

Town of Winthrop

Morton Street Resilience Project – Feasibility Report



June 2024

PREPARED FOR:
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Acronyms

CZM	Coastal Zone Management
DCR	Department of Conservation and Recreation
DEM	Digital Elevation Model
DEP	Department of Environmental Protection
EEA	Executive Office of Energy & Environmental Affairs
FBIM	Friends of Belle Isle Marsh
GPS	Global Positioning System
HTL	High Tide Line
IPCC	Intergovernmental Panel on Climate Change
MC-FRM	Massachusetts Coastal Flood Risk Model
MLW	Mean Low Water
MLLW	Mean Lower Low Water
MHW	Mean High Water
MHHW	Mean Higher High Water
MTL	Mean Tide Level
MVP	Municipal Vulnerability Preparedness
MyRWA	Mystic River Watershed Association
NAVD88	North American Vertical Datum of 1988
NOAA	National Oceanic and Atmospheric Administration
RTK	Real Time Kinematic
SLR	Sea Level Rise
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
VDatum	Vertical Datum Transformation Tool
WHG	Woods Hole Group

Acknowledgments

This project was made possible by the collaborative effort of funders, stakeholders, and community members. Funding was provided to the Town of Winthrop by MA Executive Office of Energy and Environmental Affairs’ Municipal Vulnerability Preparedness Program FY23-24. The Town of Winthrop consulted with the Mystic River Watershed Association, Friends of Belle Isle Marsh, Green International Affiliates, and Woods Hole Group to complete technical work. Regional coordination was critical to the project’s success, with thanks extended to the MA Department of Conservation and Recreation, Cities of Boston and Revere, Massachusetts Bay Transportation Authority, MA Department of Transportation, and The Nature Conservancy for their contribution through monthly and in some cases weekly meetings. Further thanks are extended to the communities of Winthrop, and especially to individual representatives who helped make up the Community Advisory Group for their continued engagement and support.



1.0 INTRODUCTION

The Town of Winthrop in collaboration with the Mystic River Watershed Association (MyRWA), Friends of Belle Isle Marsh (FBIM), Woods Hole Group (WHG), and Green International Affiliates (Green) have developed the Morton Street Resiliency Project (Project) to address flood risk concerns to the low-lying, residential and commercial area adjacent to Belle Isle Marsh. This work was funded by a Massachusetts Executive Office of Energy and Environmental Affairs (EEA) Municipal Vulnerability Preparedness (MVP) action grant for FY24.

This work occurred among efforts by a broader Regional Stakeholder Group, which has met monthly since 2021, to assess the current and future impacts of flooding and coastal storms on the Belle Isle Marsh and surrounding communities; and evaluate potential flood risk reduction strategies that at minimum preserve, but ideally improve the health of the marsh. This group includes MyRWA, City of Boston, City of Revere, Town of Winthrop, Department of Conservation and Recreation (DCR), Massachusetts Department of Transportation (MassDOT), Massachusetts Bay Transportation Authority (MBTA), The Nature Conservancy (TNC), Friends of Belle Isle Marsh (FBIM), and HYM Investments. Furthermore, a Community Advisory Group (CAG) has been led by FBIM and supported by MyRWA and WHG during this same period to provide meaningful engagement and collaboration with technical aspects of the work. Two virtual public meetings and three public site walks were held with residents of the neighborhood and broader public in support of this effort.

The Project is an extension of past work to evaluate regional risks, opportunities and constraints for adaptation, selection of priority sites, and subsequent development of conceptual adaptation strategies for the communities around Belle Isle Marsh (WHG, 2023). The shoreline of Belle Isle Marsh was segmented into unique shoreline reaches, and prioritized for adaptation by evaluating flood exposure, asset criticality, permitting feasibility, construction feasibility, community benefit, and habitat restoration value. Four reaches, consolidated into two, were selected by the Regional Stakeholder Group to advance. The team developed preliminary nature-based and hybrid solutions to reduce flood risk to the neighboring communities and critical infrastructure, preserve and enhance the habitat value of Belle Isle Marsh, and provide community engagement and public access. The two on-going (and MVP FY24 funded) priority site projects include: the *Resilient Bennington Street and Fredericks Park Project*, and the *Morton Street Resilience Project*. This report details the alternatives and feasibility assessment of the Morton Street Resilience Project.

1.1 PROJECT NEED

The Project Area spans from the Saratoga St / Main St bridge crossing, along the shoreline of Belle Isle Marsh to the Housing Authority apartments and Winthrop Cemetery, an approximately 4,000 linear foot reach (Figure 2). The upland area is low-lying, having been developed in a flood plain and in some cases atop filled tidelands or wetlands. Along some reaches, development sits just 2-3 feet above the high tide line.

The lowest point along the shore occurs at the intersection of Morton St and Banks St. Flooding is first visible in this area when high tide floods through the storm drain network, and bubbles up the catch basins. The outfalls are said to contain check valves which in such a case must require repair. Overtopping of the shoreline is the next concern, when storm surge events and northeast winds drive water over the banks and into the residential neighborhood. Precipitation events compound these flooding issues.

To the west, towards the Belle Isle Boatyard, storm surge overtops the bank and flows downhill towards the low-point at Morton St/Banks St. The storm drain network intends to convey precipitation and



overtopping back to the marsh, but in cases has been noted as blocked by debris, having insufficient capacity, and causing runoff which can erode the bank.

Open space areas exist between the roadway right-of-way (ROW) and Belle Isle Marsh, the largest of which is the Marine Ecology Park, a grassy upland supporting pathways and the Mary Kelley Pavilion. This area has been the subject of recent improvements, as it was once a private property under scrutiny for debris and contamination by the Town. The parcel was transferred to DCR. The park space was renovated and a boardwalk was constructed which connects to the Winthrop Cemetery. Other open space areas exist to the west, where a relatively narrow strip of grass, shrubs, and trees supports a park bench, and informal parking space for about ten cars.

Seaward of the shoreline reach is Belle Isle Marsh, part of the Rumney Marsh Area of Critical Environmental Concern (ACEC). The marsh adjacent Morton St is owned by Winthrop, while the greater Reservation is owned by DCR. The marsh has been dramatically impacted by anthropogenic influence to the detriment of today's and tomorrow's natural habitat and wildlife. Large areas of the marsh have been filled with sediment and landfill materials. The tidal and stormwater hydraulics have been impaired by mosquito ditching and historic berms. Critical habitat for the saltmarsh sparrow and other wildlife has been squeezed between coastal development and the rising ocean. Climate change threatens to worsen the ecological and sociological functions of Belle Isle Marsh, through sea level rise (SLR) and increased coastal storm severity.

1.1 PROJECT GOALS

Through coordination with the Belle Isle Marsh Regional Stakeholder Group and CAG, as well as Town staff, project goals were established to guide development of appropriate adaptation alternatives. Three central themes were established: flood protection, habitat quality and biodiversity, and community support and engagement (Figure 1).

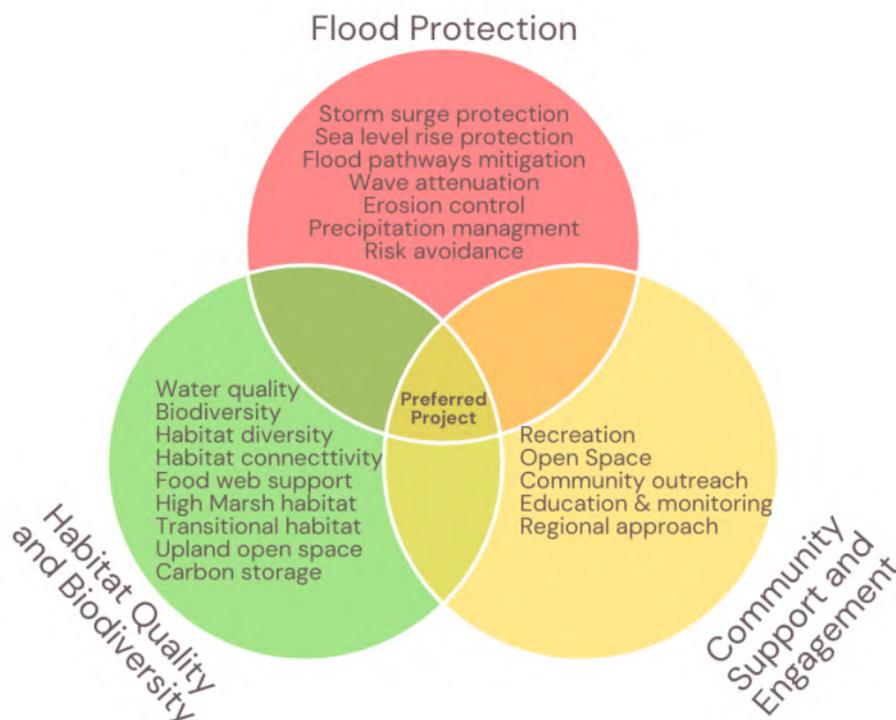


Figure 1. Morton Street Resiliency Project Goals.



Figure 2. Morton Street Resiliency Project Area.



2.0 EXISTING CONDITIONS

The following section describes existing water levels, elevations, natural resources, infrastructure and utilities, and ownership relevant to the Project area.

2.1 TIDAL DATUMS

In support of the Belle Isle Marsh Health Assessment (WHG 2022), WHG deployed tide gauges throughout Belle Isle Marsh between the period of November 9 to December 21, 2020 (42 days) to measure site-specific tidal information across a full spring and neap tidal cycle. The present day tidal range is approximately 9.7 feet, from Mean Low Water (average elevation of daily low tides) to Mean High Water (average elevation of daily high tides). Elevations throughout this report are presented with respect to the North American Vertical Datum of 1988 (NAVD88), a fixed datum established by the U.S. Geological Survey which is nearly equal to the Mean Tide Line or Mean Sea Level. Presently, the high tide at the Project area is about 5 feet above NAVD88.

Table 1 provides calculated tidal datums for the project site based on field data collection in 2020, as well as projected coastal storm water surface elevations (WSE) under present day sea level conditions.

Table 1. Present water surface elevations adjacent the Project Area.

Elevation (ft NAVD88)	Acronym	Present Day
Annual Probabilistic Water Surface Elevation (WSE)¹	0.5% WSE	9.5
	1% WSE	9.3
	2% WSE	9.0
	10% WSE	8.2
Highest Astronomical Tide	HAT ²	6.8
Mean Higher High Water	MHHW ³	5.1
Mean High Water	MHW	4.6
Mean Tide Level	MTL	-0.3
North American Vertical Datum 1988	NAVD88	0
Mean Low Water	MLW	-5.1
Mean Lower Low Water	MLLW	-5.4
Tide Range from MLW to MHW	Tide Range	9.7

¹Probabilistic WSE's were derived from the MC-FRM for north Boston Harbor (Bosma et al., 2021).

²Represents present day HAT at Boston Harbor Tide Gauge (Station 8443970) centered around 2008.

³Present day tidal datums represent observations downstream of Saratoga St bridge from Nov-9 to Dec-9, 2020.

2.2 ELEVATIONS

Elevations within the Project area were derived primarily from topographic surveying by Green International Affiliates in November of 2023. The survey extents were contained to the ROW of Morton St and Banks St and adjacent properties. Where surveying could not be completed, gaps were filled by a combined topobathymetric Digital Elevation Mode (DEM) created from U.S. Army Corps of Engineers 2018 LiDAR data and WHG 2020 field surveys (WHG, 2022). An overview of topographic and bathymetric elevations is provided in Figure 3. This best available data was carried forward to the Existing Conditions Plan Set provided in Appendix A.

The topography of the upland developed and open space shoreline is generally low-lying, but varies in elevation from approximately 7 ft to 11 ft NAVD88. The lowest point along the shoreline is located behind

residential homes on Banks St; this is also the lowest developed shoreline around all of Belle Isle Marsh. Inland of the shoreline, the lowest point also occurs on Banks St where an elevation of 5.5 ft NAVD88 barely exceeds the MHHW datum. The elevation gently rises to the east and west from this area. To the west, the shoreline elevation of 11 ft NAVD88 is present at the ramp from Main St onto the Saratoga St bridge. To the east, elevations incrementally rise inland, and 11 ft NAVD88 is attained at approximately the intersection of Banks St and Winthrop St.

Main St runs linearly along a high spine in this area of Winthrop. A downhill slope extends from Main St to Morton St, and acts as a catchment area for rainfall, directing inland runoff towards this shoreline. The high elevation of Main St does bulge out towards Morton St at Amelia Ave, but this hill quickly turns back inland leaving the Belle Isle Boatyard and surrounding development on a relatively low and flat area adjacent the main channel of Belle Isle Marsh.

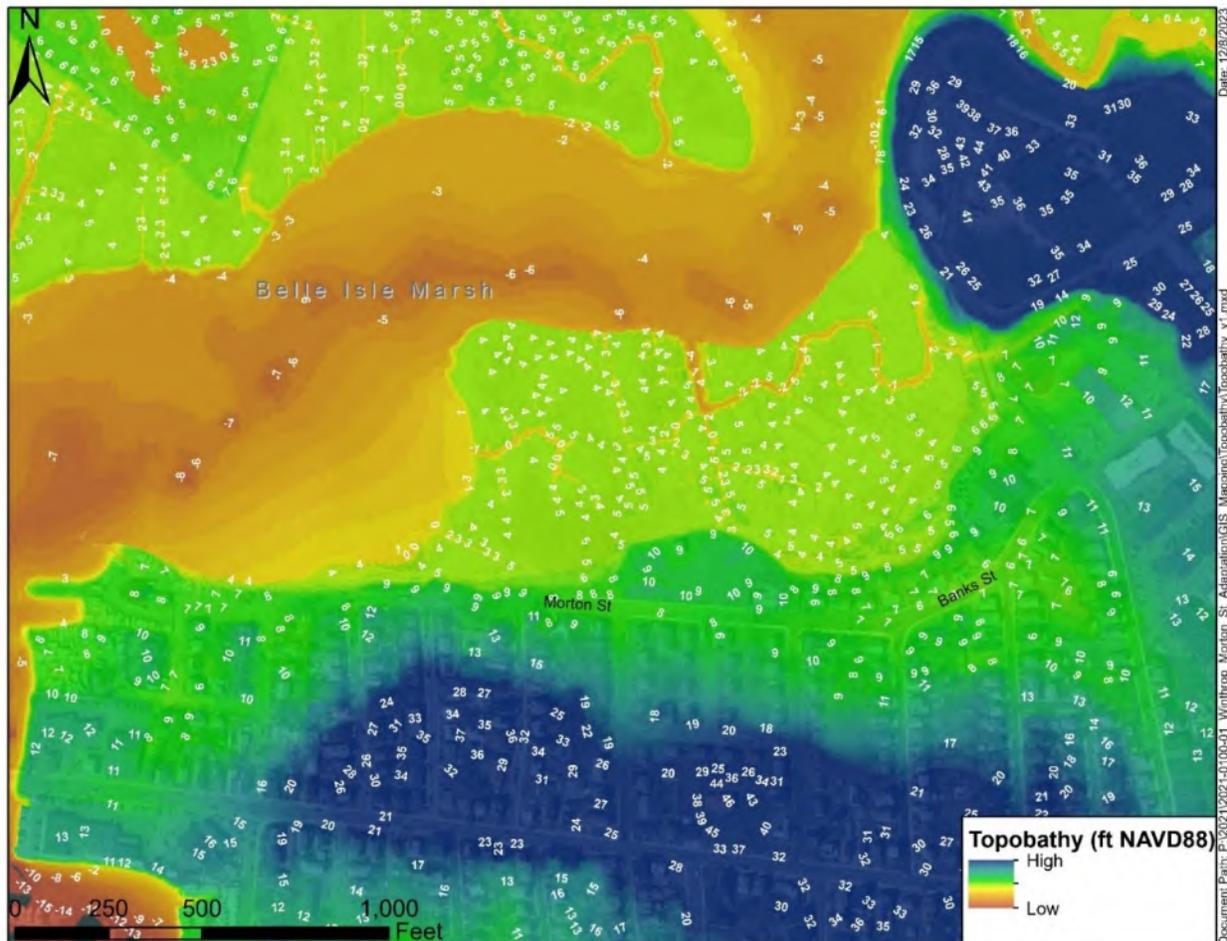


Figure 3. Elevations of tidal channel, marsh, and uplands adjacent the Project area (USACE 2018 and WHG 2022 surveys in feet, NAVD88).

2.3 WETLAND RESOURCE AREAS

On November 6th, 2023, a WHG Professional Wetland Scientist conducted a coastal resource area delineation along the shoreline seaward of Morton Street and Banks Street and within the Belle Isle Marsh in Winthrop, Massachusetts. The study area extended approximately 4,000 linear feet from the Saratoga Street bridge, north, then east along Morton Street before terminating before the North Winthrop

Cemetery. Resource areas delineated in this study included coastal beach, salt marsh, and coastal bank (Figure 4). To delineate the extent of resource areas and capture changes in topography, a survey-grade real-time Kinematic (RTK) GPS was used to collect data at sub-centimeter accuracy in both horizontal and vertical datums. Horizontal data were recorded in Massachusetts State Plane 2001 (Mainland, US survey feet) and vertical data were collected in North American Vertical Datum of 1988 (NAVD88, US survey feet). Land Subject to Coastal Storm Flowage (LSCSF) was also included in this study as mapped by FEMA. Outstanding resource waters (ORW) and the ACEC boundary are depicted as well. Descriptions of each resource area are included below.

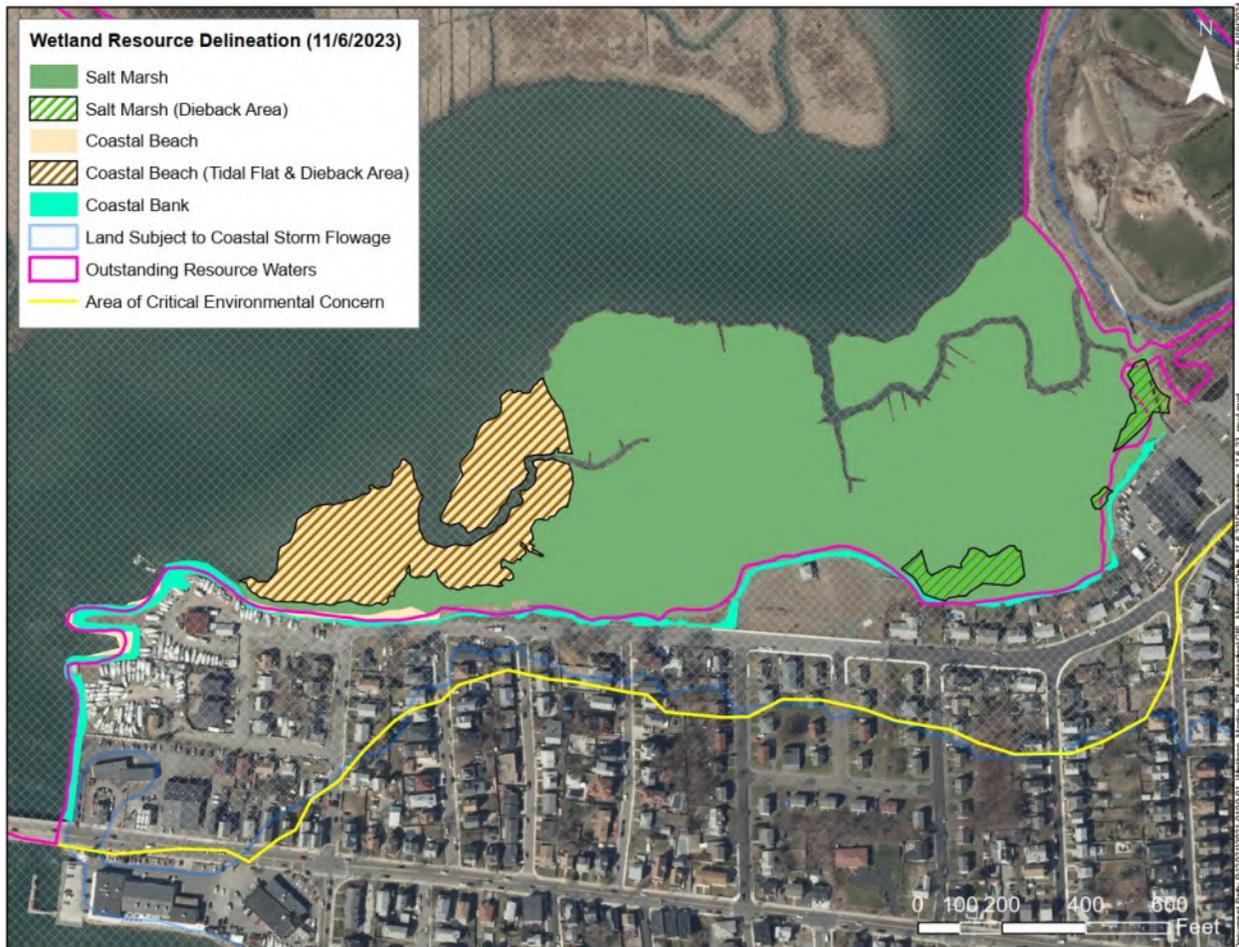


Figure 4. Resource areas delineated within the study area on November 6th, 2023.

Coastal Beach

Coastal beach was delineated at three, narrow pockets along the western and northern shoreline of the Ravosa Marine Services property (Figure 5). Sediments observed in this location were primarily fine-grained, with some gravel that has eroded from the landward coastal bank. Wrack material, among other loose debris was also scattered throughout the beach. A similar patch of coastal beach was present along the shoreline to the north. Coastal beach in this location was covered with sub-aquatic vegetation.

Seaward of Morton Street and just east of the Ravosa Marine Services property, a narrow coastal beach was present extending approximately 450 linear feet along the shoreline. The beach abutted salt marsh along its seaward edge and was backed by a low-lying coastal bank buffering it from Morton Street (Figure

6). Sediments in this location included medium to fine-grained sand and gravel, with salt marsh wrack material accumulated over a significant portion of the landward edge.



Figure 5. Coastal beach adjacent Ravosa Marine Services along the western shoreline taken facing south (left), and northern shoreline taken facing west(right).



Figure 6. Coastal beach seaward of Morton Street. Photo taken facing east.

Salt Marsh

Salt marsh was present seaward of the full length of Morton Street and Banks Street, beginning at the eastern boundary of the boatyard, and ending at the survey extent west of the cemetery. Along approximately 700 linear feet of the western shoreline, a narrow strip of living salt marsh was backed by

coastal beach and contained exclusively smooth cordgrass (*S. alterniflora*) (Figure 7). Seaward of this strip of salt marsh was mudflat containing sparse islands of vegetated marsh platform (Figure 8). To the east of this area, vegetated salt marsh platform expanded to approximately 750 linear feet in width between coastal bank and seaward extent of salt marsh (Figure 9). This expanse of salt marsh was dominated by smooth cordgrass, with pockets of high marsh containing saltmeadow cordgrass (*S. patens*) and saltgrass (*D. spicata*). Dense stands of phragmites were present along the landward edge of salt marsh. From the Belle Isle Marsh Marine Ecology Park to the eastern extent of the salt marsh, wide swaths of unvegetated marsh were observed, as well as areas containing visibly stressed vegetation (Figure 10).

Fracturing was observed along the seaward edge of the salt marsh platform (Figure 11). Mosquito ditches were present throughout the marsh in varying widths. Sides of ditches were often observed to be collapsing or sloughing. Smooth cordgrass was present throughout the seaward edge of marsh area.



Figure 7. Band of salt marsh seaward of Morton Street. Photo taken facing west.



Figure 8. Mudflat seaward of Morton Street. Photo taken facing north.



Figure 9. High marsh in foreground, low marsh in background. Photo taken facing north.



Figure 10. Stressed salt marsh vegetation near the boardwalk.



Figure 11. Fracturing of salt marsh platform observed along seaward edge. Photo taken facing west.

Coastal Bank

Coastal bank was delineated along the seaward edge of Sonny's car wash, north of the Saratoga Street bridge (Figure 12). The bank was steep and comprised of mixed media including native bank sediments, granite slabs, asphalt, bark mulch, and gravel. The presence of this armored structure prevents native sediments from eroding and conveying onto the seaward coastal beach. Therefore, this section was determined to be non-sediment source coastal bank. This bank continued north approximately 200 linear feet before transitioning to a lower lying non-sediment source coastal bank, which contained more exclusively angular stone and gravel. This bank continued approximately 1,000 feet around the seaward edge of the marine service center property and terminated seaward of the corner Belle Isle Terrace and Willis Ave.

A low-lying coastal bank was present along the shoulder of Morton Street, and seaward of the Belle Isle Marsh Ecology Park (Figure 13). Vegetation along this bank included seaside goldenrod (*S. sempervirens*), high tide bush (*I. frutescens*), staghorn sumac (*R. typhina*), black cherry (*P. serotina*), ash-leaf maple (*A. negundo*), and dense stands of phragmites (*P. australis*).

Coastal bank continued along the seaward edge of the RPM Fitness parcel, where phragmites became more prevalent (Figure 14). The bank turned north, where woody vegetation was more prevalent along the edge of the cemetery property. An approximately 350 linear foot section of armored bank was present along the edge of the cemetery property, consisting of roughly piled concrete slabs (Figure 15). Coastal bank continued beyond the northeastern extent of the study area.

Along the naturalized banks of Morton St and the backyards of parcels along Banks St, the landward edge of coastal bank was delineated by calculating the 10:1 (horizontal:vertical) slope break. This represents the boundary between a steeper coastal bank and a flatter upland. Elsewhere, the top of coastal bank was delineated as the top of the armored feature.



Figure 12. Non-sediment source coastal bank north of the Saratoga Street Bridge (left) and north of Sonny's car wash (right). Photos taken facing north.



Figure 13. Low lying coastal bank seaward of Morton Street. Photo taken facing east.



Figure 14. Coastal bank in the southeast corner of the study area. Photo taken facing southwest.



Figure 15. Concrete slabs piled along the toe of coastal bank. Photo taken facing north.

Land Subject to Coastal Storm Flowage

Land subject to coastal storm flowage (LSCSF) extended throughout the study area, inclusive of the AE Zone (Figure 16). As a result, LSCSF also encompasses all the resource areas that were observed on site.

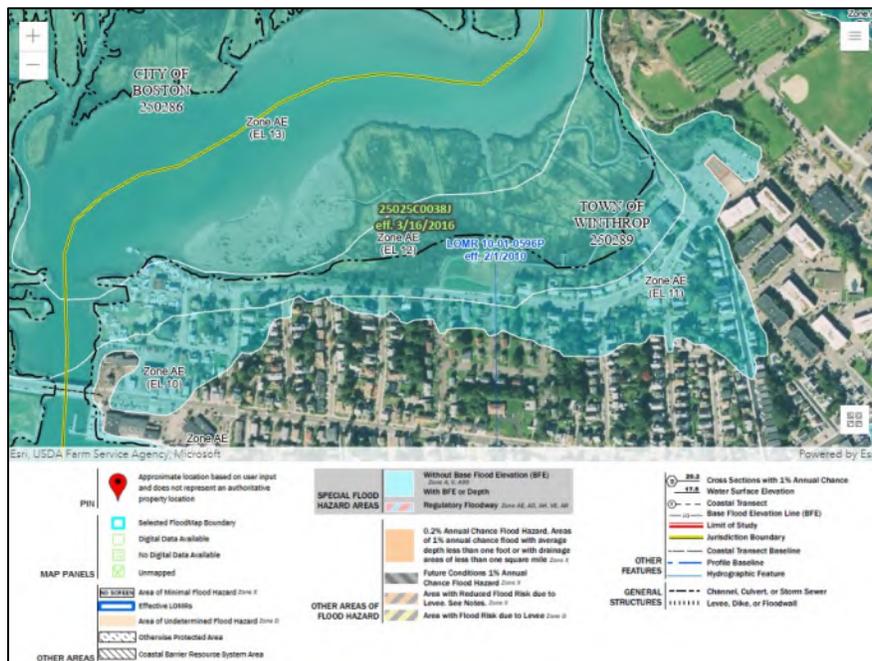


Figure 16. Extent AE and VE Zones within and adjacent to the study area.

Natural Heritage Estimated & Priority Habitat and MA Division of Marine Fisheries Shellfish Suitability Areas

Estimated and Priority Habitat for Rare or Endangered Species were identified adjacent to the study area by the Massachusetts Natural Heritage and Endangered Species Program. A significant portion of the study area was identified as spawning and settlement habitat for soft-shell clam (*Mya arenaria*), (Figure 17). No live shellfish were observed during the delineation.



Figure 17. NHESP & Shellfish suitability habitat adjacent to the Morton Street study area.

Outstanding Resource Waters and ACEC Designation

The Outstanding Resource Water (ORW) designation of Belle Isle Marsh aligns with the high tide line and prohibits any new fill or features within the marsh except for Ecological Restoration, or maintenance repair, or replacement of existing structures per 314 CMR 9.06(3) Water Quality Regulations. Therefore, all work is proposed above the high tide line to avoid impacts to the ORW.

Area of Critical Environmental Concern (ACEC) regulations come from 310 CMR 10.24(5)b). The ACEC designation aligns with the 100-year floodplain, and requires no adverse impact on the ACEC interests except for:

- Maintenance dredging,
- Ecological Restoration, and
- Improvement dredging of historically navigable areas.

Therefore, the conceptual alternatives propose only to enhance the interests of the resource areas they are present within. No conversion of resource areas and no permanent impacts to resource areas is proposed.

2.4 INFRASTRUCTURE AND UTILITIES

A site civil survey was performed by Green International Affiliates in November 2023. Detailed Existing Conditions Plans were prepared for the site and are provided in Appendix A.



The Project site abuts approximately twenty-four (24) residential buildings, six (6) commercial buildings, and one sewer pump station in Winthrop, Massachusetts. Eight (8) residential buildings are located seaward of Banks St, on the edge of the marsh. The Belle Isle Marsh Marine Ecology Park sits seaward of Morton St homes. Many homes were constructed prior to 1978, including all homes seaward of Banks St.

The Pleasant Court Sewer Pump Station was identified as the 2nd highest priority critical infrastructure for the Town (Stantec, 2017). Main Street (Saratoga Street in Boston) is an evacuation route, one of only two (the other being Winthrop Parkway) for the entire Town of Winthrop, listed as the 4th highest priority critical infrastructure.

Sewer, water, electric, gas, and telecommunication utility lines run beneath roadways of the Project area, including Morton St and Banks St. Most significantly, an 8-foot diameter Massachusetts Water Resources Authority (MWRA) sewer line conveys sewage for many communities including East Boston underneath the boat yards and Morton St to Deer Island, Winthrop.

2.5 OWNERSHIP

Adaptation along the Project reach will require collaboration from DCR, Winthrop, and residents and commercial businesses (Figure 18). Morton St and Banks St are primarily residential roadways owned and managed by Winthrop. Private residents own most waterfront parcels, approximately twenty-four (24), while the Winthrop Housing Authority owns and manages thirty-three (33) residential and housing authority buildings for family housing located on Edward, Read, Russell, Douglas, and Morton Streets. These homes are approximately seventy-five (75) feet from marshes connected to the Belle Isle Inlet (Waterfield Design Group, 2023). Commercial development includes the Dunkin’, Sonny’s Car Wash, Belle Isle Boat Yard, Ravosa Marine Services, Corolla Contracting, and RMP Fitness. The primary open space parcel of the Belle Isle Marsh Marine Ecology Park is owned by DCR and leased by the Town. The marshes adjacent Morton St and Banks St are owned by Town of Winthrop.

The alternatives analysis conducted during this study details adaptation concepts which in many cases impact private property. Most significantly impacted are likely to be residential homes seaward of Banks St, detailed in Table 2 and Figure 19, and discussed in later sections. These residents have been explicitly reached out to and engaged with throughout this project, including two public-wide site walks on November 17, 2023 and May 2, 2024, as well as a Project Abutter’s Meeting held on-site April 17, 2024.

Table 2. Property Ownership North of Morton Street within Project area

Parcel ID	Address	Year Built	Building Style
60_6	142 Morton Street	1964	Ranch
60_7	Morton Street	-	Vacant Land
60_8	148 Morton Street	1954	2 Unit
60_9	154 Morton Street	1955	Cape Cod
60_10	160 Morton Street	1957	2 Unit
60_11	70 Banks Street	1953	Ranch
60_12	76 Banks Street	1958	2 Unit
60_13	84 Banks Street	1957	2 Unit



Figure 18. Property Ownership within Project area.

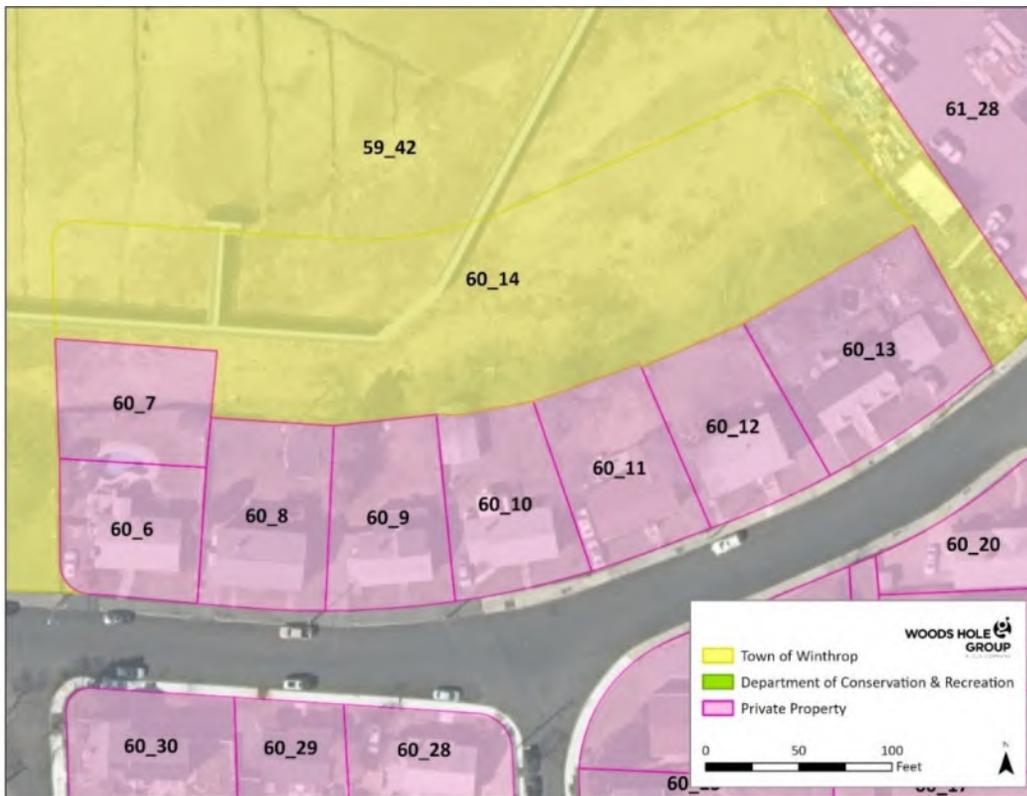


Figure 19. Property Ownership North of Banks Street within Project area likely to be impacted by adaptation alternatives.



3.0 DESIGN CRITERIA

This section details design criteria which set the framework for engineering design. Summarized here are the coastal flood risk and design flood elevations, stormwater design criteria, adaptation components, and permitting pathways.

3.1 COASTAL FLOOD RISK

Sea level rise and coastal storms are the primary concern to be addressed through this project. This section summarizes such risks, design flood elevations, and flood diversion analysis.

3.1.1 Coastal Storms

Past coastal storm events have resulted in severe inundation of the low-lying neighborhood such as the January 4th and March 2-4th, 2018 storms. These nor'easters caused high water levels in Belle Isle Marsh and flooding in the surrounding communities (Lombard et al, 2021). The National Oceanic and Atmospheric Administration (NOAA) tide gauge in Boston Harbor recorded the highest total water level on record of 9.66 ft during the January 2018 event, equating to approximately a 2% annual chance event (Figure 20). Similarly, the tide gauge recorded the third highest total water level on record of 9.16 ft during the March 2018 event (Figure 21). Coastal flooding along the Morton St waterfront also occurred during a low-pressure system on January 13, 2024, which led to a storm surge of 2 to 3 feet along the coast of Massachusetts Bay, despite offshore winds. The storm was recorded by NOAA as the 4th highest water level in Boston Harbor. Such events present a risk to low-lying communities including residential neighborhoods along Morton St/Banks St in Winthrop. Flooding primarily impacts residents. Sea level rise is anticipated to exacerbate events such as this, increasing the flood depth and frequency of coastal storms, inundating land, damaging structures/equipment, and disrupting site function.

Morton St and Banks St are the lowest developed areas along the perimeter of Belle Isle Marsh, vulnerable in the present day. A storm surge water level of 7.3 ft (NAVD88) would result in inundation of Banks St. The annual flood exceedance probability (AEP) for Banks St in present day is approximately 100%, while Morton St AEP is approximately 10% according to the Massachusetts Coastal Flood Risk Model (MC-FRM). This is equivalent to a 1-year storm flooding Banks St and a 10-year storm flooding Morton St in present day. By 2030, both Morton St and Banks St are at risk to a 1-year storm (i.e., 100% AEP). Under 2050 sea level rise conditions, flooding of Main St by way of Morton St and Boston Harbor may occur during a 2% annual chance storm. As sea level rises through 2070, flooding is anticipated to extend deeper into the neighborhood (Figure 22). Additionally, groundwater levels are anticipated to rise alongside SLR, further impacting vegetation and infrastructure (e.g., basements). See the Belle Isle Marsh Climate Vulnerability Assessment for details on the MC-FRM and flood risk in the region (WHG, 2023).



Figure 20. Flooding of Morton St during January 4th, 2018 nor'easter (left) (Stantec, 2018). Residents are evacuated by front end loader from their homes on Banks St (right).



Figure 21. Flooding of Morton St during March 2018 nor'easter (Boston.com).



Figure 22. 2070 Annual Exceedance Probability Flood Extent.

3.1.1 Sea Level Rise and Projected Water Levels

Relative sea level rise refers to the rate of change experienced at specific locales which varies from region to region, in this case being Boston Harbor. The Commonwealth of Massachusetts has developed probabilistic relative SLR projections and made them available on the Massachusetts Climate Change Clearinghouse (MA EEA, 2022). SLR planning scenarios are derived from the Massachusetts-specific probabilistic projections downscaled from global climate models (DeConto and Kopp, 2017). These local projections incorporate the best available information on the impacts of a range of greenhouse gas emissions, ocean thermal expansion, and ice sheet melt, and provide a range of sea level rise scenarios based on these parameters. The State has selected a “High” scenario for planning purposes. Flood levels derived from the High scenario are conservative (there is a 99.5% confidence level that the scenario will not be exceeded) and are considered appropriate for application where there is a low tolerance for risk. In other words, selecting the “High” scenario reduces the risk of under-preparing and under-designing for the future, while providing flexibility to move the timeline for adaptation actions further into the future if observed relative SLR follows lower trajectories. If sea level rises according to lower scenarios, sea level rise projections may occur 20 to 30 years later.

The “High” sea level rise scenario and MC-FRM modeling tool were utilized for determination of future water surface elevations (WSEs). Sea level rise projections in Boston are anticipated to be no more than 1.3 feet above the 2008 baseline (updated 1999-2017 tidal epoch) by 2030, no more than 2.5 feet above



the baseline by 2050, and no more than 4.3 feet above the baseline by 2070 (Figure 23). Based on these projections and local results from the MC-FRM, Table 3 presents present day water levels and tidal datums for the Project area, along with future projected tidal benchmarks and storm surge WSEs.

Table 3. Present and future projected water surface elevations adjacent the Project Area.

Elevation (ft NAVD88)	Acronym	Present Day	2030 (1.29 ft SLR)	2050 (2.49 ft SLR)	2070 (4.29 ft SLR)
Annual Probabilistic Water Surface Elevation (WSE)¹	0.5% WSE	9.53	10.99	12.49	14.16
	1% WSE	9.3	10.6	12.2	14.1
	2% WSE	9.06	10.42	11.64	13.58
	10% WSE	8.24	9.59	10.78	12.76
Highest Astronomical Tide	HAT ²	6.82	-	-	-
Mean Higher High Water	MHHW ³	5.1	6.5	7.8	9.6
Mean High Water	MHW	4.6	6.1	7.4	9.3
Mean Tide Level	MTL	-0.3	1.4	2.6	4.4
North American Vertical Datum 1988	NAVD88	0	0	0	0
Mean Low Water	MLW	-5.1	-3.2	-2.3	-0.6
Mean Lower Low Water	MLLW	-5.4	-3.4	-2.5	-0.8
Tide Range from MLW to MHW	Tide Range	9.7	9.3	9.7	9.9

¹Probabilistic WSE's were derived from the MC-FRM for north Boston Harbor (Bosma et al., 2021).

²Represents present day HAT at Boston Harbor Tide Gauge (Station 8443970) centered around 2008.

³Present day tidal datums represent observations downstream of Saratoga St bridge from Nov-9 to Dec-9, 2020.

