CITY OF ROCKAWAY BEACH
SOUTH CORAL STREET
STORMWATER FEASIBILITY STUDY

February 2024

Prepared For:

City of Rockaway Beach
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Stormwater Feasibility Study

1.0 INTRODUCTION

1.1 Background

During major storm events, The City of Rockaway Beach experiences routine flooding of the right of way and residences along South Coral Street from South Nehalem Avenue to South 2nd Avenue. The current drainage system consists of a very shallow drainage ditch network with a few shallow catch basins that ultimately drain to the Beacon Ditch Network which outfalls into Clear Lake, south of the site. Residents have expressed a desire to improve the area to potentially mitigate future flood events.

1.2 Purpose and Scope

Flooding along South 2nd Avenue and South Coral Street can cause barriers for residential traffic. High waters can cause unsafe conditions for motor vehicles, and pedestrians, spread onto private property, and damage foundations and other private property.

The goal of this study is to map the S Beacon Street Ditch Network to locate any potential restrictions in draining flood waters on South 2nd Avenue and South Coral Street. This study explores cost-effective solutions that may help alleviate some of the flooding and help drain the problem area.

1.3 Site Description/Flood Characteristics

The study area consists of South Coral Street from South Nehalem Avenue to South 2nd Avenue, the intersection of South 2nd Avenue and South Coral Street, and the South Beacon Street drainage channel flowing to Clear Lake. The area experiencing routine flooding is a low-lying area within the city and the storm drainage needs upgrades to more efficiently drain the right-of-way. Flooding is not contained to the right-of-way, as it flows onto private property in some areas. Figure 1 below shows drone footage captured by Bill Hassell during flooding in January 2021. The time stamp on the drone photo was cross-referenced with tide data to figure out the approximate elevation of flooding.

The cause of the flooding is due to the low-lying area at the intersection of South Second Avenue and South Coral Street receiving high amounts of runoff from the hills to the east along with high tide events backing up into pipes, preventing drainage.

Figure 1 – Approximate Extents of January 2021 Flooding (drone photo by Bill Hassell)

2.0 EXISTING CONDITIONS

2.1 Topographic Mapping

A topographic survey of South Coral Street, South Second Avenue, and the South Beacon Street Channel Network was completed by Onion Peak Design. The survey captured topographic details of the area experiencing flooding, along with invert elevations of the storm drainage network from South Coral Street to the outfall in Clear Lake.

The survey showed that South Coral Street, particularly near the intersection of South Coral and South Second Avenue, was the area's lowest point, causing most of the flooding to accumulate in this vicinity. The survey also showed the existing drainage network has minimal elevation drop from South Coral Street to the outfall pond at Clear Lake. This causes the ditch network to function more as a detention basin than an effective drainage ditch.

2.2 Existing Storm Drainage Network

The existing storm drainage network consists of a series of catch basins, shallow ditches, culverts, and a drainage channel emptying into Clear Lake. The network has experienced significant erosion and sediment transport over the years, impacting the effectiveness of the drainage. This is one reason why the channel network should be scheduled for improvements. Additionally, there is limited vertical drop from the northern end of South Coral Street to the discharge point at Clear Lake.

Starting at the north end of the drainage network on South Coral Street, north of Rock Creek near S Nehalem Avenue, there are a few catch basins that drain stormwater to the north. This stormwater network was not analyzed as a part of this study. The study area is shown in Figure 2.

Figure 2 – Extents of Study Area

The study area starts on South Coral Street, just south of Rock Creek, where stormwater runs to the gravel/grassy shoulder of the road with very shallow channels on either side of the road that flow south. The channel on the east side of the street enters a 10" concrete culvert (SD #13, 72' @ 0.89% slope) approximately 200' south of Rock Creek. The concrete culvert has minimal cover over the pipe and runs to a small ditch in between two properties. The runoff enters another 12" concrete culvert (SD #12, 159' @ -0.18% slope) that is connected to a catch basin located in a driveway. This 12" culvert has reverse slope, meaning stormwater is detained upstream of the culvert until the water rises enough to overflow out the downstream end of the culvert. From here, stormwater continues before reaching its point of discharge into a catch basin at the northeast corner of the intersection of S Coral Street and S Second Avenue. Stormwater leaves the catch basin through a 10" concrete culvert (SD #11, 33' @ 0.42% slope) to the west which crosses the road and outfalls into the primary Beacon Street drainage network. These drainage features are shown in Figure 3 and again in Appendix A.

