize several force main elements.

The prioritization for replacing the force main elements was developed using a weighted scoring matrix that identified the risk of force main failure or loss of operational capacity. We evaluated several criteria for the prioritization matrix including age, material, pipeline velocities, redundancy, and environmentally sensitive location.

The final list was issued as the City's 10-year Force Main Replacement Program. The force main segments given the highest priority are shown in the table below.

Table 1: City of Sarasota 10-Year Force Main Replacement Priority List

	From:	To:	Pipe Size	Pipe Type	Pipe LF	Age as of 2010	Repl. Pipe Size	Total Points
X	LS #17 (660 Ohio Place; @ SAL RR)	12" FM #800750 (Osprey & Bros. Geenan Way)	12	AC	360	60	12	**107**
D	36" CI pipe to Headworks	WWTP Headworks	36	CI	75	60	36	**99**
D	30" CI pipe to Headworks (to SW)	WWTP Headworks	30	CI	56	60	30	**98**
	NW corner Cocoanut Ave & 10th St.	SW corner Cocoanut Ave & 17th St.	12	AC	2,650	60	12	**98**
	E side of Cocoanut Ave & 17th St.C/L	17th St. 60' W of Orange Ave. C/L	16	AC	1,990	60	16	**98**
D	30" CI pipe to Headworks	West to capped end	24	CI	22	60	24	**97**
B	Osprey Ave & Brother Geenan Way	Osprey Ave @ Ringling Blvd	18	AC	1,760	60	24	**95**
C	S of Seaboard RR tracks (Gillespie)	Gillespie ROW 220' N of Buffalo C/L	20	AC	880	60	24	**95**
X	Osprey Ave 21' N of Hudson Bridge	Osprey Ave & Brother Geenan Way	14	AC	1,265	60	14	**95**
	LS #14 (288 Midwest Pkwy; @ Davis Blvd)	MH #905243202400 (Fruitville & Midwest)	4	AC	1,400	50	6	**93**
	Osprey Ave. 50' S. of 17th St C/L	Gillespie & North Row of 12th St.	16	AC	1,910	60	16	**93**
	Gillespie & South Row of 12th St	24" FM #800790 (Gillespie 220' N. of Buffalo)	16	AC	430	60	16	**93**
	US 41 40' N of Whitaker Bayou Bridge	US 41 north of Whitaker Bayou Bridge	16	AC	35	60	16	**93**
	US 41 S of Whitaker Bayou Bridge	24" FM #801010 (17th St. 10' east of US 41)	16	AC	980	60	16	**93**
A	Blvd of Presidents 40' N of Cleveland Dr	MH #903054000500 (Blvd of Pres; S of Polk)	12	AC	1,679	51	12	**91**
A	LS #33 (303 Bird Key Dr; @ Bird Key Yacht Clb)	31' S of LS #32; @ BOC	8	AC	250	50	8	**90**
X	Pomelo Ave @ Hudson Bayou	Osprey Ave 130' S of Hudson Bridge	14	AC	910	60	14	**90**
X	Osprey Ave 116' S of Hudson Bridge	Osprey Ave 21' S of Hudson Bridge	14	AC	95	60	14	**90**
	LS #24 (1563 Sandpiper Ln; @ Oriole Dr)	MH #900761508600 (McClellan & Hashay)	4	AC	470	57	4	**89**
A	LS #35 (450 Bird Key; 180' N of Spoonbill)	MH #903335002500 (Bird Key Dr @ Bobwhite)	4	CI	224	50	4	**88**
A	John Ringling Causeway @ East Coon Key	John Ringling Causeway @ West Bird Key	14	CI	1,020	51	14	**88**