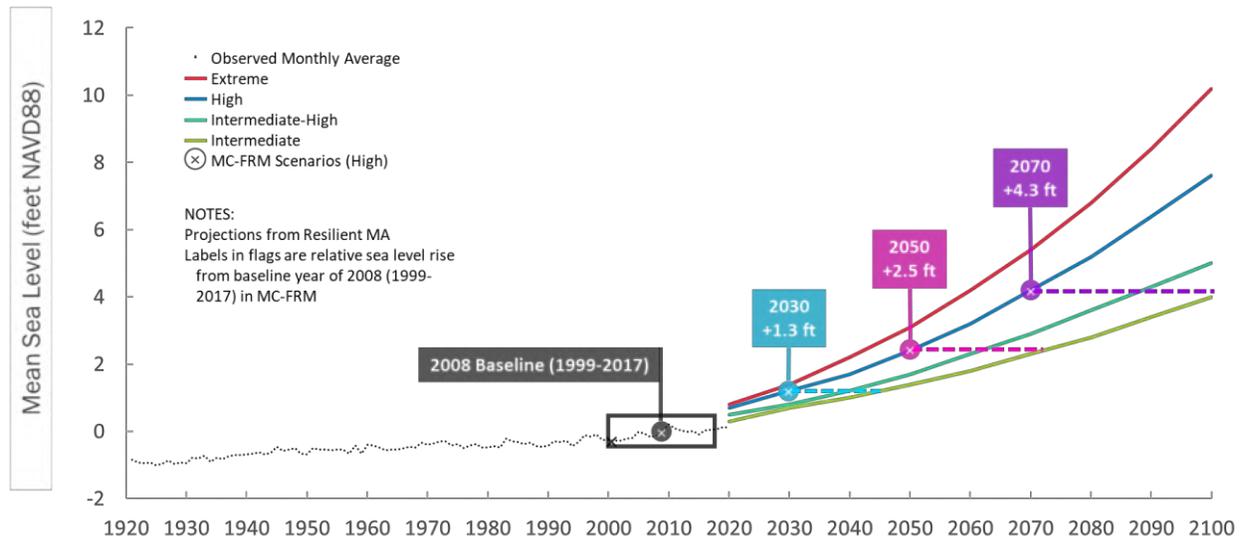


Figure 23. Observed relative mean sea level (ft NAVD88) and State projections for Boston Harbor tide gauge.



3.1.2 Design Flood Elevation

To build flood protection for the Project area without risk of flanking (i.e., flood water entering around the edge of the project length), it was important to identify a single elevation for the entire reach, that could be tied into the uplands seamlessly. The low elevation, varying shoreline condition, and different resource areas present within the Project area present greater hurdles as the focus area gets larger. A design flood elevation (DFE) is intended to represent an appropriate elevation for construction of new structures within a flood zone. DFEs correspond to past and projected still water flood elevations during storms, and may consider dynamic water levels which incorporate wave activity, where applicable. The ResilientMass Action Team (RMAT) Tool suggests design flood elevations for coastal projects across the state, and recommend the following design elevations for the project site:

- 2050 Near-Term: 11.9 ft NAVD88
- 2070 Long-Term: 13.8 ft NAVD88

Given the site topography presented in Section 2.2, achieving such DFEs is difficult. A project could consider “plugging” the lowest reaches of the shoreline, but as the Town looks to adapt to more severe storms, higher design elevations and longer project lengths are required. Feasible design elevations are discussed below, summarized in Table 4, and depicted in Figure 24.

- **7 ft NAVD88:** The top of coastal bank on the marsh-side of Banks St parcels sits as low as 7 ft NAVD88 and runs downhill from there. Inland areas could be brought up to this elevation to protect against a 1-year storm.
- **8 ft NAVD88:** A 10-year storm reaching 8 ft NAVD88 may flood both west of the Marine Ecology Park across Morton St, and east of the Marine Ecology Park across Banks St. Raising the shoreline by about 1 foot at these reaches would provide minimal flood protection.
- **9 ft NAVD88:** A project designed to 9 ft NAVD88 could feasibly run the length from Amelia Ave to Winthrop St, but would not protect the full neighborhood. This project would elevate the shoreline by 1-2 feet, and protect against a 50-year storm.
- **10 ft NAVD88:** A project design to 10 ft NAVD88 could tie-in with Willis Ave and Winthrop St, but neglects to protect properties abutting Belle Isle Inlet. This project would elevate the shoreline by 2-3 feet, and protect against a 100-year storm.
- **11 ft NAVD88:** To the west at Main St/Saratoga St Bridge, the highest elevation tie-in is 11 ft NAVD88. No project could be designed above 11 ft NAVD88 without raising Main St to address flooding from Boston Harbor.

In conversation with Town staff, it was determined that a minimum DFE should address the Present Day 100-yr storm. This requires a minimum design elevation of 10 ft NAVD88.

Table 4. Return Period Interval for Design Flood Elevations based on MC-FRM.

Elevation (feet, NAVD88)	Present Day Return Period Level	2030 Return Period Level	Minimum Project Length
7.0	1-year	Daily High Tides likely to flood	NA
8.0	10-year	1-year	500 lf
9.0	50-year	7-year	1,100 lf
10.0	100-year	~50-year	2,000 lf
11.0	500-year	200-year	3,500 lf

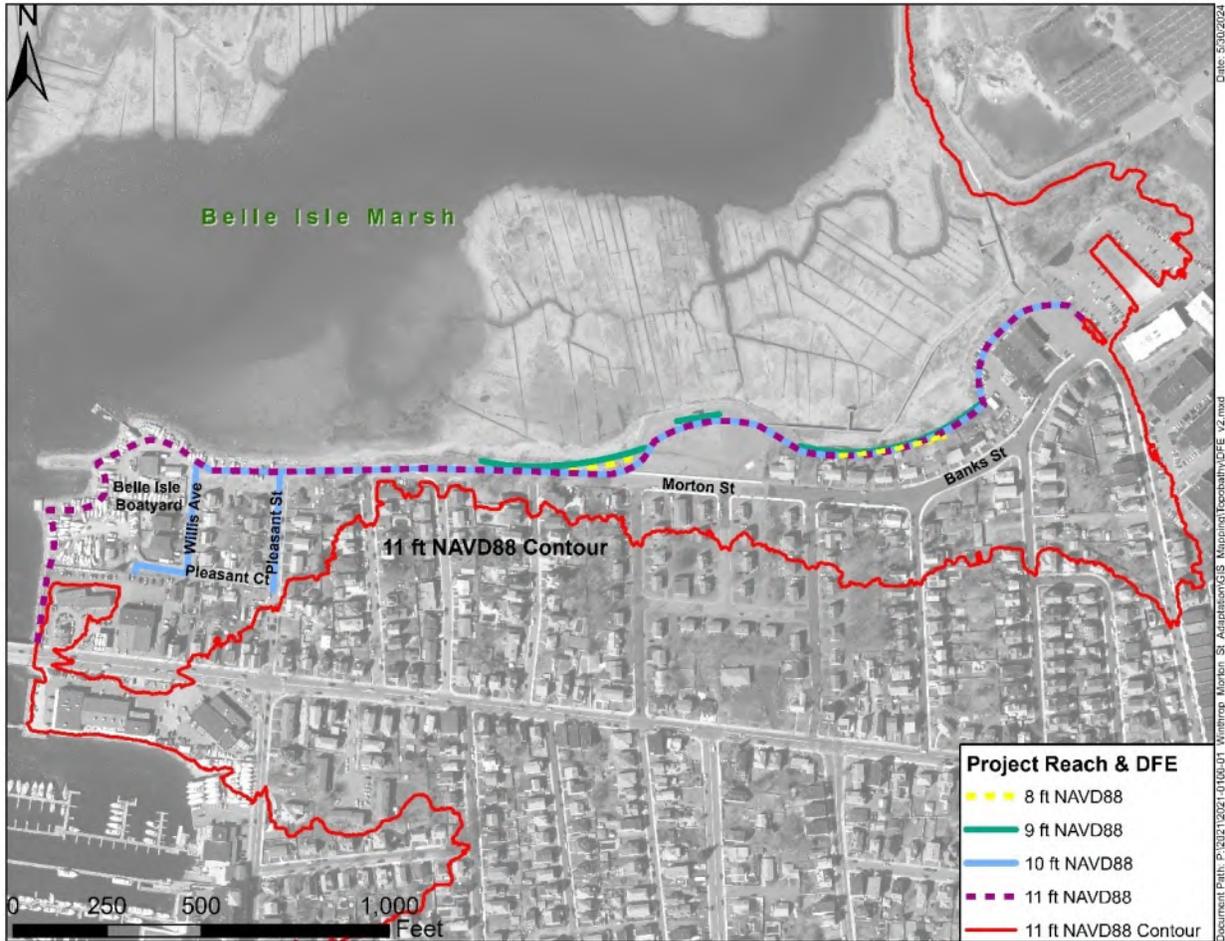


Figure 24. Project reaches with respect to varying DFEs. The 11 ft NAVD88 contour is in red.

3.1.3 Flood Diversion Analysis

Through preliminary study, WHG previously modeled the effects of flood protection along the project reach (WHG, 2023). The analysis modeled two project alignments: 1 – first extending from Main St along the shoreline to the Winthrop Cemetery representing an earthen berm concept, and 2 - the other extending from Main St along the shore to Morton St, Banks St, and Winthrop St representing a raised road alternative. Results of this study concluded the following:

- A Morton Street project could provide protection to the community under future projected storms, depending on identified DFE. A DFE of 13.4 ft NAVD88 could in theory protect against the 2070 100-year storm, but would necessarily raise Main St. (or can you say “assuming a DFE of at least X”). An alignment that features an earthen berm along the marsh edge protects an additional 1 commercial and 8 residential properties when compared to an alignment that raises Banks St.
- There is no increase in water surface elevation, and therefore no increased flooding, to properties surrounding and/or adjacent the alignments, for either of the alignments considered.
- There can be localized effects of implementing a flood protection feature, such as increased velocities at the edges of the feature where “end effects” can take hold and cause erosion. Engineering solutions should be considered at these locations to mitigate adverse impacts and ensure shoreline stability.



- Reflection of wave energy can be a concern, especially for vertical features such as seawalls. However, earthen berm concepts are in general keeping with the existing topography and would help to minimize impacts from wave reflection. Wave reflection causing issues across the marsh is not a major concern.
- A flood protection feature is unlikely to impact “flood storage” as it relates to coastal storm flooding, where there is a near-infinite amount of water entering the marsh. Water surface elevations across the marsh are driven by the storm system and coincidence with tides, as opposed to whether or not Morton St is overtopped.

3.2 STORMWATER ASSESSMENT

Green International Affiliates prepared the following stormwater analysis and engineering to address existing and future stormwater conditions across the site. Appendix B provides a detailed plan view of the preferred stormwater engineering solutions.

3.2.1 Existing Conditions and Constraints

The land area draining to Morton Street and Banks Street is comprised of roughly 45 acres of residential lots and intersecting side roads. Main Street is located approximately 600 feet to the south and is a local high point that acts as a watershed boundary. As part of this stormwater assessment, existing subcatchment areas were delineated based on flow patterns, the existing closed drainage system, and outfall locations. Six (6) existing drainage areas (EDA) were determined, which drain to individual outfalls located along Morton Street and Banks Street (Figure 34). Three (3) outfalls were located in the field, while the remaining three were not observed, likely due to being buried within the salt marsh. Outfalls that were not field located are shown approximately based on record plans and pipe directions observed in upstream drainage structures.

EDA-1 is roughly 3.81 acres in size and consists of residential lots located along parts of Pleasant Street and Pleasant Court. Runoff from EDA-1 is collected by a closed drainage system that discharges to the west of Pleasant Court. No outfall was located in the field; however, based on available record information, it appears that the closed drainage system may discharge to an armored bank, west of the existing boat yard. The lowest grade within EDA-1 is near the intersection of Pleasant Court and Willis Avenue and is elevation 6.5 feet NAVD88. Due to limited space availability and the presence of existing underground utilities in Pleasant Court and Willis Avenue, it was determined that a subsurface stormwater system is not feasible to mitigate runoff within this EDA.

EDA-2, EDA-3, and EDA-4 are positioned side-by-side, and contain parts of Pleasant Street, Pleasant Park Road, and Amelia Avenue. Each EDA contains a closed drainage system that collects and discharges runoff through three separate outfalls located on the north side of Morton Street to the salt marsh. The sizes of EDA-2, 3, and 4 are 1.68 acres, 2.36 acres, and 0.50 acres, respectively. The lowest roadway grade within these EDAs is on Morton Street at an approximate elevation of 7.5 feet NAVD88. Outfalls for EDA-2 and EDA-4 were located in the field, but the outfall for EDA-3 was not located. The outfall for EDA-2 is an 8-inch clay pipe with an approximate invert elevation of 4.17 feet NAVD88. The outfall for EDA-4 is a 12-inch corrugated metal pipe (CMP) with an approximate invert elevation of 5.11 feet NAVD88. Based on available record information, the outfall for EDA-3 is an 8-inch pipe (material unknown) with an approximate invert elevation of 3.91 feet NAVD88.

EDA-5 spans from Amelia Avenue to Douglas Street and drains to an outfall on the north side of Morton Street, which was not located during field survey. Record plans indicate that this outfall pipe is connected to a drain manhole near the intersection of Morton Street and Russell Street, which proceeds to run northeast below the Marine Ecology Park before discharging through an armored bank along the salt

marsh. However, during a site visit on May 2, 2024, heavy flows were observed bubbling up from the ground in an area on the far west side of the Marine Ecology Park, with approximate coordinates of 42°23'2.84"N, 70°59'17.04"W. Further field investigation is required to verify the source of this flow and whether an outfall exists in this location.

The size of EDA-5 is roughly 11.0 acres, and the lowest road grade is on Morton Street at an approximate elevation of 6.7 feet NAVD88. This low point exists at a catch basin on the north side of Morton Street, where a curbed sidewalk begins near the intersection of Reed Street. Flooding was observed in this area on May 2, 2024 when a brief rainfall caused pooling at the intersection with depths of 3" to 9" inches (Figure 25).

EDA-6 is roughly 21.7 acres in size and ranges from Douglas Street to Winthrop Street. Stormwater runoff generated in EDA-6 is collected by a closed drainage system and discharges through a 36-inch outfall located roughly 430 feet northwest of the intersection of Winthrop Street and Banks Street. This outfall was field-located, and the pipe material is reinforced concrete pipe (RCP). At the pipe outlet, the top of pipe was surveyed, and the calculated outfall invert is approximately -2.35 feet NAVD88. The outfall discharges to an existing channel that runs through two sections of salt marsh. The lowest grade within EDA-6 is at an approximate elevation of 6.0 feet, near the intersection of Banks Street and Wilshire Street. Residents in this area have shared significant concerns and experience with tidal backflow and stormwater related flooding at the curve in Banks Street. Supposed flap valves on the outfall pipes are not functioning, and spring tides rise above catch basin grates, which routinely flood the roadway.



Figure 25. Left – Stormwater flooding observed in the evening of May 2, 2024 following a brief, heavy rainfall. Right – Backflowing catch basins regularly flood Banks Street at the lowest grades during a spring high tide.

3.2.2 Stormwater Modeling

HydroCAD was used to model the EDAs to determine peak flow rates and runoff volumes generated for each catchment area during various storm events. Site specific information was entered into this software to develop the stormwater model, including land cover, hydrologic soil characteristics, topography, and rainfall data. Table 5 contains peak runoff volumes for each EDA based on a 24-hour storm event, for design storms ranging from a 2-year event to the projected 2050, 100-year event.



Table 5. Existing Peak Runoff Volume Summary Table.

2024 Rainfall Data (NOAA Atlas 14)								Projected 2050
		2-Year Event	5-Year Event	10-Year Event	25-Year Event	50-Year Event	100-Year Event	100-Year Event
EDA No.	Area (acres)	Volume (cu. ft)						
EDA-1	3.81	17,337	26,267	35,109	50,399	65,253	83,548	92,826
EDA-2	1.68	7,667	11,587	15,507	22,216	28,793	36,852	40,946
EDA-3	2.36	10,716	16,248	21,736	31,189	40,380	51,706	57,456
EDA-4	0.50	2,265	3,441	4,617	6,621	8,581	10,977	12,197
EDA-5	11.04	50,312	76,099	101,800	146,144	189,138	242,194	269,157
EDA-6	24.58	98,751	149,367	199,810	286,843	371,218	475,283	528,165

Rainfall data used in the drainage model is summarized in Table 6. The data shown for the 2-year through 100-year events was obtained from the NOAA Atlas 14 Precipitation Frequency Estimates for Suffolk County. The projected 2050, 100-year event was derived from a memorandum, titled “MassDEP NOAA14 PLUS – Summary of Technical Review”, dated November 15, 2022. Based on the information in this memorandum, the projected 100-year rainfall depths for Boston in 2030 and 2070 are 9.2 inches and 9.9 total inches over the course of the event, respectively. The projected 2050, 100-year event was interpolated using this information and was found to be 9.55 inches.

Table 6. Modeled Rainfall Intensity Data (Inches)

Storm	Rainfall (inches)
2-Year	3.26
5-Year	4.11
10-Year	4.9
25-Year	6.19
50-Year	7.39
100-Year	8.83
100-Year (2050 Projected)	9.55

Once peak flow rates and runoff volumes were calculated for existing conditions, the HydroCAD model was used to determine the approximate size requirements for stormwater control measures (SCMs) necessary to mitigate up to the projected 2050, 100-year storm event. The SCMs modeled were subsurface stormwater storage systems, which are underground chamber systems designed to store runoff volume during extreme storm events to prevent inland flooding due to precipitation. These systems are also equipped with large outlet pipes that increase discharge capacity to the adjacent tidal waters, helping drain runoff volume at a faster rate than the existing closed drainage system within the project area. The following descriptions related to the design of stormwater mitigation systems are based on a preliminary stormwater assessment for the project area and are only intended for conceptual planning strategies and cost estimating purposes. The stormwater systems described herein are not intended to be constructed without further evaluation that will occur in subsequent project design phases.

3.3 DESIGN COMPONENTS

The below subsections describe various adaptation components which were considered during the evaluation of alternatives. Adaptation components range from soft engineering (nature-based solutions) to hard engineering.

3.3.1 Bank Stabilization

A natural coastal bank stabilization method could be utilized to stabilize the coastal bank and provide natural habitat. There are two sections of natural coastal bank within the project area – an approximately 850-foot section seaward of Belle Isle Terrace and western Morton St and an approximately 840-foot long section seaward of residential homes along eastern Morton St and Banks St (Figure 26). These two coastal bank sections could be graded to 3:1 slopes providing a stable angle of repose. Fiber rolls or sand filled coir envelopes could be placed at the toe of bank to prevent undercutting. The slope could be planted and seeded with native species including little bluestem (*Schizachyrium scoparium*), big bluestem (*Andropogon gerardi*), indian grass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*), seaside goldenrod (*Solidago sempervirens*), and marsh elder (*Iva frutescens*). Biodegradable erosion control blankets could be placed and anchored on the regraded surface using wooden stakes. This biodegradable coir fiber will degrade with prolonged exposure to UV light. Shielding coir by burying it can prolong its lifespan.



Figure 26. Coastal bank seaward of Morton St/Belle Isle Tr (left) and seaward of Banks St (right).

3.3.2 Earthen Berm

This resiliency alternative includes a vegetated earthen berm that could provide flood protection for the Morton St neighborhood while maintaining open space and public access. The berm could be located landward of the top of the coastal bank, outside of wetland resource areas except for LSCSF. The seaward parking along Morton St could be removed to create space along Morton St, while residents along the marsh at Banks St would have to agree to construction in their backyards. The vegetated berm would tie-in to elevated roadways at various locations to the west, and Banks St/Winthrop St to the east.

The berm would be a trapezoidal feature built to a crest elevation of 10 ft NAVD88 or 11 ft NAVD88 with sides slopes at 3:1 (H:V) and constructed with an impermeable core to mitigate seepage of water from the marsh into the uplands (Figure 27). A footpath could also be constructed atop the berm along Morton St, where pedestrians typically walk the shoreline until reaching the Marine Ecology Park boardwalk. The width of the berm crest would need to be 8 feet to support a footpath, and as narrow as a 2 feet if not.



The slopes of the berm would be covered with a compostable erosion control blanket media for added slope stability and seeded. Seeding would target native salt tolerant and wetland species, utilizing a seed mix such as New England Coastal Salt Tolerant Grass Mix. As the East Boston Greenway is proposed for extension into Winthrop, the footpath would ideally be integrated with this effort to provide community connectivity. The footpath along the crest of the berm would consist of 6 inches of pea stone, decomposed granite, or crushed shell. Educational signage could be installed to inform visitors about the marsh, flood risks, and sea level rise.

Geotechnical investigations observed a subsurface comprised of approximately 5 feet of fill, overlying 5-7 feet of peat, overlying a clay layer in the area where the berm was considered. Compression is therefore a consideration, and the berm may need to be built a bit higher to allow for subsidence. Considerations of a short sheetpile beneath the berm may be required in a next phase of engineering following more detailed evaluations of structural loading.

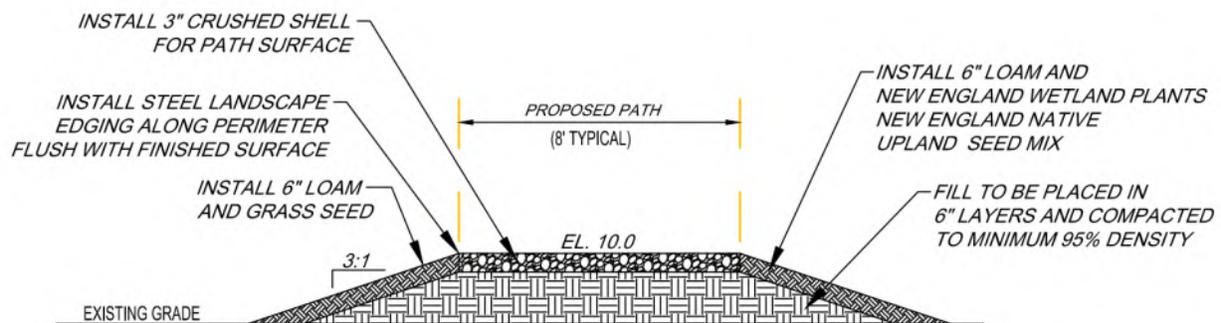


Figure 27. Schematic design of typical earthen berm section.

3.3.3 Roadway Elevation and Reconfiguration

Under existing conditions, the intersection of Morton St and Banks St is the lowest developed section along the site, sitting as low as ~5.5 ft NAVD88. Morton Street from the Belle Isle Boatyard to Read Street has an approximate width of 22-feet with no curbing or sidewalk present. Continuing east of Read Street to Winthrop Street, Morton Street/Banks Street has an approximate width of 34-feet with curb and sidewalk present on both the north and south side of the roadway. Closed drainage is also present in this section of roadway. Morton Street and Banks Street have been surveyed to show a normal crown present on both roadways.

Elevating the roadway within the right-of-way (ROW) of Morton St and Banks St would provide inland flood protection to residential streets and parcels while avoiding construction within existing open space and wetland resources of Belle Isle Marsh. Local connecting roadways such as Willis Ave, Pleasant Court, Pleasant St, or others must be raised to tie-in critical elevations. The seaward parking along Morton St would be dropped to create greater space to elevate the roadway. A design for elevating the residential roadways in the Morton St neighborhood was developed in accordance with ADA and MassDOT design standards. The following design criteria governed the design:

- A design crest elevation of 10 ft NAVD88 and up to 11 ft NAVD88 was determined as the minimum design flood elevation. Such a design crest elevation would in many cases require grading to the top step of private properties. Some properties which are especially low elevation, such as along Banks St, may need to be raised to accommodate new land elevations. Reducing parking, reducing



lanes, and removing sidewalks creates greater space to tie-in with existing elevations, and reduces impact to private property.

- A 5% slope is the maximum longitudinal slope used when grading walkways to meet ADA guidelines; any extended walkway that is in excess of 5% would require a handrail. Options may be available where walkways are not reinstalled to connect to the sidewalk but are removed/redirectioned to connect to driveways or steps are added off the back of a sidewalk to aid in the elevation difference.
- A 15% slope on driveways is the maximum slope used per MassDOT guidelines. A steeper driveway in excess of 15% carries the risk of vehicles potentially bottoming out where the driveway meets the roadway. Additionally, driveway tie-ins should be designed at less than 15% slope to provide a relatively flat area near the end of the driveway where vehicles can park comfortably. Such limitations may be flexible if all parties agree, including landowners.
- A 4:1 slope was the maximum slope used in areas of existing lawns. Any slope more than 4:1 is considered no longer mowable by typical means.

In all roadway alternatives evaluated, raising the roadway would require temporary impacts beyond the right-of-way and into private property to allow for regrading of lawns, driveways, and walkways. Additional drainage infrastructure would be required within private property to mitigate the adverse drainage implications of the elevated roadway. Such necessary impacts to private parcels occurs with even minor road raising, as represented in a design crest elevation of 8 ft NAVD88 along Banks St (Figure 28 and Figure 29). This would result in an approximate elevation increase of 2.5-3' from Banks Street to Wilshire Street.

With a roadway elevated to 10 ft NAVD88, Morton Street from the Belle Isle Boatyard to Read Street could maintain a 22-foot width with no curbing or sidewalk. Continuing east of Read Street to Winthrop Street, the overall width of Morton Street/Banks Street could be reduced to eliminate the parking lane on the north side of the roadway. As a result, this stretch of road would have only an 11-foot lane in the westbound direction and an 11-foot lane with a 6-foot shoulder in the eastbound direction. This width matches the existing eastbound width and provides a wide shoulder to allow parking. Curbing and sidewalk would be reconstructed on both the north and south side of the roadway and the closed drainage system would also be reconstructed. The normal crown of these roadways would be maintained.

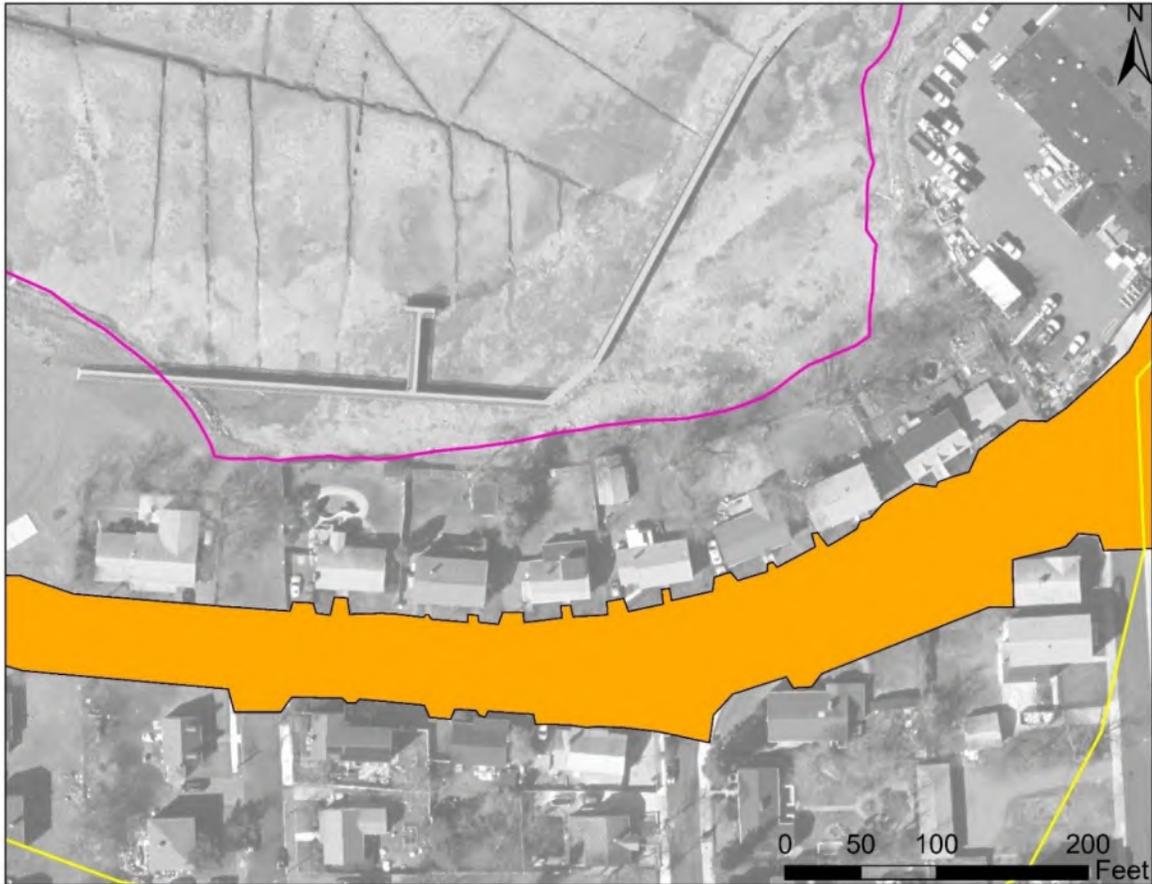


Figure 28. Banks Street with an elevation of 10 ft (NAVD88) in plan view showing impacts of fill to private parcels.

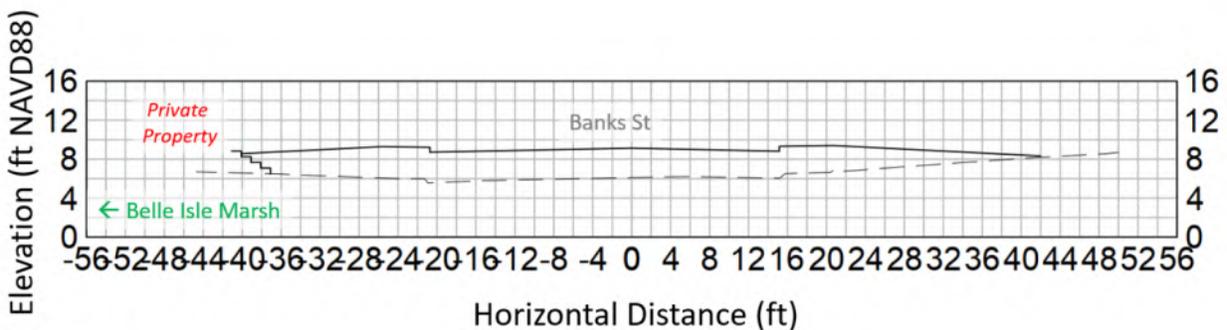


Figure 29. Banks Street with an elevation minimum of 9 ft (NAVD88) in cross-section.

3.3.4 Coastal Engineering Structures

Bulkheads, revetments, and seawalls are considered “hard” coastal engineering structures that hold the line between a waterbody and inland assets. A revetment currently provides shoreline stabilization and protection for Belle Isle Inlet, extending about 950 linear feet from the Main St bridge abutment along the shoreline to Belle Isle Terrace (Figure 30). Improving the existing armored shoreline for greater flood protection could be approached by driving steel sheetpile landward of the top of revetment. Sheetpile would be capped, and would achieve the target design flood elevation of potentially 11 ft NAVD88.

Alternatively, a structural seawall could be constructed landward of the revetment (Figure 31). Sheetpile is considered to be the lower cost approach, and is carried forward in this feasibility study.



Figure 30. Armored shoreline along Belle Isle Boatyard to the west (left) and north (right).

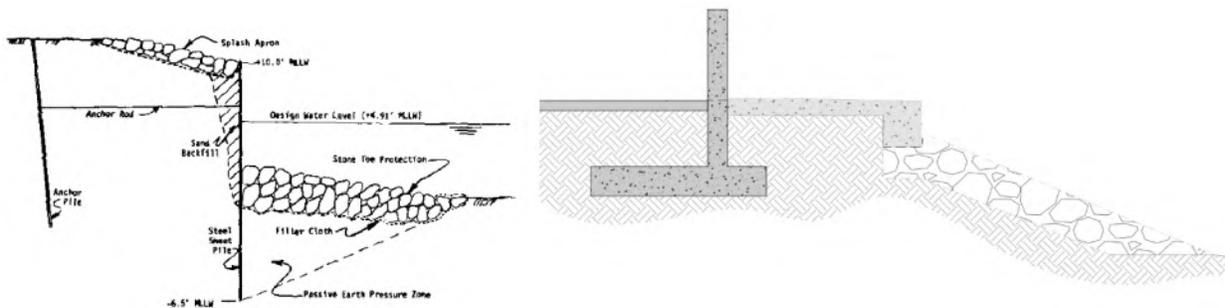


Figure 31. Typical section of a bulkhead (left) and revetment backed by a seawall (right).

3.3.5 Stormwater Management

Three proposed stormwater control measures (SCMs) were designed to mitigate the projected 2050, 100-year storm event to the greatest extent possible, with consideration of an elevated flood protection feature, available land space, existing utilities, and environmental resource areas. The proposed stormwater mitigation strategies are incremental improvements, and not permanent solutions. Beyond the implementation of new stormwater infrastructure, DPW can play a role in helping improve existing drainage conditions by checking all swales and storm drains close to their property to make sure they are clear of debris and functioning properly. If City-owned property contains non-functioning drainage ditches or stormwater inlets, the public should contact DPW to remedy the situation. See Appendix C for stormwater engineering design.

The proposed SCMs were designed under the assumption that the existing roadway grade along Morton Street and Banks Street will be raised to an approximate elevation of 10.0 feet. The basis of design for proposed SCMs #1 and #2 is the ADS StormTech SC-800 chamber, which consists of an interconnected series of 85" L x 51" W x 33" H open-bottom chambers that store stormwater runoff that enters the system. These systems are backfilled with the appropriate amount of drainage stone in order to promote infiltration into the void spaces of the stone or the ground. However, these systems would be lined with an impermeable liner due to high groundwater levels adjacent to the marsh, which will prohibit infiltration to groundwater. See Figure 32 for an example chamber system by ADS, during construction.



Figure 32. Example of an ADS subsurface system being constructed.

Proposed SCM #3 was designed as a system of concrete storage chambers, which were modeled in HydroCAD using a proprietary StormTrap SingleTrap product. The use of concrete chambers allows for a taller system that is structurally sound, which is required for SCM #3 to meet additional storage volume requirements. This system is comprised of interlocking, modular concrete chambers set on a reinforced concrete foundation. Each chamber has dimensions of 15'-4" L x 8'-6" W x 7'-6" H. This is a retention system that does not allow for infiltration. See Figure 33 for an example chamber system by StormTrap.



Figure 33. Example of a SingleTrap concrete subsurface system being constructed.

To begin the SCM sizing process, an assessment of the overall drainage area was conducted to determine the feasibility of combining closed drainage systems within various EDAs to convey stormwater to a single storage system with one discharge point. Since EDA-2, 3, and 4 are smaller watersheds and their outfalls are located in close proximity, it was determined that a single subsurface system may be implemented to capture runoff from all three watersheds and discharge through a single outfall. The watershed areas for



EDA-5 and EDA-6 are much larger and their outfalls are spaced further apart. As such, it was determined that separate subsurface systems would be required for those watersheds. System sizes were then evaluated based on available space and the ability to handle the projected 2050, 100-year storm runoff volume.

An overview of proposed conditions is provided in Figure 34. The SCM for EDA-2, 3, and 4 was positioned below Morton Street, spanning from Pleasant Park Road to Amelia Avenue (see SCM #1, Figure 35). This system location would require modifications to the existing drainpipe in Pleasant Street to reroute the conveyance east down Morton Street to the proposed subsurface system. According to available record information and field survey data, there are existing utilities near the proposed system, including an underground water main that runs along the south side of Morton Street, and a series of utility poles and overhead wires running along the north side of Morton Street. The proposed subsurface system was positioned to minimize impacts to existing utilities, and it was assumed that these utilities would not be impacted.

To mitigate the projected 2050, 100-year storm, the required system size for SCM #1 was determined to be approximately 18'W x 250'L. This system was designed with two 24-inch outlet pipes that would discharge near the existing outfall location on the north side of Morton Street, opposite Amelia Avenue. The proposed roadway elevation is set roughly 5 feet higher than the proposed outfall inverts, which allows the subsurface system to sit at a higher elevation. As a result, the outlet pipes are able to exit the bottom of the system, and discharge to the outfalls via gravity. These outlet pipes are routed through separate outlet control structures and act as the primary devices controlling outflow from the storage system. Tide check valves are proposed at the ultimate outfall locations, to prevent tidal waters from surcharging the system during astronomical high tides. If the check valves become submerged by elevated sea levels, outflow from the system would have trouble discharging through the outfalls unless there is sufficient head upstream to drain the system.

To account for this concern, SCM #1 was modeled with two submersible pumps, designed to activate when water elevation in the tank exceeds the top of the 24-inch outlet pipes. These pumps provide a mechanism for draining the subsurface system during extreme storm events and/or during astronomical high tides, when the outfalls may become submerged by elevated sea levels. The pump would activate at a higher elevation to prevent it from running regularly during smaller storm events. The 24-inch outlet pipes were designed with an outfall invert elevation of 5 feet and the pump outlet pipe was designed with an outlet invert elevation of 10 feet. The proposed grade will need to be raised in the area where the pump pipe outlets, since it is set to discharge at a higher elevation than existing grade and requires minimum cover of approximately 2 feet.

The SCM designed to mitigate stormwater runoff from EDA-5 was positioned in the Marine Ecology Park, owned by DCR, on the north side of Morton Street, since the required system size is too large to fit beneath the roadway (see SCM #2, Figure 36). In addition, there are existing underground utilities in this area below Morton Street, including a water main and a large MWRA sewer pipe. SCM #2 would intercept the existing outfall pipe that discharges all runoff generated in EDA-5 by means of a new inlet structure located immediately upstream of the system. To mitigate the projected 2050, 100-year storm, the required system size was determined to be approximately 100 feet wide by 200 feet long. This system was designed very similar to the system for EDA-2, 3, and 4, including the same invert elevations, system height, and pump design. The only difference is that SMC #2 was designed with 30-inch outlets instead of 24-inch, to provide greater discharge rates from the system. This is necessary due to EDA-5 being a larger watershed with more runoff.

The SCM designed to mitigate stormwater runoff from EDA-6 was positioned near the intersection of Banks Street and Winthrop Street, below an existing parking lot that borders the boardwalk (see SCM #3,



Figure 37). The existing outfall for EDA-6 is a 36-inch RCP pipe that runs below this parking lot and continues northwest through salt marsh (dieback area) before discharging to an existing channel. This pipe would be intercepted by a proposed drainage structure located on the upstream end of the SCM, and approximately 225 feet of downstream pipe would need to be removed where the system footprint is proposed. An outlet control structure is proposed on the downstream end of the SCM and will reconnect to the existing outfall pipe at the existing invert elevation. According to record information, there are existing sewer pipes that run below this parking lot as well, which would need to be relocated. Further assessment is required to determine the extents of these sewer utilities, and ways to reconnect to the existing system.

Since the outfall pipe is located within the salt marsh, it was assumed that the pipe location and outfall invert would remain unchanged. The outfall invert elevation is approximately -2.35 feet. The outfall pipe has an approximate slope of 0.60% and the calculated pipe invert at the north side of the subsurface system is approximately -1.50 feet. The bottom of the subsurface system was set at elevation -1.50 feet to match the existing pipe invert where the two features meet. This would allow the system to drain via gravity for portions of the day when the pipe is not submerged by tidal waters.

To mitigate the projected 2050, 100-year storm, the required system size was determined to be approximately 85'W x 200'L and comprised of 7.5'H concrete chambers. The system footprint was designed to fit within the limits of the existing parking lot. The SCM was modeled with a 36-inch outlet pipe and two submersible pumps that activate once the water elevation in the system surpasses the top of the 36-inch pipe.

Since the outfall invert is set at a low elevation, the pipe has potential to be partially or fully submerged on a regular basis as the tide rises in the marsh throughout the day. If the outfall becomes partially submerged, flow can still discharge through the check valve, granted sufficient head exists between the inland catchment elevation and the outfall depth. However, when the check valve becomes fully submerged, it would be difficult for the outfall to discharge any flow, which would back up the system.

The low outfall elevation paired with EDA-6 being a large contributing area, cause SCM #3 to be more susceptible to storm surge and elevated sea levels, which could result in flooding along Banks Street. Additional pumps could be implemented to help drain this system faster during extreme weather events, but this alternative would result in increased project costs, system maintenance, and power requirements. If the outfall pipe could be raised, it would be submerged less often, and that would alleviate concerns regarding system surcharging. However, this pipe is located in the salt marsh and runs below portions of the boardwalk, and impacting these features is likely not a viable option. Another possible alternative is to increase the system footprint by twice the size by extending the system below the adjacent parking lot to the northeast, although this is not City owned land. This would provide twice the storage volume to help detain larger storm event, yet it may not be a viable option either. These alternatives will be assessed further in subsequent project design phases.

If elevated sea levels were to overtop the berm and/or elevated roadway, water will travel via gutter flow where there is berm/curb or via sheet flow to low points in the street. The closed drainage system in the roadway will capture the water and convey flows to the SCMs. Once the SCMs and closed drainage system become overwhelmed, flooding will occur in the roadway and eventually extend to locations further inland, based on the water surface elevation. The SCMs described in this report were designed to mitigate stormwater runoff from inland locations only, and do not have capacity to mitigate tidal flows above the top of chamber elevation.