Figure 3 – Study Area Drainage Features

On the west side of S Coral Street, stormwater running along the roadside channel eventually enters a 16” corrugated plastic culvert (SD #10, 57’ @ 0.91% slope) approximately 340’ south of Rock Creek before outfalling into a small ditch at a property line. The invert of the 16” culvert is at 12.42’ and the invert of the 10” culvert leaving the ditch is 13.10’, meaning water ponds in the 16” pipe more than 6” before water leaves the short ditch. The 10” corrugated plastic culvert (SD #9, 20’ @ -1.3%) also has a reverse slope with the culvert outlet being approximately 0.25’ higher than the inlet.

Stormwater from S Coral Street runs to the ditch at the northwest corner of the intersection of South Coral Street and South Second Avenue before entering a 10” stormwater pipe (SD #8, 57’ @ -0.35%) to cross to the south side of S Second Avenue and outfall into the roadside ditch. This pipe also has reverse slope. Runoff then enters the roadside ditch on the south side of S Second Street and runs west through a series of culverts under residential driveways before reaching a culvert running under S Beacon Street. This stretch of roadside ditch also flows backward with an Invert Elevation (IE) of 13.75’ on the east side to 13.85’ on the west side. This will cause water to pool in the ditch all year round if the soil does not drain the water as seen in Figure 4 (picture taken 02/2023).

Figure 4 – Drainage Ditch on the South Side of the S 2nd Ave & S Coral St Intersection

The final stretch of ditch is the South Beacon Street Drainage Channel. This drainage channel along with the culverts are of adequate size to convey the stormwater to the point of discharge at Clear Lake. However, several culverts could be lowered to better facilitate drainage. The northernmost culvert has an invert elevation of 14.01’. This is more than a foot higher than the lowest invert upstream and only 9” below the lowest street elevation upstream. The plan and profiles of the existing South Beacon Street Ditch are included in the report appendices.

Due to years of sediment transport from the hills through the City stormwater system, many of the ditches within the system have been filled in or grown over. This is natural for a channel-based system. However, these changes impact the channel geometry and reduce the efficiency of the system as a whole. Additionally, the City is relatively flat, so once the ditches reach a certain depth, it becomes difficult to facilitate drainage to the ocean, forcing the City to utilize a system that relies more on detention than conveyance.

Table 1 lists details for culverts in the study area. Figures 5 and 6 show culverts within the study area.

Table 1 – Culvert Details							
Culvert Designation	Material	Begin Invert Elevation	End Invert Elevation	Diameter (in)	Length (ft)	Slope (%)	Downstream Culvert
SD#1	CMP	13.22	12.68	48	180	0.30	Clear Lake
SD#2	CMP	13.46	13.28	48	53	0.34	SD#1
SD#3	CPP	13.71	13.17	36	20	2.70	SD#2
SD#4	CPP	14.02	13.92	30	29	0.34	SD#3
SD#5	CPP	13.86	13.76	24	41	0.24	SD#4
SD#6	CPP	13.85	13.76	18	24	0.37	SD#5
SD#7	CPP	13.42	13.02	18	20	2.00	SD#6
SD#8	CONC	13.63	13.83	10	57	-0.35	SD#7
SD#9	CPP	13.1	13.36	10	20	-1.30	SD#8
SD#10	CPP	12.94	12.42	16	57	0.91	SD#9
SD#11	CONC	13.9	13.76	10	33	0.42	SD#8
SD#12	CONC	13.72	14	12	159	-0.18	SD#11
SD#13	CONC	14.56	13.92	10	72	0.89	SD#12

