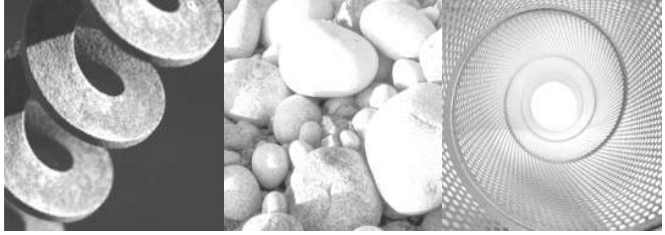

GEI Consultants

Consulting
Engineers and
Scientists

Town Landing Resiliency Study

Falmouth, Maine

Submitted to:
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Town of Falmouth
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July 14 2023
Project 2200496

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Glossary of Terms

1% annual chance storm: Also known as the "100-year storm," this storm has a 1% chance of occurring in any given year. It is also the storm condition that FEMA uses to determine their flood insurance maps.

BFE: Base Flood Elevation. This is the water elevation that is expected to be seen during a 1% annual chance storm, or "100-year storm," as predicted by FEMA. This elevation accounts for wave action (wave crests, wave setup, and wave runup) on top of the Stillwater Elevation (SWEL).

FEMA: The Federal Emergency Management Agency, responsible for distributing Flood Insurance Rate Maps (FIRMs) and determining present-day BFEs.

FIRMs: Flood Insurance Rate Maps, or maps showing the flood extents and 1% Flood Elevations for present-day conditions, distributed by FEMA.

FIS: Flood Insurance Study, issued by FEMA to accompany the FIRMs and provide details regarding the basis of the BFEs and extents.

HAT: Highest Annual Tide, the highest elevation tidal water elevation in any given year as reported by the Maine Department of Environmental Protection.

MHHW: Mean Higher High Water, the average of the higher high-water height of each tidal day observed over the National Tidal Datum Epoch.

MHW: Mean High Water, the average of all the high-water heights observed over the National Tidal Datum Epoch.

MLLW: Mean Lower Low Water, the average of the lower low water height of each tidal day observed over the National Tidal Datum Epoch.

MLW: Mean Low Water, the average of all the low water heights observed over the National Tidal Datum Epoch.

MSL: Mean Sea Level, the arithmetic mean of hourly heights observed over the National Tidal Datum Epoch.

NAVD88: The North American Vertical Datum of 1988, the vertical datum used for all elevations in this report, unless stated otherwise.

NOAA: The National Atmospheric and Oceanic Administration, responsible for data buoys providing tidal datums and observed water levels.

SLR: Sea Level Rise

SWEL: Stillwater Elevation, or "storm surge." The SWEL is the rise in the static water elevation during storms due to a decrease in atmospheric pressure and an increase in offshore winds. The SWEL does not include the additional water elevation often seen during storms due to wave setup, wave runup, or wave crests.

Executive Summary

Falmouth Town Landing is a municipal facility in the heart of Casco Bay. The site provides access to seasonal floats and boat launching facilities and serves the largest mooring field in Maine for recreational boaters, commercial fisherman, and transient vessels. Town Landing is the only developed waterfront access to Casco Bay maintained by the Town of Falmouth. The facility is enjoyed year-round by a wide range of users. Highest use occurs between spring and fall when the floats are installed and the mooring field is at capacity.

Existing features at the site include a deep-water pier, year-round boat launch, harbormaster's office, parking, and seasonal floats. The site is at low elevation in relation to tidal and flood elevations and is susceptible to flooding which, depending on the severity, has the potential to impact site uses and/or damage site features. The potential for flooding is anticipated to increase in severity in the future due to sea level rise, which will increase the associated risks to the site.

The Town of Falmouth has retained GEI Consultants to undertake an assessment of site resiliency for Falmouth Town Landing. The primary goals of this study are to:

1. Undertake an assessment of Town Landing Site Facilities.
2. Assess the risk of flood inundation to various site features to understand the depths, frequency, and impacts of flood events.
3. Develop recommendations to repair, improve, and adapt the facility to improve resilience.
4. Prepare conceptual designs for adaptation measures aimed at mitigating the effects of storm surge and inundation.

The following report summarizes the assessment that has been completed and the recommendations that are made for short-term repairs, long-term improvements, and considerations for future adaptation. These recommendations are summarized in the following table:

RESILIENCY CATEGORY	RECOMMENDED IMPROVEMENTS				IMPLEMENTATION		
	Launch Ramps	Access Road Bulkhead/Slope	Parking and Circulation	Pier & HM Office	Ballpark Budget	Planning Horizon	Regulatory Permit Considerations
MAINTENANCE REPAIRS	REHABILITATE Voids and Stone Armor	RECONSTRUCT Existing Slope Armoring.	REPAIR Pavement Surfaces.	MAINTAIN Utility Services.	$ 0.5 M to $ 0.75 M	0 to 10 years	MINIMAL Maintenance activities generally qualify for expedited approval.
LONG-TERM IMPROVEMENTS	INCREASE Ramp Resistance to Wave Action.	RAISE Slope Armoring System to protect road.	ADD Seawall to raise site.	ELEVATE to Mitigate Sea Level Rise.	$ 1.5 M to $ 2.5 M	10 to 25 years	TOWN, STATE & FEDERAL w/ Coastal Wetland & Shoreland Zoning compliance.
ADAPTATION	ACCOMMODATE Site Use in Reduced Footprint.	RELOCATE Facilities to more protected site.			Unknown at this time	25 to 50 years	PROPERTY ACQUISITION & DEVELOPMENT to be determined.

1. Introduction

GEI Consultants was retained by the Town of Falmouth to prepare this resiliency study for Falmouth Town Landing on Casco Bay. The study is made possible by a matching grant from the Maine Coastal Program that is sponsored by the Maine Department of Marine Resources.

Falmouth Town Landing is a municipal facility in the heart of Casco Bay that has likely been in continuous operation as a waterfront landing since colonial times. Since at least 1914, the 0.5-acre site has evolved to provide Town waterfront access to seasonal floats and boat launching facilities. Today, it serves the largest mooring field in Maine for recreational boaters, commercial fisherman, and transient vessels. It provides the only developed waterfront access to Casco Bay maintained by the Town. The facility is enjoyed year-round by a wide range of users. Highest use occurs between spring and fall when the floats are installed, and the mooring field is at capacity. Refer to Fig. 1 taken from the Town ESRI database that shows the property limits.

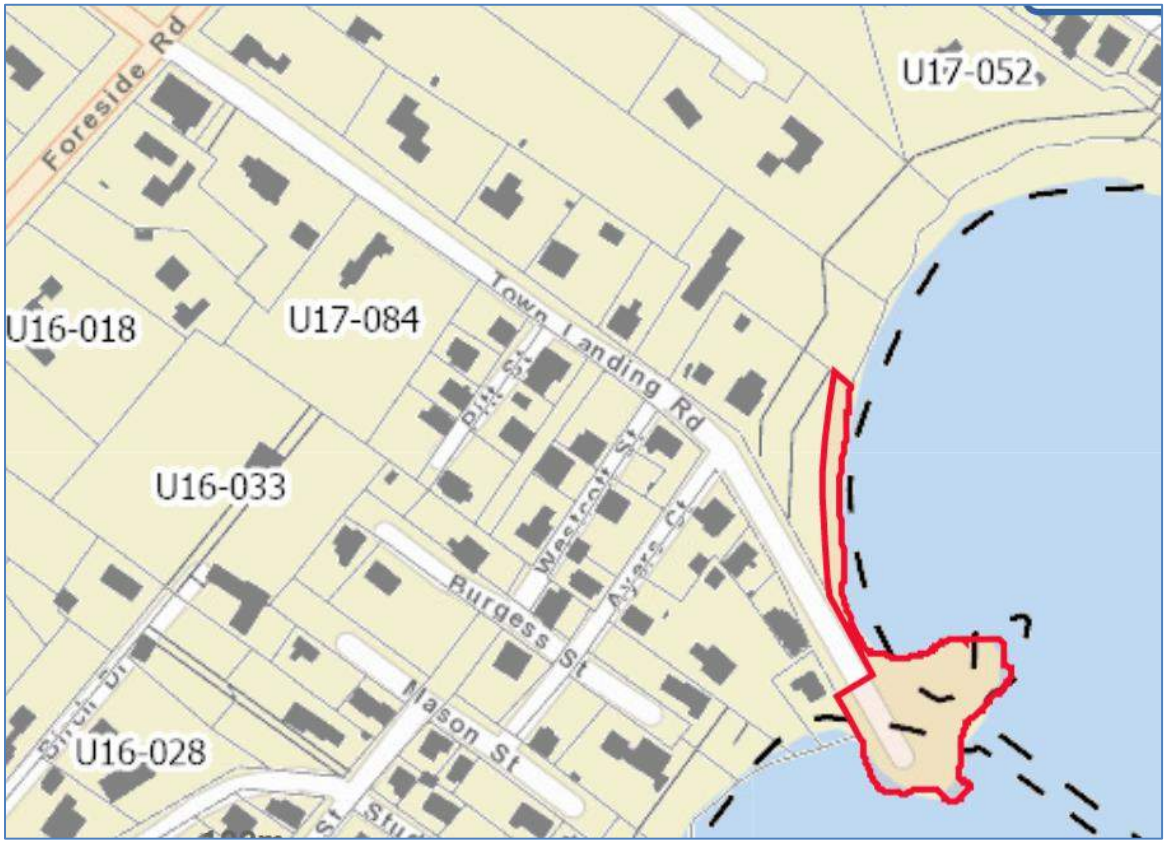


Fig. 1. Falmouth Foreside Property Location- Town ESRI Database

The purpose of this study is to investigate the vulnerability of the site to climate change and to use this information to develop recommendations for future improvements and adaptation measures to maintain public waterfront access to Casco Bay from this site into the future.

Specific task items completed for this study are summarized below along with summary observations and recommendations that are presented in more detail within the following sections of this report.

1. Prepare a baseline vulnerability assessment of the existing site infrastructure that considers historical inundation of the property and considers the impact of sea level rise using the Maine Climate Council sea level rise recommendations.

2. Develop a program of resiliency and adaptation measures to promote continued public waterfront access to Casco Bay from this site into the future.

3. Provide a road map of the regulatory and engineering steps necessary to implement the recommended resiliency program.

2. Existing Site Conditions

2.1 Existing Site Elements

The existing site is located in Falmouth Foreside and is accessed from Town Landing Road which extends from Route 88 to Casco Bay. The site is depicted in Figure 2 below. The site was developed on a natural ledge outcrop which has served as a public access point to Casco Bay for over 100 years. Features currently located at the site include a pile-supported timber pier with seasonal floating docks and gangways, a Harbormaster's office, a year-round boat launch, parking, a seasonal restroom, a small carry-in ramp, a beach access area, and a coastal embankment that follows the east side of Town Landing Road.

Fig. 2. Falmouth Town Landing Facilities- GEI Drone Photo Composite (2022)

Summarized in Table 1 below are pertinent elevations of Falmouth Town Landing Elements (highlighted in yellow) and water elevations during the typical tide cycle and due to coastal flood

scenarios from storm surge and sea level rise. Please refer to the Glossary of Terms section in the beginning of this report for definitions of acronyms provided in the table below.

