OCEAN AVENUE WEST PUMP STATION FLOOD MITIGATION – CONDITIONS ASSESSMENT

Municipal Vulnerability Preparedness Grant Program

40 Shattuck Road | Suite 110
Andover, Massachusetts 01810
800.426.4262

woodardcurran.com
COMMITMENT & INTEGRITY DRIVE RESULTS

0232827.00
City of Salem, MA
June 2020

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APPENDICES

1. INTRODUCTION

1.1 Purpose

Woodard & Curran, Inc. (Woodard & Curran) conducted an assessment of the Ocean Avenue West Stormwater Pump Station (Pump Station) to establish the capacity of the Pump Station, assess the condition of the station, and identify what, if any, improvements should be made to maintain or improve the reliability of the station to control flooding within the Jefferson Avenue neighborhood. This assessment report summarizes the results of a field visit conducted in March 2020, a hydraulic evaluation of the existing area that contributes to the Pump Station and establishes criteria to be used for the future design of a replacement Pump Station.

1.2 Background

The Pump Station was constructed as one component of the Jefferson Avenue flood control project in the early 1970s. Based on recommendations provided in the Flood Study Design Report prepared by CDM in 1966, the flood protection measures were designed for a 10-year storm event, calculated using rain gage data from Logan Airport. While the Pump Station is nearly 50 years old, it continues to serve an important function by offering protection to the Jefferson Avenue neighborhood from flooding. Stormwater from the Pump Station's contributing watershed is conveyed to the station via a closed conduit drainage system within the Jefferson Avenue neighborhood, prior to being discharged from the station over a flood control earthen berm levee, also constructed as part of the flood protection measures in the early 1970s. Reconstruction of this earthen berm levee is under design and it is anticipated that the berm will be elevated as part of the Rosie's Pond Flood Mitigation Project along with drainage improvements to the area adjacent to the berm.

1.2.1 Previous Assessment

In 2009, Woodard & Curran assessed the Pump Station as part of the South River Drainage Improvement Project and prepared the Pump Station Assessment Report (2009 Assessment). As part of the 2009 Assessment, Woodard & Curran reviewed the Pump Station's original plans and shop drawings provided by the City of Salem, MA (City) and Lakeside Equipment Corporation (Lakeside). This information included copies of the original approved manufacturer's specifications and shop drawings for the original installation in 1974, both of which are included in Appendix A to this assessment. In addition, Woodard & Curran conducted an assessment of the station to evaluate the pump instrumentation and controls, electrical and mechanical systems, as well as general health and safety observations and an overview of the building and grounds.

1.2.1.1 Pumps

The original shop drawings referenced in Section 1.2.1 include additional dimensions and installation data not identified on the plans of the station that the City made available to Woodard & Curran. Based on a review of this information, the original design parameters of the station included two 48-inch diameter triple-flight spiral screws installed at a 36-degree angle driven by 230/460volt 30-horsepower motors with gear reducers operating the flights at 45 revolutions per minute (rpm). These parameters provided for an original maximum design lifting capacity of 4,750 gallons per minute (gpm) for each screw pump for a total station capacity of 9,500 gpm, or approximately 20 cubic feet per second (cfs).

1.2.1.2 Previous Assessment Findings

Based upon the evaluation of the pump shop drawings, completion of a field visit, and assessment of the hydraulic capacity of the existing pump station, the 2009 Assessment provided recommendations for capital improvements that could be considered by the City including:

- Adding a standby emergency power generator
- Partial pump station upgrade to repair deteriorated pump components
- Improvements to the station's O&M procedures including automating some pump operations, access points, lighting, electrical systems, etc.
- Upgrading the stormwater collection system to handle the Pump Station's design storm (10-year storm event) including:
    - Increasing inlet capacity;
    - Upgrading trunk line conveyance capacity; and
    - Eliminating stormwater bypass over the Jefferson Ave. culvert.
- Full pump station upgrade

1.3 Condition Assessment Approach

Using the information gathered during the 2009 Assessment as a baseline, Woodard & Curran's 2020 Pump Station assessment approach strategy included a field visit and hydraulic evaluation of the station and supporting closed conduit infrastructure. This strategy allowed engineers to observe and model changes to the Pump Station or surrounding areas that may have occurred since the 2009 Assessment.

The 2009 Assessment concluded that the existing Pump Station is undersized and is nearing the end of its useful life. Thus Woodard & Curran approached this assessment under the premise that completely upgrading the station or replacing the station entirely may both need to be considered to mitigate flooding in the Jefferson Avenue neighborhood during the 100-year (1% annual chance) storm event. Therefore, this assessment evaluated the current condition of the pumps and building for possible salvage or reuse should the Pump Station be recommended for replacement.

2. PUMP STATION CONDITION ASSESSMENT

Woodard & Curran conducted a field visit to the Pump Station with City personnel and the City's Contract Operator, Weston and Sampson (W&S), on March 17, 2020. The goal of the site visit was to provide an evaluation of the Pump Station including existing pump instrumentation and controls, electrical systems, mechanical systems, general observations, and overview of the building and grounds, and to provide a basis for recommendations for upgrade or replacement of the station. A photo log documenting the observations made during the field visit is included as Appendix B. The following sections summarize our findings.

2.1 Pump Instrumentation and Controls

The Pump Station's instrumentation and controls system was upgraded in 2009. At that time, a conductivity probe system, cleaned on a bi-monthly basis, measured the elevation of stormwater in the wet well and a single float backup turned on both pumps with movement of a few inches. The high level and power loss alarms at the station were tied into the Salem Fire Department's alarm system. The pumps are connected to a Delta-Wye starting cabinet which was noted as functional and in fair condition.

At the time of this assessment, pump controls included a Mercoid pump controller, pressure transducer with stilling well and backup float. Pump 1 was off, and Pump 2 was in Automatic mode. As only one pump was operational, it was unclear if the backup float still activates both pumps. A Mission SCADA communication system was noted to have been added since the previous assessment. Operating setpoints, or the elevation above the bottom of the system, are provided in Table 2-1 based on a discussion with the Station Operator. These could not be confirmed in the Mercoid controller at the time of the visit.

Table 2-1: Pump Operation Set Points

Control Point	Set Point (ft)
Lag On	2.4
Pump 1 On	2.0
Pumps 1 & 2 Off	0.8
Low Water Alarm	0.5

Note: 1. Set Point is measured as feet above the floor.

2.2 Screw Pumps

2.2.1 General

For this assessment, Woodard & Curran evaluated the condition of the pump characteristics and functions as described in the following subsections. The 2009 Assessment included a more in-depth evaluation of the pumps as that assessment focused on potential repairs or upgrades to keep the existing station operational. However, as stated in Section 1.3, Woodard & Curran's approach for this assessment was to evaluate the condition of the pumps for possible salvage or reuse, knowing the station is undersized and nearing the end of its useful life. The existing 48-inch spiral screw pumps do not appear to have had any recent significant upgrade since the upper and lower bearing replacement for each pump and a new motor on Pump 2 in 1998.

Pump 1 was not operational and did not appear to have been run recently at the time of the site visit. The existing screw pumps were observed to be in fair condition. Pump 2, closer to the upper level entry door, was operated in manual mode to demonstrate operating condition. While there was some vibration in the gear box, the screw turned and conveyed water. No scraping or rubbing noise was heard indicating that the screw was not contacting the channel and the bearings were turning freely.

2.2.2 Torque Tube and Flights

The flights of the screw pumps showed edge deterioration on both pumps. The painted steel screw pump flights were in poor condition with visible corrosion, pitting, and some material loss.

Pump 1 screw flights were generally intact at the upper and lower ends, but significantly reduced in the center of the pump. As a result, flow slippage is likely encountered when operating. Rusted leading edges of the flights indicated that Pump 1 has not been run recently. Peeling paint and bare metal with areas of rust were prevalent on the torque tube and flights.

Similar to Pump 1, Pump 2 exhibited degradation at the center of the pump, likely resulting in flow slippage when operating. Pump 2 did not have rusting leading edges as the pump has continued operating since 2009.

2.2.3 Motor Housing and Belt Guards

The motor housing and belt guards on each of the pumps showed rust and general deterioration consistent with the age of the pumps but were intact on both pumps.

2.2.4 Bearings

A new Trico Streamliner bearing grease pump was observed to have been installed since the previous assessment. The original grease pump is still mounted near Pump 1 below the main distribution panel; however, it was disconnected.

Pump 1 was not run, and the bearings could not be assessed under operation. The bearings on Pump 2 appeared to be operating correctly as no grinding or excessive vibration was observed.

2.2.5 Pump Mounts

The upper pump mounts were visible and inspected. The upper mount got Pump 1 did not display any severe deterioration. The mount for Pump 2 had dislodged, with broken concrete observed on the side of the mount facing the pump station center wall. There appeared to be only 2 inches of concrete cover between the edge of the mounting pad and the anchor bolts. While the anchor bolts were intact, this deterioration may have contributed to the vibration observed in the gearbox. Additional discussion of concrete condition is included in the Building and Grounds Section of this assessment.

2.3 Electrical

The electrical system uses a 480/277 VAC 43-phase, 4-wire service. The station does not have standby power, however for large events with advanced notice, the Town has supplied temporary trailer mounted generators. These generators are temporarily placed on Jefferson Avenue above the low point in the roadway and wired directly into the Pump Station electrical distribution system as no generator connection is available. As observed in the 2009 Assessment, the utility meter was upgraded in the mid to late 2000's, but grounding rods remain unburied and are visible and subject to damage. The low voltage panel was upgraded and covered from the previous assessment. As there was an active storm, W&S could not power down the station to open and observe the pump motor starters and main distribution equipment during the field visit. The existing equipment is not likely to be sufficient for reuse for a proposed 100-year storm event condition, however, as part of the final design of the Pump Station, salvage of components of the electrical system can be evaluated.