Figure 5 – Culvert Location Map

Figure 6 – Culvert Location Map

3.0 SUMMARY OF FINDINGS AND RECOMMENDATIONS

3.1 Stormwater Deficiencies

Several issues in the existing drainage system have developed over the years. One large deficiency is the inefficiency in clearing stormwater from the collection system. Large storm events coinciding with high tides effectively trap the stormwater discharge in Clear Lake. This causes a backup of stormwater through the collection system on Beacon Street, Coral Street, and S 2nd Avenue which then overflows the ditch network at the low point in the intersection of S 2nd Ave and S Coral Street. Comparing the aerial photo shown in Figure 7 with the survey completed by Onion Peak Design, the total volume of water overflowing the ditch network within the study area during the January 2021 flood is estimated to reach upwards of 500,000 gallons. With high tides preventing runoff from draining, a comprehensive solution to flooding in town would require a larger partnership with USACE, NIMFS, and many other regional partners. A project of this scale is not feasible for the City to undertake alone. This report focuses on smaller projects the City can undertake to potentially mitigate the duration of flooding or to create more detention time in the storm system.

The second issue is the lack of consistent fall through the drainage network. There is adequate elevation change from the north end of Coral St to Clear Lake; however, in between, the pipe network zig-zags up and down, not allowing runoff to drain completely after each rain event. This causes water to pool in the storm network up to elevation 14.01 ft where the biggest hump in the network is reducing any storage downstream for the next rain event.

Finally, some culverts should be upsized to reduce the need for burdensome maintenance. During months of heavy rain, a large amount of sediment and debris moves through the City storm network. This debris can clog culverts and prevent the ditches from conveying stormwater through the system. This leads to stormwater overflowing the ditches and creates isolated flooding as shown in Figure 7. With large amounts of water flowing through the ditches and culverts, it is nearly extremely challenging for City personnel to keep culverts free of blockages until flood waters subside. One example of this is from the January 2021 flood. Drone footage shows a water surface elevation of approximately 15' in the Beacon Street ditch at the intersection of Beacon Street and S 2nd Avenue. However, approximately 250 ft to the east, the water surface elevation is approximately 16'. This would imply debris from stormwater runoff impedes smaller diameter culverts, causing a backup and early flooding.

Figure 7 – Water Surface Elevation During Flooding

3.2 Recommended Solutions

To begin to address flooding, several deficiencies should be addressed. The City should explore increasing stormwater detention capacity and upsizing culverts to reduce the flood impacts. The projects summarized below detail various ways of achieving the previously stated goals.

Project 1: South Coral Street Roadside Ditch/Drainage Improvements

Improvements should start at the location of the flooding to help alleviate flooding in the immediate area. Improving the roadside drainage ditch in South Coral Street will slightly increase the storage volume, but more importantly will allow stormwater to begin to drain out of the street, driveways, and yards after a rain event. Re-sizing and re-laying the culverts/storm pipes that are in South Coral Street (SD#9, SD#10, SD#11, SD#12, SD#13) will allow water to flow through the drainage network and begin to empty after each rain event, ultimately creating more storage volume when the next rain event occurs. The improvements included in this alternative are the following:

- Re-grade the roadside ditch on both sides of South Coral Street to maximize storage volume and eliminate any low points that currently prohibit proper drainage.
- Replace and/or adjust existing storm drains and culverts (SD#9, SD#10, SD#11, SD#12, SD#13) to promote positive drainage and ensure the entire network is working together.

Anticipated Impacts to Flooding
The primary deficiency of the system is the lack of conveyance during prolonged large storm events coinciding with high tides. The high tides prevent water from leaving Clear Lake and being

discharged into the Pacific Ocean. With Clear Lake full, the ditch network on Beacon Street backs up into S 2nd Avenue and S Coral Street before overtopping and flooding the area. This project does not remove any blockage of draining floodwaters or improve conveyance. Instead, it provides additional storage of stormwater during a flood and can help facilitate drainage once stormwater eventually starts draining from Clear Lake.