Table 1. Summary of Pertinent Elevations at the Falmouth Town Landing

PROJECT ELEVATIONS (BY DATUM)			
ELEVATION	**CHART** (ft)	**NAVD88** (ft)	**Notes**
Prepare to Manage_5.0 + BFE	29.4	24.0	Maine Climate Council 2070 Sea Level Rise Model
Commit to Manage_2.4 + BFE	26.8	21.4	
FEMA BFE Base Flood Elev 1%	24.4	19.0	FIRM PRELIMINARY, ZONE VE, 4.14.2017
Harbormasters Office Floor	19.7	14.3	Approx. from Drone Suvey/LIDAR Data
FEMA BFE Base Flood Elev 1%	17.9	12.5	FIRM EFFECTIVE , ZONE V3, 10.16.1984
Pier Deck Elevation	15.7	10.33	Approx. from Drone Suvey/LIDAR Data
Parking Elev Varies (7.0 to 9,0, Avg 8.0)	13.4	8.0	GEI Drone Survey, BDC Legacy Drawings
Top of Boat Ramp	12.4	7.0	
FEMA Stillwater 0.2% Annual Chance	14.9	9.5	FIS Cumberland County Transect 058 (Casco BAY)
FEMA Stillwater 1% Annual Chance	14.3	8.9	
FEMA Stillwater 10% Annual Chance	13.4	8.0	
HAT Highest Annual Tide	12.1	6.7	2018 MEDEP Predictions for Cow Island
MHHW	9.9	4.5	BASED ON NOAA TIDAL BM 8418150 "Portland"
NAVD88	5.4	0.0	
MLLW	0.0	-5.4	

2.2 Location and Exposure

The coast of Maine is exposed to high winds, storm surge, and wave conditions associated with a variety of storm events up to and including hurricane conditions. The hurricane season is generally from June to November which overlaps the primary use of the facility that occurs between May to October when the floats are in place.

The mainland to the west and the Casco Bay islands seaward of Falmouth Town Landing protect the site from deep-water wave action. The prevailing wind direction is light to moderate southwesterlies in the summer and stronger northerlies in the winter. The fetch diagram in Figure 3 illustrates the site protection/shadow formed by the islands of Sturdivant, Mosier, Cousins, Clapboard, Chebeague, Long, Great Diamond, Peaks, Cushing, and the headland of Cape Elizabeth. Further offshore, the islands of Jewell, Cliff, Hope, and numerous smaller islands eventually give way to the Gulf of Maine.

A summary of the site exposure is provided below.

- Falmouth Town Landing is well protected from West to North by the mainland.

- From North to East the site is in the shadow of the moderate protection provided by the Harpswell and Yarmouth headlands and the shallows of the Cumberland Foreside. While wave action and ice loading build up in the inshore fetch during a during a "Northeasterly", the Atlantic swell in the Gulf of Maine generated by these storms does not typically penetrate to the site.

- The site is most exposed to weather from the East to South quadrants. From this direction, sustained winds from a significant storm event generate storm surge and build up large waves in the Gulf of Maine that penetrate through the offshore islands to the site. When these storms occur at high tide, the coastline is most vulnerable to erosion and damage caused by wave action and flooding.

Fig. 3. Fetch on Aerial Image of Casco Bay

The coastal geology is a mix of ledge outcrops, mudflat, and glacial deposits. The Town landing site is dominated by an exposed low lying ledge outcrop that extends from shore and anchors the waterfront facility. Casco Bay has been known to freeze over. A concentration of ice build-up on the existing ledge perimeter together with tidal action has the potential to damage the existing pavement.

The property slopes steeply inland transitioning to a coastal embankment that defines the shorefront in both directions. The embankment is generally comprised of glacial deposits on a

ledge base that are highly erodible if not protected by stone and plantings. Remedial action in the past to protect these embankments has included stone armoring, plantings, and a steel bulkhead to protect the road entrance to the property.

2.3 Site History

Information on the early history of the site was not readily available for use in this study. However, the natural ledge outcrop that projects out into Casco Bay that defines, anchors, and protects site elements, makes it a good candidate for a landing site. Historical charts indicate the facility has been a landmark on Casco Bay for well over 150 years. Refer to Figs. 4 – 6 below.

The 1870 and 1896 charts refer to the site as Foster's Landing and appear to record the development of several piers along the foreside.

By 1914 the site is called out as 'Town Landing' and there is an electric tramway along the Route 88 alignment. The current pier was constructed in 1998/1999 replacing a similar structure. Refer to the 2019 Casco Bay Chart that calls out the 'special anchorage' in the area currently occupied by an extensive mooring field that is managed by the Town.

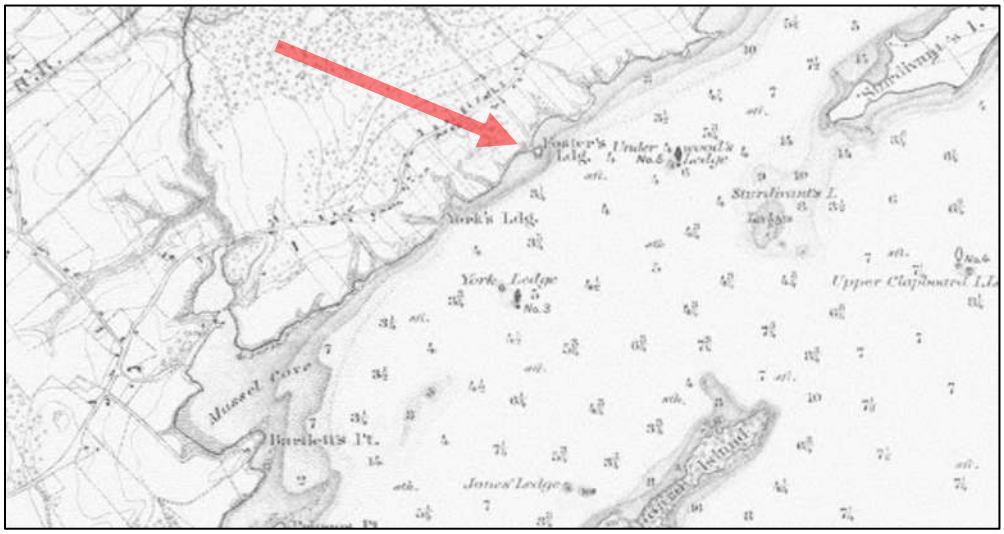


Fig. 4. 1870 Casco Bay _Historical Charts NOAA Office of Coast Survey

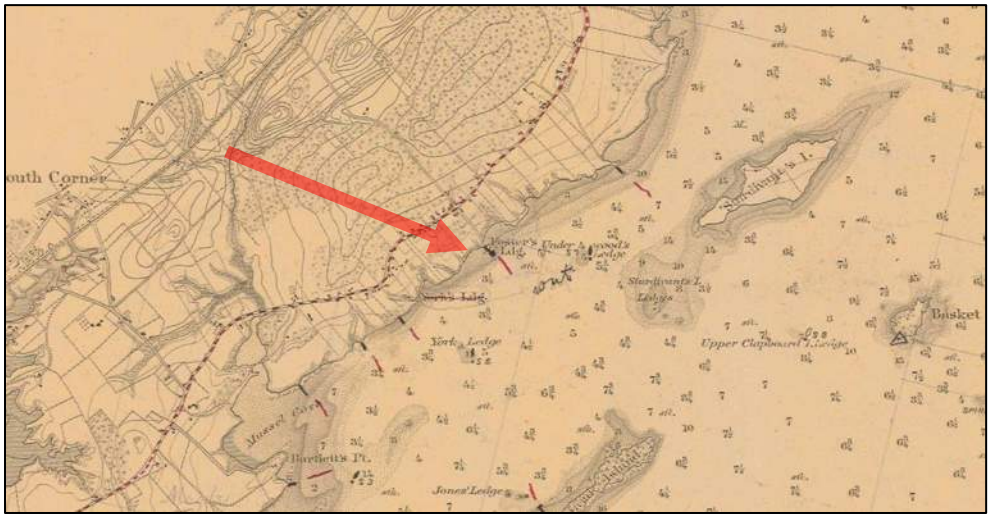


Fig. 5. 1896 Chart No 315 Casco Bay - Historical Charts NOAA Office of Coast Survey

Fig.6. 1914 ME Casco Bay USGS Quadrangle

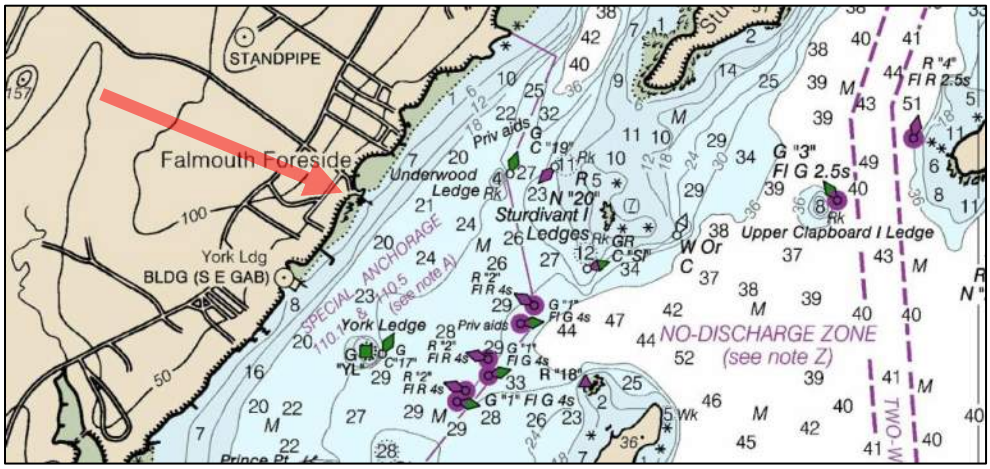


Fig. 7. 2019 Chart 13290 Casco Bay _ NOAA Office of Coast Survey

3. Site Inundation Analysis

3.1 Coastal Flood Data

Coastal storm surge, wave action, and sea level rise will likely cause flood inundation at the Falmouth Town Landing. We have reviewed and summarized the relevant data for storm surge, tide elevations, and sea level rise that is relevant to the site below. Using the available data, we have summarized the coastal storm events and sea level rise scenarios under which flood inundation at the Falmouth Town Landing is likely to occur.

3.1.1 Tides

The Portland Tide Gage (NOAA, 2022) is used to evaluate the typical range of tides at the Falmouth Town Landing.

Monthly Mean Sea Level (MSL) measurements at the Portland Tide Gage from 1912 to 2022 have been used to evaluate the historical sea level rise at the site. The NOAA website states that:

"The monthly extreme water levels include a Mean Sea Level (MSL) trend of 1.9 millimeters/year with a 95% confidence interval of +/- 0.14 millimeters/year based on monthly MSL data from 1912 to 2022 which is equivalent to a change of 0.62 feet in 100 years."

Additionally, the Portland Tide Gage provides hourly water surface elevations which can be used to estimate the duration of flooding during tidal cycles. The water level measurements from the Portland Tide Gage do not include wave action.

3.1.2 Coastal Storm Events

The Federal Emergency Management Agency (FEMA) has developed 1% annual chance Base Flood Elevations (BFEs) for the Cumberland County coastline. These elevations are the estimates of peak water surface elevations due to wave crests and/or wave runup during 1% annual chance coastal events, or events that have a 1% likelihood of occurring in any given year. These storms are also commonly known as "100-yr" storms.

FEMA estimates these values using a combination of coastal modeling techniques to transform offshore storm surge elevations and wave parameters (such as wave heights and wave periods) to nearshore wave parameters. Nearshore wave parameters, combined with the localized bathymetry near each FEMA transect, are used to calculate wave crest elevations and wave runup values. BFEs are typically based on the wave crest and wave runup results along FEMA transects. BFEs between transect locations are based on a combination of the nearest transect and the engineer's judgment.

The nearest FEMA transect to the Falmouth Town Landing is Cumberland County Transect 067, located along the beach approximately 100 ft south of the site (Fig. 8). FEMA's Preliminary Flood Insurance Rate Maps (FIRMs) specify that the 100-yr BFE at the Falmouth Town Landing, based on Transect 067, is a VE zone of 19 ft NAVD88. The VE designation indicates the wave height that contributes to the BFE is greater than 3 ft, which is likely due to wave runup. While this transect is located close to the Town Landing, the wave runup values along a sandy beach are likely to be different than the wave runup values along a steeper, rockier shoreline, like the one where the Falmouth Town Landing facility is located, meaning the 1% annual chance flood elevation at the Falmouth Town Landing may vary from FEMA's predictions. Additionally, FEMA does not include the effects of sea level rise in their BFE values. With sea level rise included, the 1% annual chance BFE would likely increase.

Fig. 8. FEMA Flood Insurance Rate Map (2017 Preliminary)

3.1.3 Sea Level Rise

The Maine Climate Council (MCC) has provided recommendations for sea level rise scenarios to use when planning for coastal infrastructure. MCC provides a minimum "Commit to Manage" (C2M) sea level rise value based on the lifespan of the proposed improvements and a more conservative "Prepare to Manage" (P2M) recommendation that should be considered in design development. Table 2 below summarizes MCC recommendations for sea level rise values to use for various timeframes.