2.4 Heat, Ventilation and Air Conditioning

As noted in the 2009 Assessment, no means of mechanical ventilation is provided for the station other than manual opening of the upper and lower access doors to the station. An electric heater on the upper level of the station is installed to provide heat in the building and maintain a minimum temperature for the electrical and control equipment. The building has no air conditioning. The discharge chute from each pump is accessible from the building via aluminum floor grating. Operations staff has placed sheet plywood over these grates to both limit heat loss and prevent animal intrusion. It appears that no improvements to the heating, ventilation and air conditioning components of the Pump Station have been made since the 2009 Assessment based on observations during the field visit.

2.5 Building and Grounds

The building consists of a cast-in-place concrete foundation, walls, floors, sumps, and discharge chutes with a removable segmental panel concrete roof with waterproofing joint sealant. The structural components of the roof and lifting hooks appear to be in fair condition.

The Pump Station is surrounded by a 6-foot chain link fence topped with barbed wire. The City's Operations contractor has maintained the grounds within the fence. There was evidence that stormwater has eroded the earth around the Pump Station with debris being collected along the outside of the fence and at the back corners of the building. In addition, erosion of soil below the upper level access stairs was observed. Signs of undermining and erosion of subbase soils under the slab of the discharge chute leading edges and joints along with movement of rip rap from its original position was observed during the filed visit.

In general, the concrete building structure was found to be in fair condition and the structural integrity is intact. However, a number of maintenance and structural repair items were identified, which would require corrective action and repairs to extend the life of the structure, as described below.

Exterior concrete walls and the concrete stair slab had several areas with localized cracking, spalling, and hollow concrete in need of repair. The sloped and flat sections of the precast roof were not accessed but a build-up of debris, moss growth, and algae indicating trapped moisture problems and poor drainage was observed. Some localized areas of leakage into the structure due to failing sealant of the removable concrete roof planks were identified. The concrete discharge chute slab has areas of hollow, delaminated concrete in need of repair along the west edge. The slab was undermined due to erosion, but this is a structural slab cantilevered off the building wall and is not dependent on the underlying soil for support.

The control room interior concrete walls, floor, and ceiling slab, and the inlet chambers below the floor level, were in fair condition. The painted steel entry door into the control room has moderate corrosion, peeling paint, and rusty hinges. Sloped concrete pads at the top mounts of each screw pump were in poor condition with cracks and spalled concrete. Some water seepage into the structure was observed at cracks and construction joints in the concrete fill between the sloped screw pump channels. Lastly, the lower aluminum catwalk and supports were observed to be in fair condition.

2.6 Plumbing

City water is provided to the station for wash down with ¾-inch copper pipe. The City water supply lacks a backflow prevention device. The field visit confirmed the findings of the 2009 Assessment that there is no water meter or main shut off located in the station, and there are no restroom facilities. The water system was not tested during the assessment, but Operators indicated that it is occasionally used.

2.7 Jefferson Avenue Neighborhood Infrastructure

During the field visit, Woodard & Curran engineers walked the neighborhood surrounding the Pump Station to observe the existing drainage infrastructure. Woodard & Curran measured a number of curb reveals throughout the neighborhood and noted several locations in which the curb reveal was less than the typical 6-inches, likely due to overlaying new pavement in the roadway over time. In several locations there was no curb reveal, and Woodard & Curran observed catch basins constructed at a high point, rather than a low point in the road. In addition, Woodard & Curran noted that several catch basins were full of debris and areas in the neighborhood roadways showed signs of ponding. These factors can cause stormwater to bypass the drainage system and pond in the roadway, limiting travel to residents and emergency vehicles, or flow into private property. These conditions will be considered in the Preliminary Design section of this report.

3. COLLECTION SYSTEM HYDROLOGIC & HYDRAULIC ANALYSIS

To determine the amount of water expected to reach the Pump Station during the 100-year storm event, Woodard & Curran developed a Stormwater Management Model (SWMM) of the existing area that contributes to the Pump Station. This section describes how the model was developed, the rainfall events that were analyzed, and the results of the model.

3.1 Model Development

The drainage analysis was performed using the Environmental Protection Agency (EPA) Stormwater Management Model, version 5.1.013 (SWMM5) on the PCSWMM v7.2.2785 platform. The analytical methods and data sources used to represent the study area are summarized in Table 3-1 below.

Table 3-1: 1-D Model Methodology and Data Source Summary

Analysis or Data Type	Method or Data Source
Computational Engine	EPA SWMM 5.1.013
Runoff Method	Nonlinear Reservoir
Infiltration Method	Modified Green-Ampt
Hydraulic Routing	Dynamic Wave
Elevation Data Source	USGS LiDAR (2016 CONED Topobathymetric Digital Elevation Model (DEM)); Survey performed 12/23/2008 by WSP Sells; Survey performed 5/19/15 by WSP Sells
Pipe Network Data Source	City of Salem GIS Database; Survey performed 12/23/2008 by WSP Sells; Survey performed 5/19/15 by WSP Sells
Land Cover Data Source	NOAA High Resolution Land Cover Database
Soil Classification Data Source	NRCS Soil Survey of Essex County
Surface Friction Data Source	NOAA Coastal Change Analysis Program (C-CAP) Land Cover

Catchment delineation using the DEM and Land use data indicate that the study area is approximately 20.7 acres and 54% impervious. Figure 3-1 depicts the watershed delineation determined for this analysis.

A 1-Dimensional (1-D) model representing the existing stormwater collection system, including inlets and underground pipes was prepared using a combination of survey data and GIS data provided by the City. A schematic of the existing drainage system model is included in Figure 3-2. The existing conditions model assumed that the Rosie's Pond Flood Mitigation Project, as configured as of May 2020, is constructed. The model includes objects to simulate pipes, inlets (catch basins), primary overland flow paths, and storage objects to represent topographic low points. SWMM calculated runoff, conduit flow and depth (open and closed channel), node depth, and storage area volume and depth at each one-minute time step.

3.2 Simulation Scenario

Based on the overall project objective of protecting public infrastructure and private property during the 100-year storm, or 1% annual chance event, the hydrologic and hydraulic analysis for this Conditions Assessment evaluated this event, as defined by the Northeast Regional Climate Center (NRCC) extreme precipitation estimates. This event produces 8.75 inches of rain in 24 hours. The tailwater condition within the South River was assumed to be the FEMA Base Flood Elevation 15.27 feet (Salem City Datum; 10 feet NAVD88) as shown on FEMA Map Number 25009C0419G, revised to reflect Letter of Map Revision effective December 29, 2017.

3.3 Existing Collector System Limitations

The existing conditions were modeled to establish design flowrates, quantify restrictions, and provide a means of evaluating proposed improvement alternatives. The 100-year storm event was simulated on the existing system model. Results from this model indicate that all existing components of the system, including roadway flow paths, inlets, conveyance piping, and pumps are undersized for the 100-year storm event. The collection system is limited by the inlet and conveyance capacity. Figure 3-3 shows the approximate extent of flooding in the existing condition, assuming that the Rosie's Pond Flood Mitigation Project, as currently designed, is constructed. The following subsections describe the limitations of each component of the collection system. Table 3-2 below indicates the peak inundation depth at each analysis point labelled on Figure 3-3.

Table 3-2: Existing Conditions Model Inundation Depths

Description	Location	Peak depth of water (ft)
Analysis Point A	Low point behind 208 Jefferson Ave	2
Analysis Point B	Jefferson Ave vertical sag	2
Analysis Point C	West end of Brooks St	3.5
Analysis Point D	Brooks Street	2.25
Analysis Point E	Behind 169 Ocean Ave W	2.5

See Appendix C for the results of the existing conditions model.

3.3.1 Main Collector Pipe Diameter

As documented in the 2009 Assessment, the main storm drain collector pipe feeding the existing Pump Station is a 24-inch reinforced concrete pipe (RCP). Based on the surveyed slope of 0.0035 ft/ft and assumed Manning's n value of 0.015, the conveyance system has an ultimate capacity of 5,200 gpm (11.6 cfs). Accounting for entrance and exit losses and elevated tailwater conditions, the actual conveyance capacity is likely less. As noted in the 2009 Assessment, the level of service provided by this pipe is less than the 10-year storm event and required replacement. The existing conditions model developed under this assessment confirmed that this pipe is inadequate for the 100-year storm as well.

3.3.2 Inlet Capacity

As documented in the 2009 Assessment, inlet capacity is frequently a limiting factor for stormwater conveyance systems due to clogging. Based on field observations and operator reports, clogging and general lack of inlet capacity is an issue for the collection system flowing to the Pump Station. In addition, the inlet capacity is limited by the type of inlet and curb reveal. A standard grate inlet has a capacity of approximately 3.5 cfs with six inches of driving head (water depth, generally provided by curb reveal); however, there is no curb reveal present at the inlet grates at the end of Ocean Avenue West, and the curb reveal along Jefferson Ave is less than three inches in most locations. This lack of curb reveal allows water to leave the road and flow into private property or buildings before being captured and conveyed to the Pump Station. Given the limited flow capacity of existing inlets, the number of inlets is also insufficient for accommodating larger events. The model confirmed that both inlet capacity and curb reveal conditions influenced the 100-year storm analysis results as well.

3.3.3 Additional Flow from South of South River

As documented in the 2009 Assessment, runoff from the south side of the South River, including from Jefferson Avenue, Laurent Road, Horton Street, Wheatland Street, Cloutman Street, Wilson Street, and Arthur Street, is able to bypass the collection system on the south side of the culvert spanning Jefferson Avenue and enter the collection system draining to the Pump Station, effectively doubling the drainage area served by the Pump Station. This occurs because the collection system and outfall that discharge into the 4-foot by 10-foot concrete culvert under Jefferson Avenue is undersized, consisting only of 12-inch pipes. Discharge is further limited when the water level in the South River is elevated and the 12-inch outfall is submerged. This Conditions Assessment simulated the area south of the South River and determined that the capacity of the 12-inch discharge is approximately 3,140 gpm (7 cfs), and thus is incapable of conveying the approximately 17,950 gpm (40 cfs) of runoff that flows to the low points in front of 213 and 214 Jefferson Ave. during the 100-year storm event.