This project would include constructing additional drainage ditches that measure approximately 2.5-3 ft in depth and 4-5 ft in top width. Doing so would allow water to drain more smoothly and would provide up to 56 gallons of storage per foot of ditch constructed. Constructing 400 ft of new ditch would provide the City with an additional 22,000 gallons of storage. However, as noted earlier, it is estimated there could be upwards of 500,000 gallons of floodwater overflowing the collection system. Therefore, this project would have very little impact in eliminating large-scale flood events.

It should be noted, that while the proposed project would have minimal impacts on flooding during large flood events, additional ditches and culverts can improve drainage of this area during small rain events, reducing the amount and frequency of ponding that occurs in the area. Table 2 shows the anticipated costs to construct the improvements in Coral Street if a contractor was hired to perform the work. Should the City choose to complete much of this work using City personnel, the costs could be significantly reduced.

Table 2 – S Coral Street Ditch Network Improvements

Item	Description	Quantity	Unit	Unit Price	Total Price
1	Mobilization	1	LS	$11,375.00	$11,375.00
2	Excavate Ditches	3000	CY	$25.00	$75,000.00
3	Lower Existing Culverts	1	EA	$10,000.00	$10,000.00
4	Install a 15" Diameter Culvert	300	LF	$150.00	$45,000.00
				Construction Subtotal	$141,375.00
				Construction Contingency (15%)	$21,206.25
				Construction Total	$162,581.25
				Engineering & Permitting (20%)	$32,516.25
				Legal & Admin (3%)	$4,877.44
				Total Cost	$199,974.94

Project 2: South 2nd Avenue Ditch Extension

One of the first areas where stormwater runoff overtops the existing ditch network is on the south side of the intersection of S 2nd Avenue and S Coral Street. Primarily, the area of concern is the segment of ditch between SD #7 and SD #8 where the northern top of the bank is estimated to be as low as 14.5' in elevation. This low point is well below the top of pipe elevations for SD #5 and 6. This means as the water level rises within the ditch network, it will overflow at this point, leaving a significant portion of the ditch network detention volume unused. The proposed project should look to construct a concrete containment curb or a small levee to raise the top elevation of this ditch to the same elevation as the top of the ditch at the outfall of SD #5. The improvements included in the proposed project include:

- Clean out the ditch between SD #6, 7, and 8
- Build concrete curb wall around the entire section of ditch to approximately 16' on the north side and 16.25' on the south side (hydraulic analysis should determine the exact top of the bank, this is not included in the cost below).

Anticipated Impacts to Flooding

The low-lying area surrounding SD #7 is the first area where stormwater overtops the existing ditch network. Due to the low-lying area, the Beacon Street channel system is unable to utilize a large portion of its detention volume during a storm event. Building up the top of the bank in these areas would allow the channel system to use the full downstream detention volume. This would delay any flood water from overtopping the bank allowing the channel network to fully utilize all available detention. Large storm events would still likely cause some flooding in low-lying areas as the existing channel system likely does not have sufficient volume to detain a large flood. However, the project would be relatively inexpensive and would allow the City to maximize existing infrastructure.

Table 3 – South 2nd Avenue Ditch Extension					
Item	Description	Quantity	Unit	Unit Price	Total Price
1	Mobilization	1	LS	$10,000.00	$10,000.00
2	Excavate Ditches	300	CY	$25.00	$7,500.00
3	Construct Concrete Curb	1	LS	$25,000.00	$25,000.00
				Construction Subtotal	$42,500.00
				Construction Contingency (15%)	$6,375.00
				Construction Total	$48,875.00
				Engineering & Permitting (20%)	$9,775.00
				Legal & Admin (3%)	$1,466.25
				Total Cost	$60,116.25

Project 3: South Beacon St./South Second Ave. Ditch Improvements

The next project includes major modifications to the South Beacon Street drainage channel as well as the South Second Avenue roadside ditch. Culverts (SD#2-SD#4) in the South Beacon Street drainage channel would be adjusted so that stormwater can flow freely from the start of the channel to the outfall into Clear Lake. Also, the channel could be widened along the entire length to increase storage volume and alleviate flooding upstream. Culverts (SD#5-SD#8) in the South Second Avenue roadside ditch need to be upsized to allow for more flow capacity. The improvements included in this Project are the following:

- Re-grading the S Beacon Street channel bottom to eliminate any high points that may prohibit drainage.
- Adjust culverts (SD#2-SD#4) to accommodate the re-grading and allow for proper drainage throughout the channel.
- Widen the channel at all possible locations to create more detention capacity.
- Upsize culverts (SD#5-SD#8) in the South Second Avenue roadside ditch to increase flow capacity.

These improvements are anticipated to have the greatest impact on flooding near the intersection of South Coral Street and South Second Avenue, as there is more room within the South Beacon Street right-of-way to expand the channel and provide more detention volume.

Anticipated Impacts to Flooding

Deepening the channel network along S Beacon Street could have a small impact on how quickly flood waters recede during a flooding event. Ultimately, the primary problem in localized flooding is the convergence of large runoff events after storms with high tide events. Deepening the S Beacon

Street channel would provide additional storage capacity in the collection system. Most of the Beacon Street channel is already below the Ordinary High-Water Mark in Clear Lake. Deepening the channel would likely cause year-round ponding water in the channel network (which could create mosquito habitat). Lowering the channel by one foot would provide approximately 37 gallons of additional storage per foot of channel lowering.

Widening the ditch would also increase the detention capacity of the City's collection system. Assuming the S Beacon Street channel network to average 4 ft deep, widening the channel by one foot would provide approximately 30 gallons of storage capacity per foot. If the City chose to both widen and lower the S Beacon Street channel by one foot between Sta. 1+00 and 18+80 (see profile for stations), the City could expect to add approximately 100,000 gallons of storage capacity to the collection system. Should the City widen the channel network by two feet and lower the average channel depth by two feet, the City could potentially expand the storage capacity of the collection system by approximately 150 gallons per foot of channel improvements. If these channel improvements were completed between Sta. 1+00 and 18+80, the City could potentially increase the overall detention capacity of the S Beacon Street channel by approximately 225,000 gallons. While this would not solve the seasonal flooding, it could have a meaningful impact on the overall flood levels.

It should be noted that these figures do not include any modeling of high tides. These figures assume the high tides are preventing stormwater from leaving Clear Lake and the existing S Beacon Street channel network is not tidally influenced. The City should sample and test the waters in the Beacon Street channel network during a flood for salinity. If the S Beacon Street channel network is tidally influenced, then expanding the detention capacity of the channels will only allow for additional seawater to be held in the channel network and will have minimal to no positive impact on water levels at the peak of a flood. However, the expanded capacity of the channels could potentially provide benefits once tides fall and the stormwater begins to drain; potentially reducing the duration of flood events. To determine the full impact of the channel expansion, a hydraulic analysis should be completed.

The final item that should be considered is the upsizing of the culverts on S 2nd Avenue between S Beacon Street and S Coral Street. These culverts are identified in this report as SD #5-8. In reviewing the aerial drone footage during a flood, it appears the flood waters on S Coral Street are up to an approximate 16 ft elevation. However, in the same photo, the water level in the S Beacon Street channel appears to be approximately one foot below the guy wires from the utility pole at the intersection of S 2nd Avenue and S Beacon Street. This would imply a water surface level of 14.5 ft. The 1.5 ft difference in elevation of flood waters is extremely unusual and would imply a potential blockage in one or more of the culverts SD #5-8. Smaller culverts, particularly SD #8 (10" diameter) will have a higher probability of being plugged with debris that has been transported through the ditch network. Once a culvert becomes plugged, the upstream collection system is effectively cut off from the downstream system, which can cause flooding where insufficient detention exists. Upsizing these culverts to a minimum of 24" in diameter will reduce the risk of the culverts being plugged. Additionally, once flood waters begin moving, drainage to the S Beacon Street channel network would be more rapid. Table 3 below shows a cost breakdown of improvements to the S Beacon Street channel network. It assumes a total of 30,000 cubic yards (CY) of material will be removed from the channels. Planning level costs are provided in Table 3 under the assumption the work is completed by a contractor under a public bid with prevailing wage rates.