Table 2. Maine Climate Council Recommendations for SLR

Planning Scenario Year	"Commit to Manage" Intermediate Scenario (ft)	"Prepare to Manage" High Scenario (ft)
2030	0.8	1.4
2050	1.5	3.0
2070	2.4	5.0
2100	3.8	8.7

3.2 Flood Inundation Estimates at the Falmouth Town Landing

Elements of the Falmouth Town Landing will likely experience flood inundation due to nuisance flooding, storm surge, and wave action from coastal storm events.

The concept of Nuisance flooding is introduced to establish a metric by which site inundation can be evaluated. Nuisance Flooding would occur when the Falmouth Town Landing is inundated under highest annual tide (HAT) conditions without the effect of wave action or coastal storms. This is also sometimes referred to as "sunny-day flooding."

Storm surge is the additional height of water above the typical static water level ("Stillwater elevation") due to a decrease in atmospheric pressure and an increase in offshore winds often occurring during extreme events, such as 100-yr storms. Storm surge is separate from the additional height of water due to wave setup, wave runup, and/or wave crests. The FEMA FIS for Cumberland County (FEMA, 2019) provides Stillwater elevations due to storm surge. These values do not include wave action. However, the FEMA Base Flood Elevations (BFEs) for the 100-yr storm event does include the effects of wave action.

In Tables 3-6 below, we have summarized the Stillwater scenarios (typical tide and storm surge events) for existing water elevations and four future time horizons (2030, 2050, 2070, and 2100) under which the Main Ramp (Table 3), Parking Lot (Table 4), Pier (Table 5), and the Harbormaster's Office (Table 6) would likely experience flood inundation. Additionally, the top row of the table includes FEMA's 100-yr BFE plus projected sea level rise rates. The values in the table represent water surface elevations and cells in the table that are highlighted indicate that the element is likely to be inundated for that scenario based on the elevation of the element.

In summary, the Main ramp is likely to experience flood inundation today due to Stillwater conditions during 10-yr storm events, by 2030 during the HAT, by 2050 and 2070 during high tides under the "prepare to manage" sea level rise scenario, and by 2100 during high tides under the "commit to manage" sea level rise scenario and for mean sea level conditions under the "prepare to manage" sea level rise scenario, as shown in Table 3. Nuisance flooding is likely to begin by 2030.

For the parking lot, we have based our analysis on the average elevation of 8.0 ft. At this elevation, the parking lot is likely to experience flood inundation today due to Stillwater

conditions for a 50-yr storm event, by 2030 during HAT under the "prepare to manage" sea level rise scenario, by 2050 during HAT events under both sea level rise scenarios evaluated, by 2070 during MHW under the "prepare to manage" sea level rise scenario," and by 2100 during MSL conditions under the "prepare to manage" sea level rise scenario, as shown in Table 4. Nuisance flooding is likely to begin by 2030.

The Pier is likely to experience flood inundation today and in 2030 due to wave action during 100-yr storm events. By 2030, the pier may experience flood inundation during Stillwater conditions of a 500-yr storm event. By 2050, the pier is likely to experience flooding due to Stillwater conditions during a 10-yr storm event under the "prepare to manage" sea level rise scenario. By 2070, the pier is likely to experience flooding due to HAT under the "prepare to manage" sea level rise scenario. By 2100, the pier is likely to experience flooding due to Stillwater conditions during MHW under the "prepare to manage" sea level rise scenario, as shown in Table 5. Nuisance flooding is likely to begin by 2070.

The Harbormaster's Office is likely to experience flood inundation today, in 2030, and in 2050 due to wave action during 100-yr storm events, and due to Stillwater conditions by 2070 during the 500-yr storm events under the "prepare to manage" sea level rise scenario, and by 2100 during the HAT under the "prepare to manage" sea level rise scenario, as shown in Table 6. Nuisance flooding is likely to begin by 2100.

Table 3. Flood Elevations and Likely Inundation of the Main Ramp due to Storm Surge and SLR

Water Condition	Elevation Reference (NAVD88, ft)		Existing Water Elevation, ft	SLR Projection							
				2030 C2M	2030 P2M	2050 C2M	2050 P2M	2070 C2M	2070 P2M	2100 C2M	2100 P2M
				0.8	1.4	1.5	3.0	2.4	5.0	3.9	8.8
				feet	feet	feet	feet	feet	feet	feet	feet
BFE	1% BFE + SLR		19	19.8	20.4	20.5	22.0	21.4	24.0	22.9	27.8
Storm Surge Stillwater Elevations	Annual Return Period	0.20%	9.5	10.3	10.9	11.0	12.5	11.9	14.5	13.4	18.3
		1%	8.9	9.7	10.3	10.4	11.9	11.3	13.9	12.8	17.7
		2%	8.6	9.4	10.0	10.1	11.6	11.0	13.6	12.5	17.4
		10%	8.0	8.8	9.4	9.5	11.0	10.4	13.0	11.9	16.8
Typical Tide Elevations	HAT		6.8	7.6	8.2	8.3	9.8	9.2	11.8	10.7	15.6
	MHHW		4.5	5.3	5.9	6.0	7.5	6.9	9.5	8.4	13.3
	MHW		4.0	4.8	5.4	5.5	7.0	6.4	9.0	7.9	12.8
	MSL		-0.5	0.3	0.9	1.0	2.5	1.9	4.5	3.4	8.3
	MLW		-5.1	-4.3	-3.7	-3.6	-2.1	-2.7	-0.1	-1.2	3.7
	MLLW		-5.4	-4.6	-4.0	-3.9	-2.4	-3.0	-0.4	-1.5	3.4

Note: Estimated flood inundation based on the Main Ramp elevation of 7.0 ft NAVD88.

Table 4. Flood Elevations and Likely Inundation of the Parking Lot due to Storm Surge and SLR

Water Condition	Elevation Reference (NAVD88, ft)		Existing Water Elevation, ft	SLR Projection							
				2030 C2M	2030 P2M	2050 C2M	2050 P2M	2070 C2M	2070 P2M	2100 C2M	2100 P2M
				0.8	1.4	1.5	3.0	2.4	5.0	3.9	8.8
				feet	feet	feet	feet	feet	feet	feet	feet
BFE	1% BFE + SLR		19	19.8	20.4	20.5	22.0	21.4	24.0	22.9	27.8
Storm Surge Stillwater Elevations	Annual Return Period	0.20%	9.5	10.3	10.9	11.0	12.5	11.9	14.5	13.4	18.3
		1%	8.9	9.7	10.3	10.4	11.9	11.3	13.9	12.8	17.7
		2%	8.6	9.4	10.0	10.1	11.6	11.0	13.6	12.5	17.4
		10%	8.0	8.8	9.4	9.5	11.0	10.4	13.0	11.9	16.8
Typical Tide Elevations	HAT		6.8	7.6	8.2	8.3	9.8	9.2	11.8	10.7	15.6
	MHHW		4.5	5.3	5.9	6.0	7.5	6.9	9.5	8.4	13.3
	MHW		4.0	4.8	5.4	5.5	7.0	6.4	9.0	7.9	12.8
	MSL		-0.5	0.3	0.9	1.0	2.5	1.9	4.5	3.4	8.3
	MLW		-5.1	-4.3	-3.7	-3.6	-2.1	-2.7	-0.1	-1.2	3.7
	MLLW		-5.4	-4.6	-4.0	-3.9	-2.4	-3.0	-0.4	-1.5	3.4

Note: Estimated flood inundation based on the Parking Lot elevation of 8.0 ft NAVD88.

Table 5. Flood Elevations and Likely Inundation of the Pier due to Storm Surge and SLR

Water Condition	Elevation Reference (NAVD88, ft)		Existing Water Elevation, ft	SLR Projection							
				2030 C2M	2030 P2M	2050 C2M	2050 P2M	2070 C2M	2070 P2M	2100 C2M	2100 P2M
				0.8	1.4	1.5	3.0	2.4	5.0	3.9	8.8
				feet	feet	feet	feet	feet	feet	feet	feet
BFE	1% BFE + SLR		19	19.8	20.4	20.5	22.0	21.4	24.0	22.9	27.8
Storm Surge Stillwater Elevations	Annual Return Period	0.20%	9.5	10.3	10.9	11.0	12.5	11.9	14.5	13.4	18.3
		1%	8.9	9.7	10.3	10.4	11.9	11.3	13.9	12.8	17.7
		2%	8.6	9.4	10.0	10.1	11.6	11.0	13.6	12.5	17.4
		10%	8.0	8.8	9.4	9.5	11.0	10.4	13.0	11.9	16.8
Typical Tide Elevations	HAT		6.8	7.6	8.2	8.3	9.8	9.2	11.8	10.7	15.6
	MHHW		4.5	5.3	5.9	6.0	7.5	6.9	9.5	8.4	13.3
	MHW		4.0	4.8	5.4	5.5	7.0	6.4	9.0	7.9	12.8
	MSL		-0.5	0.3	0.9	1.0	2.5	1.9	4.5	3.4	8.3
	MLW		-5.1	-4.3	-3.7	-3.6	-2.1	-2.7	-0.1	-1.2	3.7
	MLLW		-5.4	-4.6	-4.0	-3.9	-2.4	-3.0	-0.4	-1.5	3.4

Note: Estimated flood inundation based on the Pier Deck Elevation of 10.33 ft NAVD88.

Table 6. Flood Elevations and Likely Inundation of the Harbormaster's Office due to Storm Surge and SLR

Water Condition	Elevation Reference (NAVD88, ft)		Existing Water Elevation, ft	SLR Projection							
				2030 C2M	2030 P2M	2050 C2M	2050 P2M	2070 C2M	2070 P2M	2100 C2M	2100 P2M
				0.8	1.4	1.5	3.0	2.4	5.0	3.9	8.8
				feet	feet	feet	feet	feet	feet	feet	feet
BFE	1% BFE + SLR		19	19.8	20.4	20.5	22.0	21.4	24.0	22.9	27.8
Storm Surge Stillwater Elevations	Annual Return Period	0.20%	9.5	10.3	10.9	11.0	12.5	11.9	14.5	13.4	18.3
		1%	8.9	9.7	10.3	10.4	11.9	11.3	13.9	12.8	17.7
		2%	8.6	9.4	10.0	10.1	11.6	11.0	13.6	12.5	17.4
		10%	8.0	8.8	9.4	9.5	11.0	10.4	13.0	11.9	16.8
Typical Tide Elevations	HAT		6.7	7.5	8.1	8.2	9.7	9.1	11.7	10.6	15.5
	MHHW		4.5	5.3	5.9	6.0	7.5	6.9	9.5	8.4	13.3
	MHW		4.0	4.8	5.4	5.5	7.0	6.4	9.0	7.9	12.8
	MSL		-0.5	0.3	0.9	1.0	2.5	1.9	4.5	3.4	8.3
	MLW		-5.1	-4.3	-3.7	-3.6	-2.1	-2.7	-0.1	-1.2	3.7
	MLLW		-5.4	-4.6	-4.0	-3.9	-2.4	-3.0	-0.4	-1.5	3.4

Note: Estimated flood inundation based on the Harbormasters Office elevation of 14.3 ft NAVD88.

3.3 Flood Inundation During the December 23, 2022 Storm Event

The storm event that occurred on December 23, 2022 was a real time test of the ability of the Falmouth Town Landing facility to resist wave action and overtopping. An inspection of the site was made after the storm to provide an assessment of the damage. Refer to the table provided in Appendix A for cost estimates to repair storm damage associated with this event. While some damage to site elements did occur, the facility emerged from the storm remarkably intact and

winter operations were restored after Falmouth Public Works completed storm cleanup. The storm serves to validate site performance observations made in this report and supports the need for resiliency improvements to address increased exposure in the future due to climate change.