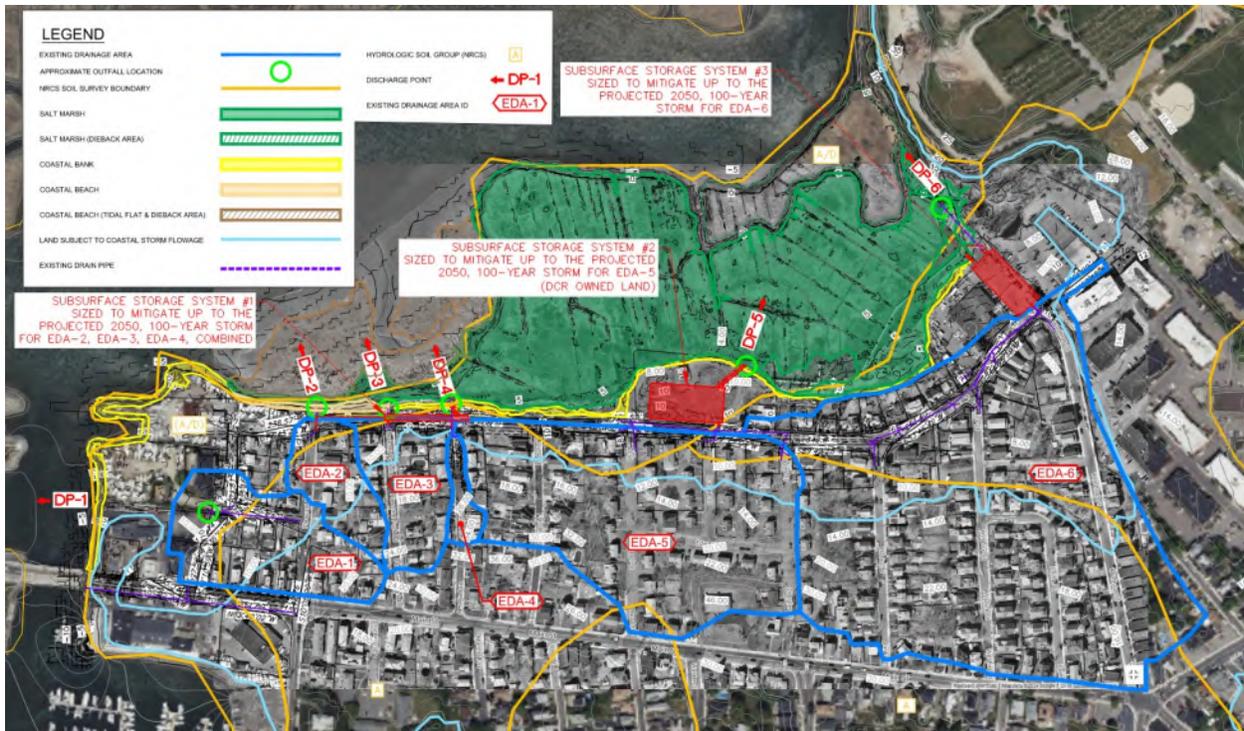
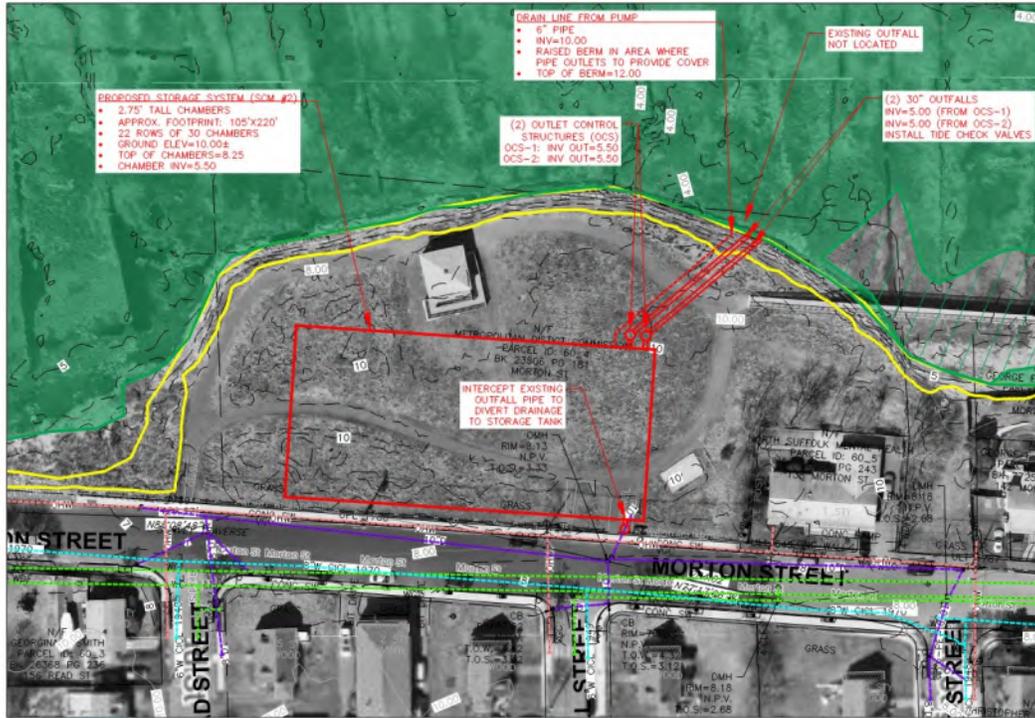


Figure 34. Stormwater proposed conditions overview.



Figure 35. Proposed subsurface storage system #1.



SUBSURFACE STORAGE SYSTEM #2 (SCM #2)
EDA-5

Figure 36. Proposed subsurface storage system #2.



SUBSURFACE STORAGE SYSTEM #3 (SCM #3)
EDA-6

Figure 37. Proposed subsurface storage system #3.



3.4 REJECTED CONSIDERATIONS

Through deliberation of adaptation design criteria, adaptation components, and permitting pathways, several initial considerations were not carried forward into the above four adaptation alternatives. The following section details the considerations that were made.

3.4.1 No Action

This alternative proposes no mitigation, adaptation, or restoration actions to be taken. The reach would be subject to ongoing coastal processes – erosion, flooding, storm surge, waves, and sediment transport, coupled with sea level rise. Based on the evaluation of flood risk, the area will increasingly experience flooding, starting at the intersection of Banks St and Morton St, and ultimately overtopping much of the marsh front. Under future sea level rise scenarios, back-flooding from Boston Harbor over Main St is anticipated to additionally impact this neighborhood. Marsh habitat is currently degraded in many locations due to oversaturation and the smothering of vegetation by wrack material. The waterfront is eroded, and composed of various materials as many sites, such as the Belle Isle Marine Ecology Park, used to be the site of local filling and dumping. Wetland habitat would be projected to migrate into the Morton St residential neighborhood as daily and monthly inundation increasingly occurs with sea level rise.

This alternative was rejected because it does not solve the primary concern of coastal and stormwater-based flooding at the site.

3.4.2 7 ft NAVD88 Design Flood Elevation

This design flood elevation is already met by the waterfront shoreline. However, Banks St is lower than the shoreline, and would be elevated to the maximum extent practical without impacting traffic or access to private property. The maximum attainable elevation was determined to be 7 ft NAVD88, a project which would extend from the Morton St/Banks St intersection, east to Wilshire St.

This alternative would improve travel along Morton St and Banks St under 1-year storm water levels. However, this alternative provides the least flood protection benefits to the Morton St neighborhood. The nine (9) marsh-adjacent parcels of Morton St/Banks St would not receive flood protection benefits. The flood risk of Banks St itself would be improved, however, only two (2) landward parcels would see reduced flooding along this reach. This alternative was rejected because it does not solve the primary concern of coastal and stormwater-based flooding at the site.

3.4.3 8 ft NAVD88 Design Flood Elevation

This alternative would stabilize, re-grade, and plant coastal bank and build a short earthen berm in the upland areas meeting a design flood elevation of 8ft NAVD88. The alignment would follow the top of coastal bank of Morton St seaward of Amelia Ave, Fairview St, and Read St, as well as the coastal bank within the private parcels of 142 Morton St, 148A and 148B Morton St, 154 Morton St, 160 Morton St, 70 Banks St, and 76 Banks St (Figure 38). Because of its short project length, this alternative protects relatively few residential parcels along Morton St and Banks St, while also protecting the roadway under low intensity storms. This alternative requires cooperation and construction within six (6) privately-owned parcels.

The DFE of 8ft NAV88 provides protection to an ~10-year coastal storm water level under present day sea level, and protects against daily high tide flooding through the 2050 sea level rise scenario. The earthen berm could be designed to be “phaseable,” becoming the foundation of an elevation project that raises the earthen berm as sea level rises. This option creates a near-term solution which maintains the opportunity for long-term adaptation at a later date. An 8 ft NAVD88 DFE, however, does not meet the

minimum requirements relayed from the Town to protect against the 100-year storm or greater. Therefore, the project was removed from further consideration.



Figure 38. Approximate location of an 8ft NAVD88 design flood elevation engineering project.

3.4.4 9 ft NAVD88 Design Flood Elevation

This alternative could elevate Morton St or build an earthen berm to a DFE of 9 ft NAVD88 to reduce coastal flood risk. Due to the downward slope of Morton St to the east, the entirety of Morton St cannot be raised because doing so would necessarily impact existing private driveways, yards, and residential access. This alternative would raise Morton St seaward of Amelia Ave, Fairview St, and Read St, tying-in to the Marine Ecology Park. Constructing an earthen berm along the Marine Ecology Park shoreline trail would create a 9 ft (NAVD88) buffer up to the residential parcels to the east. Lastly, coastal bank improvements and an earthen berm would be necessary within the private parcels of 138 Morton St, 142 Morton St, 148A and 148B Morton St, 154 Morton St, 160 Morton St, 70 Banks St, 76 Banks St, and 84 Banks St. This alternative requires cooperation and construction within eight (8) privately-owned parcels. While the logistics of coordinating with and implementing a project on private property is challenging, conversations with several affected property owners revealed enthusiasm for a project which could reduce their risk to flooding. To enhance the coastal bank, stabilization, native species planting, re-grading, and attaining of design flood elevation would reduce flood risk while enhancing the ability of coastal bank to achieve its performance standards.

The DFE of 9 ft NAV88 provides protection to a present day 50-year coastal storm water level, 2030 10-year storm, and nearly against daily high tide flooding through the 2070 sea level rise scenario. The earthen berm could be designed to be “phaseable,” becoming the foundation of an elevation project that could raise the earthen berm as sea level rises in the future. This option creates a near-term solution which saves the opportunity for long-term adaptation. A 9 ft NAVD88 DFE, however, does not meet the minimum requirements relayed from the Town to protect against the 100-year storm or greater. Therefore, the project was removed from further consideration.

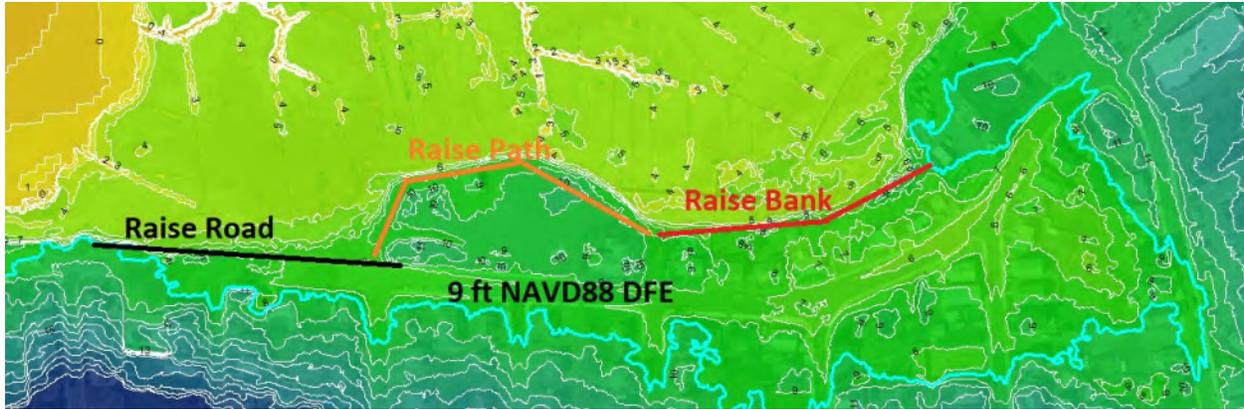


Figure 39. Approximate location of a 9 ft NAVD88 design flood elevation engineering project.

3.4.5 Salt Marsh Restoration

The potential for salt marsh restoration was identified in three areas of vegetation die-back, noted in the resource delineation and located adjacent the pedestrian boardwalk (Figure 40, Figure 41, and Figure 42). These areas sit inches below the adjacent marsh platform. A negative feedback cycle can occur in such conditions as dieback leads to a reduced capacity to retain sediment, which leads to marsh subsidence and poor drainage conditions, which leads to stagnation and oversaturation, which furthers greater vegetation die-back and expansion of pools.



Figure 40. Salt marsh restoration pilot sites from left to right: Site A, Site B, and Site C.

A pilot project was considered the areas of die-back aimed at curbing and ultimately reversing vegetation die-back by raising and planting the marsh plain. Using a scientific approach to fine-tuning restoration, the three areas would serve three approaches to thin layer deposition. Thin-layer deposition entails the placement of dredged or imported sediments for incremental increases in marsh elevation, on the scale of inches, to the controlling marsh elevation. Testing the pilot site for various restoration approaches (2-inch, 4-inch, and 8-inch lifts). Elevated marsh plains would tie-in to existing drainage channels or mosquito ditches through runneling to provide adequate drainage. Mosquito ditches may need to be cleared out for efficient drainage.

Haybales or coir logs would be used to retain the new, loose sediment and prevent runoff into waterways, while native planting ultimately aims to stabilize the sediment and begin rebuilding peat. Various blanketing and various planting schemes could additionally be tested. Much of this work could be implemented by hand through groups contributing to planting and maintenance (Friends of Belle Isle Marsh) and monitoring (Stone Living Lab). Constructing thin-layer deposition would impact existing vegetation, however it would be designed to enhance marsh elevation, promote natural revegetation, and enhance sea level rise resilience. Planting and vegetation management procedures would likely be



necessary to ensure the longevity of the salt marsh habitat. Plants that are removed or die during the early stages of growth would be replaced immediately to ensure the undisturbed growth of the remaining plants. Protection measures, such as fencing, would need to be taken to keep waterfowl from eating the young plants; and roughened surfaces such as scattered rock could help break up ice in winter. Ongoing maintenance of invasive species would be important to long-term success. After significant vegetative growth is established, only periodic maintenance/inspections would be needed. Restoration details are summarized in Table 7.

While improving the resilience of the marsh to sea level rise, this adaptation component provides little to no resilience benefit to the developed areas of the Morton St neighborhood. Salt marsh vegetation can provide wave attenuating benefits to the uplands, but large swaths of marsh are required to see such benefits, far beyond the scale of this project (WHG, 2023). Thin layer deposition would entail fill within the ORW resource area and is only permissible as an Ecological Restoration Project, and even so would be anticipated to be difficult to permit. Furthermore, DCR is preparing to investigate the opportunities for ditch remediation and runneling throughout Belle Isle Marsh, which this site is a candidate for and better addressed in the context of that marsh health driven project. This project is better isolated as an Ecological Restoration Project and pursued separately from this resilience project. Due to these reasons, salt marsh restoration was removed from further consideration.

Note that salt marsh restoration was also considered in the half-moon shaped tidal flat area seaward of Pleasant St. Salt marsh restoration in this area would entail land reclamation, i.e. filling the tidal flat with sediment, retaining sediment with a rock sill, and native planting. While this project would result in greater vegetated salt marsh and co-benefits of erosion control and wave attenuation, it is considered a large-scale ecological restoration project better suited as a standalone project.

Table 7. Salt Marsh Restoration Pilot Sites – Design Criteria.

Salt Marsh Pilot Site	Approach	Apprx. Boundary Elevation	Apprx. Subsided Marsh Elevation	Area (square feet)	Fill Volume (cubic yard)
Site A	8-Inch Lift	4.5 ft NAVD88	3.9 ft NAVD88	20,570 sf	507 cy
Site B	4-Inch Lift	4.8 ft NAVD88	4.3 ft NAVD88	1,375 sf	17 cy
Site C	2-Inch Lift	4.6 ft NAVD88	4.6 ft NAVD88	11,010 sf	108 cy

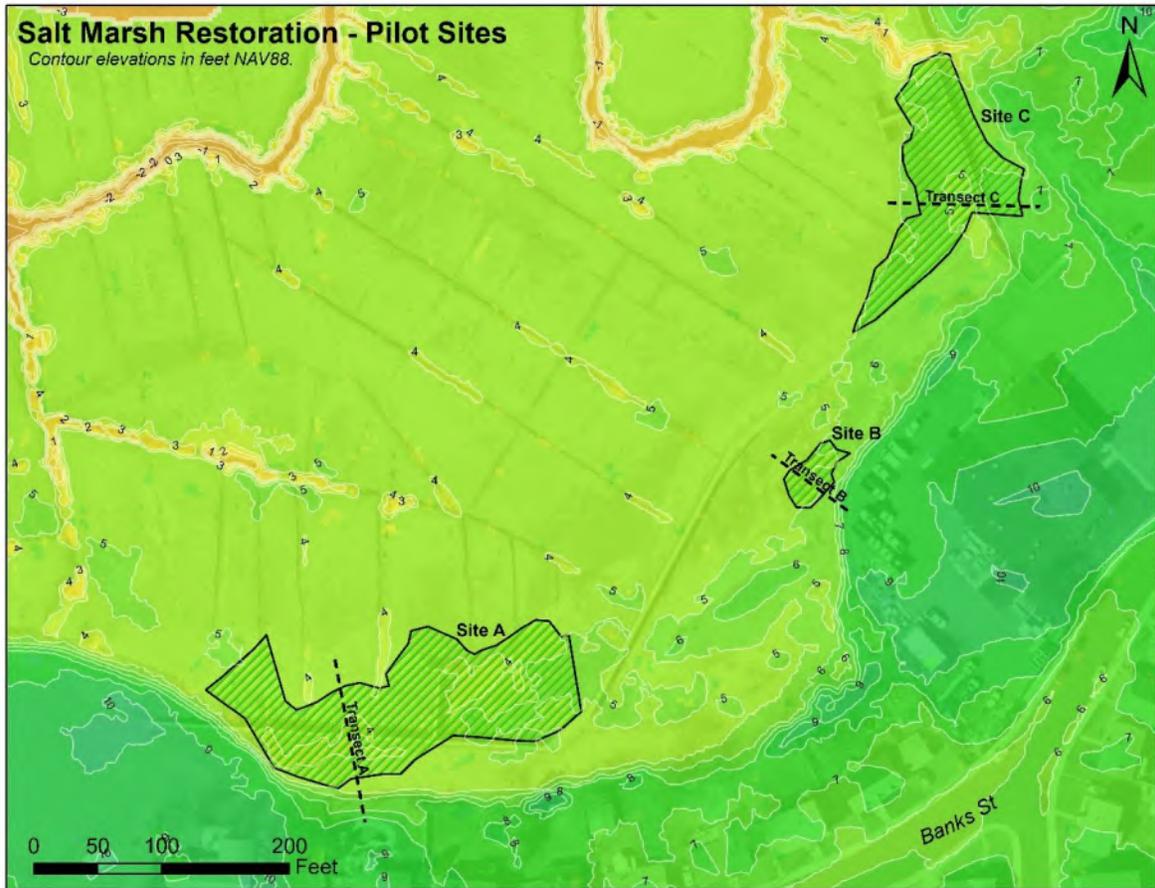


Figure 41. Salt marsh restoration pilot sites – Plan View.

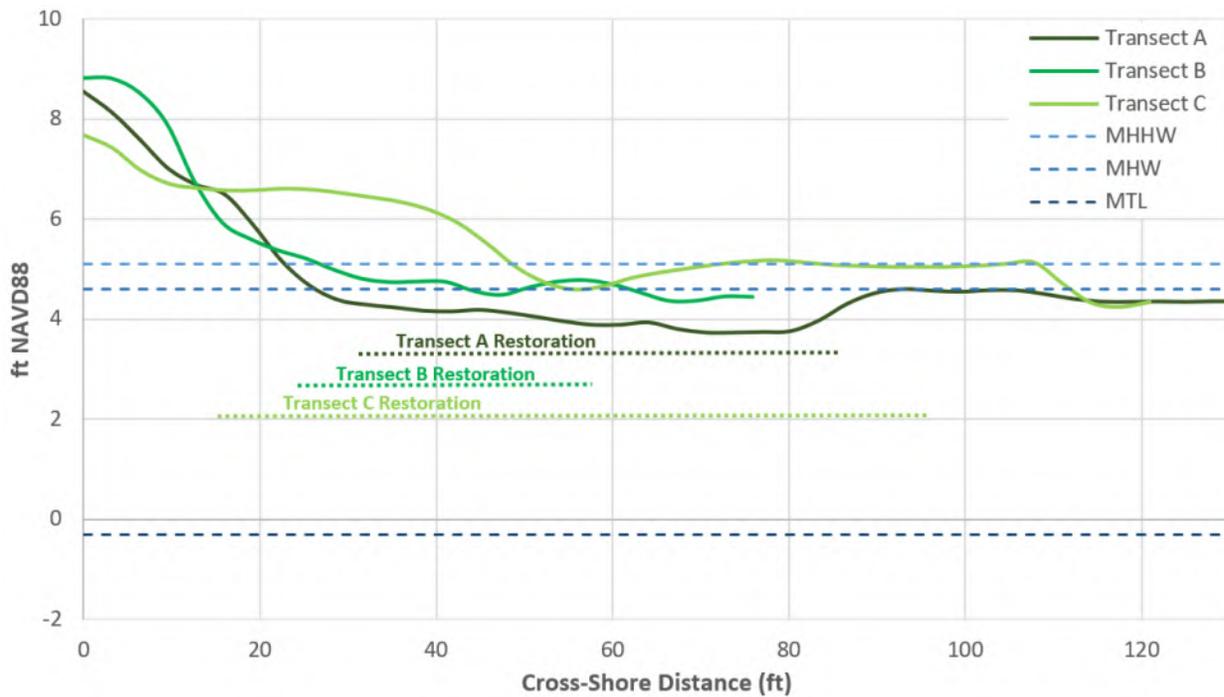


Figure 42. Salt marsh restoration pilot sites – Cross-Section.

3.4.1 Beach Nourishment

Beach nourishment entails placing compatible sediment on an existing beach to improve resiliency of the shoreline, provide a sediment source for downdrift beaches and marshes, can enhance wildlife habitat, and improve recreational space. Beach nourishment serves as storm damage protection and erosion control to upland areas by providing natural sacrificial material as a buffer between the ocean and landward assets or resources.

Localized beach nourishment was considered along the coastal beach which separates Morton St from the salt marsh and tidal flats offshore of Pleasant St (Figure 43). A mixed sand, gravel, and cobble nourishment would bolster the coastal beach resource, improve the buffer between the ocean and roadway, and increase the volume of erodible sediment sources. Sediment with a larger grain size than that of the existing beach would hold its position better in the face of wind and waves. Cobble, in particular, provides increased resiliency two ways: 1 – its high porosity and permeability reduces outgoing wave energy to friction and infiltration, and 2 – the result is that cobble is not drawn out seaward to the degree that it was originally pushed landward, resulting in landward migration in the face of storm waves.

Beach nourishment would front the coastal bank to provide a wider and more resilient buffer from the effects of wind and waves during storms. A periodic and repeated addition of sand would be required to maintain the buffer. Beach nourishment would extend along approximately 460 linear feet of shoreline, tie-in to the inland coastal bank at about 6 ft NAVD88, and slope down to the landward edge of salt marsh (Figure 44 and Figure 45). Due to necessary side slopes and avoidance of impact to salt marsh, the beach elevation could only be raised by about 1-2 ft.

Beach nourishment would not provide the type of elevation capital required to protect the Morton St neighborhood from flood risk. While nourishment could be part of a broader solution, permitting barriers related to the ORW designation of Belle Isle Marsh prevent nourishment below the high tide line, except for a purely Ecological Restoration Project, which this would not be. As a result, nourishment would be confined to a narrow band along the shoreline, and would provide almost no benefit to flood protection. Therefore, beach nourishment was found to be a component which unnecessarily adds complexity to the project, and it was removed from further consideration.



Figure 43. Coastal Beach located between salt marsh and the roadway – November 6, 2023.

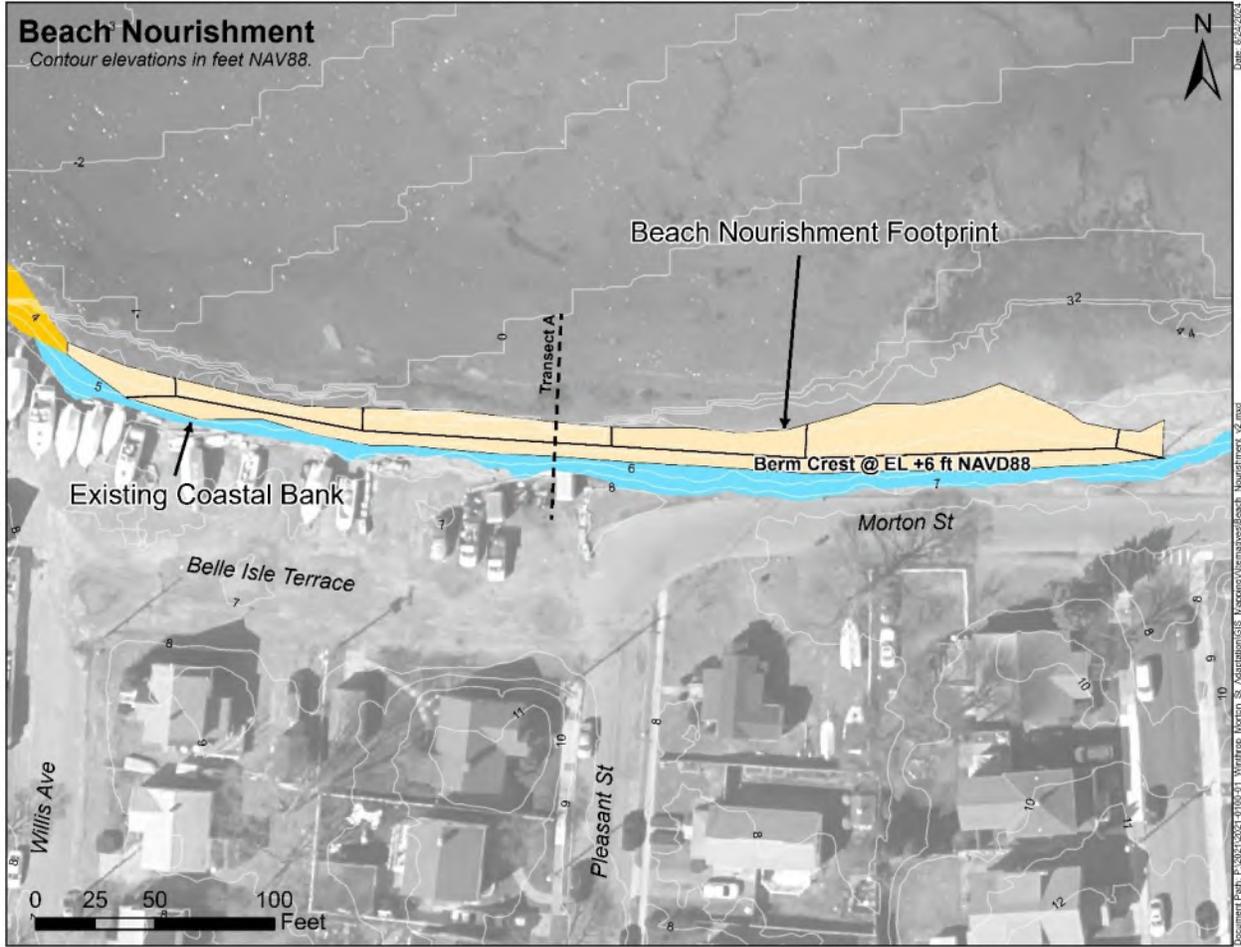


Figure 44. Beach nourishment – Plan View.

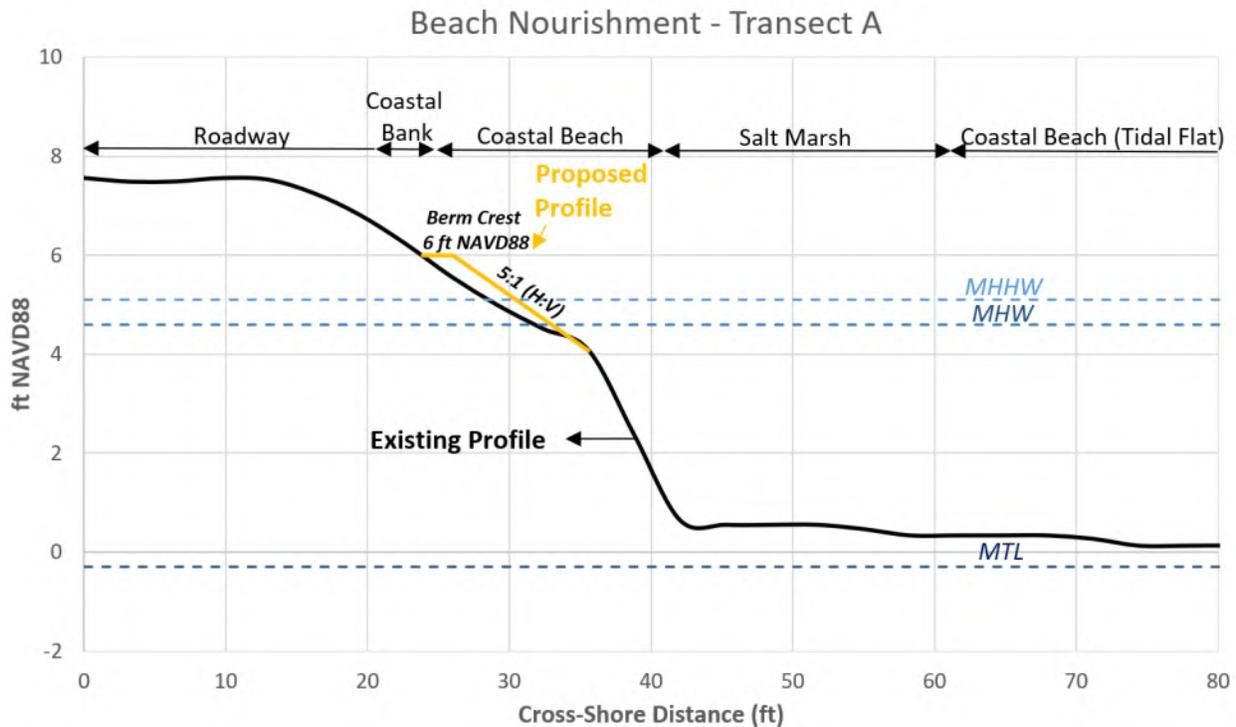


Figure 45. Beach nourishment – Cross-Section (Transect A).

3.4.2 Personal Property Improvements

Personal property and building improvements have not been incorporated into design alternatives considered for this Project, however they may be necessary for select parcels depending on where the final project alignment lands. Should homes or buildings be located seaward of a flood protection feature such as a raised roadway, several options may be considered:

- *Full Structure Elevation:* If a building or structure has a high probability of flood inundation, consideration should be given to elevating the entire structure above the projected target flood elevation to avoid critical damage from sea level rise and storm surge. Depending on the construction type and architectural style of the structure, it could be elevated on pilings (allowing water to pass under the structure without causing structural damage). Any elevation project would require the installation of additional stairs or a ramp to access the new elevated entryway. Buildings may be elevated many feet, achieving significant flood risk reduction.
- *Interior Elevation:* If a building or structure has a high probability of flood inundation, but full building elevation is not possible, consideration could instead be given to elevating just the first floor from the interior. This strategy is most appropriate for buildings constructed of flood-resistant material (e.g., masonry), where the most significant risk comes from flood water entering the structure through openings in the building (e.g., doorways, windows, etc.). However, interior elevation only works if there is an adequate floor to floor height to accommodate the floor elevation.
- *Acquisition:* Acquisition, or buyout, would entail the sale of an at-risk, flood-prone structure, plus any accompanying outbuildings, and the land to the Town of Winthrop or other buyer interested in open space. The property would be volunteered for sale by the owner, and purchased at fair market value by the purchaser. Once a buyout occurs, the residents must relocate, and if residents



are renting and not owners, precautions must be taken to protect their rights. Should federal funding be used for the purchase, the now-vacant property must be preserved as open space going forward. If desired by the homeowner, acquisition provides many benefits as it removes people and assets from a high risk area, and may support recreation, natural habitat, and future marsh migration.

- *Dry Floodproofing*: Dry floodproofing aims to ensure that no flood water enters through the exterior of the building, the basement, or any of the building's openings. This might involve installing deployable flood shields at any doors or windows below the projected target flood elevation. Traditional flood shields require permanent hardware to be installed on the frame of the opening so that barriers can be easily deployed prior to a flood event. Dry floodproofing can also involve sealing the existing exterior façade of the building with an impervious coating that stops floodwaters from penetrating pre-existing porous materials.
- *Wet Floodproofing*: Unlike dry floodproofing, wet floodproofing does not aim to stop water from entering a building or structure. Instead, it aims to reduce flood damage by allowing flood water to pass through the structure so that the forces of the water on the building's exterior do not cause significant damage to the structure itself. Because of this, wet floodproofing requires retrofitting the building's interior with 'floodable' materials and protecting mechanical and utility equipment so that these components will not suffer permanent damage during floods. This is not typically appropriate for residential buildings.
- *Mechanical & Electrical Systems*: Whenever possible, mechanical and electrical systems should be elevated above the projected target flood elevation. For low flood inundation probabilities, or if it is not feasible to relocate the system outside of the lower level, systems should be elevated on a platform to protect from flooding. Systems should always be anchored so as not to shift during a flood event, damaging other areas.
- *Flood Insurance*: Flood insurance should be considered by any property owner in the flood zone to help protect against devastating financial loss.

3.5 PERMITTING PATHWAYS

Permit acquisition for resiliency alternatives for the Project site depend upon project location with respect to wetland resource areas, the high tide line, previously filled tidelands, and Environmental Justice communities. Anticipated necessary permits are summarized below:

- MEPA Expanded Environmental Notification Form (EENF) with request for Single Environmental Impact Report (SEIR). EIR is triggered because of proximity to EJ populations.
- Notice of Intent with Conservation Commission
- MassDEP 401 Water Quality Certification (only if the project includes fill below the high tide line)
- MassDEP Chapter 91 (only if the project includes work along filled tidelands of Belle Isle Inlet or is below the MHW line)
 - MassDEP Chapter 91 licenses were researched but not identified for the existing structures along Belle Isle Inlet and around Belle Isle Boatyard. Future work must identify the history and lines associated with these structures.
- USACE General Permit (only if the project includes work below the HTL)
- CZM Federal Consistency

The following subsections detail the Wetland Protection Act, Surface Water Quality Standards, and Winthrop Wetlands Protection Chapter 12.40 regulations, which impact feasible engineering alternatives.



All of the Project's alternatives took regulations into consideration when factoring in various adaptation components.

3.5.1 Wetlands Protection Act

Coastal wetland resource areas within the Project area, as defined by the Massachusetts Department of Environmental Protection (DEP) Wetland Regulations (310 CMR 10), that may be impacted include:

- Land Subject to Coastal Storm Flowage 310 CMR 10.04
- Area of Critical Environmental Concern (ACEC) 310 CMR 10.23
- Land under the Ocean 310 CMR 10.25
- Coastal Beach 310 CMR 10.27
- Coastal Bank 310 CMR 10.30
- Salt Marsh 310 CMR 10.32
- Estimated Habitats of Rare Wildlife 310 CMR 10.37

Under present-day regulations, coastal wetland resource areas cannot be converted from one resource to another.

3.5.1.1 Land Subject to Coastal Storm Flowage 310 CMR 10.04

This area is land subject to any inundation caused by coastal storms up to and including that caused by the 100-year storm, surge of record, or storm of record, whichever is greater. There are no performance standards for Land Subject to Coastal Storm Flowage as of the time this report is being produced. However, MassDEP has recently proposed revisions to introduce new performance standards for this resource area.

3.5.1.2 Area of Critical Environmental Concern (ACEC) 310 CMR 10.24 (5)(a)

The entirety of the project area is located within the designated ACEC boundary. Under 310 CMR 10.24(5)b, projects in ACECs that will have an adverse effect on the interests of the Wetlands Protection Act are only allowed for Ecological Restoration Projects, Ecological Restoration Limited Projects, maintenance dredging, and improvement dredging needed to restore navigation to areas previously navigable. All of the alternatives proposed are aimed at minimizing adverse effects on natural resources and maintaining the interests of the coastal resources within the Project area. Wherever possible, alternatives work to promote the interest of each resource area, including salt marsh restoration, coastal beach nourishment, coastal bank stabilization, planting native vegetation, increasing permeable surfaces, enhancing stormwater capture, storage, and filtration, improving storm damage prevention, and supporting scenic recreation through collaboration with the Mary Ellen Welch Greenway Extension.

One component that could be critical in future phases is 301 CMR 12.12, Review of Designation, which states that “(1) the Secretary shall review periodically the designations of ACECs to evaluate the success of agency actions in the designated areas and whether the designation should be amended or repealed.” Future work related to this Project should include reviewing the ACEC boundary along Morton and Bank Street.

3.5.1.3 Coastal Beach 310 CMR 10.27

The 310 CMR 10.27 regulations define Coastal Beach as extending “from the mean low water line landward to the dune line, coastal bank line or the seaward edge of existing human-made structures, when these structures replace one of the above lines, whichever is closest to the ocean.” All work



proposed within Coastal Beach aims to support the performance standards. Under 310 CMR 10.27 when coastal beaches are determined to be significant to “storm damage prevention or flood control, the following characteristics are critical to the protection of those interests: (a) volume (quantity of sediments) and form; and (b) the ability to respond to wave action.” Additionally, any project on a coastal beach “shall not have an adverse effect by increasing erosion, decreasing the volume, or changing the form of any such coastal beach or an adjacent or downdrift coastal beach.” If beach nourishment was included as an adaptation component, compatible sediment would be utilized to improve the volume of the beach area. Favoring sediment of larger grain size would enhance stability and reduce erosion through a natural response to wave action. As waves run up, a coarse-grained or cobble beach would better dissipate wave energy due to friction and infiltrate water due to higher permeability. These factors work to decrease the risk of overtopping.

3.5.1.4 Coastal Bank 310 CMR 10.30

Coastal Bank, as defined by the 301 CMR 10.30 regulations, is “the seaward face or side of any elevated landform, other than a coastal dune, which lies at the landward edge of a coastal beach, land subject to tidal action, or other wetland.” All work considered on the Coastal Bank aims to support the performance standards. Coastal banks “provide a buffer to upland areas from storm waters are significant to storm damage prevention and flood control. Disturbances to a coastal bank which reduce its natural resistance to wind and rain erosion cause cuts and gullies in the bank, increase the risk of its collapse, increase the danger to structures at the top of the bank and decrease its value as a buffer.” Alternatives that include elements such as coastal bank stabilization would enhance the interests of the resource area, and features would work to mimic the natural slope and natural materials that make up the shoreline. The earthen berm alternative raises the crest elevation of the bank to achieve greater storm damage prevention and flood control as it buffers storm waters. Furthermore, alternatives for the coastal bank consider stabilization through natural and nature-based methods, including native plant establishment and temporary coir log installation.

3.5.1.5 Salt Marsh 310 CMR 10.32

As defined in the 301 CMR 10.32 regulations, salt marsh is “a coastal wetland that extends landward up to the highest high tide line, that is, the highest spring tide of the year, and is characterized by plants that are well adapted to or prefer living in saline soils.” All work considered for the Salt Marsh aims to support the performance standards, and areas of stagnation, oversaturation, vegetative die-back, and subsidence are targeted for restoration. Work outside of the existing salt marsh but within the 100-foot buffer zone would not adversely affect the productivity of the salt marsh. Fill of upland areas to create an earthen berm or living levee would utilize natural materials intended to buffer storm-related flooding but not impact the marsh. Should space allow, the gentler a slope of earthen fill could be made, the more likely this can serve as a transitional marsh habitat. Lastly, stormwater management techniques aim to reduce runoff to the marsh, reducing nutrient and pollutant loading to an already stressed system.

3.5.1.6 Estimated Habitats of Rare Wildlife 310 CMR 10.37

As described in the 301 CMR 10.37 regulations, Estimated Habitat Maps are “based on the estimated geographical extent of the habitats of all state-listed vertebrate and invertebrate species for which a reported occurrence...has been accepted by the Program and incorporated into its official database.” Alternatives considered for the Project site did not result in the loss or conversion of resource areas, so no impacts on estimated habitats of rare wildlife would occur..



3.5.1.7 Ecological Restoration Limited Project 310 CMR 10.24

Pursuant to 310 CMR 10.24(8)(b), an Ecological Restoration Limited Project in accordance with 310 CMR 10.24(8) may result in the temporary or permanent loss of Resource Areas and/or the conversion of one Resource Area to another when such loss is necessary to the achievement of the project's ecological restoration goals. Furthermore, pursuant to 310 CMR 10.32(5), a project that will restore or rehabilitate a salt marsh or create a salt marsh may be permitted in accordance with 310 CMR 10.11 through 10.14, 10.24(8) and/or 10.53(4). This regulation is applicable to the salt marsh restoration alternatives.

3.5.2 The Massachusetts Surface Water Quality Standards 314 CMR 9.00

3.5.2.1 Outstanding Resource Waters

Outstanding Resource Waters (ORW) are waters designated for protection as determined by the Department based on their “outstanding socio-economic, recreational, ecological and/or aesthetic values.” The Outstanding Resource Waters in the Project area is the Belle Isle Inlet which includes the entire inlet and those tributaries thereto, Boston/Winthrop. It is a Class SA ORW and is a qualified shellfishing area. Since portions of the Project site are within an ORW, any fill below the high tide line would only be allowed as part of an Ecological Restoration Project, improving the capacity of the ecosystem and the waters and wetlands to sustain their designated uses. This would include beach nourishment of Coastal Beach, and restoration of Salt Marsh.

3.5.3 Winthrop Wetlands Protection Chapter 12.40

The Project worked to identify any adverse effect on wetland values included under the Winthrop Wetlands Protection Chapter 12.40. Except as permitted by the conservation commission the bylaw notes that no project shall remove soil or vegetation from, fill, dredge, build upon, discharge into or alter coastal wetlands, freshwater wetlands, bank, beach, dune, marsh or flat bordering a water body; or land within one hundred (100) feet of these resource areas; or land under a water body; or land subject to flooding, tidal action or coastal storm flowage or vernal pools within a wetland; or land within one hundred (100) feet of the marsh area of critical environmental concern. Winthrop's local by-laws define coastal bank as the first significant break in slope beyond the one hundred (100) year storm elevation on a seaward face or elevated landform, other than a coastal dune, which lies at the landward edge of a coastal beach, land subject to tidal action or other coastal wetlands.