Table 4 – S Beacon Street Channel Network Improvements					
Item	Description	Quantity	Unit	Unit Price	Total Price
1	Mobilization	1	LS	$50,000.00	$50,000.00
2	Excavate Ditches	30,000	CY	$15.00	$450,000.00
3	Lower Existing Culverts	3	EA	$10,000.00	$30,000.00
4	Install 24" Diameter Culvert	150	LF	$350.00	$52,500.00
5	Install a 30" Diameter Culvert	50	LF	$450.00	$22,500.00
				Construction Subtotal	$605,000.00
				Construction Contingency (15%)	$90,750.00
				Construction Total	$695,750.00
				Engineering & Permitting (20%)	$139,150.00
				Legal & Admin (3%)	$20,872.50
				Total Cost	$855,772.50

3.3 Summary of Civil Recommendations

The recommended improvements were broken up into three separate projects. The overall improvements include widening and regrading the S Beacon Street channel to promote positive drainage, create more storage capacity, and adjust existing culvert elevations to accommodate the grading changes. Further modeling and design will be necessary to more accurately estimate the amount of detention required to alleviate flooding in this area. If enough detention cannot be generated with these improvements, it may be necessary to install a stormwater pump to pump excess stormwater into Clear Lake. It should be noted that the first two improvements will only slightly improve the flooding conditions.

A rough cost estimate was put together for the three projects shown in the table below.

Table 5 – Project Cost Estimate Summary

Item	Unit Cost	Project 1	Project 2	Project 3
Construction & Materials	(Estimated)	$ 140,000	$ 42,500	$ 605,000
Contingency	15% of project total	$ 21,000	$ 6,375	$ 90,750
Design & Permitting	20% of project total	$ 32,500	$ 10,000	$ 140,000
Legal & Admin	3% of project total	$ 5,000	$ 1,500	$ 21,000
TOTALS:		$ 198,500	$ 60,375	$ 856,750

*These costs are rough estimates and should not be used as the basis of funding

3.4 Alternative Solutions

Due to the overall scale of the problem facing Rockaway Beach, the two projects described above are not anticipated to eliminate flooding in the study area. Rather, they would remove some of the barriers to drainage the City is currently facing, allowing for flood waters to recede more rapidly. What follows is a list of alternative solutions that would improve the flooding conditions in the area. Some will benefit the City's stormwater management system. These projects are of a much larger scale in general and are not projects able to be undertaken by City Public Works personnel. Before these solutions could be designed, the following would need to be completed:

- 1-Dimensional model of the City's stormwater infrastructure would cost roughly $25,000 depending on the information provided by the City on the existing stormwater infrastructure, or;
- 2-Dimensional model of the City's stormwater infrastructure costing roughly $75,000 and includes using a certain HEC-RAS modeling software to model the flooding and analyze how certain improvements would benefit the system.

Alternative 1: Upstream Storage Facility

One option to alleviate flooding in the lower-lying areas of the city is to construct a detention storage facility upstream to intercept and detain flows during large storm events. The detention facility could be in the form of a retention basin or underground detention pipes/chambers. The work involved in constructing these improvements would most likely include land acquisition, design, earthwork, permitting, etc. The detention facility could be bypassed normally but utilized during large flow events. Diverting water into a holding pond would reduce the flood water in town. The challenge with an upstream storage facility is the significant number of regulatory requirements associated with the work. Much of the runoff flowing through the system originates on streams from the coastal range. Diverting water, even on a seasonal basis, could pose risks to aquatic wildlife.

