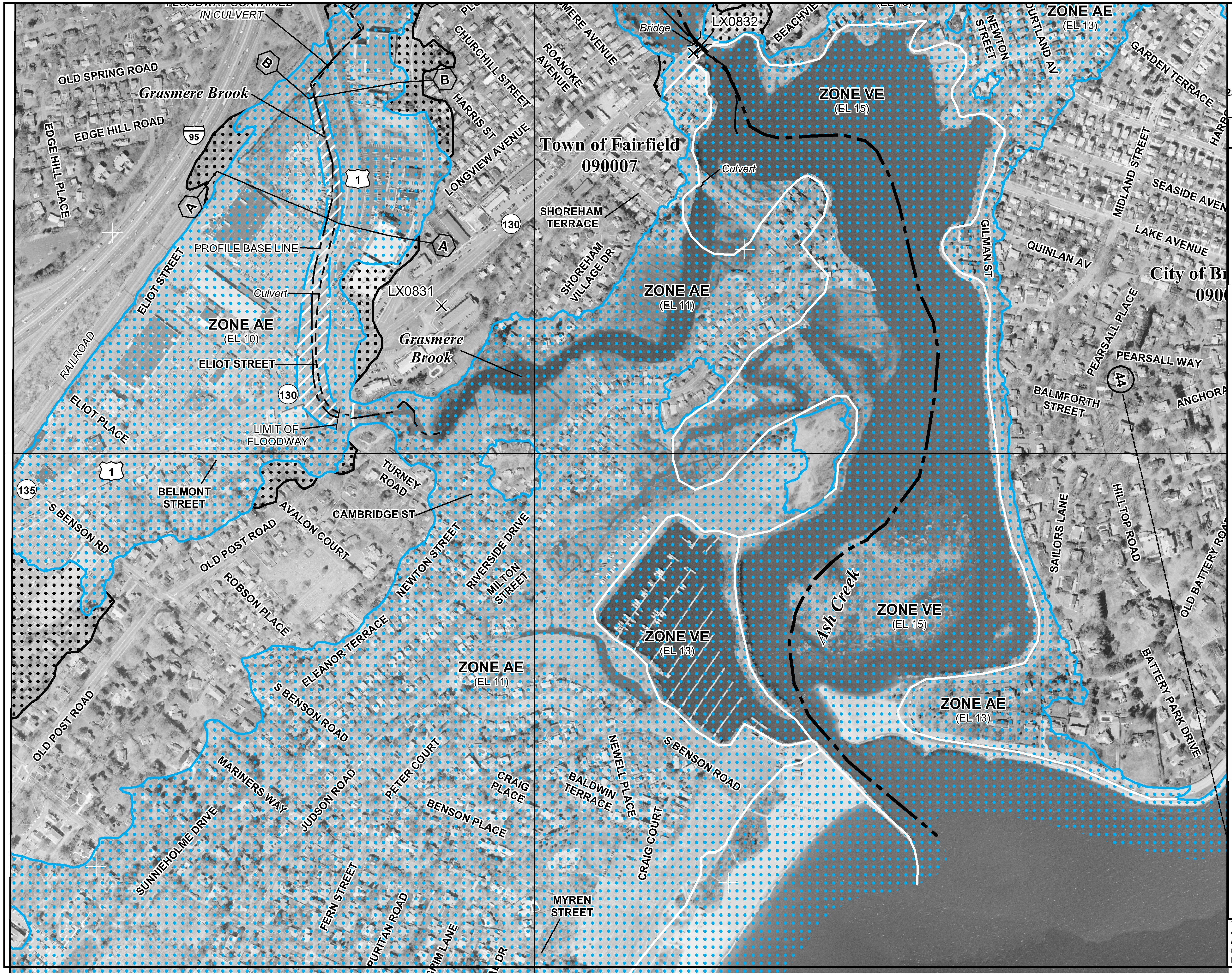
Riverside Drive/Ash Creek Resilience Study

APPENDIX A – Flood Insurance Rate Map (FIRM)

MILONE & MACBROOM®



MAP SCALE 1" = 500'

250 0 500 1000 FEET

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0438G

FIRM

FLOOD INSURANCE RATE MAP

FAIRFIELD COUNTY, CONNECTICUT
(ALL JURISDICTIONS)

PANEL 438 OF 626

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
BRIDGEPORT, CITY OF	090002	0438	G
FAIRFIELD, TOWN OF	090007	0438	G

-NOTE-

THIS MAP INCLUDES BOUNDARIES OF THE COASTAL BARRIER RESOURCES SYSTEM ESTABLISHED UNDER THE COASTAL BARRIER RESOURCES ACT OF 1982 AND/OR SUBSEQUENT ENABLING LEGISLATION.

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
09001C0438G

MAP REVISED
JULY 8, 2013

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

Riverside Drive/Ash Creek Resilience Study

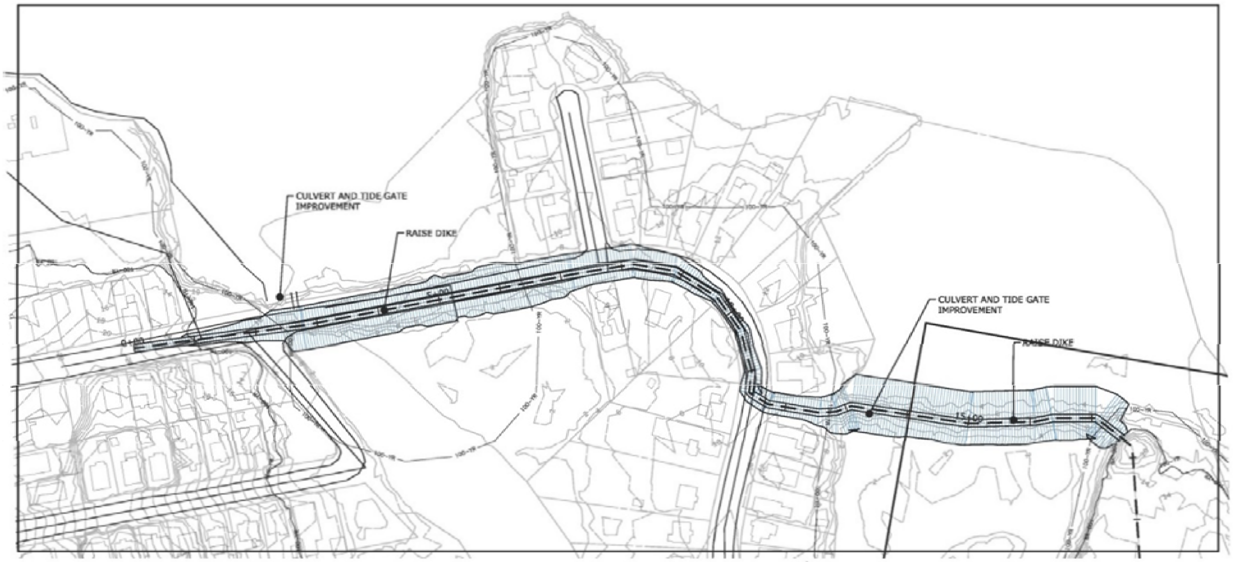
APPENDIX B – Assessment of Existing Dike and Tide Gate Systems

MILONE & MACBROOM®

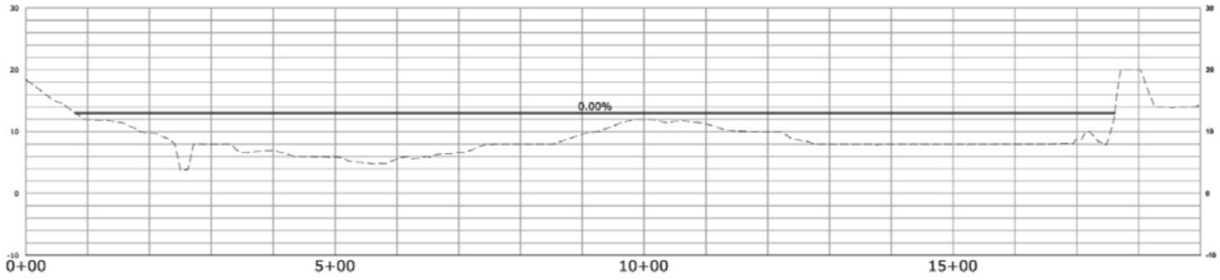
Appendix B
Assessment of Existing Dike and Tide Gate Systems

Segment 1 – Riverside Drive

Segment 1 spans the Riverside Drive residential drive area. It begins at Shoreham Terrace and extends to the Ash Creek Open Space dike over Riverside Creek (described below as Segment 2). Riverside Drive includes portions of roadway that are somewhat elevated already as compared to properties located along the road. Tide gates are located beneath Riverside Drive at the bridge over Turney Creek. As such, Segment 1 inherently includes infrastructure that currently provides some level of flood protection. The tide gate is described in more detail in Appendix C.



FLOOD CONTROL SEGMENT 1 OF 4 - PLAN
(SCALE: 1"=100')



FLOOD CONTROL SEGMENT 1 OF 4 - PROFILE
(SCALE: 1"=100'H, 1"=10'V)

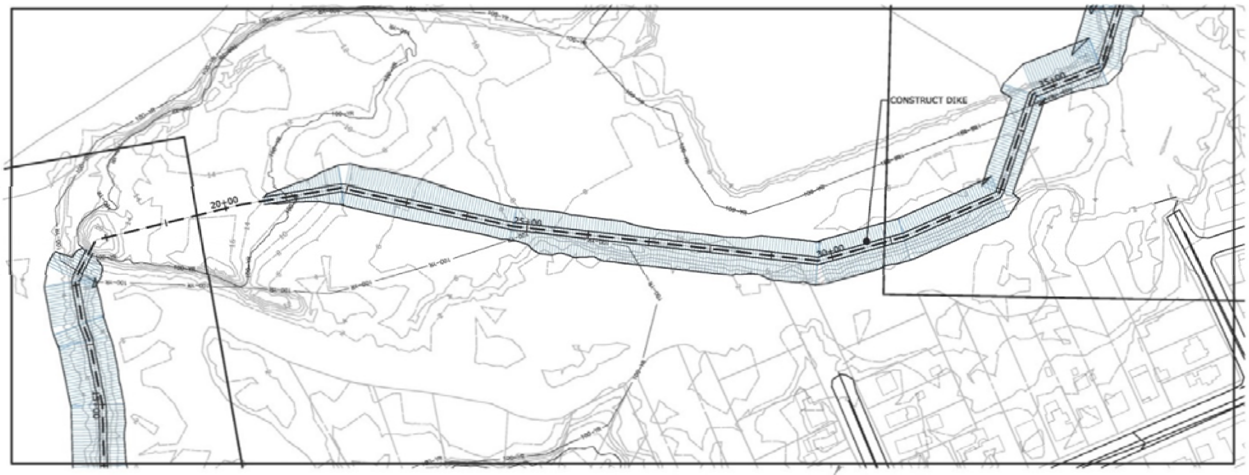
Three alternative locations for a flood control levee were considered for this segment. Modifications of the existing flood protection system along Segment 1 would be difficult to implement due to numerous construction and permitting difficulties within this residentially developed area. Since many of these homes are within close proximity to tidal marsh, construction of a levee around the waterward side of all homes on Bay Edge Court will be challenging to construct and permit. A second alternative was identified as routing a flood control system in the backyards of residences at 200-290 Riverside Drive. However, this is challenging due to the proximity of homes, sheds, and pools as well as low elevation and mature vegetation found in the area. The third alignment involves raising the elevation of Riverside Drive and adjusting the driveways and stormwater drainage that would be impacted.

Segment 2 – Ash Creek Open Space Dike

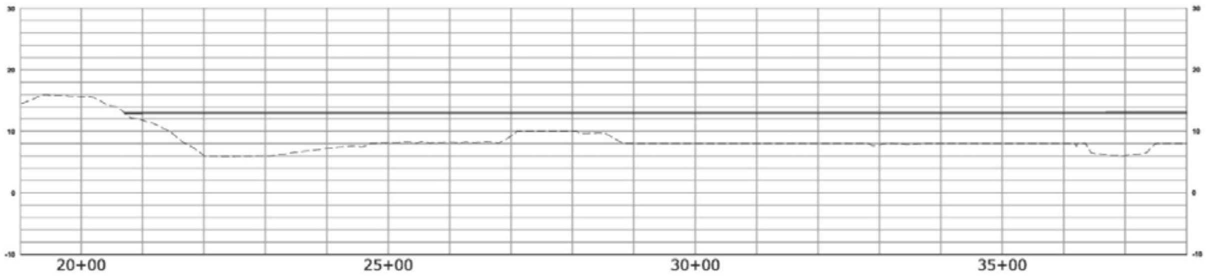
The existing dike in the Ash Creek Open Space with a walking path on its crest (on the above graphic) provides moderate flood protection from Ash Creek. The dike crest is at an elevation of 8 feet (NAVD88) with stable vegetation on both slopes. The dike contains a self-regulating tide gate (SRT) that controls upstream marsh levels. The tide gate is described in more detail in Appendix C. It is noted that the subsurface conditions of this dike system need to be understood beyond the visual reconnaissance-level inspection.

Segment 3 – Ash Creek Open Space

The Ash Creek Open Space segment includes a grassy open area with walking paths (see diagram below). The walking paths have a naturally high grade near the bank of Ash Creek. The higher grade areas are well established with mature woody vegetation and appear to provide flood protection as well as wave energy dispersion.



FLOOD CONTROL SEGMENT 2 OF 4 - PLAN
(SCALE: 1"=100')

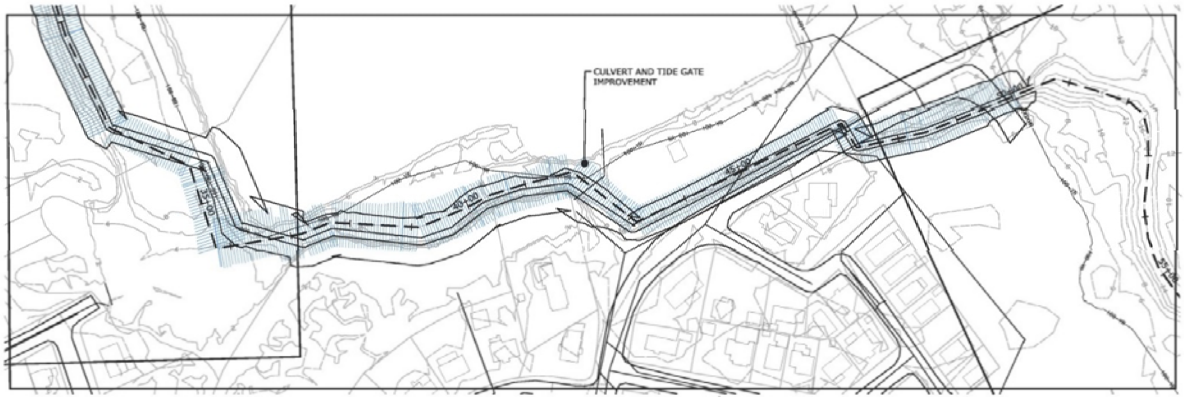


FLOOD CONTROL SEGMENT 2 OF 4 - PROFILE
(SCALE: 1"=100'H, 1"=10'V)

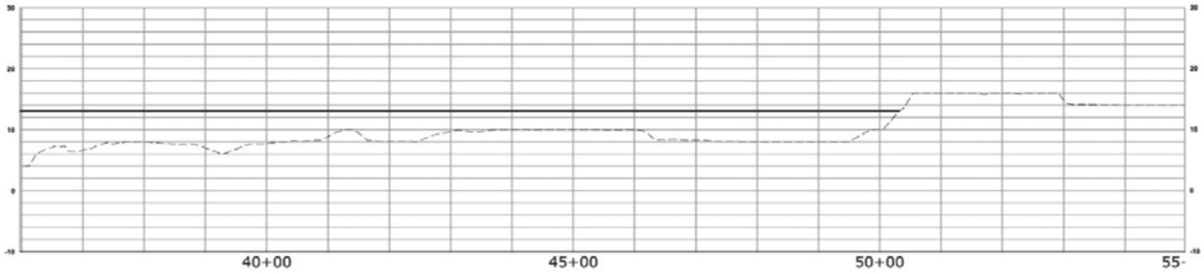
A flood protection alignment through the open grassy area would be somewhat straightforward to construct. A flood protection alignment would not impact the mature vegetation and could provide a spot for more recreational paths.

Segment 3 – Fairfield Marina

Segment 3 extends from the Ash Creek Open Space and continues around the Fairfield Marina and South Benson Road and Turney Road areas (see diagram below). The existing roadways and paved areas range in elevation from 6 feet to 10 feet (NAVD88). Potential impacts of raising the internal roadways may include the loss of some parking area and reconfiguration of the access way from two-way access to one way only and/or reconfiguration of the parking area entry point.



FLOOD CONTROL - SEGMENT 3 OF 4
(SCALE: 1"=200')

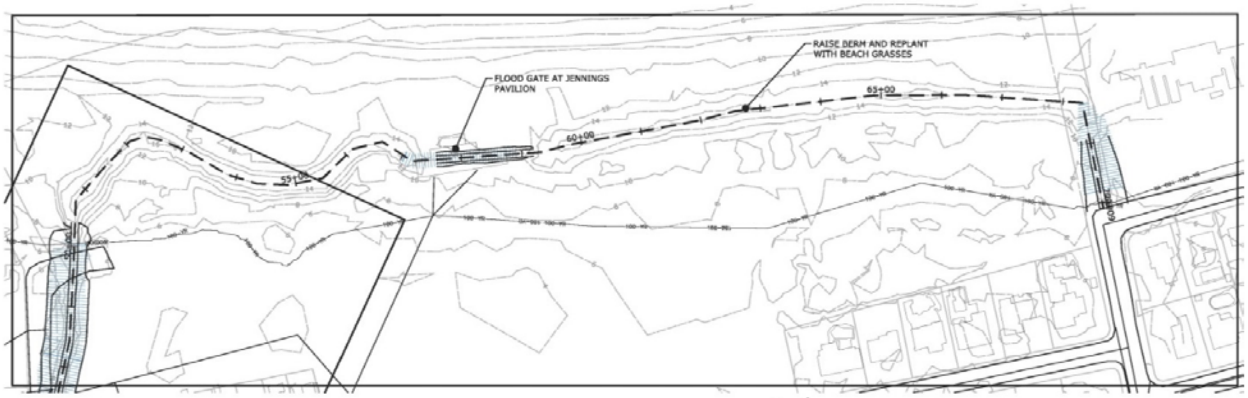


FLOOD CONTROL SEGMENT 3 OF 4 - PROFILE
(SCALE: 1"=100'H, 1"=10'V)

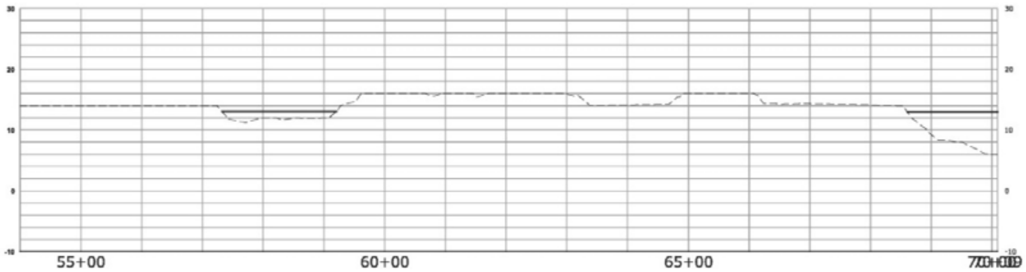
Segment 4 – Jennings Beach

Segment 4 includes the Jennings Beach earthen berm and beach pavilion areas. The Jennings Beach earthen berm appears to be relatively consistent in height, well vegetated, and stable. The top of the berm ranges in elevation between 14 and 16 feet (NAVD88) according to available Light Detection and Ranging (LiDAR). The berm shows no visible signs of damage from recent flood events and is believed to have provided flood protection from the surges associated with storms Irene and Sandy. The berm at Jennings Beach is not a true dune, however, as underlying soil appears to be silty sandy topsoil and is not naturally occurring beach sand. It is unclear who constructed this berm because the United States Army Corps of Engineers (USACE) plans for Jennings Beach (included at the end of this appendix) do not have information about the ridge running along Jennings Beach. Review of aerial photography indicates that it was constructed in the 1980s.

A naturally occurring vegetated sand dune appears to be forming at the base of the berm. This dune feature could help reduce wave energy in front of the berm, thereby protecting the berm.



FLOOD CONTROL - SEGMENT 4 OF 4
(SCALE: 1"=200')



FLOOD CONTROL SEGMENT 4 OF 4 - PROFILE
(SCALE: 1"=100'H, 1"=10'V)

The Jennings Beach pavilion is located within a gap in the earthen berm and is constructed at the elevation of the beach. The pavilion building is constructed of mortared masonry block and shows visible signs of age or structural damage at various locations. The northern wall of the pavilion has fill placed directly against it to connect laterally to the earthen berm. The southern wall of the pavilion connects laterally to a 50-foot-long floodwall constructed of two rows of 4-foot concrete blocks in between the pavilion and the southern end of the earthen berm. It appears that this pavilion structure was intended to act as part of the flood barrier system during past storm events. However, there is an unprotected pedestrian walkway in the middle of the pavilion that allows floodwaters to pass straight through. This is a significant gap in the berm's flood protection system.

Segment 5 – Turney Road

Segment 5 consists of Turney Road from the high point located south of Old Post Road to the marina entrance. The intersections with Cambridge Street, Riverside Drive, Newton Street, and Milton Street are included in Segment 5. This segment was added to the study area after the study convened, as an alternative to Riverside Drive for creating linear flood protection. Turney Road does not offer any appreciable flood protection in its current state. The roadway is not elevated.

JENNINGS BEACH, FAIRFIELD, CONNECTICUT

Condition of Improvement as of 30 September 1988

TYPE: Beach Erosion Control

LOCATION: Jennings Beach, situated on the north shore of Long Island Sound immediately west of the mouth of Ash Creek, is a public beach owned by the town of Fairfield. It is at the eastern limit of Fairfield, about 4 miles southwest of Bridgeport.

AUTHORIZATION:

Date Authorized	Authority	Work Authorized
17 May 1950	RHA - 1950	See Existing Project

EXISTING PROJECT: The existing project provides for Federal participation in the amount of one-third the first cost of construction of an impermeable jetty 800 feet long, extending southeast from the west side of the mouth of Ash Creek and, if necessary, the dredging of an inlet channel and jetty foundation through the outer bar (at the time of construction no channel dredging was required).

STATUS OF IMPROVEMENT:

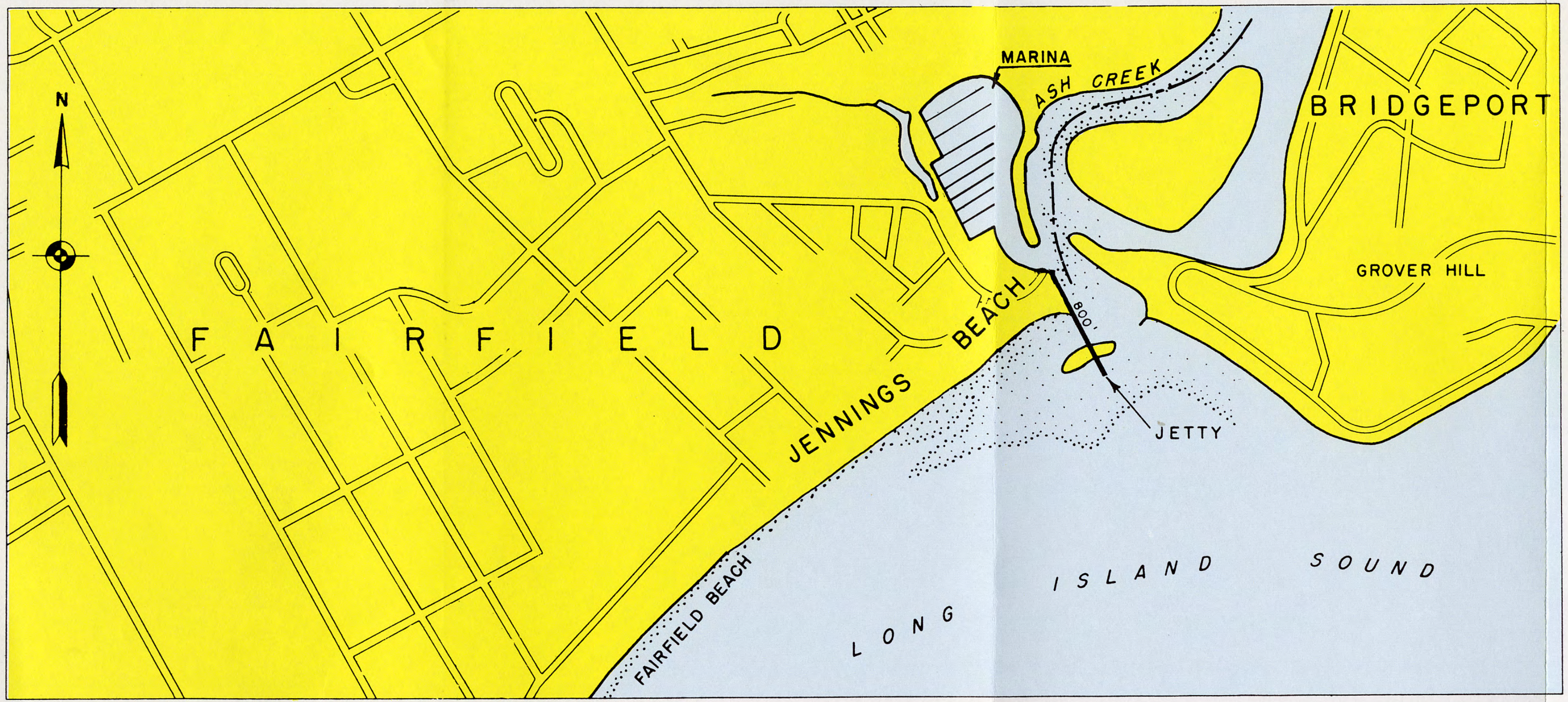
construction completed:	June 1951

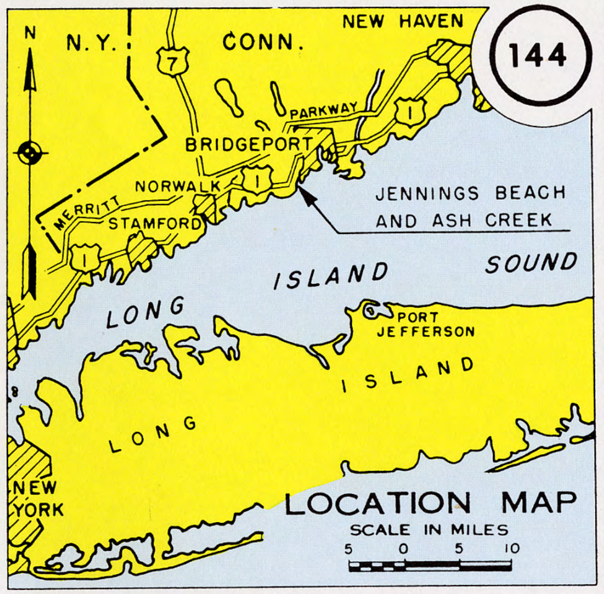
COST OF CONSTRUCTION:

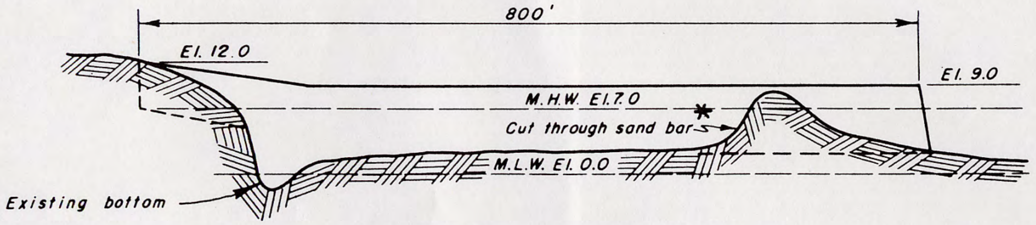
Federal	$14,401
Non-Federal	28,802
TOTAL	$43,203

WORK REMAINING:	None
MEAN RANGE OF TIDE:	6.9 feet
DATUM PLANE:	Mean Low Water
MAINTAINED BY:	Town of Fairfield

CORPS OF ENGINEERS U. S. ARMY







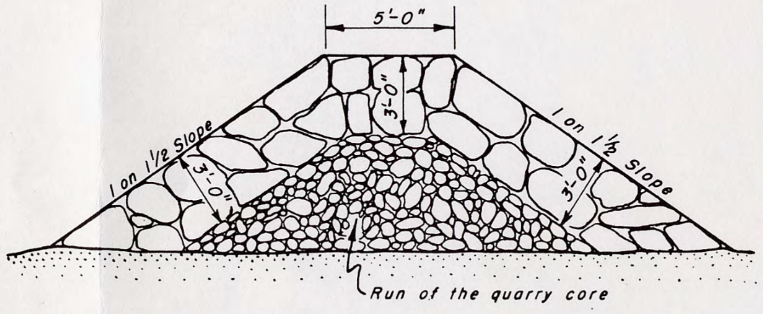
PROFILE OF JETTY

SCALE IN FEET

HOR. 100 0 100 200

VERT. 10 0 10 20

* THE BAR SCOURED NATURALLY WITH CONSTRUCTION OF THE JETTY



TYPICAL SECTION OF JETTY

SCALE IN FEET

5 0 5 10

JENNINGS BEACH

FAIRFIELD, CONN.

30 SEPTEMBER 1988

IN 1 SHEET

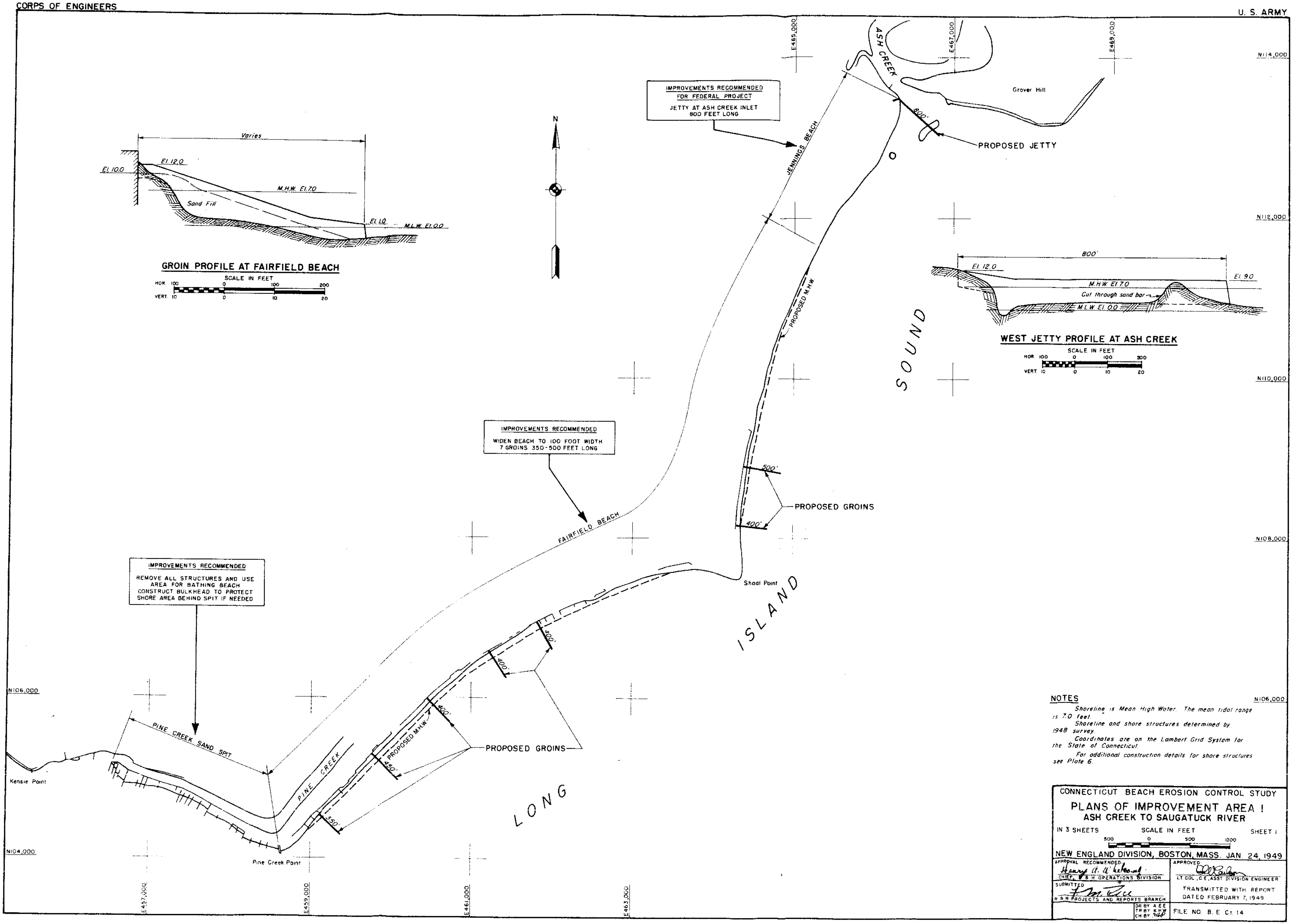
SCALE IN FEET

500 0 500 1000

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

CORPS OF ENGINEERS

U. S. ARMY



IMPROVEMENTS RECOMMENDED
FOR FEDERAL PROJECT
JETTY AT ASH CREEK INLET
800 FEET LONG

IMPROVEMENTS RECOMMENDED
WIDEN BEACH TO 100 FOOT WIDTH
7 GROINS 350-500 FEET LONG

IMPROVEMENTS RECOMMENDED
REMOVE ALL STRUCTURES AND USE
AREA FOR BATHING BEACH
CONSTRUCT BULKHEAD TO PROTECT
SHORE AREA BEHIND SPIT IF NEEDED

NOTES

Shoreline is Mean High Water. The mean tidal range is 7.0 feet.

Shoreline and shore structures determined by 1948 survey.

Coordinates are on the Lambert Grid System for the State of Connecticut.

For additional construction details for shore structures see Plate 6.

CONNECTICUT BEACH EROSION CONTROL STUDY

PLANS OF IMPROVEMENT AREA I
ASH CREEK TO SAUGATUCK RIVER

IN 3 SHEETS SCALE IN FEET SHEET I

500 0 500 1000

NEW ENGLAND DIVISION, BOSTON, MASS. JAN. 24, 1949

APPROVAL RECOMMENDED:
CHIEF, B & H OPERATIONS DIVISION

APPROVED:
LT. COL., C.E., ASST. DIVISION ENGINEER

SUBMITTED
B & H PROJECTS AND REPORTS BRANCH

TRANSMITTED WITH REPORT
DATED FEBRUARY 7, 1949

DR BY A.E.E.
TR BY K.H.W.
CH BY

FILE NO. B. E. Ct. 14

61103 O - 50 (Inside back cover) No. 17

PLATE 20

APPENDIX C – Tide Gate Memos

TO: David Murphy, P.E.

FROM: James MacBroom, P.E.

DATE: August 17, 2016 (Revised September 2, 2016)

RE: Turney Creek Tide Gates at Riverside Drive
Fairfield, Connecticut
MMI #1342-18

Introduction

Existing tide gates were inspected on August 9, 2016 at dead low tide and again on August 30 at the midpoint of an ebb tide. The gates are located at a bridge over Turney Creek next to the intersection of Shoreham Terrace, about 500 feet south of Post Road. They discharge into Ash Creek, a tidal channel that forms the boundary between Fairfield and Bridgeport.

The purpose of the tide gates is to limit the inflow of seawater into coastal creeks and wetlands at very high tide and during coastal storms to minimize inland flooding. In addition, some sites used tide gates to dry marshes for harvesting salt hay or to limit mosquito habitat. However, the excessive use of tide gates sometimes degrades marshes and habitat due to reduced tide range and salinity.

Description

The Riverside Drive bridge is a single-span reinforced concrete structure with vertical concrete abutments and concrete deck. Its span is 20.6 feet with a clear height of 9 feet. It generally is in good condition, but there are several areas of spalling concrete on the upstream wingwalls. The bridge superstructure is in good condition. The footings are not visible. These are two separate tide gate types including a set of three conventional flap gates at the bridge outlet plus an adjacent flap gate and self-regulating tide gate (SRT) of the type developed by former Conservation Department Director Tom Steinke. All five are mounted on a heavy timber bulkhead.

The three large rectangular flap gates have stainless steel top hinges and are mounted at the ends of three corrugated metal pipes that extend the bridge outlet. The three culvert extensions are corrugated metal pipe 96 inches wide by 82 inches high in fair condition with some corrosion. Each flap gate is composed of three layers of plywood with rusted vertical steel reinforcement. These three gates are functional but in fair to poor condition due to wood deterioration. The smaller flap gate is suspended from chains at a 48-inch-diameter corrugated metal pipe next to the SRT.

The single SRT unit is attached to a 48-inch-diameter corrugated metal pipe. The gate was half open and rotated easily on its hinges. The inlet to the latter gate has two 48-inch-diameter pipes separate from the bridge. Their upstream ends are rusted through, but they are still functional and could be repaired.

The three large flap gates were closed during our initial low tide inspection. This is their normal position. They should always be closed during the rising tide, plus at high tide and low tide. They will only open during the ebb tide but are not very visible then. They may not easily open on the ebb tide either as water can exit the SRT easier than pushing the large flaps open. The most likely open period is thus left to freshwater floods with an ebb tide when they were observed during the second inspection to be open about 12 inches.

Hydrology

The Turney Creek watershed has 2.38 square miles of land generally east of and parallel to Route 135. The watershed is urban with an estimated 40 percent impervious cover (*StreamStats*, USGS). The regional regression runoff equations developed by the United States Geological Survey (USGS) predict the following peak runoff rates, unadjusted for urbanization. The USGS gauge along the adjacent Rooster River watershed has a similar urban watershed with 36 years of record. A statistical analysis was conducted and the results prorated for watershed size and then a weighted average used to predict Turney Creek flows.

Storm Recurrence Frequency, Years	Unadjusted Peak Flow, cfs	Adjusted Peak Flow, cfs
2	92	394
10	212	593
25	292	672
50	357	781
100	422	869

cfs = cubic feet per second

The tide gates must have sufficient capacity to discharge the above flows, plus tide waters. The volume of the tidal prism can be flow measured in the field or estimated from bathymetric maps. Our initial preliminary tidal prism volume is based on the marsh area times the tide range and is roughly 1.5 million cubic feet of water, equal to 34 acre-feet of water, at high tide.

Tide Data

Tidal data is essential for the assessment of tide gates and flood risks as well as the ecological evaluation of the salt marshes. Key tide data includes both the normal and spring tide ranges with mean high and low waters for routine tide gate operations and marsh sustainability, plus the elevation of rare tidal surges such as Hurricanes Irene and Sandy. The latter inundated extensive areas in Fairfield south of Post Road.

Predicted Tide Levels, NAVD 88

	High Water	Low Water	Range
Spring Tide			7.9
Mean Tide	3.37	3.38	6.8

Tidal Surges

Event	Elevation, NAVD 88
Mean Annual High	6.3
10% Annual Chance	7.8
2% Annual Chance	9.3
1% Annual Chance	10
0.2% Annual Chance	11.3

The NOAA tide gauge in Bridgeport recorded Hurricane Sandy at elevation 9.3 (NAD 88), so it had an average return frequency of 50 years.

In comparison, the elevation of the crown of Riverside Drive is about elevation 8-9±, so great tidal floods may overtop the road and vertically bypass the tide gate. Based upon a comparison of tide and road elevations, Riverside Drive is subject to overtopping on the average of once every 25± years.

Sea levels have been rising for about 20,000 years since the last glacial maxima and are likely to continue rising through this century. Predictions are for the rate of sea level rise to accelerate, but it is not possible to accurately predict how high.

Hydraulics

Turney Creek is a tidal river with complex flow patterns and cycles. It has a significant urban watershed area and must be capable of conveying freshwater runoff to Ash Creek and Long Island Sound. It also accepts saltwater from Ash Creek during the rising tide and discharges it during the ebb tide. The Riverside Drive tide gate should provide several services including the following:

- Discharge of upland flood flows
- Blockage of tidal surges
- Passage of normal tidal prisms

A preliminary analysis, based on limited data, indicates that the existing tide gate does provide all of these services up to the point where very high tidal events overtop to terrain around the marsh. The SRT alone will fill and drain the marsh during the mean tide cycle, and the combination of the SRT and three flap gates should be able to pass flood flows downstream unless obstructed.

Turney Creek Marsh

Historically, use of coastal tide gates has reduced the normal volume of sea water entering salt marshes to minimize flooding, altering the tidal range and salinity levels. Side effects include the modification of marsh vegetation, expansion of invasive species, fish migration blockages, and a decline in water quality. The intent of SRT and similar structures is to enable tidal circulation during normal tide cycles but then close the gate during excessive tides to minimize tidal flooding.

During a brief inspection, the Turney Creek marsh was found to have a combination of low tide mudflats with many shellfish, healthy low marshes supporting *Spartina alterniflora* salt grass, *Spartina patens* high marsh grasses, and *Phragmites* around the perimeter. The salinity upstream of the tide gates was 20 parts per thousand (PPT) compared to 24 PPT downstream in Ash Creek. The tide range has not been checked with a gauge.

The above vegetation observations and salinity suggest the marsh is in satisfactory condition. The site was inspected at dead low tide, and at that hour, the salt marsh areas were dry, half the tidal creek had exposed muddy sediment, and the wetted channel was only 30 to 50 feet wide. Many shellfish and shells were observed, plus several shore birds.

Conclusion

The tide gates appear to be functional but worn due to their age. A preliminary analysis based on limited data and marsh observations suggest they have adequate capacity. However, the elevation of the road and surrounding terrain would be subject to overtopping during major tidal surges.

1342-18-s116-2-memo

Memorandum

TO: **David Murphy, P.E.**

FROM: **James G. MacBroom, P.E.**

DATE: **September 2, 2016**

RE: **Riverside Creek Tide Gates**
Fairfield, Connecticut
MMI #1342-18

Introduction

The existing tide gate is located at the Ash Creek side of a small tidal creek (Riverside Creek) and marsh on the south side of Riverside Drive. The culvert extends under a man-made earth dike, reportedly made in 1957, that regulates flow between Ash Creek and the Riverside Creek tidal marsh. The latter is part of a town-owned 24.3-acre open space area. The marsh is roughly 1,700 feet by 150 feet in size, equal to 5 acres, with a small tidal creek that extends from the dike to Turney Road.

Description

The 30-inch-diameter culvert under the dike is a corrugated metal pipe approximately 50 feet long. The tide gate hinges, floats, and vent appear to be operational. The Ash Creek end of the culvert is equipped with a self-regulating tide gate (SRT) in good condition. During the ebb tide, it was moving easily on its hinges. The adjacent boulder slope protection is in good condition. A large 8-foot-diameter chamber with a hinged plywood lid is near its marsh end. The earth dike is heavily vegetated, about 10 to 12 feet high, with a 10-foot-wide crest. A footpath is located on the crest. Only the ends of the culvert were visible, and they are in good condition.

Marsh Conditions

The Ash Creek marsh immediately downstream of the tide gate consists of a combination of open water, mud flat (at low tide), and large fields of *Spartina alterniflora*. This combination is indicative of an active salt marsh with a marginal tide range and salinity.

The Riverside Creek marsh on the inland side of the dike has a tidal creek that extends to Turney Drive near the marina and the tidal marsh. The latter has thin bands of *Spartina alterniflora* along the creek, patches of *Spartina patens*, and then *Phragmites*.

The extent of the invasive *Phragmites* suggests the high tide and salinity may be limited by the tide gate, dike, and fill material.

Hydraulics

Based on limited observations, the 30-inch culvert and SRT at the dike appear to be undersized and limiting tidal exchange. When viewied at mid tide, the culvert had a free discharge at Ash Creek but was limiting discharge from the Riverside marsh. Further observations would be needed to confirm how the Turney Drive culvert functions through the full tidal cycle. The dike may be prone to overtopping during storm surges.

1342-18-s116-1-memo

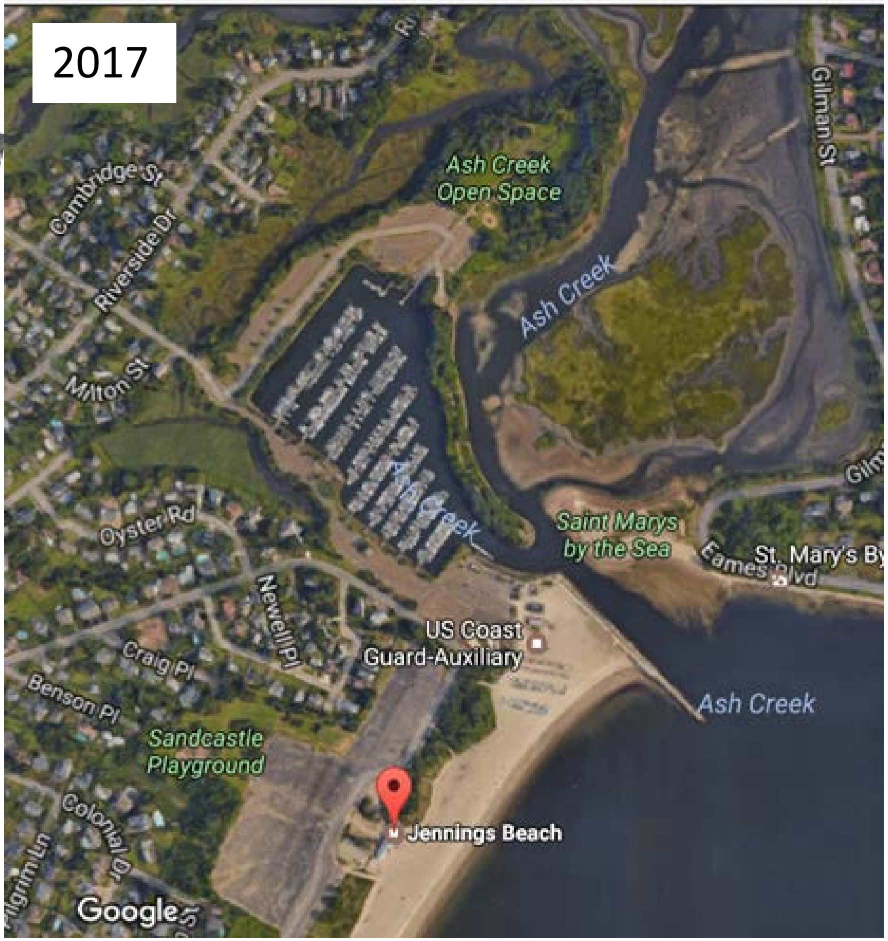
APPENDIX D – Historical Aerial Photographs

Historical aerial photographs of Jennings Beach and Ash Creek, Fairfield

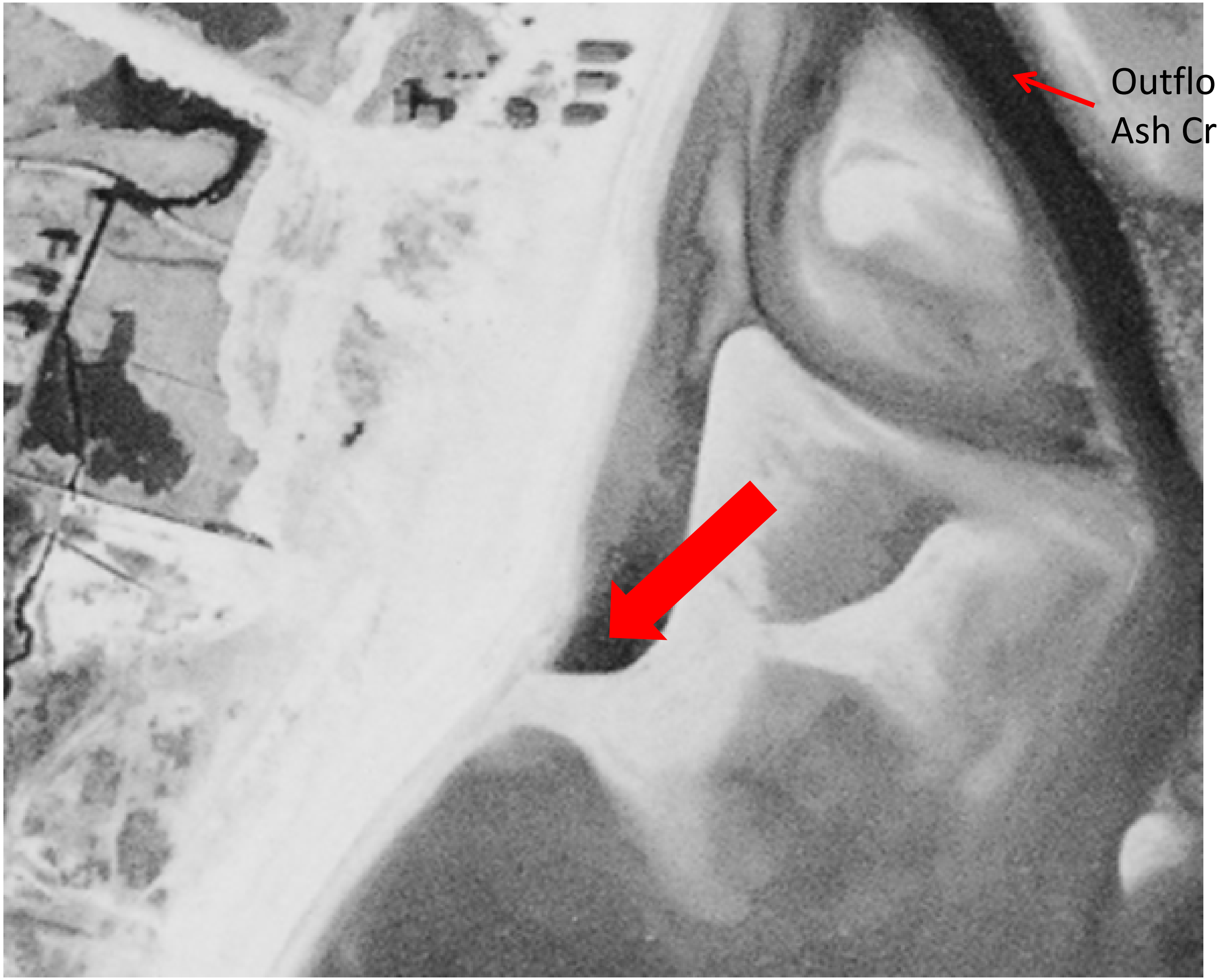
Prepared by Jennifer O'Donnell
Coastal Ocean Analytics
January 2017

The 1934 aerial photographs were taken prior to the construction of South Benson Marina and the Ash Creek jetty. Small streams can be seen through the marsh. In image CT1934_05528, sand deposition can be seen at the mouth of the creek. Comparing the 1934 and the 2017 Google Maps imagery, you can see the orientation of Jennings Beach has changed slightly, presumably due to the construction of the jetty.