Table 1: continued

A	32' N of LS #32; 3' E of BOC	14" FM #803050 Ringling Cswy @ Bird Key Dr	8	AC	1,960	50	8	**86**
D	Gillespie ROW 220' N of Buffalo C/L	21' W of 30" CI pipe @ WWTP	24	CI	21	60	24	**86**
C	Osprey Ave @ Ringling Blvd	Storm ditch N of 10 th St. (@Gillespie)	20	AC	4,250	60	24	**85**
	LS #13 (3400 Calliandra Dr; @ Breezemount)	MH #904041207500 (12 St. @ Lockwood)	6	AC	6,020	48	8	**84**
	Gulfstream Ave & Cocoanut Ave	Cocoanut Ave & 4th St	24	AC	1,625	42	24	**83**
	US 41 N of Whitaker Bayou Bridge	US 41 south of Whitaker Bayou Bridge	16	CI	80	60	16	**83**
	LS #39 (2597 Hillview St; @ Arlington Park)	Floyd St @ School Ave	10	AC	4,180	49	10	**80**
X	Osprey Ave 21' S of Hudson Bridge	Osprey Ave 21' N of Hudson Bridge	14	CI	90	60	14	**80**

X FM to be abandoned as part of LS 87 project (2010-2011 construction)
A FM replacement work under design in 2010
B 18" AC Osprey Ave FM replacement work previously prioritized to increase pumping rates at LS 16
C 20"AC FM replacement work previously prioritized to increase pumping rates at LSs 16, 17, 87
D WWTP yard piping improvements: previously prioritized to create piping redundancy

Since the development of this force main CIP list, the City has commenced design and construction of several of the recommended improvements. These improvements are vital to the long term health and safety of the City and its surrounding waters. Among the segments identified as being the top priorities for replacement are segments transmitting wastewater on and from the City's barrier islands. These segments include multiple subaqueous horizontal directional drill (HDD) crossings of various portions of Sarasota Bay, which will be the primary focus of this paper. Force main installations to be discussed include the following:

- Bird Key Force Main Replacements
- North Siesta Key Bridge Force Main Replacement
- Coon Key Bridge Force Main Replacement
- Coon Key Bridge Water Main Replacement
- Keys Force Main Replacements
- Gulfstream/Alderman Force Main Replacement

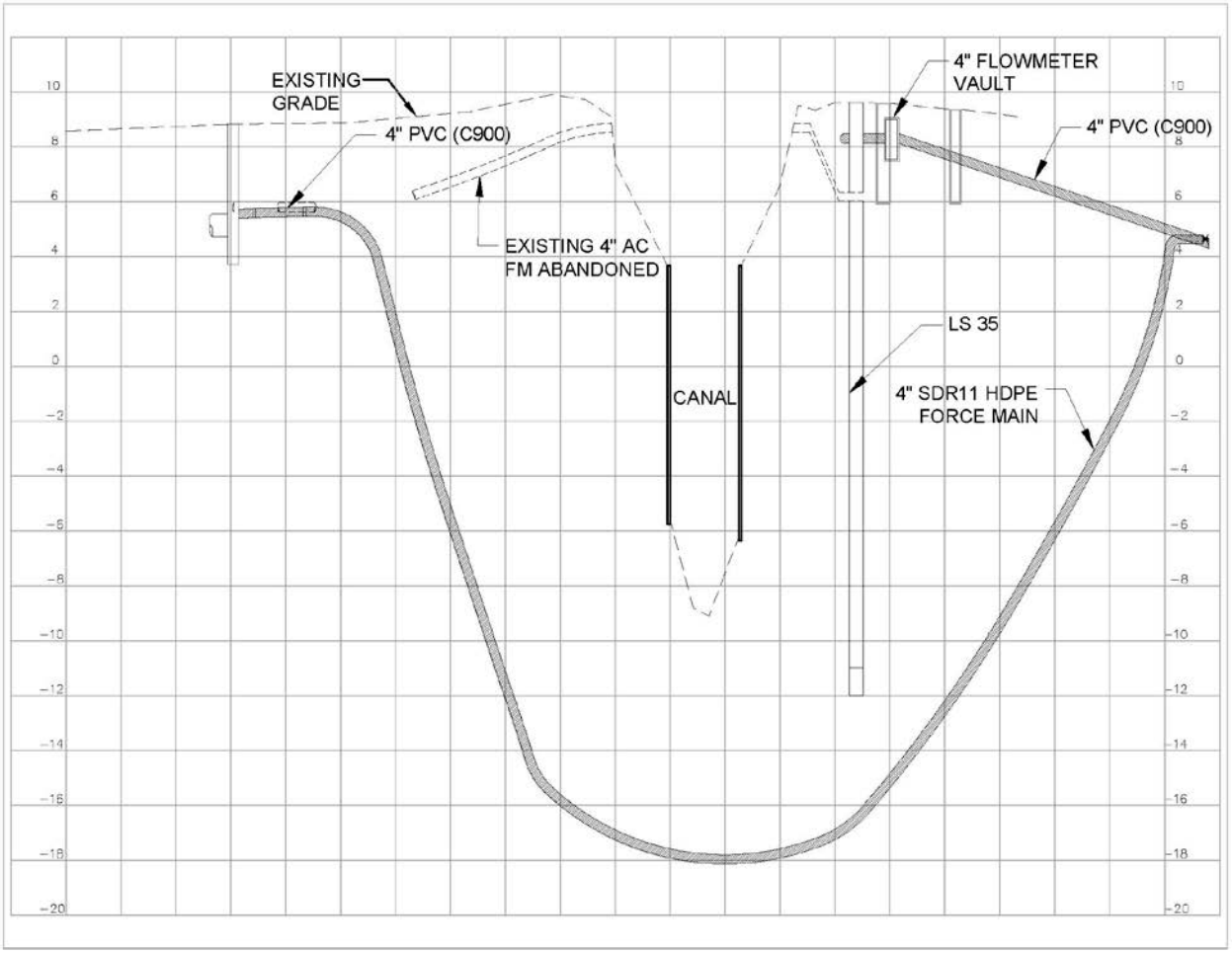
These projects are shown on the following map and discussed in greater detail in subsequent sections. Following these sections, a summary of the piping materials selected by each contractor through alternate bid options will be presented.