3.3.4 Pumping Demand

The ultimate pumping demand is a function of collection system efficiency, but the hydrologic and hydraulic analysis of the drainage area indicates that pumping demand will be in the range of 35,900 to 44,880 gpm (80 to 100 cfs) for the 100-year storm event.

3.4 Current Pump and Collector System Capacity

The existing Pump Station, as noted in Section 1 above, consists of two screw pumps which each have a capacity of approximately 4,750 gpm (10 cfs) for a total pump station capacity of 9,500 gpm (20 cfs). As noted in Section 2, only Pump 2 is currently operational, reducing the effective pump station capacity to approximately 4,750 gmp (10 cfs). Analysis of the 100-year storm event indicates that the pumping demand far exceeds the existing Pump Station and collection system capacity.

4. CONCLUSIONS AND RECOMMENDATIONS

Based on the assessment completed by Woodard & Curran for the 100-year storm event using NRCC data for the City, the existing Pump Station and the contributing stormwater conveyance system does not provide sufficient pumping capacity to handle the projected flow necessary to mitigate flooding along Jefferson Avenue and surrounding contributing areas. Based on the findings of this assessment, Woodard & Curran developed a list of recommended criteria that will be used to design upgrades to our replacement of the Pump Station and associated municipal storm drain infrastructure to improve resiliency for projected climate change impacts including the 100-year storm event and FEMA base flood event. These criteria include:

- Stormwater infrastructure, including the pump station, shall be able to convey the 100-year storm event;
- Provide permanent standby power for the pump station;
- Provide multiple duty and at least one back up pump;
- Pump station discharge elevation should be higher than the FEMA Base Flood Elevation (BFE);
- Ponding within the streets shall not exceed 12 inches in depth or prohibit the passage of emergency vehicle (whichever is less);
- Stormwater shall not be allowed to pond above the sill elevations of any house within the contributing area; and
- Ponding on private property should be minimized.

5. REFERENCES

C-CAP Land Cover, Massachusetts, 2016; NOAA, accessed March, 2020

Environmental Protection Agency Storm Water Management Model User's Manual, Version 5.1. Revised September 2015.

Extreme Precipitation in New York & New England, Northeast Regional Climate Center, Extreme Precipitation Tables obtained March, 2020

Soil Survey Geographic (SSURGO) database for Essex County, Massachusetts," Natural Resources Conservation Service Web Soil Survey, accessed online March, 2020.

City of Salem, MA GIS Database –Storm Drain Data.

Topobathymetric Model for the New England Region: States of New York, Connecticut, Rhode Island, and Massachusetts, 1887 to 2016. Accessed electronically March 2020.

United States Department of Transportation, Federal Highway Administration Hydraulic Engineering Circular No. 22, Third Edition, "Urban Drainage Design Manual." Rev. August 2013.

FEMA FIRM Map Number 25009C0419G, Revised to Reflect LOMR Effective December 29, 2017.

FIGURES

Ocean Ave West Pump Station

Condition Assessment

Figure 3-1: Study Area

N

Legend

5-foot LiDAR Contours (Salem Sewer)
- ≤10
- ≤20
- ≤35
- ≤50
- ≤75

- Outfalls
- Drain Manholes
- Culverts
- Drain Pipes (diameter (in))
- Drainage Area

References

City of Salem GIS Database, provided April 2020

Rosie's Pond & Jefferson Ave Flood Mitigation Project Plans, dated Jan 2020

FEMA National Flood Hazard Layer, obtained April 2020

USGS LiDAR, 2011 Data, obtained March 2020

Bing Maps Aerial Imagery

Notes:

This map is conceptual to be used for planning purposes only

REV	DESCRIPTION	DATE

DESIGNED BY: KJT | CHECKED BY: JJK

DRAWN BY: KJT

0 50 100 200 Feet

WOODARD & CURRAN

Project #: 0232827.00
Map Created: June 2020
Map Revised:

 Data Sources:

Ocean Ave West Pump Station

Condition Assessment

Figure 3-2:
Conceptual Model

N

Legend

5-foot LiDAR Contours (NAVD88)

- ≤10
- ≤20
- ≤35
- ≤50
- ≤75

- Outfalls
- Junctions
- Storages
- Pumps

Conduits

- Closed conduit (depth (in))
- Overland flowpath
- Drainage Area

References

City of Salem GIS Database, provided April 2020

Rosie's Pond & Jefferson Ave Flood Mitigation Project Plans, dated Jan 2020

FEMA National Flood Hazard Layer, obtained April 2020

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0 50 100 200 Feet

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Map Revised:

Ocean Ave West Pump Station

Condition Assessment

Figure 3-3:
Existing Conditions
Flood Extent

N

Legend

5-foot LiDAR Contours (NAVD88)

- ≤10
- ≤20
- ≤35
- ≤50
- ≤75
- Outfalls
- Junctions
- Storages
- Pumps

Conduits

- Closed conduit (depth (in))
- Overland flow path (depth (in))
- Approximate Flood Extent

References

City of Salem GIS Database, provided April 2020

Rosie's Pond & Jefferson Ave Flood Mitigation Project Plans, dated Jan 2020

FEMA National Flood Hazard Layer, obtained April 2020

USGS LiDAR, 2011 Data, obtained March 2020

Bing Maps Aerial Imagery

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REV	DESCRIPTION	DATE

DESIGNED BY: KJT | CHECKED BY: JJK

DRAWN BY: KJT

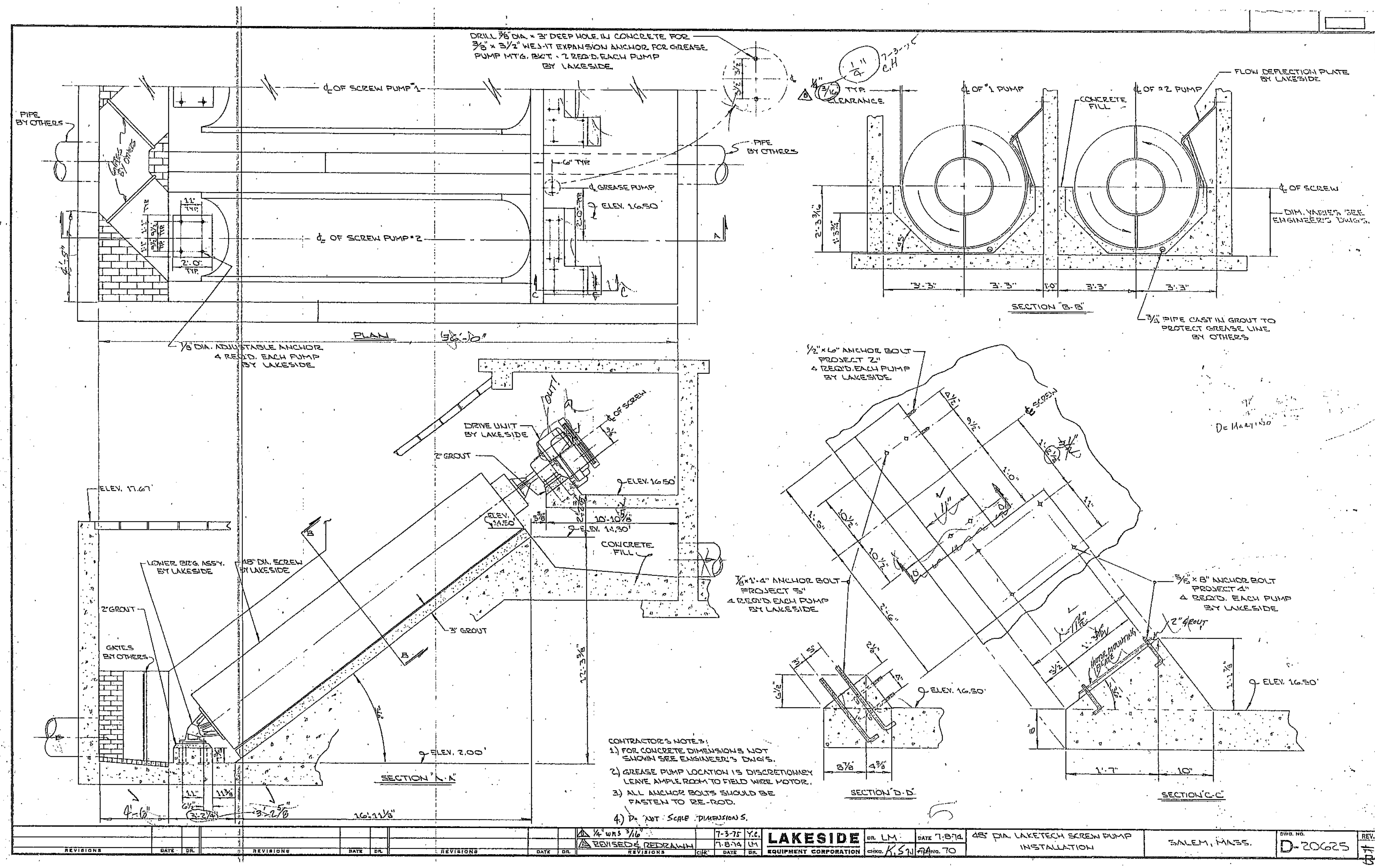
0 5 10 20 30 40 Feet

WOODARD & CURRAN

Project #: 0232827.00
Map Created: June 2020
Map Revised:
Sheet: 2 of 6

 Data Sources:

APPENDIX A: ORIGINAL MANUFACTURER'S SPECIFICATIONS & SHOP DRAWINGS



DRILL 3/8" DIA. × 3" DEEP HOLE IN CONCRETE FOR 3/8" × 3 1/2" WEJ-IT EXPANSION ANCHOR FOR GREASE PUMP MTG. BKT. - 2 REQ'D. EACH PUMP BY LAKESIDE
℄ OF SCREW PUMP 1
℄ OF SCREW PUMP 2
PIPE BY OTHERS
GATES BY OTHERS
6" TYP.
℄ GREASE PUMP
ELEV. 16.50'
2'-0" TYP.
7/8 DIA. ADJUSTABLE ANCHOR 4 REQ'D. EACH PUMP BY LAKESIDE
PLAN
TYP. CLEARANCE
℄ OF 1 PUMP
℄ OF 2 PUMP
CONCRETE FILL
FLOW DEFLECTION PLATE BY LAKESIDE
℄ OF SCREW
DIM. VARIES SEE ENGINEER'S DWG'S.
3'-3"
1'-0"
SECTION "B-B"
3/4" PIPE CAST IN GROUT TO PROTECT GREASE LINE BY OTHERS
DRIVE UNIT BY LAKESIDE
2" GROUT
℄ OF SCREW
ELEV. 16.50
ELEV. 14.50
ELEV. 14.30'
10'-10 5/8
CONCRETE FILL
ELEV. 17.67'
LOWER BRG. ASS'Y. BY LAKESIDE
48" DIA. SCREW BY LAKESIDE
2" GROUT
3" GROUT
GATES BY OTHERS
ELEV. 2.00'
12'-3 5/8"
SECTION "A-A"
16'-11 1/8"
1/2" × 6" ANCHOR BOLT PROJECT 2" 4 REQ'D. EACH PUMP BY LAKESIDE
℄ SCREW
7/8" × 1'-4" ANCHOR BOLT PROJECT 5" 4 REQ'D. EACH PUMP BY LAKESIDE
5/8" × 8" ANCHOR BOLT PROJECT 4" 4 REQ'D. EACH PUMP BY LAKESIDE
2" GROUT
ELEV. 16.50'
SECTION "D-D"
SECTION "C-C"
1'-7"
10"
CONTRACTOR'S NOTES:
1.) FOR CONCRETE DIMENSIONS NOT SHOWN SEE ENGINEER'S DWG'S.
2.) GREASE PUMP LOCATION IS DISCRETIONARY. LEAVE AMPLE ROOM TO FIELD WIRE MOTOR.
3.) ALL ANCHOR BOLTS SHOULD BE FASTEN TO RE-ROD.
4.) Do NOT SCALE DIMENSIONS.
1/4" WAS 3/16" 7-3-75 Y.C.
REVISED & REDRAWN 7-8-74 LM
REVISIONS DATE DR.
LAKESIDE EQUIPMENT CORPORATION
DR. LM DATE 7-8-74
CHKD. K.S.N. FILE NO. 70
48" DIA. LAKETECH SCREW PUMP INSTALLATION
SALEM, MASS.
DWG. NO. D-20625
REV. B

LAKESIDE EQUIPMENT CORPORATION

WATER AND SEWAGE TREATING EQUIPMENT

1022 E. DEVON AVENUE
BARTLETT, ILL. 60103

REPRESENTATIVES IN PRINCIPAL CITIES

TELEPHONE 312/837-5640

Shop Order # 8670

Date May 3, 1974
*Revised July 9, 1974

APPROVAL SPECIFICATIONS

LAKETECH SCREW PUMP

Project Location SALEM, MASSACHUSETTS Type 3 Flight

Number of Units Two (2) Dia. 48" Max. Capacity 4750 GPM at 45 RPM

Detail Specifications each unit as follows:

Drive Assembly- - - - - - One Jeffrey #7315H25 shaft mount motor mount speed reducer with backstop & HP, 1750 RPM 3/60/ 230/460 volt encapsulated motor. Power transmission between motor and reducer is by means of "V"-belts and Sheaves.

Drive Support - - - - - - - One fabricated steel drive plate and one steel motor mounting plate.

Spiral Screw- - - - - - - One 48" dia. Spiral Screw consisting of a 24" dia. steel torque tube with .312 " wall thickness and 1/4 " thick steel helical shaped flights welded continuously to the steel tube on both sides.

Upper Shaft - - - - - - - One upper fabricated steel stub shaft.

Lower Shaft - - - - - - - One lower fabricated steel "T" shaft.

Upper Bearing - - - - - - One upper thrust bearing consisting of split cast housing and dual grease lubricated bearings.

Lower Bearing - - - - - - One adjustable pivot type lower bearing with bronze sleeve sealed and pressure lubricated.

Grease Pump - - - - - - - One grease pump driven by a 1/3 HP, 3/60/ 208/220/440 volt motor. A 3/8" dia. grease line and fittings are furnished to pressure lubricate the lower bearing. Grease reservoir capacity 8,8 lbs.

Flow Deflection Plate - - One set of curved steel plates and braces fabricated from 1/8 " thick plate. 1/2" expansion anchors are provided for 2'-0" max. centers.

Anchors - - - - - - - - - One lot of adjustable galvanized steel anchors.

Grouting Equipment - - - One set of grouting sheaves and belts furnished by Lakeside and are to be returned upon completion of grouting.

Painting - - - - - - - - One shop coat of Tnemec #77 Chem-Prime after grit blasting.

Two field coats of Tnemec #66 Hi-Build Epoxy, by others.

Electrical - - - - - - - By others.

LAKESIDE EQUIPMENT CORPORATION

LM/no
6/74

APPENDIX B: PHOTO LOG

Photo 1: Grease Pump for Screw Pump Bearings

Photo 2:

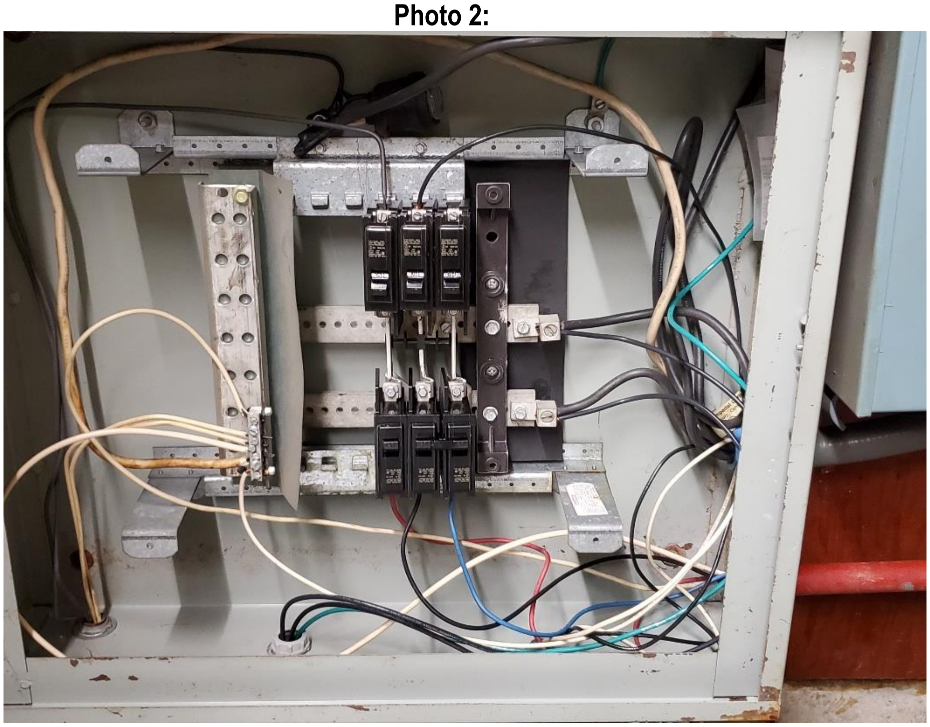


Photo 3: Pump Control Panel and Mission Communication Panel

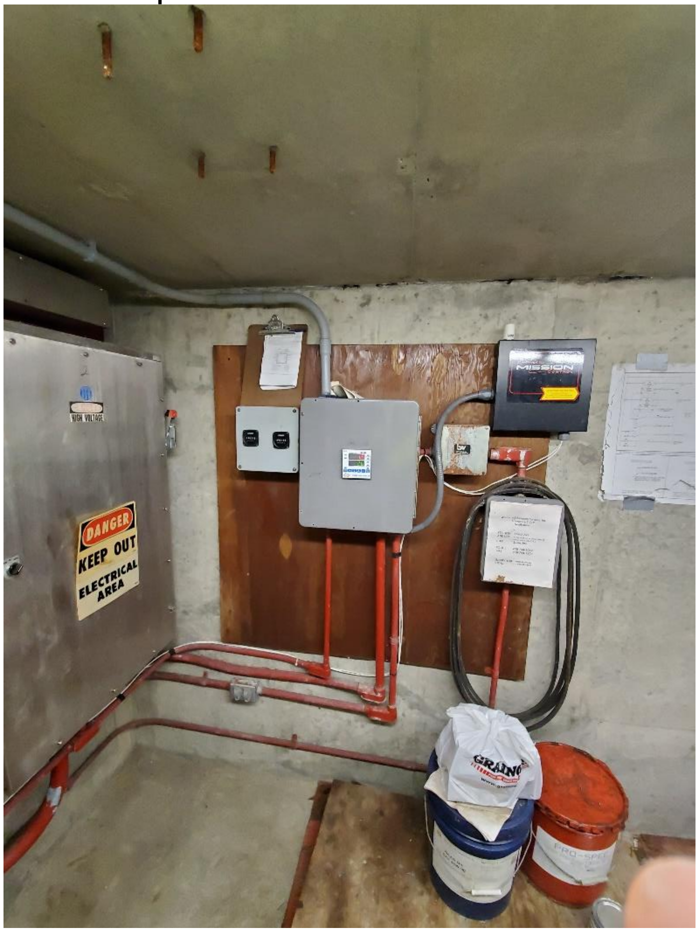


Photo 4: Pump Control Panel and Hour Meters

Photo 5: Unit heater in control room

Photo 6: View of screw pump, looking from the bottom up to the control room

Photo 7: View of screw pumps from control room. Pump 1 on left, pump 2 on right.