4.0 ALTERNATIVES DESIGN

The following alternatives design analysis summarizes four approaches to addressing flood protection, habitat enhancement, and community support and engagement. The alternatives provide inland flood protection to residential streets and parcels while avoiding impacts to existing open space and wetland resources of Belle Isle Marsh. The four alternatives are depicted in concept design in Figure 46 to Figure 49 and detailed in 30% engineering design in Appendix C. Proposed alternatives include:

- Alternative 1 – Earthen Berm (10ft NAVD88): This alternative prioritizes nature-based solutions and stormwater management. Some roadway elevation is required to tie-in elevations with the upland. This achieves a 10 ft NAVD88 Design Flood Elevation.
- Alternative 2 – Raised Roadway (10 ft NAVD88): This alternative prioritizes civil infrastructure improvements and sets flood protection 10s of feet inland of the marsh boundary. This achieves a 10 ft NAVD88 Design Flood Elevation.
- Alternative 3 – Hybrid Solution (11 ft NAVD88): This alternative prioritizes maximum flood protection and incorporates the Winthrop Greenway Extension. This achieves an 11 ft NAVD88 Design Flood Elevation.
- Alternative 4 – Earthen Berm (11 ft NAVD88): This alternative prioritizes nature-based solutions, maximum flood protection, and incorporates the Winthrop Greenway Extension. This achieves an 11 ft NAVD88 Design Flood Elevation.

Note that all alternatives incorporate the stormwater improvements discussed within Section 3.2.

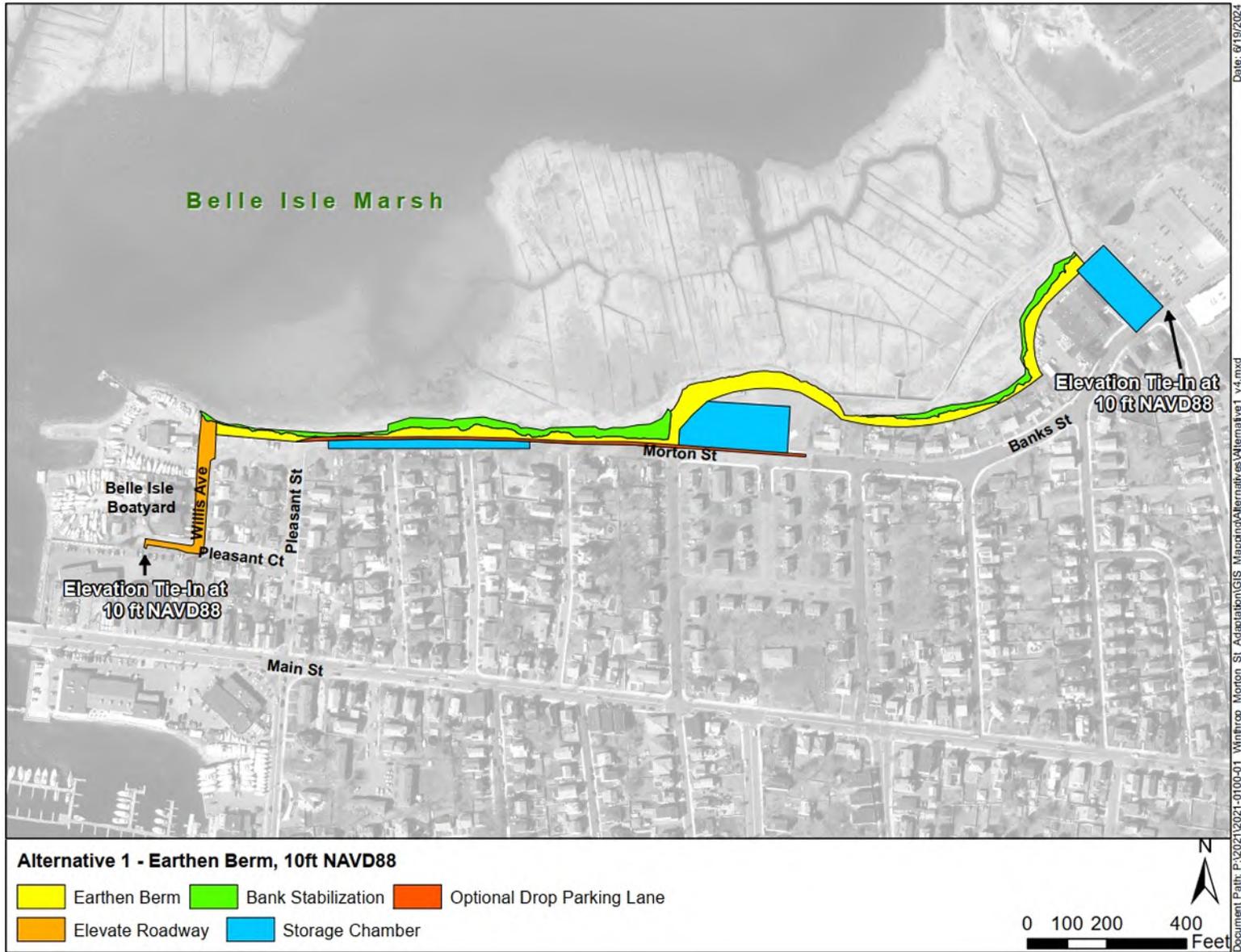


Figure 46. Alternative 1 – Earthen Berm (10 ft NAVD88) Conceptual Design.

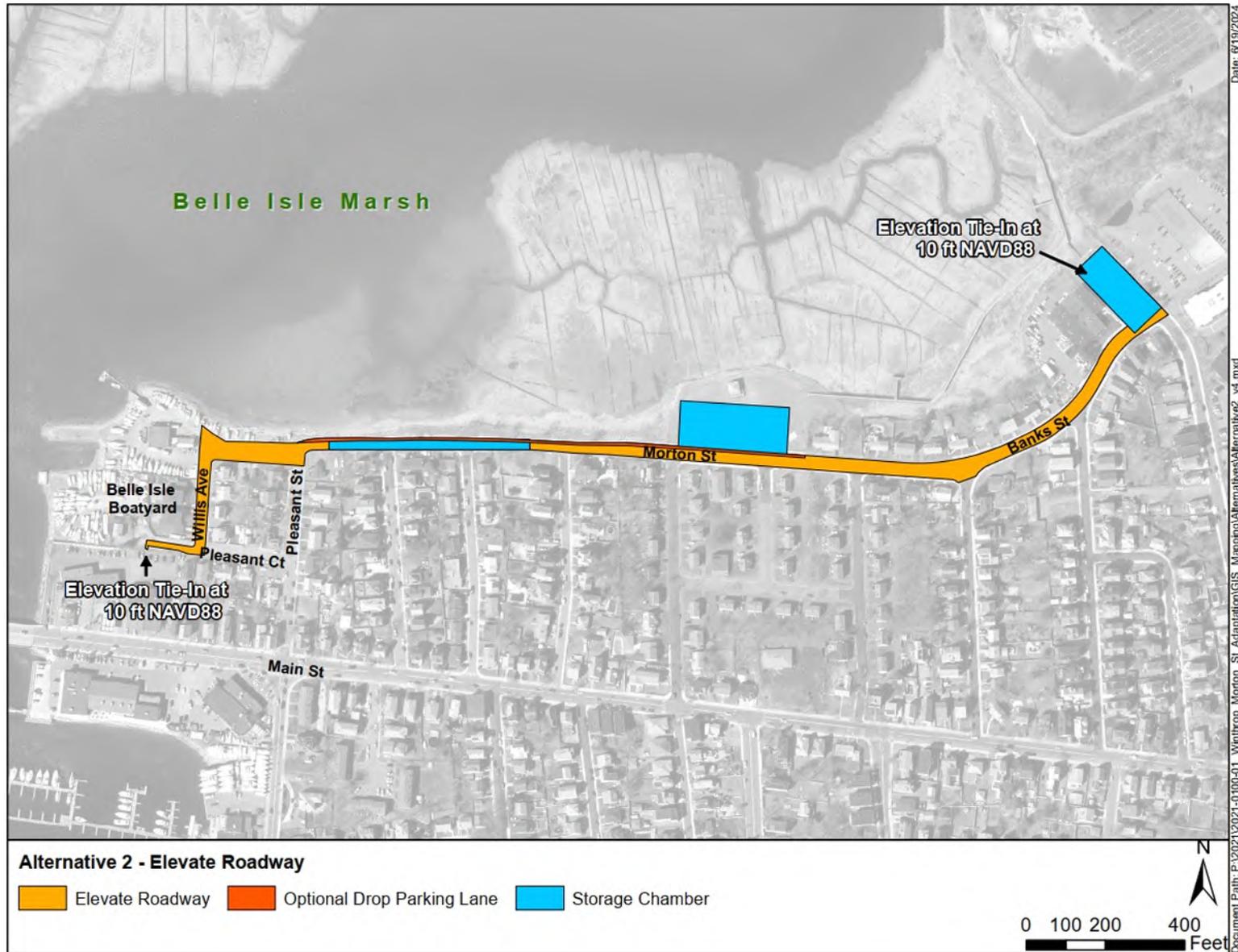


Figure 47. Alternative 2 – Raised Roadway (10 ft NAVD88) Conceptual Design.

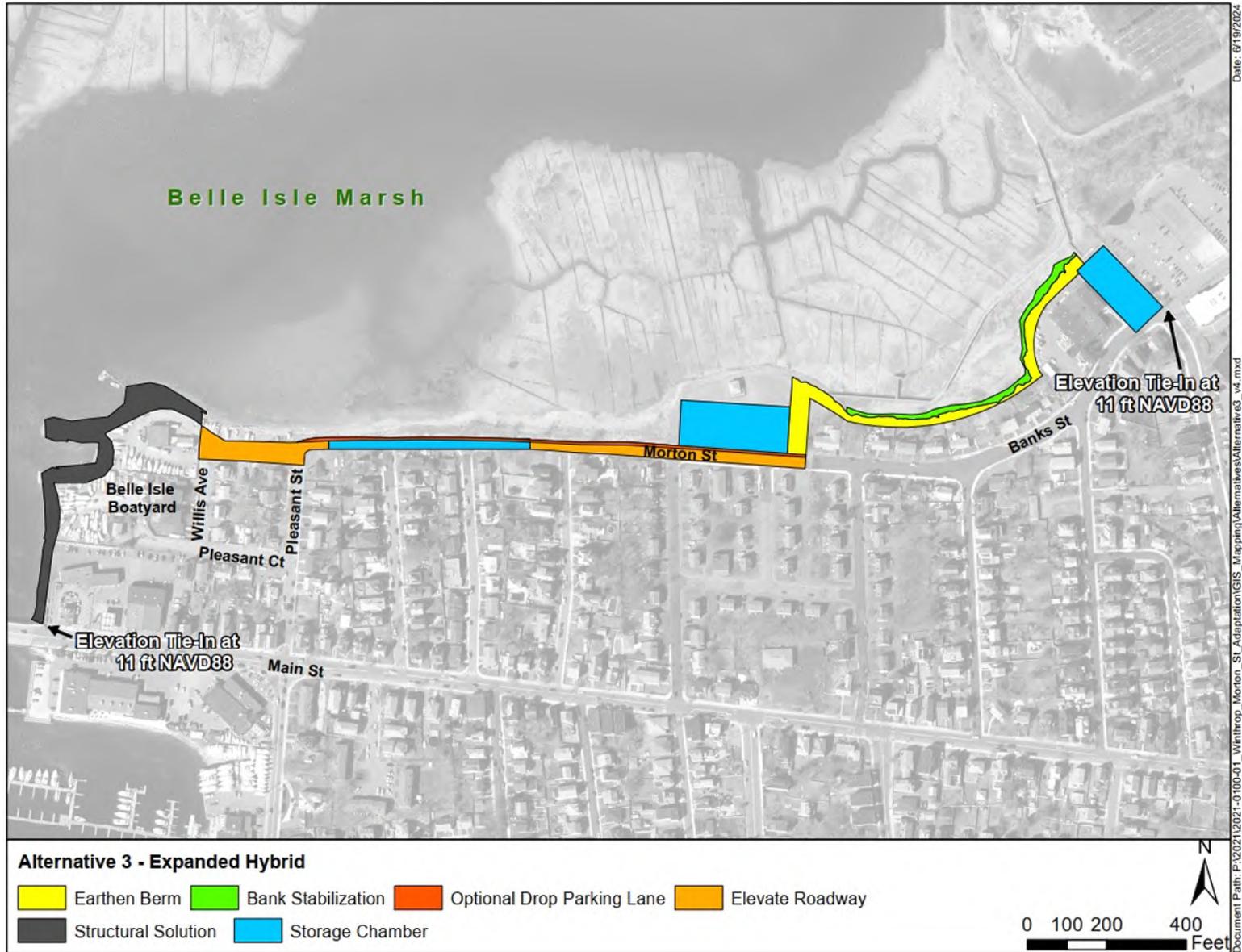


Figure 48. Alternative 3 – Hybrid Solution (11 ft NAVD88) Conceptual Design.

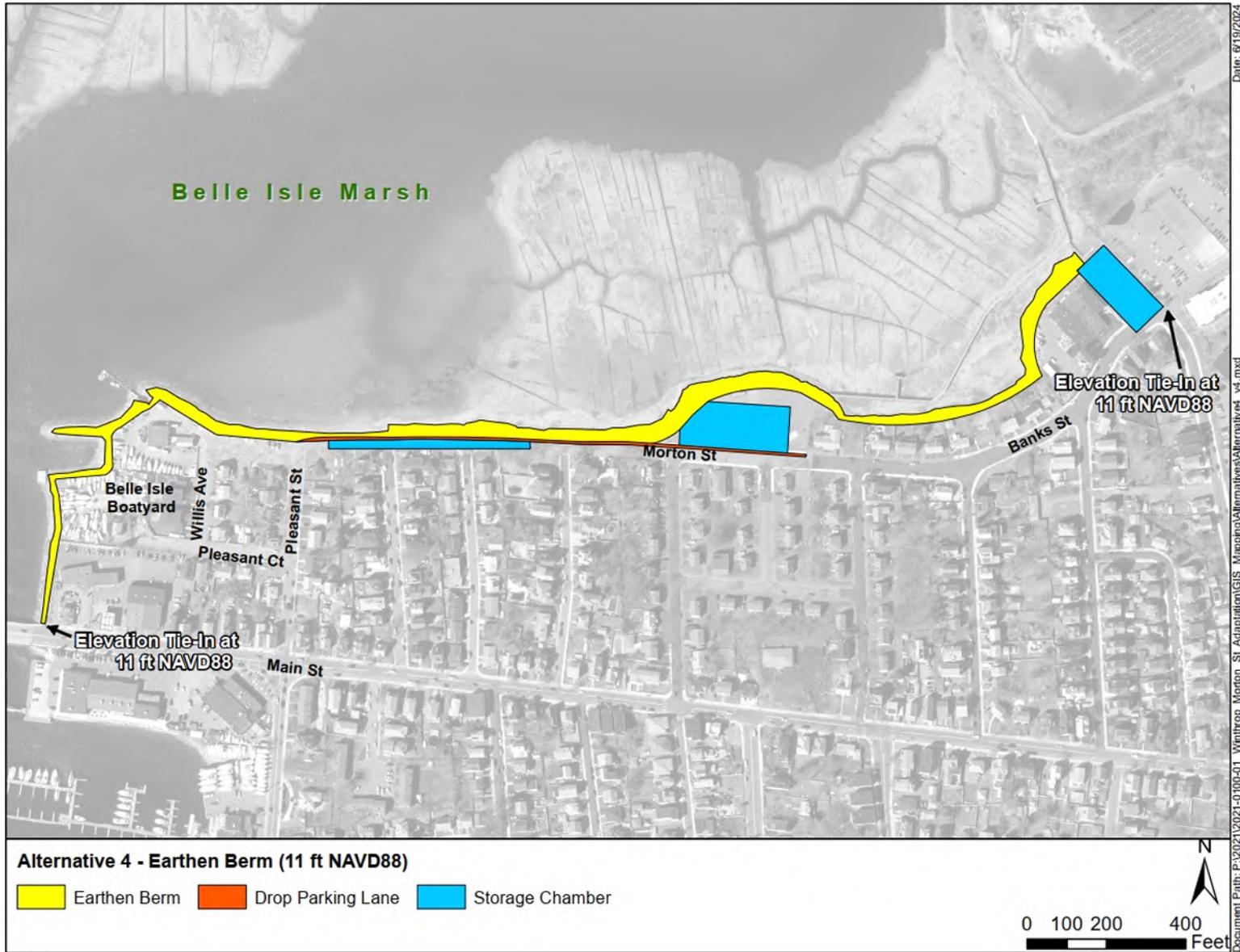


Figure 49. Alternative 4 – Earthen Berm (11 ft NAVD88) Conceptual Design.



4.1 ALTERNATIVE 1: EARTHEN BERM (10FT NAVD88), ROADWAY IMPROVEMENTS & STORMWATER IMPROVEMENTS

Design components of Alternative 1 include:

- Earthen berm along coastline from Willis Ave to Winthrop St, with coastal bank stabilization, and native plantings
- Elevate Willis Ave and parking lot at base of Winthrop St
- Three stormwater storage chambers
- Opportunity for pedestrian trail

The first alternative achieves an elevation of 10 feet NAVD88. An earthen berm is proposed along the coastline and landward of existing wetland habitat, building elevation capital while maintaining open space and supporting native vegetation. The earthen berm would be 2-3 ft in height and topped with soil, native seed, and native plantings. Coastal bank improvements seaward of the earthen berm would be included to ensure the features blend appropriately. The coastal bank's ability to achieve its performance standards would be enhanced with soils, native planting, and temporary stabilization features including coir fiber rolls and blanketing. Along Morton St and the Marine Ecology Park, the earthen berm could support a pedestrian access trail, constructed 8 ft wide and with a stone dust base. To increase open space and maintain a buffer from the marsh, the seaward parking lane of Morton St would be dropped. The earthen berm feature would necessarily occupy the backyards of private parcels, including 138 Morton St, 142 Morton St, 148A and 148B Morton St, 154 Morton St, 160 Morton St, 70 Banks St, 76 Banks St, and 84 Banks St. This alternative requires cooperation and construction within eight (8) privately-owned parcels. While the logistics of coordinating with and implementing a project on private property is challenging, conversations with several of the affected residents revealed enthusiasm for a project which could reduce their risk to flooding.

In the Town right-of-way, Willis Avenue and Pleasant Court will also require elevation by 2-3 ft to achieve 10 ft NAVD88. This roadway improvement would not result in permanent impacts beyond the right-of-way on either Willis Avenue or Pleasant Court. Approximately 6,500 SF of temporary rights would be required where side slopes would extend. Temporary impacts would result on both roadways to reconstruct slopes and driveways. The three (3) walkways along Willis Avenue would be impacted and would need to be regraded; all three would be regraded to meet ADA requirements without any adverse effects to the buildings they serve. There are five (5) driveways that would need to be re-graded at a maximum of a 15% slope. Re-grading of driveways at this slope allows one car length of flat ground between the bottom of slope and the face of building for all properties. Regrading of slopes beyond the edge of the roadway would result in negative drainage on every abutting property where stormwater draining from the roadway and from the private properties would meet at a gutter line established along the front of each property at the toe of the roadway slopes. Catch basins would need to be installed in each affected front yard to convey this water to the closed drainage system along the street. Yards would need to be regraded to allow for proper drainage to these structures. Overall, no direct impacts to buildings are anticipated in this alternative.

4.2 ALTERNATIVE 2: RAISED ROADWAY (10FT NAVD88), & STORMWATER IMPROVEMENTS

Design components of Alternative 2 include:

- Raise Willis Ave, Belle Isle Terrace, Morton St, Banks St, and parking lot at base of Winthrop St
- Three stormwater storage chambers



The second alternative achieves an elevation of 10 ft NAVD88 through raising Willis Avenue, Morton Street, and Banks Street. All roadway impacts discussed in Alternative 1 also apply to Alternative 2 for Willis Avenue and Pleasant Court. Approximately 26,000 SF of temporary rights will be required where side slopes would extend. Temporary impacts would occur from reconstruction of slopes and driveways. Minor re-grading of the two Belle Isle Marsh pedestrian entrances would be required to maintain an ADA accessible walkway. Existing sidewalk connections on properties east of Douglas Street would need to be removed, as an ADA compliant walkway could not be reestablished. In some cases, grading an ADA compliant walkway would result in impacts above the threshold of doorways and in most cases removal of existing stairs leading to front doors. There are approximately thirty-three (33) driveways that would need to be re-graded at a maximum of a 15% slope. Re-grading of driveways at this slope allows at least one car length of flat ground between the bottom of slope and the face of building for all properties except eight (8), with seven (7) of these instances occurring east of Douglas Street. In these instances, there is no additional space to extend the driveways to provide a flat parking area. Regrading of slopes beyond the edge of the roadway would result in negative drainage on every abutting property where stormwater draining from the roadway and from the private properties meets at a gutter line established along the front of each property at the toe of the roadway slopes. Catch basins would be needed in each affected front yard to convey this water to the closed drainage system along the street. Yards would need to be regraded to allow for proper drainage to these structures. Within six properties east of Douglas Street, the toe of slope would be within 5 ft of the face of the buildings. There are approximately thirteen (13) existing fences/walls that would be impacted by the slope re-grading and would require removal or resetting of each with approximately ten of these instances occurring east of Douglas Street.

Slope re-grading on the north side of Morton Street between Willis Avenue and Russell Street would require the use of 2:1 (H:V) slope to keep slope limits within the right-of-way and outside of the marsh. For safety reasons, the wooden guardrail would need to be extended the full length of this stretch, if this alternative is pursued. To increase open space and maintain a buffer from the marsh, the seaward parking lane of Morton St could be dropped. Re-grading of all side streets would be required for approximately 100 ft south of their intersection with Morton/Banks Street. Due to the increased roadway elevation aerial utility lines would have a reduced clearance over the roadway, which may be a potential concern at crossing locations and would need to be evaluated with the respective utility companies. Direct impacts to the building at 81 Banks Street, 101 Banks Street, and 105-07 Banks Street are anticipated as a result of the slope re-grading. The driveway at 81 Banks Street likely would require removal as it may be infeasible to reestablish a usable driveway. Properties listed with direct impacts are expected to receive 1-2 feet of fill material against the exposed foundation. In the case of 101 Banks Street, no exposed foundation is present, therefore fill will be placed in direct contact with the siding of the building. The resulting adverse drainage effects may necessitate the need to elevate these homes.

4.3 ALTERNATIVE 3: HYBRID SOLUTION (11 FT NAVD88) – EARTHEN BERM, RAISED ROADWAY, STRUCTURAL SOLUTIONS, & STORMWATER IMPROVEMENTS

Design components of Alternative 3 include:

- Structural solutions (e.g., bulkhead or seawall) along Belle Isle Inlet and around Belle Isle Boatyard
- Raise Belle Isle Terrace and Morton St
- Earthen berm adjacent marsh from Marine Ecology Park to Winthrop St, with coastal bank stabilization, and native plantings
- Remove seaside parking on Morton St;
- Raise Belle Isle Terrace, Morton St, and parking lot at base of Winthrop St
- Three stormwater storage chambers



- Opportunity for pedestrian trail

The third alternative achieves an elevation of 11 feet NAVD88. An earthen berm seaward of homes along Banks St and landward of existing wetland habitat would be included to build elevation capital while maintaining open space and supporting native vegetation. The earthen berm would be 3-4 ft in height and topped with soil, native seed, and native plantings. Coastal bank improvements seaward of the earthen berm would be necessary to ensure the features blend appropriately. The ability of the coastal bank to achieve its performance standards would be enhanced with soils, native planting, and temporary stabilization features including coir fiber rolls and blanketing. The feature would necessarily occupy the backyards of private parcels, including 138 Morton St, 142 Morton St, 148A and 148B Morton St, 154 Morton St, 160 Morton St, 70 Banks St, 76 Banks St, and 84 Banks St. This alternative requires cooperation and construction within eight (8) privately-owned parcels. While the logistics of coordinating with and implementing a project on private property is challenging, conversations with several affected property owners revealed enthusiasm for a project which could reduce their risk to flooding.

Roadway improvements would achieve an elevation of 11 ft NAVD88 through raising Morton Street between Willis Avenue and Douglas Street. Approximately 10,500 SF of temporary rights will be required where side slopes would extend. Temporary impacts would be required to reconstruct slopes and driveways. Extensive regrading of the two Belle Isle Marsh pedestrian entrances would also be required to maintain an ADA accessible walkway. There are approximately fifteen (15) driveways that would need to be regraded at a maximum of a 15% slope. Regrading of driveways at this slope would allow at least one car length of flat ground between the bottom of slope and the face of building for all properties except two, however, in one of these cases, there is adequate space to extend the existing driveway to accommodate the additional length needed. Regrading of slopes beyond the edge of the roadway would result in negative drainage on every abutting property where stormwater draining from the roadway and from the private properties would meet at a gutter line established along the front of each property at the toe of the roadway slopes. Catch basins would be needed in each affected front yard to convey this water to the closed drainage system along the street. Yards would need to be regraded to allow for proper drainage to these structures. There are three existing fences/walls that would be impacted by the slope re-grading and would require removal or resetting of each.

Slope re-grading on the north side of the roadway would require the use of 2:1 (H:V) slopes typically, with intermittent stretches of 1.5:1 (H:V) stone slope in order to keep slope limits within the right-of-way and outside of the marsh. For safety purposes wooded guardrail would need to be extended the full length of Morton Street if this alternative is pursued. To increase open space and maintain a buffer from the marsh, the seaward parking lane of Morton St could be dropped. Re-grading of all side streets would be required for approximately 100 ft south of their intersection with Morton Street. Due to the increased roadway elevation aerial utility lines would have a reduced clearance over the roadway. This may be a potential concern at crossing locations and would need to be evaluated with the respective utility companies. Overall, no direct impacts to buildings are anticipated in this alternative.

Lastly, given the present armoring of the shoreline along Belle Isle Inlet, as well as the flow velocities associated with the Belle Isle Inlet, a structural solution would be needed for this area of the Project site. A bulkhead could be driven landward of the existing revetment and rip rap shoreline. The bulkhead would necessarily impact the properties of existing commercial development; however, it would occupy the minimum necessary footprint to achieve flood protection. Alternatively, a concrete seawall may be considered. It may additionally be necessary to restack and enhance existing rip rap along this shoreline.

It is important to note that Alternative 3 could be amended to extend the earthen berm from the Marine Ecology Park along Morton St, in lieu of raising the roadway. This would come at a similar cost, and would



include trade-offs such as avoidance of impacts to private parcels, creation of an elevated feature adjacent the marsh which may support a pedestrian trail, and potential impacts to beach access and viewshed.

4.4 ALTERNATIVE 4: EARTHEN BERM (11FT NAVD88), ROADWAY IMPROVEMENTS, & STORMWATER IMPROVEMENTS

Design components of Alternative 4 include:

- Earthen berm adjacent marsh from Belle Isle Inlet to Winthrop St, with coastal bank stabilization, and native plantings. Added rock stabilization necessary along Belle Isle Inlet.
- Remove seaside parking on Morton St;
- Raise Belle Isle Terrace, Morton St, and parking lot at base of Winthrop St
- Three stormwater storage chambers
- Opportunity for pedestrian trail

The fourth alternative achieves an elevation of 11 feet NAVD88. An earthen berm would be built landward of existing wetland habitat, and along the entire coastline from Belle Isle Inlet to Winthrop St. The project would build elevation capital while maintaining open space and supporting native vegetation. The earthen berm would be 3-4 ft in height and topped with soil, native seed, and native plantings. Coastal bank improvements seaward of the earthen berm would be needed to ensure the features blend appropriately. The ability of the coastal bank to maintain its function would be enhanced with soils, native planting, and temporary stabilization features including coir fiber rolls and blanketing. Along Morton St and the Marine Ecology Park, the earthen berm could support a pedestrian access trail, constructed 8 ft wide and with a decomposed granite base. To increase open space and maintain a buffer from the marsh, the seaward parking lane of Morton St could be dropped. The feature would necessarily occupy the backyards of private parcels, including 30 Main St, 550 Pleasant St, Belle Isle Terrace (boatyard), 138 Morton St, 142 Morton St, 148A and 148B Morton St, 154 Morton St, 160 Morton St, 70 Banks St, 76 Banks St, and 84 Banks St. This alternative requires cooperation and construction within eleven (11) privately-owned parcels. Conversations were initiated throughout this project. Installation of an earthen berm adjacent Belle Isle Inlet requires:

1. Permanent impacts to commercial business, reducing their footprint and ability to earn income. A taking by the Town may be necessary to work in this larger footprint.
2. Increased engineering (e.g., rock apron) would be necessary to withstand storm flow velocities along the Belle Isle Inlet.

Roadway improvements would be required at Winthrop St atop stormwater features to tie-in elevations to 11 ft NAVD88.



5.0 ALTERNATIVES COMPARISON

5.1 DESIGN SUMMARY

A summary of conceptual roadway alternative impacts is provided in Table 8. Both Alternative 1, Alternative 3, and Alternative 4 present potentially feasible solutions. Alternative 2 was deemed infeasible.

- Alternative 1 requires support and cooperation by residents to construct flood protection in private property.
- Alternative 2 is not a feasible solution from a roadway perspective, unless at least 10 residential structures were elevated or acquired to accommodate new fill.
- Alternative 3 requires intrusive drainage solutions and driveway impacts to residents where roadways are raised, and requires support and cooperation by residents to construct flood protection in private property.
- Alternative 4 presents adverse impacts to commercial businesses which could be minimized by a structural solution with a smaller footprint.

Ultimately, Alternative 1 best achieves the minimum Project goals, avoids impacts to nearby resources, and minimizes negative impacts to roadways and abutting properties.



Table 8. Summary of Conceptual Alternative Impacts

Alternative	Impacted Roadways	Private Parcel Impacts	# of Driveways Impacted	# of Walkways Impacted	Resource Area Impact	Other Significant Impact
Alternative 1: Earthen Berm (10 ft NAVD88)	Pleasant Court; Willis Ave; Belle Isle Terrace; Morton St; Winthrop St	6,500 SF of Temporary Impact Occupy area within 138 Morton St, 142 Morton St, 148A and 148B Morton St, 154 Morton St, 160 Morton St, 70 Banks St, 76 Banks St, and 84 Banks St	5	3	LSCSF; Coastal Bank Treatments	Catch basins for negative drainage
Alternative 2: Raised Roadway (10 ft NAVD88)	Pleasant Court; Willis Ave; Belle Isle Terrace; Morton St; Banks St; Pleasant St; Pleasant Park Rd; Amelia Ave; Fairview St; Reed St; Russell St; Douglas St; Wilshire St; Winthrop St	26,000 SF of Temporary Impact Direct impact to 81, 101, & 105-07 Banks St	33; 8 of which would no longer meet MassDOT guidelines	25	LSCSF; 2:1 (H:V) side slopes required to avoid Coastal Bank	Catch basins for negative drainage
Alternative 3: Hybrid Solution (11f ft NAVD88)	Willis Ave; Belle Isle Terrace; Morton St; Pleasant St; Pleasant Park Rd; Amelia Ave; Fairview St; Reed St; Russell St; Douglas St; Winthrop St	10,500 SF of Temporary Impact Occupy area within 30 Main St, 550 Pleasant St, Belle Isle Terrace (boatyard), 138 Morton St, 142 Morton St, 148A and 148B Morton St, 154 Morton St, 160 Morton St, 70 Banks St, 76 Banks St, and 84 Banks St	16 2 of which would no longer meet MassDOT guidelines	5	LSCSF; 1.5 - 2:1 (H:V) side slopes required to avoid Coastal Bank; Coastal Bank Treatments for Berm	Catch basins for negative drainage
Alternative 4: Earthen Berm (11 ft NAVD88)	Belle Isle Terrace; Morton St; Banks St; Winthrop St	Occupy area within 30 Main St, 550 Pleasant St, Belle Isle Terrace (boatyard), 138 Morton St, 142 Morton St, 148A and 148B Morton St, 154 Morton St, 160 Morton St, 70 Banks St, 76 Banks St, and 84 Banks St	1; Impact to 30 Main St (carwash) exit way	NA	LSCSF; Coastal Bank Treatments	Catch basins for negative drainage



5.2 CONSTRUCTION COSTS

Preliminary order-of-magnitude costs were developed based on 30% design engineering for the four proposed alternatives. All estimates include a contingency of 30% calculated over the entire project to account for uncertainties and inflation as construction is not anticipated to occur for several years. Table 9 provides summaries by site and totals for each alternative. Detailed cost estimates are provided in Appendix D. Cost estimates are presented on the basis of understanding, design, and assumptions discussed within this report, are subject to change, and will require refinement under future engineering design. Earthen berm costs assume the widest proposed berm crest of 8 ft which may support a pedestrian pathway. Earthen berm costs include bank stabilization and native plantings. Lastly, an earthen berm along the Belle Isle Inlet is assumed to require rip rap stabilization due to current velocities, and therefore comes at increased cost.



Table 9. Order-of-Magnitude Construction Cost Estimates

Item	Quantity	Unit	Unit Cost	Total Cost	Total Cost + 40% Contingency
Alternative 1					
Mobilization	1	Lump Sum	\$320,000	\$320,000	\$448,000.0
Roadway Elevation & Improvements	1	Lump Sum	\$480,014	\$480,014	\$672,019.6
Earthen Berm & Bank Stabilization (10ft NAV88)	2,650	Linear Feet	\$800	\$2,120,000	\$2,968,000.0
Stormwater Storage Systems (3)	1	Lump Sum	\$5,944,600	\$5,944,600	\$8,322,440.0
Alternative 1 Total				\$8,864,614	\$12,500,000
Alternative 2					
Mobilization	1	Lump Sum	\$560,000	\$560,000	\$784,000.0
Roadway Elevation & Improvements	1	Lump Sum	\$3,924,054	\$3,924,054	\$5,493,675.6
Stormwater Storage Systems (3)	1	Lump Sum	\$5,944,600	\$5,944,600	\$8,322,440.0
Alternative 2 Total				\$10,428,654	\$14,600,000
Alternative 3					
Mobilization	1	Lump Sum	\$455,000	\$455,000	\$637,000.0
Roadway Elevation & Improvements	1	Lump Sum	\$2,483,209	\$2,483,209	\$3,476,492.6
Earthen Berm & Bank Stabilization (11ft NAV88)	1,250	Linear Feet	\$1,400	\$1,750,000	\$2,450,000.0
Bulkhead Seawall	900	Linear Feet	\$2,500	\$2,250,000	\$3,150,000.0
Stormwater Storage Systems (3)	1	Lump Sum	\$5,944,600	\$5,944,600	\$8,322,440.0
Alternative 3 Total				\$12,882,809	\$18,000,000
Alternative 4 (Does not include cost of potential takings in commercial areas)					
Mobilization	1	Lump Sum	\$455,000	\$455,000	\$637,000.0
Roadway Elevation & Improvements	1	Lump Sum	\$480,014	\$480,014	\$672,019.6
Earthen Berm & Bank Stabilization (11ft NAV88)	3,500	Linear Feet	\$1,500	\$5,250,000	\$7,350,000.0
Stormwater Storage Systems (3)	1	Lump Sum	\$5,944,600	\$5,944,600	\$8,322,440.0
Alternative 4 Total				\$12,129,614	\$17,000,000



5.3 ALTERNATIVES EVALUATION MATRIX

Adaptation strategies looked to both protect inland residential neighborhoods and critical infrastructure and optimize marsh health and longevity. The preferred approach will maximize the value of flood protection, habitat quality and biodiversity (through restoration), and community and public access. Furthermore, the preferred approach must be permissible, feasible to construct, provide long-term resilience (i.e., design life), and minimize necessary costs. Table 10 provides a summary of the prioritization matrix demonstrating that Alternative 1 received the highest feasibility score. Table 11 details how each adaptation strategy achieves, or falls short of, key qualities.

Table 10. Summary of Alternatives Evaluation.

Ranking	Adaptation Alternative	Feasibility Score
1	Alternative 1: Earthen Berm (10ft NAVD88)	High
2	Alternative 3: Hybrid Solution (11ft NAVD88)	Medium
3	Alternative 4: Earthen Berm (11ft NAVD88)	Medium-Low
4	Alternative 2: Raised Roadway (10ft NAVD88)	Low



Table 11. Alternatives Evaluation Prioritization Matrix of Feasibility.

Adaptation Alternative	Flood Protection	Ecological Value	Public Access Value	Permitting Feasibility	Construction Feasibility	Construction Cost	Design Life	Maintenance Requirements	Funding Potential
Alternative 1: Earthen Berm (10ft NAVD88)	Flood protection to present day 100-year coastal storm. Does not protect Belle Isle Boatyard	Coastal bank enhancement; preservation of open space; native plantings on earthen berm; stormwater capture	Potential pedestrian pathway atop earthen berm, but berm also creates hurdle between upland and marsh	Triggers MEPA EIR for EJ communities, Conservation Commission NOI	With support from Banks St residents, lateral space available to construct berm along shoreline but outside of wetlands. Stormwater capacity is constrained without elevating Morton St	\$	Earthen berm provides soft solution which may be expected to last 30-50 years	Earthen berm native plantings anticipated to require seasonal maintenance. Berm is vulnerable to erosion and may require maintenance. Stormwater pump system requires regular maintenance.	NFWF National Coastal Resilience Fund; FEMA Building Resilient Infrastructure and Communities
Alternative 2: Raised Roadway (10ft NAVD88)	Flood protection to present day 100-year coastal storm. Does not protect Banks St marsh-adjacent residents or Belle Isle Boatyard	Preservation of open space; preservation of minor salt marsh migration into neighborhood; stormwater capture	Roadway remains accessible	Triggers MEPA EIR for EJ communities, Conservation Commission NOI	Elevating Banks St is infeasible due to fill from slopes and negative stormwater drainage impacting private property	\$\$	Raised roadway expected to last 50+ years with maintenance	Stormwater pump system requires regular maintenance.	FEMA Building Resilient Infrastructure and Communities
Alternative 3: Hybrid Solution (11ft NAVD88)	Preservation and conservation of open space existing and potential future marsh habitat.	Coastal bank enhancement; preservation of open space; native plantings on earthen berm; stormwater capture	Opportunity to tie-in adaptation with Greenway Extension. Roadway remains accessible	Triggers MEPA EIR for EJ communities, Conservation Commission NOI, DEP Chapter 91, Army Corps of Engineers General Permit, & CZM Federal Consistency	Bulkhead solution preserves maximum space in commercial areas; Morton St can feasibly be raised; and with support from Banks St residents, lateral space available to construct berm	\$\$\$	Earthen berm provides soft solution which may be expected to last 30-50 years; raised roadway expected to last 50+ years; structural solutions at inlet anticipated to last 50-75 years	Earthen berm native plantings anticipated to require seasonal maintenance. Berm is vulnerable to erosion and may require maintenance. Stormwater pump system requires regular maintenance.	FEMA Building Resilient Infrastructure and Communities
Alternative 4: Earthen Berm (11ft NAVD88)	Provides justification for action where necessary, while avoiding a heavy handed response to problems which may self resolve.	Coastal bank enhancement; preservation of open space; native plantings on earthen berm; stormwater capture	Potential pedestrian pathway atop earthen berm, but berm also creates hurdle between upland and marsh. Opportunity to tie-in adaptation with Greenway Extension	Triggers MEPA EIR for EJ communities, Conservation Commission NOI, DEP Chapter 91, Army Corps of Engineers General Permit, & CZM Federal Consistency	Earthen berm impacts square footage of commercial property. Stormwater capacity is constrained without elevating Morton St	\$\$	Earthen berm provides soft solution which may be expected to last 30-50 years	Earthen berm native plantings anticipated to require seasonal maintenance. Berm is vulnerable to erosion and may require maintenance, particularly along inlet. Stormwater pump system requires regular maintenance.	NFWF National Coastal Resilience Fund; FEMA Building Resilient Infrastructure and Communities



6.0 SUMMARY AND CONCLUSIONS

The Morton St neighborhood is a low-lying, commercial and residential area abutting Belle Isle Marsh. Town property and private parcels are frequently impacted by king tides, precipitation events, and coastal storms. Sunny day flooding occurs where drainage infrastructure is in need of maintenance and cannot prevent tides from bubbling up the storm drain network. Coastal flooding overtops the shoreline under present day 1 to 2-year storm conditions, indicating a near annual expectation of flooding. The experience reported by residents in the area validates such frequency of flooding. With sea level rise, the nearly 1-mile-long shoreline is anticipated to overtop more frequently, and with increasing damage.

What is Needed

Protecting the neighborhood requires building elevation capital between Belle Isle Marsh and inland development. In many cases, development has filled areas which were once tidal marshland. As a result, little buffer exists within which work may occur. Furthermore, creating a barrier to storm surge risks forming a basin which would fill with precipitation or overtopping flow. Therefore, extensive stormwater storage and drainage improvements are required. Lastly, abutting the Belle Isle Marsh Area of ACEC and ORW comes with increased regulatory requirements. No work may occur below the high tide line, unless the work is considered an Ecological Restoration Project; and, work within resource areas must further the interests of those resources. No resource area conversion is allowable under the current environmental regulations.