1934


2017

The CT1934-05527 image shows patterns of sand deposition along Jennings Beach.



Outflow from
Ash Creek

Note the waterways through the marsh areas behind Jennings Beach

The Riverside Drive area was developed with residences by 1934 due to the higher ground in this area

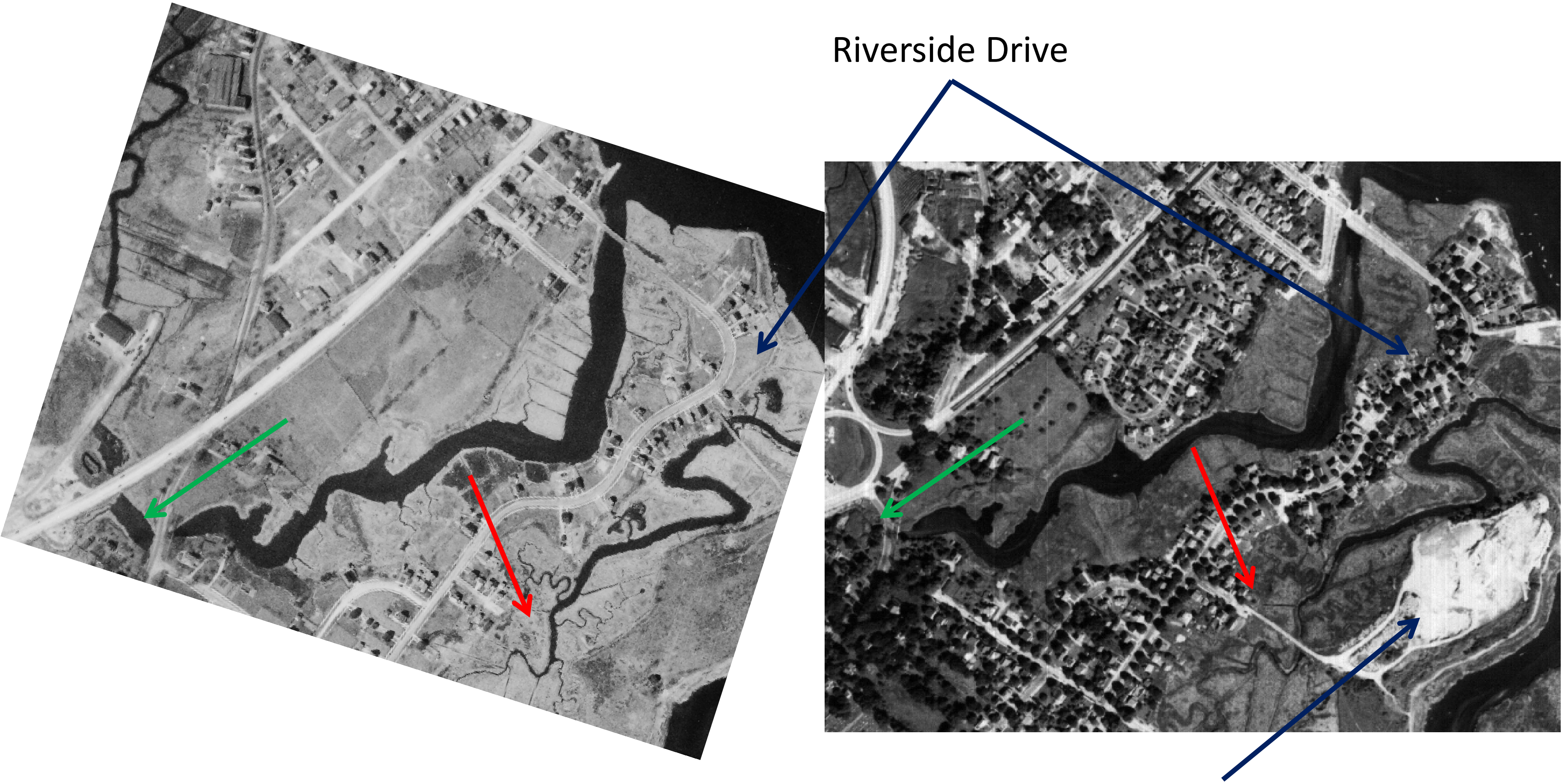
CT1934-04345

Google Earth 4/19/2016

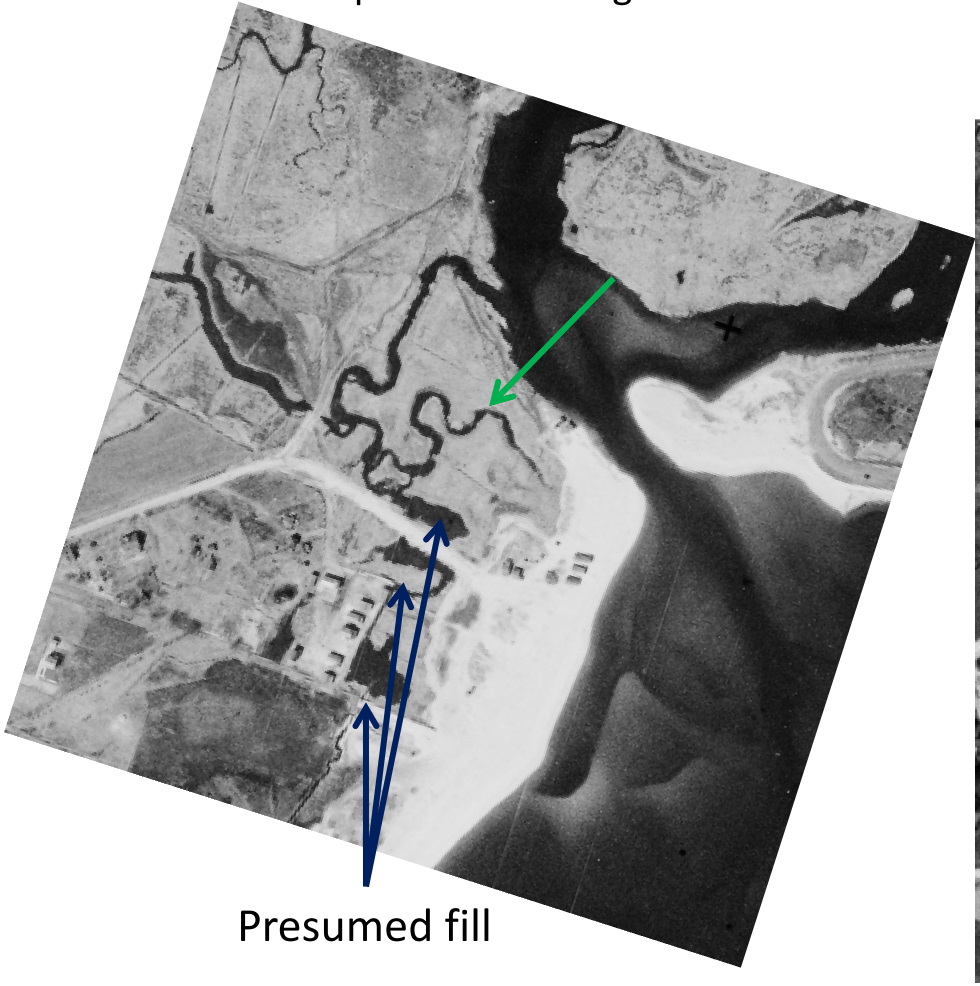
The primary changes between 1934 and 2016 are the increase in development and the construction of the South Benson Marina. Note the marsh area has been changed into a marina.

Aerial views from 1934 (CT1934_04345) and 1951

Considerable development occurred between 1934 and 1951 along Riverside Drive with a road across the marsh constructed (red arrow) and changes in the upstream section of Turney Creek (green arrow).



By the time of the 1951 aerial photograph, the Ash Creek jetty has been constructed. The 800 ft jetty was constructed in 1951 by local interests who were reimbursed 1/3 by the Federal government as noted here:
http://coastalhydraulicslaboratoryfact.tpub.com/TechReport7/TechReport70105.htm
A road (red arrow) has been created through the marsh area that is now the South Benson Marina. The road may have been constructed to allow construction access to the jetty. This seems to have resulted in some fill in this area as the creek (green arrow) which can be clearly seen in the 1934 photo is no longer evident. Other areas of fill (blue arrows) are visible.



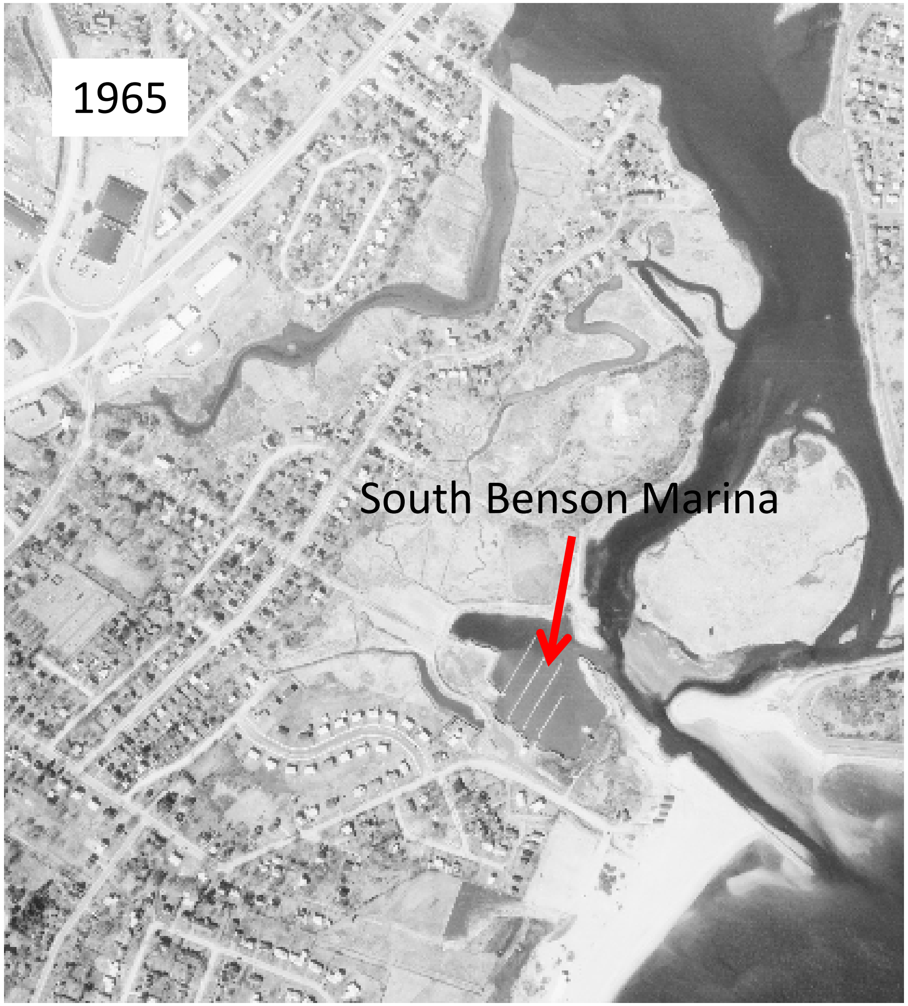
Aerial views from 1951 and 1965


1951


1965

There was considerable residential development in the coastal floodplain southwest of South Benson Road between 1951 and 1965

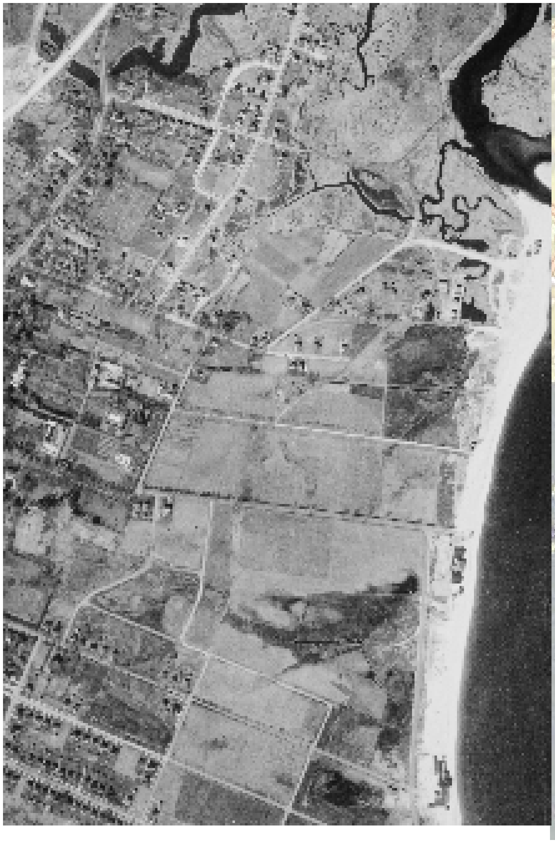
The most notable change between 1951 and 1965 in the vicinity of Ash Creek is the construction of the South Benson Marina

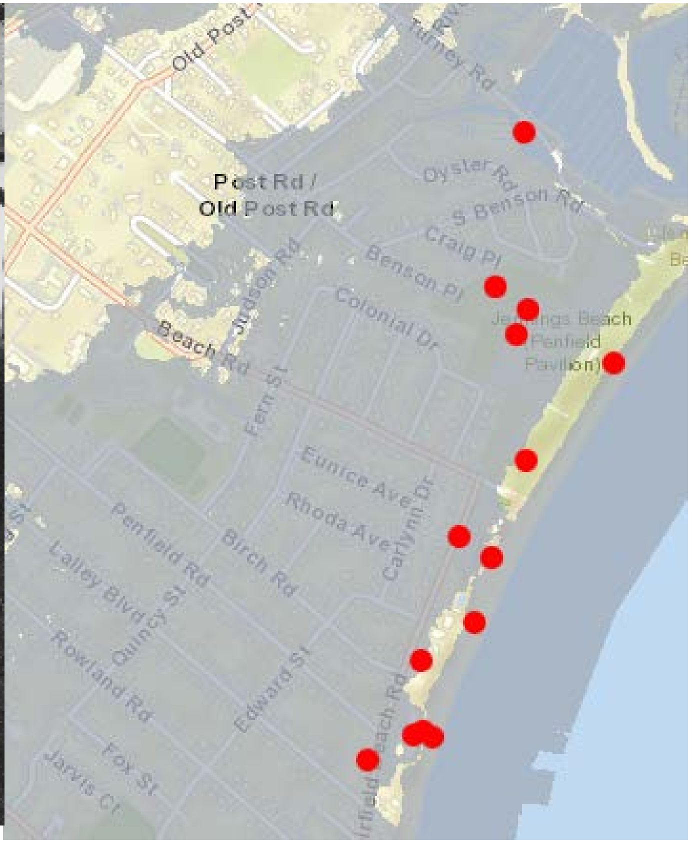


The appearance of a new channel at Riverside Creek may indicate that sediment was excavated for construction of the dike that is now parallel to this channel.

Some infill development occurred in the nearby marsh after the marina was developed.

The center image is Hurricane Sandy Flood data from http://maps.coastalresilience.org/connecticut/#. Note development in 1934 compared with 1965 and with respect to the areas flooded during Sandy.





Aerial photos from 1965 and 1970

1965

1970

The entrance location to South Benson Marina was modified between 1965 and 1970. Sand transported along Jennings Beach was deposited on the west side of the Ash Creek Jetty. The straight channel in the 1970 image suggests that dredging occurred.

Morton, Robert W., Bohlen, W.F. and Aubrey, David G., 1983, Beach changes at Milford and Fairfield beaches, Connecticut 1962-1971. USACE Misc. Paper CERC-83-5 https://babel.hathitrust.org/cgi/pt?id=mdp.39015095028927;view=1up;seq=1

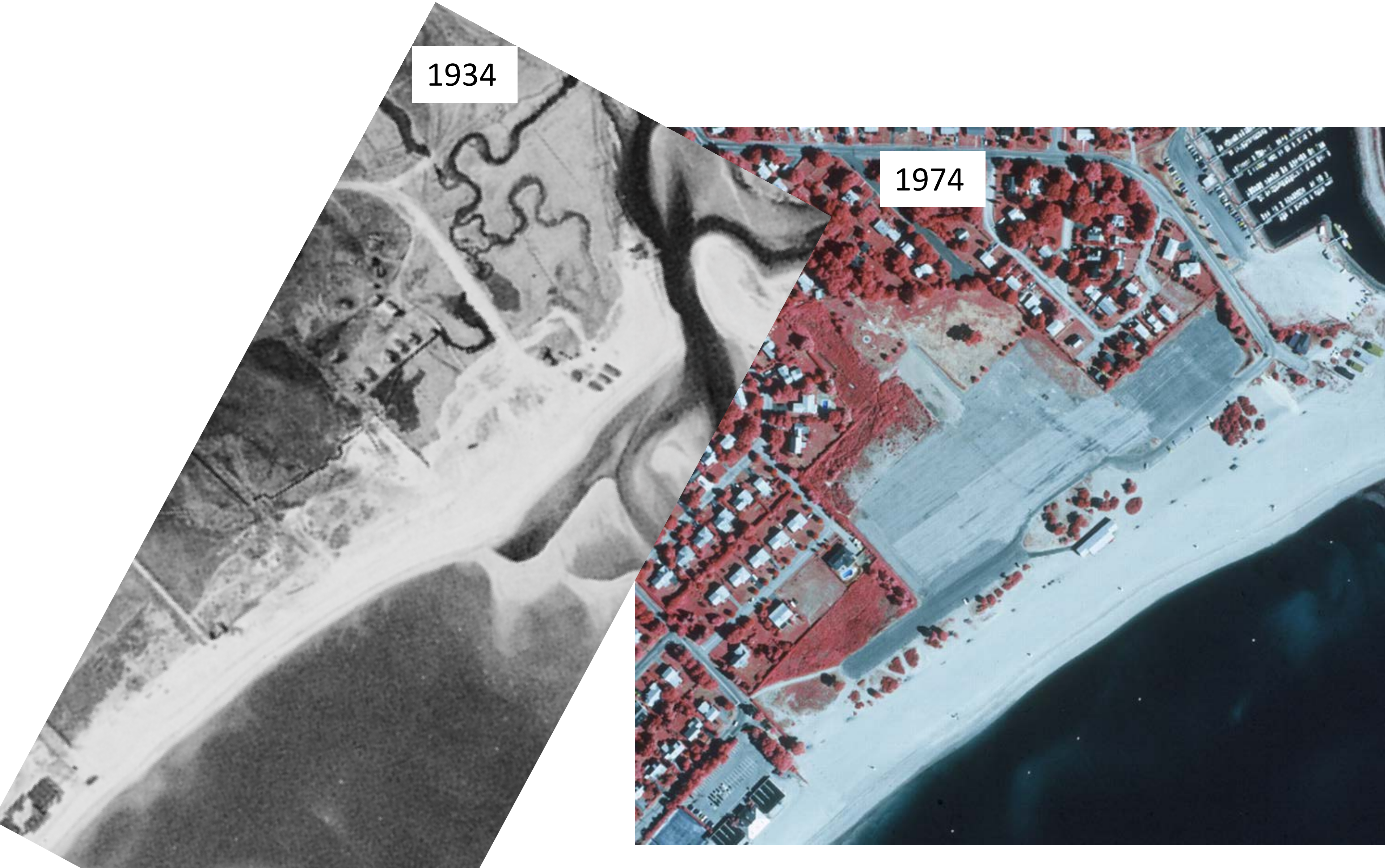
- Shore front sediments are glacial and from unconsolidated till headlands and offshore islands. Penfield Reef (extending from Shoal PT) appears to have been prominent. During late 1600s emergent peninsula extended more than a mile.
- In 1700s large amount of cobble was removed for ship's ballast and peninsula began to erode rapidly.
- By late 1800s it was largely submerged forming a reef/island complex.
- Despite management efforts, it continued to erode until obliterated by 1938 hurricane.
- Beach varies from <15m just north of Shoal PT to 46m at Ash Creek
- Beach at Ash Creek is steeper (1:10) compared with further south (1:30-1:50).
- At Ash Creek end transition to upper beach is abrupt and beach has broad horizontal or shoreward tending slope.
- Sand elevation is ~3.8m above MLW.

Comparison of 1970 and 1974 aerial images

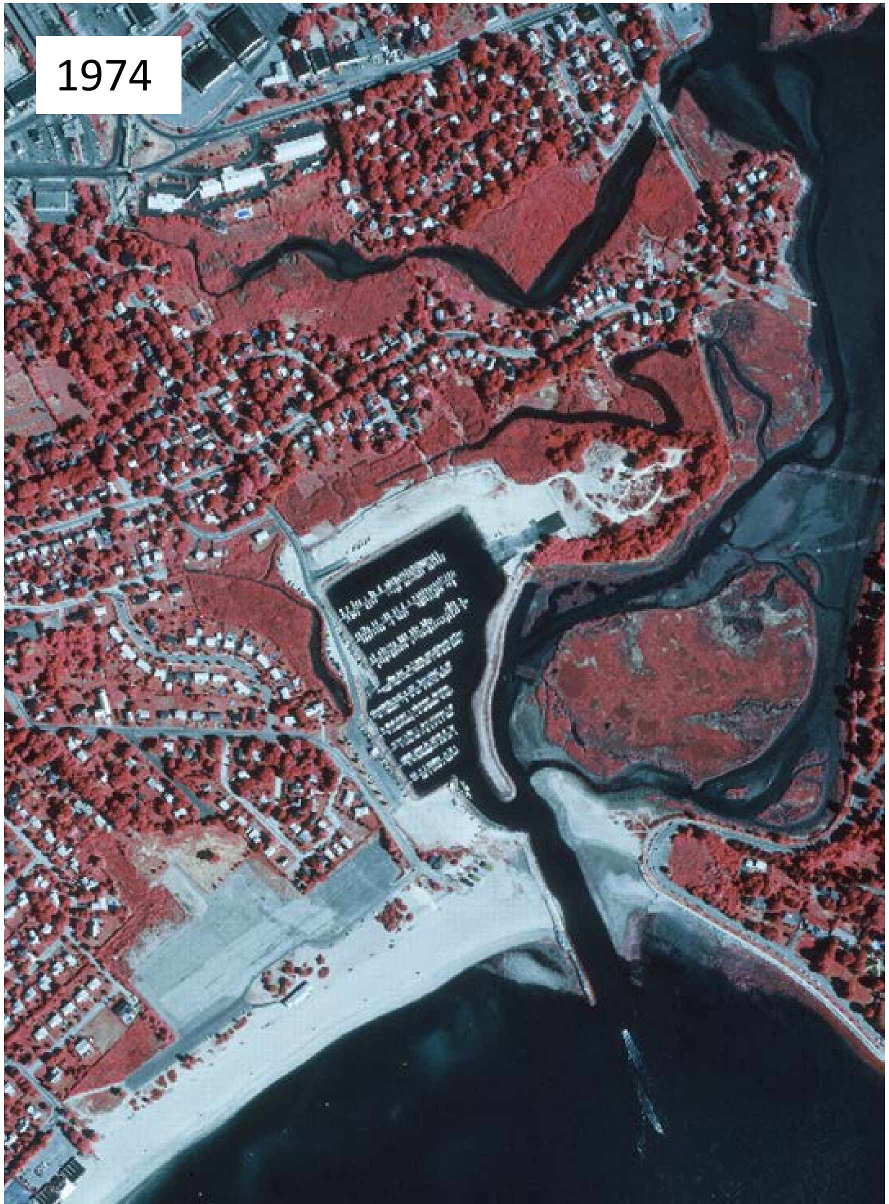
By 1974 the South Benson Marina has been completed. The open space is no longer completely vegetated. The entrance to the marina area and the boat ramp are paved. It also appears that Turney Road has been extended south along the marina and parking areas have been constructed.

It’s not clear in the 1970 image if the Jennings Beach parking area is paved, but paved area is clear in the 1974 infrared image.

Note the Jennings Beach parking area in the 1974 image which was marsh and sand in 1934.



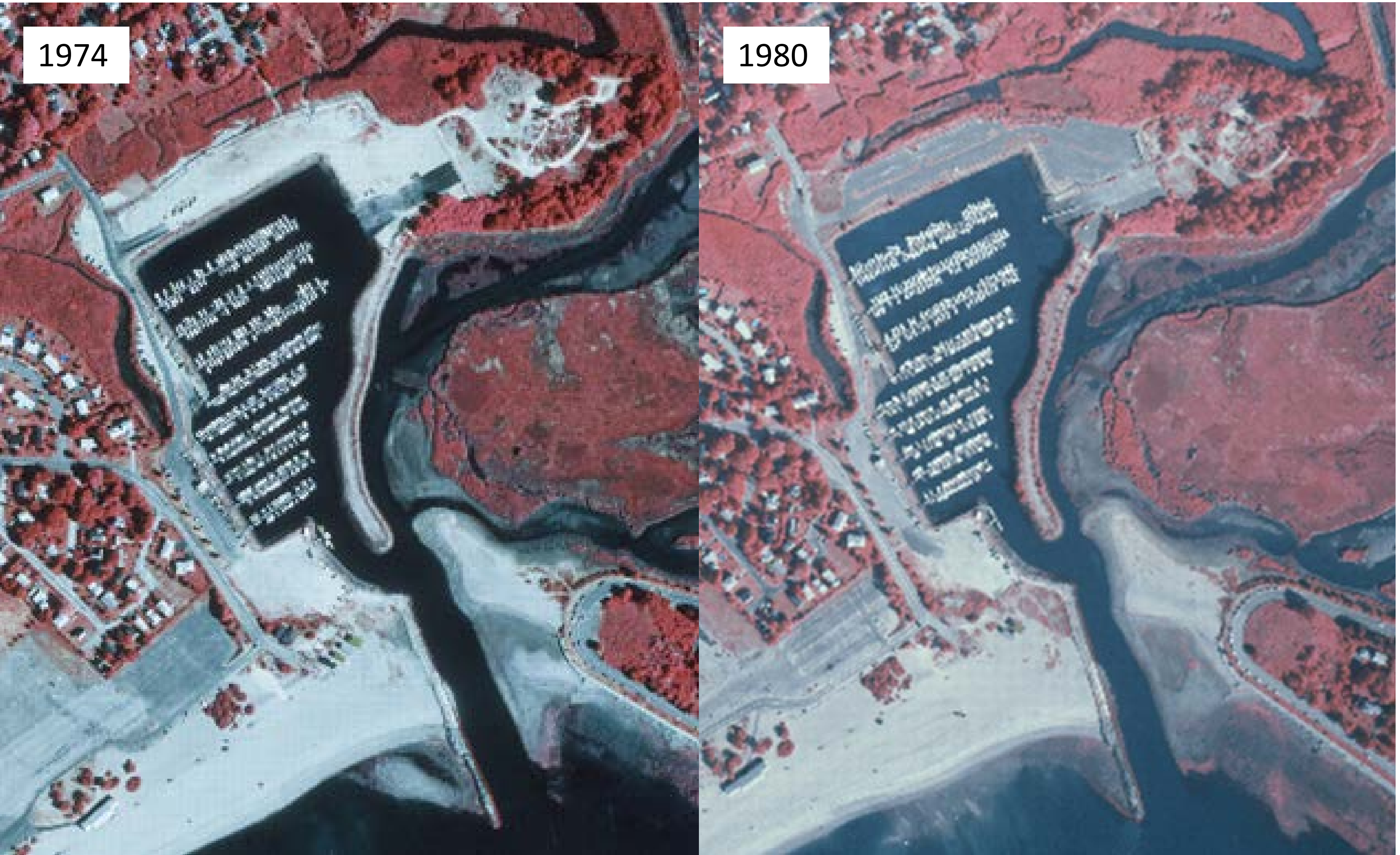
1974 and 1980 aerial photographs



1974

1980

The parking lot in the northern part of the marina was paved by 1980. There has been additional deposition at the Ash Creek jetty.



Comparison of 1980 and 1981 aerial photographs


1980


1981

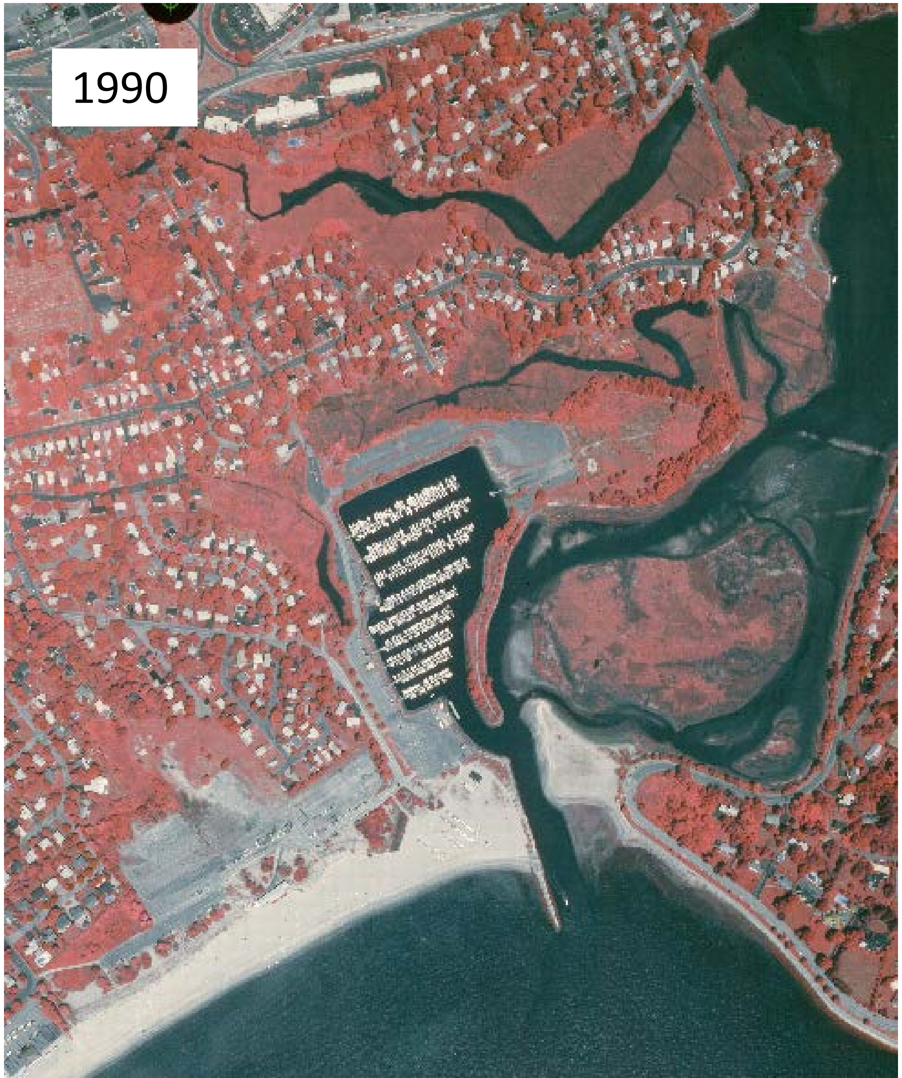
Comparison of 1981 and 1986 infrared photographs

1981

1986

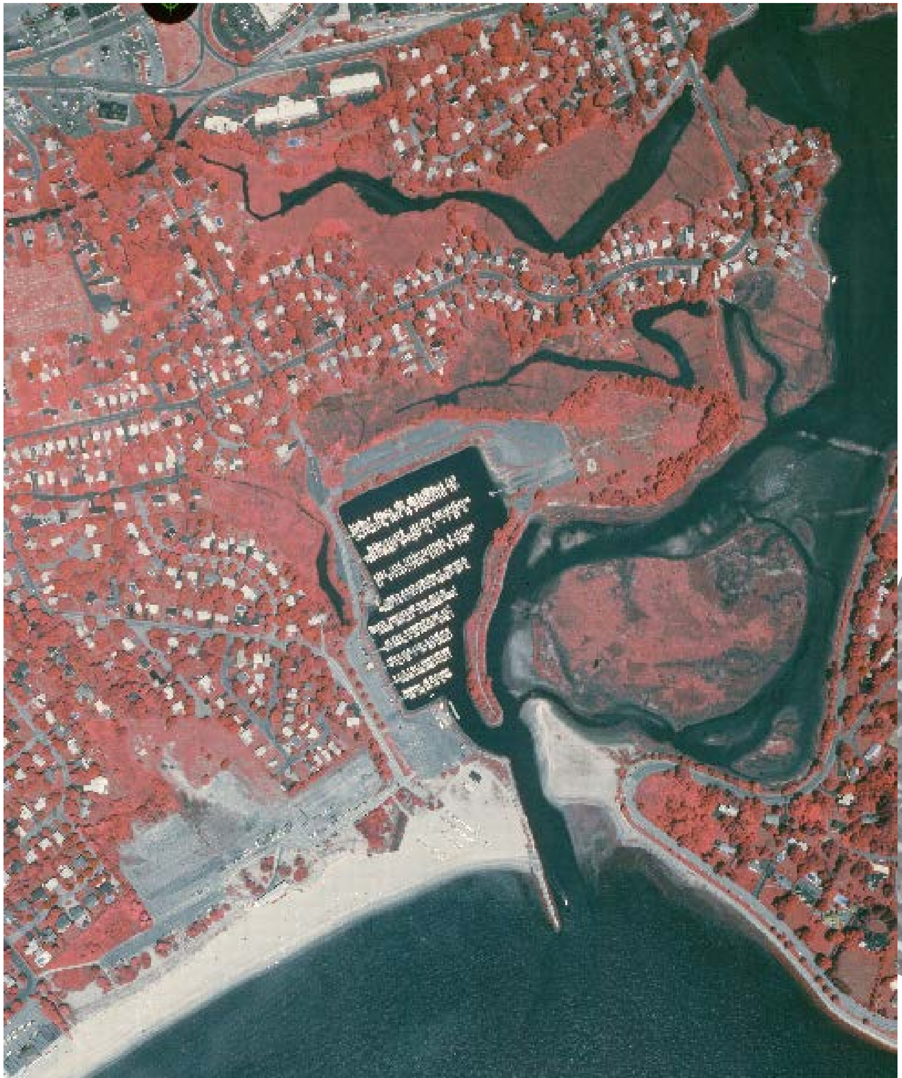
The Jennings Beach berm can be seen clearly for the first time on the 1986 image. The vegetation line behind the berm appears to have remained fairly stable since the 1951 aerials, although the vegetation is more difficult to detect in the 1934 aerials. The berm was constructed seaward of existing vegetation.

Comparison of 1986 and 1990 aerial photographs

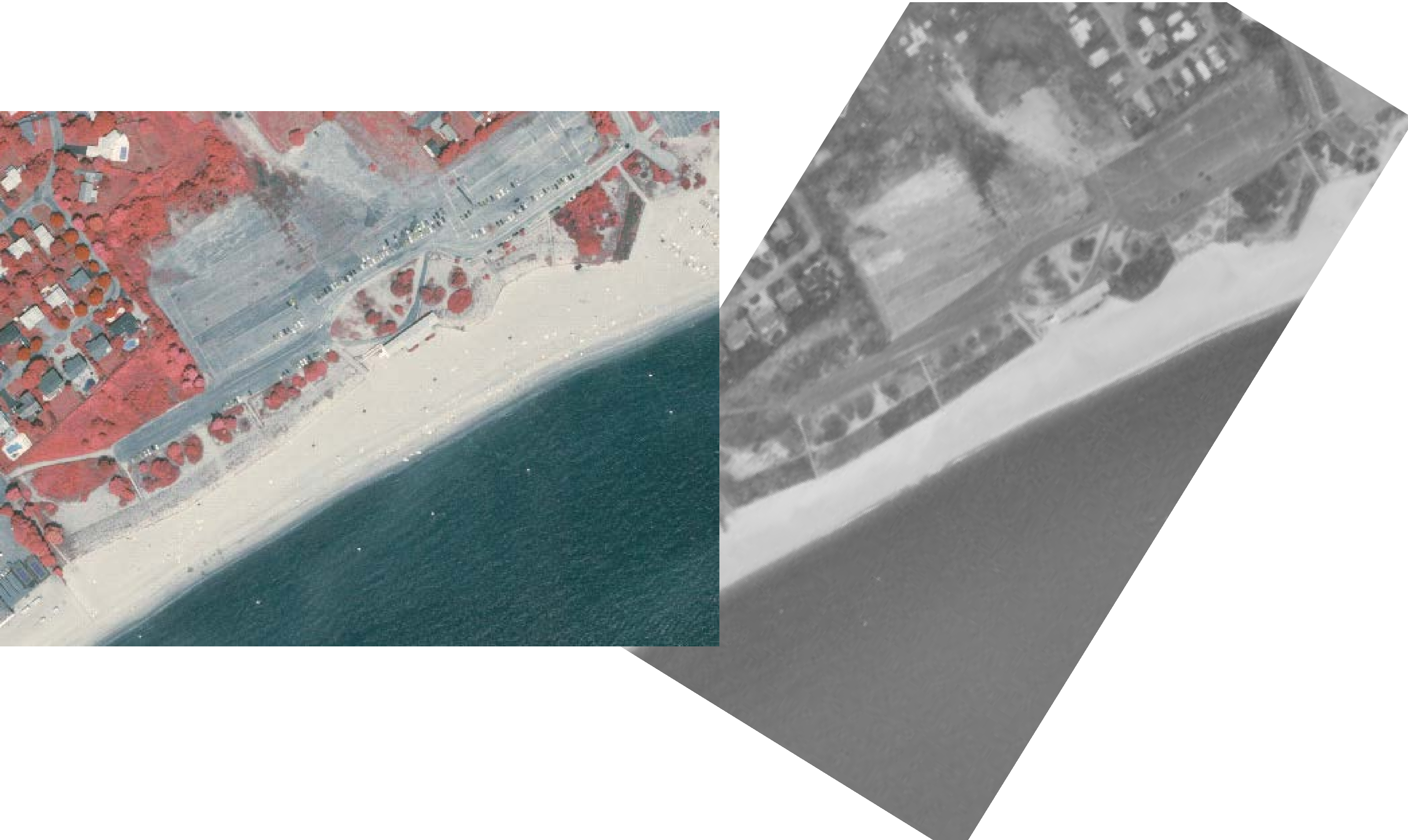


The Jennings Beach berm can be seen clearly in the 1990 image, with no significant change from 1986 image.

Comparison of 1990 infrared with 1995 B/W aerial image



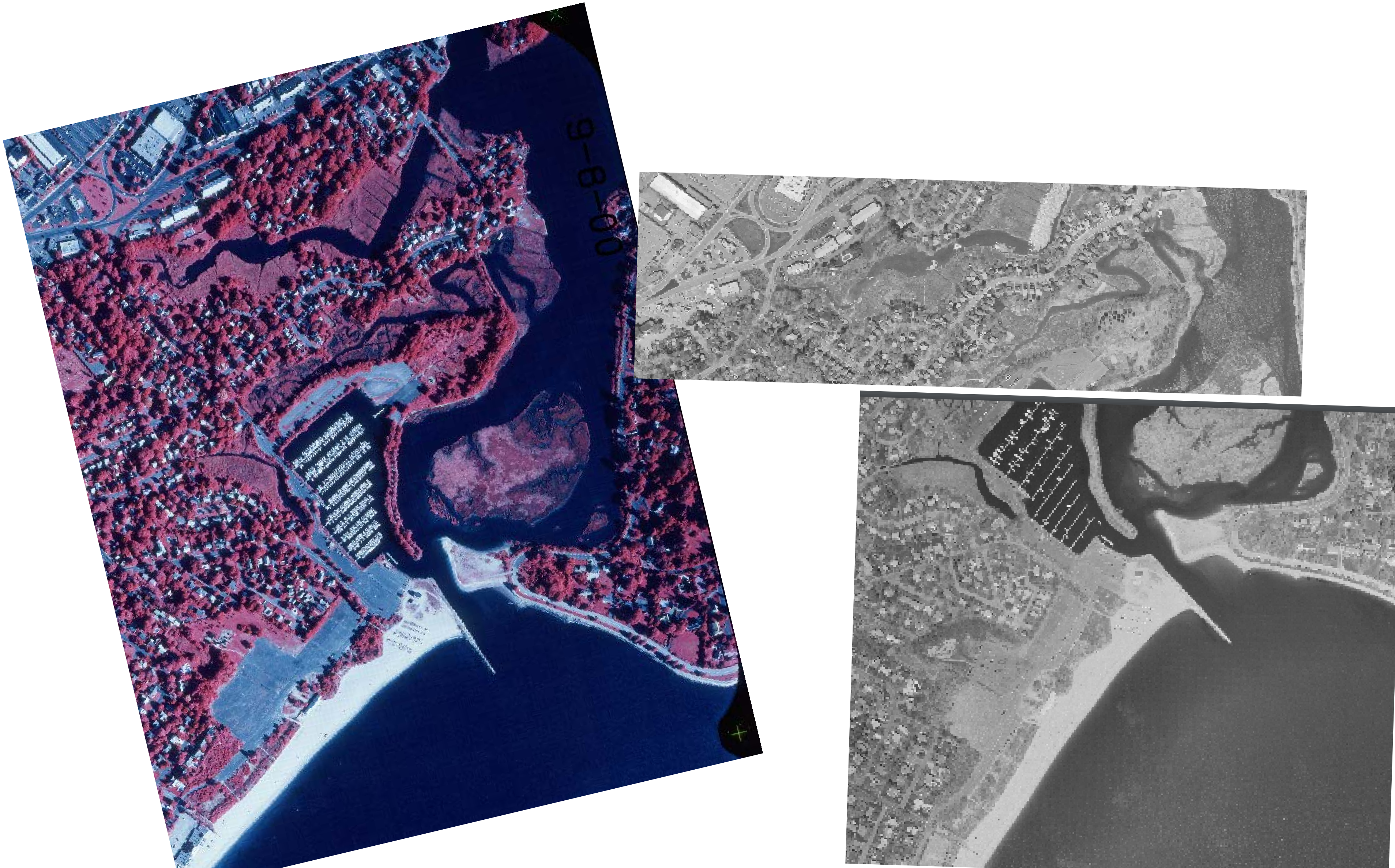
The Jennings Beach berm can be clearly identified in the 1995 photo. The dark coloring may indicate vegetation.



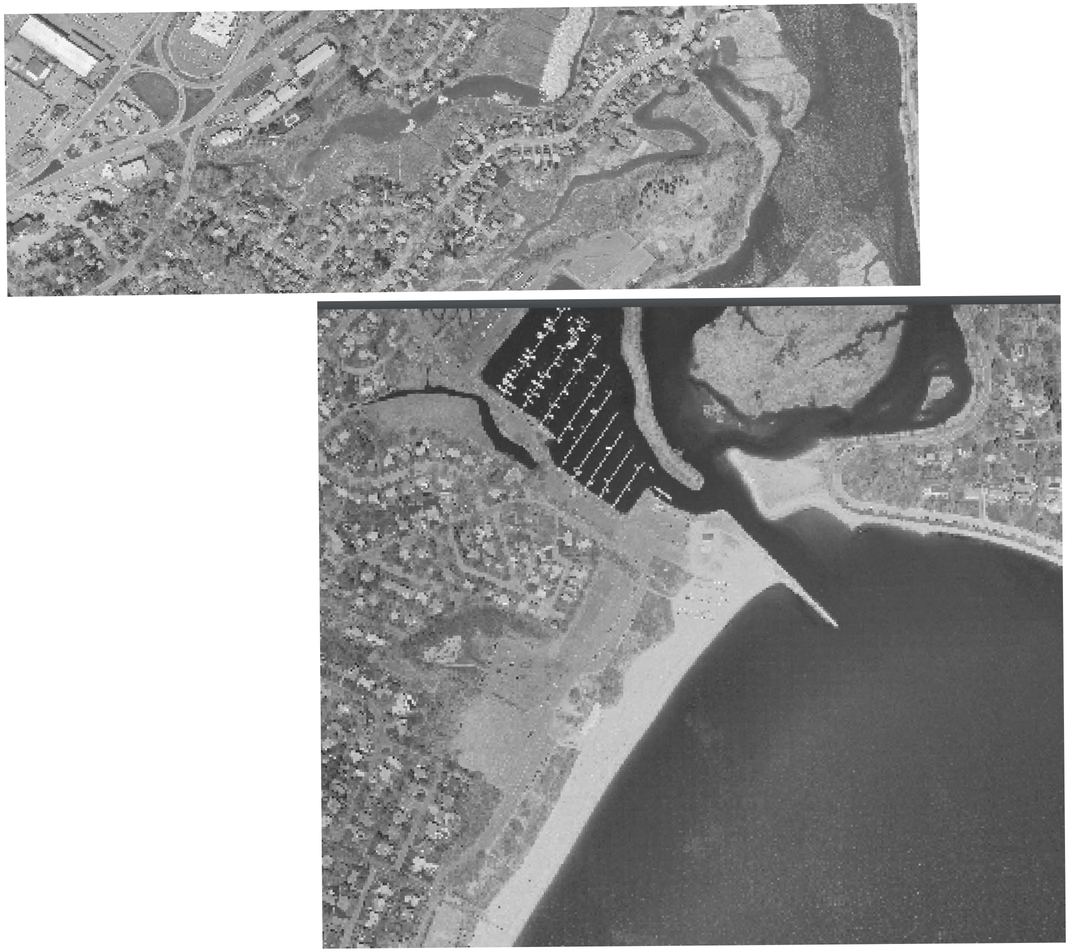
1995 B/W and 2000 infrared

The Jennings Beach berm vegetation is clearly identifiable on the 2000 infrared image.

2000 infrared and 2004 B/W



2004 B/W and 2006 color



2006 and 2008

2008 and 2010

Historical Aerial Photographs

The aerial photographs used for the preceding set of graphics are provided in sequence following this page. A list of references is provided to the right.