Alternative 2: Pump Station & Reservoir

Another option to alleviate flooding in the area would be to install a pump station in the lower-lying area where flooding is an issue and pump stormwater to either a reservoir or straight to the ocean. Discharging directly to the ocean would require complicated permitting. Discharging to a reservoir would eliminate some of the permitting but could require land acquisition for the reservoir. HBH estimated the approximate volume of flood water by comparing aerial photos from Bill Hassell to a topographic survey from Onion Peak Design. It was estimated the total volume of flood water could be upwards of 500,000 gallons. However, this figure is based primarily on aerial photography from the January 13, 2021 flood. A more thorough hydraulic analysis is needed to size a reservoir.

Alternative 3: Drywells

The third option consists of constructing a series of drywells in the roadway along South Coral Street and South Second Avenue. The roadway would require re-grading to guide stormwater and runoff into drywells. The drywells would provide some drainage but will ultimately serve the purpose of discharging the stormwater below the road surface. Due to high groundwater tables in Rockaway Beach, there would be year-round water in the drywells. However, the intent would be to infiltrate stormwater into the ground below the road surface. A geotechnical investigation/report would need to be completed to determine infiltration rates and seasonal groundwater tables to evaluate whether this project would be feasible. The goal of this alternative would be to manage the existing stormwater within the roadway without having to impact the system upstream or downstream.

Alternative 4: Highway 101 Tidegate

The final solution is a last resort if flooding is still occurring after both smaller projects 1 and 2 above fail to alleviate the flooding around the intersection of South Coral Street and South Second Avenue. This would imply water levels in the S Beacon St channel network are significantly influenced by high tides. In this project, a tide gate would be installed west of Highway 101, towards the end Clear Lake drainage channel. This would prevent tidewaters from influencing the Beacon St ditch network.

The tide gate should be set at an appropriate elevation to prohibit water from backing up into the South Beacon Street drainage channel allowing for more storage to be available during larger storm events. More in-depth modeling will be necessary to achieve a design that would be effective in eliminating flooding in the area. Should it be found that flood water is in large part coming from high tides, installing a tidegate could negatively impact other areas of the City, so a larger hydraulic analysis would be necessary to determine the feasibility of this project.

Appendix A - Figures

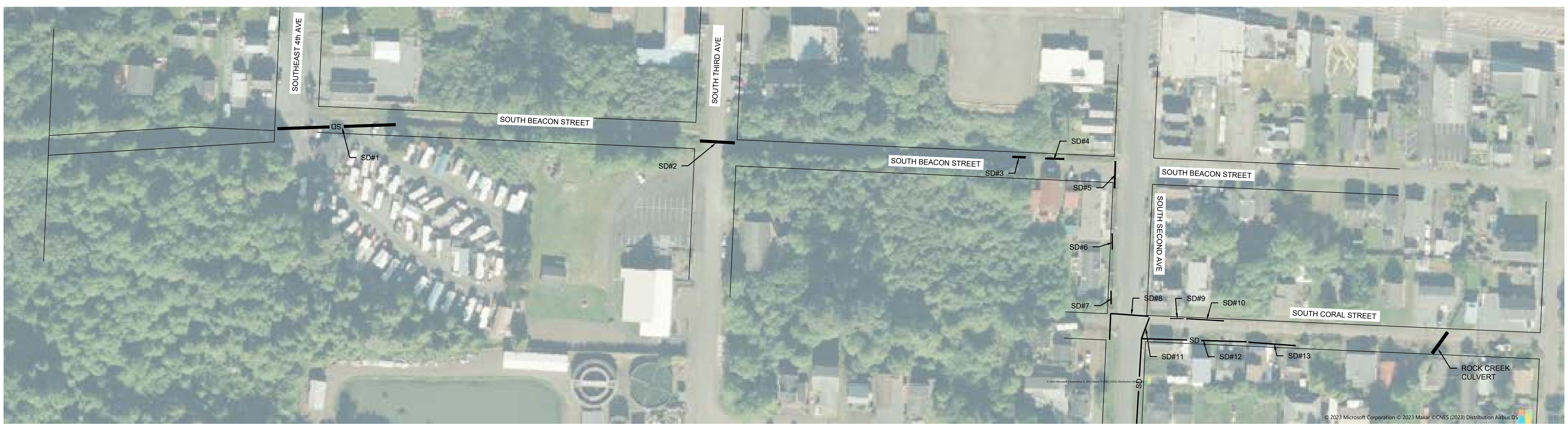
GRAPHIC SCALE

80 0 40 80 160 320

(IN FEET)
1 inch = 80 ft.