Photo 8: Screw pump 1 Gear Reducer, Motor and Upper Bearing

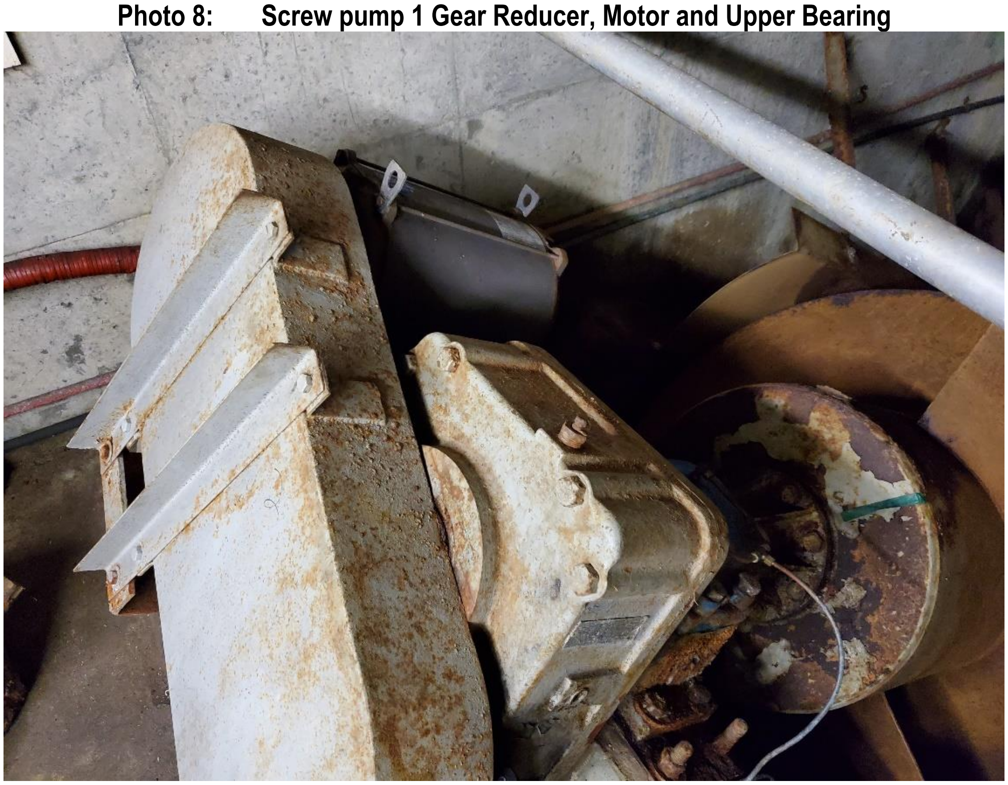


Photo 9: Wet Well access ladder and stop log channel

Photo 10: Wet Well Access Platform

Photo 11: Electrical Meter and Main Disconnect

Photo 12: Electric Meter

Photo 13: Deteriorated concrete and previous repair of Pump 1 Upper Bearing Mount

Photo 14: Front exterior of pump station.

Photo 15: Walkway leading to control room.

Photo 16: Cracking and previous repairs on exterior of building.

Photo 17: Cracking of external wall, Beam Supporting Gate Post.

Photo 18: Soil Erosion under entrance slab and security Fence.

Photo 19: Roof of pump station over wet well and screws

Photo 20: Discharge chutes.

Photo 21: Deteriorating concrete at discharge chutes and Erosion at pump station discharge.

Photo 22: Displaced rip rap following discharge chute.

Photo 23: Erosion of soils around fence line

Photo 24: Measurement showing curb reveal less than 2 feet in height.

Photo 25: Sediment filled catch basin.

Photo 26: Catch basins on Jefferson Avenue near Laurent Road with small curb reveal.

Photo 27: Culvert discharging into the South River (near Laurent Road).

APPENDIX C: EXISTING CONDITIONS MODEL RESULTS

PCSWMM Report

Salem_OceanAvePS

Model Ocean_Ave_EC.inp

June 16, 2020

Table of Contents

Summary 1: Options

Name	Ocean_Ave_EC
Flow Units	CFS
Infiltration method	MODIFIED_GREEN_AMPT
Flow routing method	Dynamic Wave
Link offsets defined by	Depth
Allow ponding	No
Skip steady flow periods	No
Inertial dampening	Partial
Define supercritical flow by	Both
Force Main Equation	H-W
Variable time step	On
Adjustment factor (%)	75
Conduit lengthening (s)	0
Minimum surface area (ft^2)	0
Starting date	Mar-19-2020 12:00:00 AM
Ending date	Mar-20-2020 12:00:00 AM
Duration of simulation (hours)	24
Antecedent dry days (days)	0
Rain interval (h:mm)	0:06
Report time step (h:mm:ss)	00:01:00
Wet time step (h:mm:ss)	00:05:00
Dry time step (h:mm:ss)	00:05:00
Routing time step (s)	5
Minimum time step used (s)	0.5
Average time step used (s)	0.9
Minimum conduit slope	0
Ignore rainfall/runoff	No
Ignore snow melt	No
Ignore groundwater	No
Ignore flow routing	No
Ignore water quality	No
Report average results	No

Summary 2: Model inventory

Name	Ocean_Ave_EC
Raingages	11
Subcatchments	38
Aquifers	0
Snowpacks	0
RDII hydrographs	0
Junction nodes	77
Outfall nodes	7
Flow divider nodes	0
Storage unit nodes	5
Conduit links	84
Pump links	1
Orifice links	0
Weir links	0
Outlet links	8
Treatment units	0
Transects	1
Control rules	0
Pollutants	0
Land Uses	0
Control Curves	0
Diversion Curves	0
Pump Curves	9
Rating Curves	4
Shape Curves	0
Storage Curves	5
Tidal Curves	0
Weir Curves	0
Time Series	11
Time Patterns	0

Summary 3: Model complexity

Name	Ocean_Ave_EC
Subcatchments	494
Groundwater	0
Aquifers	n/a
Snowpacks	n/a
RDII hydrographs	n/a
Junction nodes	224
Outfall nodes	14
Flow divider nodes	n/a
Storage unit nodes	18
Conduit links	501
Pump links	1
Orifice links	n/a
Weir links	n/a
Outlet links	16
Transect	3
Pollutants	n/a
Land Uses	n/a
Model complexity (total uncertain input parameters)	1271

Summary 4: Inflows

Name	Ocean_Ave_EC
Time series inflows	0
Dry weather	0
Groundwater	0
RDII inflows	0

Summary 5: Subcatchment statistics

Name	Ocean_Ave_EC
Max. width (ft)	282.223
Min. width (ft)	20.105
Max. area (ac)	1.8493
Min. area (ac)	0.0068
Total area (ac)	25.82
Max. length of overland flow (ft)	534.3889
Min. length of overland flow (ft)	14.7331
Max. slope (%)	16.941

Summary 5: Subcatchment statistics (continued...)

Name	Ocean_Ave_EC
Min. slope (%)	3.616
Max. imperviousness (%)	100
Min. imperviousness (%)	3.889
Max. imp. roughness	0.015
Min. imp. roughness	0.015
Max. perv. roughness	0.341
Min. perv. roughness	0.015
Max. imp. depression storage (in)	0.1
Min. imp. depression storage (in)	0.05
Max. perv. depression storage (in)	0.05
Min. perv. depression storage (in)	0.05

Summary 6: Node statistics

Name	Ocean_Ave_EC
Max. ground elev. (ft)	24.57
Min. ground elev. (ft)	0
Max. invert elev. (ft)	24.57
Min. invert elev. (ft)	-3
Max. depth (ft)	11.909
Min. depth (ft)	0

Summary 7: Conduit statistics

Name	Ocean_Ave_EC
Max. roughness	0.03
Min. roughness	0.01
Max. entry loss coef.	0.5
Min. entry loss coef.	0
Max. exit loss coef.	1
Min. exit loss coef.	0
Max. avg. loss coef.	0
Min. avg. loss coef.	0
Max. length (ft)	275.693
Min. length (ft)	4.752
Total length (ft)	5867.413
Max. slope (ft/ft)	2.2264
Min. slope (ft/ft)	-0.0232

Summary 8: Conduit Inventory

Name	Ocean_Ave_EC
Open Rectangular (ft)	81.343
Trapezoidal (ft)	58.736
Triangular (ft)	622.997
Irregular (ft)	1852.796
Circular (ft)	3251.541

Summary 9: Pipe inventory

Name	Ocean_Ave_EC
Max. pipe diameter (ft)	3
Min. pipe diameter (ft)	1
Total 12" pipe length (ft)	2121.371
Total 15" pipe length (ft)	88.875
Total 18" pipe length (ft)	238.511
Total 24" pipe length (ft)	780.271
Total 30" pipe length (ft)	10.503
Total 36" pipe length (ft)	12.01
Total pipe length (ft)	3251.541

Summary 10: Unused objects

Name	Ocean_Ave_EC
Rain Gages	10
Aquifers	n/a
Snow Packs	n/a
Unit Hydrographs	n/a
Transects	0
Control Curves	n/a
Diversion Curves	n/a
Pump Curves	8
Rating Curves	2
Shape Curves	n/a
Storage Curves	1
Tidal Curves	n/a
Weir Curves	n/a
Time Series	0
Time Patterns	n/a