Dataset	Year	Scale	
B/W	1934	1:14000	http://magic.lib.uconn.edu/magic_6/raster/37800/aerial/1934/04817_to_05993/CT1934_05527.pdf http://magic.lib.uconn.edu/magic_6/raster/37800/aerial/1934/03654_to_04816/CT1934_04346.pdf http://magic.lib.uconn.edu/magic_6/raster/37800/aerial/1934/03654_to_04816/CT1934_04345.pdf http://magic.lib.uconn.edu/magic_6/raster/37800/aerial/1934/04817_to_05993/CT1934_05528.pdf
B/W	1951-52	1:20,000	http://magic.lib.uconn.edu/magic_3/raster/37831/aerial/1951/1951_DPD_Fairfield_pma_s8/adimg_37831_01_DPD6H71_1951_s8_pma_1_p.pdf
B/W	1965	1:5280	http://magic.lib.uconn.edu/magic_7/raster/37800/aerial/1965/CTDEP657_2320_2350/CTDEP657_2343.pdf
B/W	1970	1:20,000	http://magic.lib.uconn.edu/magic_2/raster/37800/aerial/1970/flight_line_53/adimg_37800_00_53ct291_1970_s20_DPW_1_p.pdf
Infrared	1974	1:12,000	http://magic.lib.uconn.edu/magic_3/raster/37800/aerial/infrared/1974/PDF/CTDEP_CIR_12k_1974_603.pdf
Infrared	1980	1:12,000	http://magic.lib.uconn.edu/magic_3/raster/37800/aerial/infrared/1980/PDF/CTDEP_CIR_12K_1980_124.pdf http://magic.lib.uconn.edu/magic_3/raster/37800/aerial/infrared/1980/PDF/CTDEP_CIR_12K_1980_228.pdf
Infrared	1981	1:12,000	http://magic.lib.uconn.edu/magic_3/raster/37800/aerial/infrared/1981/PDF/CTDEP_CIR_12K_1981_7_104.pdf
	1985-86	1:6000	Unavailable on 1/18/2017
Infrared	1986	1:12,000	http://magic.lib.uconn.edu/magic_3/raster/37800/aerial/infrared/1986_87/PDF/CTDEP_CIR_12K_1986_3_35.pdf http://magic.lib.uconn.edu/magic_3/raster/37800/aerial/infrared/1986_87/PDF/CTDEP_CIR_12K_1986_3_34.pdf
B/W	1990	1:20,000	http://magic.lib.uconn.edu/magic_3/raster/37800/aerial/1990/flight_line_22/adimg_37800_00_22ct602_1990_s1_CTDEP_1_p.pdf http://magic.lib.uconn.edu/magic_3/raster/37800/aerial/1990/flight_line_22/adimg_37800_00_22ct603_1990_s1_CTDEP_1_p.pdf
Infrared	1990	1:12,000	http://magic.lib.uconn.edu/magic_2/raster/37800/aerial/infrared/1990/pdf/CTDEP_CIR_12K_1990_0815.pdf http://magic.lib.uconn.edu/magic_2/raster/37800/aerial/infrared/1990/pdf/CTDEP_CIR_12K_1990_0366.pdf
B/W	1995	1:20,000	http://magic.lib.uconn.edu/magic_3/raster/37800/aerial/1995/flight_line_22/adimg_37800_00_22ct100_1995_s1_STCT_1_p.pdf
Infrared	1995	1:12,000	http://magic.lib.uconn.edu/magic_2/raster/37800/aerial/infrared/1995/PDF/CTDEP_CIR_12K_1995_0195.pdf
Infrared	2000	1:12,000	http://magic.lib.uconn.edu/magic_2/raster/37800/aerial/infrared/2000/PDF/CTDEP_CIR_12K_2000_575.pdf
B/W	2004	1:24,000	http://magic.lib.uconn.edu/magic_4/raster/37800/aerial/2004/ortho_2004_10in/0410731093_7.pdf http://magic.lib.uconn.edu/magic_4/raster/37800/aerial/2004/ortho_2004_10in/0410731093_4.pdf
color	2006	1:24,000	http://magic.lib.uconn.edu/magic_4/raster/37800/aerial/2006/hdimg_37800_0000_n_4107355_sw_18_1_20060814_20070201_2006_s24_NAIP_1_tf.pdf
color	2008	1:24,000	http://magic.lib.uconn.edu/magic_4/raster/37800/aerial/2008/41073/m_4107355_sw_18_1_20080710.pdf
color	2010	1:24,000	http://magic.lib.uconn.edu/magic_4/raster/37800/aerial/2010/m_4107355_sw_18_1_20100829.pdf

1934

http://magic.lib.uconn.edu/magic_6/raster/37800/aerial/1934/03654_to_04816/CT1934_04345.pdf

1934

http://magic.lib.uconn.edu/magic_6/raster/37800/aerial/1934/03654_to_04816/CT1934_04346.pdf

1934

http://magic.lib.uconn.edu/magic_6/raster/37800/aerial/1934/04817_to_05993/CT1934_05527.pdf

1934

http://magic.lib.uconn.edu/magic_6/raster/37800/aerial/1934/04817_to_05993/CT1934_05528.pdf

1951

http://magic.lib.uconn.edu/magic_3/raster/37831/aerial/1951/1951_DPD_Fairfield_pma_s8/adimg_37831_01_DPD6H71_1951_s8_pma_1_p.pdf

1965

http://magic.lib.uconn.edu/magic_7/raster/37800/aerial/1965/CTDEP657_2320_2350/CTDEP65_7_2343.pdf

1970

http://magic.lib.uconn.edu/magic_2/raster/37800/aerial/1970/flight_line_53/adimg_37800_00_53ct291_1970_s20_DPW_1_p.pdf

1974

http://magic.lib.uconn.edu/magic_3/raster/37800/aerial/infrared/1974/PDF/CTDEP_CIR_12k_1974_603.pdf

1980

http://magic.lib.uconn.edu/magic_3/raster/37800/aerial/infrared/1980/PDF/CTDEP_CIR_12K_1980_124.pdf

1980

http://magic.lib.uconn.edu/magic_3/raster/37800/aerial/infrared/1980/PDF/CTDEP_C

1981

http://magic.lib.uconn.edu/magic_3/raster/37800/aerial/infrared/1981/PDF/CTDEP_CIR_12K_1981_7_104.pdf

1986

http://magic.lib.uconn.edu/magic_3/raster/37800/aerial/infrared/1986_87/PDF/CTDEP_CIR_12K_1986_3_34.pdf

1986

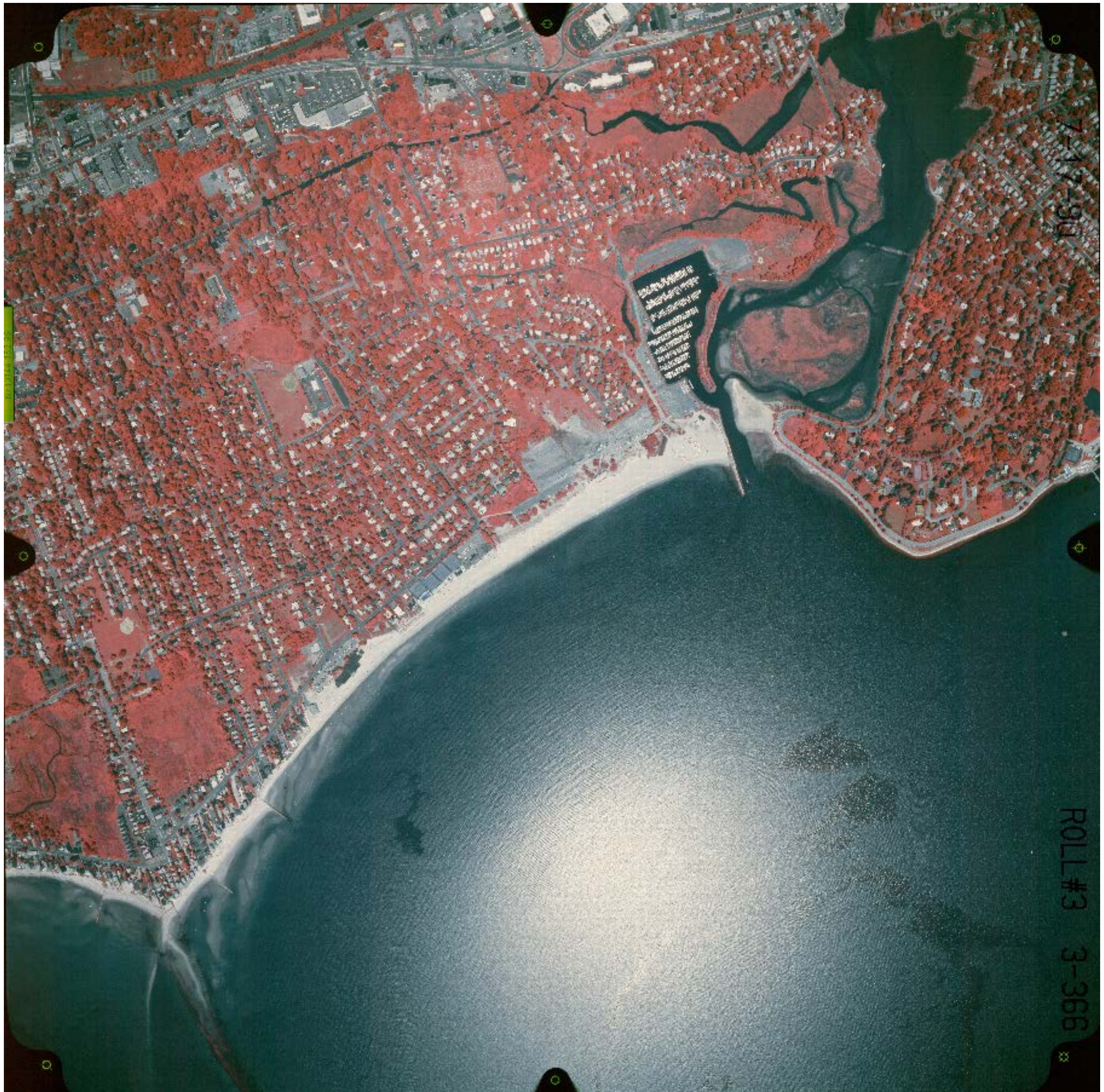
http://magic.lib.uconn.edu/magic_3/raster/37800/aerial/infrared/1986_87/PDF/CTDEP_CIR_12K_1986_3_35.pdf

1990

http://magic.lib.uconn.edu/magic_3/raster/37800/aerial/1990/flight_line_22/adimg_37800_00_22ct603_1990_s1_CTDEP_1_p.pdf

1990

http://magic.lib.uconn.edu/magic_2/raster/37800/aerial/infrared/1990/pdf/CTDEP_CIR_12K_1990_0366.pdf



1995

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2000

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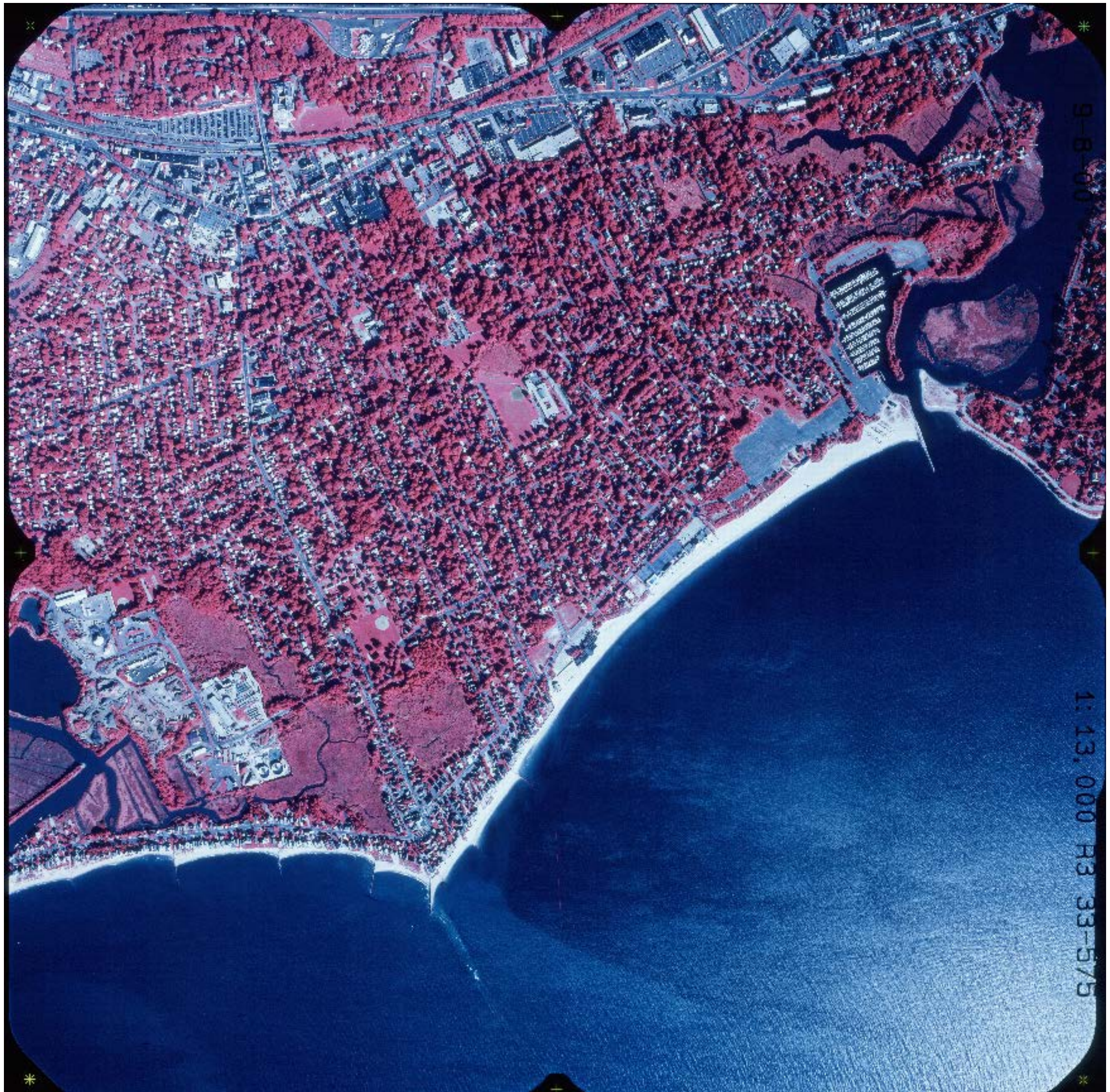

2004

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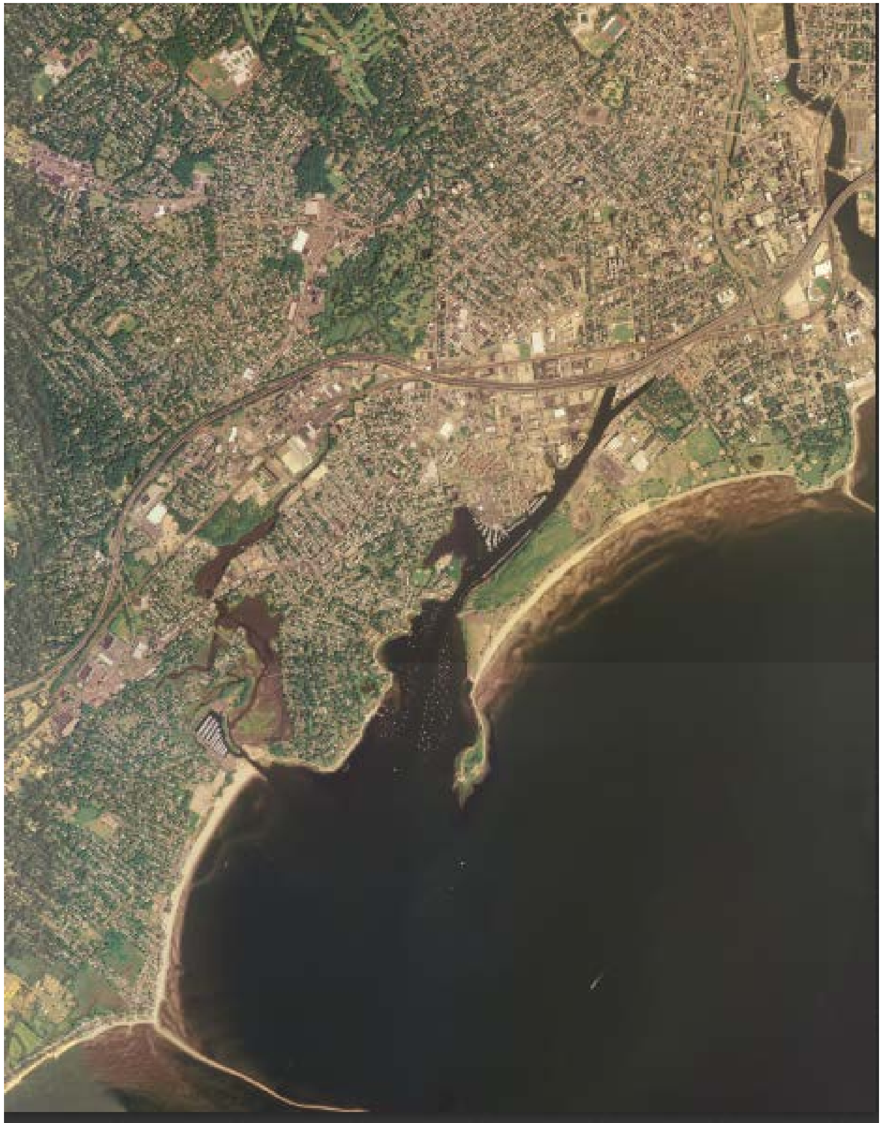
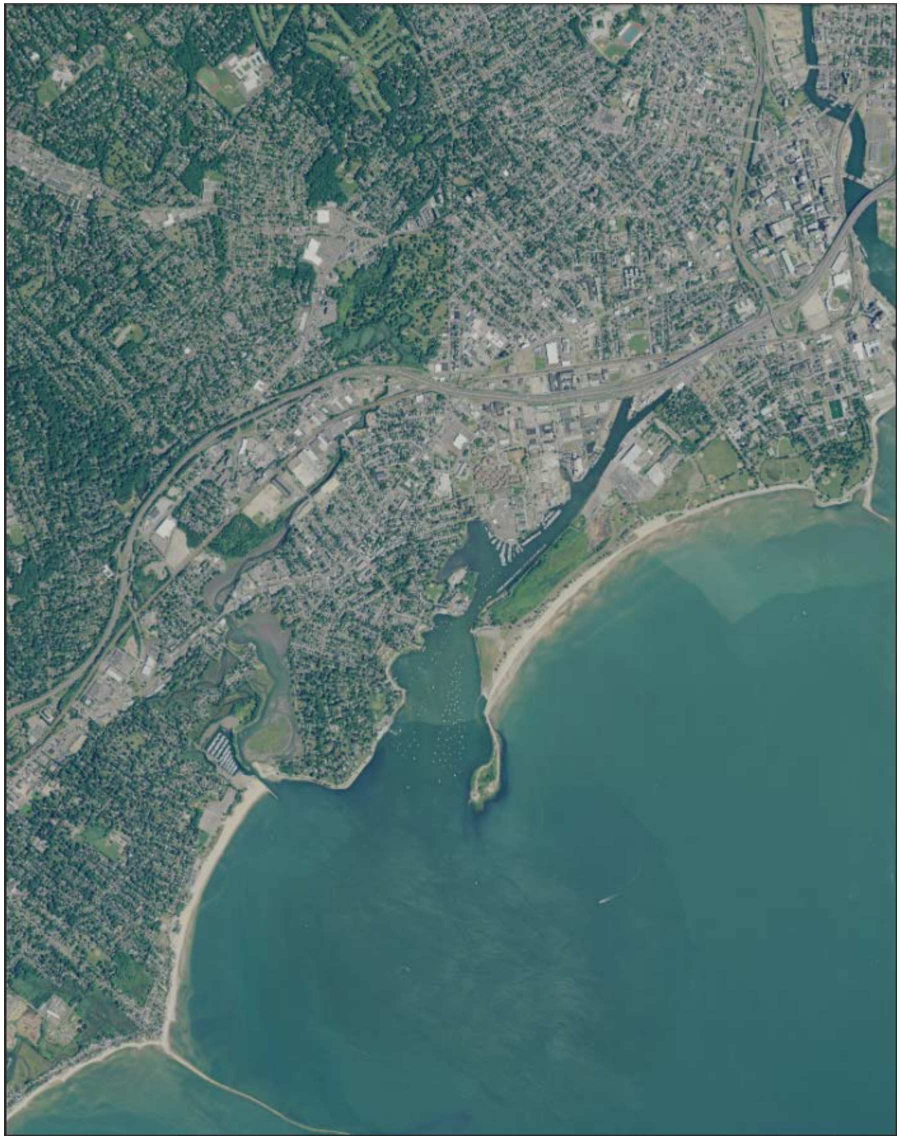
2006

http://magic.lib.uconn.edu/magic_4/raster/37800/aerial/2006/hdimg_37800_0000_n_4107355_sw_18_1_20060814_20070201_2006_s24_NAIP_1_tf.pdf



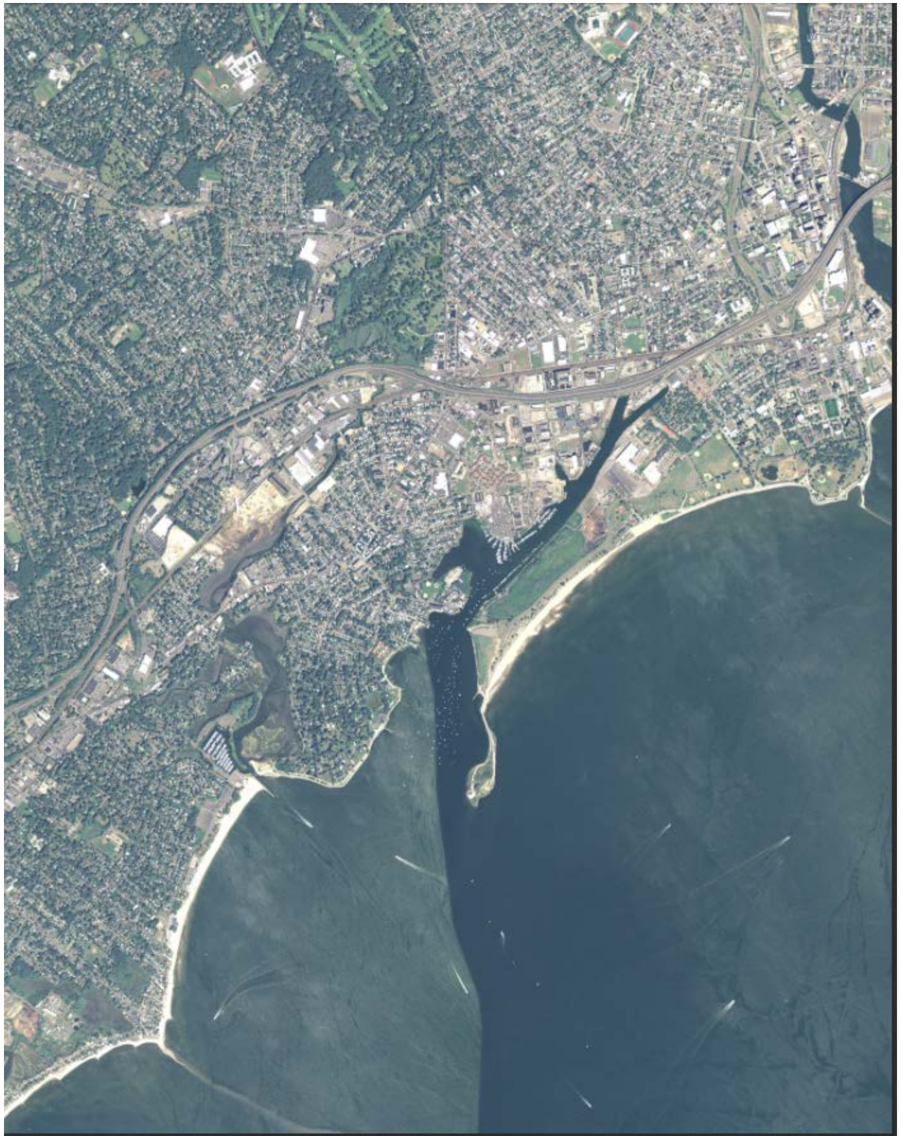
2008

http://magic.lib.uconn.edu/magic_4/raster/37800/aerial/2008/41073/m_4107355_sw_18_1_20080710.pdf



2010

http://magic.lib.uconn.edu/magic_4/raster/37800/aerial/2008/41073/m_4107355_sw_18_1_20080710.pdf



APPENDIX E – Parcel-Based Evaluation of Available Land

Appendix E
Parcel-Based Evaluation of Available Land

The conceptual project area has herein been divided into seven project areas (designated with letter A through H) for ease of discussion. The areas correspond to the five study segments as follows:

Segment 1	Area A: Riverside Drive/Bay Edge Court
Segment 2	Area B: Ash Creek Open Space Dike
Segment 3	Area C: Ash Creek Open Space – VE
	Area D: Ash Creek Open Space – AE
	Area E: Marina Entrance
	Area F: Marina Parking Adjacent to South Benson Road
Segment 4	Area G: Jennings Beach
Segment 5	Area H: Turney Road

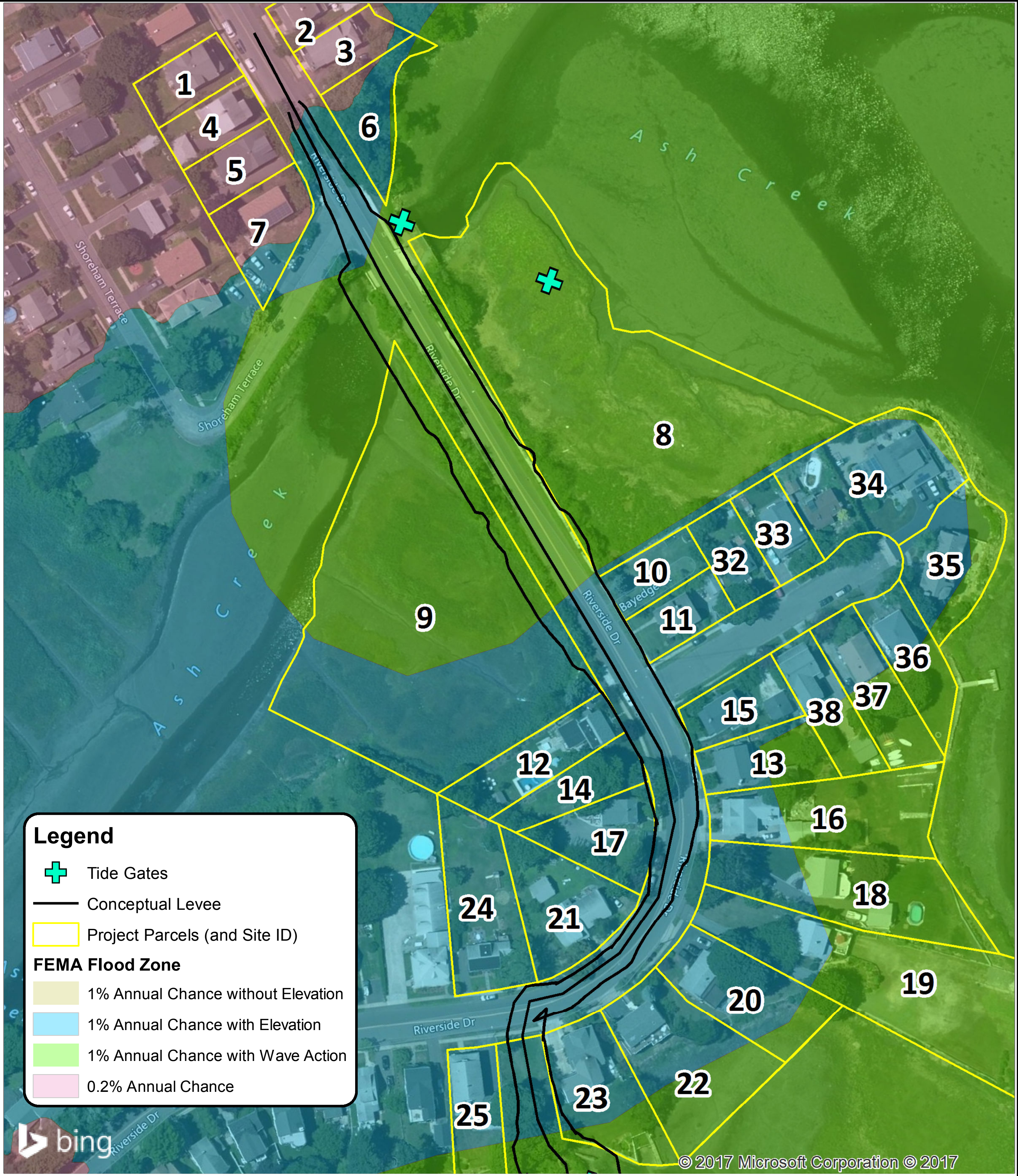
Area A – Riverside Drive/Bay Edge Court

Parcels 1, 2, 3, 4, 5, and 7 are privately owned and residentially developed. Some of the properties appear to be rentals. Parcel 1 does not have a driveway, so maintaining on-street parking would be important to the owner. The driveway at parcel 7 is located on Shoreham Terrace. Closing the loop of Shoreham Terrace at the levee may be an option if necessary for design, but Shoreham Terrace residents would no longer have access to the traffic light at the northern terminus of Riverside Drive in order to make assisted left turns onto Post Road. The nearby vacant parcel at 110 Shoreham Terrace is privately owned but may be suitable for construction staging.

Parcels 6 and 8 are owned by the Town of Fairfield, with parcel 8 containing the tide gates. Parcel 8 appears to have sufficient space for elevating the causeway. Limited area on both parcels may be available for construction staging. Shoreline protection projects may also be possible off parcel 8.

Parcel 9 is privately owned tidal marsh adjacent to Grasmere Brook. The majority of the property is at very low elevations (2 feet – NAVD88). Shoreline protection projects would likely provide little benefit. Construction staging or access does not appear feasible although construction access may be needed.

Parcels 10 through 25 are predominantly residential parcels. Parcels 12, 14, 17, 21, and 24 are located landward of Riverside Drive and are privately owned with the exception of parcel 14, which is owned by the Town of Fairfield. Parcel 25 is located landward of the dike at the Ash Creek Open Space area and is privately owned. Parcel 14 does not appear large enough to have a meaningful staging area. If a protection structure along Riverside Drive is pursued, construction easements may be needed from these residents depending on the design height of the protection structure.



SOURCE(S):
FEMA
ESRI

Area A: Riverside Drive/ Bay Edge Court

LOCATION:

Fairfield, CT

Riverside Drive/Ash Creek Resilience Study

MXD: Y:\1342-18\Maps\Appendix E Area A.mxd

Map By: MER
MMI#: 1342-18
Original: 08/30/2017
Revision: 8/31/2017
Scale: 1 inch equals 125 feet

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Parcels 10, 11, 13, 15, 16, 18, 19, 20, 22, 23, and 32 through 38 are located seaward of Riverside Drive. These parcels are all privately owned, single-family residential properties although parcel 10 is vacant and used as lawn. If a protection structure along Riverside Drive is pursued, construction easements may be needed from these residents depending on the design height of the protection structure. A seawall may also be possible from Riverside Drive through parcel 8 to parcels 34, 35, 36, 37, 16, 18, 19, 22, and 23. In this latter case, construction easements would certainly be needed from residents for the work.

Other coastal protection structures may also be possible fronting parcels 34, 35, 36, 37, 16, 18, 19, 20, 22, and 23. Finally, open area is available on parcel 19 that could potentially be utilized for construction staging. However, parcel 19 is small and may be impacted by wetlands, which suggests that a nearby town-owned parcel should be identified for staging.

Area B – Ash Creek Open Space Dike

The dike is owned by the Town of Fairfield and only supports pedestrian access. Some construction access is possible from Riverside Drive although it is likely that the majority of work would be completed from the marina side of the parcel as significant space is available for construction staging (and would reduce construction vehicle traffic on Riverside Drive).

Area C – Ash Creek Open Space VE

The Ash Creek Open Space area is owned by the Town of Fairfield and abuts the South Benson Marina. The marina is very busy during the summer such that construction access would be difficult during this period. Significant town-owned land is available along Ash Creek for consideration of a variety of shoreline protection projects although it is unlikely that such projects would be feasible in the marina proper. Area C includes the section of Ash Creek Open Space where the 1% annual chance flooding with wave action has been determined.

Area D – Ash Creek Open Space AE

Area D includes the section of Ash Creek Open Space behind Area C where the land is inundated by 1% annual chance flooding. The Ash Creek Open Space area is owned by the Town of Fairfield. It includes the town-owned and operated Benson Marina. The marina is very busy during the summer such that construction access would be difficult during this period. Significant town-owned land is available along Ash Creek for consideration of a variety of shoreline protection projects although it is unlikely that such projects would be feasible in the marina proper.

Area E – Fairfield Marina Entrance

The marina entrance area is owned by the Town of Fairfield and abuts town-owned land to the southwest along Oyster Creek. Similar to the above, it is unlikely that shoreline protection projects would be feasible in the marina. Minimal construction staging is available in this area, but this junction represents a critical thoroughfare to larger areas of the parcel and other potential project areas.

SOURCE(S):
FEMA
ESRI

Area B: Ash Creek Open Space Dike

LOCATION:
Fairfield, CT

N

Riverside Drive/Ash Creek Resilience Study

MXD: Y:\1342-18\Maps\Appendix E Area B.mxd

Map By: MER
MMI#: 1342-18
Original: 08/30/2017
Revision: 8/30/2017
Scale: 1 inch equals 125 feet

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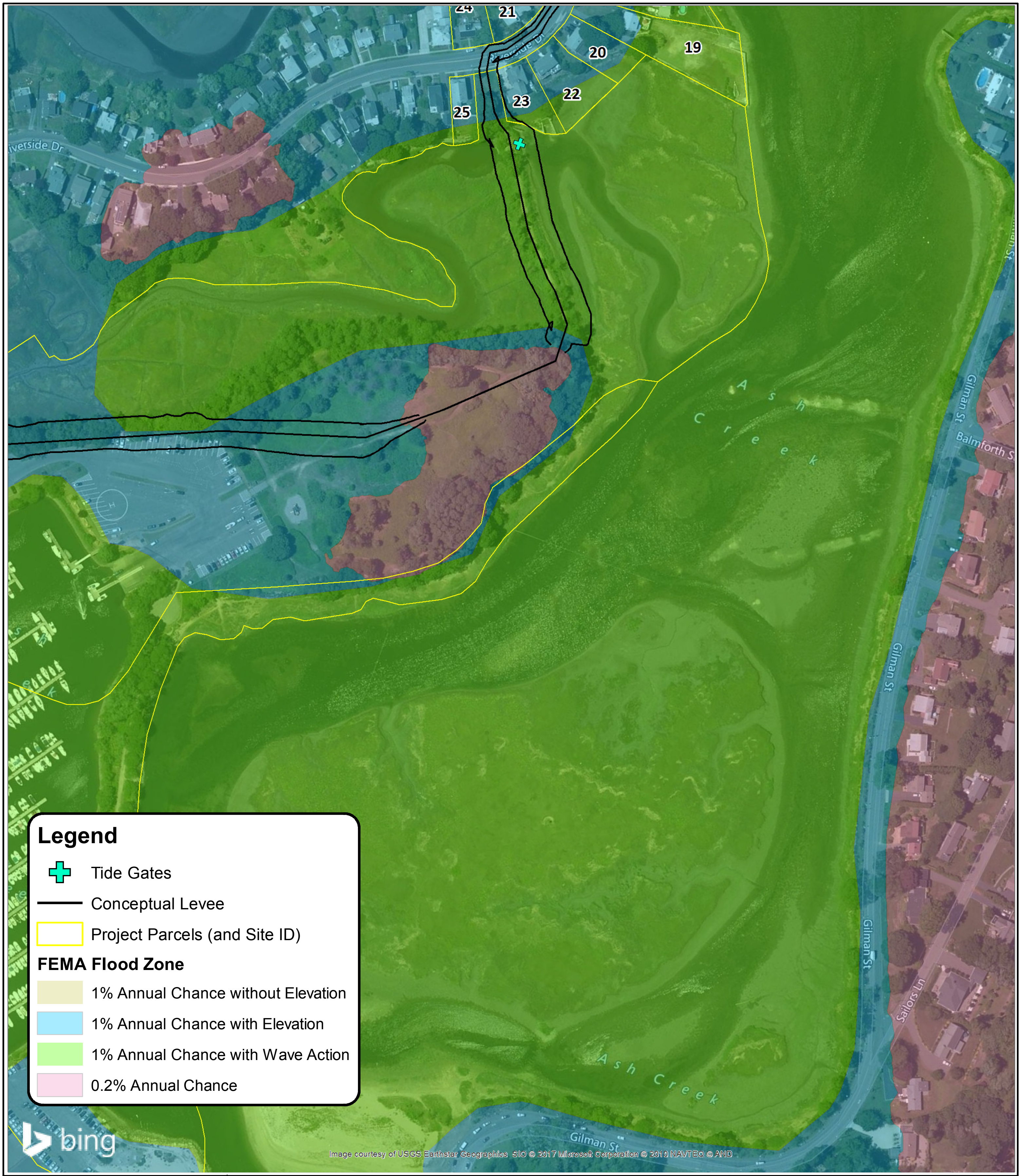

Image courtesy of USGS Earthstar Geographics SIO © 2017 Microsoft Corporation © 2010 NAVTEQ © AND

SOURCE(S):
FEMA
ESRI

Area C: Ash Creek Open Space VE

LOCATION:

Fairfield, CT

N

Riverside Drive/Ash Creek Resilience Study

MXD: Y:\1342-18\Maps\Appendix E Area C.mxd

Map By: MER
MMI#: 1342-18
Original: 08/30/2017
Revision: 8/30/2017
Scale: 1 inch equals 250 feet

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Image courtesy of USGS Earthstar Geographics SIO © 2017 Microsoft Corporation © 2010 NAVTEQ © AND

SOURCE(S):
FEMA
ESRI

Area D: Ash Creek Open Space AE

LOCATION:
Fairfield, CT

N

Riverside Drive/Ash Creek Resilience Study

MXD: Y:\1342-18\Maps\Appendix E Area D.mxd

Map By: MER
MMI#: 1342-18
Original: 08/30/2017
Revision: 8/30/2017
Scale: 1 inch equals 200 feet

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SOURCE(S):
FEMA
ESRI

Area E: Fairfield Marina Entrance

LOCATION:

Fairfield, CT

N

Riverside Drive/Ash Creek Resilience Study

MXD: Y:\1342-18\Maps\Appendix E Area E.mxd

Map By: MER
MMI#: 1342-18
Original: 08/30/2017
Revision: 8/30/2017
Scale: 1 inch equals 200 feet

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Depending on the type of project pursued, a construction easement may be needed from the owner of parcels 26 and 27. The single-family home on this parcel lies on the southwest side of Oyster Creek.

Area F – Fairfield Marina Parking Adjacent to South Benson Road

Most of this area is owned by the Town of Fairfield or is town-owned right-of-way. Currently, vehicle access into the marina skate park (parcel 30) does not appear to be possible from South Benson Road although it is noted that South Benson Road is the primary thoroughfare for traffic to Jennings Beach. A significant amount of marina parking is located in this area, and parcel 30 also has a large paved area suitable for construction staging. Shoreline protection projects may also be possible seaward of parcel 30. Parcels 28 and 29 are privately owned single-family homes located on South Benson Road. Construction easements may be needed from these properties if a protection project is constructed along South Benson Road. Parcel 28 is located at the corner of Craig Court, a neighborhood road that feeds into South Benson Road. It is notable that a portion of the Jennings Beach parcel extends behind parcels 28 and 29 to Craig Court.

Area G – Jennings Beach

This recreational area is owned by the Town of Fairfield. Shoreline protection projects may not be feasible along most of the beach as they may interfere with existing recreational needs. Significant area is available for construction staging particularly during nonsummer months. A construction easement may be needed from the Fairfield Beach Club (parcel 31) in relation to any work done near the terminus of Beach Road.

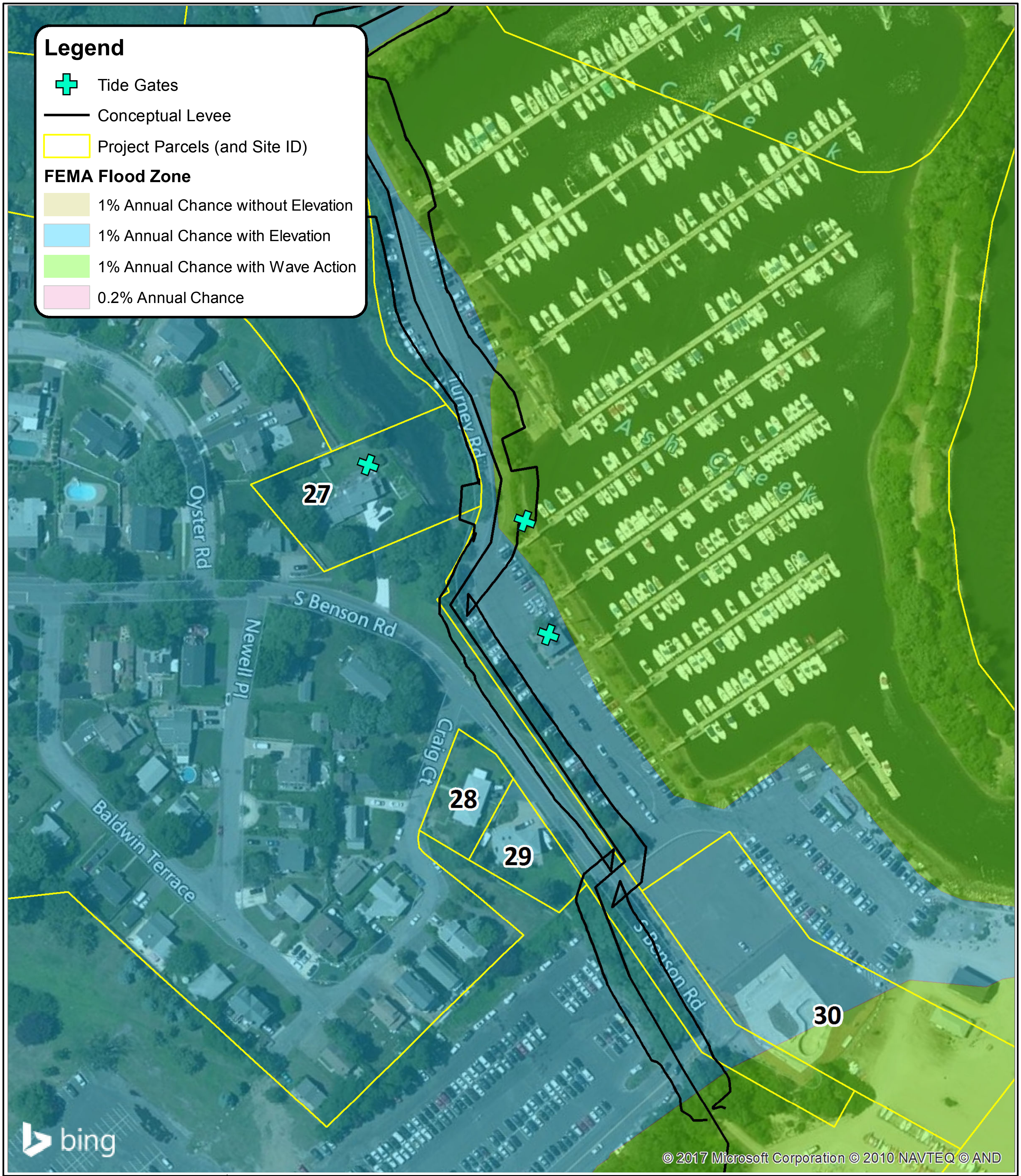
Area H – Turney Road

The entire Turney Road corridor north of the marina is comprised of private properties lining the east and west sides of the road. The total number of private properties is approximately 25. Unlike the other areas reviewed in this appendix, private property concerns will be significant whether the impacts are temporary or permanent. If a protection structure along Turney Road is pursued by elevating the road, construction easements may be needed from these residents depending on the design height of the protection structure. The impacts increase with increasing height of the road, from minimal at the northern end of the segment where existing grade is higher to more significant at the southern end where grade is lower.

Conclusion

The Town of Fairfield appears to have much of the land available for development of flood protection system components, but several private properties on Riverside Drive and about 25 on Turney Road would be impacted by driveway and access modifications related to a berm, levee, or elevated roadway system.

1342-18-11-au317-rpt (appendix e).docx



SOURCE(S):
FEMA
ESRI

Area F: Fairfield Marina Parking
Adjacent to South Benson Road

LOCATION:
Fairfield, CT

Riverside Drive/Ash Creek Resilience Study

MXD: Y:\1342-18\Maps\Appendix E Area F.mxd

Map By: MER
MMI#: 1342-18
Original: 08/30/2017
Revision: 8/30/2017
Scale: 1 inch equals 150 feet

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SOURCE(S):
FEMA
ESRI

Area G: Jennings Beach

LOCATION:

Fairfield, CT

N

Riverside Drive/Ash Creek Resilience Study

MXD: Y:\1342-18\Maps\Appendix E Area G.mxd

Map By: MER
MMI#: 1342-18
Original: 08/30/2017
Revision: 8/30/2017
Scale: 1 inch equals 200 feet

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APPENDIX F – Stamford Hurricane Barrier

SOURCE:
1. CITY OF STAMFORD, CT.

0 250 500 1,000
SCALE, FEET

STAMFORD HURRICANE PROTECTION BARRIER
FEMA ACCREDITATION
STAMFORD, CONNECTICUT

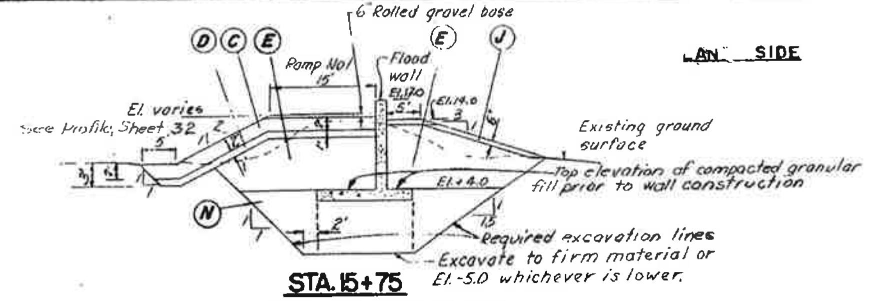
CITY OF STAMFORD WPCA
STAMFORD, CONNECTICUT

GEI Consultants

SITE LOCATION PLAN

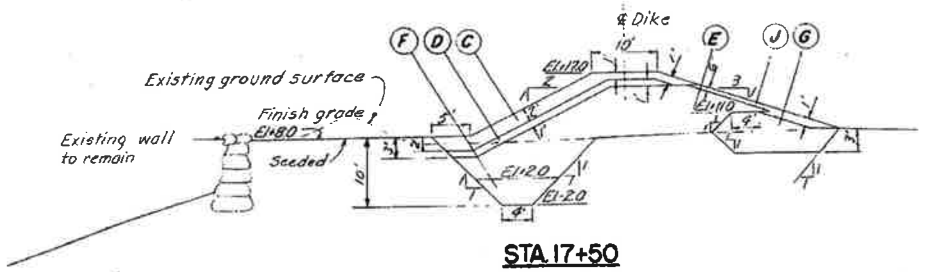
Proj. 083460-2 | March 2010 | Figure 1

J:\Projects\StamfordHurricaneBarrier\Phase2\site_location_plan.mxd



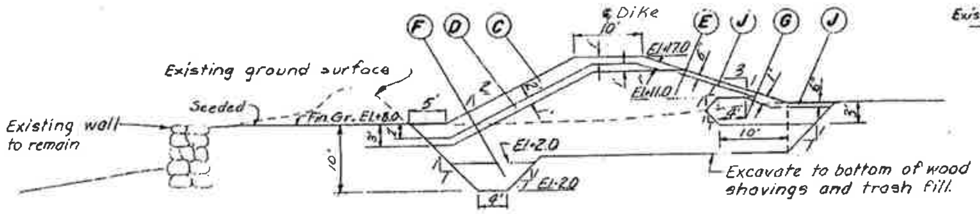
STA. 15+75

TYPICAL FROM STA. 15+08 TO 15+98
TRANSITION FROM STA. 15+98 TO 16+28



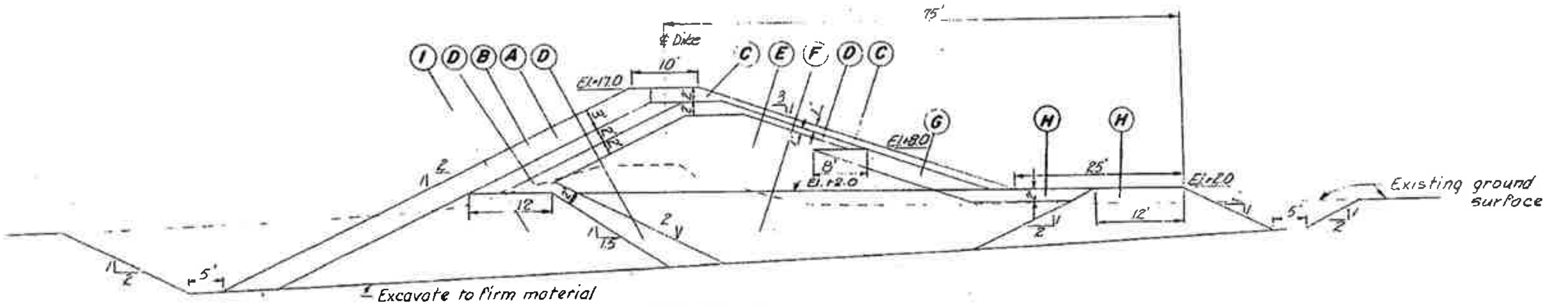
STA. 17+50

TYPICAL IN REACHES OF NON-TRASH FILL BETWEEN STA. 16+28 TO 21+50
TRANSITION FROM STA. 21+50 TO 22+00



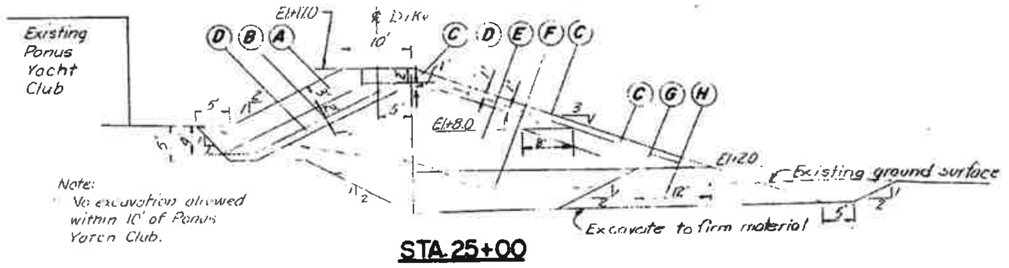
STA. 21+25

TYPICAL IN REACHES OF EXISTING TRASH FILL BETWEEN STA. 16+28 TO 21+50
TRANSITION FROM STA. 21+50 TO 22+00



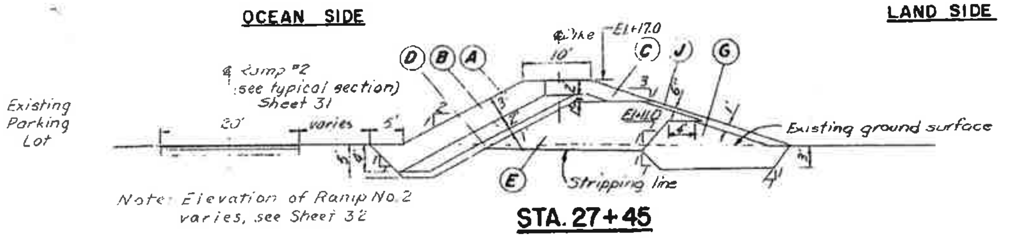
STA. 22+25

TYPICAL FROM STA. 22+00 TO 23+67
TRANSITION FROM 23+67 TO 24+91



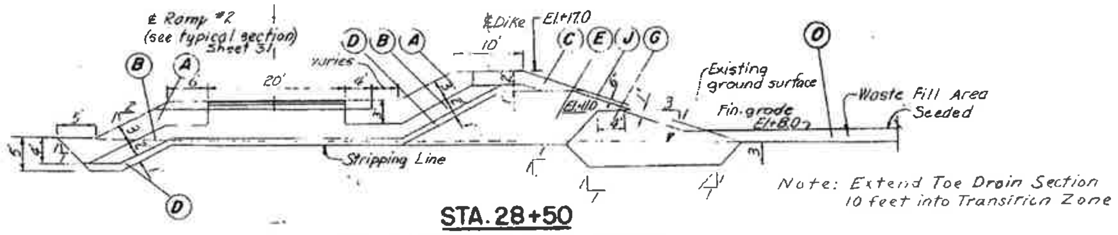
STA. 25+00

TYPICAL FROM STA. 24+91 TO 26+75
TRANSITION FROM STA. 26+75 TO 27+00



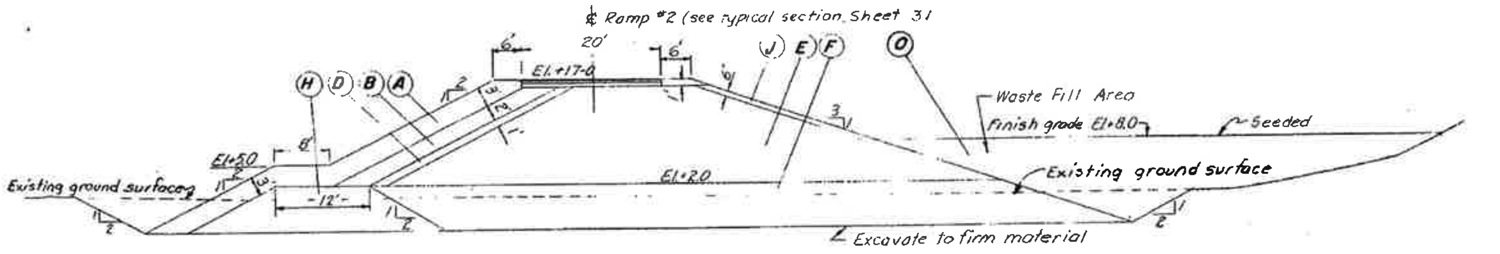
STA. 27+45

TYPICAL FROM STA. 27+00 TO 27+45
TRANSITION FROM STA. 27+45 TO 27+70



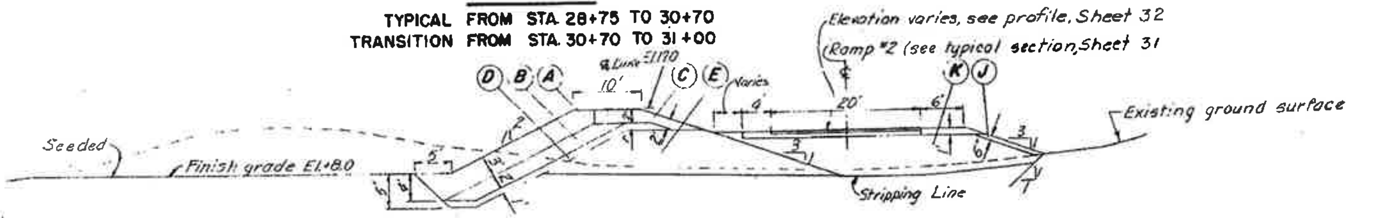
STA. 28+50

TYPICAL FROM STA. 27+70 TO 28+50
TRANSITION FROM STA. 28+50 TO 28+75



STA. 29+70

TYPICAL FROM STA. 28+75 TO 30+70
TRANSITION FROM STA. 30+70 TO 31+00



STA. 31+10

TYPICAL FROM STA. 31+00 TO 31+25

GRAPHIC SCALE
1"=10' 10' 0 10' 20'

NOTES

1. Compaction of granular fill shall be constructed to El. +4.0 before starting construction of the wall footing.
2. The initial layer of fill material on the base of a concrete wall shall be 12" thick before compaction.
3. Fill on both sides of walls shall be constructed concurrently with top elevation not varying more than 2 feet.
4. Special compaction required adjacent to walls, see Section 5 of specifications.
5. Strip all excavation areas from which Random Fill material is to be obtained.