Engineering Alternatives

Four engineering alternatives were carried to 30% design and estimate. Depending upon the level of risk acceptable to the Town, Alternative 1 or Alternative 3 are the highest ranked of the four concepts. Evaluation criteria were developed, leading to feasibility rankings of the alternatives. Results are summarized below:

1. Alternative 1 – Earthen Berm (10 ft NAVD88)

This alternative ranked as the most feasible alternative for the following reasons:

- The project includes Banks St residents which are the most vulnerable parcels around the entirety of Belle Isle Marsh.
- The project provides a nature-based solution, preserving open space and recreational access.
- The project does not impact Morton St parcels.
- The project is the lowest cost, estimated at \$12,500,000.

Drawbacks of this alternative include the following:

- The project provides little resilience to sea level rise, as by 2030 State projections, it no longer protects against a 100-year storm.
- The project does not provide flood protection to properties along Belle Isle Inlet.

2. Alternative 3: Hybrid Solution (11ft NAVD88)

This alternative ranked as the 2nd most feasible alternative for the following reasons:

- The project includes Banks St residents, which are the most vulnerable parcels around the entirety of Belle Isle Marsh, as well as commercial and residential properties along Belle Isle Inlet.
- The project tailors solutions according to the space available. Earthen berm is proposed along Banks St to include all residents. Raising Morton St is proposed west of the Marine Ecology Park,



reducing risk to that roadway, and preserving the natural shoreline and viewshed. Structural solutions are proposed along Belle Isle Inlet, reducing impacts on businesses.

- The project achieves the maximum DFE for flood protection along this reach.

Drawbacks of this alternative include the following:

- Raising Morton St will require grading of lawns/driveways within private parcels on Morton St.
- The project is the highest cost, estimated at \$18,000,000.

It is important to note that Alternative 3 could be amended to extend the earthen berm from the Marine Ecology Park along Morton St, in lieu of raising the roadway. This alternative would come at a similar (slightly reduced) cost, and would include trade-offs.

Alternative 4: Earthen Berm (11ft NAVD88)

This alternative ranked as the 3rd most feasible alternative for the following reasons:

- The project includes Banks St residents, which are the most vulnerable parcels around the entirety of Belle Isle Marsh, as well as commercial and residential properties along Belle Isle Inlet.
- The project achieves the maximum DFE for flood protection along this reach.
- The project provides a nature-based solution, preserving open space and recreational access.
- The project does not impact Morton St parcels.

Drawbacks of this alternative include the following:

- Installation of an earthen berm adjacent Belle Isle Inlet requires: 1) permanent impacts to commercial business, reducing their footprint and ability to earn income, potentially a taking by the Town, and 2) increased engineering (e.g., rock apron) to withstand storm flow velocities.
- Potential impact on flood drainage capacity of proposed stormwater features.
- Potential impacts to beach access and viewshed.
- The project is the 3rd highest cost, estimated at \$17,000,000, not including potential takings.

3. Alternative 2: Raised Roadway (10ft NAVD88)

This alternative ranked as the least feasible alternative. The pros of this alternative include:

- The project focuses work within the Town right-of-way, increasing legal and logistical feasibility.
- The project avoids potential impacts to beach access and viewshed.
- The project is the 2nd lowest cost, estimated at \$14,600,000.

However, drawbacks of this alternative render it infeasible:

- Elevating Banks St is infeasible, due to the significant amount of fill and impact to residents required to achieve design elevations.
- Raising Morton St will require grading of lawns/driveways within private parcels on Morton St.
- The project does not provide flood protection to properties along Belle Isle Inlet or seaward of Morton St.
- The project provides little resilience to sea level rise, as by 2030 State projections, it no longer protects against a 100-year storm.

Interim Improvements

Implementation of a preferred alternative is anticipated to take several years, assuming funding is acquired. In the interim, residents of Belle Isle Terrace, Morton St, and Banks St are likely to experience flooding, potential damage to assets, and risk to safety and health. Temporary measures are necessary to



alleviate the primary concerns at the site. Through discussion with the Town and residents, it was determined that the following measures would help stem flood risks in the near-term:

- Inspect and maintain existing stormwater drainage network.
- Install check valves on outfalls to inhibit backflow during spring tides.
- Install temporary barriers at low points along the shoreline where flooding first overtops. Bringing up the grade of the shoreline to 8 ft NAVD88 would only span two reaches of 150 ft and 290 ft, with tie-in points along the way. These are the two primary flood pathways identified both in modeling and resident reporting.
- Manage traffic during flooding events to prevent drivers from plowing through deep water, which can produce waves that overtop front door thresholds.

7.0 REFERENCES

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DeConto and Kopp, 2017. Massachusetts Sea Level Assessment and Projections. Technical Memorandum.

Lombard, P.J., Olson, S.A., Sturtevant, L.P. and Kalmon, R.D., 2021. *Documentation and mapping of flooding from the January and March 2018 nor'easters in coastal New England* (No. 2021-5109). US Geological Survey.

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Town of Winthrop, 2018. Community Resiliency Building Workshop – Summary of Findings. Prepared by Town of Winthrop and Woodard & Curran. June 2018.

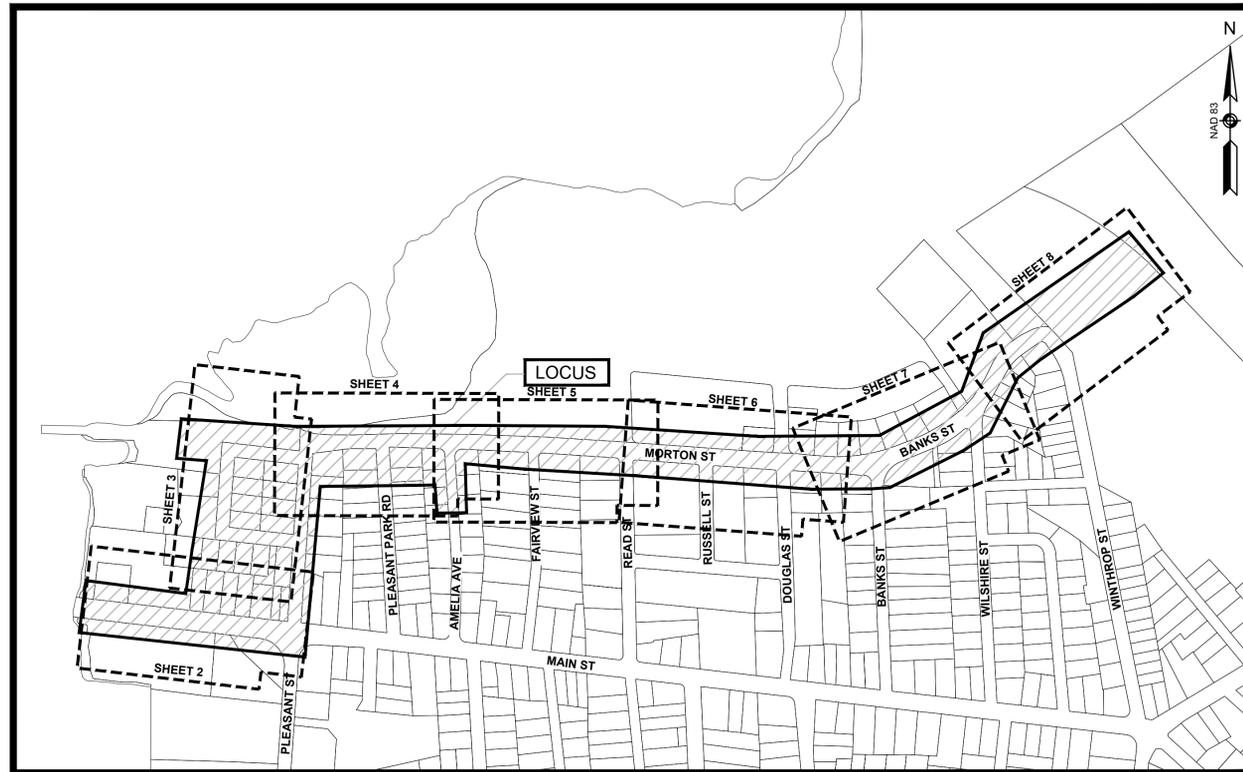
Waterfield Design Group, 2023. Flood Study – Veteran's Housing- Pleasant, Read, Russell, Douglas, & Morton Streets, Winthrop, MA.

Woods Hole Group, 2022. Belle Isle Marsh – Environmental Inventory, Coastal Modeling, and Restoration Assessment. Prepared for Mystic River Watershed Association. December 2022.

Woods Hole Group, 2023. Belle Isle Marsh – Climate Vulnerability Assessment. Prepared for Town of Winthrop and Mystic River Watershed Association. June 2023.



Appendix A. Existing Conditions Plan Set



UTILITY NOTES:

- ALL UNDERGROUND UTILITIES AS SHOWN WERE COMPILED USING FIELD SURVEY INFORMATION AND AVAILABLE RECORD INFORMATION.
- RECORD UTILITY INFORMATION FROM THE VARIOUS UTILITY COMPANIES AND PUBLIC AGENCIES, ARE APPROXIMATE ONLY AND ACTUAL LOCATIONS MUST BE DETERMINED IN THE FIELD.
- ALL UTILITY COMPANIES, PUBLIC AND PRIVATE MUST BE NOTIFIED, INCLUDING THOSE IN CONTROL OF UTILITIES NOT SHOWN ON THIS PLAN, (SEE CHAPTER 370, ACTS OF 1963, MASSACHUSETTS) PRIOR TO DESIGNING, EXCAVATING, BLASTING, INSTALLING, BACKFILLING, GRADING, PAVEMENT RESTORING OR REPAVING.
- THE LOCATION OF EXISTING PIPES OR OTHER UNDERGROUND STRUCTURES OR PROPERTY LINES ARE NOT WARRANTED TO BE EXACT, NOR IS IT WARRANTED THAT ALL UNDERGROUND PIPES OR STRUCTURES ARE SHOWN. THE CONTRACTOR SHALL CALL "DIG SAFE" (1-888-344-7233) 72 HOURS (EXCLUDING SATURDAYS, SUNDAYS AND HOLIDAYS) PRIOR TO ANY EXCAVATION TO OBTAIN ACCURATE UTILITY LOCATIONS.
- SUBSURFACE UTILITY LOCATIONS HAVE BEEN PLOTTED TO MEET UTILITY QUALITY LEVEL "C" AS DESCRIBED IN ASCE STANDARD 38-02 AND SUMMARIZED BELOW. THE UNDERGROUND UTILITIES ARE SHOWN IN APPROXIMATE LOCATIONS BASED ON ABOVE-GROUND FIELD OBSERVATION AND EXISTING RECORD INFORMATION RECEIVED FROM UTILITY STAKE-HOLDERS. UTILITY RECORD PLANS WERE REQUESTED AND RECEIVED FROM THE FOLLOWING UTILITY COMPANIES/AGENCIES/MUNICIPALITIES:
- INVERTS SHOWN ON PLAN ARE NOT GUARANTEED TO BE ACCURATE. DUE TO THE LIMITATIONS OF FIELD OBSERVATION AND SURVEY TECHNIQUES THE INVERTS ARE SHOWN AS APPROXIMATE ONLY AND SHALL NOT BE WARRANTED TO BE CORRECT. ADDITIONAL FIELD INVESTIGATION IS NECESSARY WHERE ACCURATE MEASUREMENTS ARE REQUIRED FOR DESIGN OF CRITICAL AREAS.
- THE EXISTING CONDITIONS PLAN IS TO BE USED FOR THE SPECIFIED PROJECT ONLY AND IS NOT WARRANTED TO BE COMPLETE FOR ANY OTHER FUTURE PROJECTS.

SUMMARY OF UTILITY MAPPING QUALITY LEVELS:

THE FOLLOWING IS A SUMMARY OF THE SURVEY MAPPING LEVELS FOR UTILITIES AS DESCRIBED IN ASCE STANDARD 38-02, "STANDARD GUIDELINE FOR THE DEPICTION OF EXISTING SUBSURFACE UTILITY DATA". THESE GUIDELINES ARE MORE FULLY DESCRIBED IN THE ASCE STANDARD.

UTILITY QUALITY LEVEL A:
PRECISE HORIZONTAL AND VERTICAL LOCATION OF UTILITIES OBTAINED BY THE ACTUAL EXPOSURE OR VERIFICATION OF PREVIOUSLY EXPOSED AND SURVEYED UTILITIES AND SUBSEQUENT MEASUREMENT OF SUBSURFACE UTILITIES, USUALLY AT A SPECIFIC POINT. MINIMALLY INTRUSIVE EXCAVATION EQUIPMENT IS TYPICALLY USED TO MINIMIZE THE POTENTIAL FOR UTILITY DAMAGE. A PRECISE HORIZONTAL AND VERTICAL LOCATION, AS WELL AS OTHER UTILITY ATTRIBUTES, IS SHOWN ON PLAN DOCUMENTS. ACCURACY IS TYPICALLY SET TO 15-MM VERTICAL AND TO APPLICABLE HORIZONTAL SURVEY AND MAPPING ACCURACY AS DEFINED OR EXPECTED BY THE PROJECT OWNER.

UTILITY QUALITY LEVEL B:
INFORMATION OBTAINED THROUGH THE APPLICATION OF APPROPRIATE SURFACE GEOPHYSICAL METHODS TO DETERMINE THE EXISTENCE AND APPROXIMATE HORIZONTAL POSITION OF SUBSURFACE UTILITIES. QUALITY LEVEL B DATA SHOULD BE REPRODUCIBLE BY SURFACE GEOPHYSICS AT ANY POINT OF THEIR DEPICTION. THIS INFORMATION IS SURVEYED TO APPLICABLE TOLERANCES DEFINED BY THE PROJECT AND REDUCED ONTO PLAN DOCUMENTS.

UTILITY QUALITY LEVEL C:
INFORMATION OBTAINED BY SURVEYING AND PLOTTING VISIBLE ABOVE-GROUND UTILITY FEATURES AND BY USING PROFESSIONAL JUDGMENT IN CORRELATING THIS INFORMATION TO QUALITY LEVEL D INFORMATION.

UTILITY QUALITY LEVEL D:
INFORMATION DERIVED FROM EXISTING RECORDS OR ORAL RECOLLECTIONS. INFORMATION DERIVED FROM EXISTING RECORDS OR ORAL RECOLLECTIONS.

LEGEND

- | | | | |
|---------|---------------------------------------|----------|--------------------------------|
| ● BF# | BANK FLAG | ○ PED | PEDESTRIAN SIGNAL |
| ● BHL # | BORE HOLE | ○ PK | PK NAIL |
| ○ | BUSH | ○ POST | CIRCULAR POST |
| ● BM # | BENCHMARK | □ POST | SQUARE POST |
| ○ BOL | BOLLARD | ○ RB | REBAR/IRON PIN |
| □ | BOUND (CONC, STONE, LAND COURT, ETC.) | ○ | ROCK |
| ○ CB | CABLE MANHOLE | ○ SN | STAKE AND NAIL |
| ■ CB | CATCH BASIN - SQUARE | ○ SP | STAND PIPE |
| ● DH | DRILL HOLE | ○ | SEWER MANHOLE |
| ○ EHH | DRAIN MANHOLE | ○ | STUMP |
| ○ | ELECTRIC HANDHOLE | ■ | TACKLE/DETECTABLE WARNING PAD |
| ○ | ELECTRIC MANHOLE | ■ TCB | TRAFFIC SIGNAL CONTROL CABINET |
| ■ EM | ELECTRIC METER | ○ | TELEPHONE MANHOLE |
| ● EPLP | ESCUTCHEON PIN IN LEAD PLUG | ■ TFMR | TRANSFORMER |
| △ FES | FLARED END SECTION | ■ TPIT # | TEST PIT |
| ○ FP | FLAG POLE | △ | TRAVERSE POINT |
| ○ GG | GAS GATE | ● 22" | TREE |
| ■ GM | GAS METER | ○ TS | TRAFFIC SIGNAL |
| ○ | GAS MANHOLE | ○ TS | TRAFFIC SIGNAL |
| ○ GPL | GUY POLE | ○ | SIGN |
| ← | GUY WIRE ANCHOR | ○ | SIGN - DOUBLE POST |
| ○ | FIRE HYDRANT | ○ UG | UNKNOWN GATE |
| □ ICV | IRRIGATION CONTROL VALVE | ○ ULT# | UTILITY POLE W/ LIGHT |
| ○ IP | IRON PIPE | ○ UPL# | UTILITY POLE |
| ○ | LIGHT POLE | ○ VP | VENT PIPE |
| ○ MAG | MAG NAIL | ○ | WATER MANHOLE |
| □ MB | MAIL BOX | ○ WG | WATER GATE |
| ■ MHB | MASSACHUSETTS HIGHWAY BOUND | ■ WM | WATER METER |
| ○ MW | MONITORING WELL | ○ WSO | WATER SHUTOFF |
| ○ | OTHER MANHOLE | ○ WELL | WELL (POTABLE) |
| □ PB | PULL BOX | ● WF# | WETLAND FLAG |

ABBREVIATIONS

- | | | | |
|------|--------------------|-----|-----------------------|
| BIT | BITUMINOUS | PED | PEDESTRIAN |
| BM | BENCHMARK | R | PROPERTY LINE |
| CB | CATCH BASIN | SGE | SLOPED GRANITE EDGING |
| CLF | CHAIN LINK FENCE | SL | STOP LINE |
| CONC | CONCRETE | STR | STAIRS |
| CW | CROSSWALK | SW | SIDEWALK |
| DBYL | DOUBLE YELLOW LINE | SWL | SOLID WHITE LINE |
| EP | EDGE OF PAVEMENT | SYL | SOLID YELLOW LINE |
| GRAN | GRANITE | VGC | VERTICAL GRANITE CURB |
| INV | INVERT | VLF | VINYL FENCE |
| N/F | NOW OR FORMERLY | | |

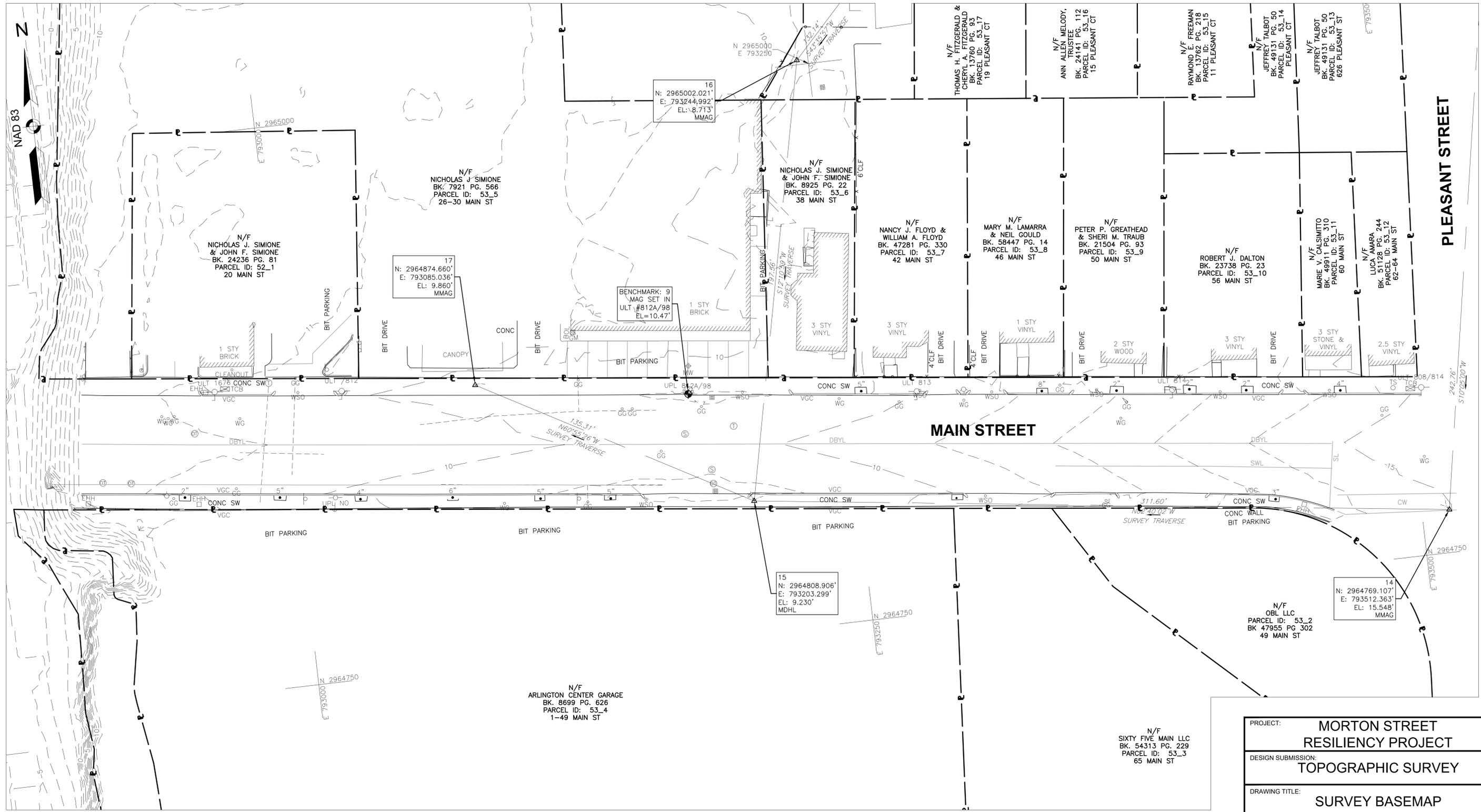
GENERAL NOTES

- THE EXISTING CONDITIONS SHOWN ON THIS BASE MAP ARE THE RESULT OF AN ON-THE-GROUND INSTRUMENT SURVEY PERFORMED BETWEEN NOVEMBER 6, 2023 AND MARCH 12, 2024 BY GREEN INTERNATIONAL AFFILIATES, INC. (GREEN).
- HORIZONTAL AND VERTICAL CONTROL WAS ESTABLISHED BY GREEN INTERNATIONAL AFFILIATES, INC. BETWEEN NOVEMBER 6, 2023 AND NOVEMBER 16, 2023. HORIZONTAL DATUM IS BASED ON THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM (MAINLAND) NAD83 (2011), 2010.00 EPOCH. VERTICAL DATUM IS NAVD88 (COMPUTED USING GEOID18).
- THE RIGHT OF WAY LINES SHOWN HERE ARE RESULT OF GIS. PRIVATE PROPERTY LINES HAVE NOT BEEN SURVEYED AND SHOULD BE CONSIDERED APPROXIMATE.

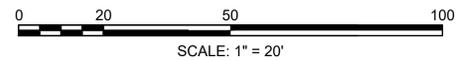
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PROJECT:	MORTON STREET RESILIENCY PROJECT	
DESIGN SUBMISSION:	TOPOGRAPHIC SURVEY	
DRAWING TITLE:	TITLE SHEET	
PREPARED FOR:	TOWN OF WINTHROP	
	45 PAULINE ST WINTHROP, MASSACHUSETTS	
PREPARED BY:	 Green International Affiliates, Inc. Civil and Structural Engineers 100 AMES POND DRIVE, SUITE 200, TEWKSBURY, MA 01876 978.923.0400 www.greenintl.com	
SCALE:	AS NOTED	FIELD CHIEF: KR
DATE:	6/18/2024	DRAWN BY: CM
PROJECT NO.:	23078	CHECKED BY: SV
		SHEET NO. 1 OF 8

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RESILIENCY PROJECT**

DESIGN SUBMISSION: **TOPOGRAPHIC SURVEY**

DRAWING TITLE: **SURVEY BASEMAP**

PREPARED FOR:
TOWN OF WINTHROP

45 PAULINE ST
WINTHROP, MASSACHUSETTS

PREPARED BY:
Green International Affiliates, Inc.
Civil and Structural Engineers

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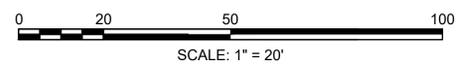
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MORTON ST REAR

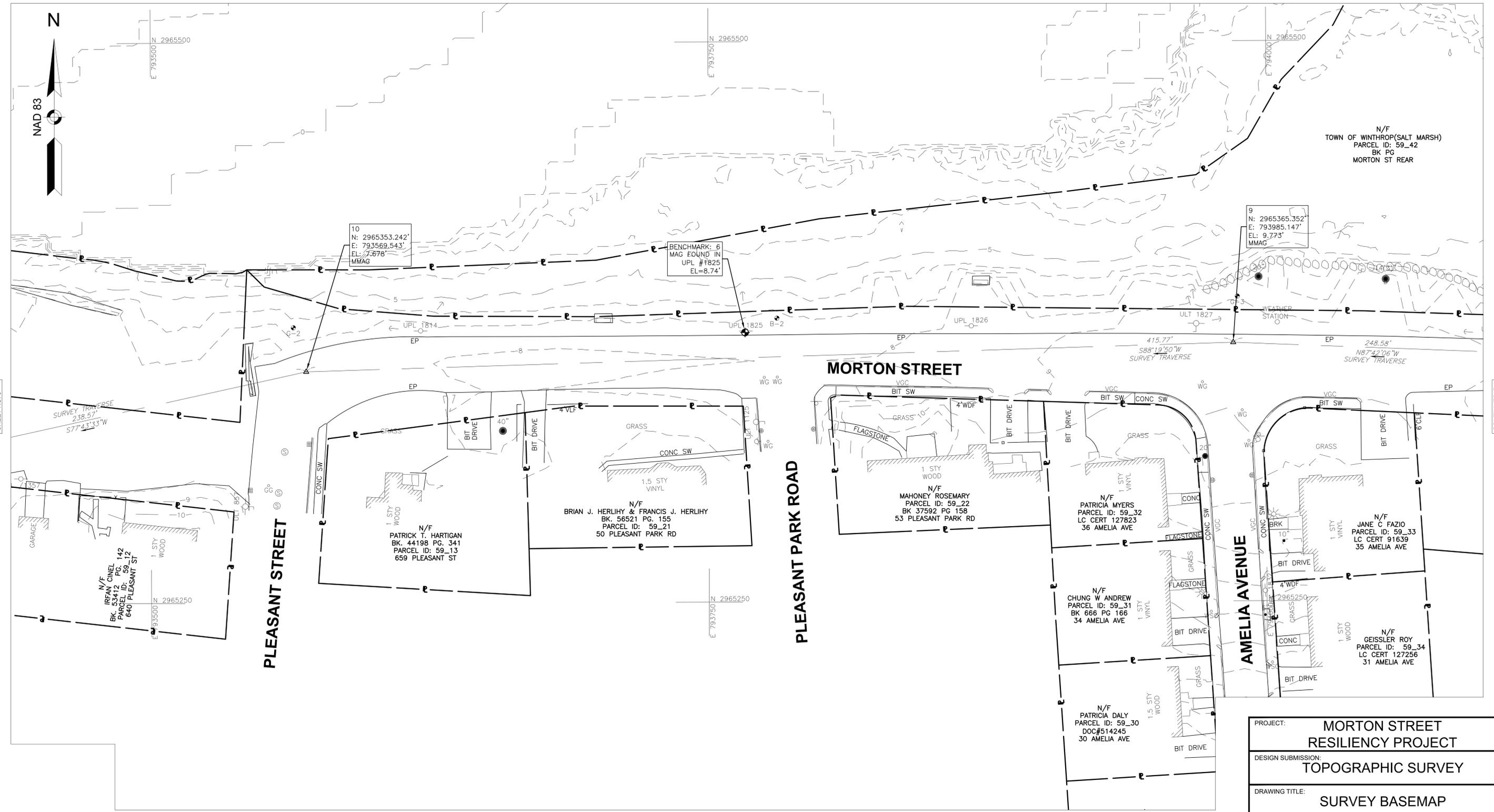
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MMAG

BENCHMARK: 6
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UPL #1825
EL=8.74'

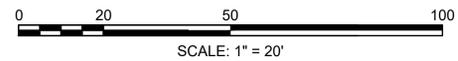
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DRAWING TITLE: **SURVEY BASEMAP**

PREPARED FOR:
TOWN OF WINTHROP
45 PAULINE ST
WINTHROP, MASSACHUSETTS

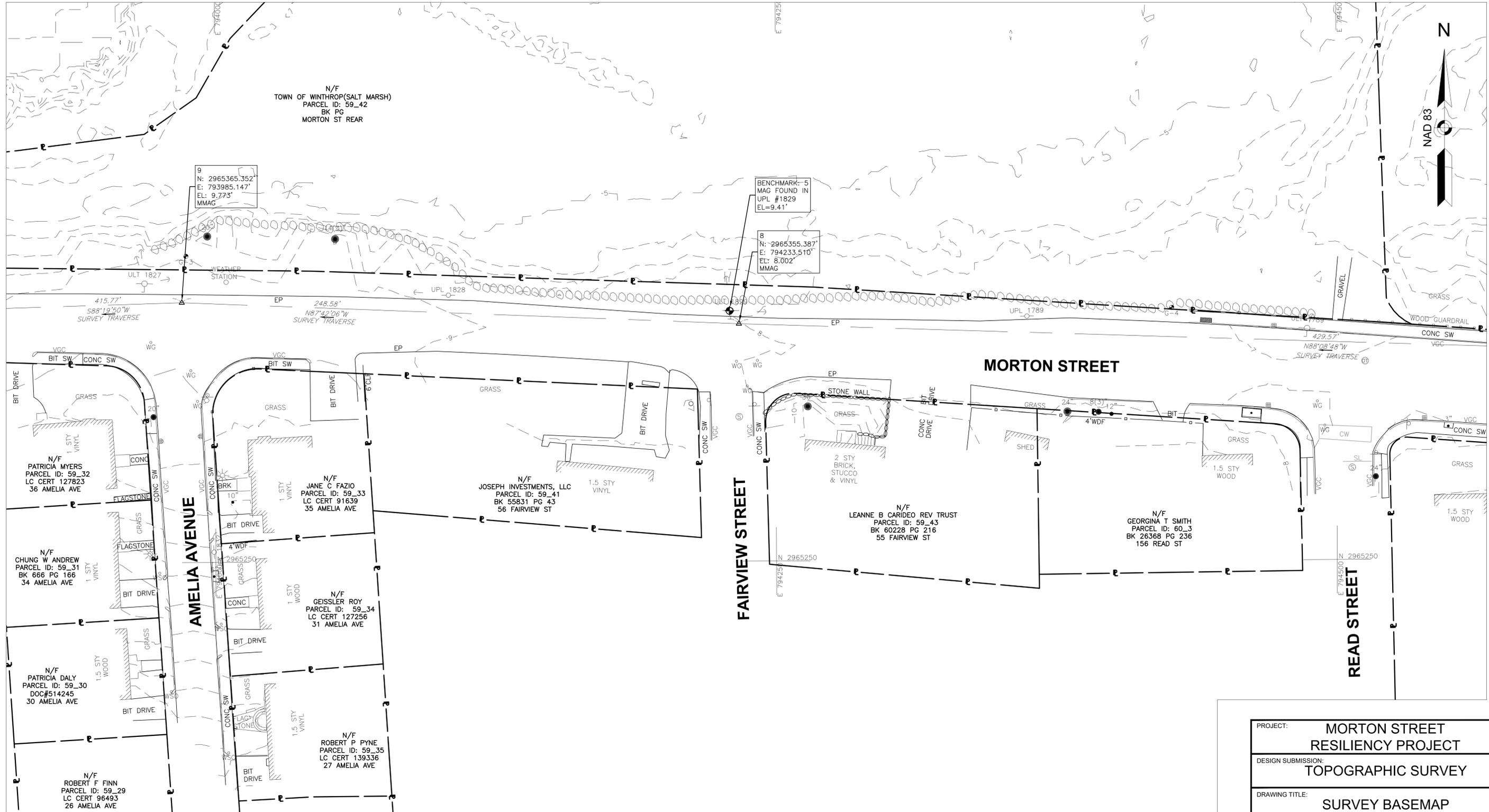
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PROJECT NO. 23078

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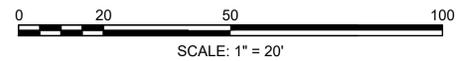
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PREPARED FOR:
TOWN OF WINTHROP

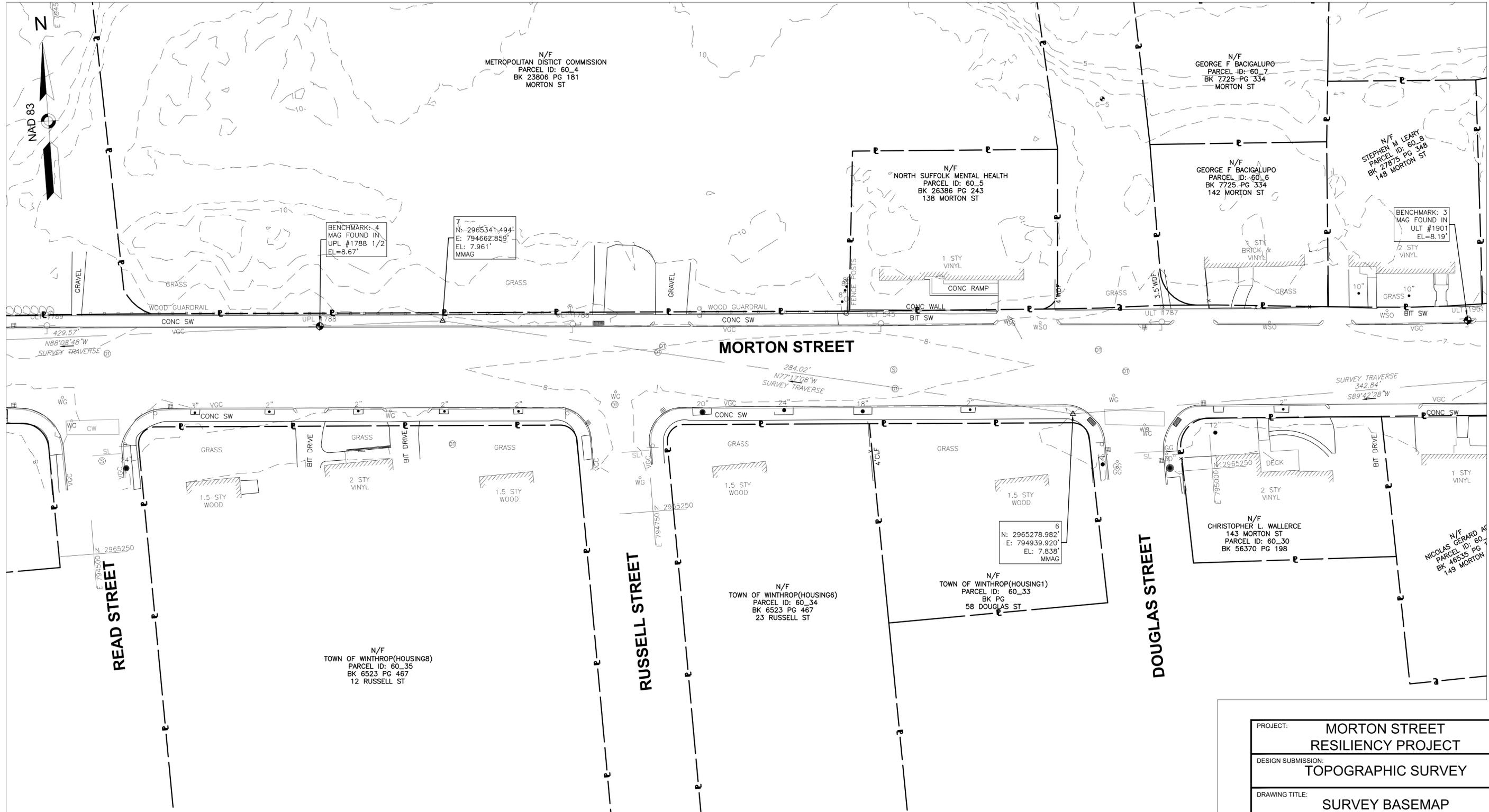
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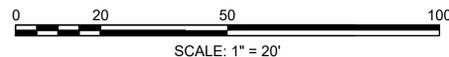
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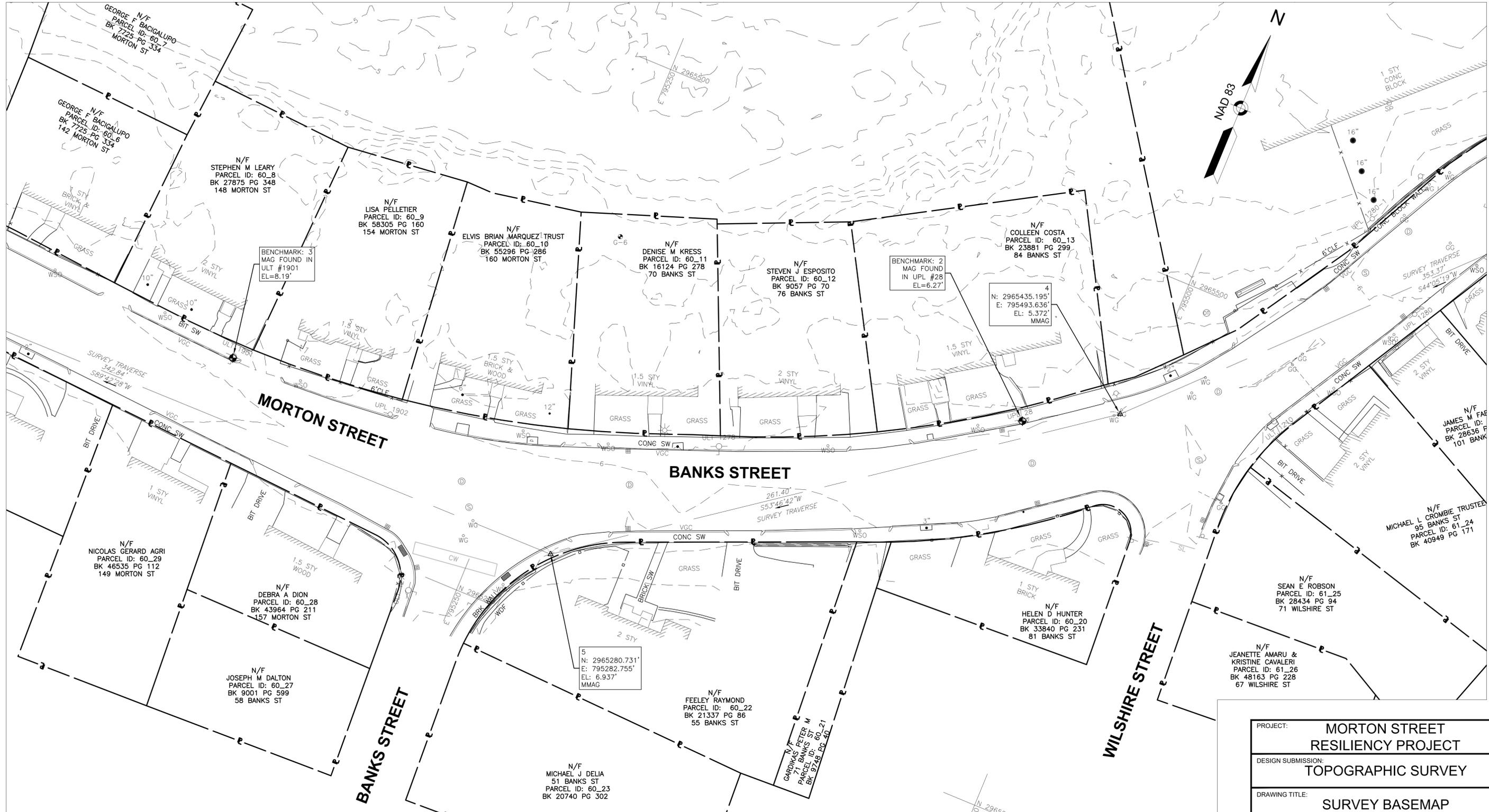
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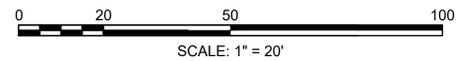


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PREPARED BY:		 Green International Affiliates, Inc. Civil and Structural Engineers 100 AMES POND DRIVE, SUITE 200, TEWKSBURY, MA 01876 978.923.0400 www.greenintl.com	
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DATE: 6/18/2024	DRAWN BY: CM		
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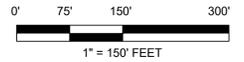
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Appendix B. Stormwater Engineering – 30% Design



NOTE: WETLAND RESOURCE AREAS DEPICTED ARE IN REFERENCE TO WETLAND DELINEATION PLAN (11/6/2023), PROVIDED BY WOODS HOLE GROUP



LEGEND	
EXISTING DRAINAGE AREA	
APPROXIMATE OUTFALL LOCATION	
NRCS SOIL SURVEY BOUNDARY	
SALT MARSH	
SALT MARSH (DIEBACK AREA)	
COASTAL BANK	
COASTAL BEACH	
COASTAL BEACH (TIDAL FLAT & DIEBACK AREA)	
LAND SUBJECT TO COASTAL STORM FLOWAGE	
TOE OF BANK	
EXISTING DRAIN PIPE	

HYDROLOGIC SOIL GROUP (NRCS)

DISCHARGE POINT

EXISTING DRAINAGE AREA ID

EDA No.	Area (acres)	Current 2024 Rainfall Data					Projected 2050	
		2-Year Event	5-Year Event	10-Year Event	25-Year Event	50-Year Event	100-Year Event	100-Year Event
EDA-1	3.81	17,337	26,267	35,109	50,399	65,253	83,548	92,826
EDA-2	1.68	7,667	11,587	15,507	22,216	28,793	36,852	40,946
EDA-3	2.36	10,716	16,248	21,736	31,189	40,380	51,706	57,456
EDA-4	0.50	2,265	3,441	4,617	6,621	8,581	10,977	12,197
EDA-5	11.04	50,312	76,099	101,800	146,144	189,138	242,194	269,157
EDA-6	24.58	98,751	149,367	199,810	286,843	371,218	475,283	528,165

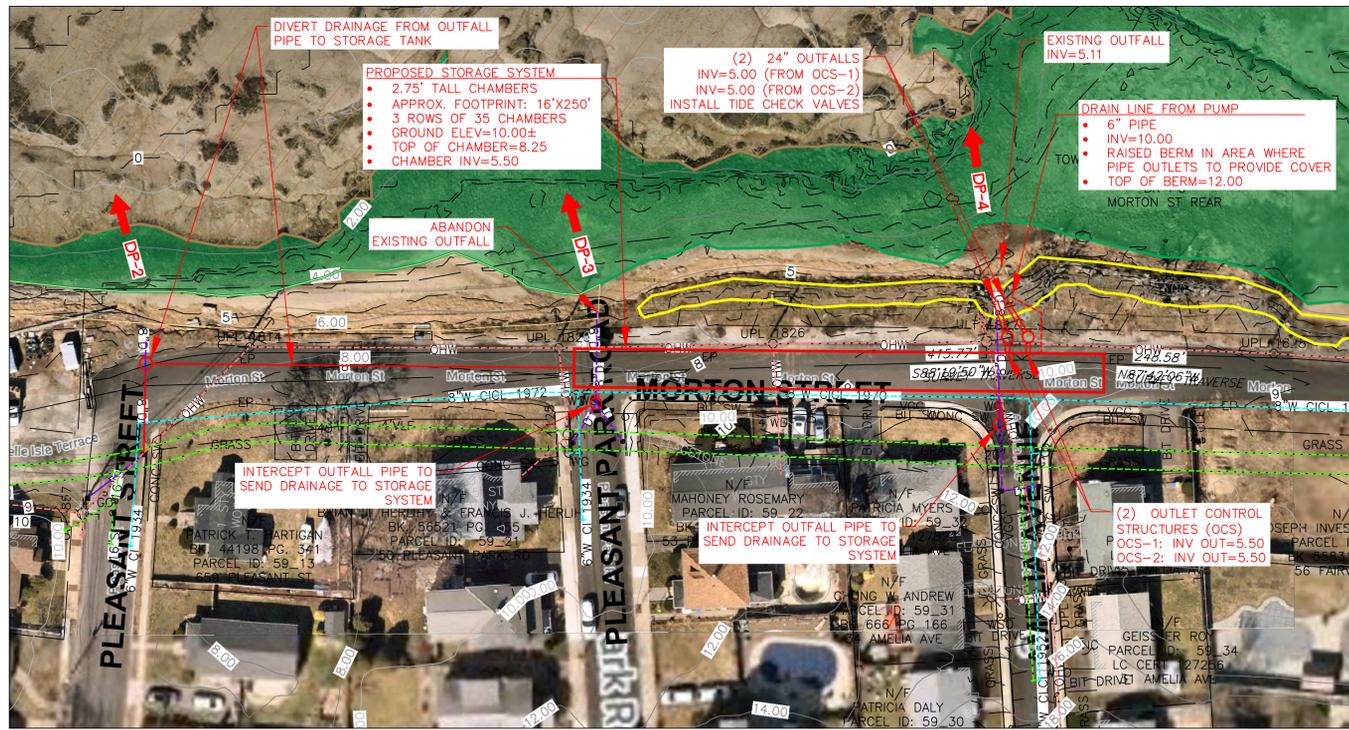
2-Year	3.26
5-Year	4.11
10-Year	4.90
25-Year	6.19
50-Year	7.39
100-Year	8.83
100-Year (2050 Projected)	9.55

RAINFALL DATA OBTAINED FROM NOAA ATLAS 14 PRECIPITATION FREQUENCY ESTIMATES FOR SUFFOLK COUNTY, MA.