Summary 11: Runoff quantity continuity

Name	Ocean_Ave_EC
Initial LID storage (in)	n/a
Initial snow cover (in)	n/a
Total precipitation (in)	8.750
Outfall runon (in)	n/a
Evaporation loss (in)	0.000
Infiltration loss (in)	3.122
Surface runoff (in)	5.594
LID drainage (in)	n/a
Snow removed (in)	n/a
Final snow cover (in)	n/a
Final storage (in)	0.047
Continuity error (%)	-0.152

Summary 12: Flow routing continuity

Name	Ocean_Ave_EC
Dry weather inflow (MG)	0.000
Wet weather inflow (MG)	3.922
Groundwater inflow (MG)	0.000
RDII inflow (MG)	0.000
External inflow (MG)	0.001
External outflow (MG)	3.594
Flooding loss (MG)	0.000
Evaporation loss (MG)	0.000
Exfiltration loss (MG)	0.000
Initial stored volume (MG)	0.002
Final stored volume (MG)	0.339
Continuity error (%)	-0.209

Summary 13: Results statistics

Name	Ocean_Ave_EC
Max. subcatchment total runoff (MG)	0.53
Max. subcatchment peak runoff (cfs)	19.63
Max. subcatchment runoff coefficient	0.991
Max. subcatchment total precip (in)	8.75
Min. subcatchment total precip (in)	8.75
Max. node depth (ft)	9.53
Num. nodes surcharged	45
Max. node surcharge duration (hours)	24
Max. node height above crown (ft)	7.137
Min. node depth below rim (ft)	0
Num. nodes flooded	0
Max. node flooding duration (hours)	0
Max. node flood volume (MG)	0
Max. node ponded volume or depth (acre-in/1000 ft³/ft)	0
Max. storage volume (1000 ft³)	46.657
Max. storage percent full (%)	100
Max. outfall flow frequency (%)	100
Max. outfall peak flow (cfs)	21.12
Max. outfall total volume (MG)	2.286
Total outfall volume (MG)	3.594
Max. link peak flow (cfs)	37.21
Max. link peak velocity (ft/s)	20.03
Min. link peak velocity (ft/s)	0
Num. conduits surcharged	58
Max. conduit surcharge duration (hours)	24
Max. conduit capacity limited duration (hours)	22.21