MATERIALS LEGEND

DESIGNATION	TYPE	ITEM NO.
(A)	Cover Stone, Quarry Run(450 lbs to 700 lbs.	⟨14⟩
(B)	Bedding Stone, Quarry Run (2" to 150 lbs.)	⟨15⟩
(C)	Protection Stone, Quarry Run (2" to 150 lbs.)	⟨15⟩
(D)	Gravel Bedding	⟨13⟩
(E)	Compacted Impervious Fill	⟨8⟩
(F)	Dumped Impervious Fill	⟨9⟩
(G)	Compacted Gravel Fill	△ ⟨10⟩
(H)	Dumped Gravel Fill	⟨10⟩
(I)	Rock Fill, Quarry Run	⟨16⟩
(J)	Topsoil and Seed	⟨69⟩⟨70⟩⟨71⟩
(K)	Compacted Random Fill	⟨5⟩
(L)	Uncompacted Random Fill	⟨5⟩
(M)	Dumped Random Fill	⟨5⟩
(N)	Compacted Granular Fill	⟨11⟩
(O)	Waste Fill	⟨5⟩
	Unclassified Excavation	⟨5⟩
	Rock Excavation	⟨6⟩

SAFETY PAYS

REVISION	DATE	DESCRIPTION	BY
△2	12-22-64	Spec. No. revised.	
△1	12-3-64	Item No. changed.	

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY M.Z. | DR. BY D.L.W. | CK. BY M.Z.

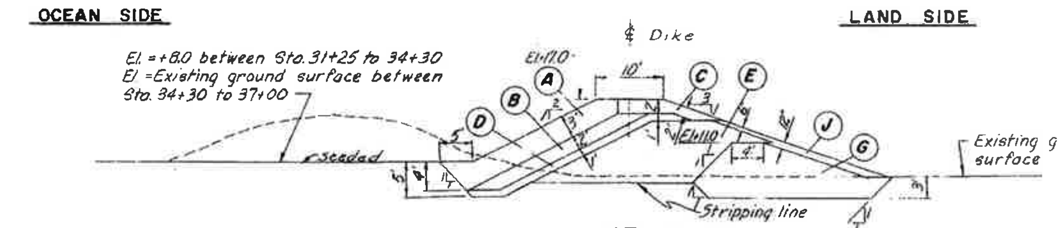
SUBMITTED: CHIEF, LAYOUT SECTION
REVIEWED: PROJECT ENGINEER
SUBMITTED: Peter A. Murphy CHIEF, DESIGN BRANCH
APPROVED: CHIEF, ENGINEERING DIVISION

STAMFORD HURRICANE BARRIER
EMBANKMENTS
WEST BRANCH DIKE SECTIONS
STA. 15+08 TO STA. 31+25

STAMFORD CONNECTICUT

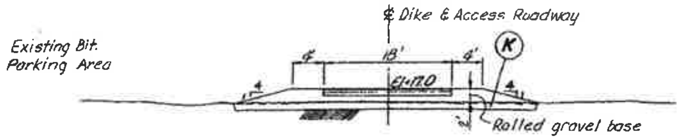
DATE APRIL 1964

SCALE 1" = 10'
SPEC. NO. CIV. ENG. 19-016-65-5
DRAWING NUMBER △2
STA-1
SHEET 17



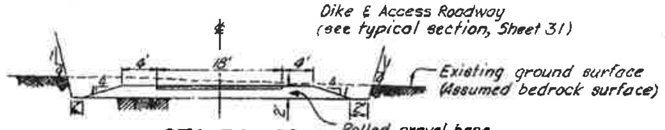
STA. 31+50

1. Typical from Sta. 31+25 to 31+80
2. Typical from Sta. 32+50 to 36+70 except omit compacted gravel fill zone between Sta. 35+00 to 36+70



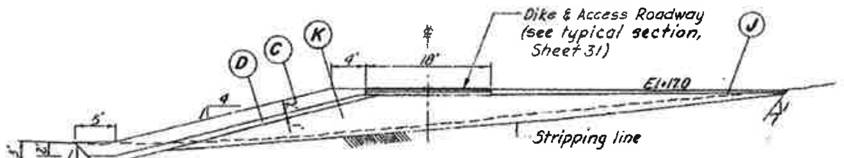
STA. 38+00

TYPICAL FROM STA. 36+70 TO 39+50



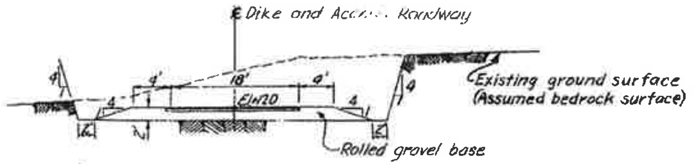
STA. 39+60

TYPICAL FROM STA. 39+50 TO 41+50



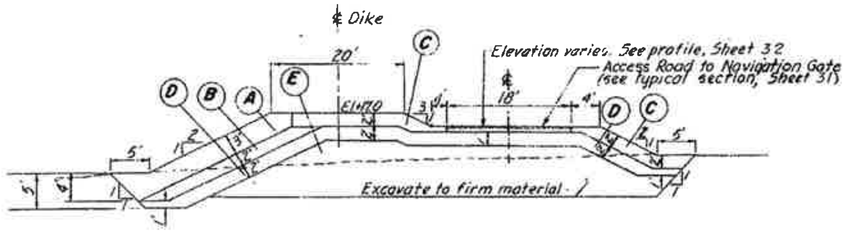
STA. 42+20

TYPICAL FROM STA. 41+50 TO 42+85



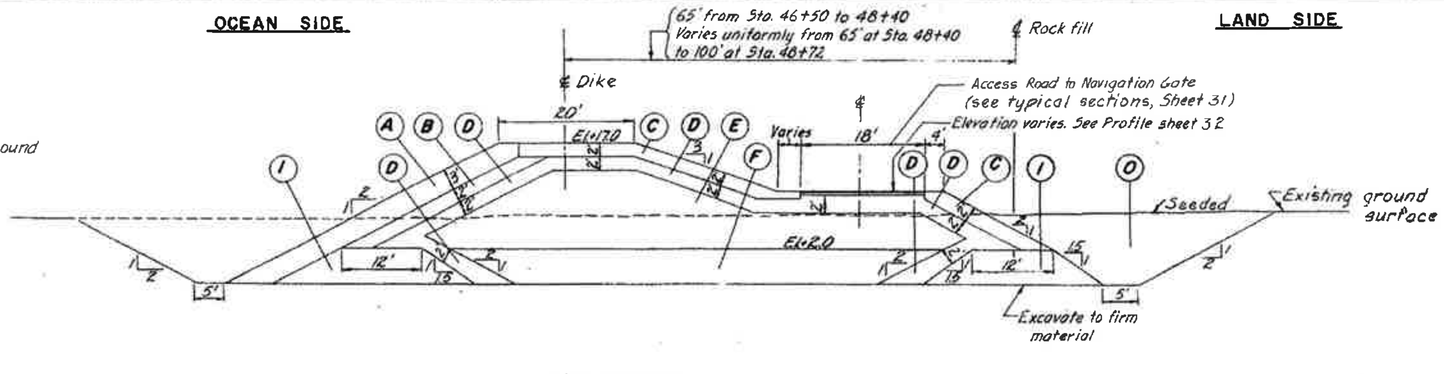
STA. 44+30

TYPICAL FROM STA. 42+85 TO 45+00



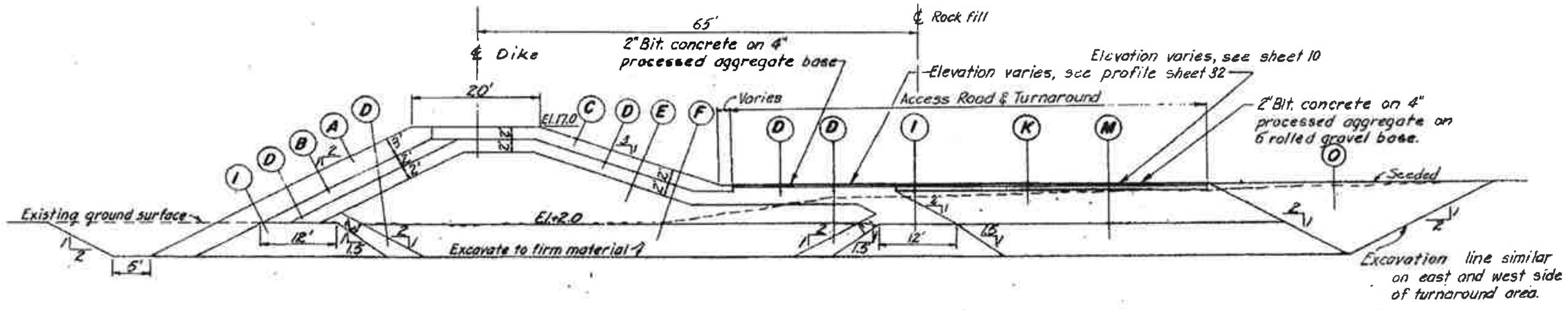
STA. 45+70

TYPICAL FROM STA. 45+00 TO 46+00
TRANSITION FROM STA. 46+00 TO 46+50



STA. 47+00

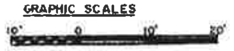
TYPICAL FROM STA. 46+50 TO 47+74
TYPICAL FROM STA. 47+92 TO 48+72



STA. 47+83

TYPICAL FROM STA. 47+74 TO 47+92

Notes
1. Strip all excavation areas from which random fill material is to be obtained.



REVISION	DATE	DESCRIPTION	BY
⚠	[illegible]	Note and spec. no. revised.	

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY M.Z. | DR. BY E.A. | CK. BY M.J.

SUBMITTED:
CHIEF, LAYOUT SECTION

REVIEWED:
H. Martin
PROJECT ENGINEER

APPROVED:
Peter A. Murphy
CHIEF, DESIGN BRANCH

STAMFORD HURRICANE BARRIER
EMBANKMENTS
WEST BRANCH AND EAST BRANCH DIKE SECTIONS
STA 31 + 25 TO STA. 47 + 92

STAMFORD CONNECTICUT

APPROVED John Wm. Leslie
CHIEF, ENGINEERING DIVISION

DATE APRIL 1964

SCALE: 1" = 10'
SPEC. NO. CIV. ENG. 19-016-65-5

DRAWING NUMBER ⚠
STA - 1

SHEET 18

⚠ ⚠

APPENDIX G – Establishment of Design Criteria

Appendix G
Establishment of Design Criteria

Review of FEMA Flood Insurance Study (FIS)

The primary purpose of Federal Emergency Management Agency (FEMA) FIS Coastal Study Transects is to provide detailed information to help coastal engineers and planners understand the predicted extent and force of coastal floodwaters. There are two FEMA FIS Coastal Study Transects that flank the study area: Transect 43 and Transect 44. Transect 43 is located just north of Shoal Point along Jennings Beach. Transect 44 is located east of Ash Creek, adjacent to St. Mary's Point in the Black Rock section of Bridgeport. Table 1 presents the various water elevations associated with each transect.

TABLE 1
FEMA Transects Flanking the Study Area

Flooding Source and Transect Number	**Stillwater Elevation**				**Total Water Level**	**Zone**	**Base Flood Elevation (NAVD88)**
	10-percent annual chance	2-percent annual chance	1-percent annual chance	0.2-percent annual chance	1-percent annual chance		
Transect 43	7.9	9.5	10.1	11.5	11.1	AE	11-13
						VE	13-17
Transect 44	7.9	9.4	10.0	11.4	12.9	AE	14-15
						VE	15-19

Transect 43

Transect 43 has a stillwater 1% annual chance elevation of 10.1 feet (NAVD88). Transect 43 has a wave setup depth of 1.03 feet, and the 1% total water level is equal to 11.1 feet. The significant wave height is 12.85 feet, and the significant period for that is 5.92 seconds. The control height is 20.56 feet while the maximum 1% wave crest is at an elevation of 17 feet. The V Zone mapping method for this transect is based on breaking wave height. The designated AE elevation is 11 feet, and the designated VE elevation is 13 feet.

Transect 44

Transect 44 has a stillwater 1% annual chance elevation of 10.0 feet (NAVD88). Transect 44 has a wave setup depth of 3.18 feet, and the 1% total water level is equal to 12.9 feet. The significant wave height is 12.20 feet, and the significant period for that is 5.72 seconds. The control height is 19.52 feet while the maximum 1% wave crest is at an elevation of 19 feet. The V Zone mapping method for this transect below is based on runup. The designated AE elevation is 13 feet, and the designated VE elevation is 15 feet.

While this transect should only be applicable to the Black Rock shoreline, it appears to have been used to assign flood risks in the Ash Creek estuary where the designated VE elevation is 15 feet despite the protection from waves in the open Long Island Sound.

Review of NACCS Data

The North Atlantic Coast Comprehensive Study (NACCS) was authorized by the Disaster Relief Act of 2013 on January 29, 2013. The study area included the Atlantic Ocean coastline, back-bay shorelines, and estuaries within portions of the United States Army Corps of Engineers (USACE) North Atlantic Division. As part of the NACCS analysis, the Advanced Circulation (ADCIRC) modeled prediction of storm surge and flooding water surface elevations. The NACCS data can be extracted for different points of interest.

TABLE 2
NACCS Water Level Data

Storm Surge	**10-Year**	**50-Year**	**100-Year**	**500-Year**
Ash Creek	6.94	8.97	9.86	12.91
Jennings Beach	6.84	8.88	9.76	12.78
Surge + Tide	**10-Year**	**50-Year**	**100-Year**	**500-Year**
Ash Creek	8.94	10.78	11.80	15.08
Jennings Beach	8.81	10.61	11.53	14.68

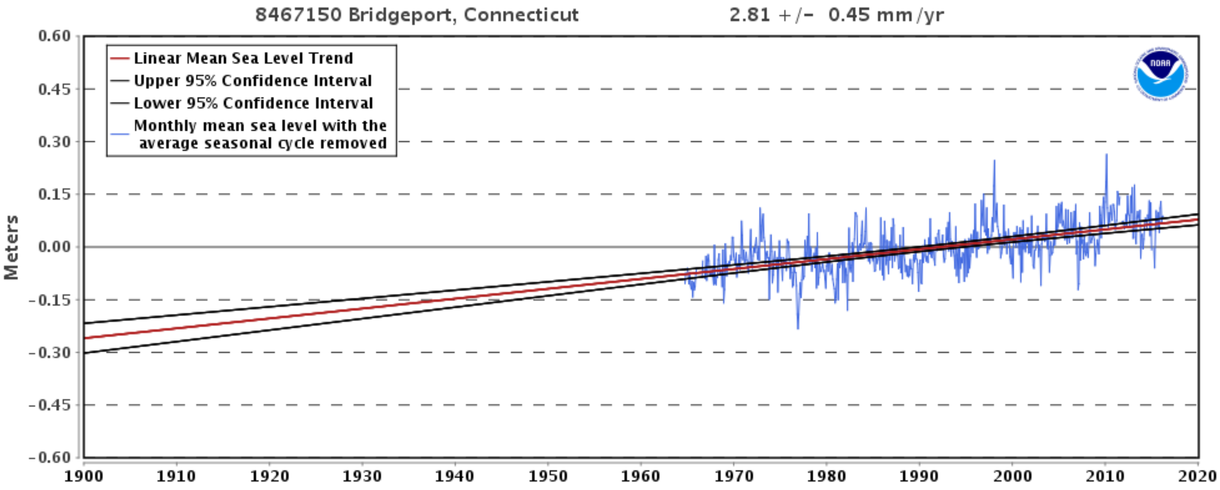
Whereas the water levels from the FIS were based on the results of a local tide gauge analysis, the NACCS water levels were based on simulations of tropical and extratropical storms using a coupled wave and surge model. Both studies include a wave setup component at the 1% annual chance storm water level. For Fairfield, water elevations from the NACCS are generally similar to those in the FIS.

Tide Gauge Analysis

Two tide gauges were operated by the National Oceanic and Atmospheric Administration (NOAA) near the study area. One gauge to the west was installed in Southport Harbor and removed shortly thereafter. A gauge to the east of the study area was installed in Black Rock Harbor and removed shortly thereafter. Based on interpolations of these data, the average maximum elevation of high tide (Mean Higher High Water, or MHHW) is 3.54 feet (NAVD88), and the average elevation of high tide (Mean High Water, or MHW) is 3.20 feet for the study area.

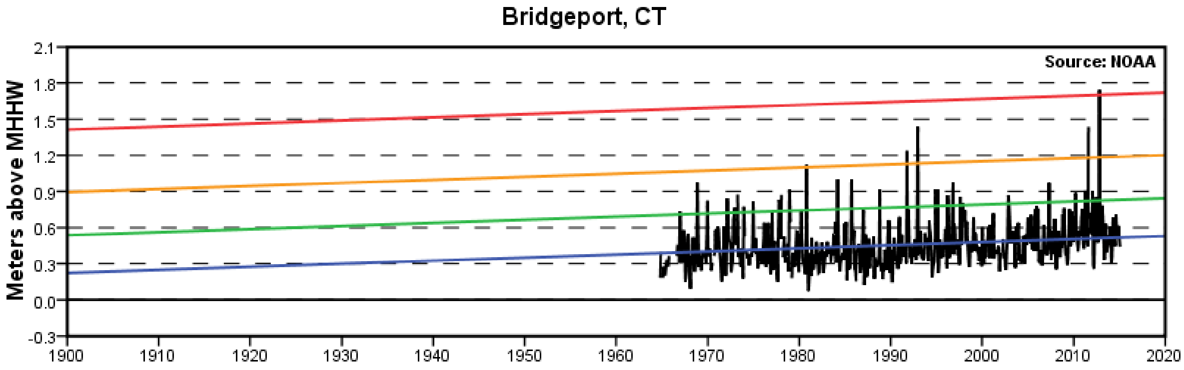
The nearest *long-term* operational gauge to Fairfield is the tide gauge in Bridgeport. Based on tide gauge data collected at that station from 1964 to 2015, Mean Sea Level (MSL) has been increasing at a rate of 2.81 millimeters (0.11 inches) per year, which is equivalent to a rise of 0.92 feet over 100 years (Figure 1).

Figure 1
Mean Sea Level Trend at Bridgeport Tide Gauge



Based on the tide gauge data collected at the Bridgeport station between 1964 and 2015, extreme water levels have been plotted in Figure 2.

Figure 2
Extreme Water Levels at Bridgeport Tide Gauge



The plots show the monthly highest and lowest water levels with the 1%, 10%, 50%, and 99% annual exceedance probability levels in red, orange, green, and blue, respectively. *On average*, the 1% level (red) will be exceeded in only 1 year per century, the 10% level (orange) will be exceeded in 10 years per century, and the 50% level (green) will be exceeded in 50 years per century. The 99% level (blue) will be exceeded in all but 1 year per century although it could be exceeded more than once in other years. It is important to note that any storm could occur in any given year.

Top 5 Highest Water Levels at Bridgeport Gauge since 1964	Elevation (NAVD88)
10/30/12 (Sandy)	9.19
8/28/11 (Irene)	8.23
12/11/92 (Nor'easter)	8.17
10/31/91 ("Perfect Storm")	7.49
10/25/80	7.09

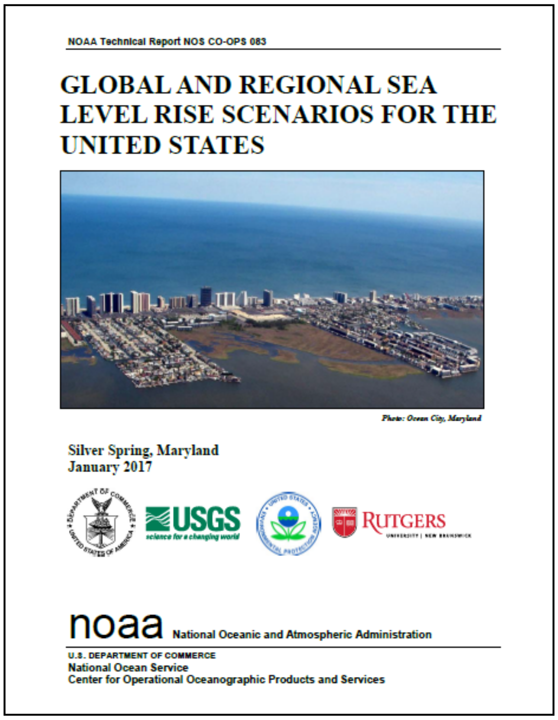
The extreme water levels figure reveals that five storms have surpassed the 10% annual exceedance probability levels, which include the Nor'easter of 1992 and Hurricanes Irene and Sandy. According to the plot, Hurricane Sandy surpassed the 1% annual exceedance probability level for the location of this gauge.

Generation of Future Conditions

Sea Level Rise Projections

In its landmark 2001 report, the Intergovernmental Panel on Climate Change (IPCC) projected that global sea level may rise 9 to 88 centimeters (0.30 - 2.89 feet) during the 21st century. According to the most recent update, *Fifth Assessment Report of the Intergovernmental Panel on Climate Change, 2013*, these predictions have been revised to a rise of **28 to 98 centimeters (0.9 to 3.2 feet)** by 2100 relative to 1986-2005 levels.

The January 2017 NOAA Technical Report titled *Global and Regional Sea Level Rise Scenarios for the United States* (pictured to the right) builds on and updates the December 2012 report authored by NOAA and the USACE and is the current reference for sea level rise planning in the United States. The report's updated global mean sea level range for the year 2100 is between **0.3 and 2.5 meters (1.0 to 8.2 feet)** above current levels.



NOAA Technical Report NOS CO-OPS 083

GLOBAL AND REGIONAL SEA LEVEL RISE SCENARIOS FOR THE UNITED STATES

Photo: Ocean City, Maryland

Silver Spring, Maryland
January 2017

noaa National Oceanic and Atmospheric Administration

U.S. DEPARTMENT OF COMMERCE
National Ocean Service
Center for Operational Oceanographic Products and Services

Sea level rise is not consistent around the world and is affected by local variations in currents, temperature, and changes in land surface elevation. It has long been expected that the rate of sea level rise in Connecticut will be slightly higher than the global projections due to the effects of regional subsidence. However, more recent studies have asserted that changes in ocean circulation will increase the relative sea level rise along the Atlantic coast even more.

The NOAA report finds that sea level along the Northeast Atlantic Coast is projected to be greater than the global average for almost all future scenarios. In Connecticut specifically, sea level rise is projected to be 0 to greater than 1 meter (3.3 feet) higher than the rise in global mean sea level.

Relative Sea Level on the Connecticut Coast is Projected to Rise
1-8 feet
Above 2000 Levels by 2100.

Projections of the rate and extent of sea level rise in the future were used to determine Fairfield's risks to future coastal conditions. Uncertainties exist with regard to multiple factors that contribute to sea level change, including the rate of change in the land surface elevation, the extent and rate of glacial melting, and changes in human development and greenhouse-gas emission patterns. For this reason, multiple projections are available.

The USACE hosts a sea level rise web tool ("Sea-Level Change Curve Calculator") that provides sea level projections using both USACE and NOAA projections at existing tidal gauges. The most recent version (2015.46) was used for this assessment; *note that projections developed for the 2017 NOAA technical report have not yet been incorporated into this tool, and the curves presented here reflect the projections of the previous report (2012).*

For planning purposes, it is advisable to use medium or high sea level rise projections such that a community will be better protected against worst-case scenarios. The nearest operating gauge to Fairfield is the tide gauge in Bridgeport. Calculated sea level rise for this gauge is depicted in the following table and graph. In each case, the base year is 1992. Rates are as follows:

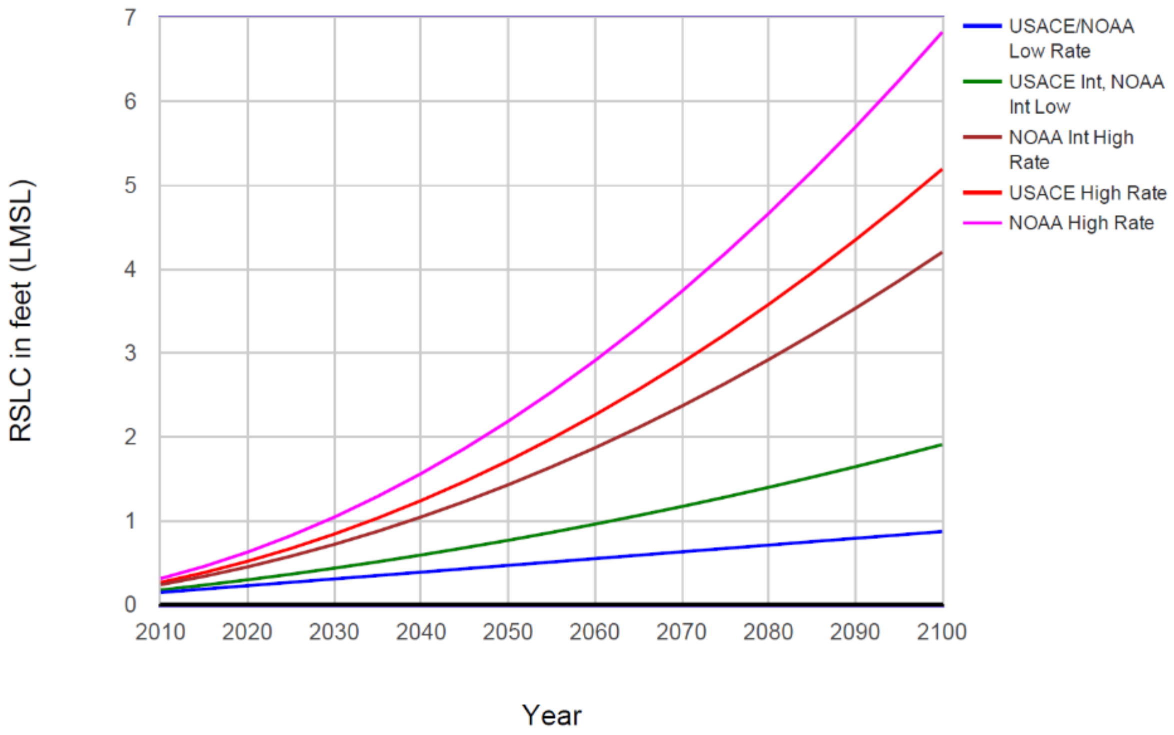
- ***NOAA Low and USACE Low***: Historic rate of sea level change is the rate of change moving forward.
- ***NOAA Intermediate Low and USACE Intermediate***: Ocean warming and the local rate of vertical land movement determine sea level change rate.
- ***NOAA Intermediate High***: the projected rate assuming both ocean warming and a moderate rate of melting of the arctic ice sheets
- ***USACE High***: considers both the most recent IPCC projections and modified National Research Council projections with the local rate of vertical land movement added
- ***NOAA High***: rate based on heating of the oceans and a maximum loss of the ice caps

Below are the projections (based on model outcomes) of relative sea level change for the Bridgeport, Connecticut, tide gauge from 2015 to 2100. The year 2015 was selected as the starting point to facilitate generation of projections at 5-year intervals. Sea level has been rising at a regional rate of 0.0084 feet per year. The slopes of the lines in Figure 3 are due to the equations associated with each projection; in reality, the rising elevation of the sea surface will not follow a smooth line.

TABLE 3
Estimated Relative Sea Level Change from 2015 to 2100 at Bridgeport Tide Gauge

Gauge 8467150, Bridgeport, Connecticut NOAA's Regional Rate: 0.00840 feet per year							
Year	**NOAA Low**	**USACE Low**	**NOAA Int Low**	**USACE Int**	**NOAA Int High**	**USACE High**	**NOAA High**
2015	0	0	0	0	0	0	0
2020	0.04	0.04	0.07	0.07	0.12	0.14	0.17
2030	0.13	0.13	0.21	0.21	0.39	0.47	0.59
2040	0.21	0.21	0.37	0.37	0.72	0.87	1.12
2050	0.29	0.29	0.55	0.55	1.1	1.35	1.74
2060	0.38	0.38	0.74	0.74	1.55	1.9	2.47
2070	0.46	0.46	0.96	0.96	2.05	2.52	3.3
2080	0.55	0.55	1.19	1.19	2.61	3.22	4.23
2090	0.63	0.63	1.44	1.44	3.22	3.99	5.27
2100	0.71	0.71	1.7	1.7	3.9	4.84	6.4

Figure 3
Relative Sea Level Change Projections at Bridgeport Tide Gauge



The ranges calculated in Figure 3 and Table 2 are quite wide, but even the low projections show that sea level rise will continue throughout the current century. The United States Geological Survey (USGS) has demonstrated that sea levels along the mid-Atlantic and northeast coasts of the United States are already rising three to four times faster than the global average since 1990.

Specific Projections

Based on sea level rise projections for the Bridgeport tide gauge, sea levels projected for the study area were calculated using the MHW as a starting elevation. Sea level rise projections were calculated to help establish quantitative design criteria to mitigate flooding.

TABLE 4
Estimated MHW Change from 2015 to 2100

Estimated MHW Change – Gauge 8467150, Bridgeport, Connecticut NOAA's Regional Rate: 0.00840 feet per year Values expressed in feet relative to the 1992 Local Mean Sea Level (LMSL)							
Year	**NOAA Low**	**USACE Low**	**NOAA Int Low**	**USACE Int**	**NOAA Int High**	**USACE High**	**NOAA High**
2015	3.2	3.2	3.2	3.2	3.2	3.2	3.2
2020	3.24	3.24	3.27	3.27	3.32	3.34	3.37
2030	3.33	3.33	3.41	3.41	3.59	3.67	3.79
2040	3.41	3.41	3.57	3.57	3.92	4.07	4.32
2050	3.49	3.49	3.75	3.75	4.3	4.55	4.94
2060	3.58	3.58	3.94	3.94	4.75	5.1	5.67
2070	3.66	3.66	4.16	4.16	5.25	5.72	6.5
2080	3.75	3.75	4.39	4.39	5.81	6.42	7.43
2090	3.83	3.83	4.64	4.64	6.42	7.19	8.47
2100	3.91	3.91	4.9	4.9	7.1	8.04	9.6

Design scenarios for future combinations of sea level rise and storm surges, with conditions and water surface elevations, are described for three planning horizons: 30 years, 50 years, and 100 years. For purposes of conceptual design and available data, this represents design scenarios based on 2060, 2070, and 2100. Design scenarios will help determine how projects can be phased over time.

2050 Planning Horizon

Table 5 presents potential flood elevations for the five sets of projections in the 2050 planning horizon calculated by adding the incremental increases to the MHW, MHHW, and FEMA water surface elevations.

TABLE 5
Flood Elevations by FEMA Transect for 2050 Planning Horizon

Year	Projection	Source	Transect #	MHW	MHHW	Stillwater Elevation, 2015 (NAVD88)				Total Water Level	Max Wave Crest
						10% annual chance	2% annual chance	1% annual chance	0.2% annual chance	1% annual chance	
2015		**FEMA**	**43**	**3.2**	**3.54**	**7.9**	**9.5**	**10.1**	**11.5**	**11.1**	**17**
		FEMA	**44**			**7.9**	**9.4**	**10**	**11.4**	**12.9**	**19**
2050	**NOAA Low** **USACE Low**	FEMA	43	3.49	3.83	8.19	9.79	10.39	11.79	11.39	17.29
		FEMA	44			8.19	9.69	10.29	11.69	13.19	19.29
	NOAA Int Low **USACE Int**	FEMA	43	3.75	4.09	8.45	10.05	10.65	12.05	11.65	17.55
		FEMA	44			8.45	9.95	10.55	11.95	13.45	19.55
	NOAA Int High	FEMA	43	4.3	4.64	9	10.6	11.2	12.6	12.2	18.1
		FEMA	44			9	10.5	11.1	12.5	14	20.1
	USACE High	FEMA	43	4.55	4.89	9.25	10.85	11.45	12.85	12.45	18.35
		FEMA	44			9.25	10.75	11.35	12.75	14.25	20.35
	NOAA High	FEMA	43	4.94	5.28	9.64	11.24	11.84	13.24	12.84	18.74
		FEMA	44			9.64	11.14	11.74	13.14	14.64	20.74

It is important to note that these figures were generated by simply adding the increments of sea level rise to current levels. In reality, the fundamental forces contributing to floods are changing, and therefore, the "starting point" elevations for the 10%, 2%, 1%, and 0.2% events will change.

In the 2050 planning horizon, Transect 43 will increase from 10.1 feet (NAVD88) for a 1% annual chance storm event under current conditions to 10.39 feet with NOAA and USACE low sea level rise projections and to 11.84 and 11.45 feet with NOAA and USACE high sea level rise projections, respectively. Transect 44 will increase from 10.0 feet (NAVD88) for a 1% annual chance storm event under current conditions to 10.29 feet with NOAA and USACE low sea level rise projections and to 11.74 and 11.35 feet with NOAA and USACE high sea level rise projections, respectively. Additionally, the maximum 1% wave crest is at an elevation of 17 feet and 19 feet under current conditions for Transects 43 and 44, respectively. Combined with sea level rise projections for 2050, it is anticipated that the maximum 1% wave crest for Transect 43 will increase to as much as 18.74 and 18.35 feet under NOAA and USACE high sea level rise projections, respectively. It is anticipated that the maximum 1% wave crest for Transect 44 will increase to as much as 20.74 and 20.35 feet under NOAA and USACE high sea level rise projections, respectively. For more information, please refer to the table below.

2070 Planning Horizon

Table 6 presents potential flood elevations for the five sets of projections in the 2070 planning horizon calculated by adding the incremental increases to the MHW, MHHW, and FEMA water surface elevations.

TABLE 6
Flood Elevations by FEMA Transect for 2070 Planning Horizon

Year	Projection	Source	Transect #	MHW	MHHW	Stillwater Elevation, 2015 (NAVD88)				Total Water Level	Max Wave Crest
						10% annual chance	2% annual chance	1% annual chance	0.2% annual chance	1% annual chance	
2015		FEMA	43	3.2	3.54	7.9	9.5	10.1	11.5	11.1	17
		FEMA	44			7.9	9.4	10	11.4	12.9	19
2070	NOAA Low	FEMA	43	3.66	4	8.36	9.96	10.56	11.96	11.56	17.46
	USACE Low	FEMA	44			8.36	9.86	10.46	11.86	13.36	19.46
	NOAA Int Low	FEMA	43	4.16	4.5	8.86	10.46	11.06	12.46	12.06	17.96
	USACE Int	FEMA	44			8.86	10.36	10.96	12.36	13.86	19.96
	NOAA Int High	FEMA	43	5.25	5.59	9.95	11.55	12.15	13.55	13.15	19.05
		FEMA	44			9.95	11.45	12.05	13.45	14.95	21.05
	USACE High	FEMA	43	5.72	6.06	10.42	12.02	12.62	14.02	13.62	19.52
		FEMA	44			10.42	11.92	12.52	13.92	15.42	21.52
	NOAA High	FEMA	43	6.5	6.84	11.2	12.8	13.4	14.8	14.4	20.3
		FEMA	44			11.2	12.7	13.3	14.7	16.2	22.3

In the 2070 planning horizon, Transect 43 will increase from 10.1 feet (NAVD88) for a 1% annual chance storm event under current conditions to 10.56 feet with NOAA and USACE low sea level rise projections and to 13.4 and 12.62 feet with NOAA and USACE high sea level rise projections, respectively. Transect 44 will increase from 10.0 feet (NAVD88) for a 1% annual chance storm event under current conditions to 10.46 feet with NOAA and USACE low sea level rise projections and to 13.3 and 12.52 feet with NOAA and USACE high sea level rise projections, respectively. Additionally, the maximum 1% wave crest is at an elevation of 17 feet and 19 feet under current conditions for Transects 43 and 44, respectively. Combined with sea level rise projections for 2070, it is anticipated that the maximum 1% wave crest for Transect 43 will increase to as much as 20.3 and 19.52 feet under NOAA and USACE high sea level rise projections, respectively. It is anticipated that the maximum 1% wave crest for Transect 44 will increase to as much as 22.3 and 21.52 feet under NOAA and USACE high sea level rise projections, respectively. For more information, please refer to the table below.

2100 Planning Horizon

Table 7 presents potential flood elevations for the five sets of projections in the 2100 planning horizon, calculated by adding the incremental increases to the MHW, MHHW, and FEMA water surface elevations.

TABLE 7
Flood Elevations by FEMA Transect for 2100 Planning Horizon

Year	Projection	Source	Transect #	MHW	MHHW	Stillwater Elevation, 2015 (NAVD88)				Total Water Level	Max Wave Crest
						10% annual chance	2% annual chance	1% annual chance	0.2% annual chance	1% annual chance	
2015		FEMA	43	3.2	3.54	7.9	9.5	10.1	11.5	11.1	17
		FEMA	44			7.9	9.4	10	11.4	12.9	19
2100	NOAA Low USACE Low	FEMA	43	3.91	4.25	8.61	10.21	10.81	12.21	11.81	17.71
		FEMA	44			8.61	10.11	10.71	12.11	13.61	19.71
	NOAA Int Low USACE Int	FEMA	43	4.9	5.24	9.6	11.2	11.8	13.2	12.8	18.7
		FEMA	44			9.6	11.1	11.7	13.1	14.6	20.7
	NOAA Int High	FEMA	43	7.1	7.44	11.8	13.4	14	15.4	15	20.9
		FEMA	44			11.8	13.3	13.9	15.3	16.8	22.9
	USACE High	FEMA	43	8.04	8.38	12.74	14.34	14.94	16.34	15.94	21.84
		FEMA	44			12.74	14.24	14.84	16.24	17.74	23.84
	NOAA High	FEMA	43	9.6	9.94	14.3	15.9	16.5	17.9	17.5	23.4
		FEMA	44			14.3	15.8	16.4	17.8	19.3	25.4

In the 2100 planning horizon, Transect 43 will increase from 10.1 feet (NAVD88) for a 1% annual chance storm event under current conditions to 10.81 feet with NOAA and USACE low sea level rise projections and to 16.5 and 14.94 feet with NOAA and USACE high sea level rise projections, respectively. Transect 44 will increase from 10.0 feet (NAVD88) for a 1% annual chance storm event under current conditions to 10.71 feet with NOAA and USACE low sea level rise projections and to 16.4 and 14.84 feet with NOAA and USACE high sea level rise projections, respectively. Additionally, the maximum 1% wave crest is at an elevation of 17 feet and 19 feet under current conditions for Transects 43 and 44, respectively. Combined with sea level rise projections for 2070, it is anticipated that the maximum 1% wave crest for Transect 43 will increase to as much as 23.4 and 21.84 feet under NOAA and USACE high sea level rise projections, respectively. It is anticipated that the maximum 1% wave crest for Transect 44 will increase to as much as 25.4 and 23.84 feet under NOAA and USACE high sea level rise projections, respectively. For more information, please refer to the table below.

Establishment of Typical Design Criteria

Based on literature review, there are many ways in which federal and state agencies determine design flood elevations. A uniform method to establish quantitative design criteria has not been established. Consider the following:

- The USACE passed Regulation No. 1100-2-8162 in December 2013, "Incorporating Sea Level Change in Civil Works Programs." This regulation requires federally funded projects to incorporate sea level change scenarios at the nearest tide gauge using the online USACE sea level rise calculator.

- In January 2015, the USACE, through the "North Atlantic Coast Comprehensive Study (NACCS): Resilient Adaptation to Increasing Risk" main report, recommended using the predicted 500-year flood elevation, including wave runup, plus 3 additional feet for a sea level rise allowance when designing storm surge barriers that protect multiple buildings. The USACE also recommended using the 100-year flood elevation, including wave runup, plus 3 additional feet for a sea level rise allowance when designing structural measures for individual building protection.

- Conversely, at the lower end of the spectrum, FEMA requires coastal levees to meet an elevation standard of the 100-year flood, including wave runup, plus 1 additional foot. This lower standard does not account for future sea level rise as the 1 foot freeboard merely accounts for uncertainties or a safety factor.

The Federal Flood Risk Management Standard (FFRMS) described in the report requires the consideration of future risk in the design of federally funded projects, with an approach that incorporates the use of climate-informed science ("climate informed science approach" or CISA) when providing estimates of future flooding. The other FFRMS approaches are using freeboard ("freeboard value approach" or FVA) or using the 0.2% annual chance flood elevation, often called the 500-year floodplain (0.2PFA).

Reputable design flood elevation standards have been established by the Port Authority of New York and New Jersey, the American Society of Civil Engineers (ASCE), as well as the California Department of Water Resources:

- The Port Authority of New York and New Jersey calls for a shelf life of projects to last until 2080, where the FEMA 1% base flood elevation plus 2 feet of freeboard and 3 additional feet for sea level rise are considered.

- ASCE calls for buildings and structures in Flood Design Class 4 occupancy (essential facilities) to be designed to either: a) base flood elevation plus 2 feet, b) a local design flood elevation, or c) the 500-year flood elevation. Whichever is the highest elevation is chosen for design.

- The California Department of Water Resources recommends levees and floodwalls to be designed using the 200-year stillwater elevation, including wave runup, plus 3 additional feet for sea level rise allowance.

Recent examples of the use of all of the above methods can be found in the United States. For example, in the preliminary design of the Staten Island flood protection system[1] (Appendix J), the USACE utilized a number of different stillwater elevations to set elevations of the tops of earthen levees, floodwalls, and a buried seawall. The levee crest elevations are 16, 17, 18, and 19 feet NGVD, demonstrating considerable variation depending on position relative to the FEMA flood zone. The floodwall design elevations are 16, 18, 20.5, and 22.5 feet NGVD corresponding to stillwater elevations of 13, 14, 16, and 17 feet NGVD, respectively. This demonstrates that considerable freeboard (3 to 5 feet) is being applied for this flood protection system, likely consisting of a consideration for sea level rise plus a safety factor.

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[1] Coastal Storm Risk Management Feasibility Study for South Shore of Staten Island Phase I

If design flood elevations in Connecticut are selected using the 500-year flood event (the 0.2% annual chance event), it is important to understand that the appropriate length of tide gauge records is not available to tell us previous elevations of a 500-year event. For example, if we have 100 years of data, the highest flood elevation is roughly equal to the 100-year elevation because it happened once in 100 years. This explanation somewhat oversimplifies the methods of calculating recurrent intervals, but generally there is not sufficient data to always understand the 0.2% annual chance event. Furthermore, FEMA has calculated the 0.2% annual chance elevation in only 18% of the areas studied.[2] For these reasons, it can be challenging to use the 0.2% annual chance flood elevation to generate design criteria.

The Connecticut Department of Energy & Environmental Protection (CTDEEP) is aware of limitations to calculate the 0.2% annual chance flood elevation and outlines an alternate procedure in its guidance "How to Calculate the 500-Year Flood Elevation in a FEMA Designated Coastal Flood Hazard Area for the Purposes of Obtaining a Flood Management Certificate from DEEP."[3] CTDEEP recommends following the FEMA Technical Fact Sheet 1.6, which suggests that the elevation for the 500-year flood event in a coastal flood hazard area can be approximated by multiplying the elevation of the 100-year base flood elevation by 1.25. Unfortunately, the accuracy of these calculations drops off quickly when moving inland from tidally influenced zones of flood risk.

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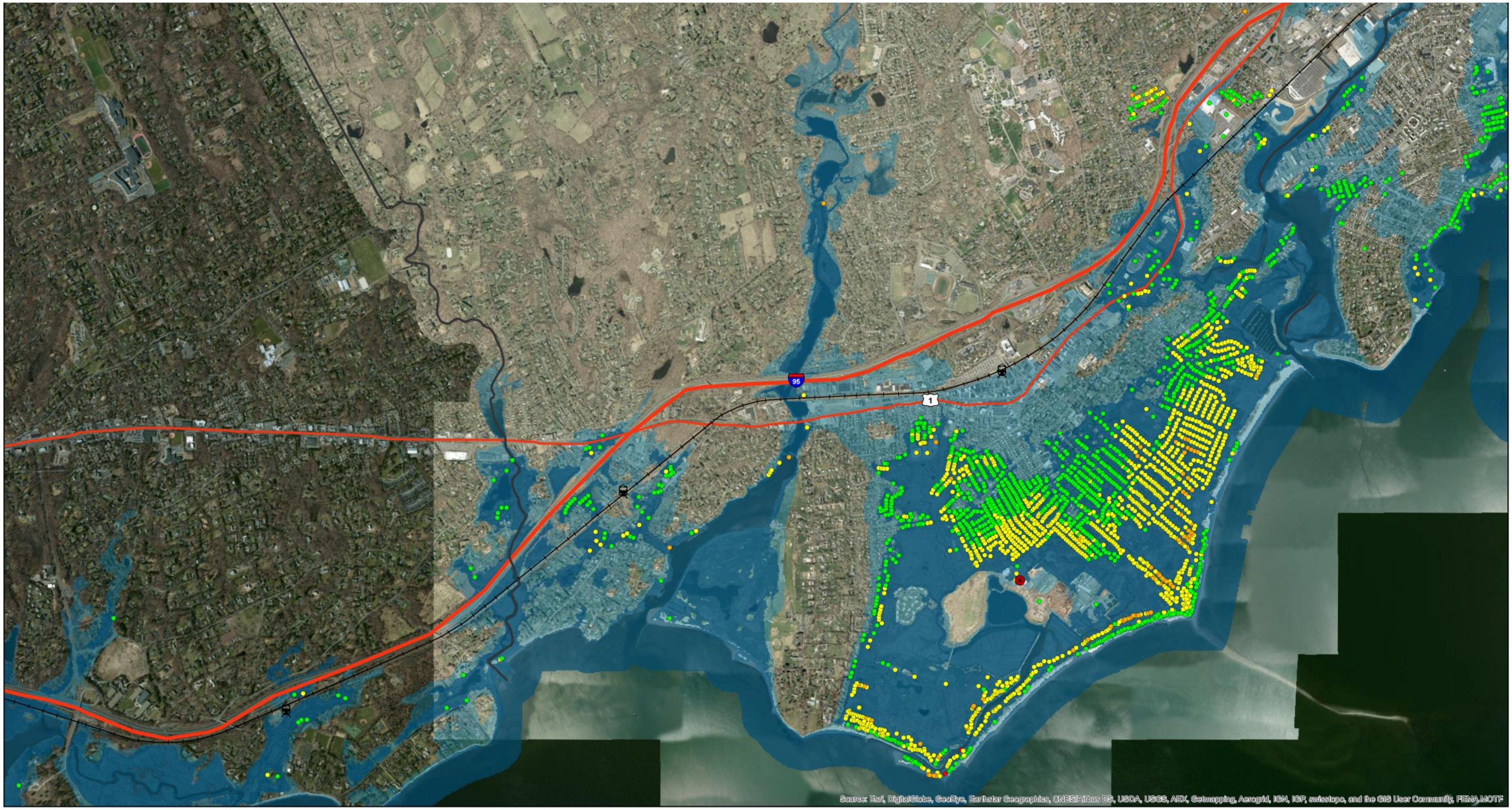
[2] Federal Register Vol. 81, No. 162, 8/22/16 Proposed Rules

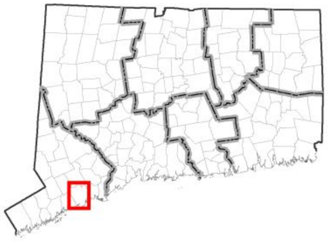
[3] http://www.ct.gov/deep/lib/deep/water_inland/flood_mgmt/how_to_calculate_the_500_year_flood_elevation_in_a_fema_designated_coastal_flood_hazard_areaversiontwo.pdf

APPENDIX H – CIRCA Map of Fairfield

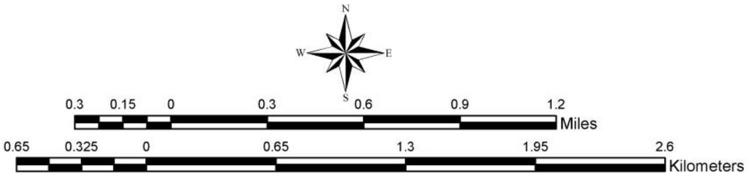


Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, FEMA MOTF

Fairfield, CT



Potential Severe Storm Surge and Effects of Hurricane Sandy



Infrastructure Sites

▲ Energy Facillities
● Wastewater Treatment Facilities
⬢ Marine Terminals
🚆 Train Stations

FEMA Individual Assistance (IA) Household Inspection Damage Damage Classification (Hurricane Sandy Impacts)

🟢 Affected – Total Full Verified Loss (FVL) greater than $0 to $5,000
🟡 Minor – Total Full Verified Loss (FVL) $5,000 to $17,000
🟠 Major – Total Full Verified Loss (FVL) more than $17,000
🔴 Destroyed - If indicated by IA Inspector

FINAL - High Resolution Storm Surge Extent

■ Hurricane Sandy (FEMA Modeling Task Force (MOTF) Impact Analysis)

Projected Hurricane Surge Inundation Areas

■ Category 3 Hurricane (Army Corps of Engineers 2012 Surge Model)

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UNIVERSITY OF CONNECTICUT

CIRCA
Connecticut Institute for Resilience and Climate Adaptation

Connecticut Department of
ENERGY & ENVIRONMENTAL PROTECTION

Riverside Drive/Ash Creek Resilience Study

APPENDIX I – Federal Flood Risk Management Standard

Federal Flood Risk Management Standard

Contents

Use of Executive Order 11988, Floodplain Management and Relationship to the FFRMS

This Federal Flood Risk Management Standard (FFRMS) builds upon Executive Order (EO) 11988 and is to be incorporated into existing Federal department and agency processes used to implement EO 11988.[1]

Development and Update of the Federal Flood Risk Management Standard

The Mitigation Framework Leadership Group (MitFLG), established through the National Mitigation Framework (NMF) through Presidential Policy Directive 8 (PPD-8), developed this Standard and will continue to reassess the Standard in order to provide recommendations for updating the Standard to the Water Resources Council in consultation with the Federal Interagency Floodplain Management Task Force (FIFMTF). The FIFMTF works to promote the health, safety, and welfare of the public by encouraging programs and policies that reduce flood losses and protect the natural environment through improved coordination, collaboration,and transparency in floodplain management efforts within the federal government. As a senior level group that promotes coordination of mitigation efforts across the Federal Government, MitFLG is responsible for assessing the effectiveness of Mitigation core capabilities as they are developed and deployed across the Nation. To that end, the MitFLG facilitates information exchange, coordinates policy implementation recommendations on national-level issues and oversees the successful implementation of the NMF.