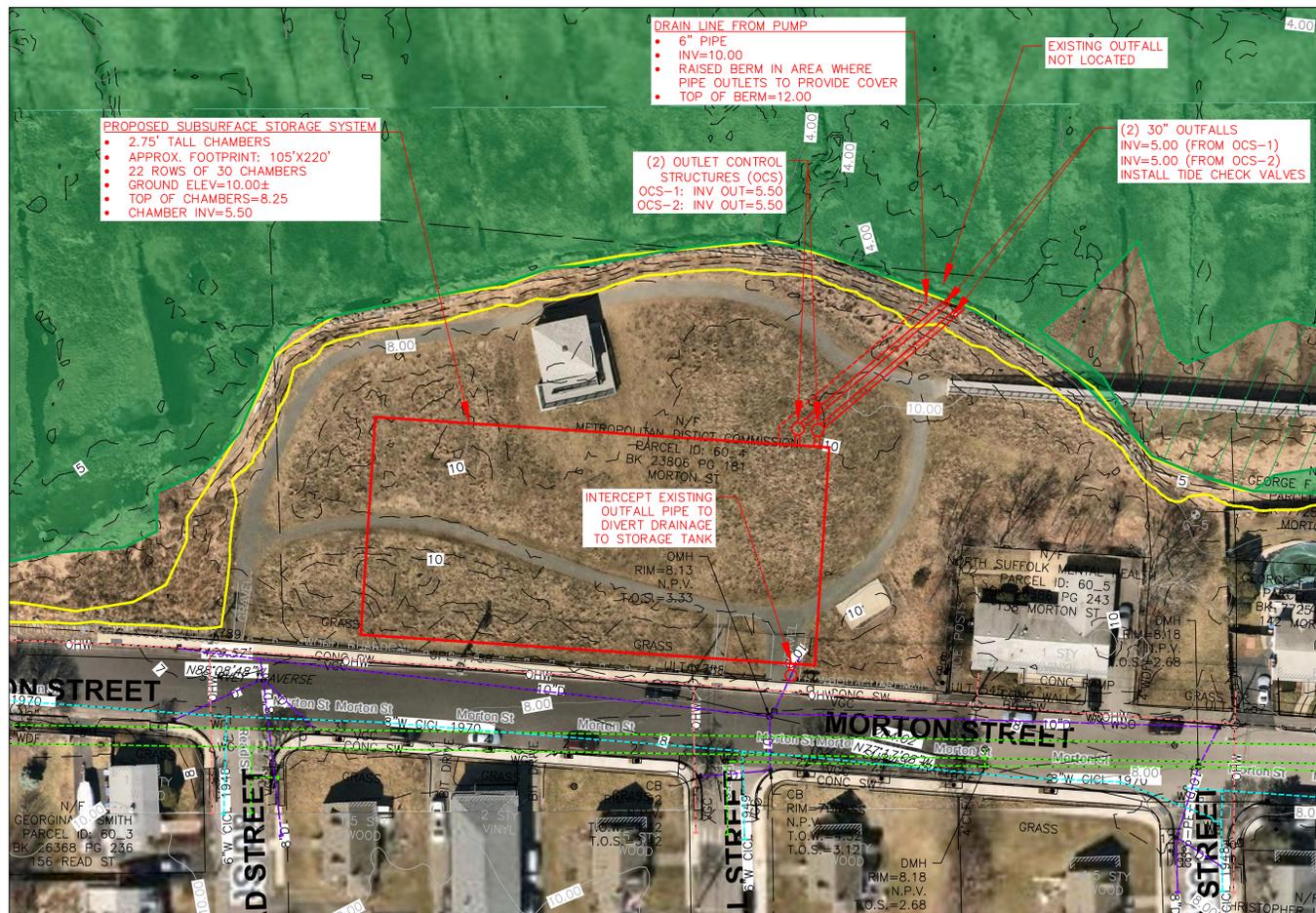
2050 PROJECTED 100-YEAR STORM RAINFALL DATA DERIVED FROM MASSDEP NOAA14-PLUS - SUMMARY OF TECHNICAL REVIEW MEMORANDUM, DATED NOVEMBER 15, 2022. THE INTENSITY FOR THIS STORM WAS INTERPOLATED FROM 2030 AND 2070 PROJECTED RAINFALL INTENSITIES.

NOT FOR CONSTRUCTION

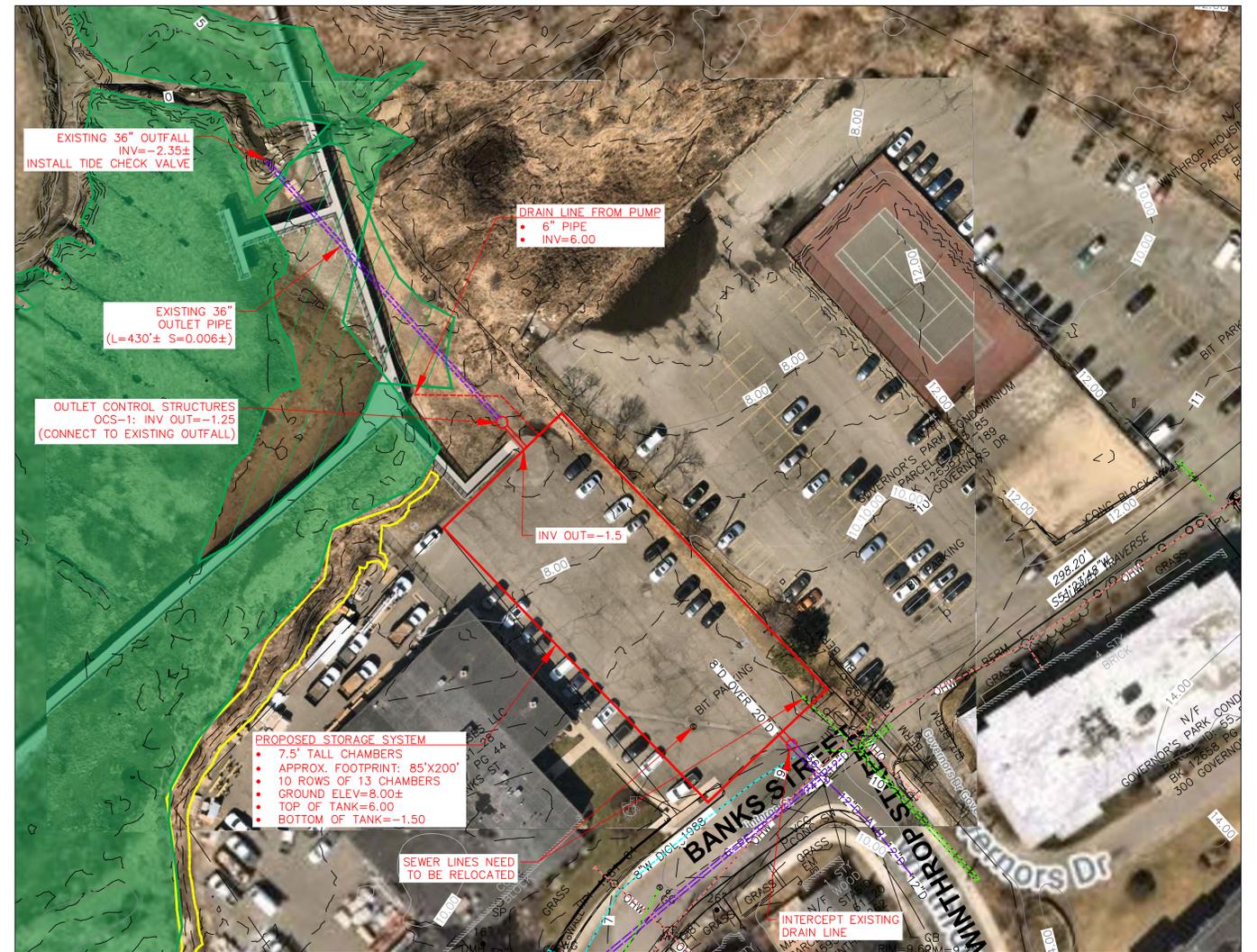
DATE	REVISIONS
DRAINAGE AREAS & STORMWATER SYSTEM SIZING	
STREET RESILIENCY PROJECT MORTON STREET, WINTHROP, MA	
PREPARED BY: Green International Affiliates, Inc. 100 Ames Pond Drive, Suite 200 Tewksbury, MA 01878	PREPARED FOR: WOODS HOLE GROUP 107 WATERHOUSE ROAD BOURNE, MA 02532
SCALE 1" = 150'	PROJECT NO. 23078.0306
APPROVED:	DESIGNED BY: JM DRAWN BY: JM CHECKED BY: -
	FIGURE NO. 1



SUBSURFACE STORAGE SYSTEM #1 (SCM #1)
EDA-2, EDA-3, EDA-4



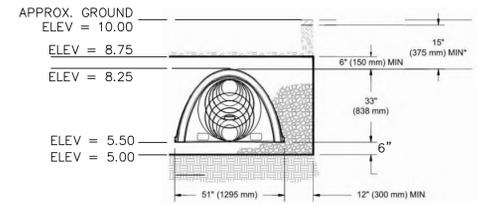
SUBSURFACE STORAGE SYSTEM #2 (SCM #2)
EDA-5



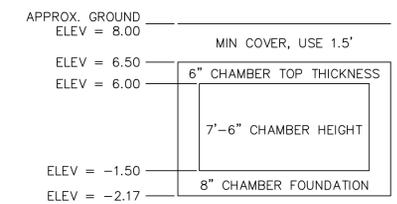
SUBSURFACE STORAGE SYSTEM #3 (SCM #3)
EDA-6

UTILITY LEGEND

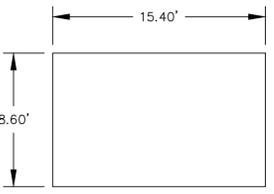
- EXISTING DRAIN PIPE
- EXISTING SEWER PIPE
- EXISTING OVERHEAD ELECTRICAL LINE
- EXISTING WATER PIPE
- PROPOSED DRAINAGE



SUBSURFACE STORAGE SYSTEMS #1 & #2 (CORRUGATED PLASTIC CHAMBERS) SECTION (NTS)



SUBSURFACE STORAGE SYSTEMS #3 (CONCRETE CHAMBERS) SECTION (NTS)



SINGLE CHAMBER PLAN VIEW

	Acronym	Elevation (ft NAVD88)			
		Present Day	2030 (1.29 ft SLR)	2050 (2.49 ft SLR)	2070 (4.29 ft SLR)
Annual Probabilistic Water Surface Elevation (WSE)	0.5% WSE	9.53	10.99	12.49	14.16
	1% WSE	9.3	10.6	12.2	14.1
	2% WSE	9.06	10.42	11.64	13.58
	10% WSE	8.24	9.59	10.78	12.76
	HAT**	6.82			
Highest Astronomical Tide	HAT**	6.82			
Mean Higher High Water	MHHW***	5.1	6.5	7.8	9.6
Mean High Water	MHW	4.6	6.1	7.4	9.3
Mean Tide Level	MTL	-0.3	1.4	2.6	4.4
North American Vertical Datum 1988	NAVD88	0	0	0	0
Mean Low Water	MLW	-5.1	-3.2	-2.3	-0.6
Mean Lower Low Water	MLLW	-5.4	-3.4	-2.5	-0.8
Tide Range from MLW to MHW	Tide Range	9.7	9.3	9.7	9.9

**Probabilistic WSE's were derived from the MC-FRM for north Boston Harbor (Bosma et al., 2021).
***Represents present day HAT at Boston Harbor Tide Gauge (Station 8443970) centered around 2008.
Present day tidal datums represent observations from BI-1 (downstream of Saratoga St bridge) from Nov-9 to Dec-21, 2020.

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REVISIONS	
DATE	REVISIONS
SUBSURFACE STORAGE SYSTEM CONCEPTUAL PLAN	
STREET RESILIENCY PROJECT	
MORTON STREET, WINTHROP, MA	
PREPARED BY:	PREPARED FOR:
Green International Affiliates, Inc. 100 Ames Pond Drive, Suite 200 Tewksbury, MA 01878	WOODS HOLE GROUP 107 WATERHOUSE ROAD BOURNE, MA 02532
SCALE 1" = 40'	DATE: 6/18/2024
DESIGNED BY: JM	PROJECT NO. 23078.0306
DRAWN BY: JM	FIGURE NO.
CHECKED BY: -	2

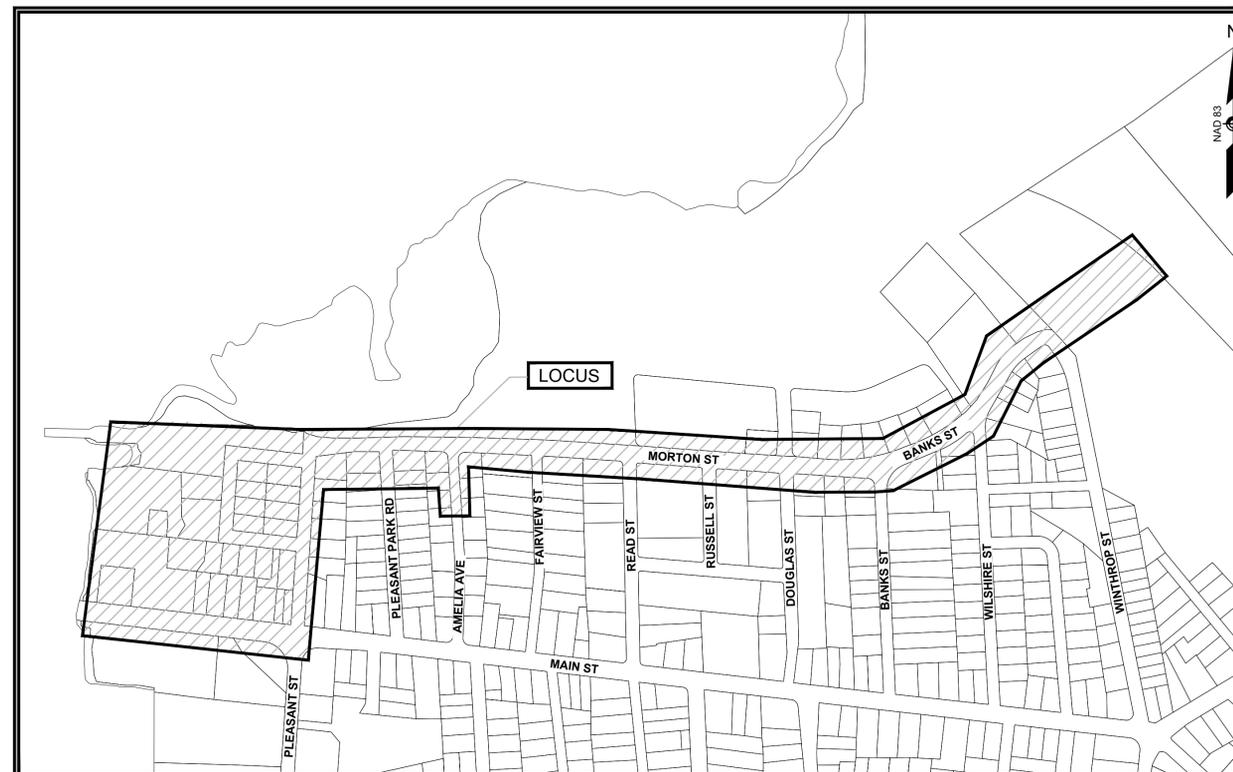


Appendix C. Alternatives Engineering – 30% Design

TOWN OF WINTHROP, MASSACHUSETTS

MORTON STREET RESILIENCY PROJECT

ALTERNATIVE 1



SCALE: 1" = 1000'

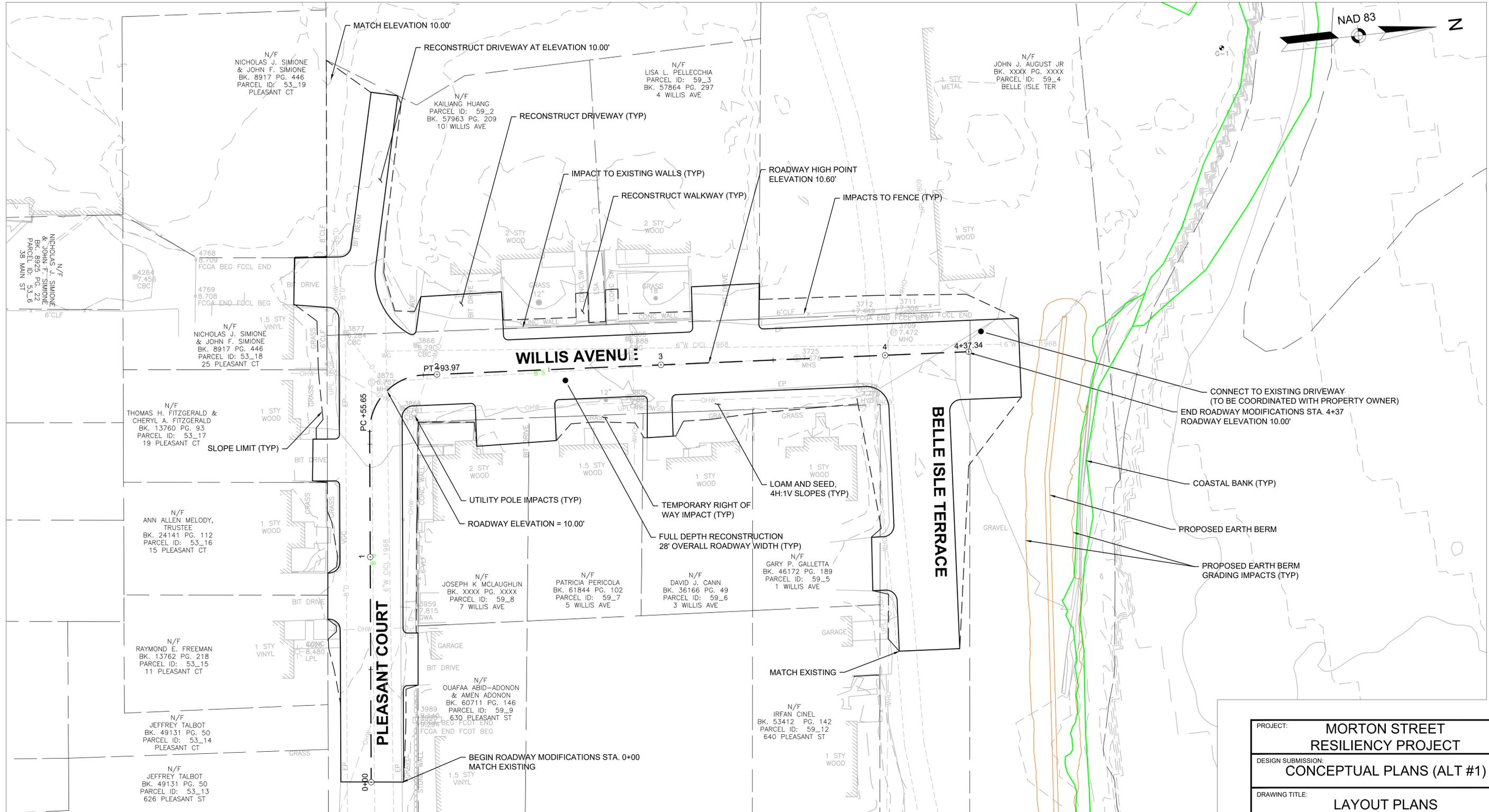
LOCATION PLAN

GENERAL NOTES

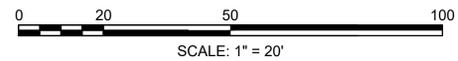
1. THE EXISTING CONDITIONS SHOWN ON THIS BASE MAP ARE THE RESULT OF AN ON-THE-GROUND INSTRUMENT SURVEY PERFORMED BETWEEN NOVEMBER 6, 2023 AND MARCH 12, 2024 BY GREEN INTERNATIONAL AFFILIATES, INC. (GREEN).
2. HORIZONTAL AND VERTICAL CONTROL WAS ESTABLISHED BY GREEN INTERNATIONAL AFFILIATES, INC. BETWEEN NOVEMBER 6, 2023 AND NOVEMBER 16, 2023. HORIZONTAL DATUM IS BASED ON THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM (MAINLAND) NAD83 (2011), 2010.00 EPOCH. VERTICAL DATUM IS NAVD88 (COMPUTED USING GEOID18).
3. THE RIGHT OF WAY LINES SHOWN HERE ARE RESULT OF GIS. PRIVATE PROPERTY LINES HAVE NOT BEEN SURVEYED AND SHOULD BE CONSIDERED APPROXIMATE.

PROJECT: MORTON STREET RESILIENCY PROJECT	
DESIGN SUBMISSION: CONCEPTUAL PLANS (ALT #1)	
DRAWING TITLE: TITLE SHEET	
PREPARED FOR: TOWN OF WINTHROP 45 PAULINE ST WINTHROP, MASSACHUSETTS	
PREPARED BY: GREEN INTERNATIONAL AFFILIATES, INC. Civil and Structural Engineers (978) 923-0400 Tewksbury, Massachusetts Greenintl.com	
SCALE: AS NOTED	DESIGNED BY: SS
DATE: 6/21/2024	DRAWN BY: SS
PROJECT NO. 23078	CHECKED BY: DV
SHEET NO. 1 OF 9	

NO.	DATE	REVISIONS



CONTINUED ON SHEET NO. 4



PROJECT: **MORTON STREET RESILIENCY PROJECT**

DESIGN SUBMISSION: **CONCEPTUAL PLANS (ALT #1)**

DRAWING TITLE: **LAYOUT PLANS**

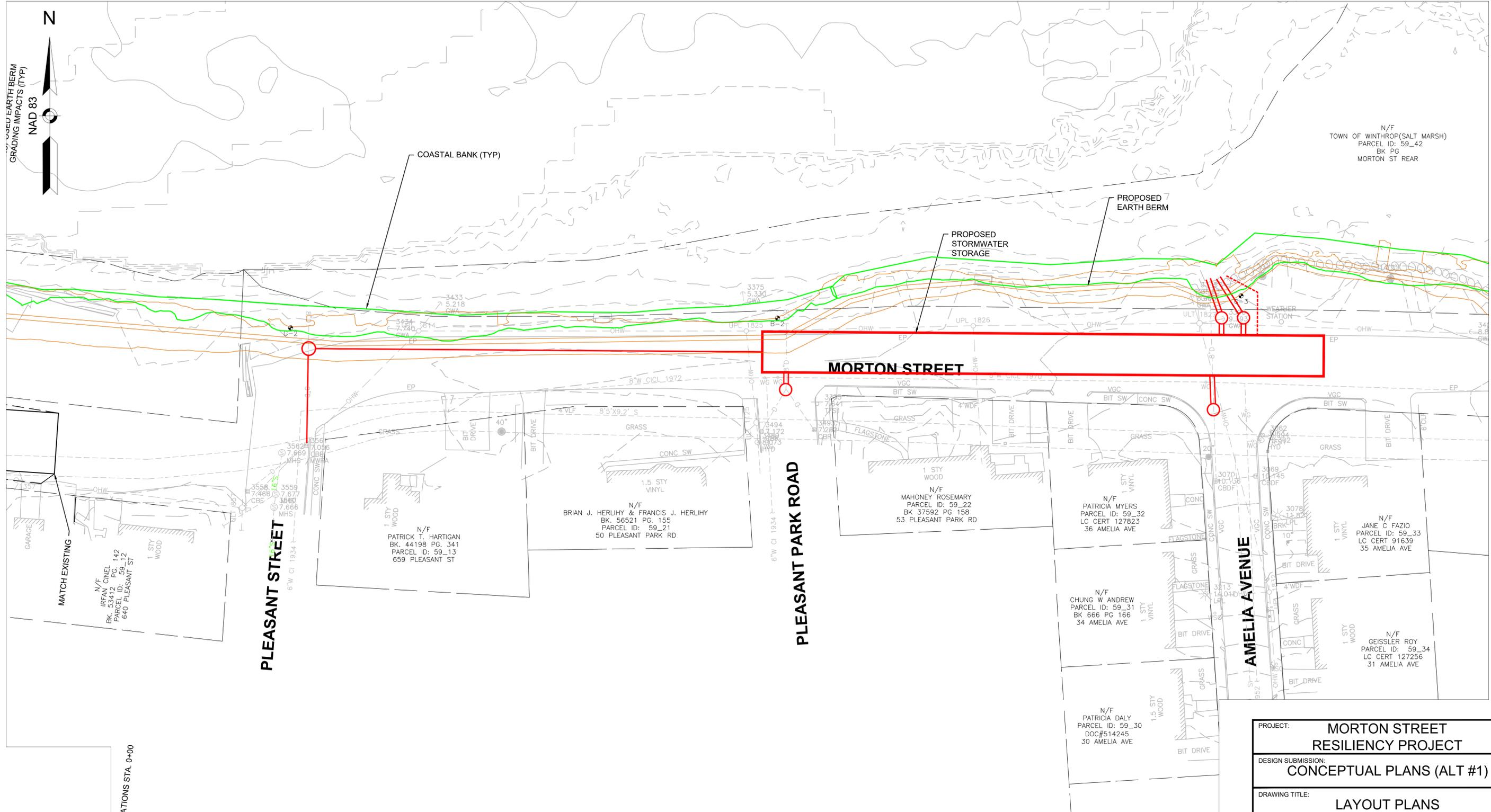
PREPARED FOR: **TOWN OF WINTHROP**

45 PAULINE ST
WINTHROP, MASSACHUSETTS

PREPARED BY:
GREEN INTERNATIONAL AFFILIATES, INC.
Civil and Structural Engineers (978) 923-0400
Tewksbury, Massachusetts GreenIntl.com

SCALE: AS NOTED	DESIGNED BY: SS	SHEET NO. 3 OF 9
DATE: 6/21/2024	DRAWN BY: SS	
PROJECT NO. 23078	CHECKED BY: DV	

NO.	DATE	REVISIONS



CONTINUED ON SHEET NO. 3

CONTINUED ON SHEET NO. 5

N/F
TOWN OF WINTHROP (SALT MARSH)
PARCEL ID: 59_42
BK PG
MORTON ST REAR

ATIONS STA. 0+00

PROJECT: **MORTON STREET RESILIENCY PROJECT**

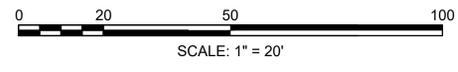
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DRAWING TITLE: **LAYOUT PLANS**

PREPARED FOR:
TOWN OF WINTHROP
45 PAULINE ST
WINTHROP, MASSACHUSETTS

PREPARED BY:
GREEN INTERNATIONAL AFFILIATES, INC.
Civil and Structural Engineers (978) 923-0400
Tewksbury, Massachusetts GreenIntl.com

SCALE: AS NOTED	DESIGNED BY: SS	SHEET NO. 4 OF 9
DATE: 6/21/2024	DRAWN BY: SS	
PROJECT NO. 23078	CHECKED BY: DV	



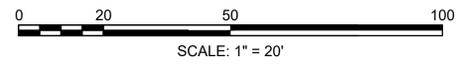
NO.	DATE	REVISIONS



CONTINUED ON
SHEET NO. 4

CONTINUED ON
SHEET NO. 6

PROJECT: MORTON STREET RESILIENCY PROJECT		
DESIGN SUBMISSION: CONCEPTUAL PLANS (ALT #1)		
DRAWING TITLE: LAYOUT PLANS		
PREPARED FOR: TOWN OF WINTHROP 45 PAULINE ST WINTHROP, MASSACHUSETTS		
PREPARED BY: GREEN INTERNATIONAL AFFILIATES, INC. Civil and Structural Engineers (978) 923-0400 Tewksbury, Massachusetts GreenIntl.com		
SCALE: AS NOTED	DESIGNED BY: SS	SHEET NO. 5 OF 9
DATE: 6/21/2024	DRAWN BY: SS	
PROJECT NO. 23078	CHECKED BY: DV	

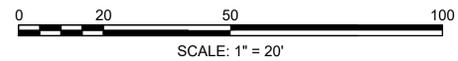
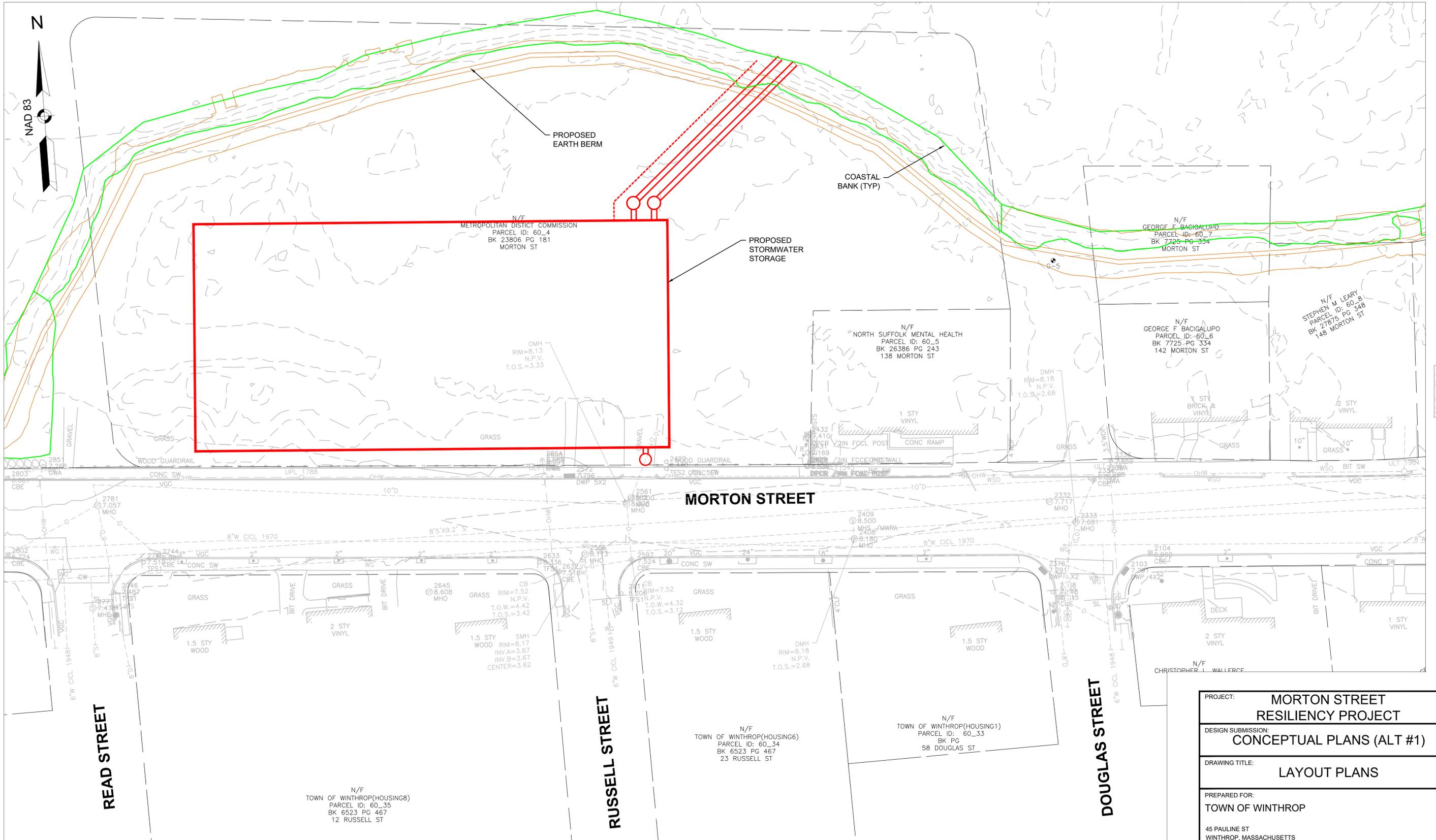


NO.	DATE	REVISIONS



CONTINUED ON SHEET NO. 5

CONTINUED ON SHEET NO. 7



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DESIGN SUBMISSION: **CONCEPTUAL PLANS (ALT #1)**

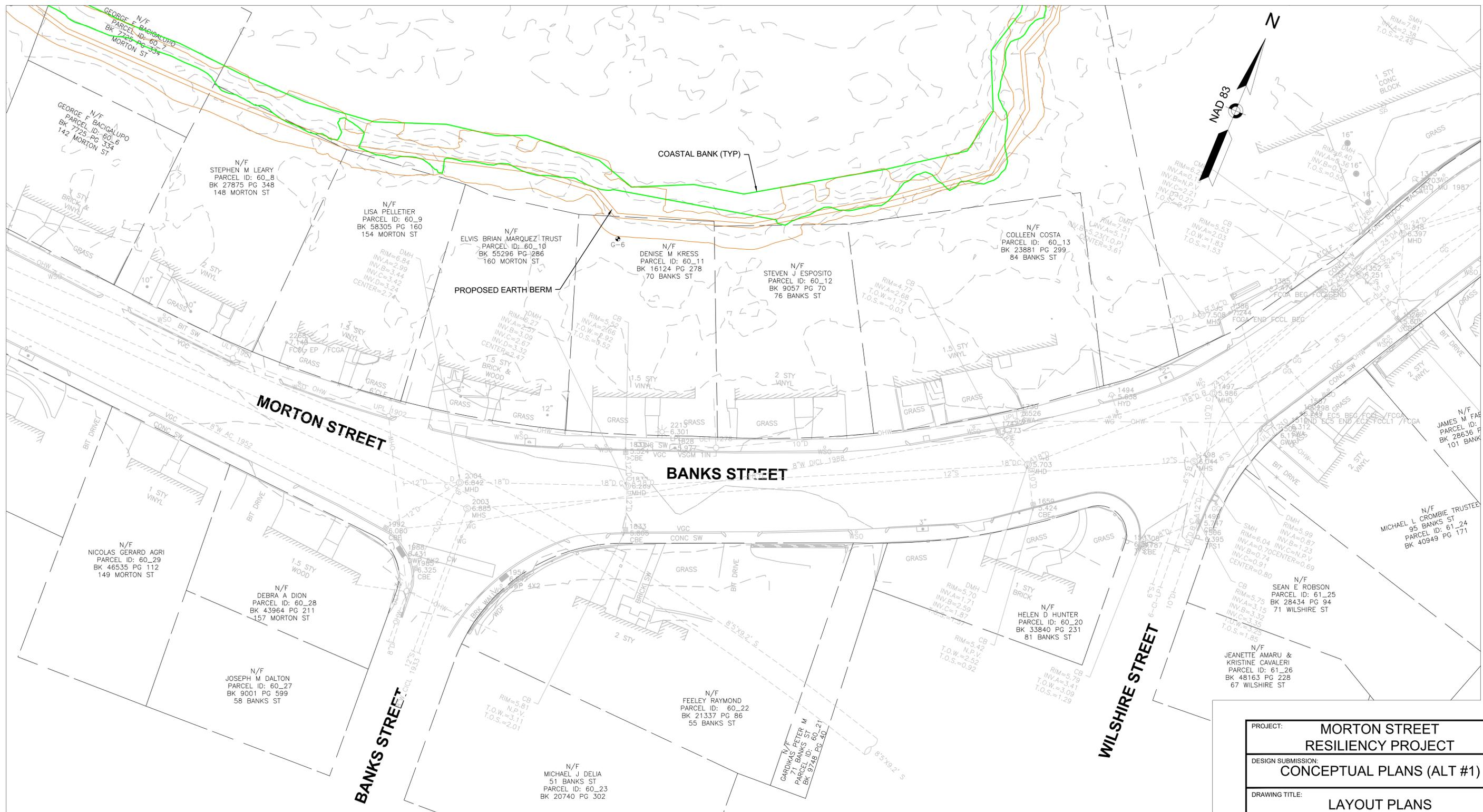
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PREPARED FOR:
TOWN OF WINTHROP
45 PAULINE ST
WINTHROP, MASSACHUSETTS

PREPARED BY:
GREEN INTERNATIONAL AFFILIATES, INC.
Civil and Structural Engineers (978) 923-0400
Tewksbury, Massachusetts GreenIntf.com

SCALE: AS NOTED	DESIGNER: SS	SHEET NO. 6 OF 9
DATE: 6/21/2024	DRAWN BY: SS	
PROJECT NO. 23078	CHECKED BY: DV	

NO.	DATE	REVISIONS



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CONTINUED ON SHEET NO. 8

PROJECT: **MORTON STREET RESILIENCY PROJECT**

DESIGN SUBMISSION: **CONCEPTUAL PLANS (ALT #1)**

DRAWING TITLE: **LAYOUT PLANS**

PREPARED FOR: **TOWN OF WINTHROP**
 45 PAULINE ST
 WINTHROP, MASSACHUSETTS

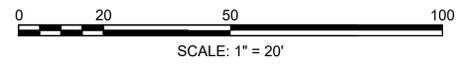
PREPARED BY: **GREEN INTERNATIONAL AFFILIATES, INC.**
 Civil and Structural Engineers (978) 923-0400
 Tewksbury, Massachusetts GreenIntl.com

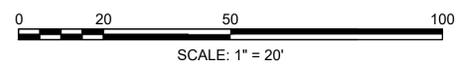
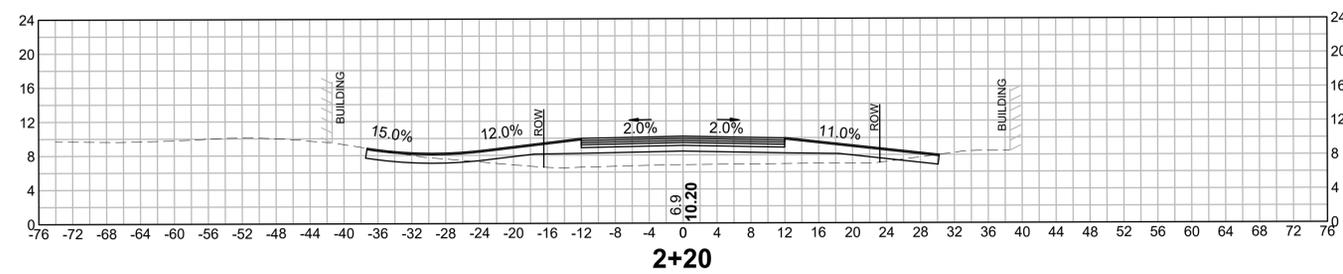
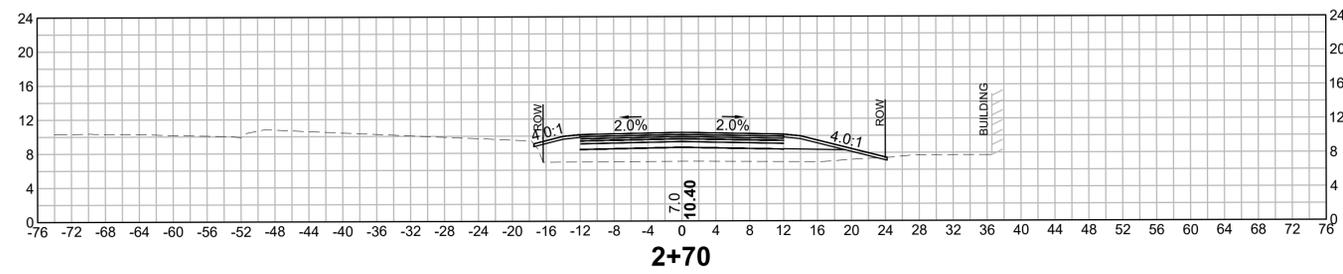
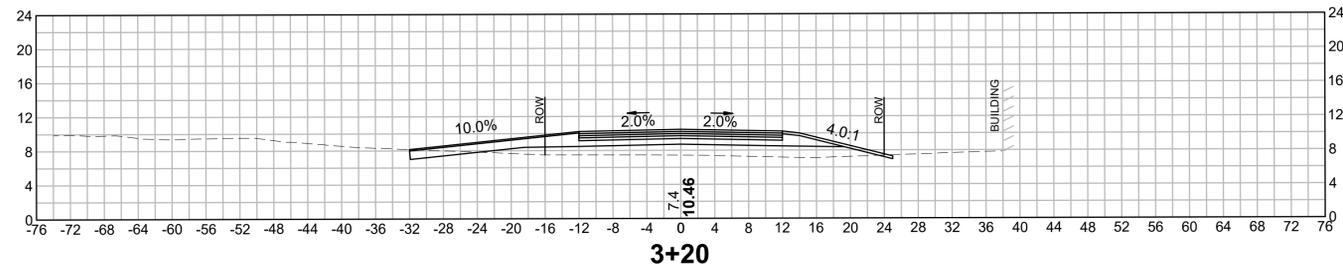
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 DATE: 6/21/2024
 PROJECT NO. 23078

DESIGNED BY: SS
 DRAWN BY: SS
 CHECKED BY: DV

SHEET NO. **7** OF **9**

NO.	DATE	REVISIONS





PROJECT: **MORTON STREET
RESILIENCY PROJECT**

DESIGN SUBMISSION: **CONCEPTUAL PLANS (ALT #1)**

DRAWING TITLE: **CRITICAL CROSS SECTIONS**

PREPARED FOR:
TOWN OF WINTHROP

45 PAULINE ST
WINTHROP, MASSACHUSETTS

PREPARED BY:
GREEN INTERNATIONAL AFFILIATES, INC.
Civil and Structural Engineers (978) 923-0400
Tewksbury, Massachusetts GreenIntl.com

SCALE: AS NOTED

DESIGNED BY: SS

DATE: 6/21/2024

DRAWN BY: SS

PROJECT NO. 23078

CHECKED BY: DV

SHEET NO.