Figure 1: Project Location Map

2. BIRD KEY FORCE MAIN REPLACMENT PROJECT

The Bird Key Force Main Replacement Project involved the replacement of four sections of aging, bridge-mounted, four-inch ductile iron force mains on Bird Key with new HDPE force mains installed by horizontal directional drill. Each force main conveys flows from an existing lift station on the Key to a downstream manhole located on the other side of a canal. Due to the proximity of each lift station to the canal, force mains had to be installed by open cut away from the canal a sufficient distance prior to drilling, and the directional drills had to be installed at steep entry/exit angles to quickly achieve a suitable depth under the floor of the canal. A typical installation is shown below:

Figure 2: Typical Installation – Bird Key Force Main Replacement Project



Public outreach proved to be a key component to the success of the project, and included multiple presentations from City utility staff to the Bird Key Homeowners Association. Homeowners were given the chance to see the plan and ask questions as to what impacts they could expect. The City was able to successfully calm homeowner concerns through explanation of the HDD construction techniques to be used, and the resultant limited impacts to landscaping and expensive driveways. The City was also able to guarantee that all roads and driveways would remain open.

Required permits included a Noticed General Permit for new wastewater construction through the Florida Department of Environmental Protection (FDEP), two environmental resource permits through FDEP (one specifically for the waterway crossings and one for the minor upland impacts), and a nationwide US Army Corps of Engineers (USACE) permit (SAJ-14).

3. NORTH SIESTA KEY BRIDGE FORCE MAIN REPLACEMENT

The North Siesta Key Bridge Force Main Replacement Project involved the installation of a new 1,500-foot, 8-inch force main conveying wastewater flows from the northern portion of Siesta Key to mainland Sarasota. This main was constructed to supplement an existing 8-inch ductile iron force main crossing, with the intent of removing the existing DI force main from service when its condition warrants removal. This new force main was also installed using HDD methods.