Application to all Federal Actions

The FFRMS applies to all Federal Actions, as described in section 1 of EO 11988. EO 11988 and the Floodplain Management Guidelines For Implementing EO 11988 (Implementing Guidelines) apply to Federal Actions in or affecting floodplains[2] and define a Federal Action as

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[1] http://www.archives.gov/federal-register/codification/executive-order/11988.html

[2] EO 11988 defines floodplains as “lowland and relatively flat areas adjoining inland and coastal waters including floodprone areas of offshore islands, including at a minimum, that area subject to a one percent or greater chance of flooding in any given year.”

any Federal activity including: “(1) acquiring, managing, and disposing of Federal lands and facilities; (2) providing Federally undertaken, financed or assisted construction and improvements; and (3) conducting Federal activities and programs affecting land use, including but not limited to, water and related land use resource planning, regulating, and licensing activities.”

Applying the FFRMS to all Federal Actions: ensures that Federal departments and agencies make sound flood risk and floodplain management decisions; provides consistency with the current, understood process for implementing EO 11988 as well as the National Environmental Policy Act (NEPA), where applicable; and eases implementation by establishing a consistent overall approach for all Federal activities in or affecting floodplains, while also allowing Federal departments and agencies flexibility to implement the FFRMS by selecting the approach that best aligns with their missions, authorities, and programs.

The elevation component of the FFRMS applies to all new construction and substantially improved structures (e.g., reconstruction, rehabilitation, addition, and any other improvement) the cost of which equals or exceeds 50 percent of the value of the structure.[3]

The elevation component of the FFRMS also applies to substantial damage projects for structures (e.g., when damage sustained from any source or event equals or exceeds 50 percent of the value of the structure) if the project will rely on Federal funding.

If desired, Federal departments and agencies may extend the determination of substantial improvement, or the repair of substantial damage, or both, to include a cumulative determination in which Federal investments are tracked over time. One approach that Federal departments and agencies can adopt to monitor activity is to track improvements and repairs until they meet or exceed 50 percent of the value of the structure. Federal departments and agencies interested in implementing a cumulative approach will need to develop a process to track their respective cumulative Federal investments.

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[3] The definition of ‘structure’ is a walled and roofed building, mobile home, gas or liquid storage tank that is primarily above ground.

Exceptions, Class Reviews, and Simplified Evaluation and Review Processes

The head of a Federal department or agency, or an appropriate designee as set forth in the agency implementing plan, may except particular department or agency activities and facilities from the provisions of the FFRMS where it is in the interest of national security, where the agency action is an emergency action, where application to a Federal facility or structure is demonstrably inappropriate, or where the agency action is a mission-critical requirement related to a national security interest or emergency action. Agencies will provide more specific descriptions of what may constitute a national security interest or an emergency action by that agency in its policies and rules. When an agency action is excepted because it is in the interest of national security, it is an emergency action, or it is a mission-critical requirement related to a national security interest or an emergency action, the agency head shall rely on the land subject to the base flood.

In addition, Federal departments and agencies may use an altered or shortened decision-making process for actions with insignificant impacts or actions of a short duration, as the current EO 11988 process specifies. Federal departments and agencies may also choose to conduct general review of activities in lieu of site-specific reviews and class reviews of certain repetitive actions. The Implementing Guidelines for EO 11988 will be amended to provide detailed guidance to Federal departments and agencies regarding applicability, exceptions, and processes for documenting compliance with the FFRMS.

Critical Actions

Critical Action is defined in the Implementing Guidelines to EO 11988 to include any activity for which even a slight chance of flooding is too great. The concept of Critical Action reflects a concern that the impacts of flooding on human safety, health, and welfare for many activities could not be minimized unless a higher degree of protection or resilience than that delivered by the base flood elevation was provided.

Federal departments and agencies will be responsible for determining whether a Federal Action constitutes a Critical Action, which includes questions such as:

- If flooded, would the proposed action create an added dimension to the disaster, as could be the case for liquefied natural gas terminals and facilities producing and storing highly volatile, toxic, or water-reactive materials?
- Given the flood warning lead-time available, would the occupants of buildings such as hospitals, nursing homes, prisons, and schools be sufficiently mobile to avoid loss of life and injury?
- Would essential and irreplaceable records, scientific and cultural museum collections, utilities, emergency services, national laboratories, and structures that may house critical equipment, systems, networks, and functions be lost?

Improvements in Implementation of EO 11988

The FFRMS has been developed to create a national minimum flood risk management standard to ensure that Federal Actions that are located in or near the floodplain when there are no other practical alternatives last as long as intended by considering risks, changes in climate, and vulnerability.

The FFRMS seeks to improve the implementation of EO 11988 through the following enhancements:

- The FFRMS encourages the use of natural features and nature-based approaches in the development of alternatives for Federal Actions.
- The FFRMS provides a higher vertical elevation and corresponding floodplain, where appropriate, to address current and future flood risks.
- The elevation and corresponding floodplain of the FFRMS can be determined using three approaches, outlined in later sections of this document.

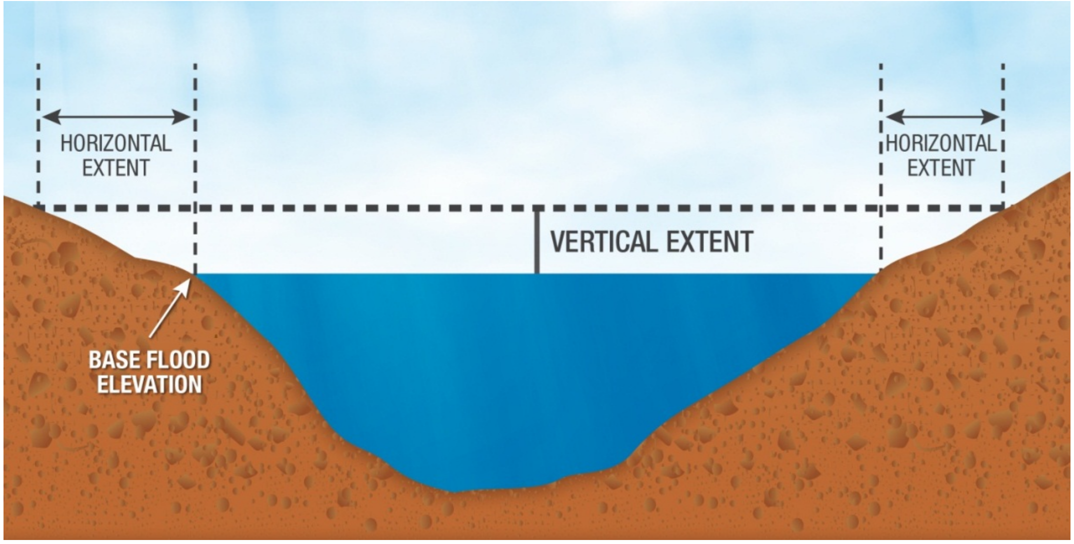
Consideration of Natural Features and Nature-Based Solutions

The FFRMS encourages the use of natural systems, ecosystem processes, and nature-based approaches in the development of alternatives for Federal Actions in implementing Step 3 of the Implementing Guidelines. This approach, combined with restoration of natural systems and ecosystem processes where appropriate, recognizes the growing role of natural and restored systems and of features engineered to mimic natural processes (generally known as “green infrastructure”) in mitigating flood risk and building the resilience of Federal investments both within and that will affect floodplains. Using natural and natured-based approaches is consistent with Section 1 of EO 11988 which directs Federal departments and agencies to take action to restore and preserve the natural and beneficial values served by floodplains.

Encouraging the use of natural systems and nature-based approaches earlier in the planning and design of Federal Actions is consistent with the Federal Government policy priorities and best practices, which promote the integration of green infrastructure for coastal flood risk management following Hurricane Sandy (e.g., Hurricane Sandy Rebuilding Strategy recommendations 19-22), and with the Climate Action Plan (e.g., references to “natural defenses”). This policy is also broadly consistent with and supports other policy and guidance documents, such as the *Principles and Guidelines for Water and Land Related Resources Implementation Studies (now updated and referenced as Principles, Requirements and Guidelines or PR&G)*, *Guidance on Effective Use of Programmatic NEPA Reviews* and other agency implementing guidance.

Higher Vertical Elevation

The FFRMS provides a higher vertical elevation to ensure that uncertainties associated with climate change and other future changes are more adequately accounted for in the department or agency decision processes for future Federal Actions.



EO 11988 currently uses the base floodplain to determine the vertical elevation and floodplain boundary. The FFRMS increases both the vertical elevation and the corresponding area of the floodplain to which the FFRMS applies.

As in EO 11988, the FFRMS flood hazard elevation establishes the level to which a structure or facility must be resilient – this may include elevating the structure or, where appropriate, designing it to withstand or otherwise quickly recover from a flood event. In selecting the appropriate resilience approach, Federal departments and agencies should consider several factors such as flood depth, velocity, rate of rise of floodwater, duration of floodwater, erosion, subsidence, the function or use and type of structure or facility, and other factors. Additional guidance on these concepts will be provided in an update to the Implementing Guidelines.

Approaches for Establishing the FFRMS Elevation and Flood Hazard Area

Three approaches are available for establishing the FFRMS elevation and flood hazard area. These approaches include:

- Utilizing the best-available, actionable hydrologic and hydraulic data and methods that integrate current and future changes in flooding based on climate science (heretofore referred to as the "climate-informed science approach");
- Freeboard (Base Flood Elevation (BFE) + X); and
- 500-year flood elevation.

The climate-informed science approach is preferred. Federal departments and agencies should use this approach when data to support such an analysis are available.

Climate-Informed Science Approach

For areas vulnerable to coastal flood hazards, the climate-informed science approach includes the regional sea-level rise variability and lifecycle of the Federal Action. The climate-informed science approach for Federal Actions affected by coastal flood hazards includes:

- Use of the U.S. Department of Commerce's - National Oceanic and Atmospheric Administration's (NOAA's) or similar global mean sea-level-rise (GMSLR) scenarios, adjusted to local relative sea-level (LRSL) conditions.
- A combination of the LRSL conditions with surge, tide, and wave data using state-of-the-art science in a manner appropriate to policies, practices, criticality, and consequences (risk).

For areas vulnerable to riverine flood hazards, the climate-informed science approach for Federal Actions is as follows:

- Account for changes in riverine conditions due to current and future changes in climate and other factors (e.g., land use) by applying state-of-the art science in a manner appropriate to policies, practices, criticality, and consequences (risk).

The climate-informed science approach for Critical Actions will utilize the same methodology as used for other non-critical actions that are subject to EO 11988, but with an emphasis on criticality as one of the factors for departments and agencies to consider when conducting the analysis. Note that the climate-informed science approach for Critical Actions will differ between coastal and riverine systems.

Freeboard Value

The FFRMS defines the following freeboard values:

- An additional two (2) feet shall be added to the BFE.
- For Critical Actions, an additional three (3) feet shall be added to the BFE.
- These increases will apply to both the vertical elevation and the corresponding horizontal extent of the floodplain.

500-Year Elevation

Federal departments and agencies may elect to use available "500-year" flood data as the basis of the FFRMS elevation and corresponding floodplain extent. Note that the "500-year" flood hazard data produced by the U.S Department of Homeland Security's - Federal Emergency

Management Agency (FEMA) in coastal areas only considers storm-surge hazards. These data do not include local wave action or storm-induced erosion that are considered in the computation of BFEs. Federal departments and agencies are encouraged to obtain or develop the necessary data, including wave heights, to ensure that any "500-year" data applied will achieve an appropriate level of flood resilience for the proposed investment.

Further Guidance on Application of 500-year and Freeboard Options

When a Federal department or agency does not use a climate-informed science approach in a coastal flood hazard area, the department or agency must use, at a minimum, the applicable freeboard elevation (i.e., BFE + 3 feet for Critical Actions, or BFE + 2 feet for other actions). In some cases where the FEMA 500-year flood elevation does not include a wave height, or a wave height has not been determined, the result will likely either be lower than the current BFE or the BFE plus applicable freeboard. The "500-year" elevation should not be used in these cases.

When actionable science is not available and a Federal department or agency opts not to follow the climate-informed science approach for riverine flood hazard areas**,** the Federal department or agency may also select either the freeboard approach, or "500-year" flood elevation approach, or a combination of approaches, as appropriate. A Federal department or agency is not required to use the higher of the elevations but may opt to do so.

Updates to the FFRMS

The FFRMS shall be reviewed after adoption and implementation, as Federal departments and agencies are able to identify scientific, technological, and economic information that may affect the implementation of the FFRMS. Periodic updates will allow the FFRMS to include requirements based on timely and relevant advances in science that takes into account changes to climate and other changes in flood risk. The MitFLG, established by the NMF, in consultation with the FIFMTF and after seeking stakeholder input, will reassess the FFRMS annually to determine if updates are warranted and will provide any recommendations to the Water Resources Council. The Water Resources Council shall issue an update to the Standard at least every 5 years. A full update will be conducted at least every five years.

Four areas have been identified that could trigger review and potential revision of the FFRMS: implementation experience; changes in national consensus standards used to inform the policy; changes in the underlying flood hazard information; and changes in current climate science that address critical data and information gaps.

Implementation Experience

As Federal departments and agencies implement the FFRMS, implementation challenges as well as opportunities to enhance or modify the FFRMS may be identified. In order to ensure that the FFRMS continues to meet its stated objectives, implementation of the policy will be monitored. Federal departments and agencies should collect feedback on implementation from relevant programs and offices, indentify potential gaps in the process, and outline areas for improvement with the Standard. Such information should be provided to the MitFLG as part of the annual reassessment of the FFRMS.

Consensus Standard Revised

As the International Code Series, published by the International Code Council, and reference standards such as the American Society of Civil Engineers (ASCE)-24 are updated, the Federal Government should consider whether such updates require reconsideration of the FFRMS.

Changes in the Underlying Flood Hazard Information

The Technical Mapping Advisory Council established by FEMA, as mandated by the Biggert-Waters Reform Act of 2012 (BW-12), will make recommendations on how to incorporate projected sea-level rise and other future climate change impacts into the existing flood study process. These recommendations may include mapping areas of future flood risk and developing methods to inform the potenational revision of flood hazard elevations in both riverine and coastal areas. The MitFLG will review these recommendations should be reviewed in detail for potential implications to the FFRMS and coordinated with activities undertaken to address the critical data and information gaps noted above.

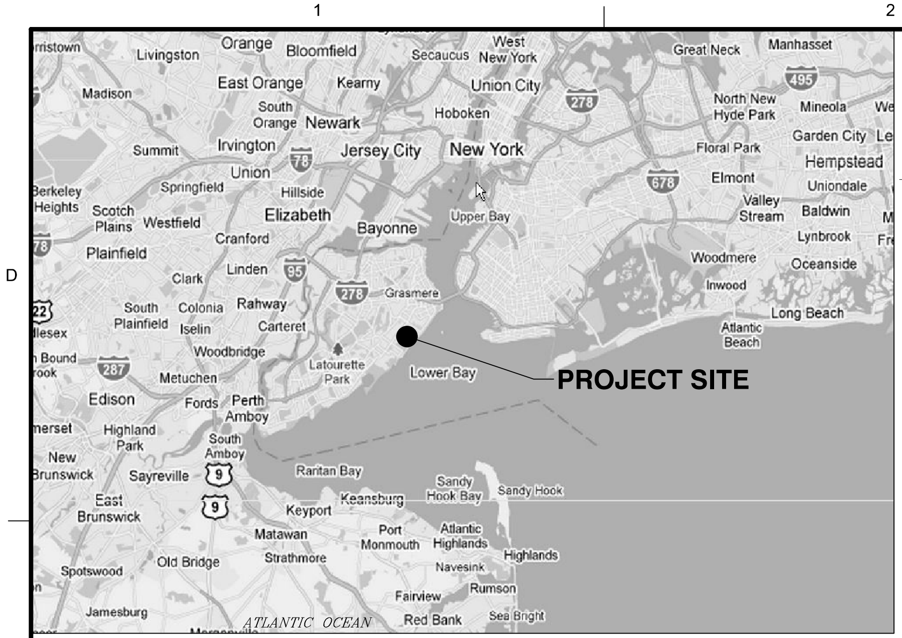
Changes in Current Climate Science

In developing the guidance contained in the FFRMS, the MitFLG working group identified a number of critical data and information gaps. These gaps reflect challenges that Federal departments and agencies will likely face in implementing the current FFRMS, as well as other scientific issues that, if addressed in the near term (i.e., within two-to-three years), could be used to review and potentially revise the FFRMS. One important gap identified to improve the riverine climate-informed science option is to convene a working group that produces a new method to estimate projected future flood-flow frequencies.

References

1. Executive Order 11988, Floodplain Management, 1977, 42 CFR 26951, 3CFR 1977.
2. The Floodplain Management Guidelines for Implementing E.O. 11988, Water Resources Council, 1978.
3. Further Advice on Executive Order 11988, Federal Interagency Floodplain Management Task Force, 1987.
4. The Principles and Requirements for Federal Investments in Water Resources, March 2013.
5. The National Environmental Policy Act (NEPA) of 1969, as amended (42 U.S.C. 4321 et seq.).
6. The National Flood Insurance Act of 1968, as amended (42 U.S.C. 4001 et seq.).
7. The Flood Disaster Protection Act of 1973 (Public Law 93-234, 87 Stat. 975).
8. The Coastal Barrier Resources Act of 1982 as amended (16 U.S.C. 3501 et seq.).
9. The Coastal Zone Management Act (16 U.S.C. 1451 et seq.).
10. The Coastal Barrier Improvement Act of 1990 (Public Law 101-591; 104 Stat. 2931).
11. The Endangered Species Act of 1973, as amended (15 U.S.C. 1531 et seq.).

APPENDIX J – Staten Island Flood Protection System Plans

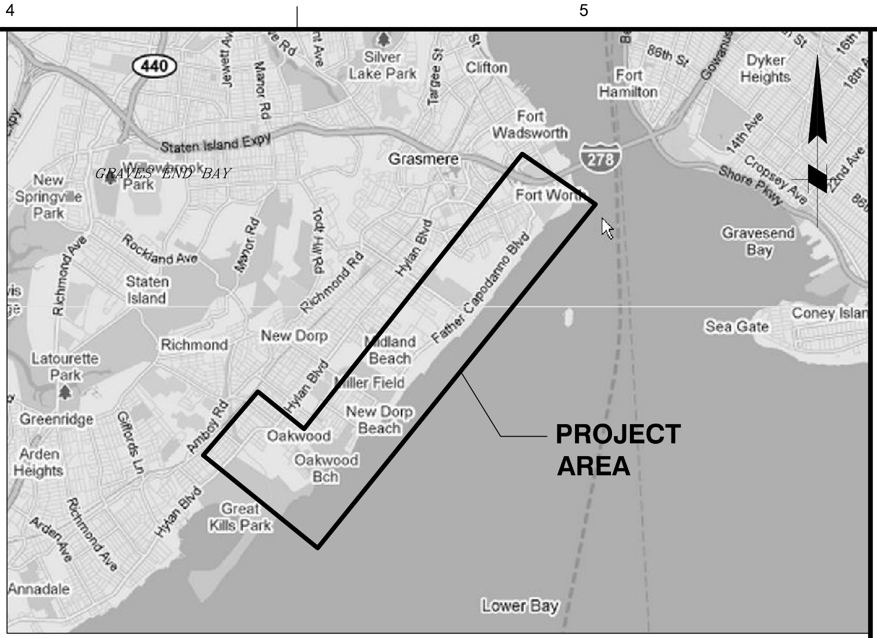


VICINITY MAP

NTS

COASTAL STORM RISK MANAGEMENT FEASIBILITY STUDY FOR THE SOUTH SHORE OF STATEN ISLAND

PHASE 1
FORT WADSWORTH TO OAKWOOD BEACH



LOCATION PLAN

NTS

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COASTAL STORM RISK MANAGEMENT
FEASIBILITY STUDY FOR THE
SOUTH SHORE OF STATEN ISLAND

COVER SHEET

SHEET
IDENTIFICATION
G-001
SHEET X OF Y

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COASTAL STORM RISK MANAGEMENT
FEASIBILITY STUDY FOR THE
SOUTH SHORE OF STATEN ISLAND

OVERALL SITE AERIAL (1 OF 3)

SHEET IDENTIFICATION
G-101
SHEET OF

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COASTAL STORM RISK MANAGEMENT
FEASIBILITY STUDY FOR THE
SOUTH SHORE OF STATEN ISLAND

OVERALL SITE AERIAL (2 OF 3)

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COASTAL STORM RISK MANAGEMENT
FEASIBILITY STUDY FOR THE
SOUTH SHORE OF STATEN ISLAND

OVERALL SITE AERIAL (3 OF 3)

SHEET IDENTIFICATION
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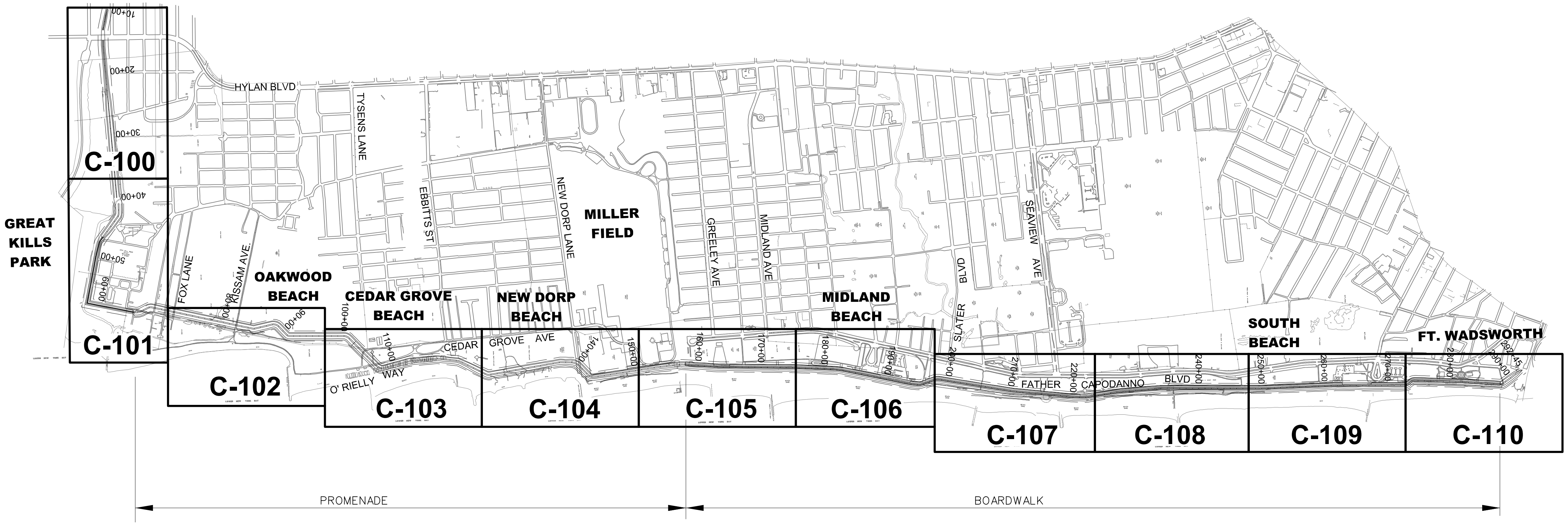

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GRAPHICAL SCALE

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COASTAL STORM RISK MANAGEMENT
FEASIBILITY STUDY FOR THE
SOUTH SHORE OF STATEN ISLAND

SHEET KEY PLAN

SHEET
IDENTIFICATION
G-104
SHEET X OF Y

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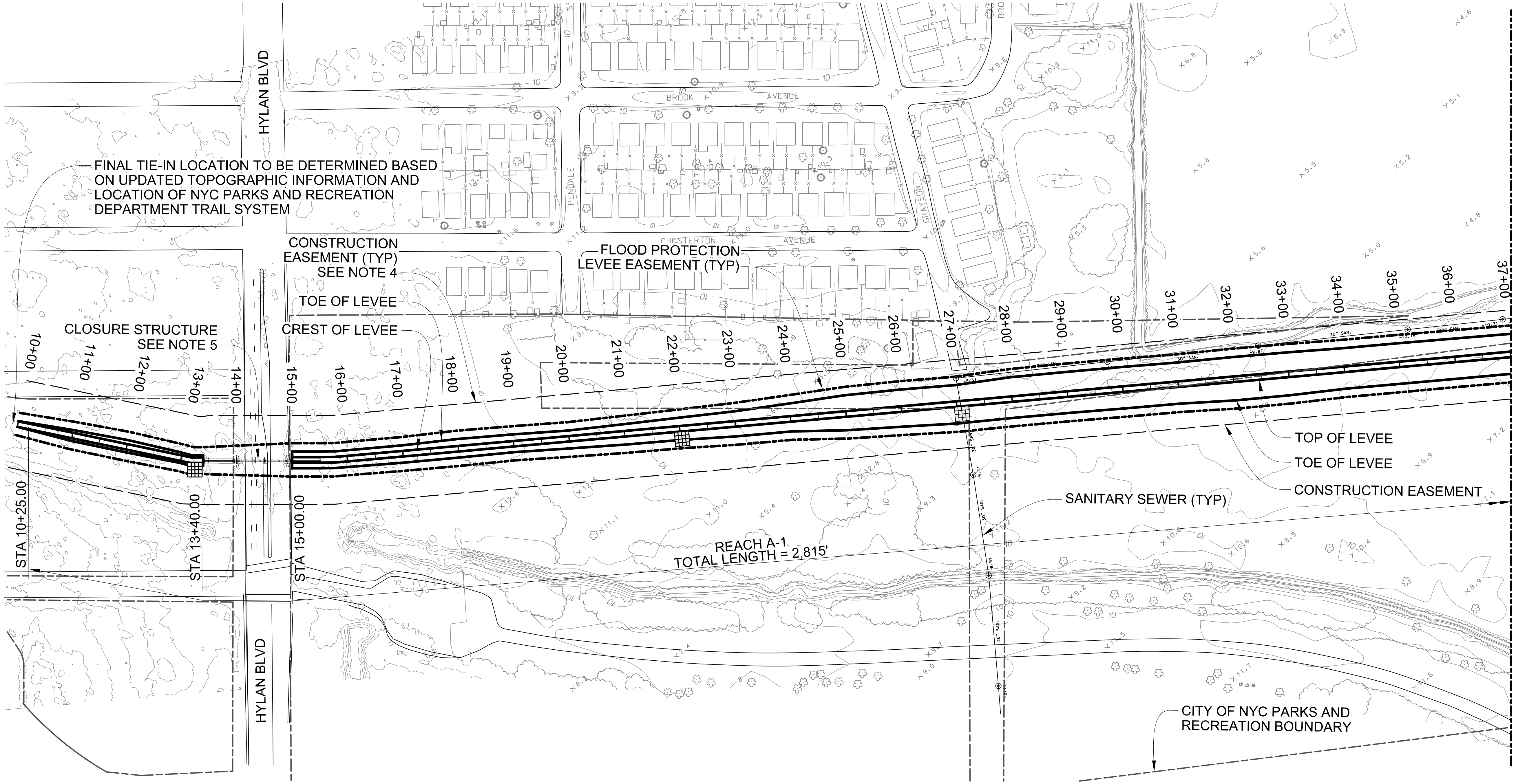

NOTES

1. TYPICAL SECTIONS SHOWN ON SHEETS C-501 TO C-507.
2. ALL ELEVATIONS REFERENCED TO NGVD 29.
3. STRUCTURE LIMITS SHOWN FOR LEVEL OF PROTECTION ARE BASED ON THE 15.6 FT SWL.
4. CONSTRUCTION EASEMENT LINE @ 50' OFFSET TO PROPOSED STRUCTURES.
5. CLOSURE STRUCTURE ON SHEETS C-515 & C-516.
6. SANITARY SERVICE ROAD SECTION SHOWN ON SHEET C-507.
7. THE LINE OF PROTECTION (LOP) STRUCTURES WITHIN THE OAKWOOD BEACH CORRIDOR HAVE BEEN DESIGNED TO ACCOMMODATE THE CITY OF NEW YORK'S STATEN ISLAND BLUEBELT PLAN.

LEGEND

PA	PEDESTRIAN ACCESS STAIRS SEE SHEET C-509
DTP	COMBINED TRUCK & PEDESTRIAN ACCESS RAMP, SEE SHEET C-510
MVA	MAINTENANCE VEHICLE ACCESS RAMP, SEE SHEET C-510
BA	BOARDWALK ACCESS SEE SHEET C-508
☒	DRAINAGE CONTROL STRUCTURE, SEE SHEET C-512
▦	SANITARY/DRAINAGE CONTROL STRUCTURE SEE SHEET C-514
TG	TIDE GATE SEE SHEET C-513
30" SAN. -8.71	SANITARY SEWER
W x H STM	MAJOR STORM SEWER OUTFALL
■	SAND COVER
▨	BOARDWALK SEE SHEET C-507
⁘	PROMENADE SEE SHEET C-504

KEY PLAN

0 100' 200'
SCALE:1"=100'

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SITE PLAN (1 OF 11)

SHEET IDENTIFICATION
C-100
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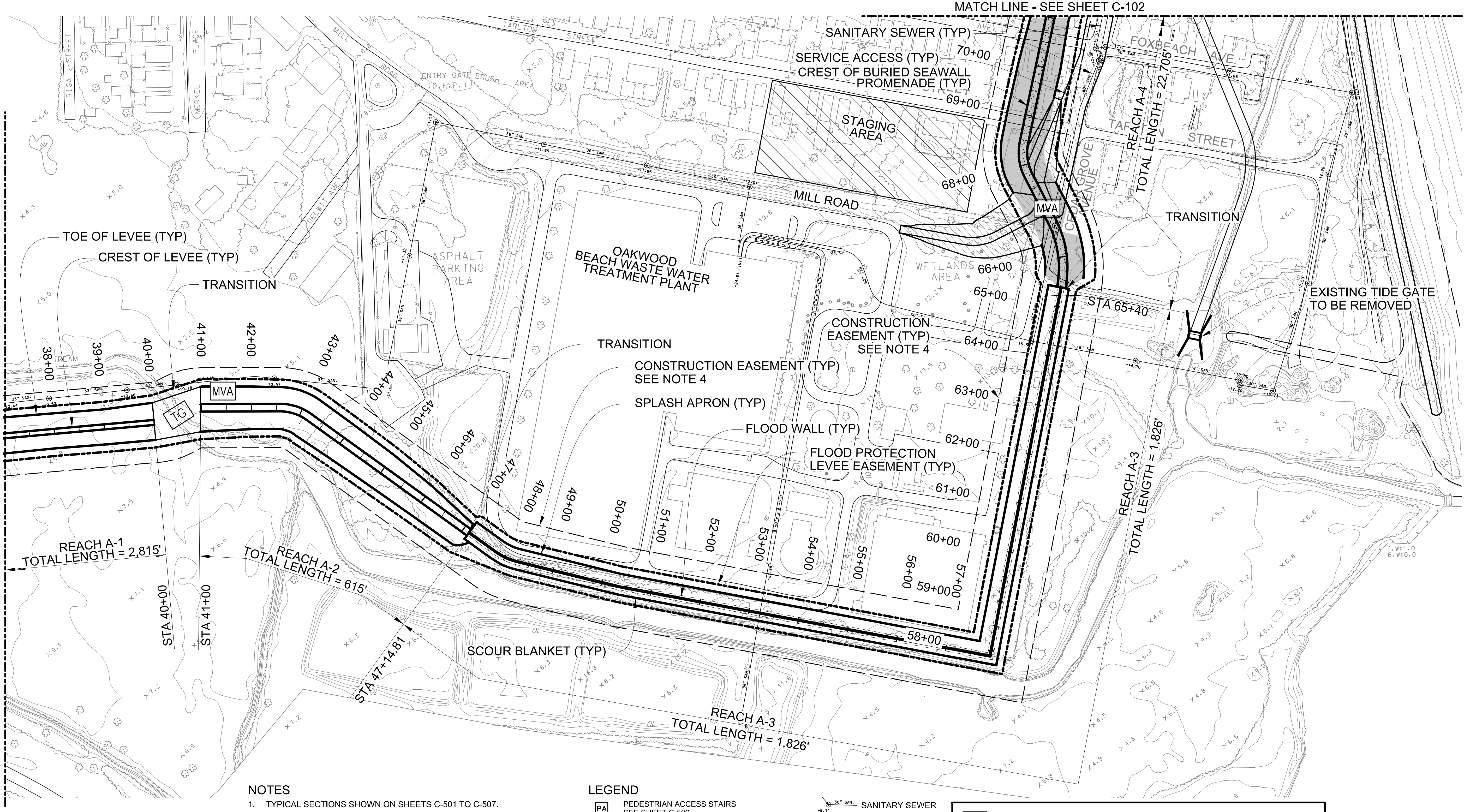

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LEGEND

PA	PEDESTRIAN ACCESS STAIRS SEE SHEET C-509
DTP	COMBINED TRUCK & PEDESTRIAN ACCESS RAMP, SEE SHEET C-510
MVA	MAINTENANCE VEHICLE ACCESS RAMP, SEE SHEET C-510
BA	BOARDWALK ACCESS SEE SHEET C-508
☒	DRAINAGE CONTROL STRUCTURE, SEE SHEET C-512
▦	SANITARY/DRAINAGE CONTROL STRUCTURE SEE SHEET C-514
TG	TIDE GATE SEE SHEET C-513
30" SAN. -8.71	SANITARY SEWER
■ x H STM	MAJOR STORM SEWER OUTFALL
■	SAND COVER
▨	BOARDWALK SEE SHEET C-507
⁘	PROMENADE SEE SHEET C-504

KEY PLAN

0 100' 200'

SCALE:1"=100'

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MARK	DESCRIPTION	DATE	APPR.
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COASTAL STORM RISK MANAGEMENT
FEASIBILITY STUDY FOR THE
SOUTH SHORE OF STATEN ISLAND

SITE PLAN (2 OF 11)

SHEET IDENTIFICATION
C-101
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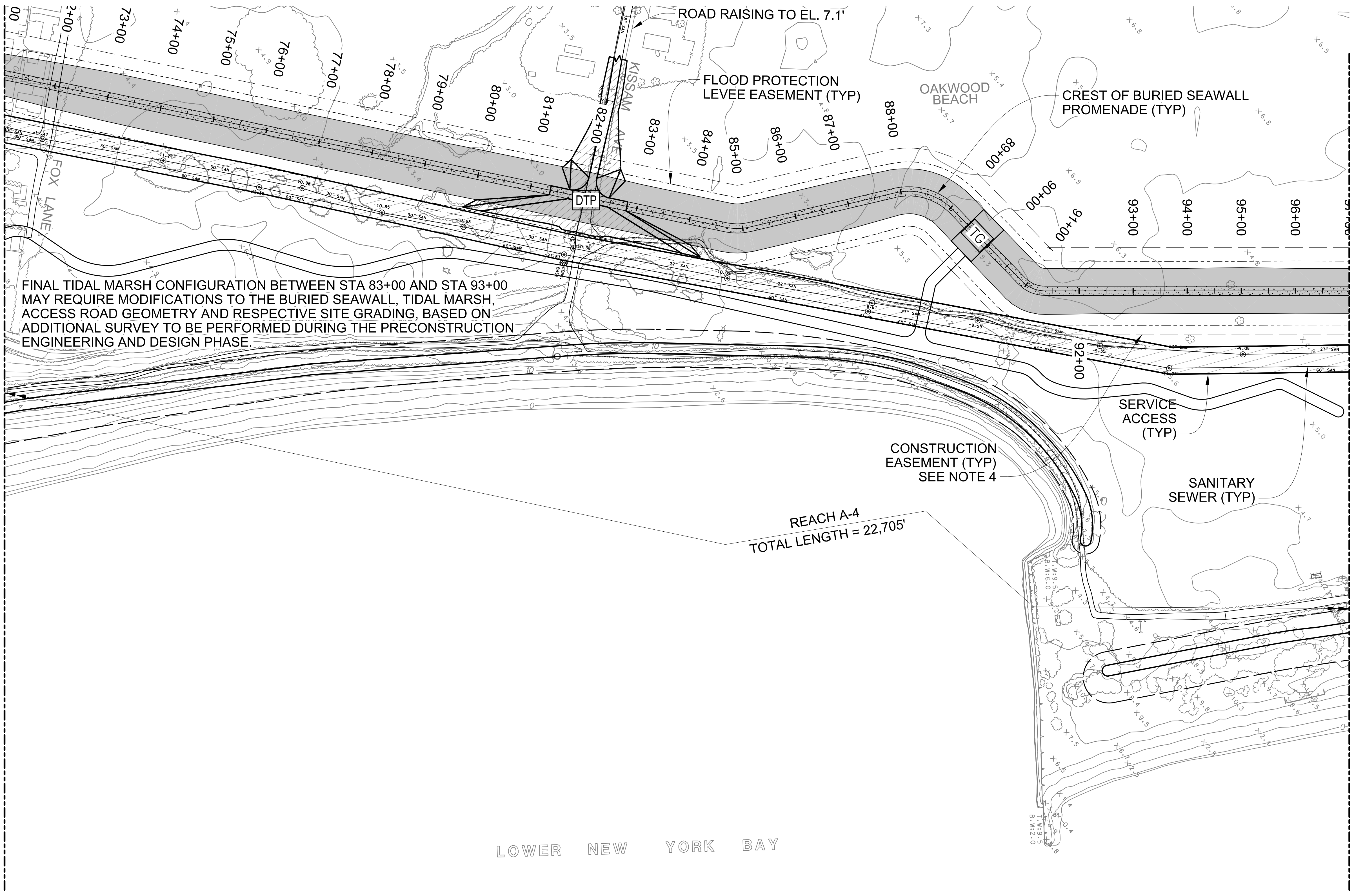


FINAL TIDAL MARSH CONFIGURATION BETWEEN STA 83+00 AND STA 93+00 MAY REQUIRE MODIFICATIONS TO THE BURIED SEAWALL, TIDAL MARSH, ACCESS ROAD GEOMETRY AND RESPECTIVE SITE GRADING, BASED ON ADDITIONAL SURVEY TO BE PERFORMED DURING THE PRECONSTRUCTION ENGINEERING AND DESIGN PHASE.

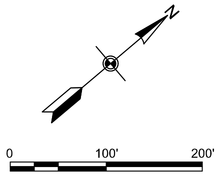
NOTES

1. TYPICAL SECTIONS SHOWN ON SHEETS C-501 TO C-507.
2. ALL ELEVATIONS REFERENCED TO NGVD 29.
3. STRUCTURE LIMITS SHOWN FOR LEVEL OF PROTECTION ARE BASED ON THE 15.6 FT SWL.
4. CONSTRUCTION EASEMENT LINE @ 50' OFFSET TO PROPOSED STRUCTURES.
5. CLOSURE STRUCTURE ON SHEETS C-515 & C-516.
6. SANITARY SERVICE ROAD SECTION SHOWN ON SHEET C-507.
7. THE LINE OF PROTECTION (LOP) STRUCTURES WITHIN THE OAKWOOD BEACH CORRIDOR HAVE BEEN DESIGNED TO ACCOMMODATE THE CITY OF NEW YORK'S STATEN ISLAND BLUEBELT PLAN.

LEGEND

PA	PEDESTRIAN ACCESS STAIRS SEE SHEET C-509
DTP	COMBINED TRUCK & PEDESTRIAN ACCESS RAMP, SEE SHEET C-510
MVA	MAINTENANCE VEHICLE ACCESS RAMP, SEE SHEET C-510
BA	BOARDWALK ACCESS SEE SHEET C-508
☒	DRAINAGE CONTROL STRUCTURE, SEE SHEET C-512
▦	SANITARY/DRAINAGE CONTROL STRUCTURE SEE SHEET C-514
TG	TIDE GATE SEE SHEET C-513
30" SAN. -8.71	SANITARY SEWER
W x H STM	MAJOR STORM SEWER OUTFALL
■	SAND COVER
▨	BOARDWALK SEE SHEET C-507
⁘	PROMENADE SEE SHEET C-504

KEY PLAN



SCALE:1"=100'

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COASTAL STORM RISK MANAGEMENT
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SITE PLAN (3 OF 11)

SHEET IDENTIFICATION
C-102
SHEET OF

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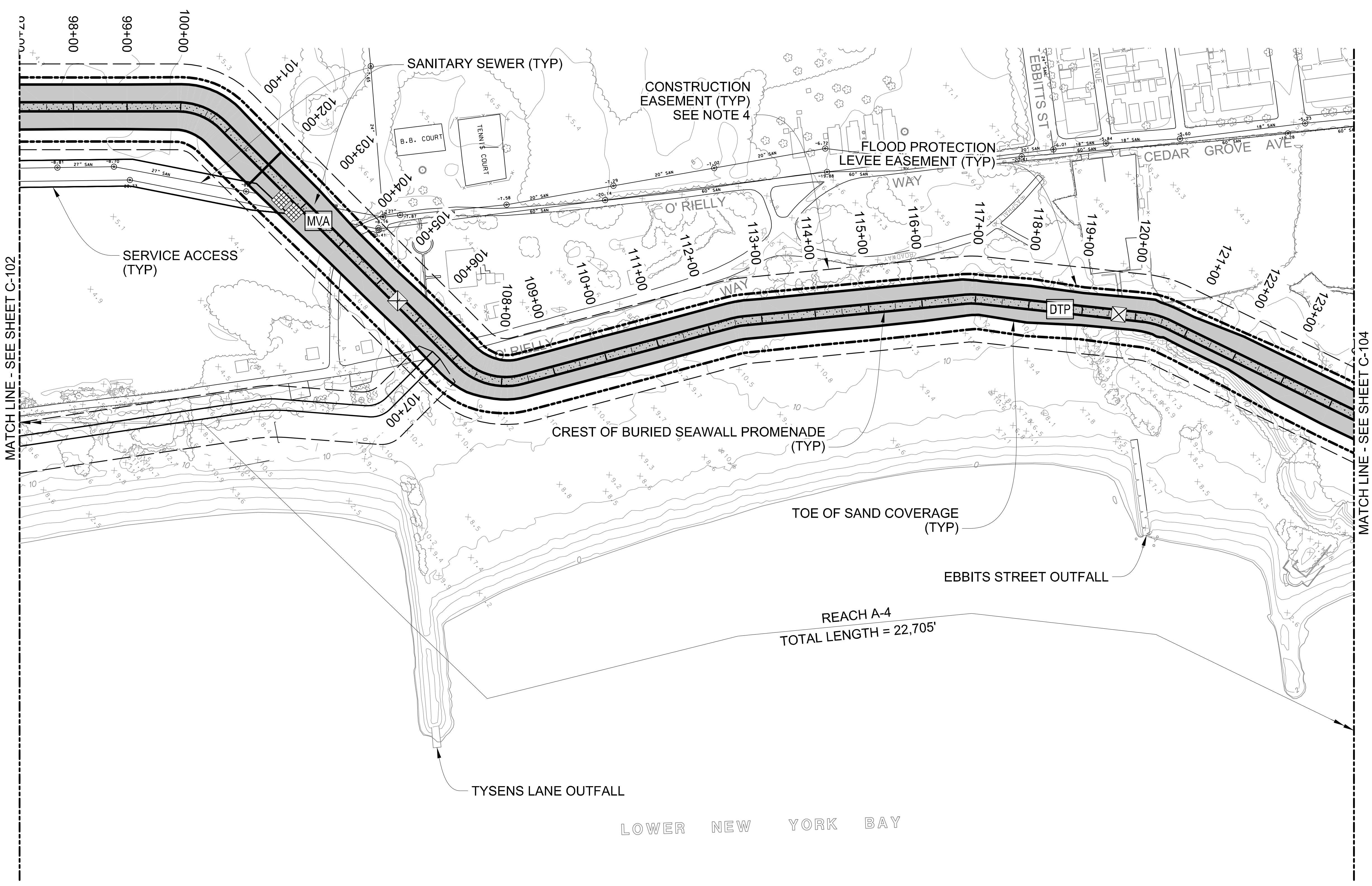

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30" SAN	SANITARY SEWER
W x H STM	MAJOR STORM SEWER OUTFALL
■	SAND COVER
▨	BOARDWALK SEE SHEET C-507
⁘	PROMENADE SEE SHEET C-504

KEY PLAN

0 100' 200'

SCALE:1"=100'

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MARK	DESCRIPTION	DATE	APPR.
2	INCORPORATES SPONSOR AND STAKEHOLDER COMMENTS	3/21/2016	MAP
1	REVISIONS FOR AJR COMMENTS	1/9/2015	MAP

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SUBMITTED BY: MARK PIRELLO		CONTRACT NO.: XXXX
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COASTAL STORM RISK MANAGEMENT
FEASIBILITY STUDY FOR THE
SOUTH SHORE OF STATEN ISLAND

SITE PLAN (4 OF 11)

SHEET IDENTIFICATION
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SHEET OF

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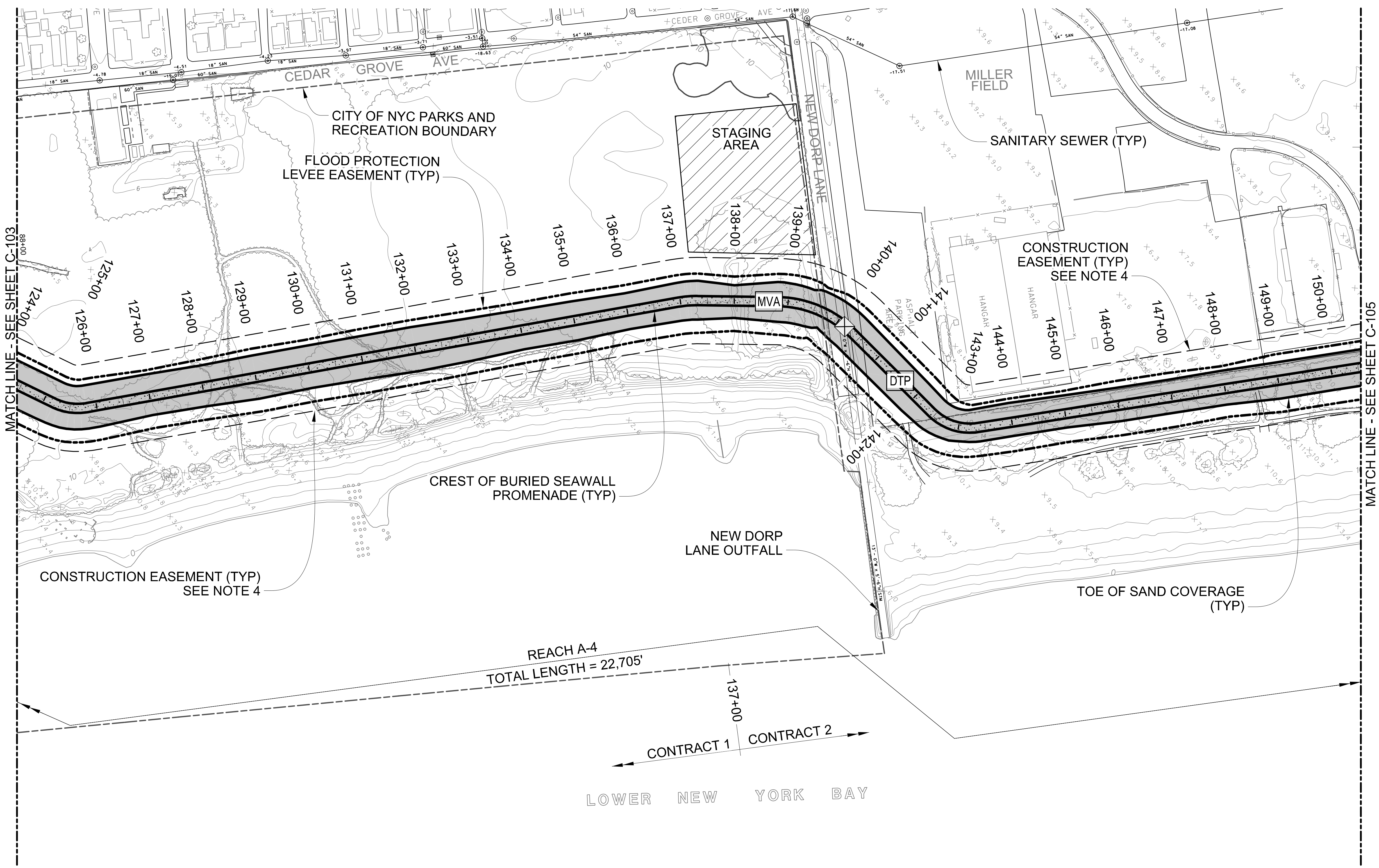

FINAL JUNE 2016
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TG	TIDE GATE SEE SHEET C-513
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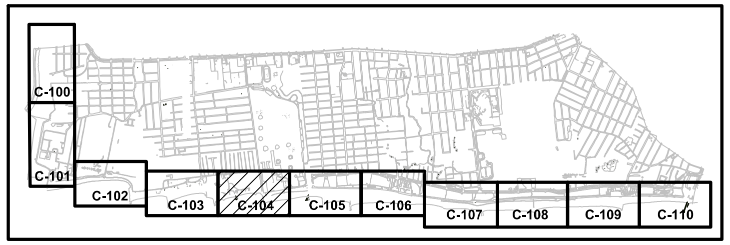
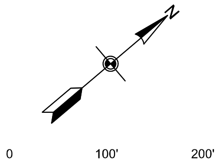
W x H STM	MAJOR STORM SEWER OUTFALL
▒	SAND COVER
▨	BOARDWALK SEE SHEET C-507
⁘	PROMENADE SEE SHEET C-504



KEY PLAN



SCALE:1"=100'

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MARK	DESCRIPTION	DATE	APPR.
2	INCORPORATES SPONSOR AND STAKEHOLDER COMMENTS	3/21/2016	MAP
1	REVISIONS FOR AJR COMMENTS	1/9/2015	MAP

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NEW YORK
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New York, New York 10017
212-768-7454

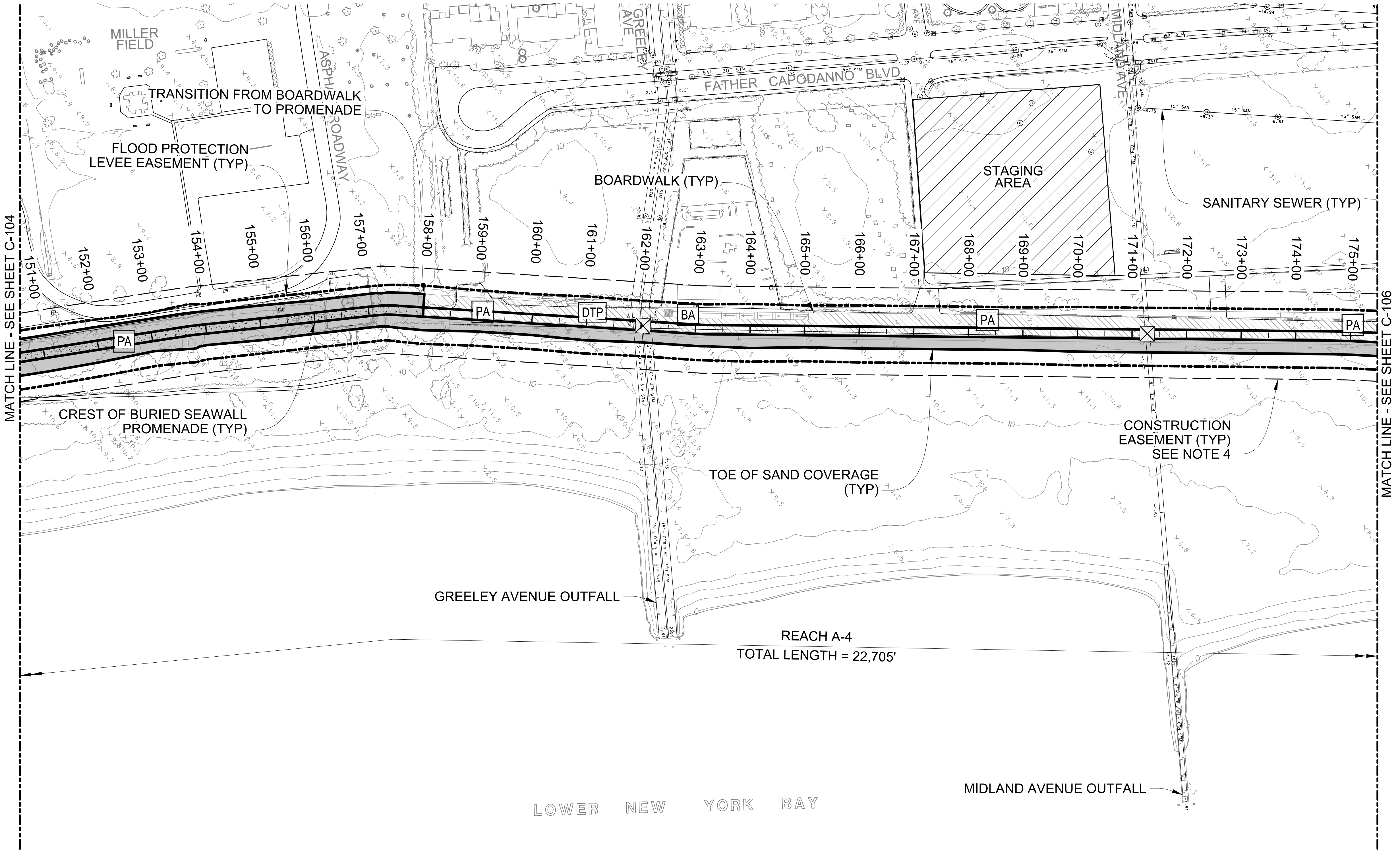
DESIGNED BY: MAP		DATE: 2016/03/11
DWN BY: DJMac	CKD BY: MAP	SOLICITATION NO.: XXXX
SUBMITTED BY: MARK PIRELLO		CONTRACT NO.: XXXX
PLOT SCALE: 1:200	PLOT DATE: 6/2/2016	FILE NUMBER: XXXX
SIZE: ANSI D	FILE NAME: 698705C-104.dgn	

COASTAL STORM RISK MANAGEMENT
FEASIBILITY STUDY FOR THE
SOUTH SHORE OF STATEN ISLAND

SITE PLAN (5 OF 11)

SHEET
IDENTIFICATION
C-104
SHEET OF

LAST PLOTTED BY: arsmith 3:10:32 PM 6/2/2016 FILE: 698705C-105.dgn PATH: Q:\TA6987-05\cadd_Active_Preliminary\

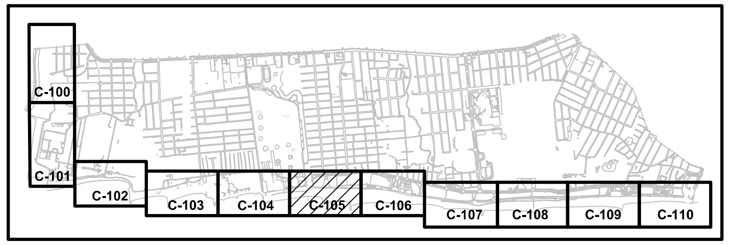


NOTES

1. TYPICAL SECTIONS SHOWN ON SHEETS C-501 TO C-507.
2. ALL ELEVATIONS REFERENCED TO NGVD 29.
3. STRUCTURE LIMITS SHOWN FOR LEVEL OF PROTECTION ARE BASED ON THE 15.6 FT SWL.
4. CONSTRUCTION EASEMENT LINE @ 50' OFFSET TO PROPOSED STRUCTURES.
5. CLOSURE STRUCTURE ON SHEETS C-515 & C-516.
6. SANITARY SERVICE ROAD SECTION SHOWN ON SHEET C-507.
7. THE LINE OF PROTECTION (LOP) STRUCTURES WITHIN THE OAKWOOD BEACH CORRIDOR HAVE BEEN DESIGNED TO ACCOMMODATE THE CITY OF NEW YORK'S STATEN ISLAND BLUEBELT PLAN.