The record water elevation at the Portland Tide Gauge (NOAA, 2022) for December 23, 2022 storm event is the second highest on record. The characteristics of the December 23, 2022 storm event are defined by the recorded data from the Portland Tide Gage (NOAA, 2022). The Storm Event Characteristics and observed water levels are summarized below:

Storm Event Characteristics:	**December 23, 2022 (24-hr period):**
Predicted High Tide:	Elev. 6.07 ft NAVD88 @ 10:12 AM
Recorded Highwater (validated):	Elev. 8.46 ft NAVD88 @ 10:42 AM
Average Wind Direction (24-hr day):	118 Degrees (ESE)
Average Wind Speed (24-hr day):	28 knots
Maximum Wind Gust:	52.5 knots @ 12:10 EST
Average Wave Height (24-hr day):	4 m (13-ft)
Maximum Wave Height:	6.5 m @ 13:20 EST

The figure below provides an image of the conditions at the Falmouth Town Landing within an hour of the 23 December 23, 2022 storm peak. The image shows that the water overtopped the parking lot and reached the elevation of the pier.

Fig. 9. Falmouth Town Landing Pier 12.23.2022

Based on the information presented in the section, the following observations can be made regarding the December 23, 2022 storm event.

1. High water elevations (tidal plus storm surge without wave action) have been recorded at the Portland Tide Gage for more than 100 years. The Stillwater elevation measured at the peak of the December 23, 2022 storm was 8.46 ft NAVD88 = 2.4-ft above the predicted tidal elevation and 0.4-ft below the record of 8.87 ft set in 1978.
2. Eyewitness accounts and video show wave height peaking near the pier deck elevation of 10.3 ft NAVD88, suggesting an additional 1.9 ft of flood elevation above the Stillwater elevation due to wave action.

4. Recommendations

GEI has developed recommendations for site improvements and adaptation based on our assessment of existing site conditions and flood related risks. The following section summarizes our observations and recommendations. The recommendations are further summarized in Appendix B.

4.1 Recommended Measures to Adapt to Flood Inundation

The Main Ramp, Parking Lot, Pier, and Harbormaster's Office are expected to experience flood inundation due to coastal storms and wave action during a 100-yr storm event for present-day sea level conditions. The increase in Sea Level Rise associated with climate change will likely lead to more frequent flooding events.

Considering the site conditions and flood inundation estimates, the following recommendations and timeframe for site modifications can be made.

- **Raise the top of the Boat Launch and Parking Area should be to elevation 10.0 ft NAVD88.** This elevation corresponds with the height of the abutting property driveway at the site entrance and would not go higher than the existing pier elevation.

  Recommendation- This minimizes impact to abutting properties with the installation of new resiliency measures. Increase elevation of site area by filling interior and installing a perimeter seawall that will be anchored to the existing ledge so that it can resist the overtopping and wave action associated with significant storm events.

- **Plan for replacement of pier with design with improved resilience when it reaches the end of its useful life in approximately 2070.**
  Under MCC C2M SLR predictions, the pier would not be subject to daily overtopping from nuisance flooding in 2070. However, under the more conservative MCC P2M SLR predictions, the pier would likely experience Nuisance Flooding by 2070.

  Recommendation- Continue to inspect the pier after major storm events to record deterioration or damage. Monitor SLR changes and model refinements to pace strengthening of pier components to resist wave action/overtopping and to optimize height for inevitable pier replacement. Periodically update cost benefit analysis to determine timing for pier replacement using updated estimates for SLR and rate of deterioration of the structure.

- **Replace the Harbormasters Office when the pier is replaced.** Flood damage from wave overtopping due to coastal storm events is likely to be severe due to the potential depth of water above the finish floor elevation. The Harbormaster Building replacement will need to

comply with the Falmouth Flood Hazard Development Ordinance which requires the lowest structural member clear the BFE by 2-ft.

Recommendation- The Harbormaster building should be replaced or relocated offsite when the pier is replaced.

4.2 Key Recommendations for Resiliency Improvements

This section identifies key opportunities for site improvements that consider site maintenance needs and resiliency and adaptation strategies. The recommendations in this section can be used to guide planning decisions, design development, permitting and capital expense planning.

Table 7. Key Opportunities to Address Climate Change

RESILIENCY CATEGORY	RECOMMENDED IMPROVEMENTS				IMPLEMENTATION		
	Launch Ramps	Access Road Bulkhead/Slope	Parking and Circulation	Pier & HM Office	Ballpark Budget	Planning Horizon	Regulatory Permit Considerations
MAINTENANCE REPAIRS	REHABILITATE Voids and Stone Armor	RECONSTRUCT Existing Slope Armoring.	REPAIR Pavement Surfaces.	MAINTAIN Utility Services.	$ 0.5 M to $ 0.75 M	0 to 10 years	MINIMAL Maintenance activities generally qualify for expedited approval.
LONG-TERM IMPROVEMENTS	INCREASE Ramp Resistance to Wave Action.	RAISE Slope Armoring System to protect road.	ADD Seawall to raise site.	ELEVATE to Mitigate Sea Level Rise.	$ 1.5 M to $ 2.5 M	10 to 25 years	TOWN, STATE & FEDERAL w/ Coastal Wetland & Shoreland Zoning compliance.
ADAPTATION	ACCOMMODATE Site Use in Reduced Footprint.	RELOCATE Facilities to more protected site.			Unknown at this time	25 to 50 years	PROPERTY ACQUISITION & DEVELOPMENT to be determined.

4.2.1 Maintenance of Existing Town Landing Elements

The existing pier, harbormasters office and launch ramp facilities were designed and constructed in 1998/1999 in accordance with FEMA 1984 predictions for site flooding.

A site inspection was completed for each structure to provide a visual assessment of the condition and vulnerability to storm damage. A cost assessment to restore the site to pre-December 23, 2022 storm conditions is located in Appendix A. Maintenance requirements to site element groups are summarized in Table 7.

Maintenance items essentially repair what has already been installed on the site and therefore requires minimal permitting. These should be executed to keep the facility operational in a short-term of 0 to 10 years.

4.2.2 Long-Term Resiliency Improvements

Long-term improvements will require design development and permitting to implement. There are three (3) major recommendations for facility improvements highlighted in Table 3.

Elevate the site area to secure operational parking and circulation until at least 2100. Refer to the Figures below that contain and elevate the site within a perimeter seawall.

- Refer to the previous section on flood inundation. An elevation of 10.0 ft NAVD88 will interface with the driveway elevation of the abutting property and accommodates waterfront access with no change in parking capacity.
- A seawall has been selected directly fastened to the ledge below.
- The site grade is raised from 1 to 3-ft and accommodates ramp and beach access.
- It would be possible to increase site resilience by raising the seawall above the parking grade, but the design will need to consider the number of openings to accommodate ramps and beach access.

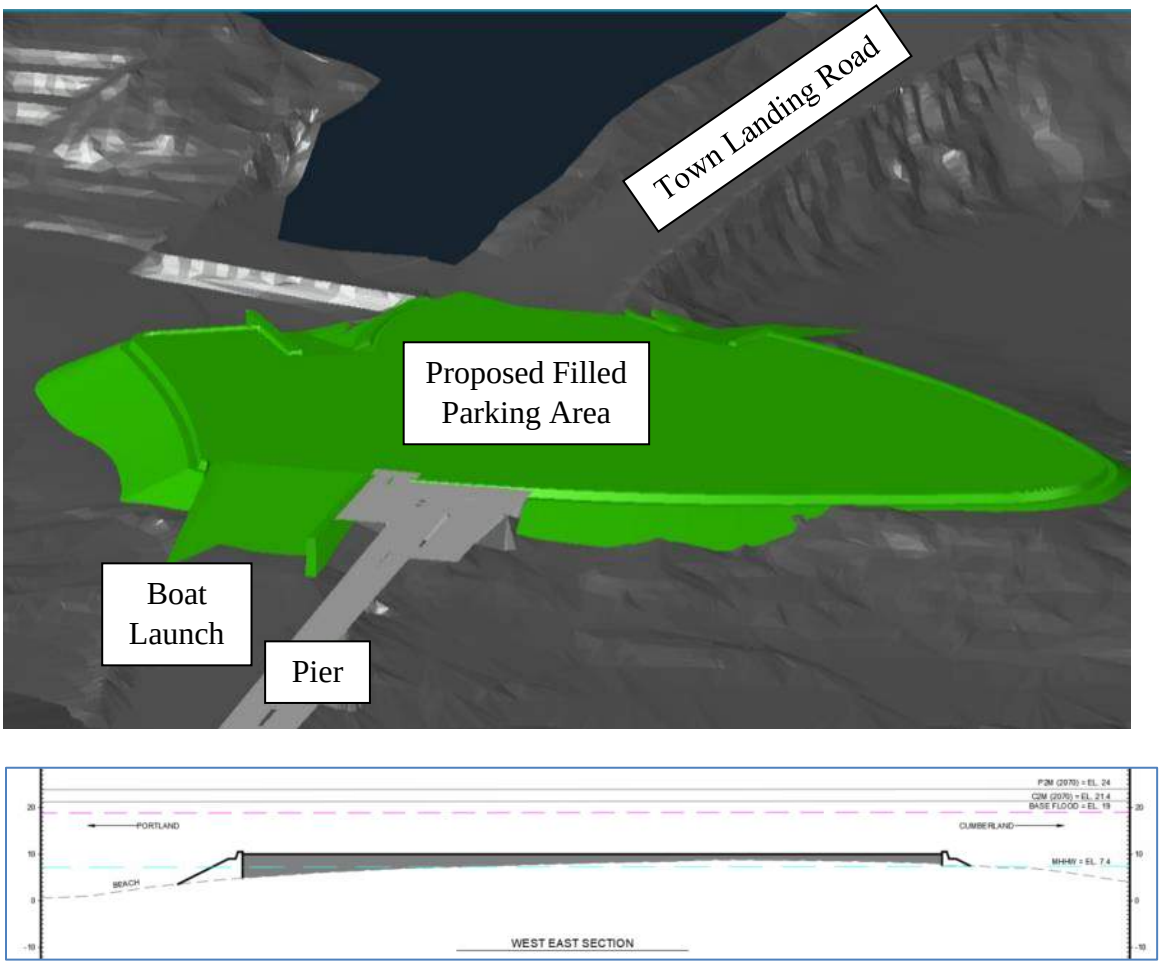


Fig. 10. Isometric and Section of Raised Parking Area

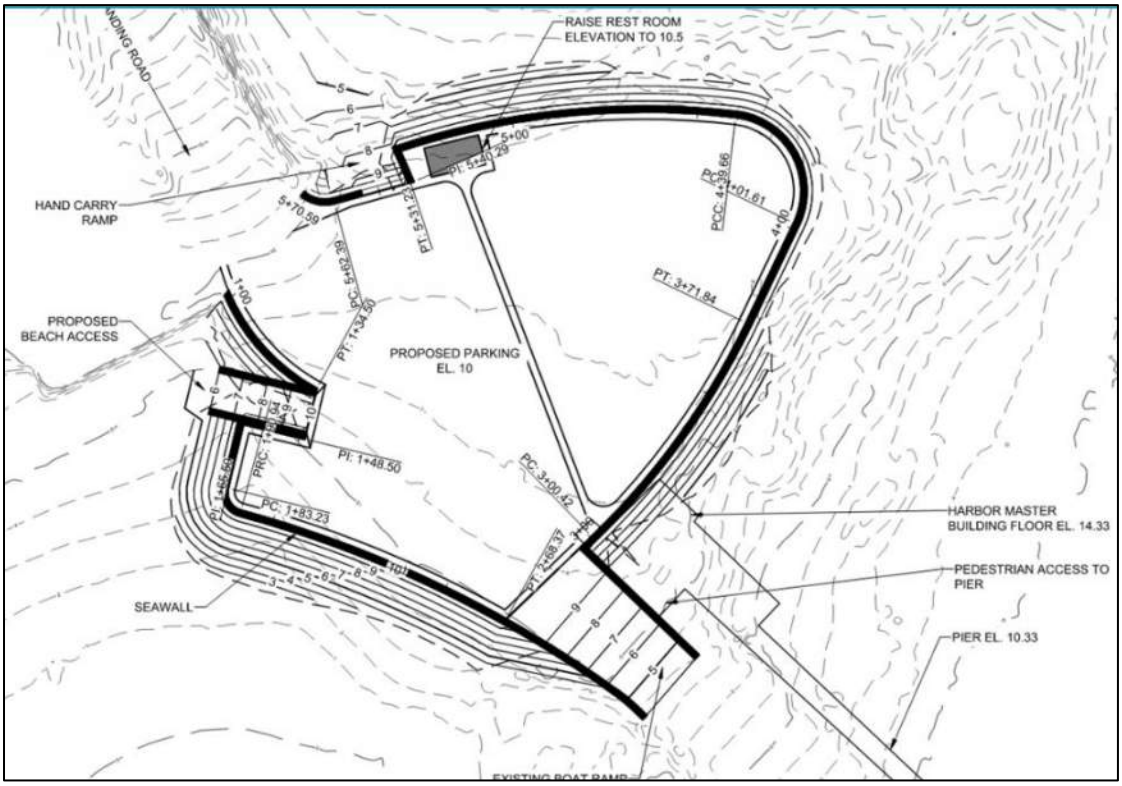


Fig. 11. Plan of Proposed Site Enhancements

Replace Pier and Harbormaster Building in 2070. The existing structures will be approximately 70 years old, and many components will be near the end of their useful life. Replacement allows the new structures to be designed in accordance with flood models which predict an increase in SLR due to Climate Change.