Required permits included a Noticed General Permit for new wastewater construction through the Florida Department of Environmental Protection (FDEP), an environmental resource permit through FDEP, a nationwide US Army Corps of Engineers (USACE) permit (SAJ-14), and a right-of-way use permit through the Florida Department of Transportation (FDOT). The timing of this project made the FDOT permit especially difficult to secure, as FDOT had plans of their own to perform rehabilitation work on the bridge a short time after the scheduled construction. The project was completed within the required time frame to ensure the rehabilitation work could proceed as planned.

4. COON KEY BRIDGE FORCE MAIN REPLACEMENT

The Coon Key Bridge Force Main Replacement Project involved the installation of a new 1,400-foot 16-inch force main to replace an existing 14-inch bridge mounted ductile iron force main. This new force main was also installed using HDD methods. The contractor experienced a loss of drill fluid pressure in June 2012, resulting in the abandonment of the drill and redrilling at a greater depth and length, in January 2013. Although an actual frac out of drill fluids was not evident, the loss of pressure triggered frac out response procedures outlined as part of regulatory permitting to ensure any release of materials was limited.

Required permits included a Noticed General Permit for new wastewater construction through the Florida Department of Environmental Protection (FDEP), an environmental resource permit through FDEP, a nationwide US Army Corps of Engineers (USACE) permit (SAJ-14), and a right of way use permit through the Florida Department of Transportation (FDOT).

5. COON KEY BRIDGE WATER MAIN REPLACEMENT

The Coon Key Bridge Water Main Replacement Project involved the installation of a new 1,500-foot 18-inch water main to replace an existing 16-inch bridge mounted ductile iron water main. This new water main was also installed using HDD methods.

Required permits included a Noticed General Permit for new wastewater construction through the Florida Department of Environmental Protection (FDEP), an environmental resource permit through FDEP, a nationwide US Army Corps of Engineers (USACE) permit (SAJ-14), and a right-of-way use permit through the Florida Department of Transportation (FDOT).

6. LIFT STATION 23, 29, 31 FORCE MAIN REPLACEMENTS

The force main replacements for lift stations 23, 29 and 31 included force mains ranging in diameter from 6-inches to 14-inches on St. Armand's Key. Each new force main replaced a section of asbestos-cement pipeline conveying flows from the lift station to a discharge manhole. Installations were made primarily utilizing HDD techniques to help avoid impacts to expensive driveways, landscaping, and traffic. HDD installations included two canal crossings.

Public outreach proved to be a key component to the success of the project, and included presentations from City utility staff to the St. Armand's Circle Association, a group comprising local business representatives. The City was able to successfully calm business owner concerns through explanation of the HDD construction techniques to be used, and the resultant limited impacts to customer traffic.

Required permits included a Noticed General Permit for new wastewater construction through the Florida Department of Environmental Protection (FDEP), an environmental resource permit through FDEP, a nationwide

US Army Corps of Engineers (USACE) permit (SAJ-14), and a right-of-way use permit through the Florida Department of Transportation (FDOT).

7. GULFSTREAM/ALDERMAN FORCE MAIN REPLACEMENT

The Gulfstream/Alderman Force Main Replacement Project involved the installation of a new 2,400-foot, 24-inch force main to replace an existing 20-inch DI force main. This section of force main is part of the City's primary looped force main system and coveys flows from its largest lift station. This new force main was installed using HDD methods in park space adjacent to the City's bay front. While this installation did not include a subaqueous water crossing, HDD installation was utilized to ensure the contractor would avoid impacts to large trees within the park space and limit the visual nuisance to both tourists visiting the bay front, and to those residing in nearby condominiums.

Figure 2: Gulfstream Avenue Park Area

Permits required included a Noticed General Permit for new wastewater construction through the Florida Department of Environmental Protection (FDEP) and an environmental resource permit through FDEP.