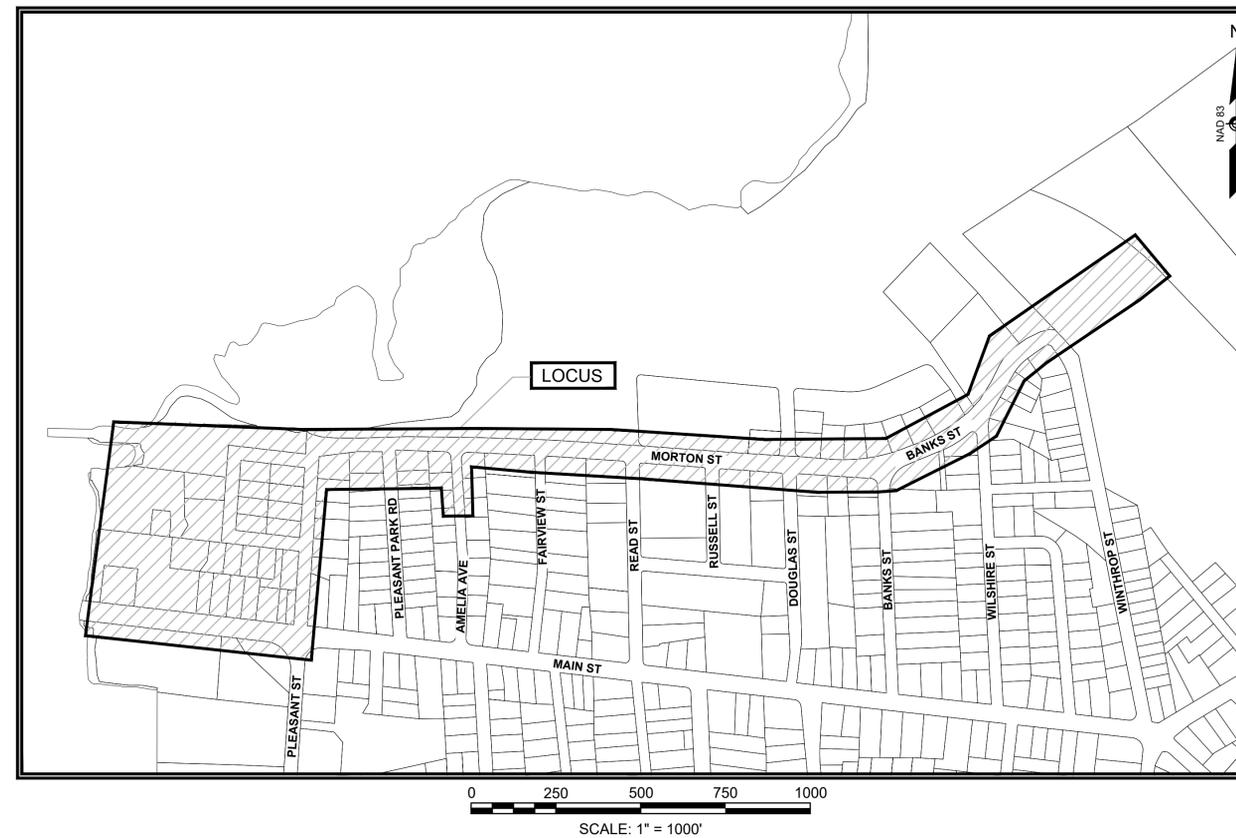
9 OF **9**

NO.	DATE	REVISIONS

TOWN OF WINTHROP, MASSACHUSETTS

MORTON STREET RESILIENCY PROJECT

ALTERNATIVE 2



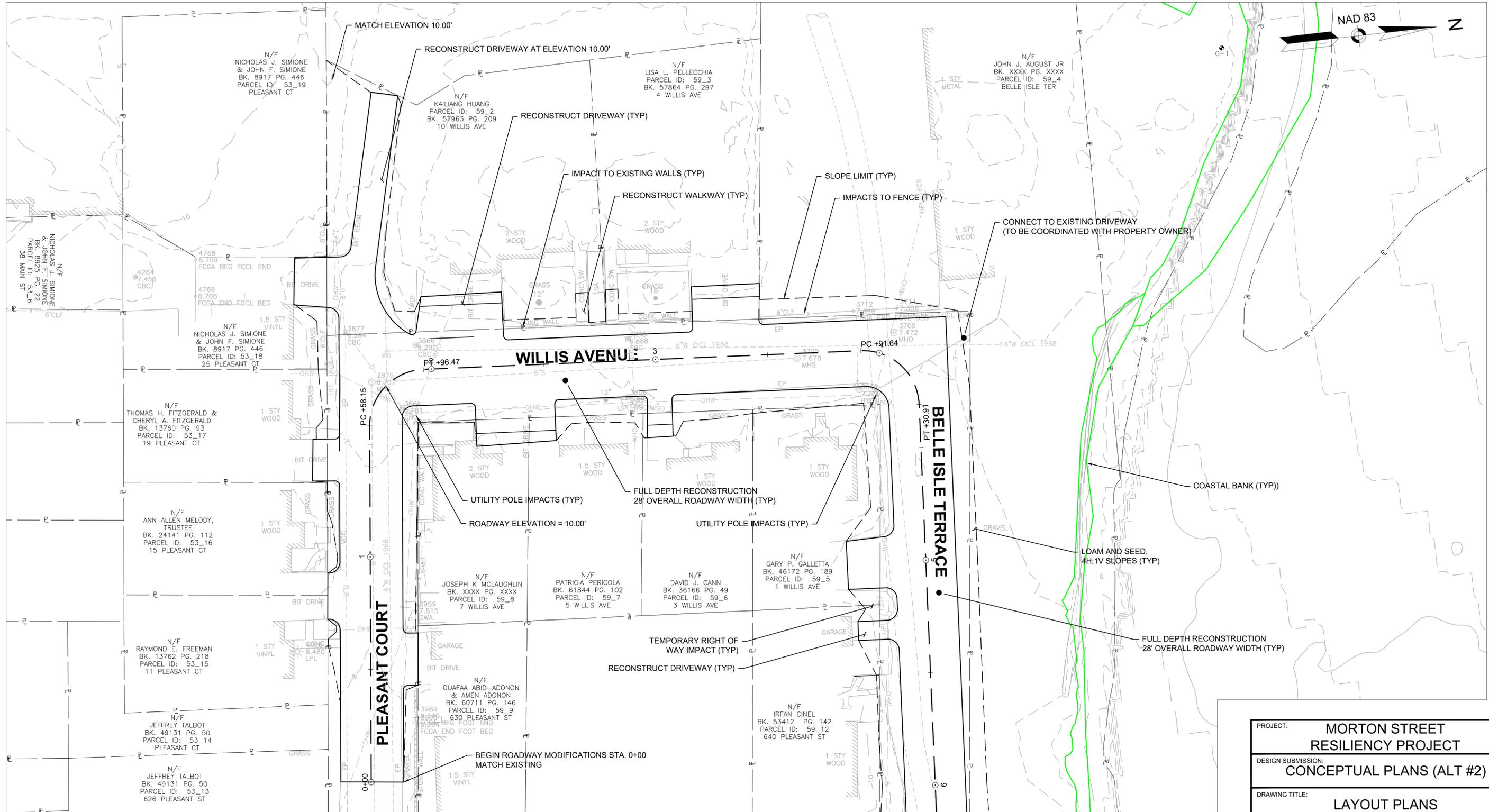
SCALE: 1" = 1000'

LOCATION PLAN

GENERAL NOTES

1. THE EXISTING CONDITIONS SHOWN ON THIS BASE MAP ARE THE RESULT OF AN ON-THE-GROUND INSTRUMENT SURVEY PERFORMED BETWEEN NOVEMBER 6, 2023 AND MARCH 12, 2024 BY GREEN INTERNATIONAL AFFILIATES, INC. (GREEN).
2. HORIZONTAL AND VERTICAL CONTROL WAS ESTABLISHED BY GREEN INTERNATIONAL AFFILIATES, INC. BETWEEN NOVEMBER 6, 2023 AND NOVEMBER 16, 2023. HORIZONTAL DATUM IS BASED ON THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM (MAINLAND) NAD83 (2011), 2010.00 EPOCH. VERTICAL DATUM IS NAVD88 (COMPUTED USING GEOID18).
3. THE RIGHT OF WAY LINES SHOWN HERE ARE RESULT OF GIS. PRIVATE PROPERTY LINES HAVE NOT BEEN SURVEYED AND SHOULD BE CONSIDERED APPROXIMATE.

PROJECT: MORTON STREET RESILIENCY PROJECT	
DESIGN SUBMISSION: CONCEPTUAL PLANS (ALT #2)	
DRAWING TITLE: TITLE SHEET	
PREPARED FOR: TOWN OF WINTHROP	
45 PAULINE ST WINTHROP, MASSACHUSETTS	
PREPARED BY: GREEN INTERNATIONAL AFFILIATES, INC. Civil and Structural Engineers (978) 923-0400 Tewksbury, Massachusetts GreenIntl.com	
SCALE: AS NOTED	DESIGNED BY: SS
DATE: 6/21/2024	DRAWN BY: SS
PROJECT NO. 23078	CHECKED BY: DV
NO.	DATE
	REVISIONS
SHEET NO. 1 OF 10	



PROJECT: **MORTON STREET RESILIENCY PROJECT**

DESIGN SUBMISSION: **CONCEPTUAL PLANS (ALT #2)**

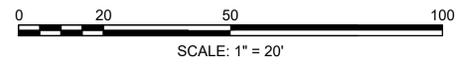
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PREPARED FOR:
TOWN OF WINTHROP
 45 PAULINE ST
 WINTHROP, MASSACHUSETTS

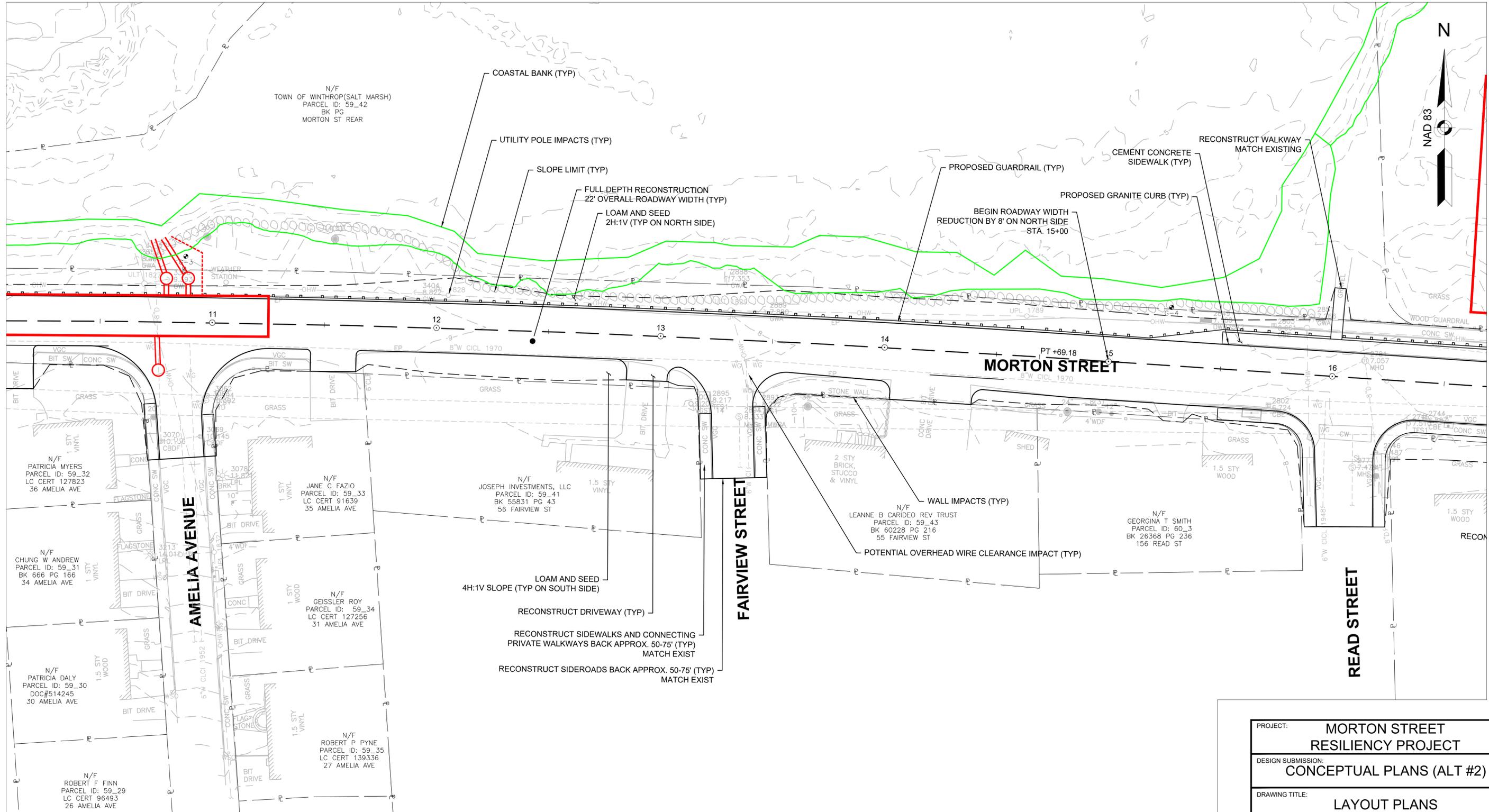
PREPARED BY:
GREEN INTERNATIONAL AFFILIATES, INC.
 Civil and Structural Engineers (978) 923-0400
 Tewksbury, Massachusetts GreenIntl.com

SCALE: AS NOTED	DESIGNED BY: SS	SHEET NO. 3 OF 10
DATE: 6/21/2024	DRAWN BY: SS	
PROJECT NO. 23078	CHECKED BY: DV	

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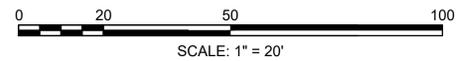


NO.	DATE	REVISIONS



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PROJECT: **MORTON STREET RESILIENCY PROJECT**

DESIGN SUBMISSION: **CONCEPTUAL PLANS (ALT #2)**

DRAWING TITLE: **LAYOUT PLANS**

PREPARED FOR: **TOWN OF WINTHROP**

45 PAULINE ST
WINTHROP, MASSACHUSETTS

PREPARED BY: **GREEN INTERNATIONAL AFFILIATES, INC.**
Civil and Structural Engineers (978) 923-0400
Tewksbury, Massachusetts GreenIntl.com

SCALE: AS NOTED DESIGNED BY: SS

DATE: 6/21/2024 DRAWN BY: SS SHEET NO. 5 OF 10

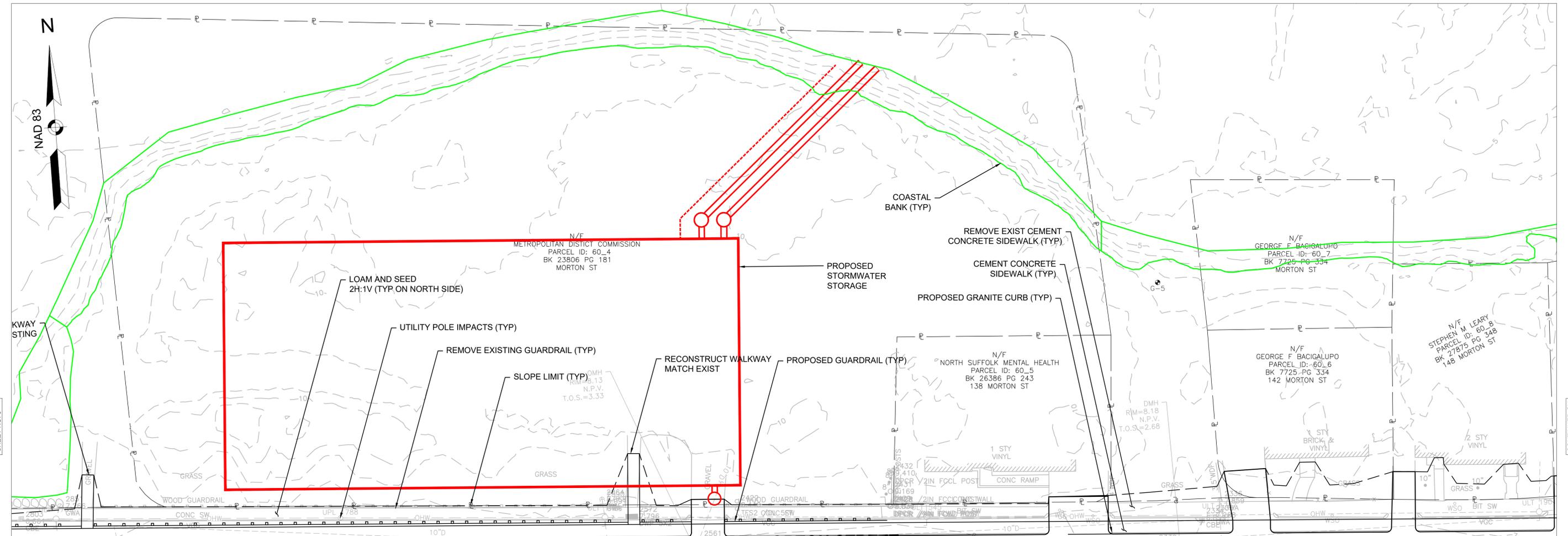
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NO.	DATE	REVISIONS

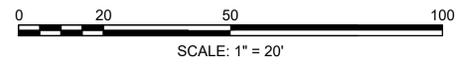
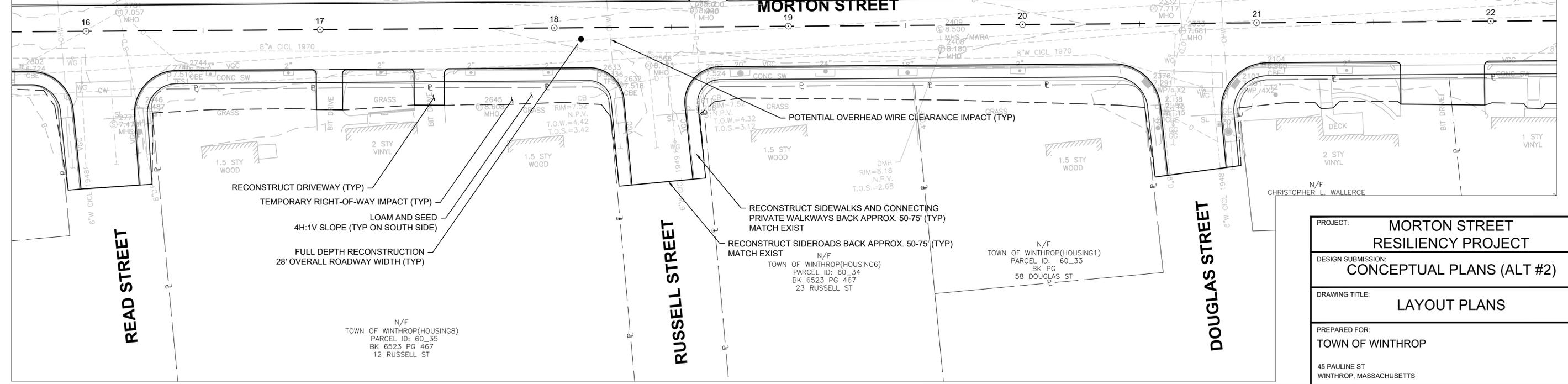


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CONTINUED ON SHEET NO. 7



MORTON STREET



PROJECT: **MORTON STREET RESILIENCY PROJECT**

DESIGN SUBMISSION: **CONCEPTUAL PLANS (ALT #2)**

DRAWING TITLE: **LAYOUT PLANS**

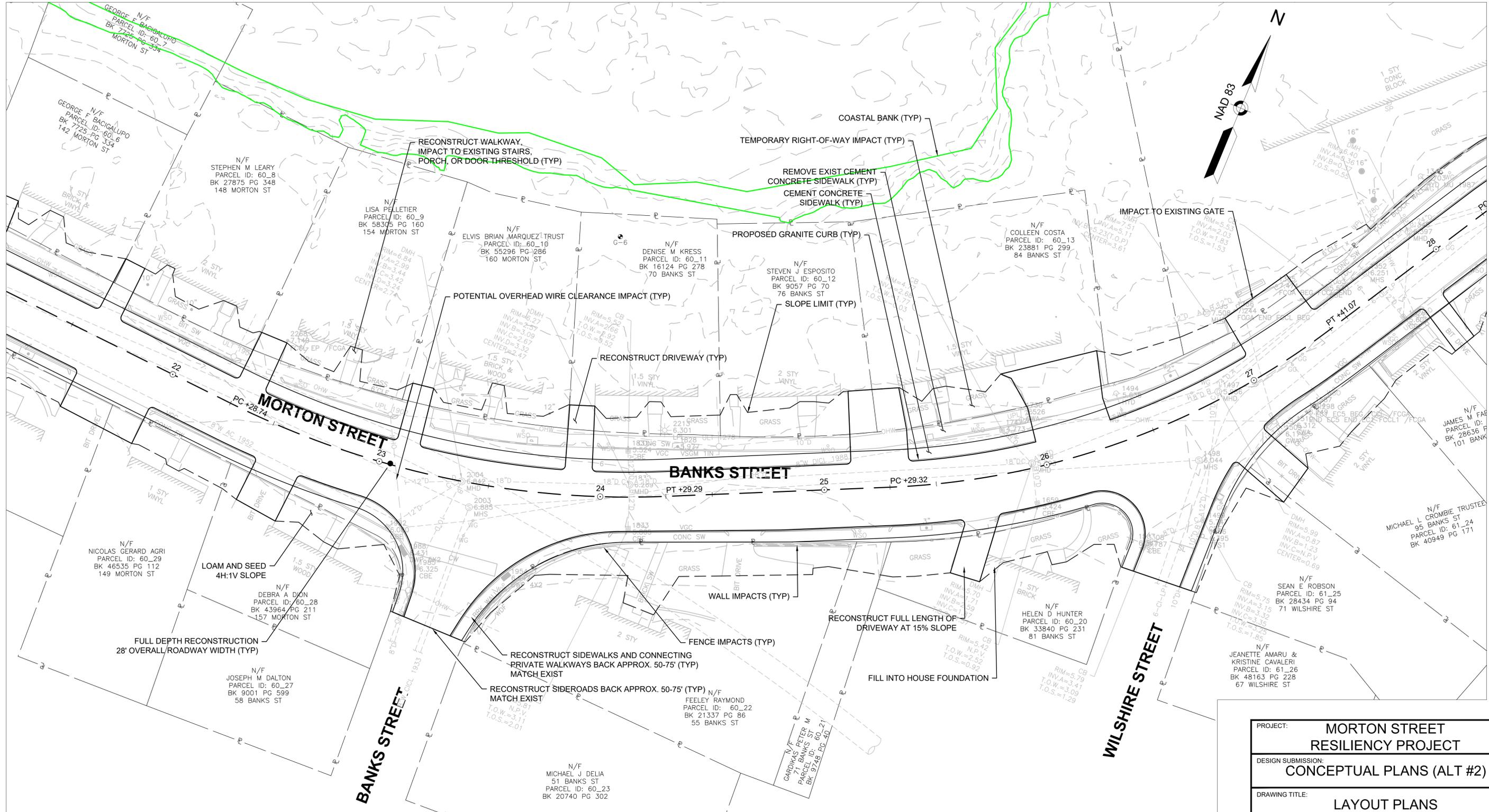
PREPARED FOR: **TOWN OF WINTHROP**

45 PAULINE ST
WINTHROP, MASSACHUSETTS

PREPARED BY:
 **GREEN INTERNATIONAL AFFILIATES, INC.**
 Civil and Structural Engineers (978) 923-0400
 Tewksbury, Massachusetts GreenIntf.com

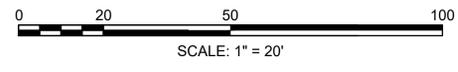
SCALE: AS NOTED	DESIGNED BY: SS	SHEET NO. 6 OF 10
DATE: 6/21/2024	DRAWN BY: SS	
PROJECT NO. 23078	CHECKED BY: DV	

NO.	DATE	REVISIONS



CONTINUED ON SHEET NO. 6

CONTINUED ON SHEET NO. 8



PROJECT: **MORTON STREET RESILIENCY PROJECT**

DESIGN SUBMISSION: **CONCEPTUAL PLANS (ALT #2)**

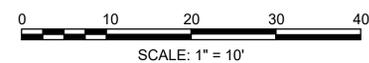
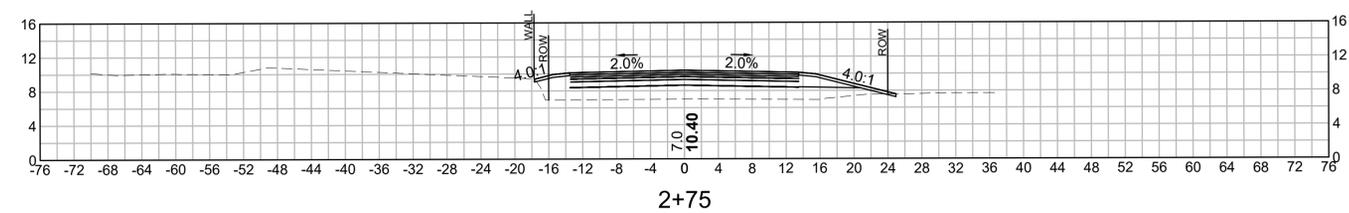
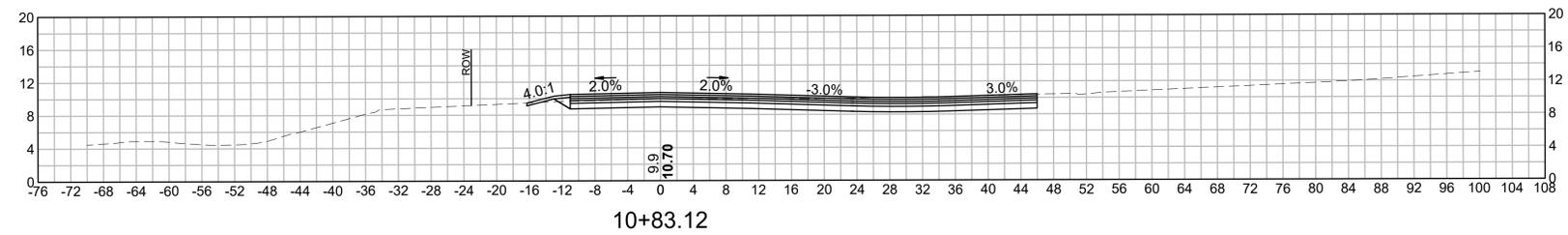
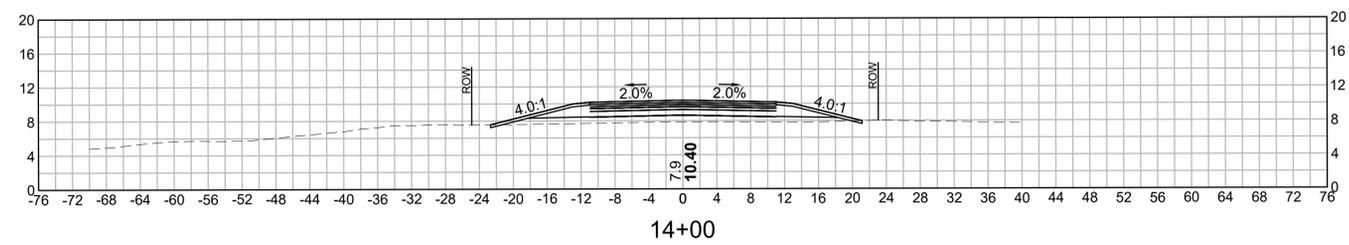
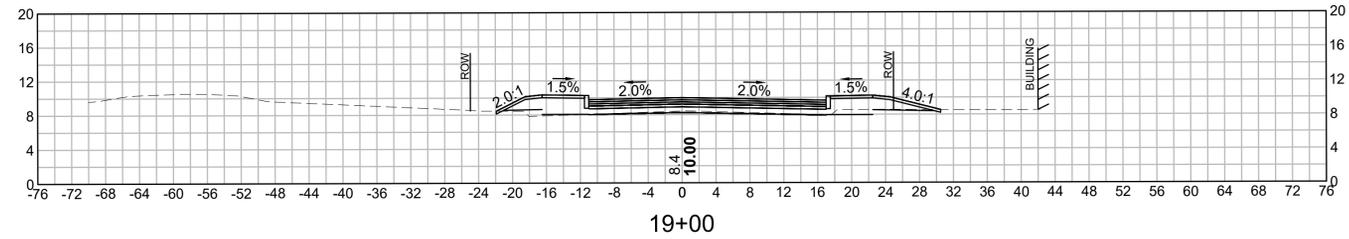
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PREPARED FOR:
TOWN OF WINTHROP
 45 PAULINE ST
 WINTHROP, MASSACHUSETTS

PREPARED BY:
 **GREEN INTERNATIONAL AFFILIATES, INC.**
 Civil and Structural Engineers (978) 923-0400
 Tewksbury, Massachusetts GreenIntl.com

SCALE: AS NOTED	DESIGNED BY: SS	SHEET NO. 7 OF 10
DATE: 6/21/2024	DRAWN BY: SS	
PROJECT NO. 23078	CHECKED BY: DV	

NO.	DATE	REVISIONS



PROJECT: **MORTON STREET
RESILIENCY PROJECT**

DESIGN SUBMISSION: **CONCEPTUAL PLANS (ALT #2)**

DRAWING TITLE: **CRITICAL CROSS SECTIONS**

PREPARED FOR:
TOWN OF WINTHROP

45 PAULINE ST
WINTHROP, MASSACHUSETTS

PREPARED BY:
GREEN INTERNATIONAL AFFILIATES, INC.
Civil and Structural Engineers (978) 923-0400
Tewksbury, Massachusetts GreenIntf.com

SCALE: AS NOTED

DESIGNED BY: SS

DATE: 6/21/2024

DRAWN BY: SS

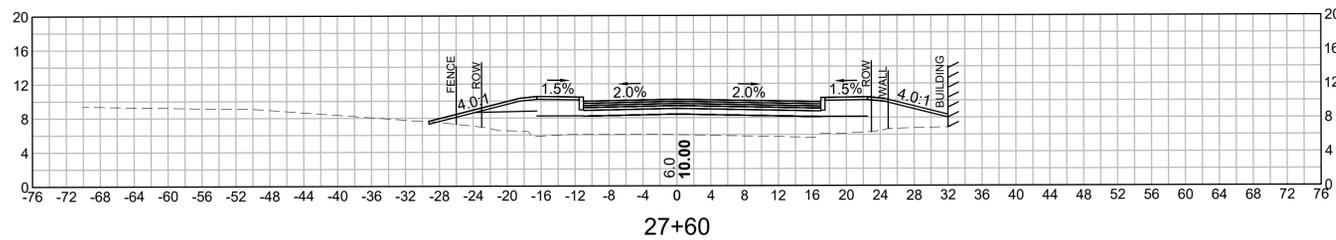
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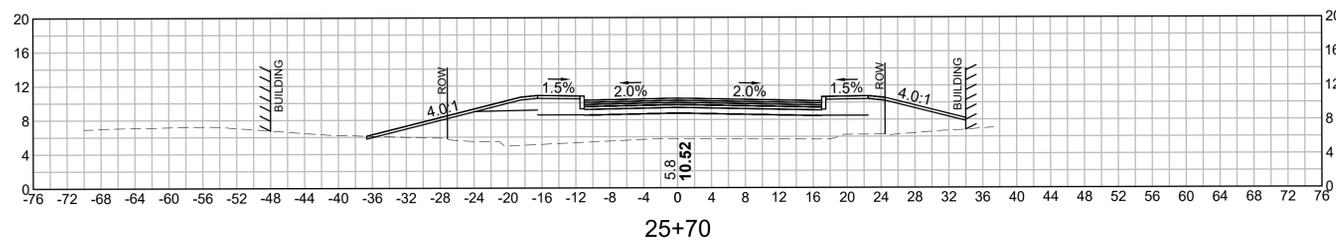
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9 OF **10**

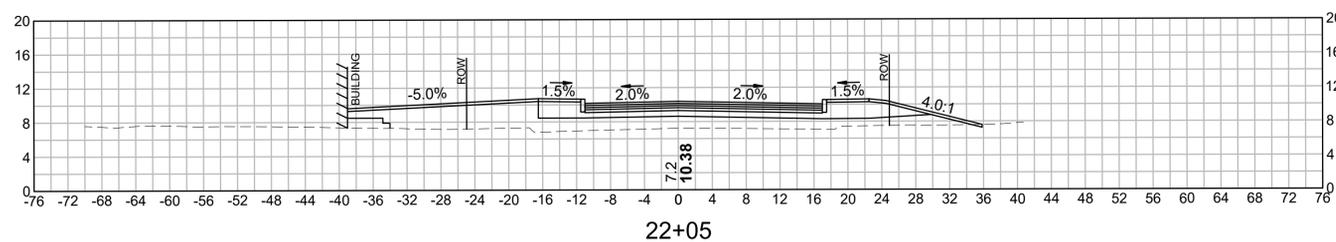
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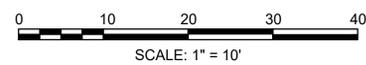
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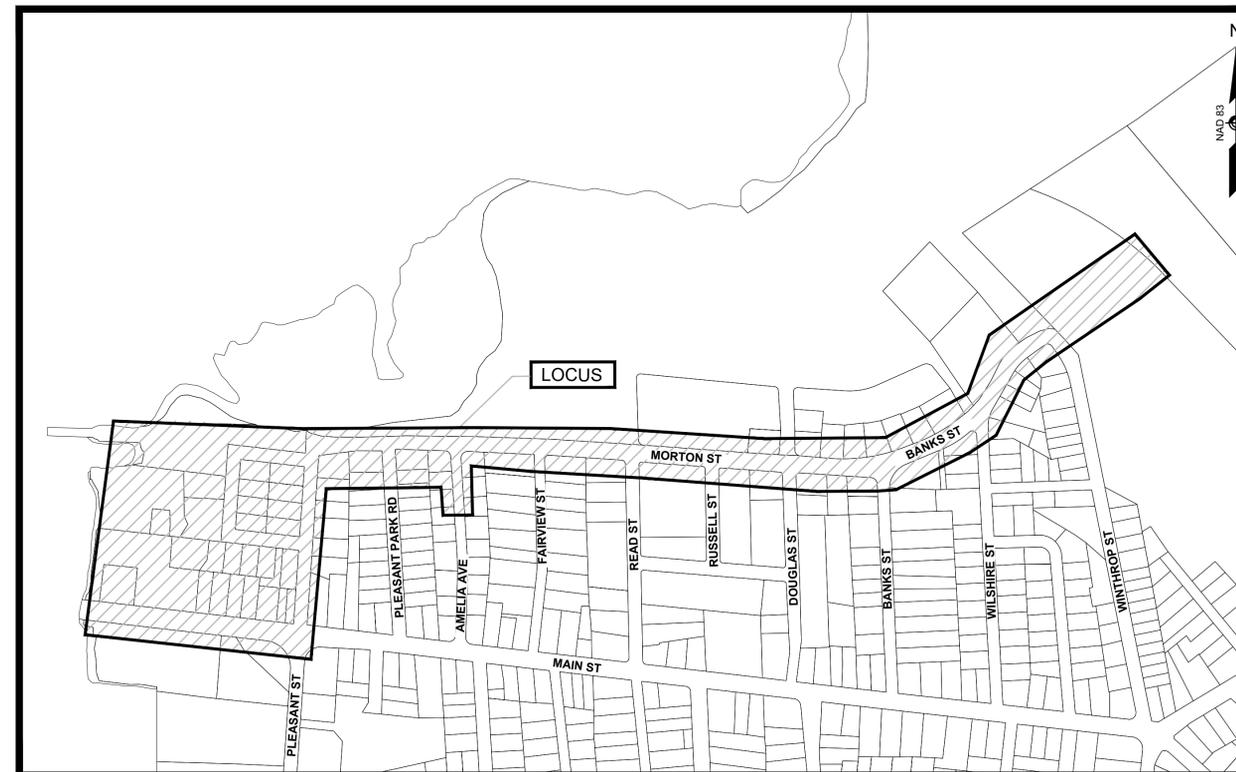


PROJECT: MORTON STREET RESILIENCY PROJECT		
DESIGN SUBMISSION: CONCEPTUAL PLANS (ALT #2)		
DRAWING TITLE: CRITICAL CROSS SECTIONS		
PREPARED FOR: TOWN OF WINTHROP		
45 PAULINE ST WINTHROP, MASSACHUSETTS		
PREPARED BY: GREEN INTERNATIONAL AFFILIATES, INC. Civil and Structural Engineers (978) 923-0400 Tewksbury, Massachusetts GreenIntl.com		
SCALE: AS NOTED	DESIGNED BY: SS	SHEET NO. 10 OF 10
DATE: 6/21/2024	DRAWN BY: SS	
PROJECT NO. 23078	CHECKED BY: DV	
NO.	DATE	REVISIONS

TOWN OF WINTHROP, MASSACHUSETTS

MORTON STREET RESILIENCY PROJECT

ALTERNATIVE 3



SCALE: 1" = 1000'
LOCATION PLAN

GENERAL NOTES

1. THE EXISTING CONDITIONS SHOWN ON THIS BASE MAP ARE THE RESULT OF AN ON-THE-GROUND INSTRUMENT SURVEY PERFORMED BETWEEN NOVEMBER 6, 2023 AND MARCH 12, 2024 BY GREEN INTERNATIONAL AFFILIATES, INC. (GREEN).
2. HORIZONTAL AND VERTICAL CONTROL WAS ESTABLISHED BY GREEN INTERNATIONAL AFFILIATES, INC. BETWEEN NOVEMBER 6, 2023 AND NOVEMBER 16, 2023. HORIZONTAL DATUM IS BASED ON THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM (MAINLAND) NAD83 (2011), 2010.00 EPOCH. VERTICAL DATUM IS NAVD88 (COMPUTED USING GEOID18).
3. THE RIGHT OF WAY LINES SHOWN HERE ARE RESULT OF GIS. PRIVATE PROPERTY LINES HAVE NOT BEEN SURVEYED AND SHOULD BE CONSIDERED APPROXIMATE.