STUDY AREA

HORIZONTAL SCALE: 1" = 160'



GRAPHIC SCALE

80 0 40 80 160 320

(IN FEET)
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STUDY AREA

HORIZONTAL SCALE: 1" = 160'

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CITY OF ROCKAWAY BEACH
STORMWATER FEASIBILITY STUDY

STUDY AREA

DRAWN BY: MCC DATE: 12/1/2023

File: I:\2015-009.27\4-design\dwg\xref\base map.dwg

FIG. 1

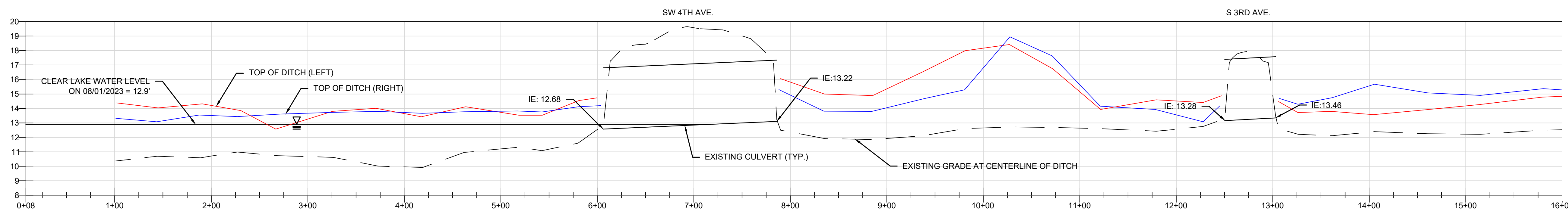
GRAPHIC SCALE

(IN FEET)
1 inch = 60 ft.

STANDARD PLAN VIEW STA 2+50 TO 21+16

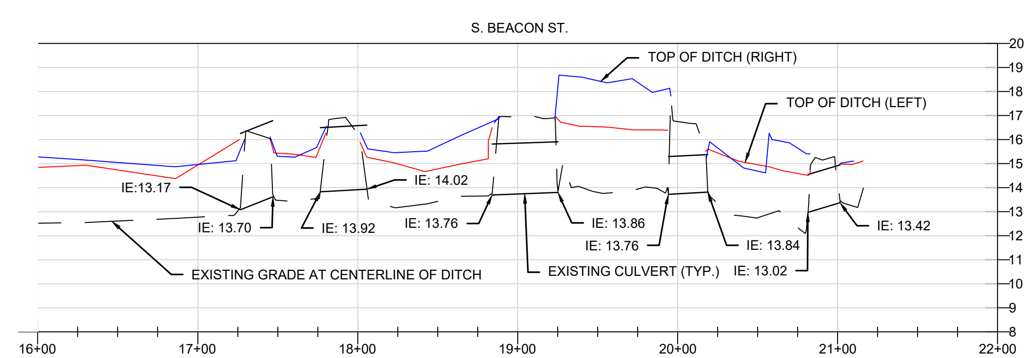
HORIZONTAL SCALE: 1" = 120'

HORIZ. 0 30 60 120
Scale In Feet



PROFILE VIEW STA 0+08 TO 16+00

HORIZONTAL SCALE: 1" = 120'
VERTICAL SCALE: 1" = 8'



PROFILE VIEW STA 16+00 TO 22+00

HORIZONTAL SCALE: 1" = 120'
VERTICAL SCALE: 1" = 8'

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CITY OF ROCKAWAY BEACH
STORMWATER FEASIBILITY STUDY

S BEACON ST DITCH PROFILE

DRAWN BY: MCC DATE: 12/1/2023

File: I:\2015-009.27\4-design\dwg\xref\base map.dwg

FIG. 2