8. DISCUSSION OF ENVIRONMENTAL BENEFITS OF HDD INSTALLATIONS

One of the primary benefits of utilizing HDD installation techniques on the projects discussed above was the ability to greatly reduce impacts to surrounding bay waters during the construction process. With major excavation required at only the bore pits and receiving pits, the contractor was able to concentrate spoils management in only those areas. This also allowed construction inspection efforts by City staff and representatives of permitting agencies to focus on just these excavated areas to ensure the strict requirements set forth through environmental permitting were adhered to during construction. As a result, there were no major incidents of sediments being released to adjacent bay waters during installation.

9. DISCUSSION OF CONTRACTOR MATERIAL SELECTION WITH BID-OPTION

As a cost-saving measure for each of the projects listed above, contractors were allowed the option, during bid, of either utilizing high density polyethylene (HDPE) pipe or fusible polyvinyl chloride (FPVC) pipe. In two specific cases, HDPE pipe was mandated due to the aggressive bending radii required by the designed alignment and due to system hydraulics specifically requiring an inner diameter unique to 8-inch HDPE pipe. Otherwise, the contractors had the option of selecting a preferred material based on multiple factors, including familiarity with the material, material availability, and material cost. All HDPE material bid options were DIPS DR-11 while the FPVC options were C900 DR-18 or C905 DR-25, dependent on the pipe size and operating pressure. In all cases, the nominal HDPE pipe diameter was one size larger than its FPVC bid equivalent (i.e. 8-inch DIPS DR-11 HDPE vs. 6-inch C900 DR-18 FPVC) to ensure system hydraulics were not adversely affected due to the small inner diameter of the HDPE pipe.

The bid items from the various projects are summarized below in one table. The bid items are sorted from smallest pipe diameter to largest. From the table below, it can be generally stated that the HDPE bid options were selected for pipe diameters below 12-inches, whereas the FPVC bid options were selected most often for larger diameter installations.

Table 2: Summary of Bid Options

Bid Number	Pipe Description	Bidder #1 (LOW)	Bidder #2	Bidder #3
C- 7a	4" DIPS DR 11 HDPE FM BY HDD - LS 34	x	x	x
C- 7b	4" DR 18 FPVC FM BY HDD - LS 34			
C- 8a	4" DIPS DR 11 HDPE FM BY HDD - LS 35	x	x	x
C- 8a	4" DR 18 FPVC FM BY HDD - LS 35			
C- 9a	4" DIPS DR 11 HDPE FM BY HDD - LS 36	x	x	x
C- 9b	4" DR 18 FPVC FM BY HDD - LS 36			
A- 4a	6" DR 11 HDPE FM BY HDD	x	x	x
A- 4b	8" DR 18 FPVC FM BY HDD			
B- 10a	8" DIPS DR 11 HDPE WM BY HDD	x	x	x
B- 10b	8" DR 18 FPVC FM BY HDD			
C- 6a	8" DIPS DR 11 HDPE FM BY HDD - LS 33	x	x	x
C- 6b	8" DR 18 FPVC FM BY HDD - LS 33			
C- 10a	8" DIPS DR 11 HDPE WM BY HDD	x	x	x
C- 10b	8" DR 18 FPVC FM BY HDD			
A- 2a	14" DR 11 HDPE FM BY HDD	x		
A- 2b	12" DR 18 FPVC FM BY HDD		x	x
B- 9a	16" DIPS DR 11 HDPE WM BY HDD	x		
B- 9b	14" DR 18 FPVC WM BY HDD		x	x
B- 8a	18" DIPS DR 11 HDPE WM BY HDD	x		
B- 8b	16" DR 18 FPVC WM BY HDD		x	x
2 a	30" DIPS DR 11 HDPE FM BY HDD			
2 b	24" DR 18 FPVC FM BY HDD	x	x	x

SUMMARY

To provide more reliable service to its citizens, the City of Sarasota utilized HDD design for replacing these critical sections of force main. HDD technology allowed the City to make multiple subaqueous crossings of bay waters with no significant environmental impacts, while still keeping costs at acceptable levels. The installations were also

completed with little impact to existing high-end residential neighborhoods, City park space, and commercial shopping districts and with no interruptions to major roads leading to and from the barrier islands.