LEGEND

PA	PEDESTRIAN ACCESS STAIRS SEE SHEET C-509
DTP	COMBINED TRUCK & PEDESTRIAN ACCESS RAMP, SEE SHEET C-510
MVA	MAINTENANCE VEHICLE ACCESS RAMP, SEE SHEET C-510
BA	BOARDWALK ACCESS SEE SHEET C-508
☒	DRAINAGE CONTROL STRUCTURE, SEE SHEET C-512
▦	SANITARY/DRAINAGE CONTROL STRUCTURE SEE SHEET C-514
TG	TIDE GATE SEE SHEET C-513
30" SAN. -8.71	SANITARY SEWER
— ▼ × H STM —	MAJOR STORM SEWER OUTFALL
■	SAND COVER
▨	BOARDWALK SEE SHEET C-507
⁖	PROMENADE SEE SHEET C-504



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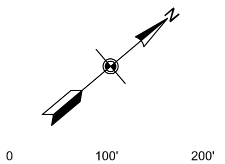

SCALE:1"=100'

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MARK	DESCRIPTION	DATE	APPR.
2	INCORPORATES SPONSOR AND STAKEHOLDER COMMENTS	3/21/2016	MAP
1	REVISIONS FOR AJR COMMENTS	1/9/2015	MAP

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CKD BY: MAP
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SUBMITTED BY: MARK PIRELLO
CONTRACT NO.: XXXX
PLOT SCALE: 1:200
PLOT DATE: 6/2/2016
FILE NUMBER: XXXX
SIZE: ANSI D
FILE NAME: 698705C-105.dgn

COASTAL STORM RISK MANAGEMENT
FEASIBILITY STUDY FOR THE
SOUTH SHORE OF STATEN ISLAND

SITE PLAN (6 OF 11)

SHEET IDENTIFICATION
C-105
SHEET OF

PATH: Q:\TA\6987-05\cadd_Active_Preliminary\

FILE: 698705C-106.dgn

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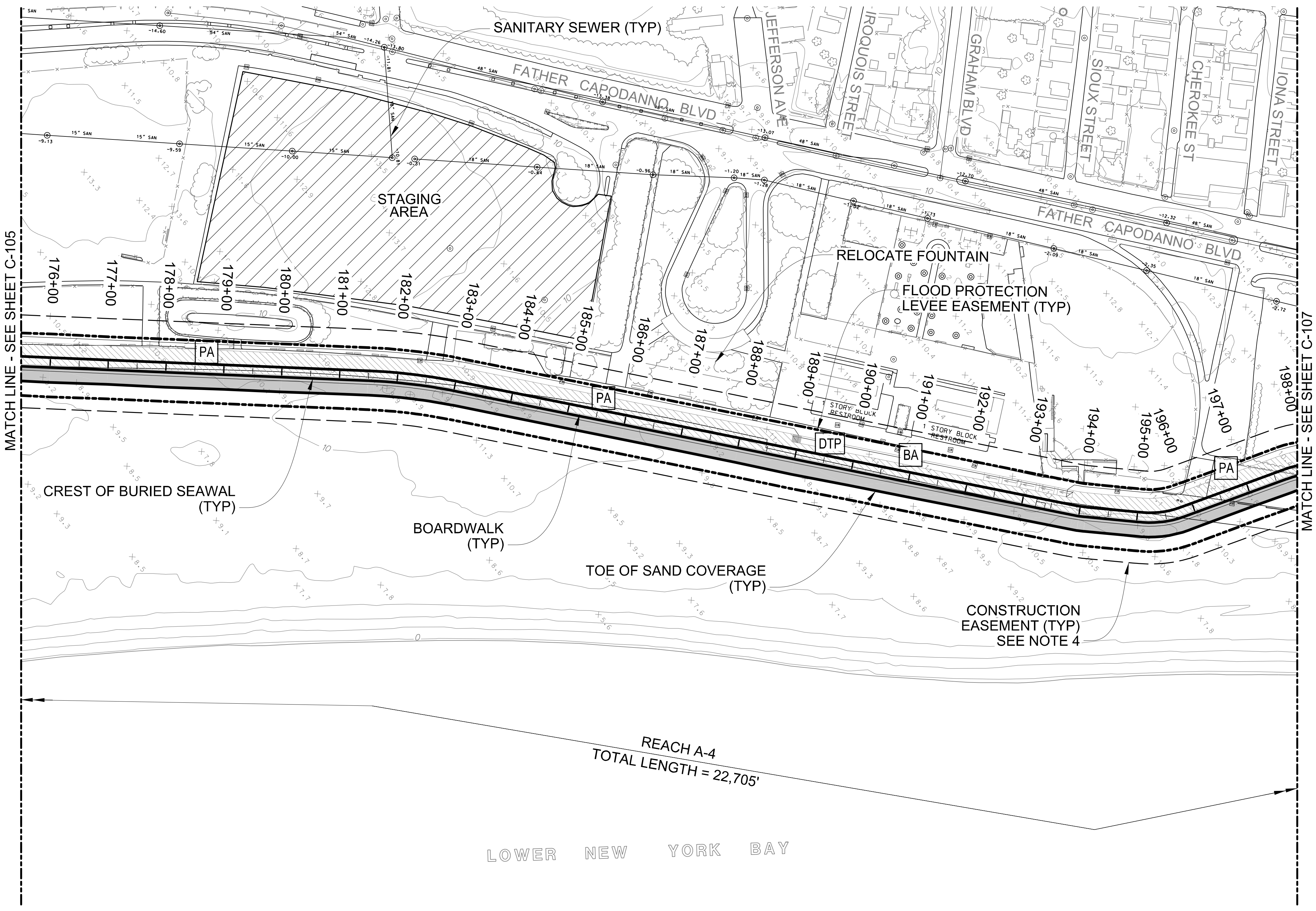

NOTES

1. TYPICAL SECTIONS SHOWN ON SHEETS C-501 TO C-507.
2. ALL ELEVATIONS REFERENCED TO NGVD 29.
3. STRUCTURE LIMITS SHOWN FOR LEVEL OF PROTECTION ARE BASED ON THE 15.6 FT SWL.
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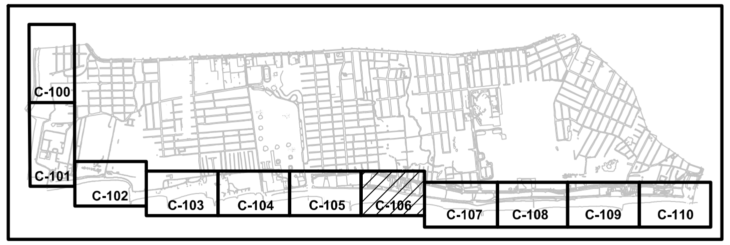
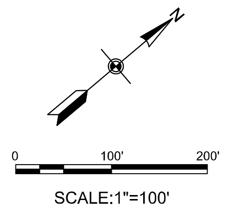
FINAL JUNE 2016
NOT FOR CONSTRUCTION

LEGEND

PA	PEDESTRIAN ACCESS STAIRS SEE SHEET C-509
DTP	COMBINED TRUCK & PEDESTRIAN ACCESS RAMP, SEE SHEET C-510
MVA	MAINTENANCE VEHICLE ACCESS RAMP, SEE SHEET C-510
BA	BOARDWALK ACCESS SEE SHEET C-508
☒	DRAINAGE CONTROL STRUCTURE, SEE SHEET C-512
▦	SANITARY/DRAINAGE CONTROL STRUCTURE SEE SHEET C-514
TG	TIDE GATE SEE SHEET C-513
30" SAN. -8.71	SANITARY SEWER
W x H STM	MAJOR STORM SEWER OUTFALL
■	SAND COVER
▨	BOARDWALK SEE SHEET C-507
⁘	PROMENADE SEE SHEET C-504



KEY PLAN



SCALE:1"=100'

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MARK	DESCRIPTION	DATE	APPR.
2	INCORPORATES SPONSOR AND STAKEHOLDER COMMENTS	3/21/2016	MAP
1	REVISIONS FOR AJR COMMENTS	1/9/2015	MAP

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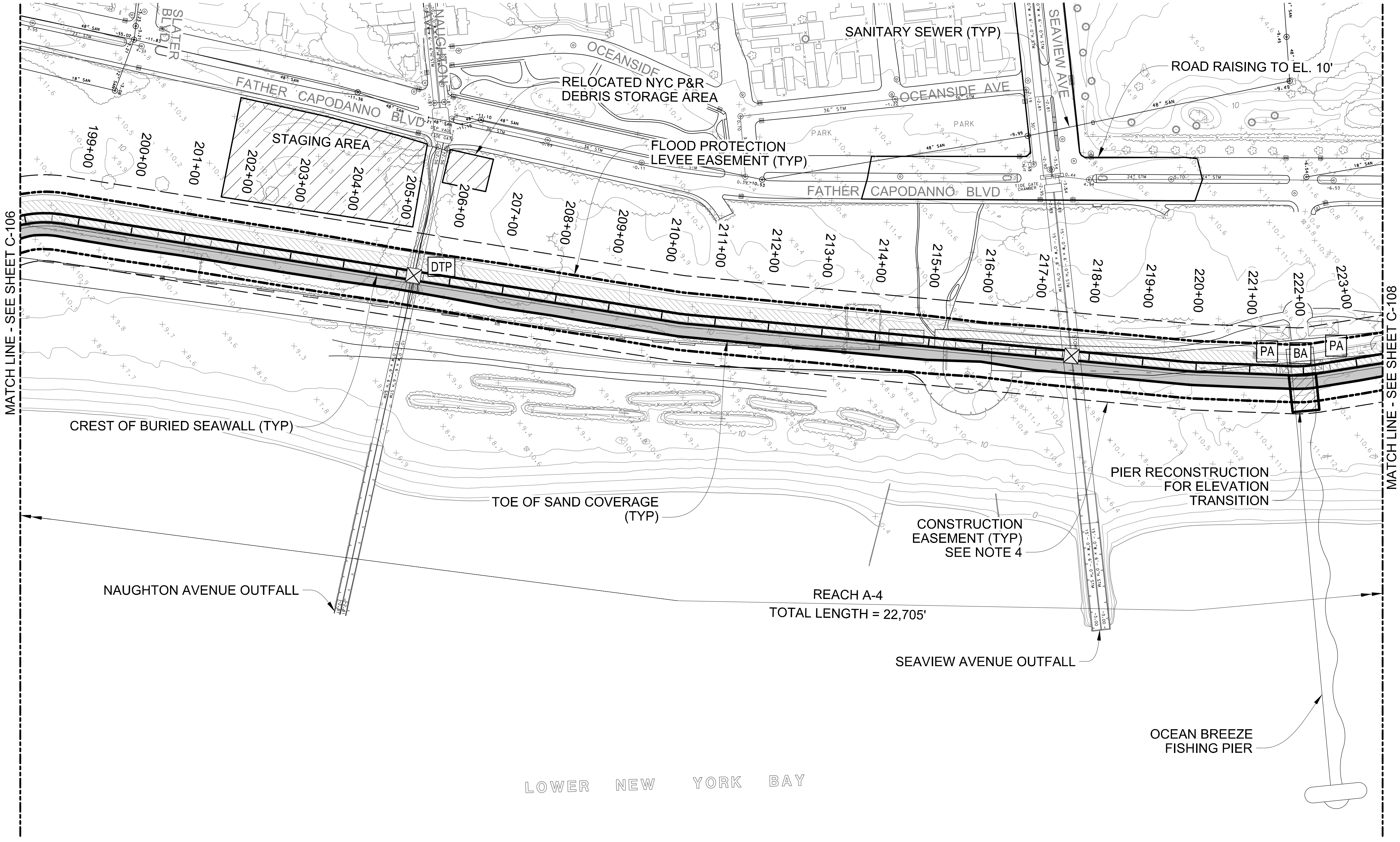
DWN BY: DJMac
CKD BY: MAP
SUBMITTED BY: MARK PIRELLO
PLOT SCALE: 1:200
PLOT DATE: 6/2/2016
SIZE: ANSI D
FILE NAME: 698705C-106.dgn
DATE: 2016/03/11
SOLICITATION NO.: XXXX
CONTRACT NO.: XXXX
FILE NUMBER: XXXX

COASTAL STORM RISK MANAGEMENT
FEASIBILITY STUDY FOR THE
SOUTH SHORE OF STATEN ISLAND

SITE PLAN (7 OF 11)

SHEET IDENTIFICATION
C-106
SHEET OF



NOTES

1. TYPICAL SECTIONS SHOWN ON SHEETS C-501 TO C-507.
2. ALL ELEVATIONS REFERENCED TO NGVD 29.
3. STRUCTURE LIMITS SHOWN FOR LEVEL OF PROTECTION ARE BASED ON THE 15.6 FT SWL.
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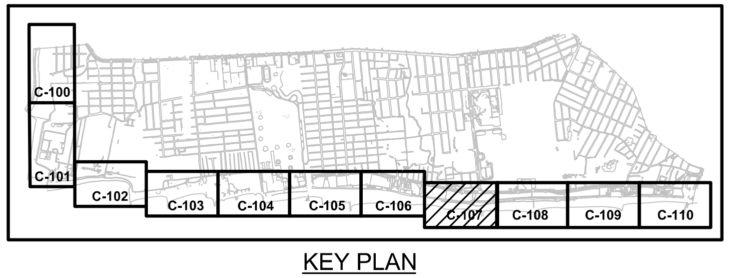
7. THE LINE OF PROTECTION (LOP) STRUCTURES WITHIN THE OAKWOOD BEACH CORRIDOR HAVE BEEN DESIGNED TO ACCOMMODATE THE CITY OF NEW YORK'S STATEN ISLAND BLUEBELT PLAN.

LEGEND

PA	PEDESTRIAN ACCESS STAIRS SEE SHEET C-509
DTP	COMBINED TRUCK & PEDESTRIAN ACCESS RAMP, SEE SHEET C-510
MVA	MAINTENANCE VEHICLE ACCESS RAMP, SEE SHEET C-510
BA	BOARDWALK ACCESS SEE SHEET C-508
☒	DRAINAGE CONTROL STRUCTURE, SEE SHEET C-512
▦	SANITARY/DRAINAGE CONTROL STRUCTURE SEE SHEET C-514
TG	TIDE GATE SEE SHEET C-513
30" SAN. -8.71	SANITARY SEWER
W x H STM	MAJOR STORM SEWER OUTFALL
■	SAND COVER
▨	BOARDWALK SEE SHEET C-507
⁘	PROMENADE SEE SHEET C-504



KEY PLAN

N

0 100' 200'

SCALE:1"=100'

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US Army Corps
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MARK	DESCRIPTION	DATE	APPR.
2	INCORPORATES SPONSOR AND STAKEHOLDER COMMENTS	3/21/2016	MAP
1	REVISIONS FOR AJR COMMENTS	1/9/2015	MAP

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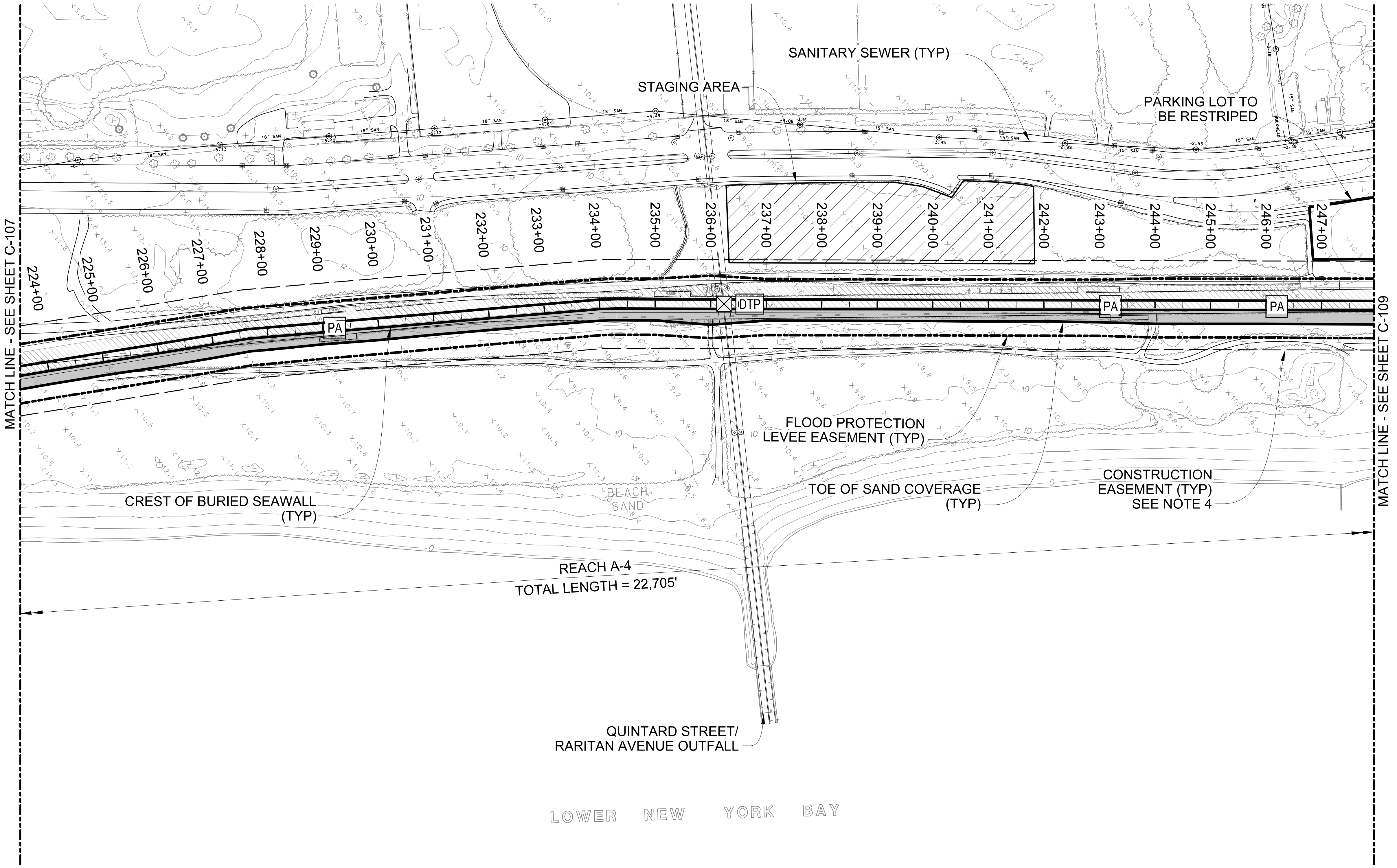
DWN BY:	CKD BY: MAP	SOLICITATION NO.: XXXX
SUBMITTED BY:		CONTRACT NO.: XXXX
PLOT SCALE: 1:200	PLOT DATE: 6/2/2016	FILE NUMBER:
SIZE: ANSI D	FILE NAME: 698705C-107.dgn	

COASTAL STORM RISK MANAGEMENT
FEASIBILITY STUDY FOR THE
SOUTH SHORE OF STATEN ISLAND

SITE PLAN (8 OF 11)

SHEET
IDENTIFICATION
C-107
SHEET OF

PATH: Q:\TA\6987-05\cadd_Active_Preliminary\ FILE: 698705C-108.dgn 6/2/2016 3:12:33 PM LAST PLOTTED BY: arsmith



NOTES

1. TYPICAL SECTIONS SHOWN ON SHEETS C-501 TO C-507.
2. ALL ELEVATIONS REFERENCED TO NGVD 29.
3. STRUCTURE LIMITS SHOWN FOR LEVEL OF PROTECTION ARE BASED ON THE 15.6 FT SWL.
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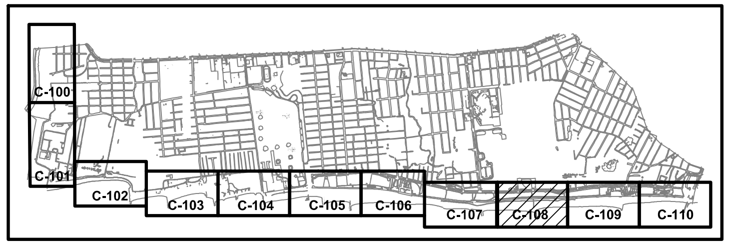
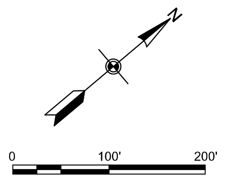
7. THE LINE OF PROTECTION (LOP) STRUCTURES WITHIN THE OAKWOOD BEACH CORRIDOR HAVE BEEN DESIGNED TO ACCOMMODATE THE CITY OF NEW YORK'S STATEN ISLAND BLUEBELT PLAN.

LEGEND

PA	PEDESTRIAN ACCESS STAIRS SEE SHEET C-509
DTP	COMBINED TRUCK & PEDESTRIAN ACCESS RAMP, SEE SHEET C-510
MVA	MAINTENANCE VEHICLE ACCESS RAMP, SEE SHEET C-510
BA	BOARDWALK ACCESS SEE SHEET C-508
☒	DRAINAGE CONTROL STRUCTURE, SEE SHEET C-512
▦	SANITARY/DRAINAGE CONTROL STRUCTURE SEE SHEET C-514
TG	TIDE GATE SEE SHEET C-513
30" SAN. -8.71	SANITARY SEWER
X' x H STM	MAJOR STORM SEWER OUTFALL
■	SAND COVER
▨	BOARDWALK SEE SHEET C-507
⁘	PROMENADE SEE SHEET C-504



KEY PLAN



SCALE:1"=100'

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MARK	DESCRIPTION	DATE	APPR.
2	INCORPORATES SPONSOR AND STAKEHOLDER COMMENTS	3/21/2016	MAP
1	REVISIONS FOR AJR COMMENTS	1/9/2015	MAP

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DATE: 2016/03/11
DWN BY: DJMac
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SOLICITATION NO.: XXXX
SUBMITTED BY: MARK PIRELLO
CONTRACT NO.: XXXX
PLOT SCALE: 1:200
PLOT DATE: 6/2/2016
FILE NUMBER: XXXX
SIZE: ANSI D
FILE NAME: 698705C-108.dgn

COASTAL STORM RISK MANAGEMENT
FEASIBILITY STUDY FOR THE
SOUTH SHORE OF STATEN ISLAND

SITE PLAN (9 OF 11)

SHEET IDENTIFICATION
C-108
SHEET OF

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FILE: 698705C-109.dgn

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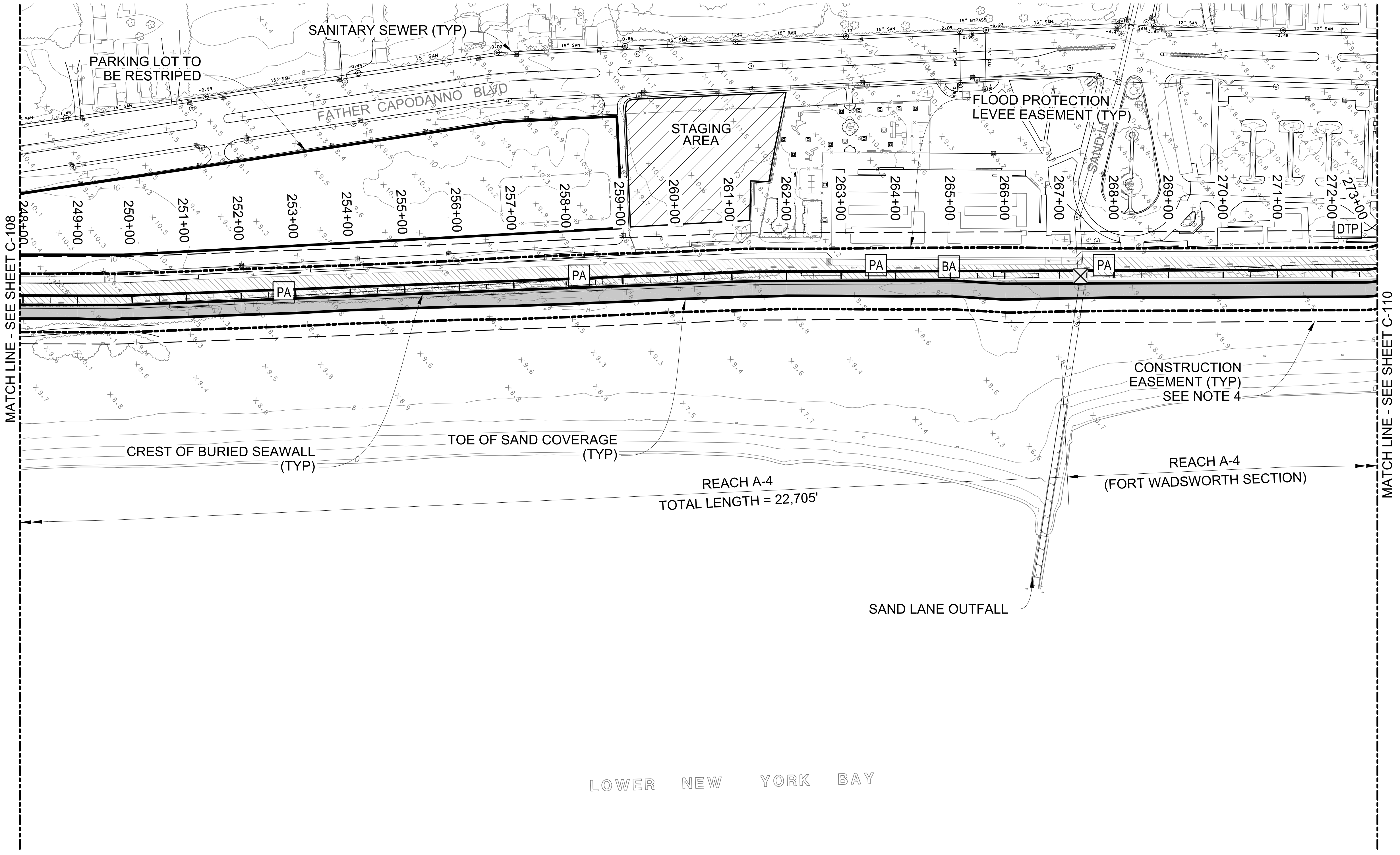
LAST PLOTTED BY: arsmith



NOTES

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LEGEND

PA	PEDESTRIAN ACCESS STAIRS SEE SHEET C-509
DTP	COMBINED TRUCK & PEDESTRIAN ACCESS RAMP, SEE SHEET C-510
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BA	BOARDWALK ACCESS SEE SHEET C-508
☒	DRAINAGE CONTROL STRUCTURE, SEE SHEET C-512
▦	SANITARY/DRAINAGE CONTROL STRUCTURE SEE SHEET C-514
TG	TIDE GATE SEE SHEET C-513
30" SAN. −8.71	SANITARY SEWER
W x H STM	MAJOR STORM SEWER OUTFALL
■	SAND COVER
▨	BOARDWALK SEE SHEET C-507
⁘	PROMENADE SEE SHEET C-504

KEY PLAN

0 100' 200'

SCALE:1"=100'

FINAL JUNE 2016
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MARK	DESCRIPTION	DATE	APPR.
2	INCORPORATES SPONSOR AND STAKEHOLDER COMMENTS	3/21/2016	MAP
1	REVISIONS FOR AJR COMMENTS	1/9/2015	MAP

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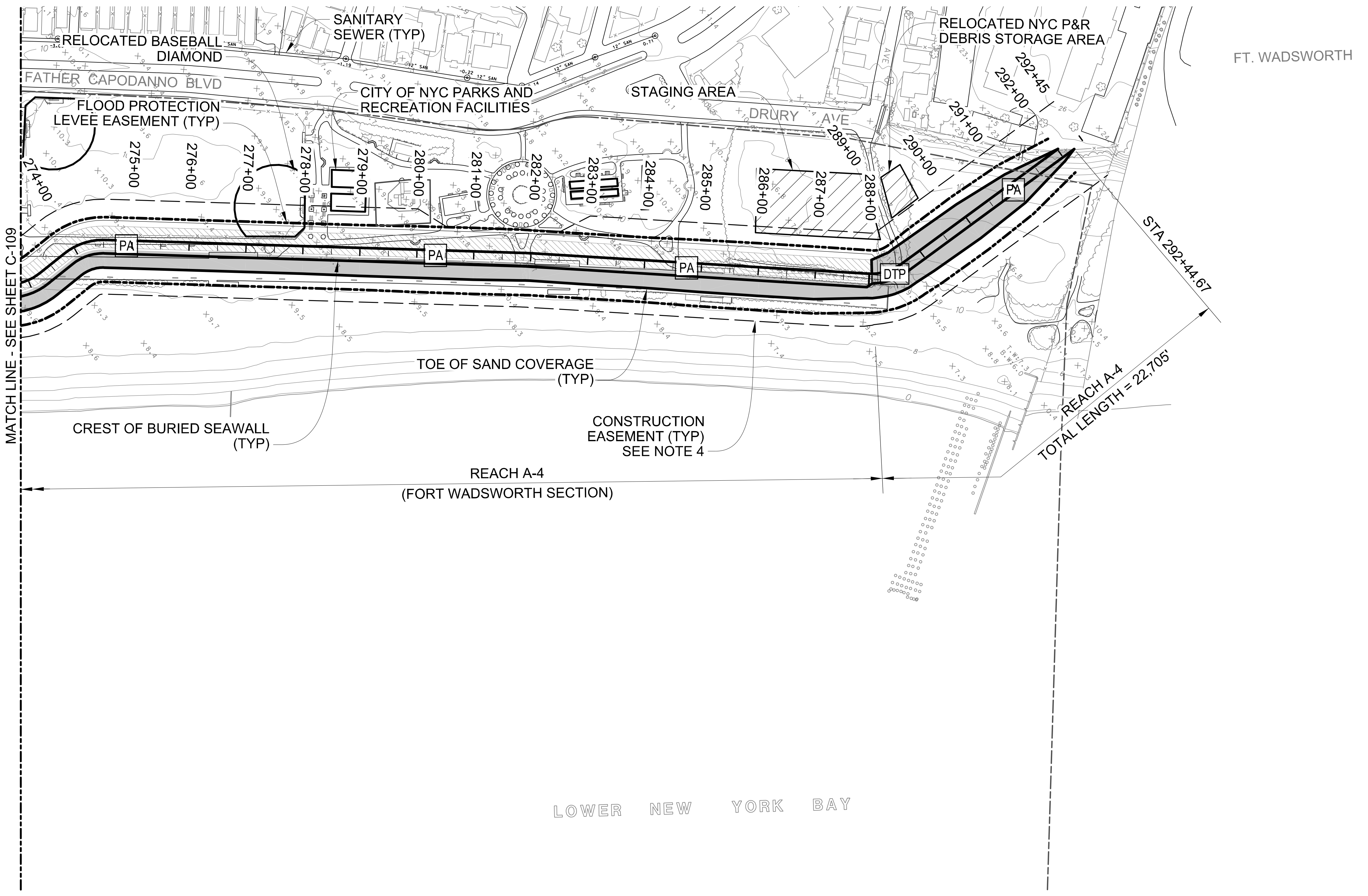
SUBMITTED BY: MARK PIRELLO
PLOT SCALE: 1:200
PLOT DATE: 6/2/2016
SIZE: ANSI D
FILE NAME: 698705C-109.dgn
DATE: 2016/03/11
SOLICITATION NO.: XXXX
CONTRACT NO.: XXXX
FILE NUMBER: XXXX

COASTAL STORM RISK MANAGEMENT
FEASIBILITY STUDY FOR THE
SOUTH SHORE OF STATEN ISLAND

SITE PLAN (10 OF 11)

SHEET IDENTIFICATION
C-109
SHEET OF

LAST PLOTTED BY: arsmith 3:13:55 PM 6/2/2016 FILE: 698705C-110.dgn PATH: Q:\TA\6987-05\cadd_Active_Preliminary\



FINAL JUNE 2016
NOT FOR CONSTRUCTION

NOTES

1. TYPICAL SECTIONS SHOWN ON SHEETS C-501 TO C-507.
2. ALL ELEVATIONS REFERENCED TO NGVD 29.
3. STRUCTURE LIMITS SHOWN FOR LEVEL OF PROTECTION ARE BASED ON THE 15.6 FT SWL.
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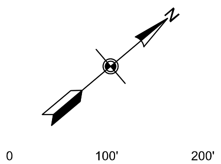
LEGEND

PA	PEDESTRIAN ACCESS STAIRS SEE SHEET C-509
DTP	COMBINED TRUCK & PEDESTRIAN ACCESS RAMP, SEE SHEET C-510
MVA	MAINTENANCE VEHICLE ACCESS RAMP, SEE SHEET C-510
BA	BOARDWALK ACCESS SEE SHEET C-508
☒	DRAINAGE CONTROL STRUCTURE, SEE SHEET C-512
▦	SANITARY/DRAINAGE CONTROL STRUCTURE SEE SHEET C-514
TG	TIDE GATE SEE SHEET C-513
30" SAN. -8.71	SANITARY SEWER
X' x H' STM	MAJOR STORM SEWER OUTFALL
■	SAND COVER
▨	BOARDWALK SEE SHEET C-507
⁘	PROMENADE SEE SHEET C-504

KEY PLAN



SCALE:1"=100'

MARK	DESCRIPTION	DATE	APPR.
2	INCORPORATES SPONSOR AND STAKEHOLDER COMMENTS	3/21/2016	MAP
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DESIGNED BY: MAP
DATE: 2016/03/11
DWN BY: DJMac
CKD BY: MAP
SOLICITATION NO.: XXXX
SUBMITTED BY: MARK PIRELLO
CONTRACT NO.: XXXX
PLOT SCALE: 1:200
PLOT DATE: 6/2/2016
FILE NUMBER: XXXX
SIZE: ANSI D
FILE NAME: 698705C-110.dgn

COASTAL STORM RISK MANAGEMENT
FEASIBILITY STUDY FOR THE
SOUTH SHORE OF STATEN ISLAND

SITE PLAN (11 OF 11)

SHEET IDENTIFICATION
C-110
SHEET OF

PATH: Q:\TA\6987-05\cadd_Active_Preliminary\

FILE: 698705C-501.dgn

6/2/2016

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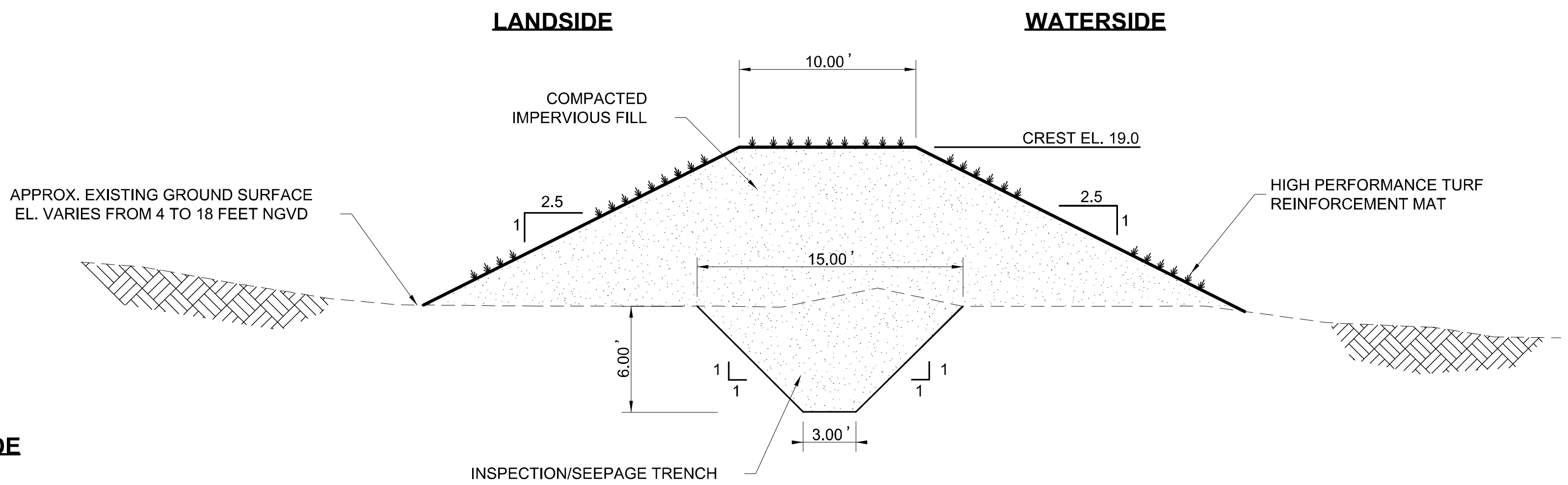
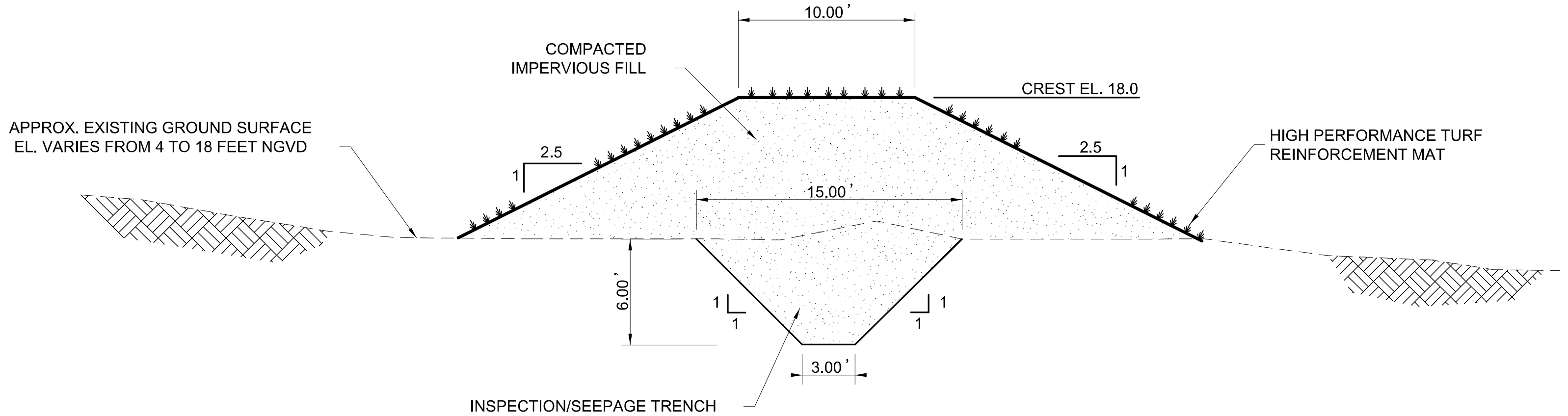
LAST PLOTTED BY: arsmith



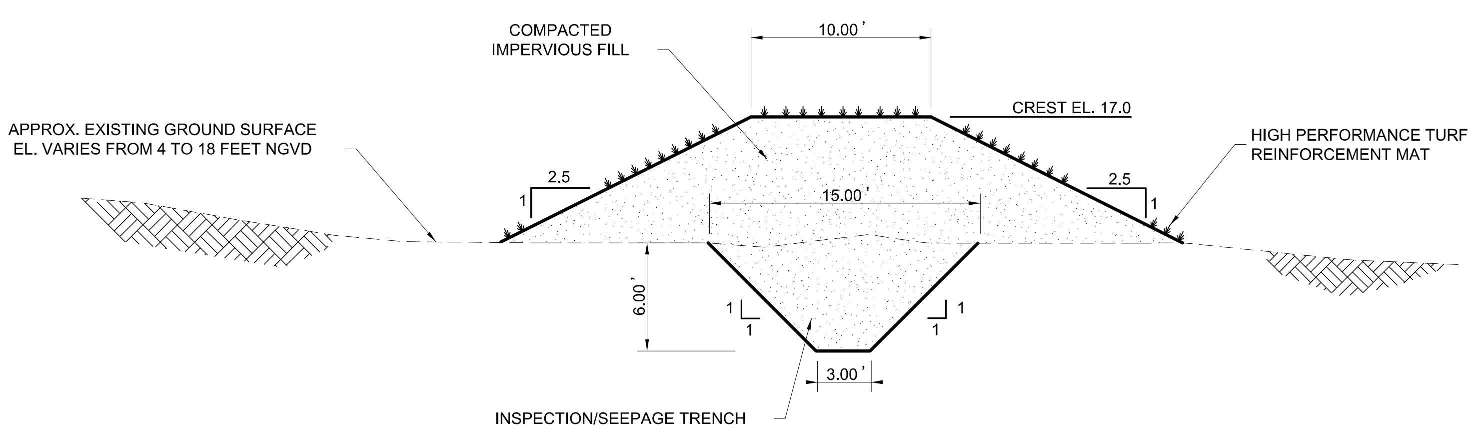
D4 C-501 LEVEE SECTION (16.6 FT SWL)

SCALE: 3/16"=1'-0"



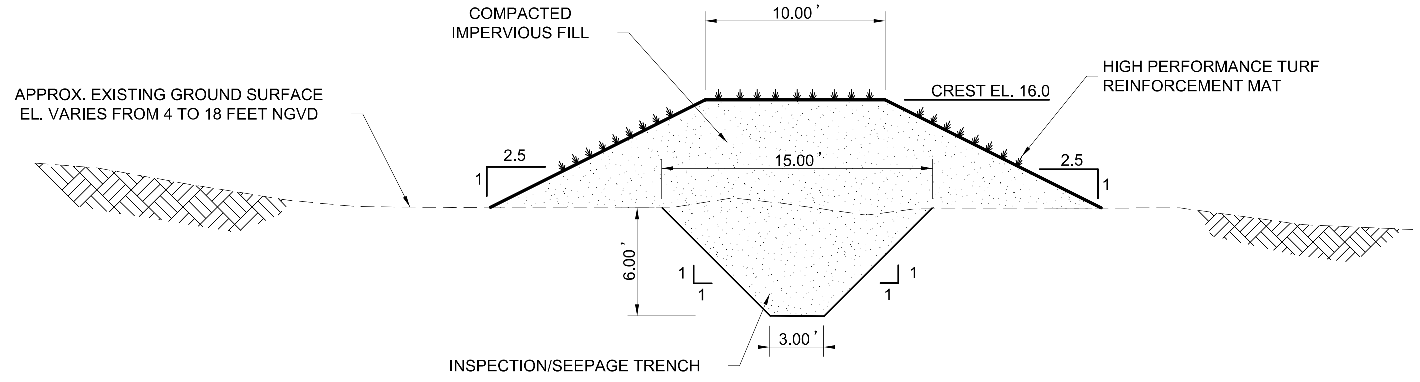
C2 C-501 LEVEE SECTION (15.6 FT SWL)

SCALE: 3/16"=1'-0"



B4 C-501 LEVEE SECTION (14.3 FT SWL)

SCALE: 3/16"=1'-0"



A2 C-501 LEVEE SECTION (13.3 FT SWL)

SCALE: 3/16"=1'-0"

NOTES

1. SECTION REPRESENTS STA 10+25 TO 13+40 AND 15+00 TO 40+00.

FINAL JUNE 2016
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0 4' 8' 12'
SCALE:3/16"=1'