Increase height of Embankment Stabilization. The access road bulkhead and coastal slope is vulnerable to the predicted wave action and runup. Refer to Plans located in Appendix C.

4.3 Considerations for Future Adaptation

Long-term planning should also consider options for future adaptation of site uses and features to reduce exposure to future flood risks that may occur. This could involve relocating certain features to an alternate location where risks are more easily mitigated, for example recreational user parking and the harbormaster's office. The Town should seek opportunities for land acquisition or adaptation of use of existing Town owned land to support relocation of these features. Additionally, the Town could investigate the relocation of the entire facility to an alternate site. A significant challenge with relocation is that the existing waterfront throughout the Town of Falmouth is largely developed for existing residential and commercial uses and new undeveloped properties have not been identified. For long-term planning, the Town may consider the acquisition of a new parcel to relocate the Town Landing if an opportunity arises.

5. References

1. Coastal Geology
    a. Bedrock Geology of the Portland 7.5' Quadrangle, Cumberland County, Maine; Arthur Hussey; 2003.
    b. Bedrock Geology Mapping; Portland East Quadrangle, Maine; Me Geological Survey; 03-90; 2003
    c. Coastal Landside Hazards Mapping; Portland East Quadrangle, Me; Maine Geological Survey; 01-534; 2001.
    d. Coastal Bluffs Mapping; Portland East Quadrangle, Me; Maine Geological Survey; 02-205; 2002.
    e. Surficial Geology Mapping; Portland East Quadrangle, Me; Maine Geological Survey; 99-95; 1999.
    f. Surficial Materials Mapping; Portland East Quadrangle, Me; Maine Geological Survey; 99-39; 1999.
    g. Coastal Marine Geological Environments Mapping; Portland East Quadrangle, Me; Maine Geological Survey; 76-121; Barry Timson; 1976
2. Flood studies and Mapping
    a. FEMA NFIP FIRM; Community Panel 230045 0009 B; Town of Falmouth; Cumberland County, Maine; Effective 10/16/1984.
    b. FEMA NFIP FIRM; Community Panel 230045 0013 B; Town of Falmouth; Cumberland County, Maine; Effective 10/16/1984.
    c. FEMA NFIP FIRM; Community Panel 230045 0703 F; Town of Falmouth; Cumberland County, Maine; Preliminary 4/14/2017.
    d. FEMA NFIP FIS; Community; Falmouth 230045; Cumberland County, Maine; Preliminary 8/30/2019.
    e. Maine Climate Council Technical Reports and references; http://climatecouncil.maine.gov/
    f. Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS); http://neracoos.org/
    g. National Oceanic and Atmospheric Administration; National Ocean Service; https://tidesandcurrents.noaa.gov/waterlevel
    h. Federal Emergency Management Agency (FEMA) (2017). Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update. FEMA Region VI, FEMA Headquarters.

3. Regulatory Documents
    a. Chapter 305 -Permit by Rule- Maine Natural Resources Protection Act; Amended to June 8, 2012. https://www.maine.gov/dep/land/nrpa/index.html
    b. Chapter 310-Wetlands- Maine Natural Resources Protection Act; Amended to November 11, 2018. https://www.maine.gov/dep/land/nrpa/index.html
    c. Maine General Permit; Dept of the Army; October 2020 https://www.nae.usace.army.mil/Missions/Regulatory/State-General-Permits/Maine-General-Permit/
    d. Maine Department of Environmental Protection (Maine DEP) (2018). Highest Annual Tide (HAT) Levels for Year 2018 Maine Coast from Eastport to Kittery.
4. Survey Data
    a. GEI Drone Survey and Imagery; 2022 04
    b. Maine GIS: Various Land Use Data Sets that include aerial imagery and lidar contour information.
    c. NOAA Chart 13292; Portland Harbor and Vicinity
5. Town of Falmouth
    a. Property: Falmouth Tax Map Reference: R02-012

Appendix A

Cost Estimate for Post 12-23-2022 Storm Repairs

Preliminary Cost Estimate of Town Landing Storm Damage						
ITEM	Unit	Unit Cost	Quantity	SubTotal	TOTAL	Notes
General					$ 80,100	
Mobilization/Demobilization	10%	$ 69,000	1	$ 69,000		Separate Structural/Shorefront stabilization contracts.
Erosion Control	LF	$ 10	360	$ 3,600		Parking Perimeter + Embankment Length.
Disposal	LS	$ 5,000	1	$ 5,000		Town Dump.
Maintenance of Traffic	LS	$ 2,500	1	$ 2,500		
Buildings					$ 33,930	
Harbormasters Office						
Storage Area Door	LS	$ 75	42	$ 3,150		Replace damaged door.
Misc Timber Strapping	SF	$ 40	70	$ 2,800		Replace wall slats.
Restroom						
Re-anchor Buiding	LS	$ 1,000	1	$ 1,000		Remove and Reset_Fasten to Slab.
Grout below slab	CF	$ 100	30	$ 3,000		Pump Grout.
Rock Armor/Pad Replacement	LS	$ 23,980	1	$ 23,980		See separate Kayak Estimate.
Pier					$ 5,000	
RC Foundation Repair	EA	$ 3,000	1	$ 3,000		Replace sonotube, Rest Galvanized Tie connector.
Pile/Ledge Grout Pack	Each	$ 200	10	$ 2,000		
Launch Ramp					$ 39,350	
Riprap		$ 25,700	1	$ 25,700		Maine Coastal Protectioon Estimate (Pin to Ledge).
RC Plank surgery	Day	$ 3,000	1	$ 3,000		Remove loose rebar at connections.
Grout Voids below slabs		$ 10,650	1	$ 10,650		Knowles industrial Estimate.
Parking					$ 115,672	
Cleanup	LS	$ 4,000	1	$ 4,000		Town Crew- 4 Men + Equipment.
Paving Shim & Patch	LS	$ 7,500	1	$ 7,500		Build-up damaged areas of existing paving.
Perimeter Curb	LF	$ 100	250	$ 25,000		Defines edge of paving at ledge to resist peel back.
Paving Overlay	Tons	$ 250	157	$ 39,172		2-inch Overlay after shim repairs.
Striping	LS	$ 2,500	1	$ 2,500		Reinstate existing spaces.
Replace Signage	LS	$ 1,000	1	$ 1,000		Allowance to replace damaged signage.
Light Pole Bases Reconstruction	LS	$ 1,500	1	$ 1,500		Reconstruction cap to mitigate damage.
Misc Slope Restoration	LF	$ 500	70	$ 35,000		Replace stone washed out and protect existing outfall.
Site Access Road Embankment					$ 252,000	
Steel Bulkhead Embankment	LF	$ 1,200	180	$ 216,000		Reconstruct riprap embankment to stabilize bulkhead.
Planting	LF	$ 200	180	$ 36,000		Stabilization Mat- Salt tolerant species.
Utilities					$ 10,000	
Pier Pumpout Piping Repair	Day	$ 4,000	1	$ 4,000		Plumber.
Electrical Check (labor & material)	Est	$ 6,000	1	$ 6,000		Electrician to check junction boxes etc. for water damage.
Engineering					$ 40,500	
Post Flood Inspection and Ltr Report		$ 3,000	1	$ 3,000		
Drone Survey		$ 2,000	1	$ 2,000		Drone Survey.
Design	3.5%	$ 20,000	1	$ 20,000		Plans & Specifications for Competitive Bid
Permitting		$ 4,000	1	$ 4,000		Assume DEP Permit By Rule and ACOE Notification.
Construction Support	2%	$ 11,500	1	$ 11,500		
			Project Total	$ 576,552	$ 576,552	
		Contingency	20%	$ 115,310		
			TOTAL	$ 691,863		

Appendix B

Town Landing Infrastructure Assessment

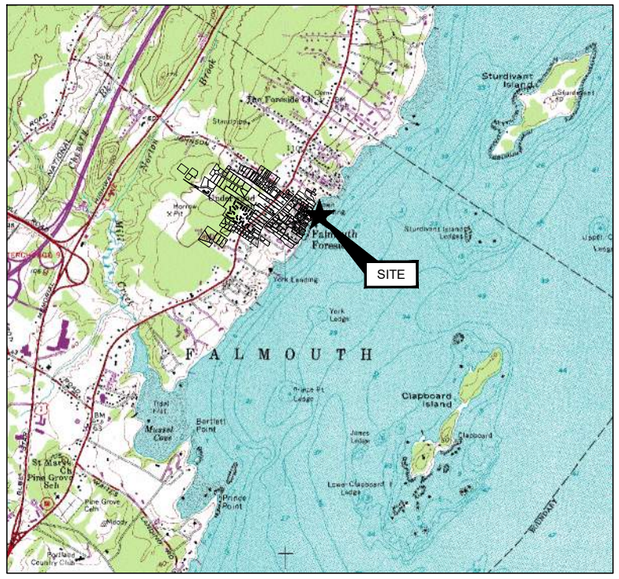
TOWN LANDING								
Infrastructure Element	Boat Launch	Carry-in Ramp	Steel Bulkhead	Coastal Embankment	Parking	Restroom Seasonal	Town Pier	Harbormaster Office
Function								
Year Built (Most Recent)	1999	Frequent Repair/ Upgrade	2002	Same as Bulkhead	Frequent Repair/ Upgrade	2001	2000	2000 installed with new Pier
Purpose	Boat Launch/Barge Landing	Beach & Paddle Craft Access	Road Tie-back Retaining Wall	Protects road/ Bulkhead	Vehicle Parking/ Float Storage	Portable ADA Toilets	Deepwater Float Access	Public Safety
Users	Boaters, Fishermen, Haulers	Beach Goers	Supports vehicle access to site	NA	30 + 8 spaces =36 + 2 Staff	Facility Users & Visitors	Sightseeing, Birding, Fishing	HM Office, Safety equipment.
Seasonal Transformation	Winter removal of ramp floats	-----	-----	Winter Vegetation Dieback	Float Storage reduces spaces	Portable Units removed	Gangway barriers, Winterize Pumpout	Reduced Staff/Hours in Winter
ADA Access	~15% Grade	~15% Grade	-----	-----	ADA Space	ADA Unit	ADA Walkway	ADA Walkway Switchback
Offsite Alternative	Portland East End, Yarmouth	Mackworth Island Public Access	-----	-----	Rte. 88 Lot, Rte. 1 Malls	-----	Portland Yacht Club. Handy Boat	Falmouth Police Station
Existing Condition Assessment								
Overtopping Elevation ft. NAVD88	7.0	7.0	7.0	7.0	7.0 to 9.0	8.0	10.3	21.0
Condition (Post 23Dec2022 Storm)	PC Plank Deterioriation Stone Armor Loss		Toe Erosion, Section Loss, Planting Failure.		Pavement Damage/Loss	Enclosure Damage/ Stone Protection	Pump-out, Electrical System, RC Pile Base Deterioration	
MAINTENANCE REPAIRS to address deterioration	REHABILITATE stone armor. Grout voids.		RECONSTRUCT toe armor stone and plantings		REHABILITATE Pavement	REPAIR Enclosure	UPGRADE Plumbing and OVERHAUL Electrical system. REPAIR Pile bases.	
Approximate 2023 Cost	$60,000	Included with Parking	$375,000		$250,000		$25,000	$25,000
Adaptation Measures to address sea level rise and increased storm frequency & intensity								
SITE IMPROVEMENTS for Long-term Resiliency	RAISE grade at head of ramp.	STABILIZE existing ramp.	RECONSTRUCT/ADD embankment armor stone & salt-tolerant plantings		RAISE Parking grade and seasonal restroom to reduce nuisance flooding		MONITOR SLR to guide Pier & HM Bldg. replacement (2050-2075).	
Approximate 2023 Cost	$1,500,000 to $2,000,000						$2,000,000 to $2,500,000	
ADAPTATION Options	RAISE Ramp. ELIMINATE parking to ACCOMMODATE Vehicle Turning movements.		MODIFY Access for Pedestrians, Trailers, and EMERGENCY Vehicles.		PROVIDE Dedicated Offsite Parking and Restroom Facilities		RETREAT to higher ground. Establish new Town Landing base.	
Cost Considerations	Property Acquisition & Development							