Figure 1: Extent 1 - Drainage Area

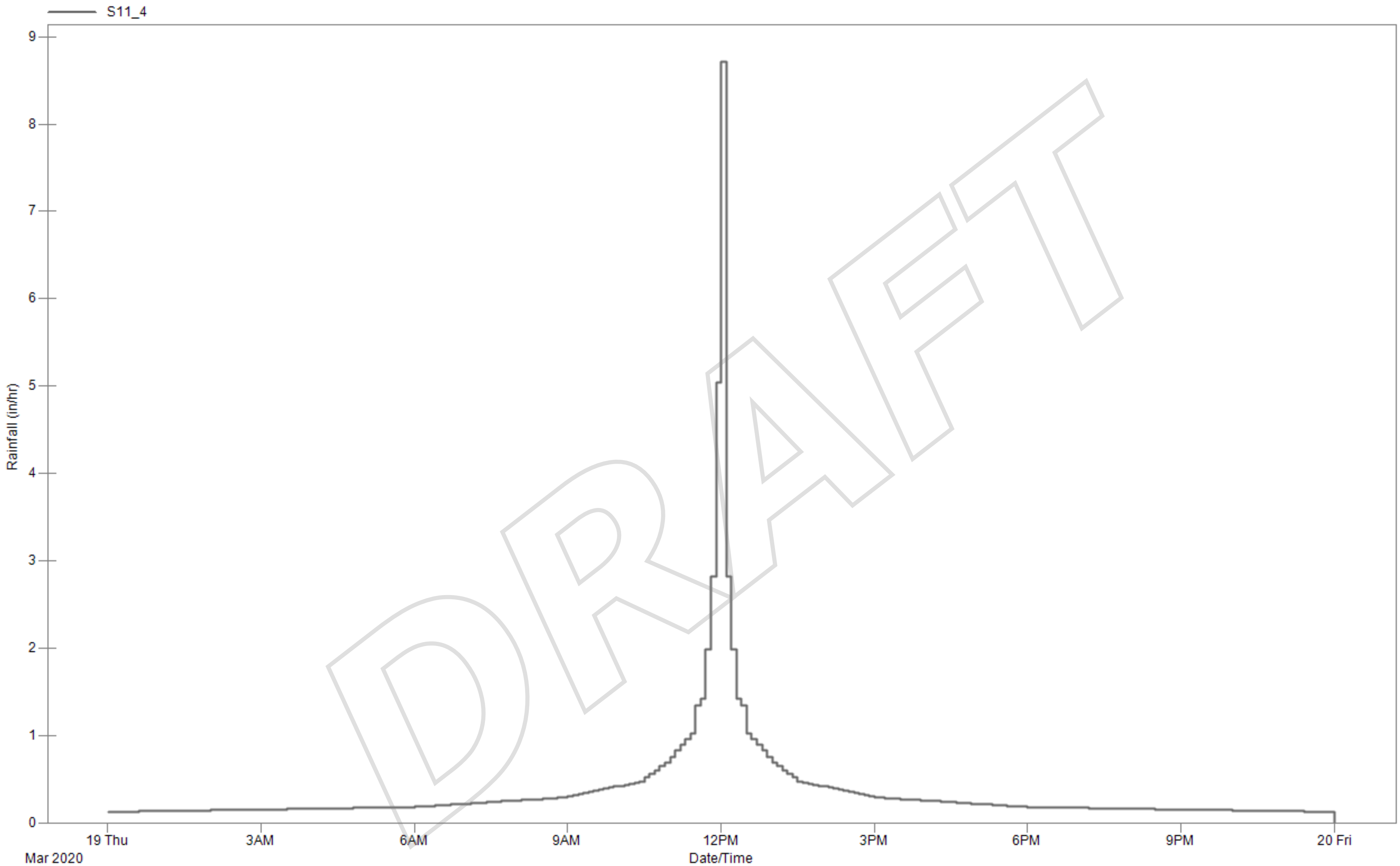


Figure 2: Rainfall_NRCC100yr

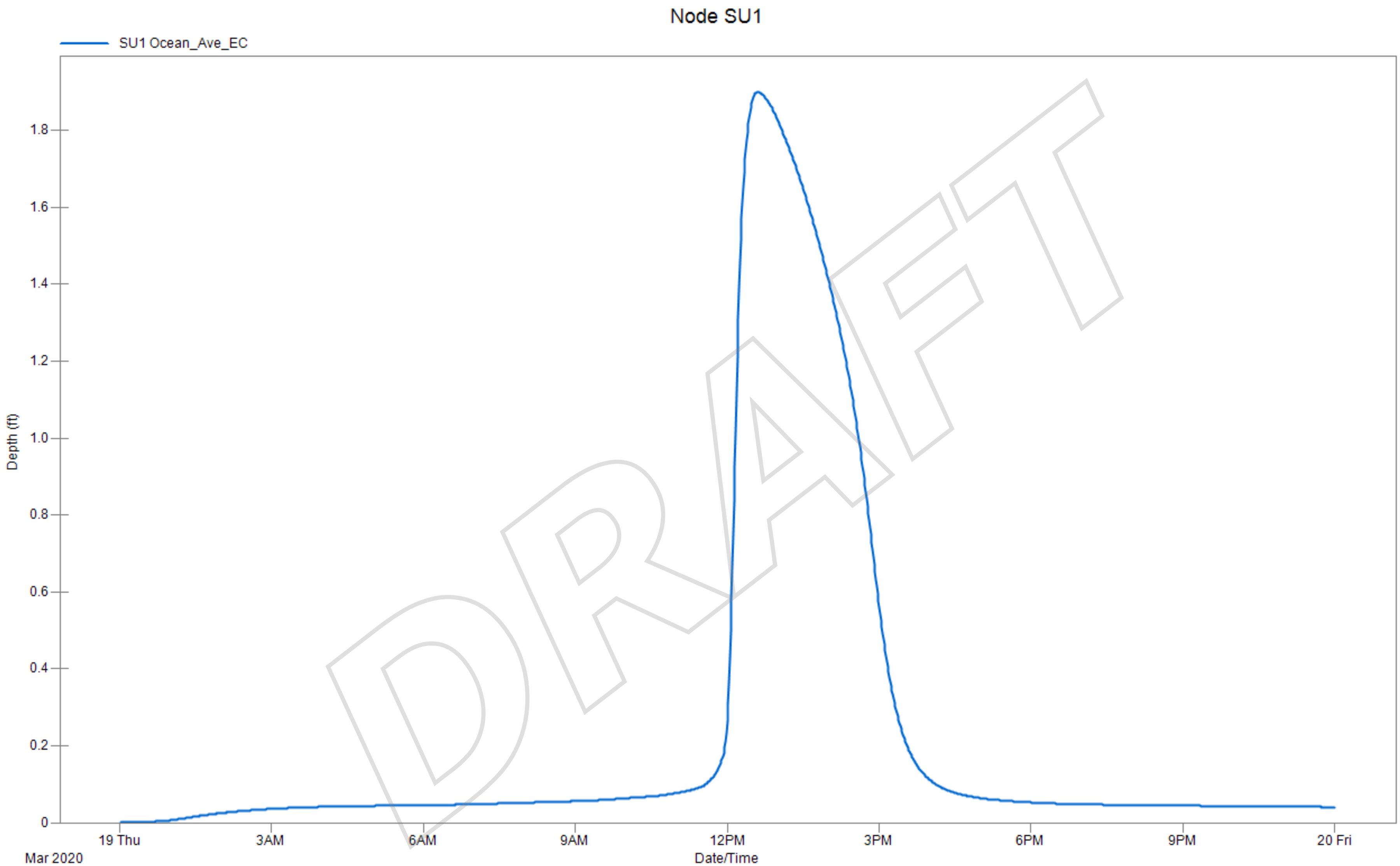


Figure 3: Analysis Point A

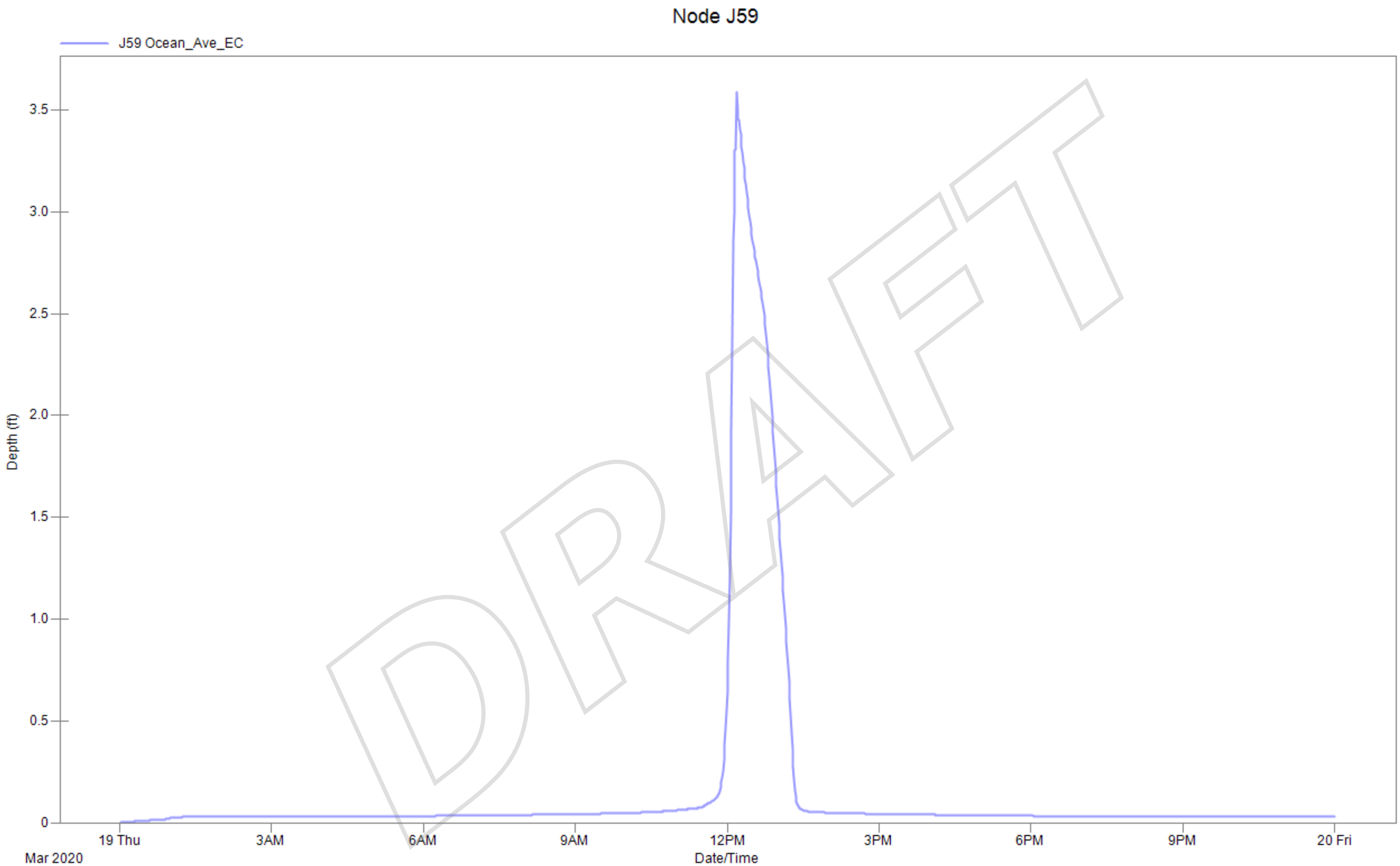


Figure 4: Analysis Point C

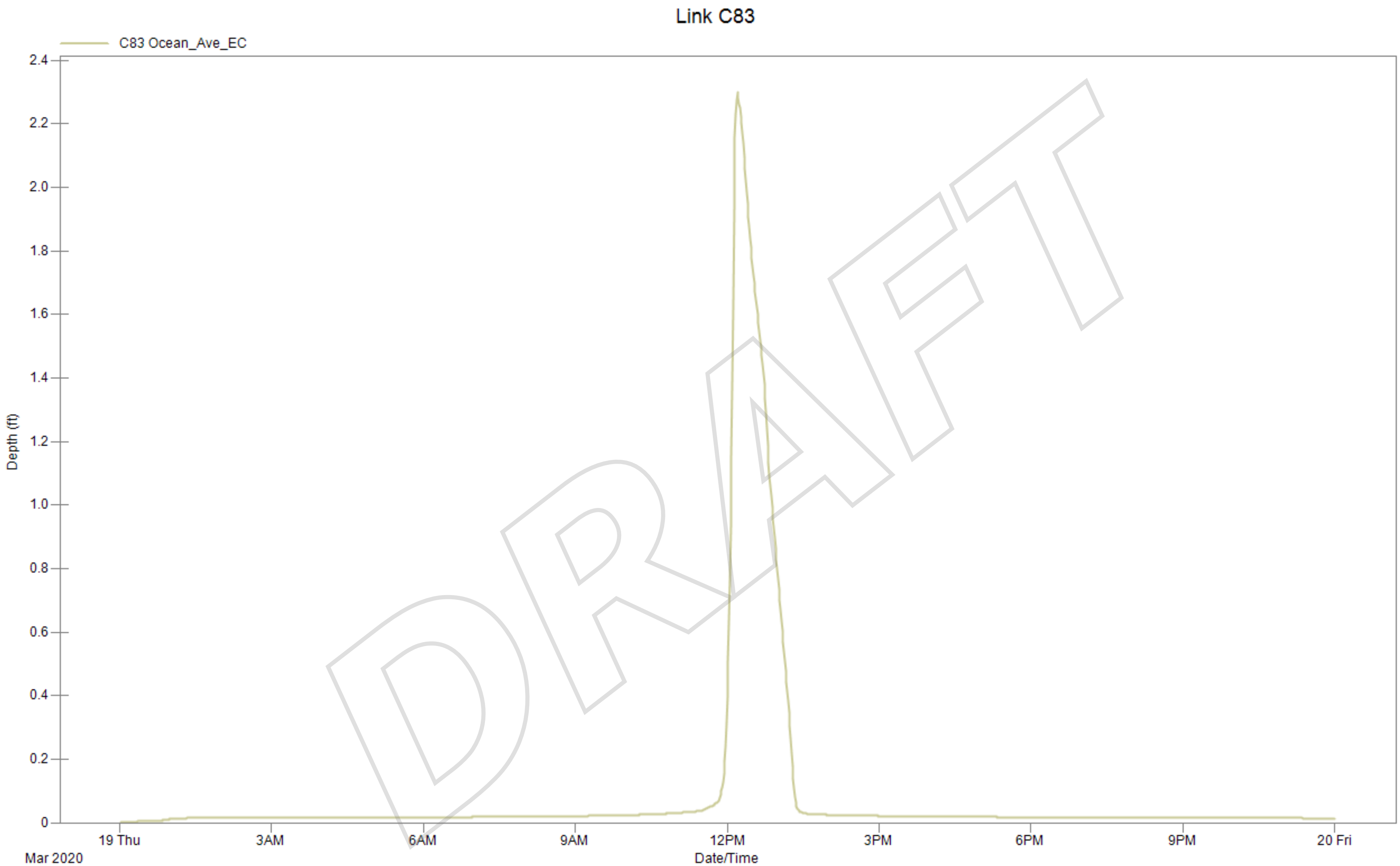