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MARK	DESCRIPTION	DATE	APPR.
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DESIGNED BY: MAP
DATE: 2016/03/11
DWN BY: CSG
CKD BY: MAP
SOLICITATION NO.:
SUBMITTED BY:
CONTRACT NO.:
PLOT SCALE: 1:2
PLOT DATE: 6/2/2016
FILE NUMBER:
SIZE: ANSI D
FILE NAME: 698705C-501.dgn

COASTAL STORM RISK MANAGEMENT
FEASIBILITY STUDY FOR THE
SOUTH SHORE OF STATEN ISLAND

TYPICAL SECTIONS REACH A-1

SHEET IDENTIFICATION
C-501
SHEET OF

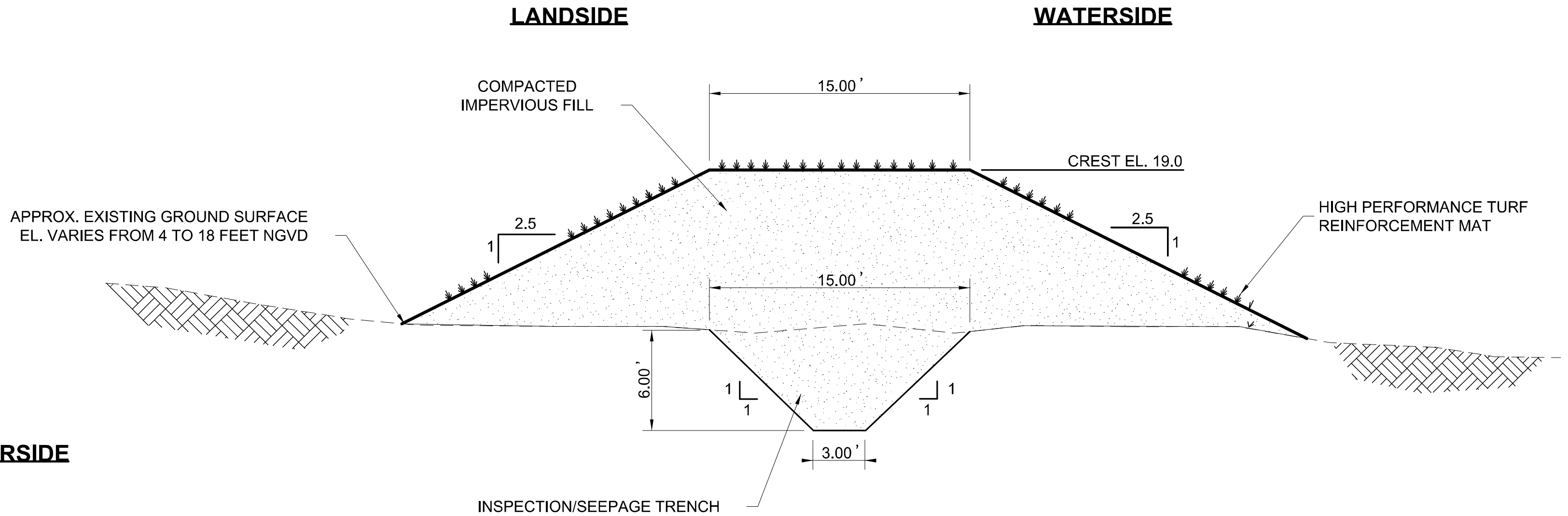
PATH: Q:\TA\6987-05\cadd_Active_Preliminary\

FILE: 698705C-502.dgn

6/2/2016

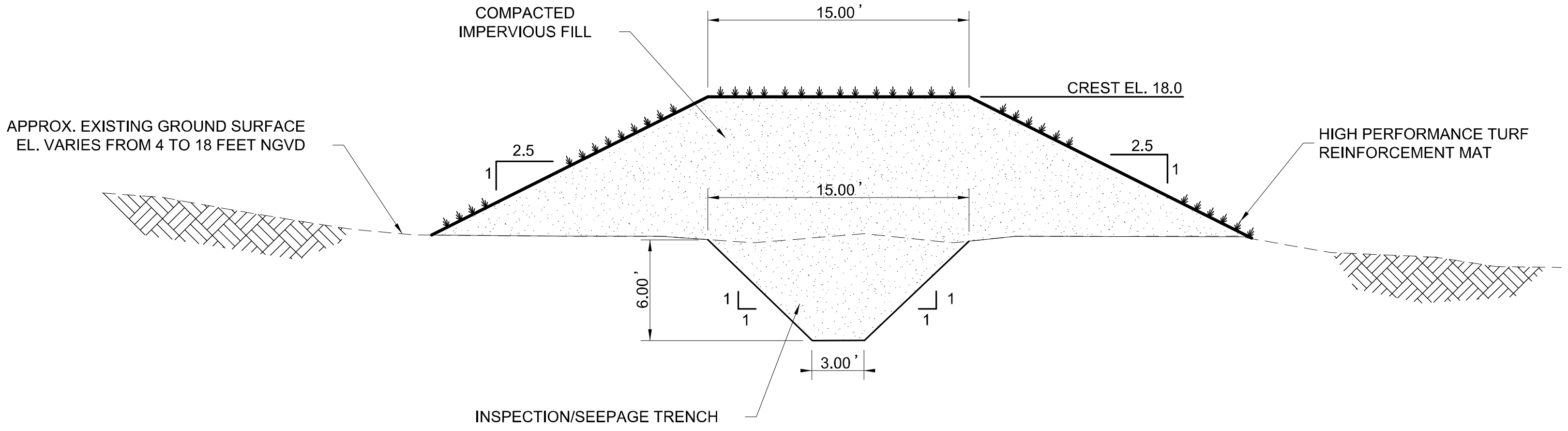
3:14:00 PM

LAST PLOTTED BY: arsmith



D4 C-502 LEVEE SECTION (16.6 FT SWL)

SCALE: 3/16"=1'-0"



C2 C-502 LEVEE SECTION (15.6 FT SWL)

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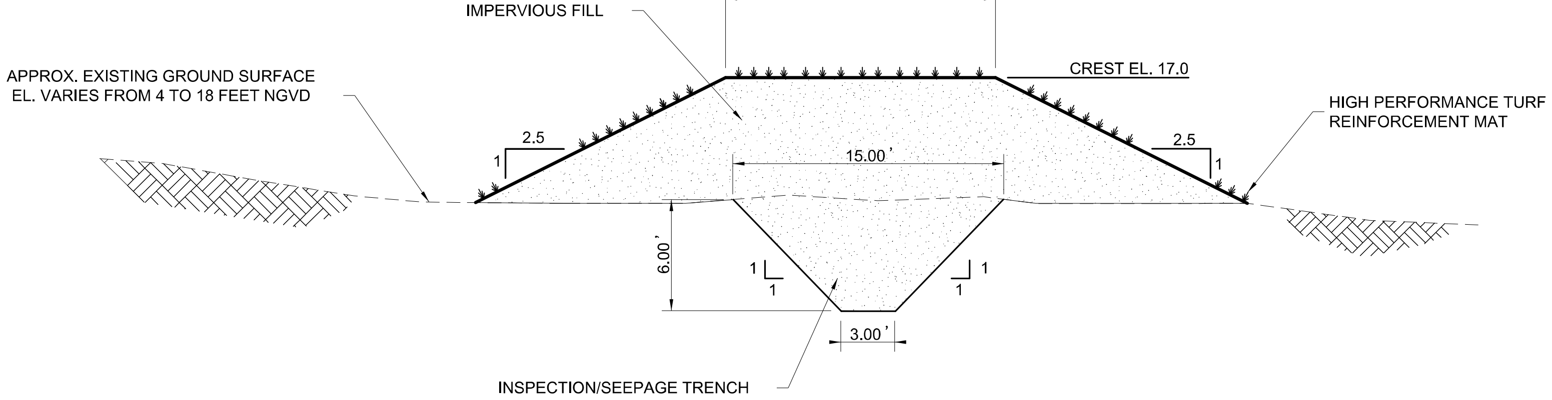
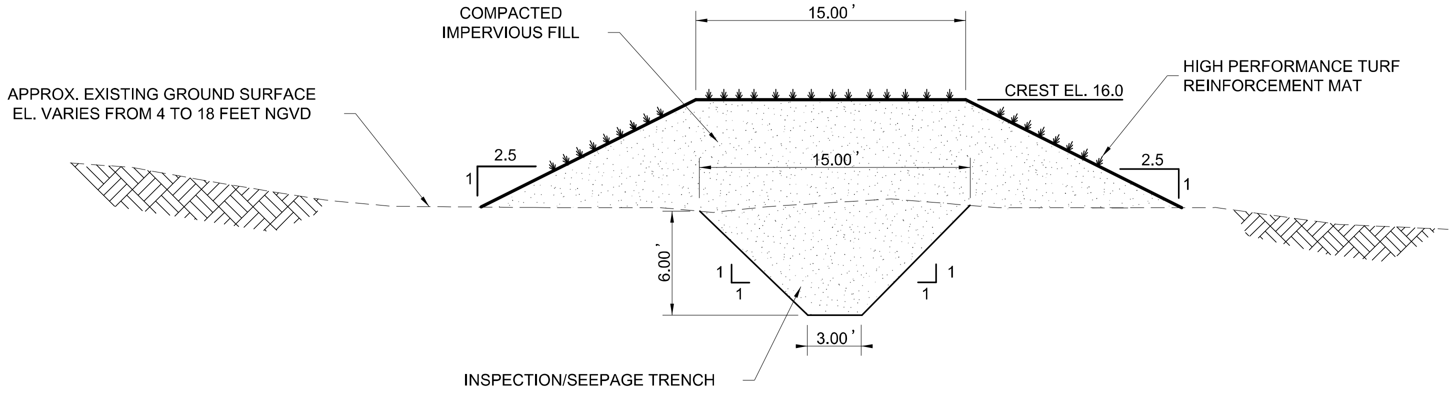


B4 C-502 LEVEE SECTION (14.3 FT SWL)

SCALE: 3/16"=1'-0"



A2 C-502 LEVEE SECTION (13.3 FT SWL)

SCALE: 3/16"=1'-0"

NOTES

1. SECTION REPRESENTS STA 41+00 TO STA 47+14.81.

FINAL JUNE 2016
NOT FOR CONSTRUCTION

0 4' 8' 12'
SCALE:3/16"=1'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
2	INCORPORATES SPONSOR AND STAKEHOLDER COMMENTS	3/21/2016	MAP
1	REVISIONS FOR AJR COMMENTS	1/9/2015	MAP

DESIGNED BY: MAP
DATE: 2016/03/11
DWN BY: CSG
CKD BY: MAP
SOLICITATION NO.:
SUBMITTED BY:
CONTRACT NO.:
PLOT SCALE: 1:2
PLOT DATE: 6/2/2016
FILE NUMBER:
SIZE: ANSI D
FILE NAME: 698705C-502.dgn

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 5th Avenue, 14th Floor
New York, New York 10017
212-768-7454

COASTAL STORM RISK MANAGEMENT
FEASIBILITY STUDY FOR THE
SOUTH SHORE OF STATEN ISLAND

TYPICAL SECTIONS REACH A-2

SHEET IDENTIFICATION
C-502
SHEET OF

Riverside Drive/Ash Creek Resilience Study

APPENDIX K – Public Meeting Materials – July 12, 2016

FINAL

MINUTES OF THE SPECIAL MEETING OF FLOOD & EROSION CONTROL BOARD THE TOWN OF FAIRFIELD JULY 12, 2016

The Special Meeting of the Flood & Erosion Control Board was held on Tuesday July 12, 2016 at 7:00 P.M, the Board of Education Building, Kings Highway.

PRESENT: Rick Grauer, Dick Dmochowski, Steve Stearns, Don Lamberty
ABSENT: Paul Landino

Malone & MacBroom Representatives David Murphy (M&M), John McGrane (GEI), Jennifer O'Donnell (COA), Conservation Director Brian Carey, Public Works Director Joe Michelangelo, Chief of Staff, Tom Dubrosky, members of the public.

The special meeting was called to order at 7:10 P.M. by F&E Chairman Rick Grauer.

ITEM 1 ON CALL: INTRODUCTION OF FLOOD & EROSION CONTROL BOARD

After introduction of Board Members, Mr. Grauer stated the F&E Control Board created a masterplan, we are here to discuss Measure #1. The Flood & Erosion Control Board is your voice to solve the flooding situation in our Town. Our email address is FECB@fairfieldct.org on the Town website. We are still in the study phase for this measure and need public support to make this happen.

ITEM 2 ON CALL: PRESENTATION OF COASTAL RESILIENCY PLANNING STUDY FROM RIVERSIDE DRIVE TO JENNINGS BEACH BY MILONE & MACBROOM, CONSULTING ENGINEERS

Conservation Director Brian Carey explained the grant for this study was obtained from CDBG-CR program thru the State of Connecticut coastal resiliency studies from Riverside Ave to Jennings Beach. The project was awarded to Malone & MacBroom, who have a long history of coastal studies. They are here to show potential solutions. This is a planning grant. He then introduced David Murphy of Milone & MacBroom.

Mr. Murphy explained the background of this project, then presented the audience with a 40 minute Power Point Presentation of this very complex area. Flood Protection is intrusive work. He equated Resiliency to Reduced Recovery Time, Risk, to Frequency x Vulnerability. Although we can't control frequency, we can control our vulnerability.

Segment I deals with the existing dike and tide gates system. He shared elevation videos of Riverside Ave. and Bay Edge Ct.

Alicia Israel, asked, “Why this area if there was no flooding?”

Mr. Murphy commented the dikes and tide gates are methods to reduce wave levels.

*See Power Point Attachment for detailed slides.

ITEM 3 ON CALL: PUBLIC COMMENTS AND QUESTIONS ON THE PLAN

The floor was opened to the public for questions.

Sally Harold, South Benson Road,“ Is flood proofing storm drains being considered?

Mr. Michelangelo commented, water will still find its path once it gets past the barrier.

Alicia Israel, asked, “Why this area if there was no flooding?”

Mr. Murphy commented the dikes and tide gates are methods to reduce wave levels.

Craig Tolmie, Riverside Drive, shared comments about the cresting tide, 3 hrs before high tide filled the marsh at the marina.

Alicia Israel, Rowland Road**, “**Why haven’t we had a nice study like this?” There is no planning grant for our area.

Mr. Grauer noted, the project is financially too big to be one study that’s why we have 12-13 segments being addressed. How much protection do the homeowners really want?

Mr. Carey explained,
1. The $250,000 is the whole study, not easily negated with one solution.
2. Conservation has aging tide gates that would be in need of replacement.
3. The Town owns a lot of land in that area, something could be done quickly.

The area didn’t flood in Sandy but will during the 100 year storm that’s why the study.

Alicia Israel, “I am not a fan of these expensive studies, we need to look at the end goal, will there be funding? People don’t want berms, they want things that will work for the whole area.”

Eileen Wilhelm, Shoreham Village Dr., The flood gates directly affect their properties.

Karen Wackerman, Shoreham Village Dr., RTM Rep, “Are there steps to raising the dikes?”

Mr. Carey commented, “We need to make sure the existing infrastructure is functioning during storms.
Mr. Michelangelo, “Flooding will still occur in multiple ways.”
Don Lamberty, “Is there anything less than 12’, less obtrusive that can be done?”
Mr. Murphy, “Does it make sense? Maybe.Will it pass FEMA regulations? No”
All these questions need to be sorted out.

Bill Schaberg, Riverside Dr. commented – they never had any flooding, 3 weeks ago paid off mortage, first thing he did was cancel his flood insurance.

Kristin McCarthy –Vahee, State Rep District # 133
“Will there be suggestions in the documents that will include other options or just the elevations 12’, 14’ 18’? Will you be looking for eligible money?

Mr. Murphy stated, “We will need to get creative with the funding sources.”

Alicia Israel, “The Town got 9 million dollars to elevate homes, but only 4.5 million had been used, where is that unused money? Would you be willing to find out?”

Mr. Murphy,” Typically, unused money is returned to the State.”

Mr. Grauer closed the Q&A noting that the presentation will be posted in the documents link on the FECB website – www.fairfieldct.org/FECB . Please send emails with your concerns.

The meeting adjourned at 8:15 pm

Respectfully Submitted,

Kyle Fournier

Riverside Drive and Ash Creek Flood Mitigation / Coastal Resilience Study

Informational Meeting

Consultant Team Members Present

- David Murphy, P.E., CFM
- James Murac, P.E., CFM
- John McGrane, P.E., CFM
- Jennifer O'Donnell, Ph.D.

Town of Fairfield Representatives

- Brian Carey, Conservation Director
- Joe Michelangelo, P.E., Public Works Director
- Fairfield Flood and Erosion Control Board

Town of Fairfield | July 12, 2016

Agenda

- Project Background
- Mitigation, Resilience, Risk, and Adaptation
- Existing Dike and Tide Gate Systems
- Initial Thoughts about Design Criteria
- View Google Earth Pro Tool
- What Else is Being Considered?
- Next Steps

Agenda

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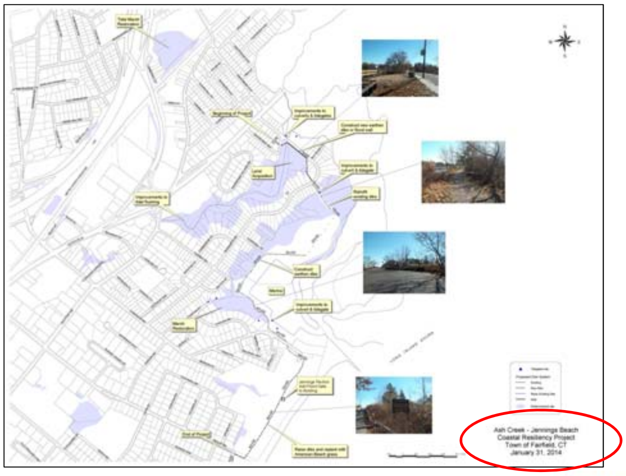
MILONE & MACBROOM

Background

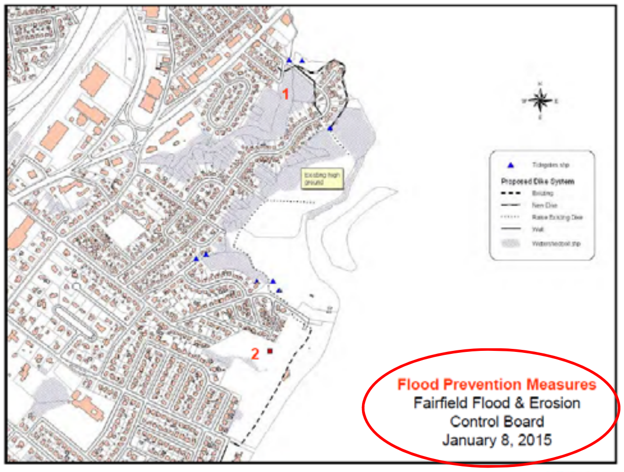
- **The Riverside Drive/Ash Creek/Jennings Beach corridor was an early focus for resiliency after Hurricane Sandy…**



MILONE & MACBROOM

Background

- **Consequently, the corridor was a key part of the Town's "Flood Mitigation Plan"**

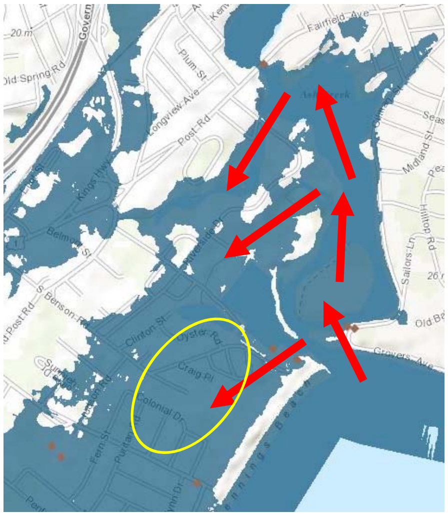


Flood Prevention Measures
Fairfield Flood & Erosion Control Board
January 8, 2015

But why?

Background

- The surges from Storms Irene and Sandy moved upstream along Ash Creek and spilled into the Town's coastal floodplain
- The surges were impeded by high ground at Jennings Beach and the open space east of South Benson Road
- The coastal floodwaters were pooled between South Benson Road and Jennings Beach for days after Hurricane Sandy
    - A separate project may help resolve this



Sandy flood extents (USGS)

Background

- Peak tide elevations in Fairfield during Tropical Storm Irene were between 8.52 feet NAVD88 (Bridgeport) and 8.66 feet NAVD88 (Norwalk)

- Peak tide elevations in Fairfield have not been published for Hurricane Sandy, but are believed 7.4 to 10.4 feet NAVD88 based on published heights above grade

MILONE & MACBROOM

Background

- Consequently, many “Repetitive Loss Properties” are located here

- These properties were likely flooded from Ash Creek before the surge arrived from Pine Creek
- Neighbors were also flooded but do not come up on the FEMA RL list

MILONE & MACBROOM

Background

- **Many flood-related challenges in Fairfield are already being addressed. For example:**
  - ✓ U.S. Army Corps of Engineers is involved with evaluation of the coastal dike system and greater Pine Creek area
  - ✓ Many homeowners are individually elevating their homes and repairing their bulkheads or walls
- **The Riverside Drive/Ash Creek area remains a significant "unmet need"**
  - ✓ This CDBG-DR grant is making it possible to evaluate flood mitigation methods and options for the Riverside Drive/Ash Creek area

COMMUNITY PLANNING DEVELOPMENT

CDBG Disaster Recovery Eligible Activities

Agenda

- Project Background
- **Mitigation, Resilience, Risk, and Adaptation**
- Existing Dike and Tide Gate Systems
- Initial Thoughts about Design Criteria
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- Next Steps

What is Flood Mitigation? What is Resilience?

- **Flood Mitigation** is a sustained set of actions to reduce flood losses. Examples include prevention, property protection, etc.
- **Resilience** is "the ability of any system (infrastructure, government, business) to resist, absorb and recover from or adapt to an adversity"
- **Community** Resilience is "the ability of a community to prepare for anticipated hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions."
- **Coastal** Resilience is the ability to resist, absorb, recover from, or adapt to coastal hazards such as sea level rise, increased flooding, and more frequent storm surges.

A home is elevated
Photo: Shoreline Times

Resilience Concepts

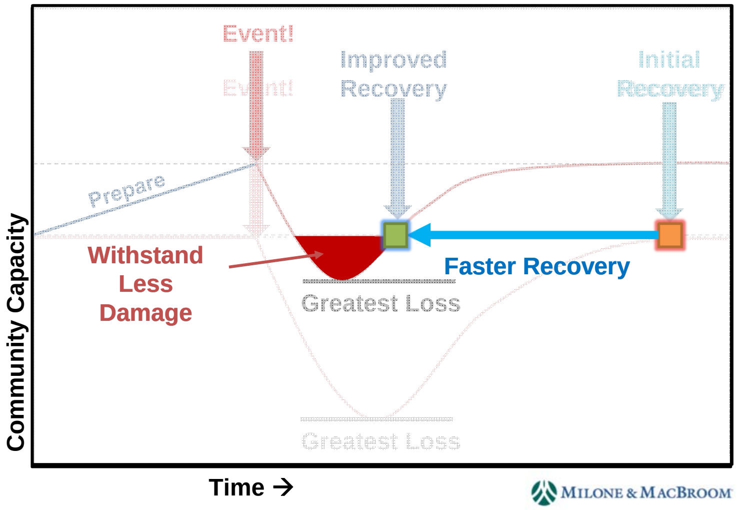
Resilience

- Prepare
- Adapt
- Withstand
- Recover

Reduce Recovery Time

Decrease Damage

Increase Capacity

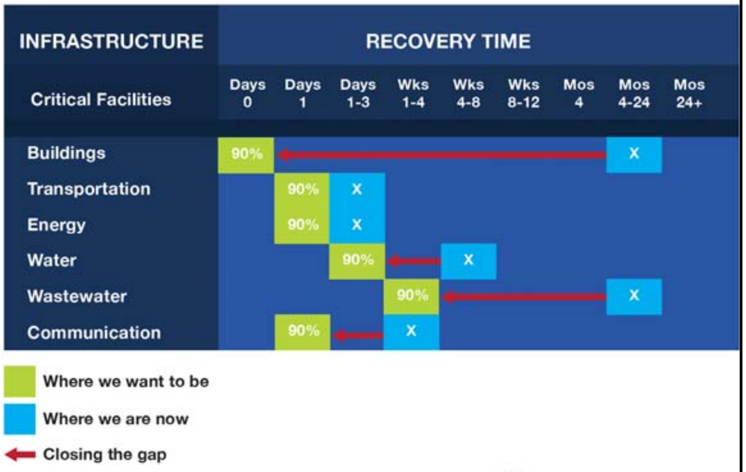


Resilience Concepts

Resilience

- Prepare
- Adapt
- Withstand
- Recover

Reduce Recovery Time



INFRASTRUCTURE	RECOVERY TIME								
Critical Facilities	Days 0	Days 1	Days 1-3	Wks 1-4	Wks 4-8	Wks 8-12	Mos 4	Mos 4-24	Mos 24+
Buildings	90%	←	←	←	←	←	←	X	
Transportation		90%	X						
Energy		90%	X						
Water			90%	←	X				
Wastewater				90%	←	←	←	X	
Communication		90%	←	X					

🟩 Where we want to be

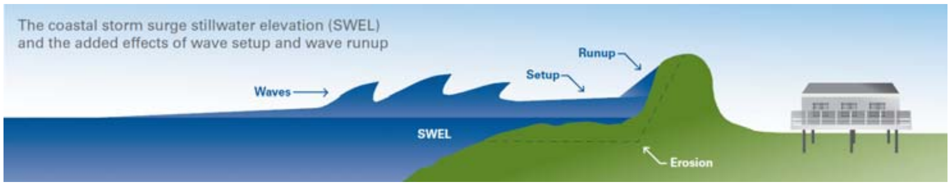
🟦 Where we are now

← Closing the gap

What About Risk?

- **Storm Surges and Waves**

- **FEMA Studies and the North Atlantic Coast Comprehensive Study (NACCS) tell us about surges, wave setup, and wave runup**



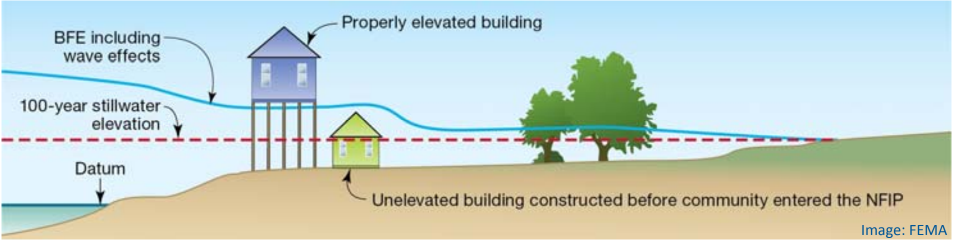
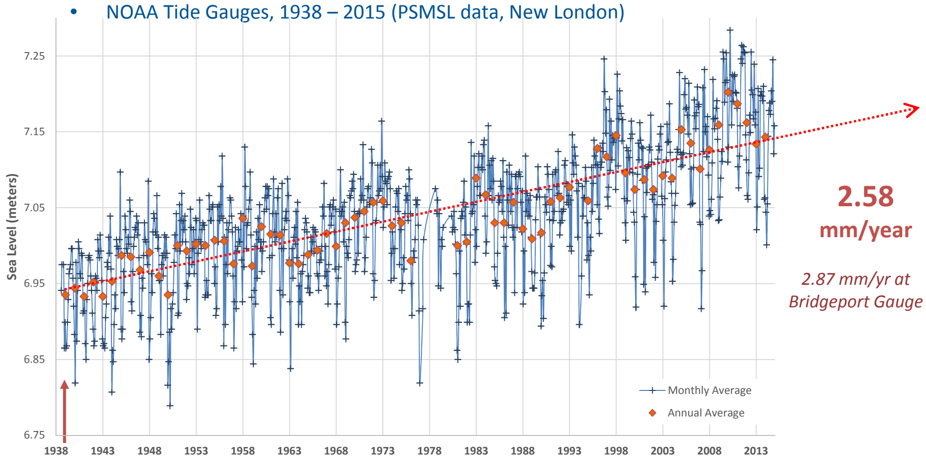


Image: FEMA

BFE = base flood elevation (FEMA 100-yr elevation)

What About Risk?

- **Sea Level Has Been Rising**
  - NOAA Tide Gauges, 1938 – 2015 (PSMSL data, New London)



2.58 mm/year

2.87 mm/yr at Bridgeport Gauge

September 1938
"Long Island Express" New England Hurricane

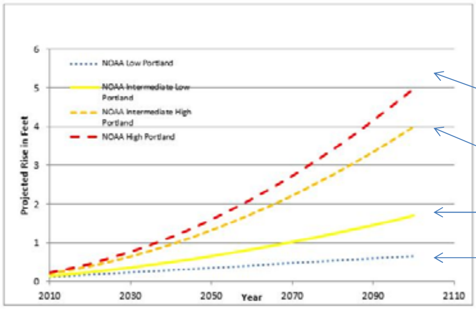
MILONE & MACBROOM

What About Risk?

- NOAA and the Army Corps of Engineers developed several sets of projections that were published in 2012
- This is now federal guidance

Global Sea Level Rise Scenarios for the United States National Climate Assessment

December 6, 2012



Ocean warming + highest polar ice melt

Ocean warming + some polar ice melt

Ocean warming

Continuation of historical trend

MILONE & MACBROOM

What About Risk?

- **How do the risks combine?**
- **Risk = frequency x vulnerability**
  - Sea level rise is increasing frequency of events like daily inundation, damaging storm surges, and erosion
  - Vulnerabilities can remain static and risks will increase in the face of rising seas and increased coastal storm frequency or magnitude
  - Vulnerabilities can be reduced to hold risk at bay, or…
  - If vulnerabilities can be reduced even <u>further</u>, then risks can be lowered, leading to increased resilience

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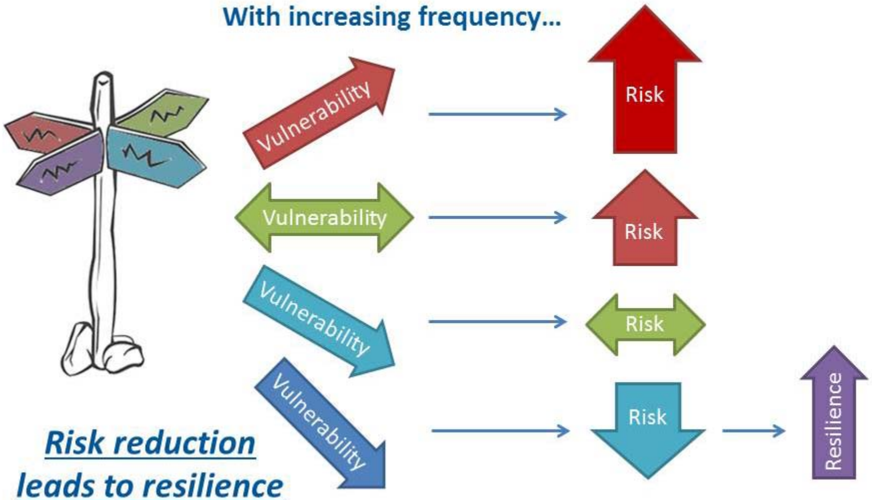
Risk and Resilience

<u>Fairfield is at a Crossroads</u>

With increasing frequency…

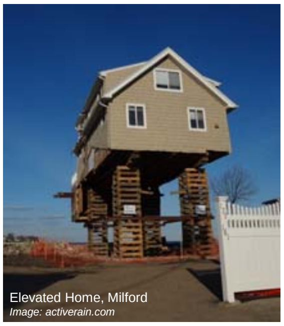


<u>Risk reduction leads to resilience</u>

Adaptation Concepts

3 General Types of Adaptation (1990)

- **Retreat**
  - No shoreline protection
  - Abandon vulnerable area
- **Accommodation**
  - No shoreline protection
  - Remain in vulnerable area
  - Adjust structures, infrastructure, etc.
- **Protection**
  - Shoreline protection
  - Remain in vulnerable area
  - No adjustment of structures, infrastructure, etc.
  - DEEP and USACE approvals needed


Elevated Home, Milford
Image: activerain.com


Milford
Image:
David Murphy

MILONE & MACBROOM

Adaptation Concepts

7 Updated Categories of Adaptation (NOAA, 2010)

1. Impact Identification and Assessment

Know the facts

2. Awareness and Assistance

Share the facts

3. Growth and Development Management

Prevent creation of new vulnerabilities

4. Loss Reduction

Decrease existing vulnerabilities

5. Shoreline Management

Protect natural, aesthetic, & economic benefits of beach & shore

6. Coastal Ecosystem Management

Protect natural, aesthetic, & economic benefits of coastal ecosystems

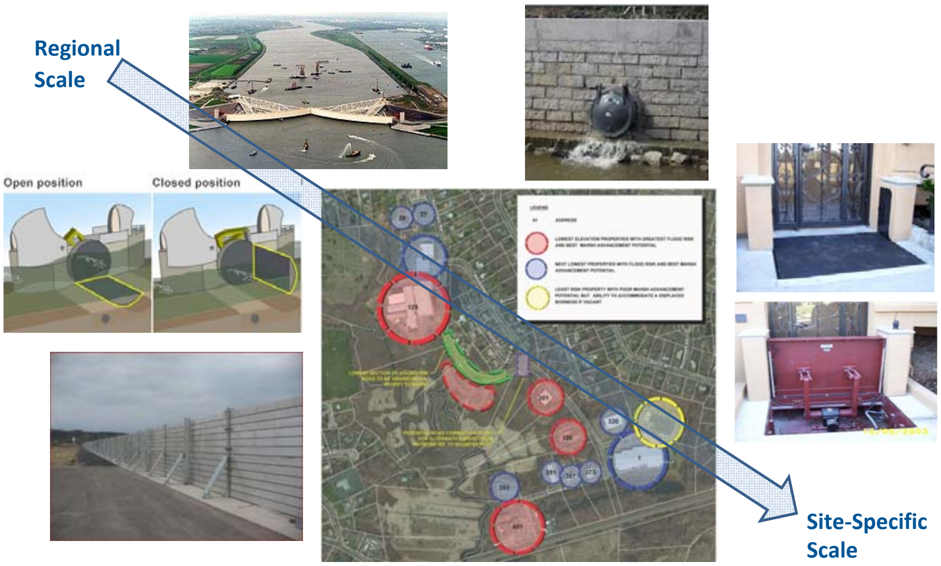
7. Water Resource Management

Decrease unique risks to drainage & water supply infrastructure


FEMA Specialists Discuss Preparedness with Madison Residents
Image: FEMA / Jocelyn Augustino

MILONE & MACBROOM

Adaptation Concepts: Scale Matters!



We are finding that the neighborhood scale is best

What Works in Connecticut?

Specific Options for Connecticut

- **Transportation Options**

Elevate or Retire Roads

- **Shoreline Management**

Living Shorelines, Beach Nourishment, Sediment Management, Dune Management, Bioengineered Banks

- **Shore Protection Structures**

Seawalls, Bulkheads, Revetments

- **Infrastructure Management**

Stormwater, Wastewater, Water Supply

- **Building Elevation**
- **Retreat**

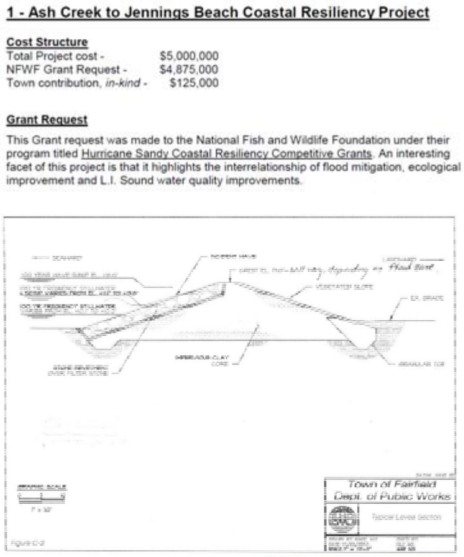
Fairfield
Image: Town of Fairfield

Milford
Image: David Murphy

Fairfield Flood Mitigation Plan

- The Flood Mitigation Plan held a cost of $5 million for a Riverside Drive/Ash Creek “project”

- The Flood Mitigation Plan provided a schematic cross section of a flood protection system



1 - Ash Creek to Jennings Beach Coastal Resiliency Project

Cost Structure

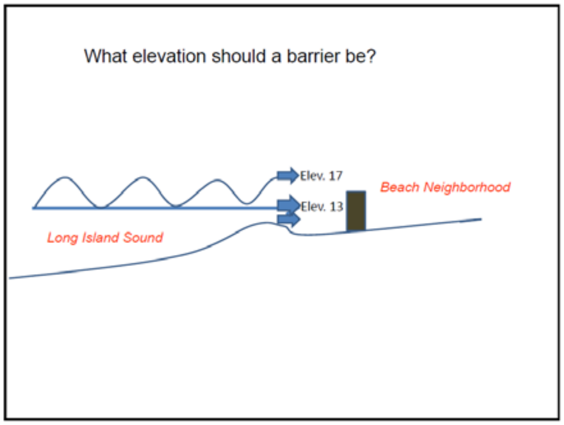
Total Project cost -	$5,000,000
NFWF Grant Request -	$4,875,000
Town contribution, *in-kind* -	$125,000

Grant Request

This Grant request was made to the National Fish and Wildlife Foundation under their program titled Hurricane Sandy Coastal Resiliency Competitive Grants. An interesting facet of this project is that it highlights the interrelationship of flood mitigation, ecological improvement and L.I. Sound water quality improvements.

Fairfield Flood Mitigation Plan

- **But more importantly, the Plan posed the question: *what elevation should a barrier be?***
- This is one of the main themes for this study – what elevations are appropriate for flood protection?



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- Initial Thoughts about Design Criteria
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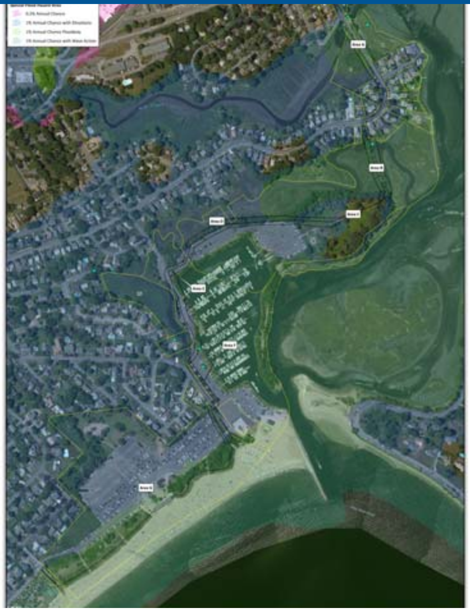
Existing Dike and Tide Gate Systems



Seven areas have been delineated to look at land:

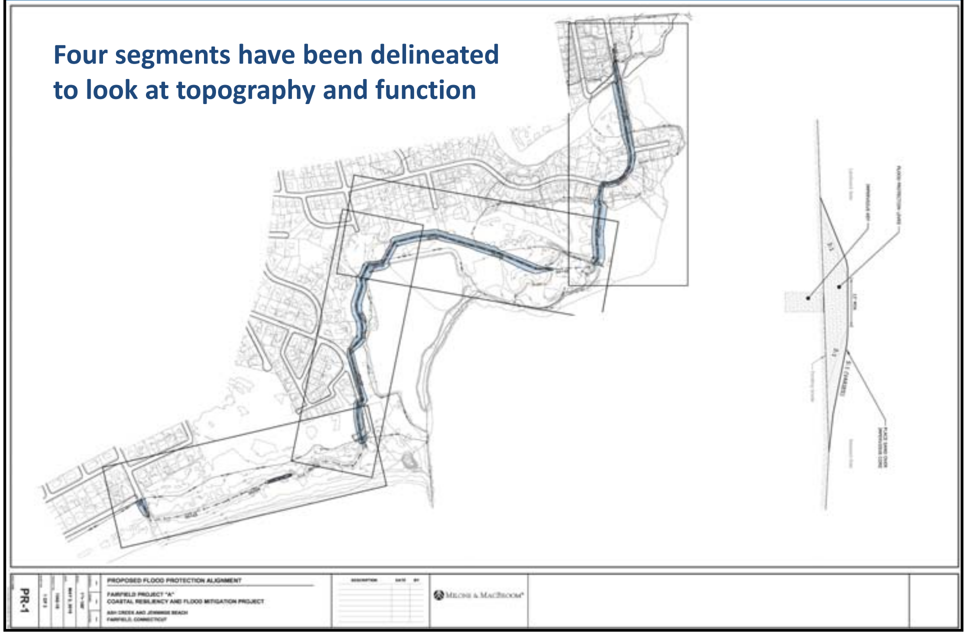
a. Riverside Dr/Bay Edge Ct
b. Ash Creek Open Space Dike
c. Ash Creek Open Space – “VE zone”
d. Ash Creek Open Space – “AE zone”
e. Turney Rd/Marina Entrance
f. Marina Parking
g. Jennings Beach

Most land is owned by the Town

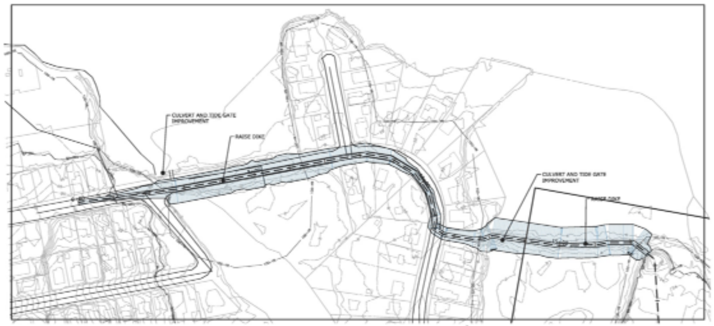
Private properties are mainly involved at the bend in Riverside Drive

Existing Dike and Tide Gate Systems

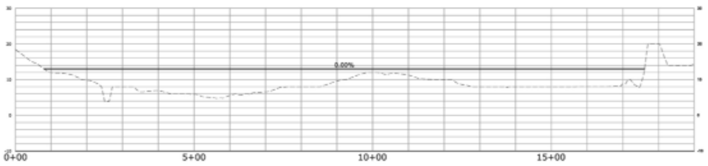
Four segments have been delineated to look at topography and function



Segment 1



FLOOD CONTROL SEGMENT 1 OF 4 - PLAN
(SCALE: 1"=100')



FLOOD CONTROL SEGMENT 1 OF 4 - PROFILE
(SCALE: 1"=100'H, 1"=10'V)

MILONE & MACBROOM

Existing Dike and Tide Gate Systems

- Somewhat elevated portion of Riverside Drive
- Tide gates beneath Riverside Drive (condition and operations vary)

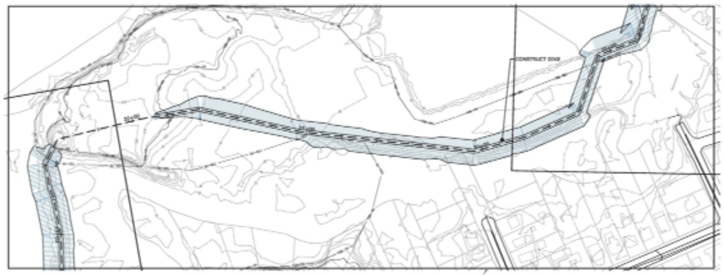
Existing Dike and Tide Gate Systems

- Riverside Drive residential area
- Portions of the road along this curve are somewhat elevated already
- This may be the most challenging part of the study area
  - ✓ Many property owners
  - ✓ Many short, flat driveways
  - ✓ Waterward route for flood protection would protect all but significantly impact properties
  - ✓ Roadway alignment for flood protection would affect driveways and stormwater drainage and leave some outside the protected area
  - ✓ Landward route would offer protection to none here

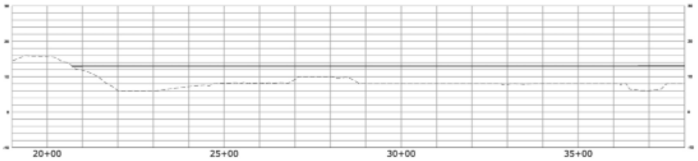
Existing Dike and Tide Gate Systems

- An existing dike with a walking path on its crest provides some flood protection from Ash Creek
- Dike crest is at elevation of 8 feet, and overtopping can occur easily
- The crest is too narrow for vehicular access
- A self regulating tide gate controls the upstream marsh levels

Segment 2



FLOOD CONTROL SEGMENT 2 OF 4 - PLAN



FLOOD CONTROL SEGMENT 2 OF 4 - PROFILE

Existing Dike and Tide Gate Systems

- The Ash Creek open space area includes a grassy open area with walking paths with a natural high-grade on the bank of Ash Creek
- The higher grade areas are well established with mature woody vegetation and appear to provide flood protection as well as wave dispersion
- A flood protection alignment through the open grassy area would be a) easier to construct b) would not destroy the mature vegetation and c) could provide a spot for more recreation paths

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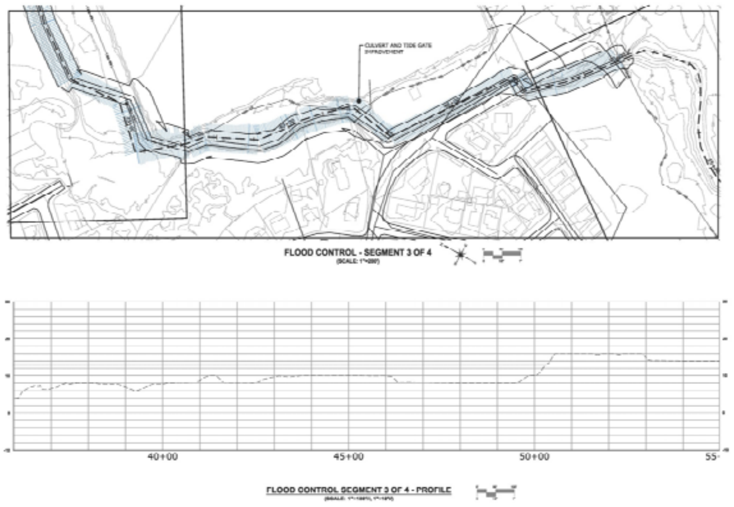
Segment 3



Existing Dike and Tide Gate Systems

- South Benson/Turney Road Marina
- The existing roadway ranges in elevation from 6 feet to 10 feet
- Flood protection would require the reconstruction of a driveway/parking area that serves the South Benson Marina and the Ash Creek Public Access Canoe Launch
- Impacts of raising the roadway may include the loss of some parking area and reconfiguration of the accessway, but this has not been determined yet

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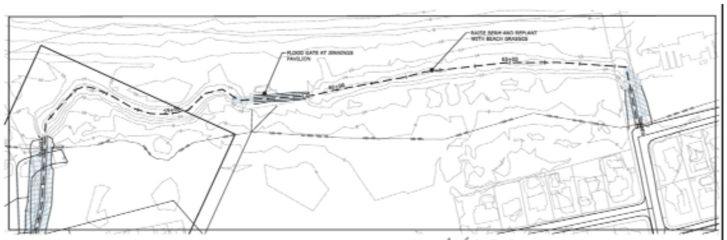
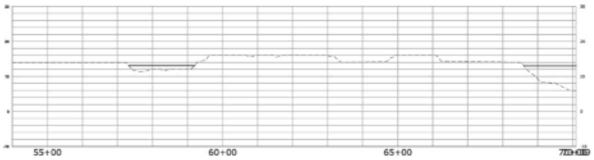
Segment 4



FLOOD CONTROL - SEGMENT 4 OF 4



FLOOD CONTROL SEGMENT 4 OF 4 - PROFILE

Existing Dike and Tide Gate Systems

- The ridge at Jennings Beach is not a true dune
- Wave energy is more direct here, as the area is not protected
- The beach profile and base of the ridge provided flood protection from the surges of Irene and Sandy
- Top of the ridge ranges in elevation from 14' to 16'

Existing Dike and Tide Gate Systems

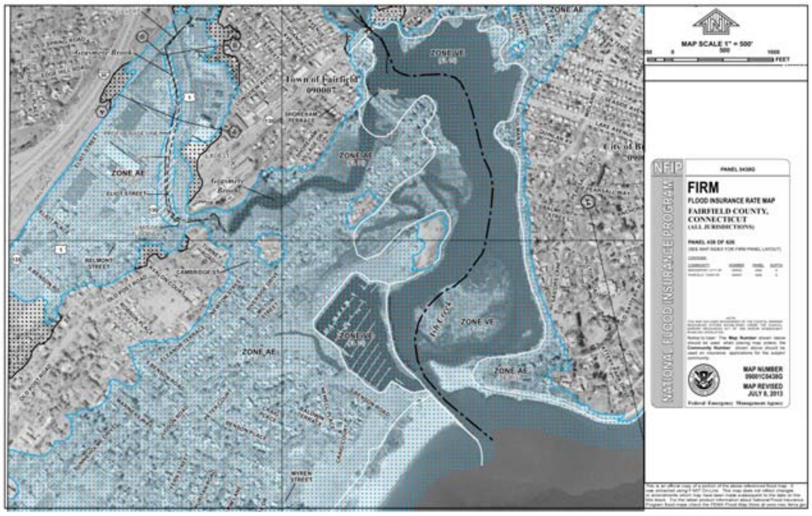
- Sand dune appears to be forming and vegetating at the base of the ridge
- Beach access is provided over the ridge
- The Jennings Beach pavilion is located within a gap in the ridge
- The sides of the pavilion were connected to the dune ridge system, but this does not make the pavilion able to provide flood protection

Agenda

- Project Background
- Mitigation, Resilience, Risk, and Adaptation
- Existing Dike and Tide Gate Systems
- **Initial Thoughts about Design Criteria**
- View Google Earth Pro Tool
- What Else is Being Considered?
- Next Steps

Initial Thoughts about Design Criteria

- FEMA tells us the base flood elevations (BFEs)



Initial Thoughts about Design Criteria

- The North Atlantic Coast Comprehensive Study (NACCS) Advanced Circulation (ARCIRC) modeled water elevations are comparable to FEMA

Surge	10-Year	50-Year	100-Year	500-Year
Ash Creek	6.94	8.97	9.86	12.91
Jennings Beach	6.84	8.88	9.76	12.78

Surge + Tide	10-Year	50-Year	100-Year	500-Year
Ash Creek	8.94	10.78	11.80	15.08
Jennings Beach	8.81	10.61	11.53	14.68

All figures in feet NAVD88

Initial Thoughts about Design Criteria

- 44 CFR Ch.1 (10-1-11 Edition) Sec. 65.10, FEMA, “Mapping of areas protected by levee systems
  - ✓ For coastal levees, 100-year including maximum wave runup V zone elevation + one foot (sec. iii)
- Executive Order 11988, Floodplain Management, January 30, 2015
  - ✓ 100-year BFE + three feet for critical actions, or 500-year flood, or best available climate science
- Important to remember that the Federal Flood Risk Management Standard (2015) does “not establish a required size, crest, elevation, or scale for levees, floodwalls, dunes or other infrastructure used for flood risk reduction”

Initial Thoughts about Design Criteria

- US Army Corps of Engineers, “North Atlantic Coast Comprehensive Study (NACCS): Resilient Adaptation to Increasing Risk,” Main Report, January 2015
  - ✓ For Storm Surge Barriers protecting multiple buildings: 0.2% flood elevation with wave runup (500-year flood V zone elevation) + 3’ sea level rise allowance
- US Army Corps of Engineers, Regulation No. 1100-2-8162, “Incorporating Sea Level Change in Civil Works Programs,” 31 December 2013
  - ✓ Use low, intermediate, and high scenarios at nearest tide gauge using online USACE sea level calculator

What Have We Seen?