Appendix C

Project Plans

TOWN LANDING RESILIENCY STUDY

TOWN OF FALMOUTH, MAINE



USGS LOCATION MAP
(NOT TO SCALE)

TAX MAP U17
(NOT TO SCALE)

SHEET INDEX

SHEET NO.	DRAWING NO.	TITLE
1	G-01	COVER SHEET
2	C-01	RESILIENCY PLAN
3	C-02	COASTAL EMBANKMENT PLAN
4	C-03	BOAT LAUNCH STABILIZATION PLAN
5	C-04	CARRY-IN RAMP STABILIZATION
6	C-05	NORTH-SOUTH & WEST-EAST SECTIONS
7	C-06	TYPICAL SEAWALL SECTION
8	C-07	COASTAL EMBANKMENT SECTION

PREPARED FOR:

TOWN OF FALMOUTH
FALMOUTH, MAINE

PREPARED BY:

GEI CONSULTANTS, INC.
5 MILK STREET
PORTLAND, ME 04101
(207)797-8901

PRELIMINARY
NOT FOR CONSTRUCTION

GEI PROJECT NO. 2200496

NO.	DATE	ISSUE/REVISION	APP
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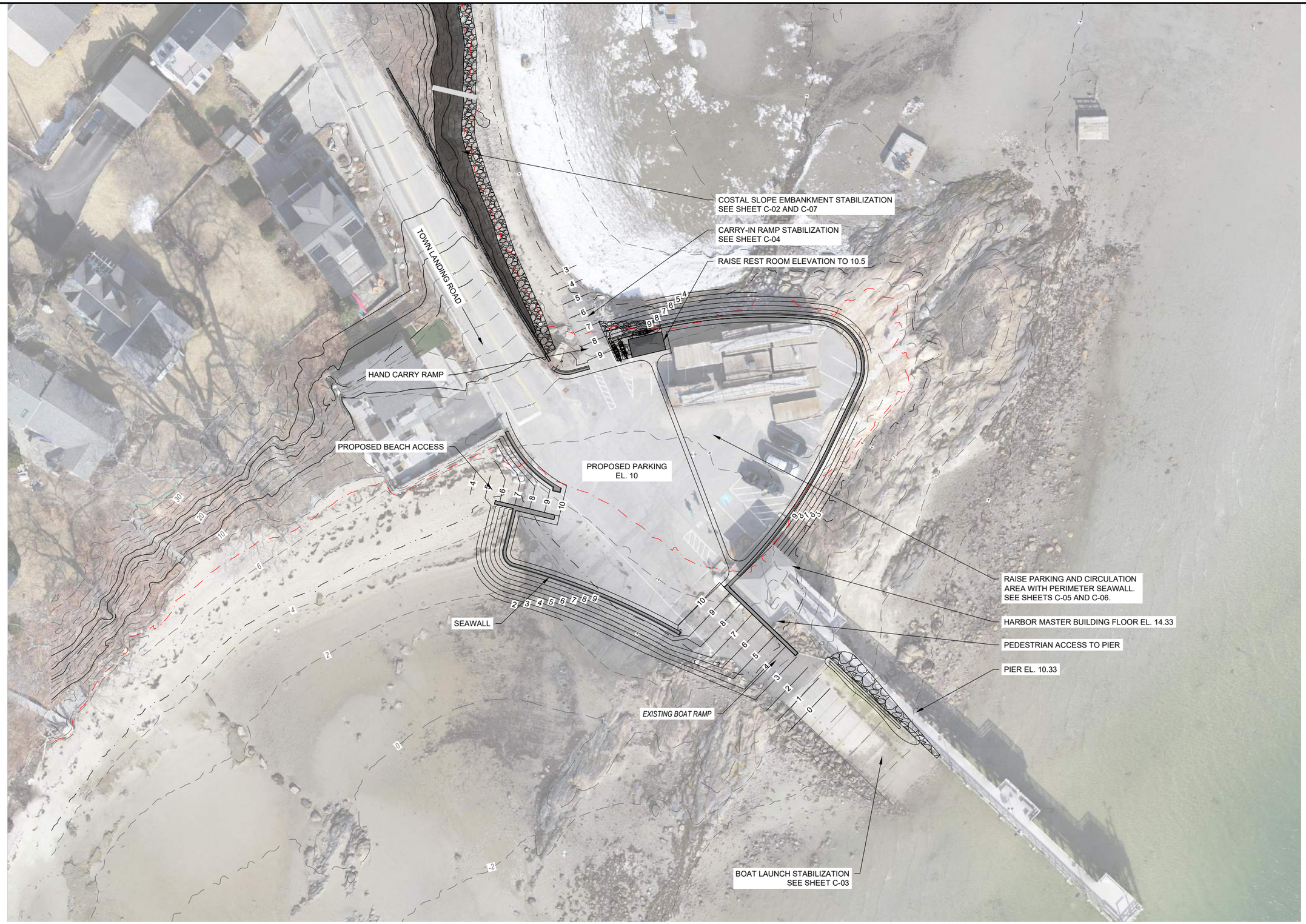
DWG. NO.
G-01

SHEET NO.
1 OF 8



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SCALE, FEET

RESILIENCY PLAN

Preliminary

Not for Construction

GEI Consultants
GEI CONSULTANTS, INC.
5 MILK STREET
PORTLAND, ME 04101
(207)797-8901

TOWN OF FALMOUTH

FALMOUTH, MAINE

TOWN LANDING RESILIENCY STUDY

FALMOUTH, MAINE

P.E. No.:	
Approved:	BJB
Checked:	BJB
Drawn:	JLD
Designed:	BJB
GEI Project	2200496

Attention: 0 1"
If this scale bar does not measure 1" then drawing is not original scale.

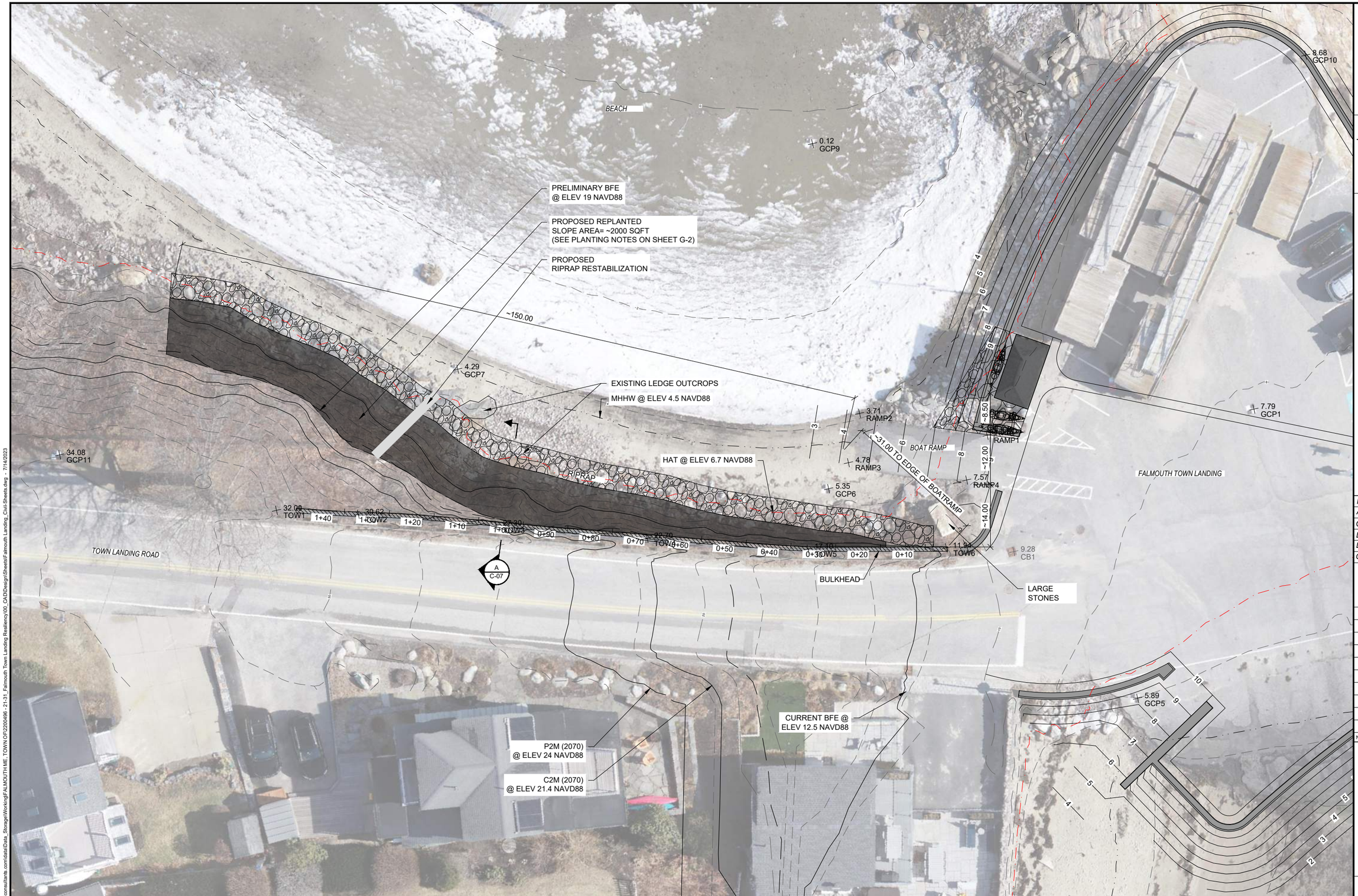
NO.	DATE	ISSUE/REVISION	APP.
1	7/14/2023	FINAL REPORT	BJB

SHEET NAME

RESILIENCY PLAN

SHEET NO.

C-01



COSTAL EMBANKMENT PLAN

Preliminary

Not for Construction

GEI Consultants

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(207)797-8901

TOWN OF FALMOUTH

FALMOUTH, MAINE

TOWN LANDING RESILIENCY STUDY

FALMOUTH, MAINE

P.E. No.:	
Approved:	BJB
Checked:	BJB
Drawn:	JLD
Designed:	BJB
GEI Project	2200496

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If this scale bar does not measure 1" then drawing is not original scale.

NO.	DATE	ISSUE/REVISION	APP
1	7/14/2023	FINAL REPORT	BJB

SHEET NAME

COASTAL EMBANKMENT PLAN

SHEET NO.