Figure 5: Analysis Point D

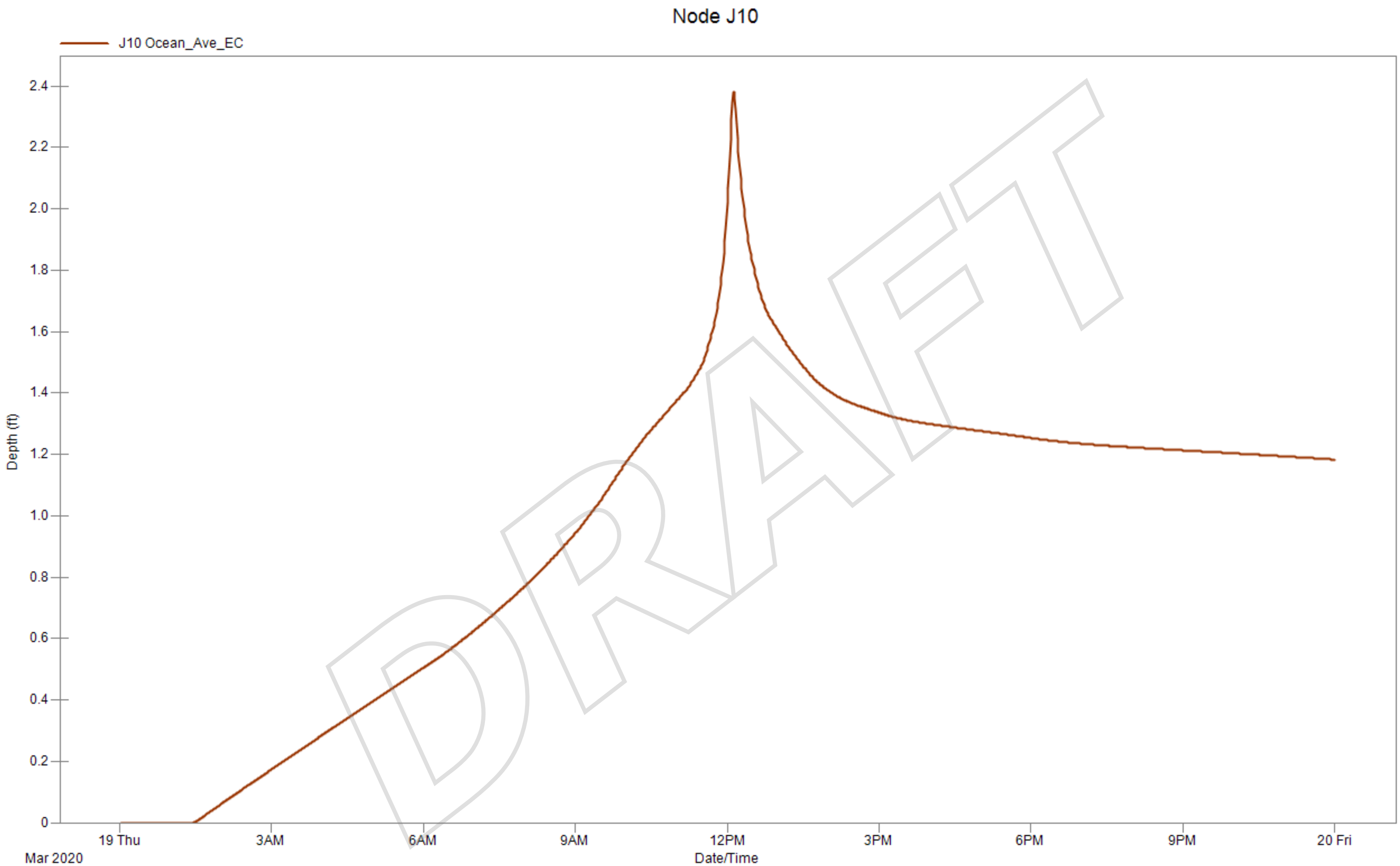


Figure 6: Analysis Point E

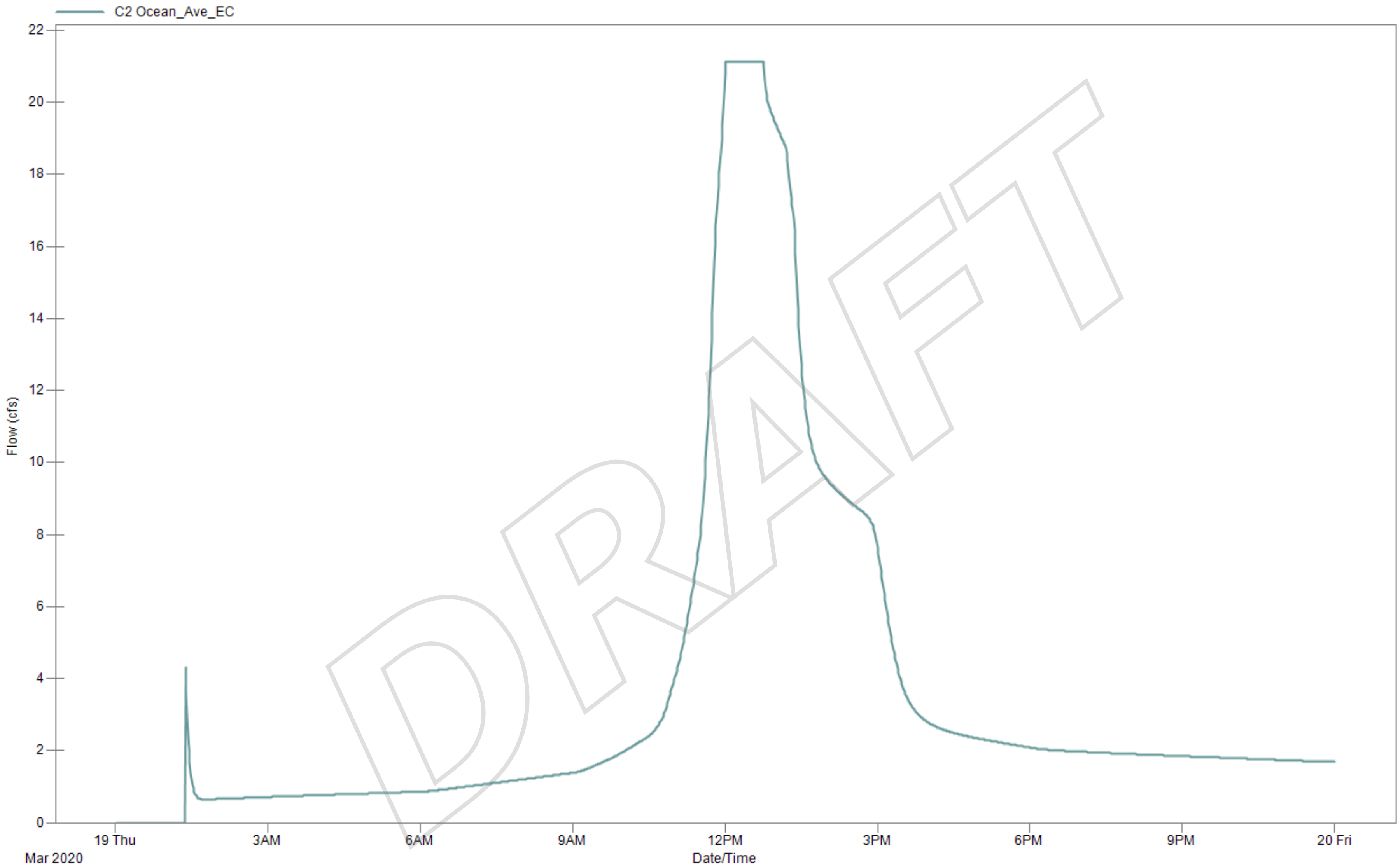


Figure 7: OceanAveW_PS

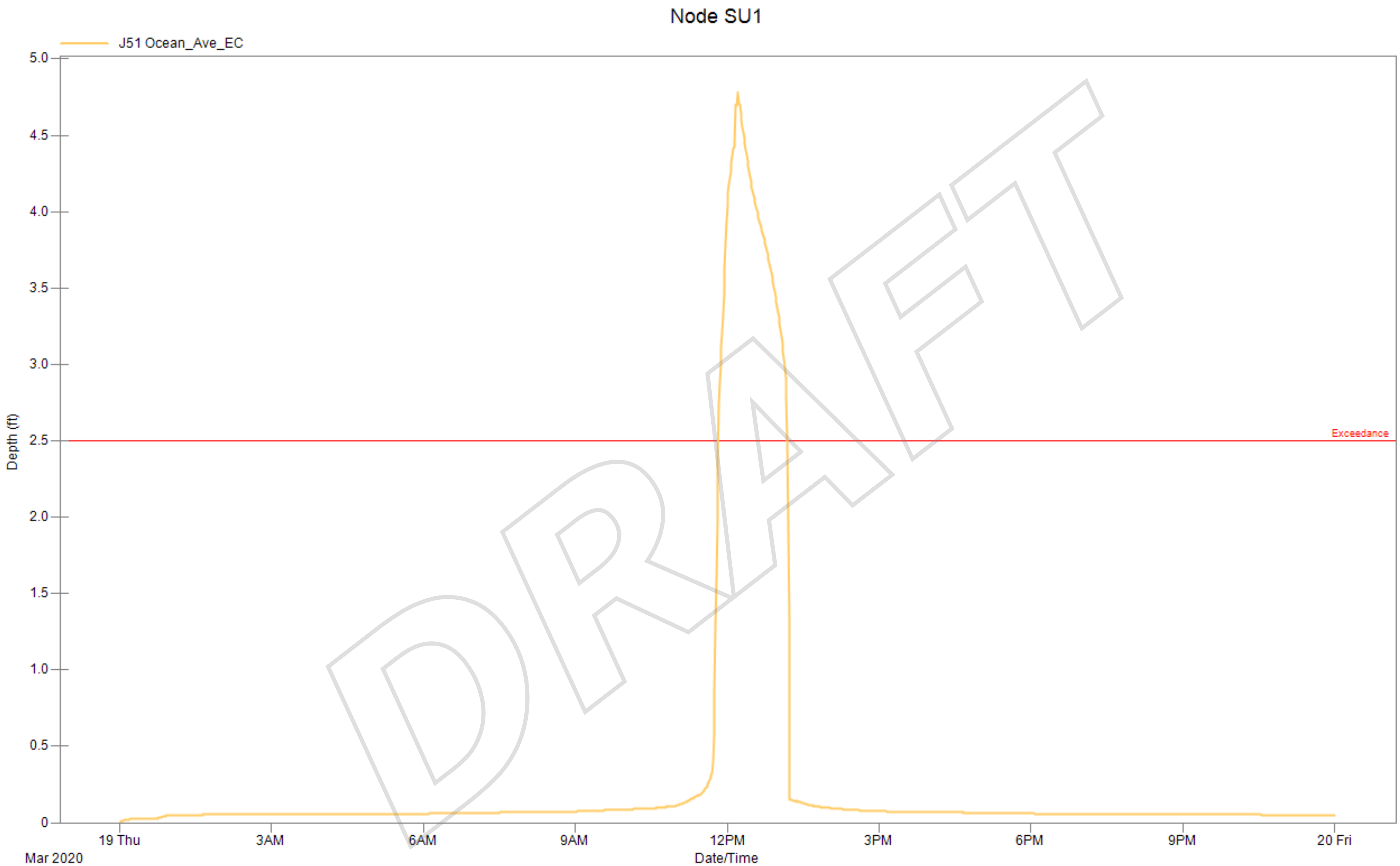


Figure 8: Analysis Point B

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