- Top five highest water levels at the Bridgeport gauge since 1964 (all NAVD88):

Date	Elevation
10/30/12 (Sandy)	9.19
8/28/11 (Irene)	8.23
12/11/92 (nor’easter)	8.17
10/31/91 (“perfect storm”)	7.49
10/25/80	7.09

Summary of Flood Water Levels

- **Design Criteria:**
  - **100-year + SLR**
  - **100-year + freeboard**
  - **500-year… or 500-year plus SLR!**

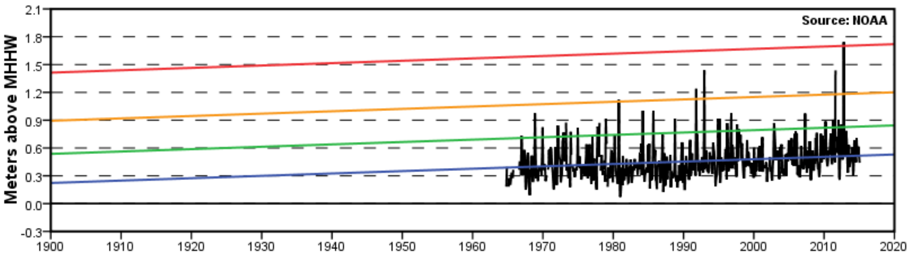
	Segment 1	Segment 2	Segment 3	Segment 4
100-Yr Stillwater	10	10	10	10.1
100-yr AE Zone	11	11	11	
100-yr VE Zone	15	15	13	15
100-yr Max Wave Crest	-	-	-	17
500-Yr Stillwater	11.5	11.5	11.5	11.5
NACCS Surge (100-yr)	9.86	9.86	9.86	9.76
NACCS Surge + Tide	11.8	11.8	11.8	11.53
***SLR @ 2100**	2 – 4 ft	2 – 4 ft	2 – 4 ft	2 – 4 ft

*SLR:
2 ft (2007 IPCC High Emissions)
3.8 ft (2012 NOAA technical report, medium SLR projection)

What Have We Seen?

- Bridgeport tide gauge shows SLR and high water exceedances
- The highs are getting higher

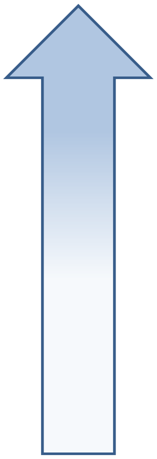
Bridgeport, CT



- Red: 1% annual exceedance
- Orange: 2% annual exceedance
- Green: 10% annual exceedance
- Blue: 99% annual exceedance

How High Would **YOU** Build Flood Protection?

- VE = 13 to 15 feet
- NACCS 1% + tide = 11.5 to 11.8 feet
- 0.2% Stillwater = 11.4 to 11.5 feet
- AE = 11 feet
- 1% Stillwater = 10 to 10.1 feet
- NACCS 1% surge = 9.8 to 9.9 feet
- Sandy = 9.19 to10.4 feet
- Irene = 9.19 to 8.52 feet
- Coastal Jurisdiction Line = 5.2 feet
- MHHW = 3.54 feet
- MHW = 3.20 feet



All NAVD88

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Discussion and Questions

- Do the various FEMA, NACCS, and other water level figures make sense when compared to the Irene and Sandy water levels?
- Which SLR projections seem most appropriate for design?
- Which set of best available guidance makes sense for Fairfield? Consider Sandy-level protection vs. a FEMA-accredited levee
- Can the Town tolerate a flood protection system designed to the higher projections and safety factors?

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Agenda

- Project Background
- Mitigation, Resilience, Risk, and Adaptation
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- **View Google Earth Pro Tool**
- What Else is Being Considered?
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- **What Else is Being Considered?**
- Next Steps

What Else is Being Considered?

- Methods of reducing flood levels or relaxing flood protection components
- Other options
- Emergency services and egress often underpin all resilience options

Evaluation of Flood Protection Options
- a. Dike System Enhancements
- b. Tide Gate Modifications
- c. Dune Creation/Enhancement
- d. Beach Enhancement
- e. Shoreline Structures (Jetties, Groins, Seawalls) and Hybrid Approaches
- f. Offshore Structures (Breakwaters, Reefs, Wave Attenuators) and Hybrid Approaches

Evaluation of Other Mitigation and Resilience Options
- a. Access and Egress
- b. Individual Property Mitigation
- c. Relocation
- d. Utility Infrastructure
- e. Roadways
- f. Emergency Services

Agenda

- Project Background
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- Existing Dike and Tide Gate Systems
- Initial Thoughts about Design Criteria
- View Google Earth Pro Tool
- What Else is Being Considered?
- **Next Steps**

Next Steps

- **Continue study and consider:**
  - ✓ Flood protection system
  - ✓ Options in lieu of, or working with, a flood protection system
- **Additional public participation**

Discussion

Riverside Drive and Bay Edge Ct

Levee at Elev. = 12.0ft NAVD 88

Riverside Drive and Bay Edge Ct

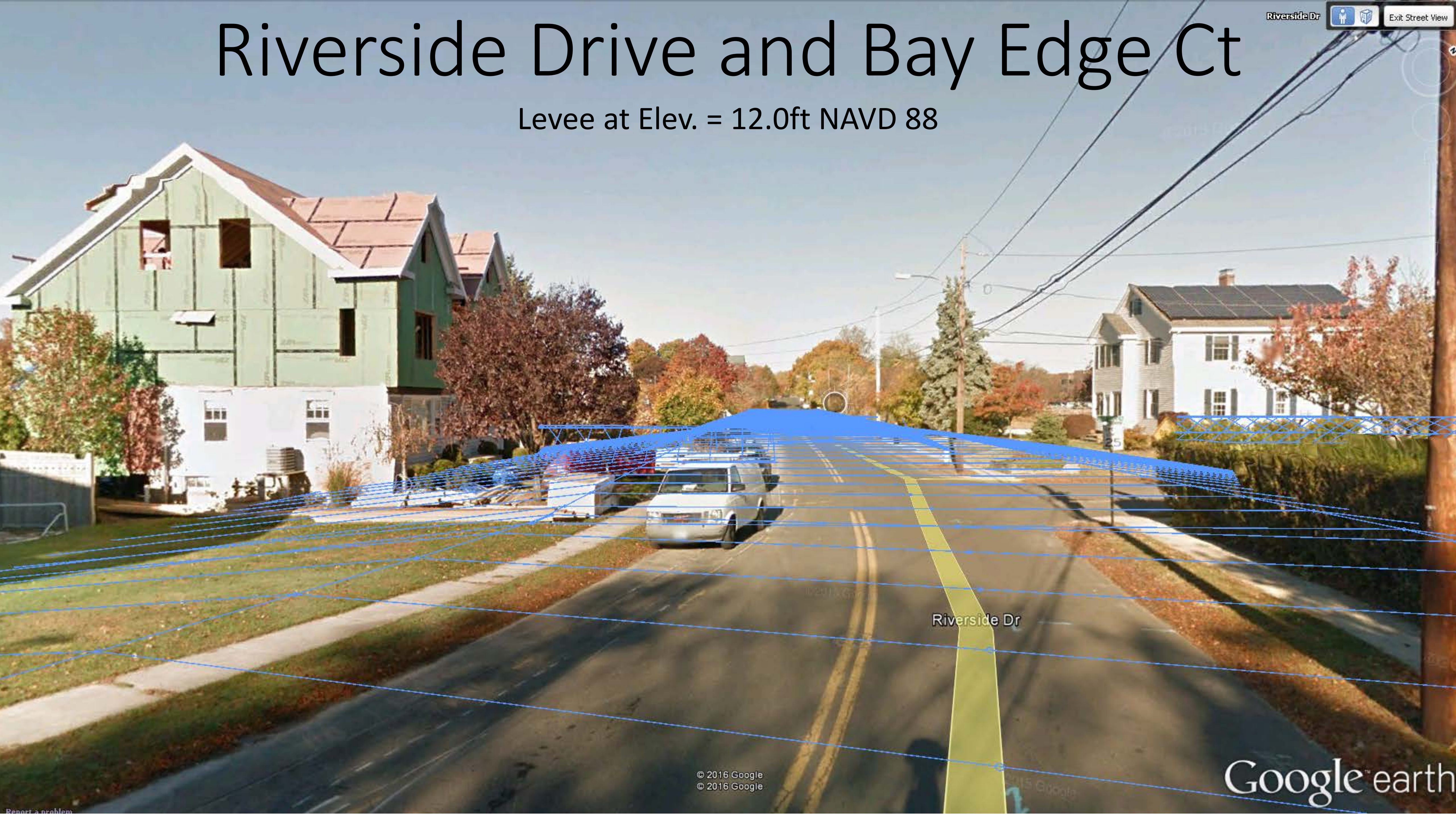
Levee at Elev. = 15.0ft NAVD 88

Riverside Drive and Bay Edge Ct

Levee at Elev. = 18.0ft NAVD 88

Riverside Drive and Bay Edge Ct

Levee at Elev. = 12.0ft NAVD 88



Riverside Drive and Bay Edge Ct

Levee at Elev. = 15.0ft NAVD 88

Riverside Drive and Bay Edge Ct

Levee at Elev. = 18.0ft NAVD 88

South Benson/Fairfield Marina

Levee at Elev. = 12.0ft NAVD 88

South Benson/Fairfield Marina

Levee at Elev. = 15.0ft NAVD 88

South Benson/Fairfield Marina

Levee at Elev. = 18.0ft NAVD 88

Jennings Beach

Levee at Elev. = 12.0ft NAVD 88

Jennings Beach

Levee at Elev. = 15.0ft NAVD 88

Jennings Beach

Levee at Elev. = 18.0ft NAVD 88

Riverside Drive/Ash Creek Resilience Study

APPENDIX L – Public Meeting Materials – January 19, 2017

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<u>DRAFT</u> MINUTES OF THE
Special Meeting of Flood & Erosion Control Board
Thursday January 19, 2017

Meeting was called to order at 7:15 by Chairman Dmochowski

Members present: Mr. Dmochowski, Mr. Lamberty, Mr. Stearns, Mr. Petise (a quorem)

Excused: Mr. Landino,

Also present: Ms. Pulie, Members of the public

Item 1 - Introductions:

The Chairman Introduced the members of the Flood & Erosion Control Board, Town Sr. Civil Engineer, Laura Pulie and Milone & MacBroom Project Manager, David Murphy. Mr. Murphy then introduced the other consultants present; Mr. Murac, Ms.O'Donnell and Mr. McGrane.

Item 2 - Presentation: Mr. Murphy went through the entire 1/19/17 slide presentation which can be viewed on the FECB webpage (http://www.fairfieldct.org/fecb). He briefly touched on the original baseline information and during his presentation included statements of what the team heard (slide #18) from residents at both the first Public meeting on this topic in July, 2016 and also at an update meeting on October 19, 2016.

Mr. Murphy introduced the alphabet soup of the various elevation standards used by Government Agencies in suggesting and evaluating flood protection levels which introduce the relationship between elevation and risk. This study selected protection levels of 12', 15' and 18' as representing our possible choices along that Elevation / Risk continuum. He recognized that while raising Riverside Drive to an elevation of 18' would provide the floodplain great protection from the 100 year storm along that area, it is not on anyone's list of realistic mitigation measures.

He also talked about the challenges at the Marina to include increased flood protection while maintaining - or, possibly, improving - its functionality. The Marina, Jennings Beach and the Penfield Mill Open Space should be considered together as, combined, they are a major Town recreational resource.

He noted that the existing Tide Gates at the Riverside Drive bridge are in bad shape and should be replaced with an installation that has improved ability to release water after a flood event.

He recognized that in addition to different elevations and paths of "public" projects, alternate flood mitigation measures are available to individual residents such as elevating individual homes. In the present regulatory environment, receiving permits for much of the proposed work could pose additional difficulties in executing some measures.

Finally, any action plans that might result from this study must co-ordinate with other Town projects to assure they work in consort and support a holistic approach to mitigating the risk of Coastal Storms to Fairfield. Specifically, another current study is evaluating installing a Pump Station at Jennings Beach which would help our existing floodplain storm sewer system to better evacuate rainwater and any L.I. Sound floodwaters that get trapped behind the coastal dune.

Item 3 - Public Comments and Questions:

The Chairman reiterated the existence of the presented documents on our webpage and invited the audience to email any subsequent questions or comments to us (fecb@fairfieldct.org) . The floor was then opened for Q&A:

Elizabeth Sweeney, 258 Riverside: Has the wall along the water's edge been eliminated? Mr. Dmochowski replied no, that is what's shown as 'outside the bend'.

Michael Meehan, 196 Riverside: Mr. Meehan read a prepared document on behalf of an Ad Hoc neighborhood group:

> *Riverside Study Talking Points – January 19th, 2017*
>
> *Thank you to Malone & MacBroom for performing the study and thank you to Brian Carey for securing the grant to fund the study. We realize that this study was commissioned as a result of conservation securing the grant to fund it. We also appreciate the involvement of the Flood and Erosion Control Board. We would also like to remind everyone while we are supportive of measures to improve flood protection, we ask that you keep the interests of the residents in your actions going forward.*
>
> *1. We, the residents have the following concerns.:*
>
> - *With all of the money involved in the study, no one attempted to talk to the 12 residents that reside between the northerly stretch of the Riverside Drive and Bay Edge Court to the town owned path to the open spaces to get our feedback about flooding and the proposed protection.*
> - *Of these 12 residents, and several others surrounding this area, no one filed claims with FEMA after Sandy.*
> - ***We will NOT approve the drawings raising Riverside Drive from the entrance to the open space to Bay Edge Court to 12', 15' or 18' as represented in drawings 1A.*** *You will not be able to obtain easements. We are a FEMA AE-11 zone. Even the 12' drawings are higher than many of our first floors.*
> - *Why are you, as the engineer or the town, proposing these elevations for an AE-11 zone when the town that has invested 11.4 million into the building and rebuilding of the Penfield Pavilion which sits in a FEMA V-13 zone and only has elevation 11 protection? Shouldn't the town be the first to set the example for flood protection?*
> - *Your 1B drawings go behind 4 residences, does any of that plan tread onto marshes? How much private property does it take? You will need easements to do any work on private property, which we will not support. It does also leave more homes directly subject to direct flooding from Ash Creek.*

- *We understand that the regulatory bodies will never allow diking between Ash Creek and the residences on the east side of Riverside Drive, so we would like to better understand your rationale behind the 1C drawings.*
- *The stretch of road from the bridge (at Shoreham Terrace) to the homes was barely topped during Sandy. Being 100% town property, why doesn't the town raise that part of the road as part of a public works project. Adding water to the marsh diminishes its ability to drain rain water through the undersized tide gates under the bridge causing unusually high water levels to remain in the marsh creating added hydrostatic pressure on home owners' basements. Many of our neighbors had no water in their basements until a day or two after Sandy left and believe that was caused by the town installed tide gates under the bridge that do not let the water out fast enough.*
- *Because the path to the open spaces was topped by Sandy why hasn't the town taken actions to raise that elevation? A few trucks of fill can't cost too much and it would stop the flooding from that side in the case of high storm surge.*
- *After Sandy that portion of Ash Creek became a huge lake that took 10 days to drain completely out of the single undersized tide gate, which caused basement flooding of houses all along the southern side of Riverside Drive due to the increases hydrostatic pressure. Why isn't there talk about installing a sluice gate in that berm to allow the water that does get behind to drain faster?*

2. *We would ask that the public works department implement what we believe is an affordable common sense approach to obtaining a level of flood protection that is acceptable to all the affected residents. We pay our taxes that support other projects in town and respectfully ask that the town work with us to construct an acceptable common sense solution that you can get easements for.*

3. *We want to thank the Flood & Erosion Control Board for the master plan they developed. We understand that we are one small part of a larger plan and that you have to start somewhere. However, it is crucial to take our experiences and thoughts into consideration since we are the homeowners of private residences that will directly be impacted.*

Respectfully the residents of Riverside Drive and Bay Edge Court.

Mr. Meehan also commented on the street elevation at his residence being lower than reported - it is 7' not 9'. He also noted that the Town has recently been accepted into the FEMA Community Rating System which will result in a 10% Flood Insurance premium reduction and the individual residents should decide on raising their homes or paying some level of insurance premium.

Residents feel they are not involved. They did not immediately get water into their basements and thus feel it was the length of time the flood water sat without draining out and thus releasing the water is critical.

Mr. Dmochowski commented that the Penfield Pavilion project was controlled by that Building Committee and FECB did, unsuccessfully, try to influence them to incorporate better flood protection for the neighborhood beyond.

David Murphy noted that we addressed some of these comments in our presentation because we previously heard them from residents.

Bill Bower, 299 Riverside: The water took 10 days to drain out; getting it out sooner needs to be an important part of your plan. Sandy did not rise to what's shown on slide # 6. Mr. Dmochowski commented that the sustained higher water levels, post Sandy, reduced otherwise routine draining back into L.I. Sound.

Sean Upton, 37 Bay Edge: Questioned the water volumes used to estimate and predict flooding. Mr. Murphy replied that flooding comes into the flood plain from both Pine Creek and Ash Creek. They also used the GIS Mapping system to look at water rising in 1 ft. increments. The audience took exception with the belief that flooding comes from the Pine Creek side; *you should believe us, the eye-witnesses*. Mr. Murphy said, That's what we're here to hear tonight, tell us how flooding happened from Sandy in your view. Mr. Upton said Sandy did not top the roadway.

Steve Toner, 223 Riverside: I've live at the bend and your proposed 12' and 18' berms go thru my house so, either way, my house is going to be gone. At about 2 AM the night of Sandy, the water on the Ash Creek side was up to the sidewalk around the bridge but not coming over it.

Randy Weis, 50 Bay Edge: I drove from Bay Edge to the Post Road at about 10:30 PM and there was only about 6-8" of water on that section of Riverside Drive. The water was into my yard but did not reach the foundation. I don't believe any of my neighbors filed any claims for loss. We're trying to solve a problem that doesn't exist. These measures will only reduce the value of our properties. Mr. Dmochowski commented that we are not trying to solve a Sandy size problem but the potential 100 year flood problem which is more severe.

Peggy Weis, 50 Bay Edge: Damage to properties is greater the longer the flood waters remain. What about buying the property at 217 Turney Road and putting a pumping station there to evacuate the flood water into the marina? Mr. Dmochowski commented that another study is underway to identify the most effective storm water pumping station plan. That installation would, conceptually, be located at the perimeter of the Jennings Beach parking lot.

Mike Mears, 44 Bay Edge: If you build these levees, the problem will be that water will not drain out. They will not let the water out. The focus should be on something to get the water out.

Mr. Murphy commented that this study must look at all scenarios related to predicted storm surge levels and projected sea level rise. We do understand the impact of these measures on residents, I personally don't like levees either, either. We get it that Sandy did not flood many homes but we must look at the future potential storms and floods. We have to consider the various guidances that are out there – that is why the 18' elevation is included.

Michael Meehan, 196 Riverside: What was the most horrendous storm that Fairfield has had? Shouldn't we be guided by that?

Alyssa Israel, 679 Rowland Road: I understand the 1938 flood went up to the Railroad Station. Ms. Israel asked about the unspent HMGP grant monies. Mr. Dmochowski responded that those monies remain with the Fed/State to be applied to other measures. Ms. Israel would prefer pumping stations and drainage to levees. She desires a solution that applies to the entire floodplain. Mr. Murphy commented that the comparative cost of elevating homes is one of the considerations within this study. There was further discussion of the HMGP elevation grant program.

Cristin McCarthy-Vehey, 1625 Melville Avenue: Suggested that talking with Mr. Wendt and the First Selectman is proper with respect to the HMGP grant topic. She stressed the importance of neighbors supporting each other and for the Town to keep an open dialog with them. Ms. McCarthy-Vehey concurred with what the residents are saying that this type of plan with a huge impact on them is really not what people are looking for. She also commented that it is important to look at what might happen in the future. Mr. Dmochowski shared the experience of the Pine Creek Residents Association's similar concerns about a 2013 study that recommended raising the Pine Creek Dike by some 3 ft. He also gave a personal opinion on how DEEP regulations inform our possible actions.

Ronnie Lovich , 299 Riverside: Mitigation is also about reducing harm so there should be a short term solution which is improving the sluice gates to achieve quicker drainage. This obvious fix should not be held hostage to the more expensive, longer term solutions. Mr. Dmochowski concurred and noted that Brian Carey has replacing the Tide Gate assembly at the bridge as one of the top priority items on his must do list.

Craig Tolmie, 726 Riverside: Commented on the "Crazy Plan" of a hurricane barrier across the marina channel. That would protect Black Rock and the area all the way up Ash Creek/ Rooster River. It might cost a lot of money but it would work. Mr. McGrane commented on the Stamford Hurricane Gate that is operated by the Army Corps of Engineers. He further commented on the risk profile of various plans and the influence of Federal Grant money on what elevations they would support.

Elizabeth Sweeney, 258 Riverside: Expressed concerns about the road elevation, even at 12' her property would be unacceptably impacted. Her first floor is at 15' already. Mr. Dmochowski asked what reaction she would have to a 6' high "wall" at the rear of her property. She would choose to keep her view.

Brian McCall, 234 Turney Road: Expressed concerns about the reconfiguring of the marina roadways and the impact on trailered boats. I accept it is going to flood. When you choose to live here you accept flooding. Mr. Dmochowski noted that the Parks & Recreation Commission has not been briefed on this plan and they can be expected to vigorously support marina operations.

Mike Meehan, 196 Riverside: Actual elevations marked on the pavement would be helpful to visualize the impact of some of these proposals.

Item 3 - Adjourn:

The Chairman thanked those attending and encouraged them to email us any subsequent thoughts they have on the topic. The meeting was adjourned at 9:05 PM.

Respectfully submitted,

Dick Dmochowski

Riverside Drive and Ash Creek Flood Mitigation / Coastal Resilience Study

Informational Meeting

Consultant Team Members Present

- David Murphy, P.E., CFM
- James Murac, P.E., CFM
- John McGrane, P.E., CFM
- Jennifer O'Donnell, Ph.D.

Town of Fairfield Representatives

- Brian Carey, Conservation Director
- Joe Michelangelo, P.E., Public Works Director
- Fairfield Flood and Erosion Control Board

Town of Fairfield | January 19, 2017

Agenda

- Project Background
- Mitigation, Resilience, Risk, and Adaptation
- Review of July 12, 2016 Meeting
- Design Criteria
- Flood Protection System Layout
- Other Flood Protection Options
- Tide Gates
- Next Steps

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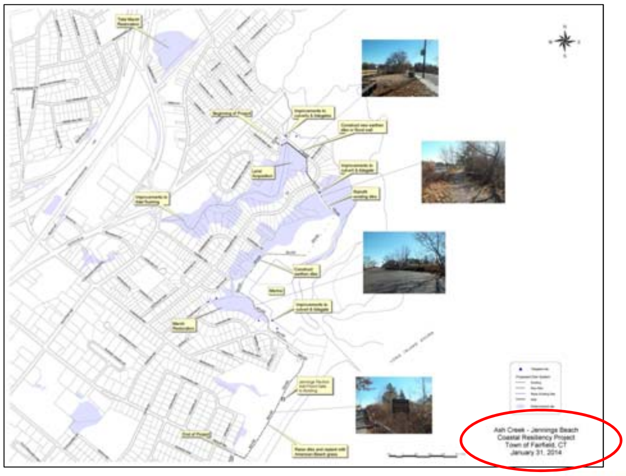
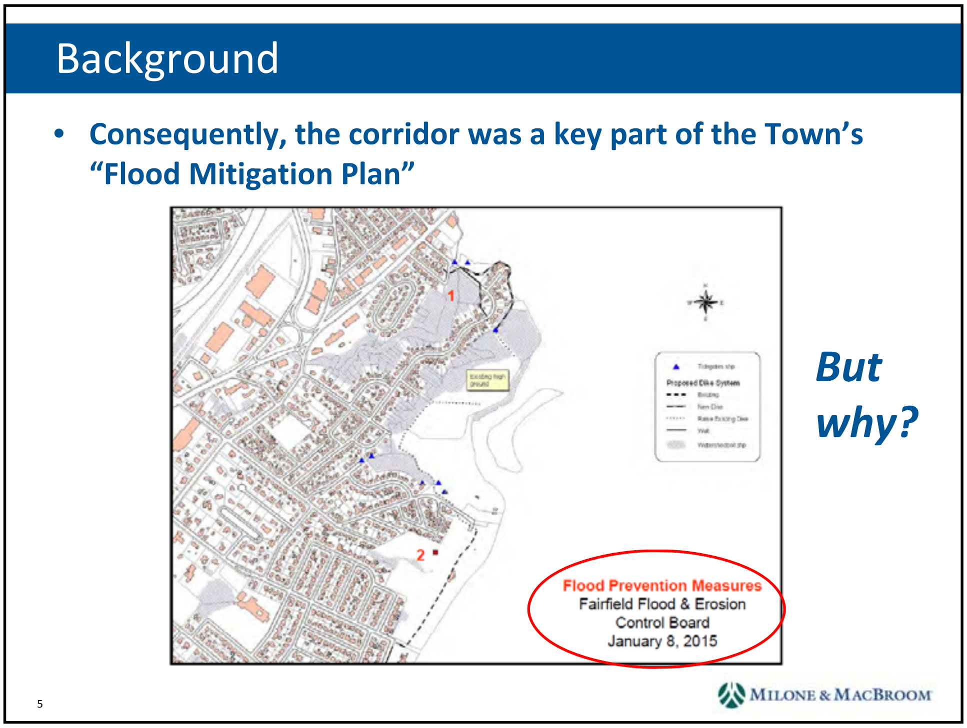
Background

- **The Riverside Drive/Ash Creek/Jennings Beach corridor was an early focus for resiliency after Hurricane Sandy…**



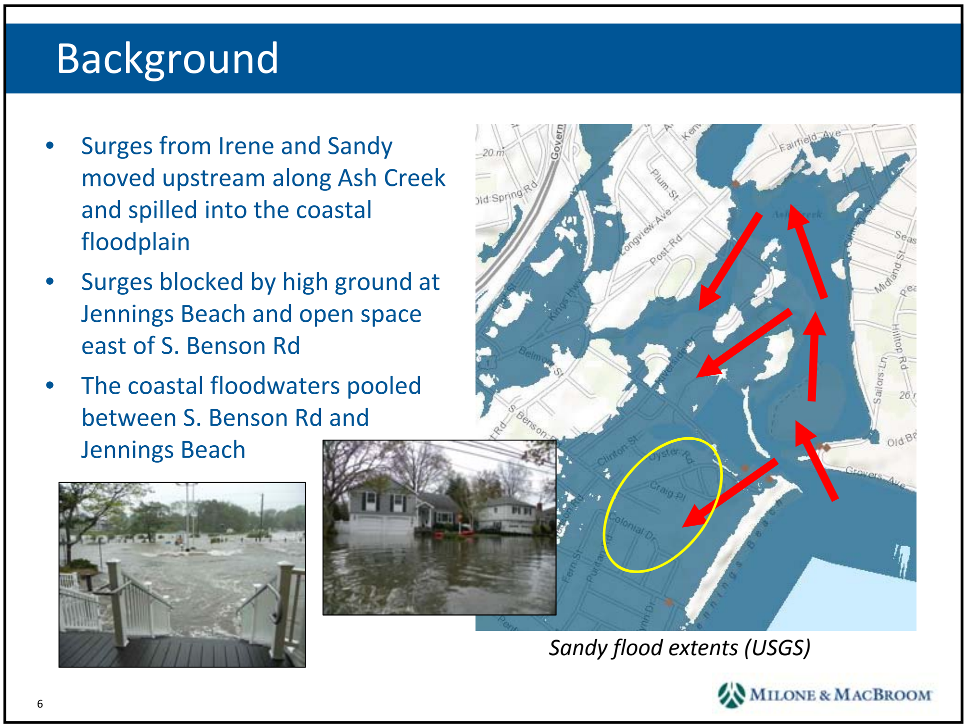


Background

- **Consequently, the corridor was a key part of the Town's "Flood Mitigation Plan"**

Flood Prevention Measures
Fairfield Flood & Erosion
Control Board
January 8, 2015

But why?



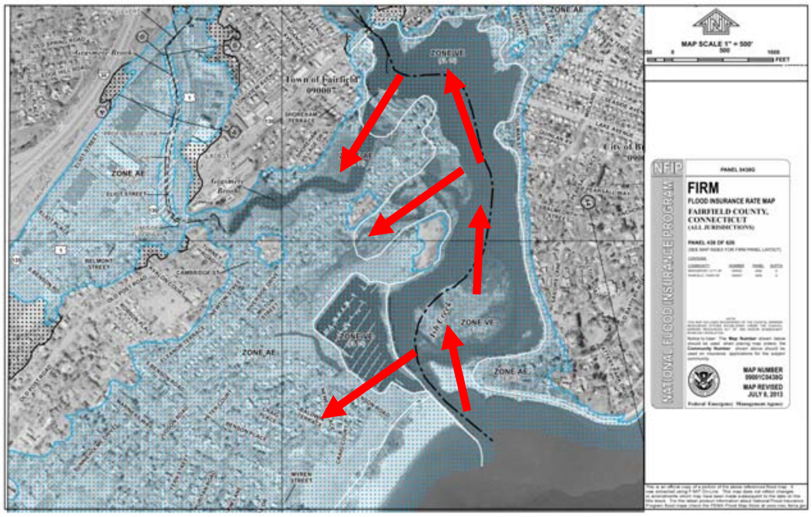
Background

- Surges from Irene and Sandy moved upstream along Ash Creek and spilled into the coastal floodplain
- Surges blocked by high ground at Jennings Beach and open space east of S. Benson Rd
- The coastal floodwaters pooled between S. Benson Rd and Jennings Beach

Sandy flood extents (USGS)

Background

- Past flooding is consistent with FEMA risk mapping



Background

- **Many flood-related challenges in Fairfield are already being addressed. For example:**
  - ✓ U.S. Army Corps of Engineers is involved with evaluation of the coastal dike system and greater Pine Creek area
  - ✓ Many homeowners are individually elevating their homes and repairing their bulkheads or walls
- **The Riverside Drive/Ash Creek area remains a significant “unmet need”**
  - ✓ This CDBG-DR grant is making it possible to evaluate flood mitigation methods and options for the Riverside Drive/Ash Creek area

COMMUNITY PLANNING DEVELOPMENT

CDBG Disaster Recovery Eligible Activities

Agenda

- Project Background
- **Mitigation, Resilience, Risk, and Adaptation**
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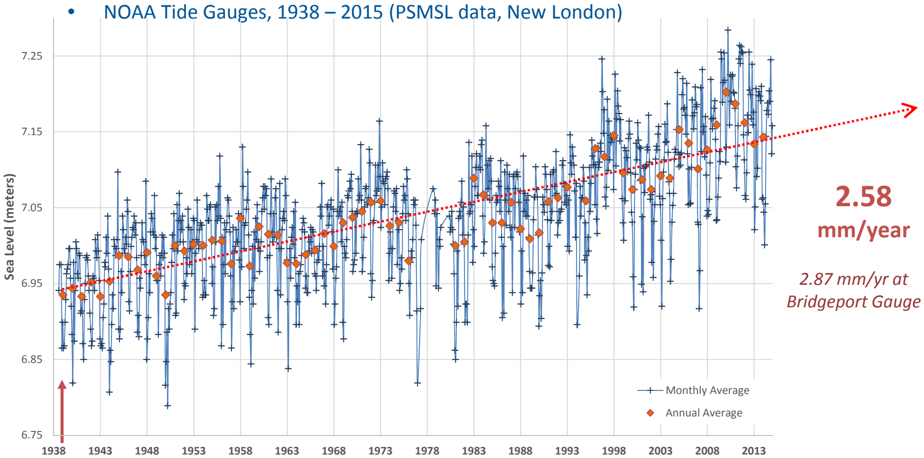
What is Flood Mitigation? What is Resilience?

- **Flood Mitigation** is a sustained set of actions to reduce flood losses. Examples include prevention, property protection, etc.
- **Resilience** is "the ability of any system (infrastructure, government, business) to resist, absorb and recover from or adapt to an adversity"
- **Community** Resilience is "the ability of a community to prepare for anticipated hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions."
- **Coastal** Resilience is the ability to resist, absorb, recover from, or adapt to coastal hazards such as sea level rise, increased flooding, and more frequent storm surges.

A home is elevated
Photo: Shoreline Times

What About Risk?

- **Sea Level Has Been Rising**
  - NOAA Tide Gauges, 1938 – 2015 (PSMSL data, New London)



2.58 mm/year

2.87 mm/yr at Bridgeport Gauge

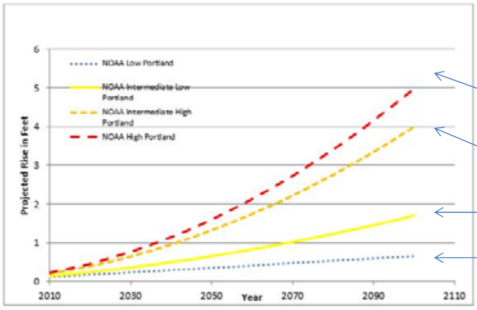
September 1938
"Long Island Express" New England Hurricane

What About Risk?

- NOAA and the Army Corps of Engineers developed several sets of projections that were published in 2012
- This is now federal guidance

Global Sea Level Rise Scenarios for the United States National Climate Assessment

December 6, 2012



Ocean warming + highest polar ice melt

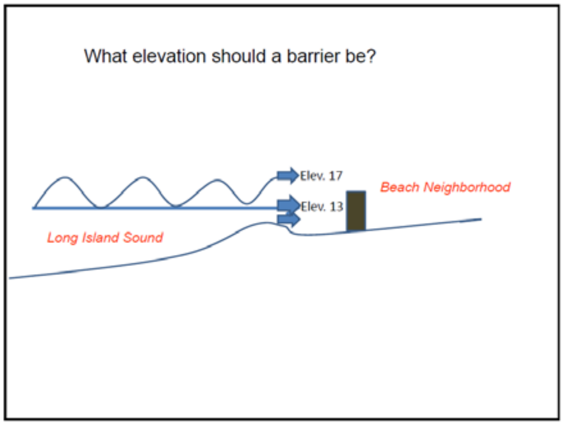
Ocean warming + some polar ice melt

Ocean warming

Continuation of historical trend

What About Risk?

- **The Town's Flood Mitigation Plan posed the question: *what elevation should a barrier be?***
- This is one of the main themes for this study – what elevations are appropriate for flood protection?



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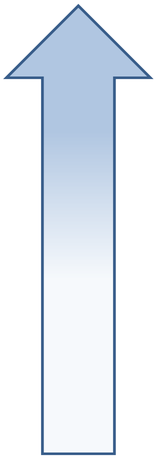
Review of July 12, 2016 Meeting

We posed the question "how high would YOU build flood protection?

- VE = 13 to 15 feet
- NACCS 1% + tide = 11.5 to 11.8 feet
- 0.2% Stillwater = 11.4 to 11.5 feet
- AE = 11 feet
- 1% Stillwater = 10 to 10.1 feet
- NACCS 1% surge = 9.8 to 9.9 feet
- Sandy = 9.2 to 10.4 feet
- Irene = 8.5 to 8.7 feet
- Coastal Jurisdiction Line = 5.2 feet
- MHHW = 3.54 feet
- MHW = 3.20 feet



All NAVD88

Review of July 12, 2016 Meeting

We asked these questions:

- Do the various FEMA, NACCS, and other water level figures make sense when compared to the Irene and Sandy water levels?
- Which SLR projections seem most appropriate for design?
- Which set of best available guidance makes sense for Fairfield? Consider Sandy-level protection vs. a FEMA-accredited levee
- Can the Town tolerate a flood protection system designed to the higher projections and safety factors?

Review of July 12, 2016 Meeting

We looked at some dike/levee simulations

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Review of July 12, 2016 Meeting

And we heard the following:

Observations:

- The extent of flooding was similar when comparing Sandy and Irene with some nor'easter flood events.
- Shifts in wind direction appear to affect flood extents.

Scope and Technical Questions:

- Will the study consider floodwaters that surcharged from stormwater systems?
- Decreasing the duration of flooding would be helpful if possible.
- Will the study consider lower design elevations for flood protection systems?

Implementation:

- Will the study consider breaking projects into components?
- Will the study identify funding sources for implementation?

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Agenda

- Project Background
- Mitigation, Resilience, Risk, and Adaptation
- Review of July 12, 2016 Meeting
- **Design Criteria**
- Flood Protection System Layout
- Other Flood Protection Options
- Tide Gates
- Next Steps

Initial Thoughts about Design Criteria

- 44 CFR Ch.1 (10-1-11 Edition) Sec. 65.10, FEMA, "Mapping of areas protected by levee systems
  - ✓ For coastal levees, 100-year including maximum wave runup V zone elevation + one foot (sec. iii)
- Executive Order 13690, Floodplain Management, January 30, 2015 (Federal Flood Risk Management Standard, FFRMS)
  - ✓ 100-year BFE + 2' or 3', or 500-year flood, or best available climate science
  - ✓ FFRMS does "not establish a required size, crest, elevation, or scale for levees, floodwalls, dunes or other infrastructure used for flood risk reduction"

Initial Thoughts about Design Criteria

- US Army Corps of Engineers, Regulation No. 1100-2-8162, “Incorporating Sea Level Change in Civil Works Programs,” 31 December 2013
  - ✓ Use low, intermediate, and high scenarios at nearest tide gauge using online USACE sea level calculator
- US Army Corps of Engineers, “North Atlantic Coast Comprehensive Study (NACCS): Resilient Adaptation to Increasing Risk,” Main Report, January 2015
  - ✓ For Storm Surge Barriers protecting multiple buildings: 0.2% flood elevation with wave runup (500-year flood V zone elevation) + 3’ sea level rise allowance

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What’s New With the FFRMS?

- Risk establishment approaches have acronyms:
  - ✓ 100-year BFE + two feet for non-critical actions **(“FVA,” or freeboard value approach)**
  - ✓ 100-year BFE + three feet for critical actions
  - ✓ 500-year flood **(“0.2PFA,” or 0.2% annual chance flood approach)**
  - ✓ best available climate science **(“CISA,” or climate informed science approach)**

What’s New With the FFRMS?

- Federal agencies are currently determining how to use the FFRMS
  - ✓ **HUD** will apply CISA, FVA, or 0.2PFA to buildings
  - ✓ **FEMA** prefers the CISA or FVA
  - ✓ **USACE** prefers the CISA for characterizing risk and making decisions, but says that it is NOT meant to be design criteria

Fairfield Has Two Paths to Consider

Sandy/Irene flood levels, NACCS

About 12 to 15’

Protection from the next Irene, Sandy, or nor’easter with a marginal buffer for SLR

FFRMS or typical levee design requirements

About 18’ or higher

Protection that allows a FEMA map revision with perpetual levee accreditation

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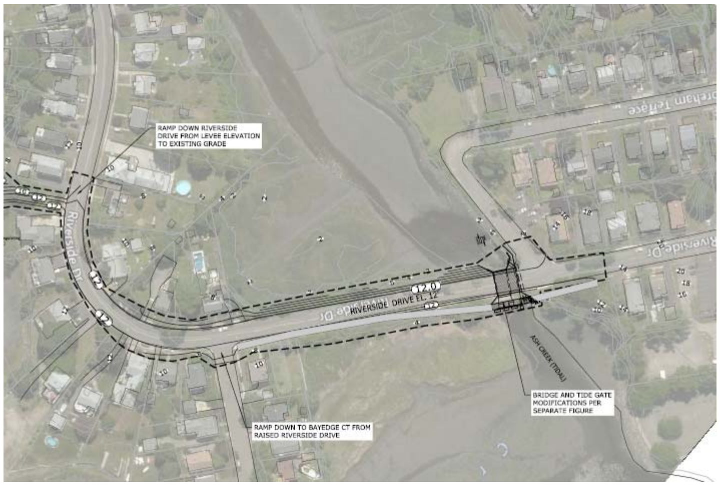
Flood Protection System Layout

- **Three sets of layouts have been prepared:**
  - ✓ Top elevation 12’
  - ✓ Top elevation 15’
  - ✓ Top elevation 18’
- **Several layouts are depicted on the next few slides**
- **A complete set is provided on easels in the room**
- **Layouts can be assembled like a puzzle**
  - ✓ For example, choose 18’ for Jennings Beach ridge and 12’ to 15’ for the other segments

Flood Protection System Layout – 12’



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Flood Protection System Layout – 12’

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Flood Protection System Layout – 12’

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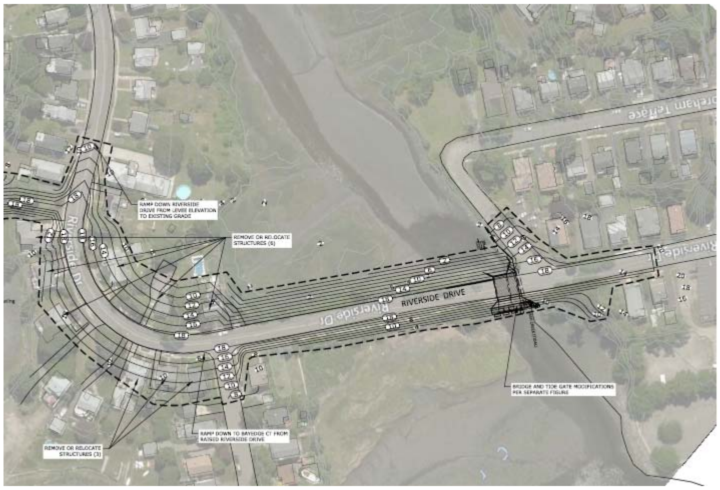
Flood Protection System Layout – 18’



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Flood Protection System Layout – 18’

Flood Protection System Layout – 18’

Flood Protection System Alternates

Outside the Curve of Riverside Drive

Elevation 12’

Elevation 18’

Flood Protection System Alternates

Inside the Curve of Riverside Drive

Elevation 12’

Elevation 18’

Flood Protection System Alternates

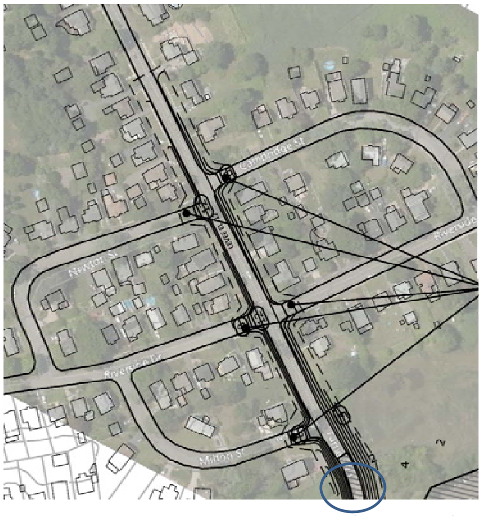
Elevate Turney Road

Unprotected homes – need to elevate as currently required for Substantial Damage or Substantial Improvement

Protected homes

Flood Protection System Alternates

Elevate Turney Road



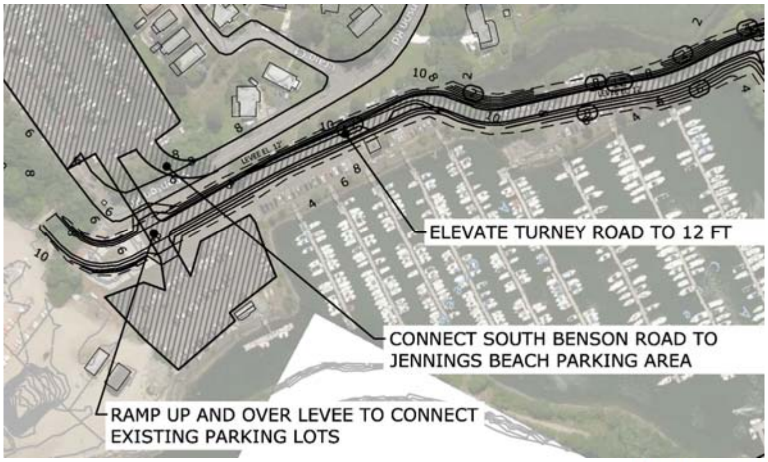
10% grade connections to side streets

Connect to segment that runs along the marina

Flood Protection System Alternates

Maintain Turney Road and South Benson Road

Does not dead end Turney Rd or South Benson Rd, but at the expense of marina parking



ELEVATE TURNEY ROAD TO 12 FT

CONNECT SOUTH BENSON ROAD TO JENNINGS BEACH PARKING AREA

RAMP UP AND OVER LEVEE TO CONNECT EXISTING PARKING LOTS

Flood Protection System Summary of Choices

- **Choices at Riverside Drive bridge**
  - ✓ Elevate roadway?
  - ✓ Elevate sidewalk or construct wall along side?
- **Choices at the bend in Riverside Drive**
  - ✓ Elevate roadway?
  - ✓ Go around the outside of the curve?
  - ✓ Stay inside the curve?
  - ✓ Elevate Turney Road in lieu of Riverside Drive?
- **Choices at the marina**
  - ✓ Maintain internal circulation?
  - ✓ Cut off internal circulation and maintain two entrances?

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Review of Other Flood Protection Options

- **Dune creation/enhancement** – Dunes at the rear of the beach may reduce flood water surface elevations at Jennings Beach, but likely not necessary due to the relatively high ridge elevation
- **Beach enhancement** – A different profile may reduce flood water surface elevations at Jennings Beach, but likely not necessary due to the relatively high ridge elevation
- **Shoreline structures** – Likely not necessary, except perhaps at the pavilion gap
- **Offshore structures** – May reduce wave energy, but the Jennings Beach profile and ridge are likely providing equivalent protection

Review of Other Flood Protection Options

Hurricane Barrier

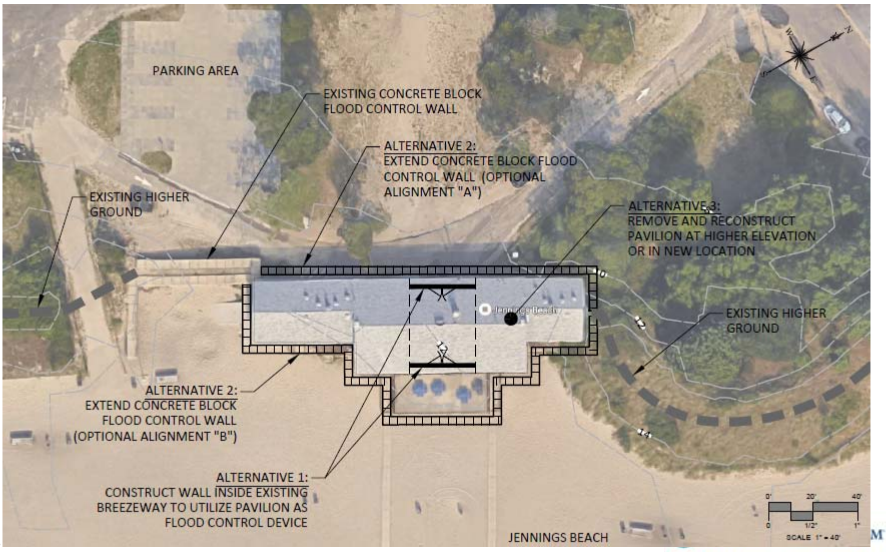
Crazy?

Review of Other Flood Protection Options

Options for the gap at the Jennings Beach Pavilion

Review of Other Flood Protection Options

Options for the gap at the Jennings Beach Pavilion



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Review of Tide Gate Options

- **Turney Creek tide gates beneath Riverside Drive (condition and operations vary)**






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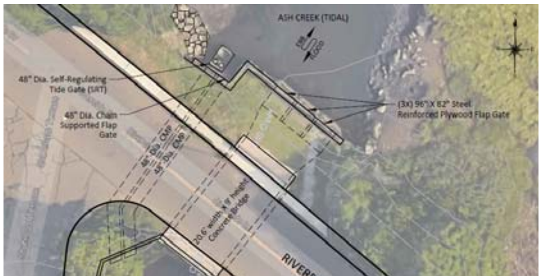
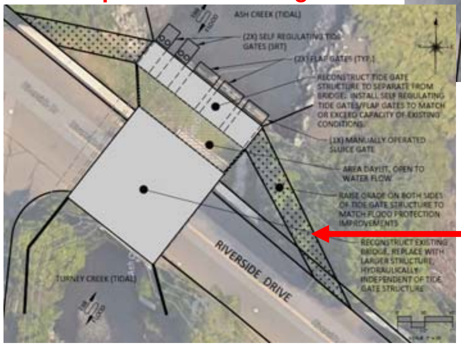
Review of Tide Gate Options

Existing Conditions



Potential Modification to De-Couple from the Bridge



If the bulkhead is high enough to provide flood protection, tie into high ground or elevated road

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Review of Tide Gate Options

- **A dike with a walking path on its crest provides some flood protection from Ash Creek at Riverside Creek**
- **One SRT controls the upstream marsh levels**

Review of Tide Gate Options

Elevate dike to provide additional flood protection

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Next Steps

- **Complete plan document/report**
- **Planning level cost estimates**
- **Permit evaluation for different options**
- **Coordination with other projects in Fairfield**

Discussion