C-02

RIPRAP REPAIR LOCATION

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SCALE, FEET

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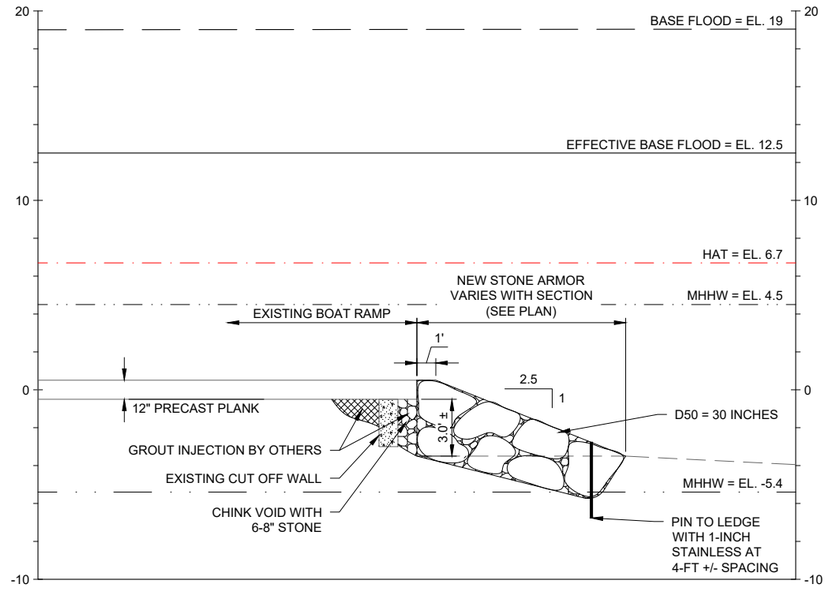

A SECTION
BOAT RAMP STABILIZATION
SCALE: 1" = 4'

0 2 4 8
SCALE, FEET

Preliminary

Not for Construction

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TOWN OF FALMOUTH

FALMOUTH, MAINE

TOWN LANDING RESILIENCY STUDY

FALMOUTH, MAINE

P.E. No.:	
Approved:	BJB
Checked:	BJB
Drawn:	JLD
Designed:	BJB
GEI Project	2200496

Attention:
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If this scale bar does not measure 1" then drawing is not original scale.

NO.	DATE	ISSUE/REVISION	APP
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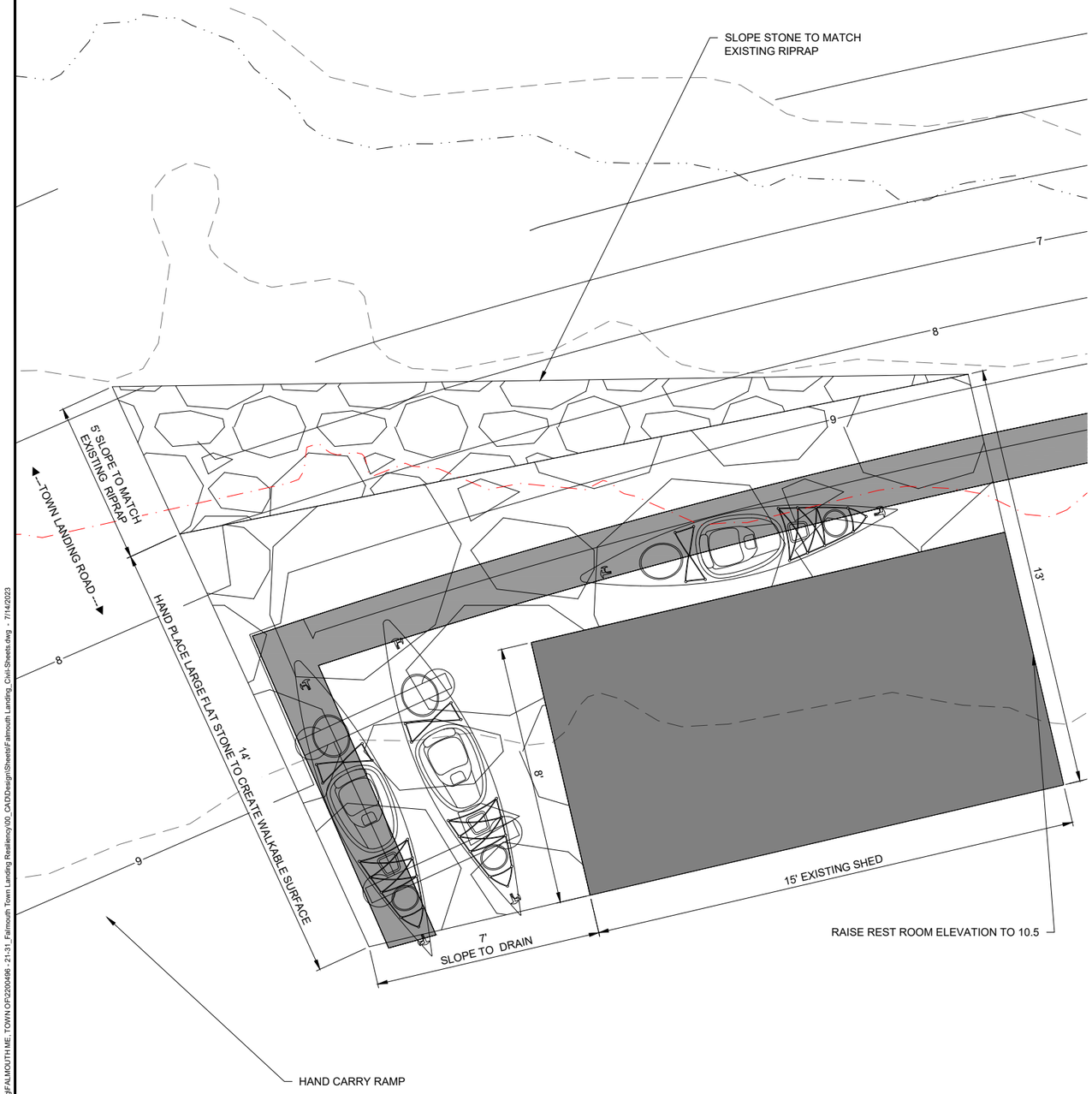
SHEET NAME

BOAT LAUNCH STABILIZATION PLAN

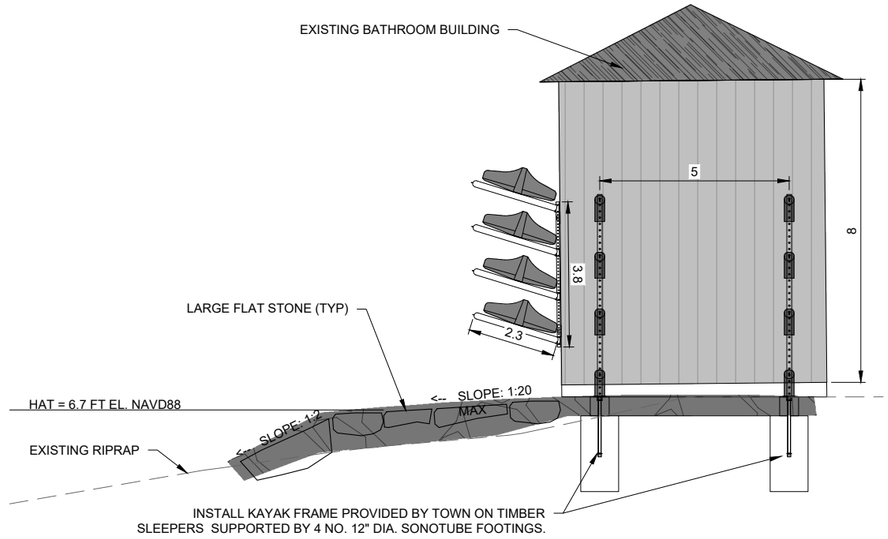
SHEET NO.

C-03



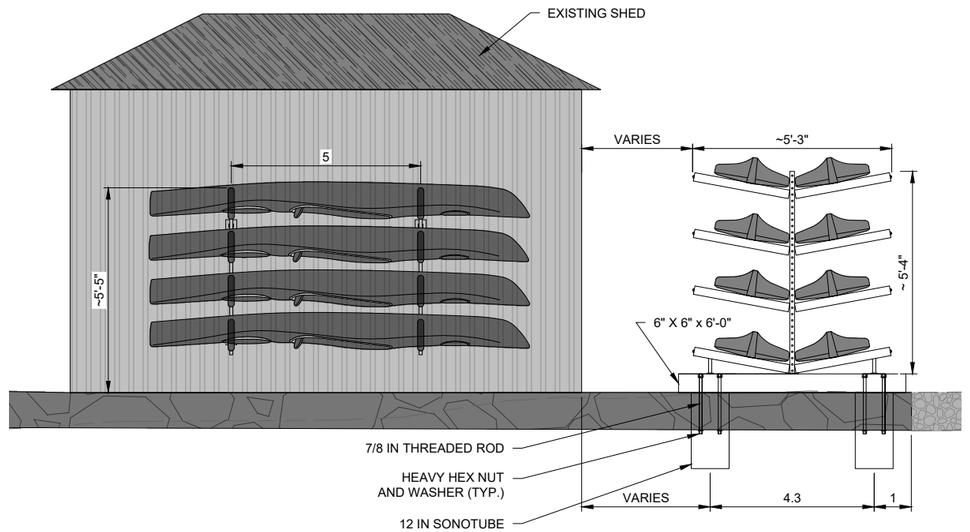
PLAN

SCALE: 1/2" = 1'-0"



EAST ELEVATION

SCALE: 1/2" = 1'-0"



NORTH ELEVATION

SCALE: 1/2" = 1'-0"

0 2 4

SCALE, FEET

Preliminary

Not for Construction

GEI Consultants

GEI CONSULTANTS, INC.
5 MILK STREET
PORTLAND, ME 04101
(207)797-8901

TOWN OF FALMOUTH

FALMOUTH, MAINE

TOWN LANDING RESILIENCY STUDY

FALMOUTH, MAINE

P.E. No.:	
Approved:	BJB
Checked:	BJB
Drawn:	JLD
Designed:	BJB
GEI Project	2200496

Attention:
0 1"
If this scale bar does not measure 1" then drawing is not original scale.

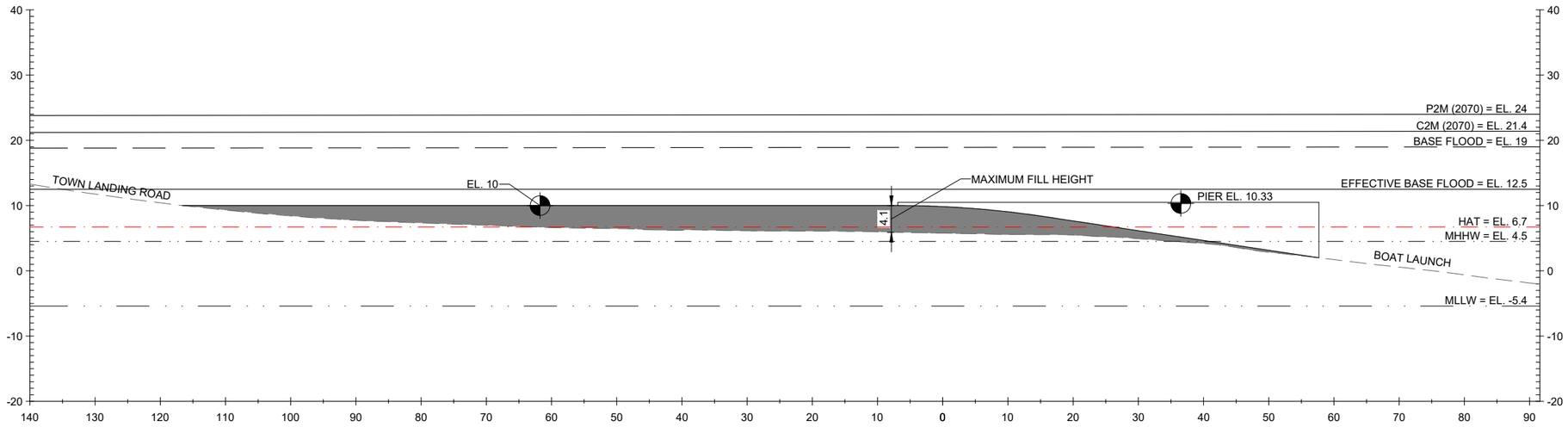
NO.	DATE	ISSUE/REVISION	APP
1	7/14/2023	FINAL REPORT	BJB

SHEET NAME

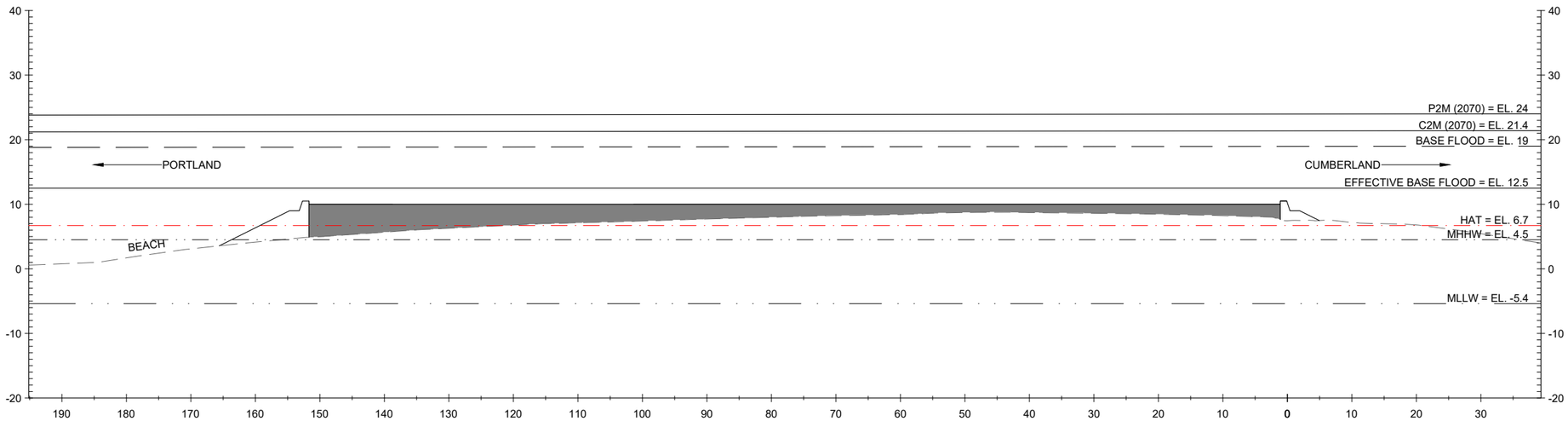
CARRY-IN RAMP STABILIZATION PLAN

SHEET NO.

C-04



1 C-01 SECTION
NORTH-SOUTH
SCALE: 1" = 10'



2 C-01 SECTION
WEST-EAST
SCALE: 1" = 10'

0 10 20
SCALE, FEET

Preliminary

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PORTLAND, ME 04101
(207)797-8901

TOWN OF FALMOUTH

FALMOUTH, MAINE

TOWN LANDING RESILIENCY STUDY

FALMOUTH, MAINE

P.E. No.:	
Approved:	BJB
Checked:	BJB
Drawn:	JLD
Designed:	BJB
GEI Project	2200496

Attention:
0 1"
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NO.	DATE	ISSUE/REVISION	APP
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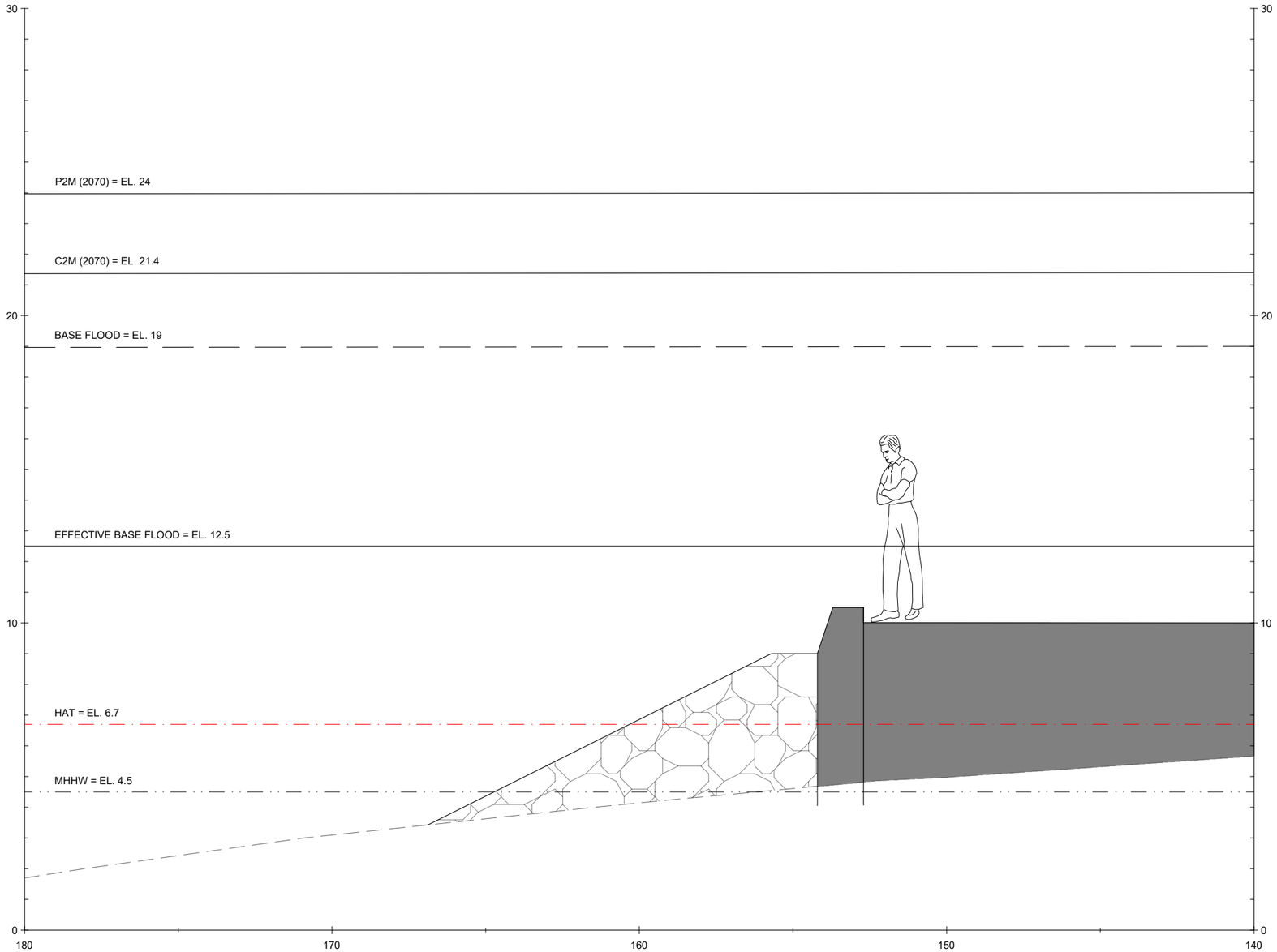
SHEET NAME

NORTH-SOUTH & WEST-EAST SECTIONS

SHEET NO.

C-05



A C-01 TYPICAL SECTION
SEAWALL

SCALE: 1/2" = 1'-0"

0 2 4
SCALE, FEET

Preliminary

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TOWN OF FALMOUTH

FALMOUTH, MAINE

TOWN LANDING RESILIENCY STUDY

FALMOUTH, MAINE

P.E. No.:	
Approved:	BJB
Checked:	BJB
Drawn:	JLD
Designed:	BJB
GEI Project	2200496

Attention:
0 1"
If this scale bar does not measure 1" then drawing is not original scale.

NO.	DATE	ISSUE/REVISION	APP
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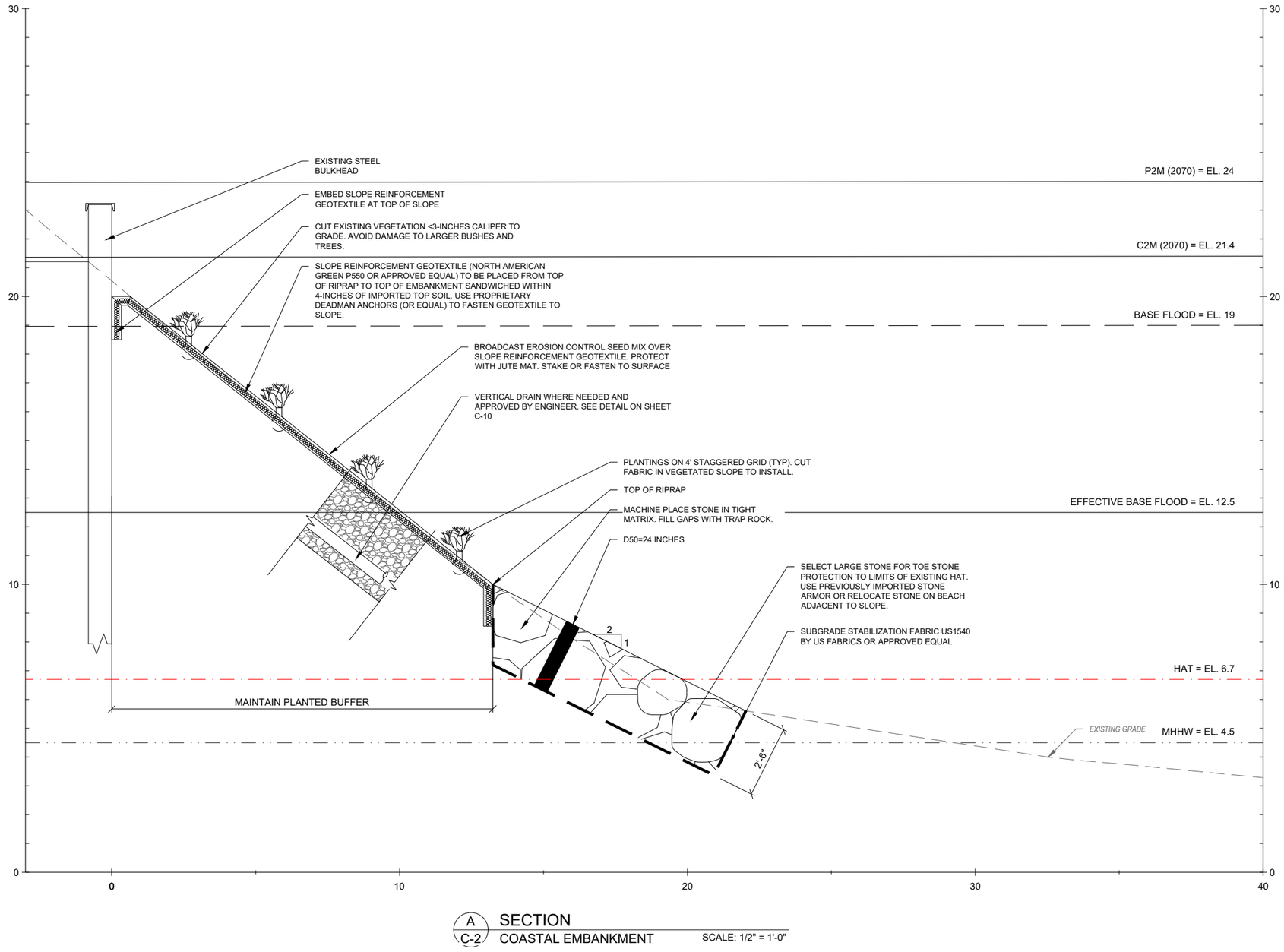
SHEET NAME

TYPICAL SEAWALL SECTION

SHEET NO.

C-06



A C-2 SECTION
COASTAL EMBANKMENT
SCALE: 1/2" = 1'-0"

0 2 4
SCALE, FEET

Preliminary

Not for Construction

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TOWN OF FALMOUTH

FALMOUTH, MAINE

TOWN LANDING RESILIENCY STUDY

FALMOUTH, MAINE

P.E. No.:	
Approved:	BJB
Checked:	BJB
Drawn:	JLD
Designed:	BJB
GEI Project	2200496

Attention: 0 1"
If this scale bar does not measure 1" then drawing is not original scale.

NO.	DATE	ISSUE/REVISION	APP
1	7/14/2023	FINAL REPORT	BJB

SHEET NAME

COASTAL EMBANKMENT SECTION

SHEET NO.

C-07