PROJECT: MORTON STREET RESILIENCY PROJECT	
DESIGN SUBMISSION: CONCEPTUAL PLANS (ALT #3)	
DRAWING TITLE: TITLE SHEET	
PREPARED FOR: TOWN OF WINTHROP	
45 PAULINE ST WINTHROP, MASSACHUSETTS	
PREPARED BY: GREEN INTERNATIONAL AFFILIATES, INC. Civil and Structural Engineers (978) 923-0400 Tewksbury, Massachusetts GreenInf.com	
SCALE: AS NOTED	DESIGNED BY: SS
DATE: 6/21/2024	DRAWN BY: SS
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SHEET NO. 1 OF 11	

NO.	DATE	REVISIONS

ABBREVIATIONS

GENERAL	
AADT	ANNUAL AVERAGE DAILY TRAFFIC
ABAN	ABANDON
ADJ	ADJUST
APPROX.	APPROXIMATE
A.C.	ASPHALT CONCRETE
ACCM PIPE	ASPHALT COATED CORRUGATED METAL PIPE
BIT.	BITUMINOUS
BC	BOTTOM OF CURB
BD.	BOUND
BL	BASELINE
BLDG	BUILDING
BM	BENCHMARK
BO	BY OTHERS
BOS	BOTTOM OF SLOPE
BR.	BRIDGE
CB	CATCH BASIN
CBCI	CATCH BASIN WITH CURB INLET
CBFC	CATCH BASIN WITH FRAME AND COVER
CC	CEMENT CONCRETE
CCM	CEMENT CONCRETE MASONRY
CEM	CEMENT
CI	CURB INLET
CIP	CAST IRON PIPE
CIT	CHANGE IN TYPE
CLF	CHAIN LINK FENCE
CL	CENTERLINE
CMP	CORRUGATED METAL PIPE
CSP	CORRUGATED STEEL PIPE
CO.	COUNTY
CONC	CONCRETE
CONT	CONTINUOUS
CONST	CONSTRUCTION
CR GR	CROWN GRADE
CS	COPPER SERVICE LINE
CTE	CONNECT TO EXISTING
DGCB	DOUBLE GRATE CATCH BASIN
DHV	DESIGN HOURLY VOLUME
DI	DROP INLET
DIA	DIAMETER
DIP	DUCTILE IRON PIPE
DSMH	DEEP SUMP MANHOLE
DW	STEADY DON'T WALK - PORTLAND ORANGE
DWY	DRIVEWAY
ELEV (or EL.)	ELEVATION
EMB	EMBANKMENT
EOP	EDGE OF PAVEMENT
EXIST (or EX)	EXISTING
EXC	EXCAVATION
F&C	FRAME AND COVER
F&G	FRAME AND GRATE
FDN.	FOUNDATION
FLDSTN	FIELDSTONE
GAR	GARAGE
GD	GROUND
GG	GAS GATE
GI	GUTTER INLET
GIP	GALVANIZED IRON PIPE
GRAN	GRANITE
GRAV	GRAVEL
GRD	GUARD
HDW	HEADWALL
HMA	HOT MIX ASPHALT
HOR	HORIZONTAL
HYD	HYDRANT
INV	INVERT
JCT	JUNCTION
L	LENGTH OF CURVE
LB	LEACH BASIN
LP	LIGHT POLE
LT	LEFT
MAX	MAXIMUM
MB	MAILBOX
MH	MANHOLE
MHB	MASSACHUSETTS HIGHWAY BOUND
MIN	MINIMUM
NIC	NOT IN CONTRACT
NO.	NUMBER
PC	POINT OF CURVATURE
PCC	POINT OF COMPOUND CURVATURE
P.G.L.	PROFILE GRADE LINE
PI	POINT OF INTERSECTION
POC	POINT ON CURVE
POT	POINT ON TANGENT

ABBREVIATIONS (cont.)

GENERAL	
PRC	POINT OF REVERSE CURVATURE
PROJ	PROJECT
PROP	PROPOSED
PSB	PLANTABLE SOIL BORROW
PT	POINT OF TANGENCY
PVC	POINT OF VERTICAL CURVATURE
PVI	POINT OF VERTICAL INTERSECTION
PVT	POINT OF VERTICAL TANGENCY
PVMT	PAVEMENT
PWW	PAVED WATER WAY
R	RADIUS OF CURVATURE
R&D	REMOVE AND DISPOSE
RCP	REINFORCED CONCRETE PIPE
RD	ROAD
RMD	REMODEL
RDWY	ROADWAY
REM	REMOVE
RET	RETAIN
RET WALL	RETAINING WALL
ROW	RIGHT OF WAY
RR	RAILROAD
R&R	REMOVE AND RESET
R&S	REMOVE AND STACK
RT	RIGHT
SB	STONE BOUND
SHLD	SHOULDER
SMH	SEWER MANHOLE
ST	STREET
STA	STATION
SSD	STOPPING SIGHT DISTANCE
SHLO	STATE HIGHWAY LAYOUT LINE
SW	SIDEWALK
T	TANGENT DISTANCE OF CURVE/TRUCK %
TAN	TANGENT
TEMP	TEMPORARY
TC	TOP OF CURB
TOS	TOP OF SLOPE
TYP	TYPICAL
UP	UTILITY POLE
VAR	VARIES
VERT	VERTICAL
VC	VERTICAL CURVE
WCR	WHEEL CHAIR RAMP
WG	WATER GATE
WIP	WROUGHT IRON PIPE
WM	WATER METER/WATER MAIN
X-SECT	CROSS SECTION

TRAFFIC SIGNAL

CAB.	CABINET
CCVE	CLOSED CIRCUIT VIDEO EQUIPMENT
DW	STEADY DON'T WALK
FDW	FLASHING DON'T WALK
FR	FLASHING CIRCULAR RED
FRL	FLASHING RED LEFT ARROW
FRR	FLASHING RED RIGHT ARROW
FY	FLASHING CIRCULAR AMBER
FYL	FLASHING AMBER LEFT ARROW
FYR	FLASHING AMBER RIGHT ARROW
G	STEADY CIRCULAR GREEN
GL	STEADY GREEN LEFT ARROW
GR	STEADY GREEN RIGHT ARROW
GSL	STEADY GREEN SLASH LEFT ARROW
GSR	STEADY GREEN SLASH RIGHT ARROW
GV	STEADY GREEN VERTICAL ARROW
OL	OVERLAP
PED	PEDESTRIAN
PTZ	PAN, TILE, ZOOM
R	STEADY CIRCULAR RED
RL	STEADY RED LEFT ARROW
RR	STEADY RED RIGHT ARROW
TR SIG	TRAFFIC SIGNAL
TSC	TRAFFIC SIGNAL CONDUIT
W	STEADY WALK
Y	STEADY CIRCULAR AMBER
YL	STEADY AMBER LEFT ARROW

GENERAL SYMBOLS

EXISTING	PROPOSED	DESCRIPTION
		JERSEY BARRIER ON BRIDGE OR JERSEY BARRIER
		CATCH BASIN
		CATCH BASIN CURB INLET
		FLAG POLE
		GAS PUMP
		MAIL BOX
		POST SQUARE
		POST CIRCULAR
		WELL
		ELECTRIC HANDHOLE
		FENCE GATE POST
		GAS GATE
		BORING HOLE
		MONITORING WELL
		TEST PIT
		HYDRANT
		LIGHT POLE
		COUNTY BOUND
		GPS POINT
		CABLE MANHOLE
		DRAINAGE MANHOLE
		ELECTRIC MANHOLE
		GAS MANHOLE
		MISC MANHOLE
		SEWER MANHOLE
		TELEPHONE MANHOLE
		WATER MANHOLE
		MASSACHUSETTS HIGHWAY BOUND
		MONUMENT
		STONE BOUND
		TOWN OR CITY BOUND
		TRAVERSE OR TRIANGULATION STATION
		TROLLEY POLE OR GUY POLE
		TRANSMISSION POLE
		UTILITY POLE W/ FIREBOX
		UTILITY POLE WITH DOUBLE LIGHT
		UTILITY POLE W / 1 LIGHT
		UTILITY POLE
		BUSH
		TREE
		STUMP
		SWAMP / MARSH
		WATER GATE
		PARKING METER
		SIGN AND POST
		SIGN AND POST (2 POSTS)
		OVERHEAD CABLE/WIRE
		CURBING
		CONTOURS
		UNDERGROUND DRAIN PIPE (DOUBLE LINE 24 INCH AND OVER)
		UNDERGROUND ELECTRIC DUCT (DOUBLE LINE 24 INCH AND OVER)
		UNDERGROUND GAS MAIN (DOUBLE LINE 24 INCH AND OVER)
		UNDERGROUND SEWER MAIN (DOUBLE LINE 24 INCH AND OVER)
		UNDERGROUND TELEPHONE DUCT (DOUBLE LINE 24 INCH AND OVER)
		UNDERGROUND WATER MAIN (DOUBLE LINE 24 INCH AND OVER)
		BALANCE STONE WALL
		GUARD RAIL - STEEL POSTS
		GUARD RAIL - WOOD POSTS
		CHAIN LINK OR METAL FENCE
		WOOD FENCE
		HAY BALES/SILT FENCE
		TREE LINE OR LIMIT OF CLEARING AND GRUBBING
		SAWCUT LINE
		TOP OR BOTTOM OF SLOPE
		LIMIT OF EDGE OF PAVEMENT OR COLD PLANE AND OVERLAY
		BANK OF RIVER OR STREAM
		BORDER OF WETLAND
		100 FT WETLAND BUFFER
		200 FT RIVERFRONT BUFFER
		STATE HIGHWAY LAYOUT
		TOWN OR CITY LAYOUT
		COUNTY LAYOUT
		RAILROAD SIDELINE
		TOWN OR CITY BOUNDARY LINE
		PROPERTY LINE OR APPROXIMATE PROPERTY LINE
		EASEMENT
		TREE AND PLANT PROTECTION
		GAS METER
		MISCELLANEOUS GATE

TRAFFIC SYMBOLS

EXISTING	PROPOSED	DESCRIPTION
		CONTROLLER PHASE ACTUATED
		TRAFFIC SIGNAL HEAD (SIZE AS NOTED)
		WIRE LOOP DETECTOR (6' x 6' TYP UNLESS OTHERWISE SPECIFIED)
		VIDEO DETECTION CAMERA
		MICROWAVE DETECTOR
		PEDESTRIAN PUSH BUTTON, SIGN (DIRECTIONAL ARROW AS SHOWN) AND SADDLE
		EMERGENCY PREEMPTION CONFIRMATION STROBE LIGHT
		VEHICULAR SIGNAL HEAD
		VEHICULAR SIGNAL HEAD, OPTICALLY PROGRAMMED
		FLASHING BEACON
		PEDESTRIAN SIGNAL HEAD, (TYPE AS NOTED OR AS SPECIFIED)
		RAILROAD SIGNAL
		SIGNAL POST AND BASE (ALPHA-NUMERIC DESIGNATION NOTED)
		MAST ARM, SHAFT AND BASE (ARM LENGTH AS NOTED)
		HIGH MAST POLE OR TOWER
		MAST ARM WITH LUMINAIRE
		OPTICAL PRE-EMPTION DETECTOR
		CONTROL CABINET, GROUND MOUNTED
		CONTROL CABINET, POLE MOUNTED
		FLASHING BEACON CONTROL AND METER PEDESTAL
		LOAD CENTER ASSEMBLY
		PULL BOX 12"x12" (OR AS NOTED)
		ELECTRIC HANDHOLE 12"x24" (OR AS NOTED)
		TRAFFIC SIGNAL CONDUIT

PAVEMENT MARKINGS SYMBOLS

EXISTING	PROPOSED	DESCRIPTION
		PAVEMENT ARROW - WHITE
		LEGEND "ONLY" - WHITE
		LEGEND "BUS" - WHITE
		STOP LINE
		12-INCH SOLID WHITE LINE
		CROSSWALK - 12" WHITE ON RED BACKGROUND
		SOLID WHITE LINE - 6"
		SOLID YELLOW LINE - 6"
		BROKEN WHITE LINE - 6" (10' LINE SEGMENT AND 30' GAP)
		BROKEN YELLOW LINE - 6" (10' LINE SEGMENT AND 30' GAP)
		DOTTED WHITE LINE - 6" (3' LINE SEGMENT AND 9' GAP)
		DOTTED YELLOW LINE - 6" (3' LINE SEGMENT AND 9' GAP)
		DOTTED WHITE LINE EXTENSION - 6" (2' LINE SEGMENT AND 6' GAP)
		DOTTED YELLOW LINE EXTENSION - 6" (2' LINE SEGMENT AND 6' GAP)
		DOUBLE WHITE LINE - 6"
		DOUBLE YELLOW LINE - 6"
		12" SOLID YELLOW GORE LINES @ 45°

PROJECT: **MORTON STREET RESILIENCY PROJECT**

DESIGN SUBMISSION: **CONCEPTUAL PLANS (ALT #3)**

DRAWING TITLE: **LEGEND & ABBREVIATIONS**

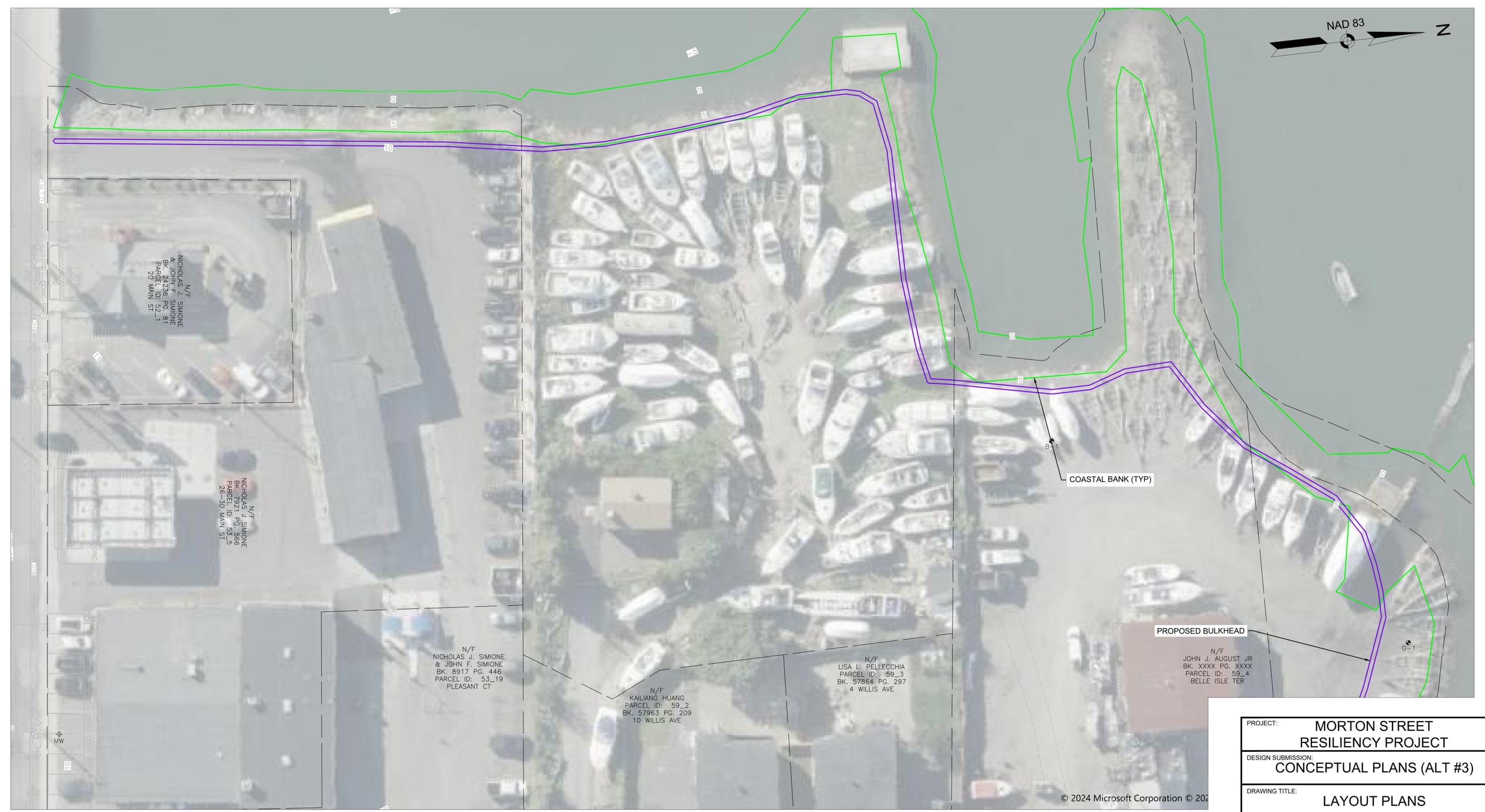
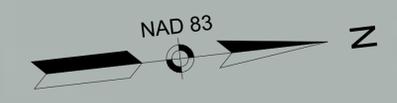
PREPARED FOR: **TOWN OF WINTHROP**

45 PAULINE ST
WINTHROP, MASSACHUSETTS

PREPARED BY: **GREEN INTERNATIONAL AFFILIATES, INC.**
Civil and Structural Engineers (978) 923-0400
Tewksbury, Massachusetts GreenIntl.com

SCALE: AS NOTED DESIGNED BY: SS
DATE: 6/21/2024 DRAWN BY: SS SHEET NO. 2 OF 11
PROJECT NO. 23078 CHECKED BY: DV

NO. DATE REVISIONS



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CONTINUED ON SHEET NO. 4

PROJECT: **MORTON STREET RESILIENCY PROJECT**

DESIGN SUBMISSION: **CONCEPTUAL PLANS (ALT #3)**

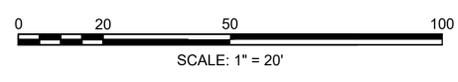
DRAWING TITLE: **LAYOUT PLANS**

PREPARED FOR: **TOWN OF WINTHROP**

45 PAULINE ST
WINTHROP, MASSACHUSETTS

PREPARED BY:
GREEN INTERNATIONAL AFFILIATES, INC.
Civil and Structural Engineers (978) 923-0400
Tewksbury, Massachusetts GreenIntl.com

SCALE: AS NOTED	DESIGNED BY: SS	SHEET NO. 3 OF 11
DATE: 6/21/2024	DRAWN BY: SS	
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NAD 83
Z

N/F
NICHOLAS J. SIMIONE
& JOHN F. SIMIONE
BK. 8917 PG. 446
PARCEL ID: 53_19
PLEASANT CT

N/F
KAILIANG HUANG
PARCEL ID: 59_2
BK. 57963 PG. 209
10 WILLIS AVE

N/F
LISA L. PELLECCIA
PARCEL ID: 59_3
BK. 57864 PG. 297
4 WILLIS AVE

N/F
JOHN J. AUGUST JR
BK. XXXX PG. XXXX
PARCEL ID: 59_4
BELLE ISLE TER

N/F
NICHOLAS J. SIMIONE
& JOHN F. SIMIONE
BK. 8925 PG. 22
PARCEL ID: 53_6
38 MAIN ST

N/F
NICHOLAS J. SIMIONE
& JOHN F. SIMIONE
BK. 8917 PG. 446
PARCEL ID: 53_18
25 PLEASANT CT

N/F
THOMAS H. FITZGERALD &
CHERYL A. FITZGERALD
BK. 13760 PG. 93
PARCEL ID: 53_17
19 PLEASANT CT

N/F
ANN ALLEN MELODY,
TRUSTEE
BK. 24141 PG. 112
PARCEL ID: 53_16
15 PLEASANT CT

N/F
RAYMOND E. FREEMAN
BK. 13762 PG. 218
PARCEL ID: 53_15
11 PLEASANT CT

N/F
JEFFREY TALBOT
BK. 49131 PG. 50
PARCEL ID: 53_14
PLEASANT CT

N/F
JEFFREY TALBOT
BK. 49131 PG. 50
PARCEL ID: 53_13
626 PLEASANT ST

N/F
JOSEPH K. McLAUGHLIN
BK. XXXX PG. XXXX
PARCEL ID: 59_8
7 WILLIS AVE

N/F
PATRICIA PERICOLA
BK. 61844 PG. 102
PARCEL ID: 59_7
5 WILLIS AVE

N/F
DAVID J. CANN
BK. 36166 PG. 49
PARCEL ID: 59_6
3 WILLIS AVE

N/F
GARY P. GALLETTA
BK. 46172 PG. 189
PARCEL ID: 59_5
1 WILLIS AVE

N/F
OUAFAA ABID-ADONON
& AMEN ADONON
BK. 60711 PG. 146
PARCEL ID: 59_9
630 PLEASANT ST

N/F
IRFAN CINEL
BK. 53412 PG. 142
PARCEL ID: 59_12
640 PLEASANT ST

WILLIS AVENUE

PLEASANT COURT

BELLE ISLE TERRACE

FULL DEPTH RECONSTRUCTION
28' OVERALL ROADWAY WIDTH (TYP)

BEGIN ROADWAY MODIFICATIONS STA. 2+00
MATCH EXISTING

UTILITY POLE IMPACTS (TYP)

RECONSTRUCT DRIVEWAY (TYP)

TEMPORARY RIGHT OF
WAY IMPACT (TYP)

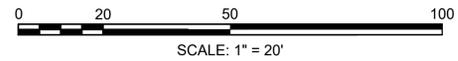
CONNECT TO EXISTING DRIVEWAY
(TO BE COORDINATED WITH PROPERTY OWNER)

STA. 4+00
ROADWAY ELEVATION = 11.00'

COASTAL BANK (TYP)

LOAM AND SEED,
4H:1V SLOPES (TYP)

FULL DEPTH RECONSTRUCTION
28' OVERALL ROADWAY WIDTH (TYP)



CONTINUED ON
SHEET NO. 5

PROJECT: **MORTON STREET
RESILIENCY PROJECT**

DESIGN SUBMISSION:
CONCEPTUAL PLANS (ALT #3)

DRAWING TITLE:
LAYOUT PLANS

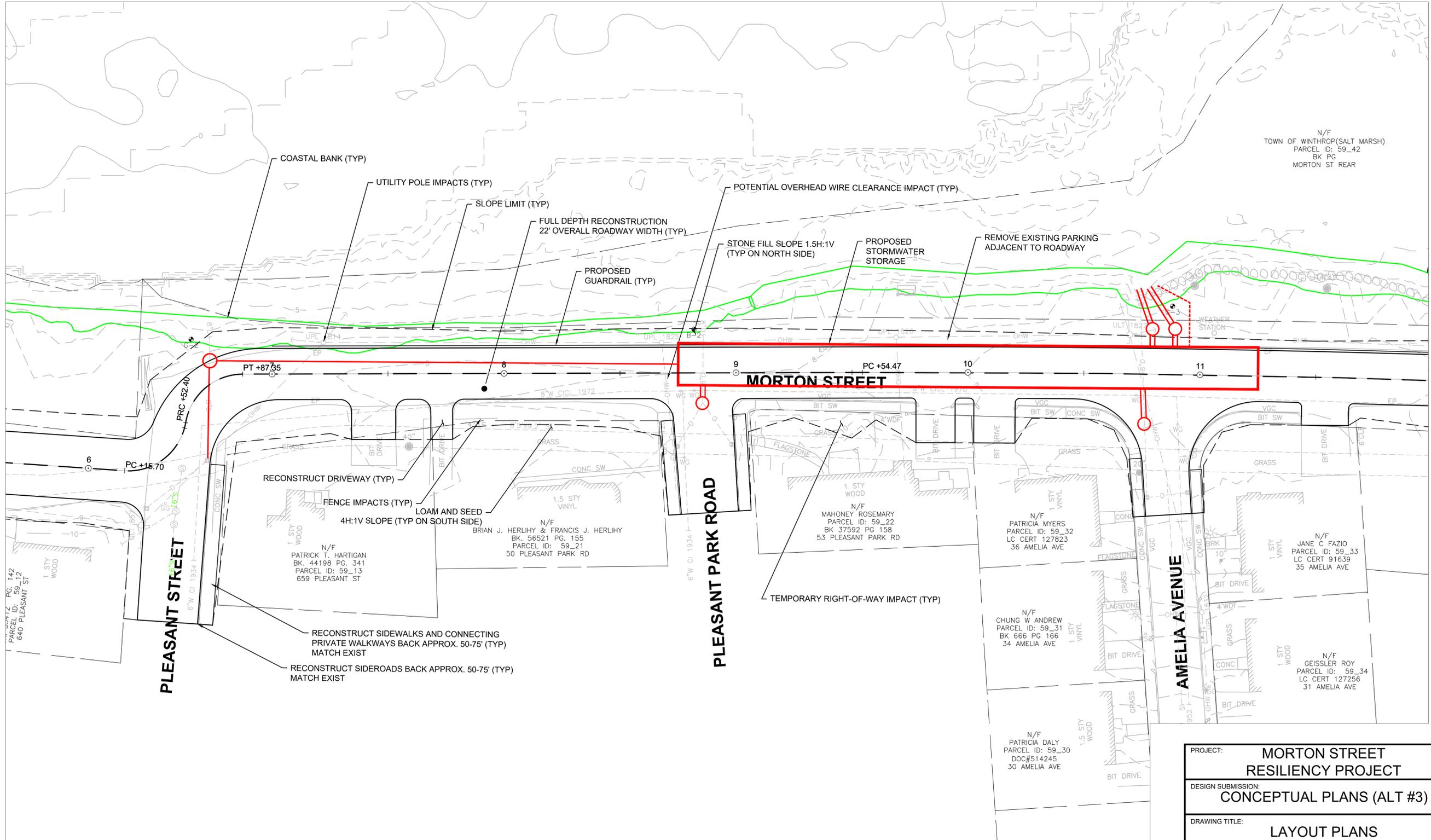
PREPARED FOR:
TOWN OF WINTHROP

45 PAULINE ST
WINTHROP, MASSACHUSETTS

PREPARED BY:
GREEN INTERNATIONAL AFFILIATES, INC.
Civil and Structural Engineers (978) 923-0400
Tewksbury, Massachusetts GreenIntl.com

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DATE: 6/21/2024	DRAWN BY: SS	
PROJECT NO. 23078	CHECKED BY: DV	

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N/F
TOWN OF WINTHROP(SALT MARSH)
PARCEL ID: 59_42
BK PG
MORTON ST REAR

CONTINUED ON SHEET NO. 4

CONTINUED ON SHEET NO. 6

PARCEL 12 PG. 142
59_12
640 PLEASANT ST

PLEASANT STREET

PLEASANT PARK ROAD

AMELIA AVENUE

RECONSTRUCT DRIVEWAY (TYP)
FENCE IMPACTS (TYP)
LOAM AND SEED
4H:1V SLOPE (TYP ON SOUTH SIDE)
N/F PATRICK T. HARTIGAN
BK. 44198 PG. 341
PARCEL ID: 59_13
659 PLEASANT ST
N/F BRIAN J. HERLIHY & FRANCIS J. HERLIHY
BK. 56521 PG. 155
PARCEL ID: 59_21
50 PLEASANT PARK RD
RECONSTRUCT SIDEWALKS AND CONNECTING
PRIVATE WALKWAYS BACK APPROX. 50-75' (TYP)
MATCH EXIST
RECONSTRUCT SIDEROADS BACK APPROX. 50-75' (TYP)
MATCH EXIST

MAHONEY ROSEMARY
PARCEL ID: 59_22
BK 37592 PG 158
53 PLEASANT PARK RD
N/F PATRICIA MYERS
PARCEL ID: 59_32
LC CERT 127823
36 AMELIA AVE
N/F CHUNG W. ANDREW
PARCEL ID: 59_31
BK 666 PG 166
34 AMELIA AVE
N/F PATRICIA DALY
PARCEL ID: 59_30
DOC#514245
30 AMELIA AVE
N/F JANE C FAZIO
PARCEL ID: 59_33
LC CERT 91639
35 AMELIA AVE
N/F GEISSLER ROY
PARCEL ID: 59_34
LC CERT 127256
31 AMELIA AVE

PROJECT: **MORTON STREET RESILIENCY PROJECT**

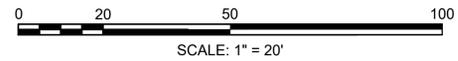
DESIGN SUBMISSION: **CONCEPTUAL PLANS (ALT #3)**

DRAWING TITLE: **LAYOUT PLANS**

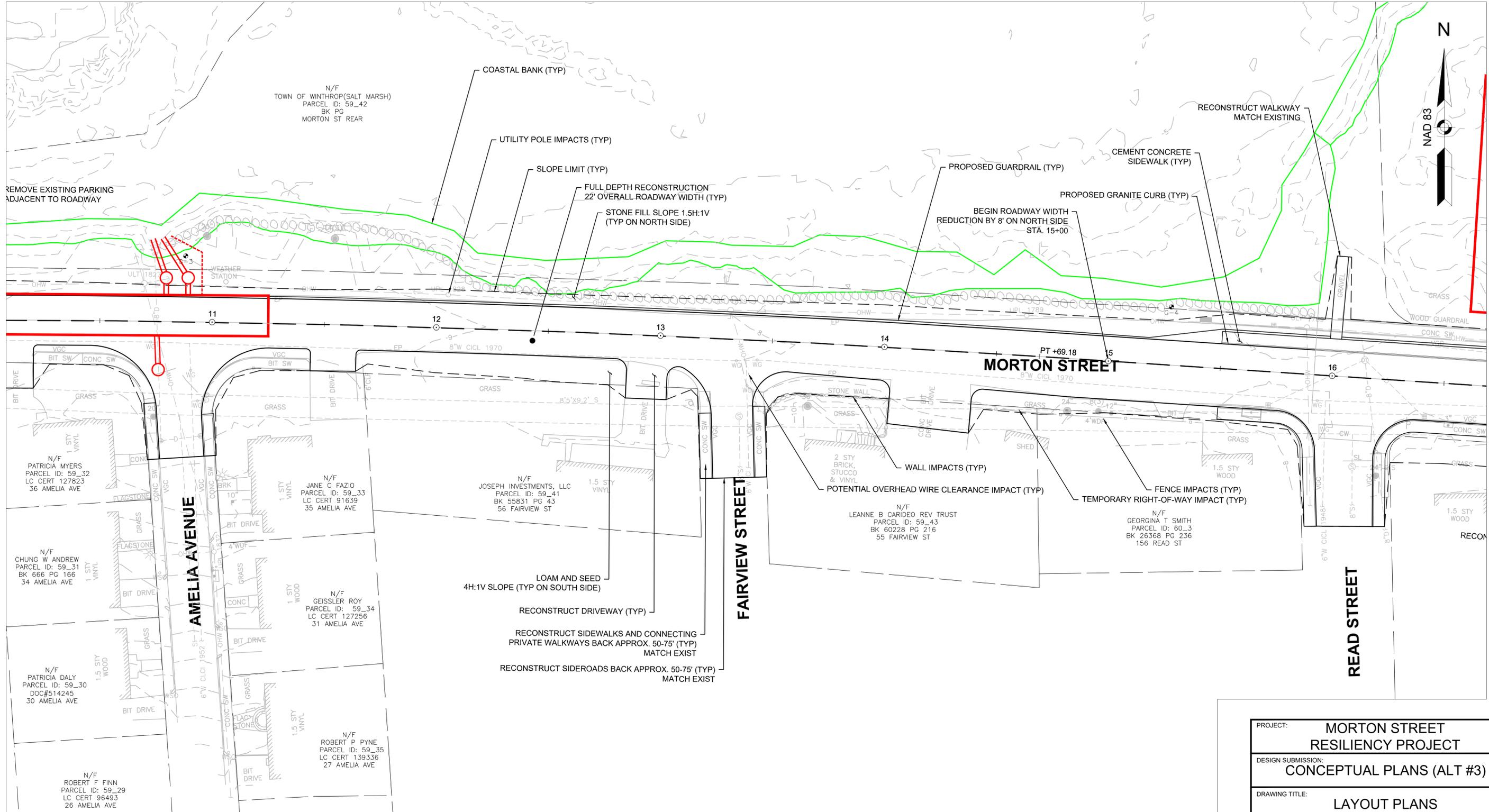
PREPARED FOR:
TOWN OF WINTHROP
45 PAULINE ST
WINTHROP, MASSACHUSETTS

PREPARED BY:
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Civil and Structural Engineers (978) 923-0400
Tewksbury, Massachusetts GreenIntl.com

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DATE: 6/21/2024	DRAWN BY: SS	
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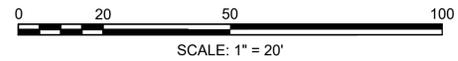


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CONTINUED ON SHEET NO. 7



PROJECT: **MORTON STREET RESILIENCY PROJECT**

DESIGN SUBMISSION: **CONCEPTUAL PLANS (ALT #3)**

DRAWING TITLE: **LAYOUT PLANS**

PREPARED FOR: **TOWN OF WINTHROP**

45 PAULINE ST
WINTHROP, MASSACHUSETTS

PREPARED BY: **GREEN INTERNATIONAL AFFILIATES, INC.**
Civil and Structural Engineers (978) 923-0400
Tewksbury, Massachusetts GreenIntl.com

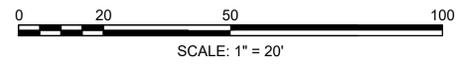
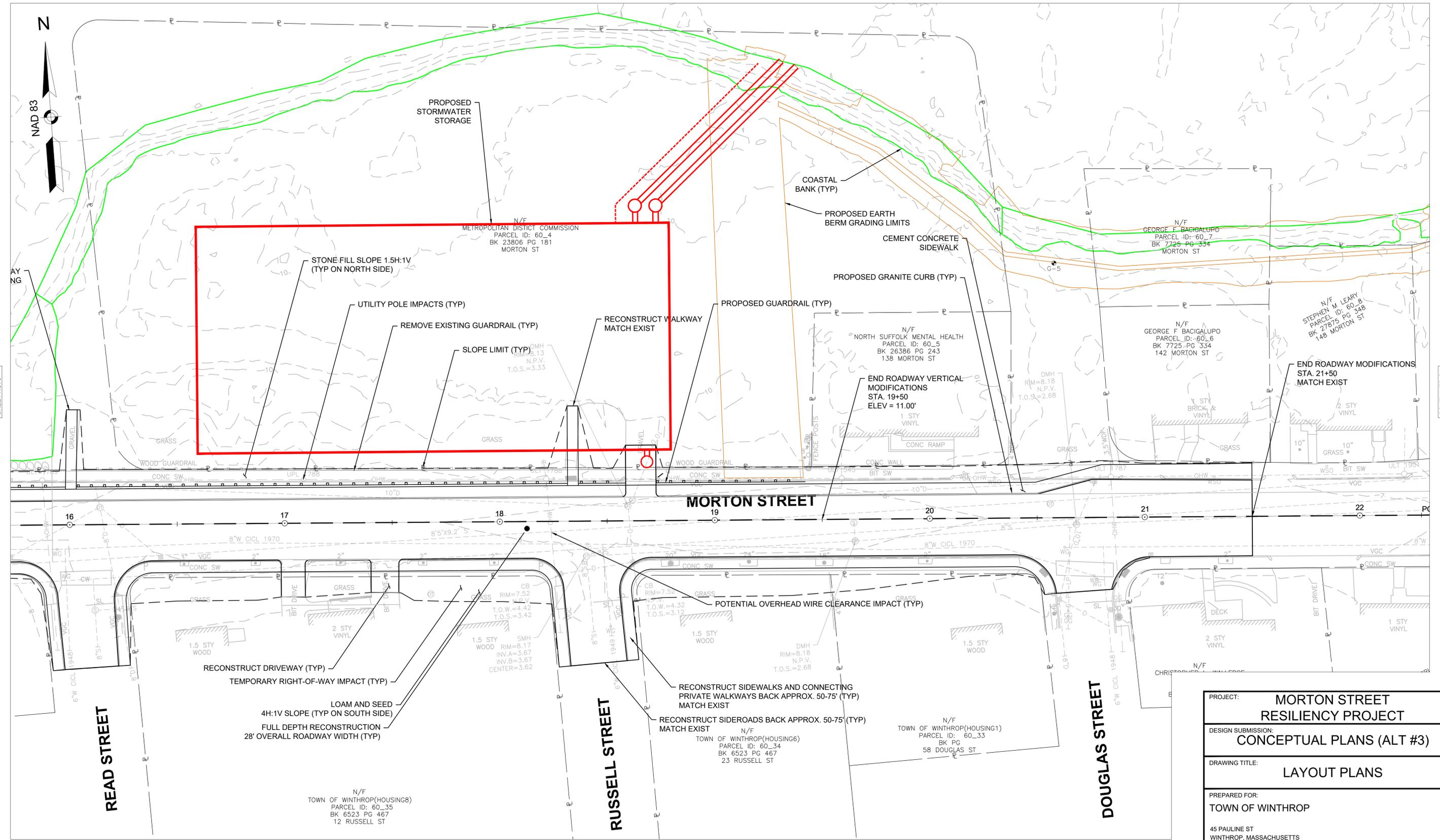
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CONTINUED ON SHEET NO. 8



PROJECT: **MORTON STREET RESILIENCY PROJECT**

DESIGN SUBMISSION: **CONCEPTUAL PLANS (ALT #3)**

DRAWING TITLE: **LAYOUT PLANS**

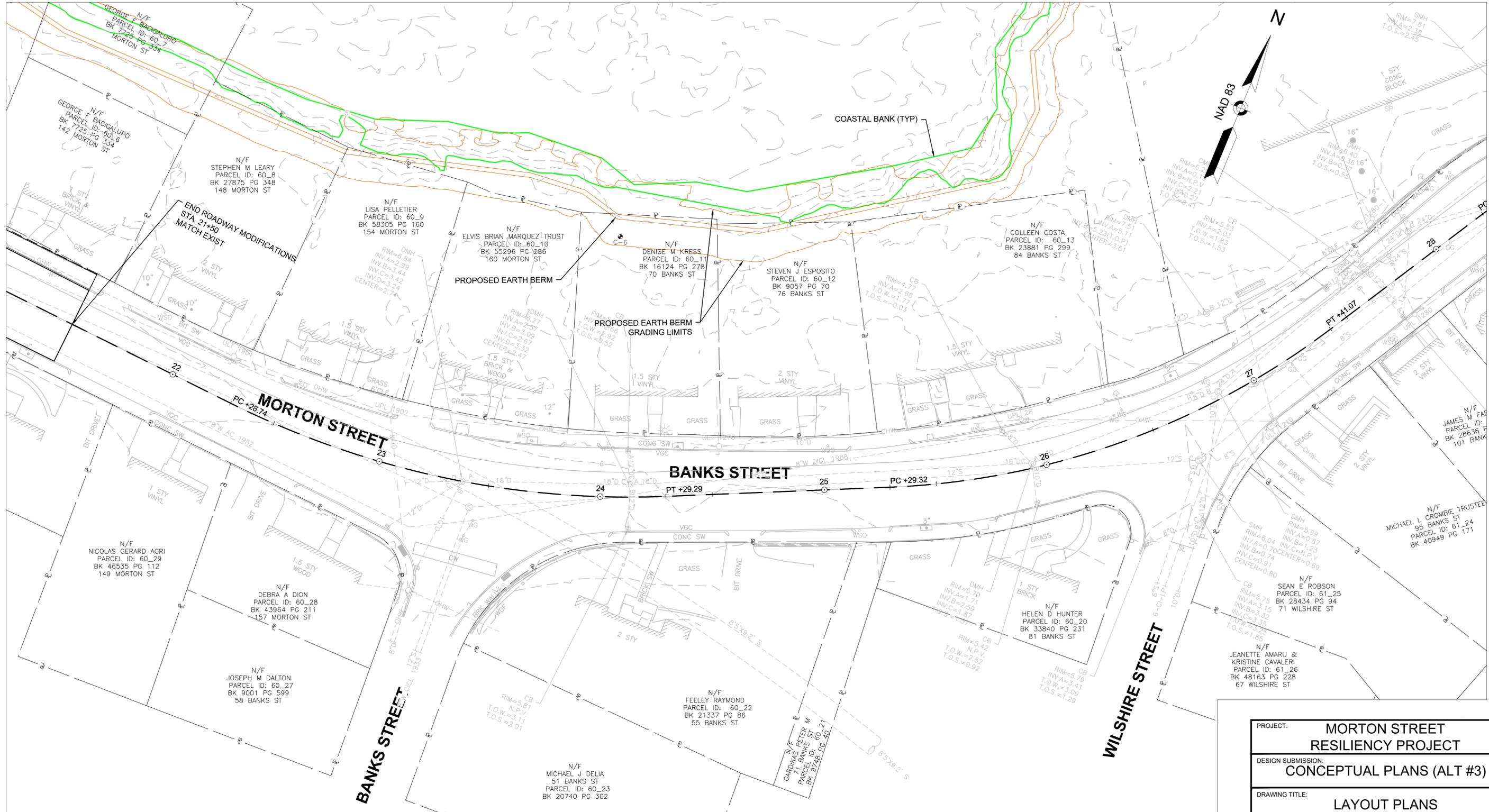
PREPARED FOR: **TOWN OF WINTHROP**

45 PAULINE ST
WINTHROP, MASSACHUSETTS

PREPARED BY: **GREEN INTERNATIONAL AFFILIATES, INC.**
Civil and Structural Engineers (978) 923-0400
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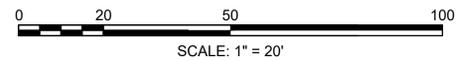
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PROJECT NO. 23078	CHECKED BY: DV	

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CONTINUED ON SHEET NO. 9



PROJECT: **MORTON STREET RESILIENCY PROJECT**

DESIGN SUBMISSION: **CONCEPTUAL PLANS (ALT #3)**

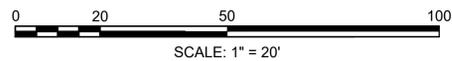
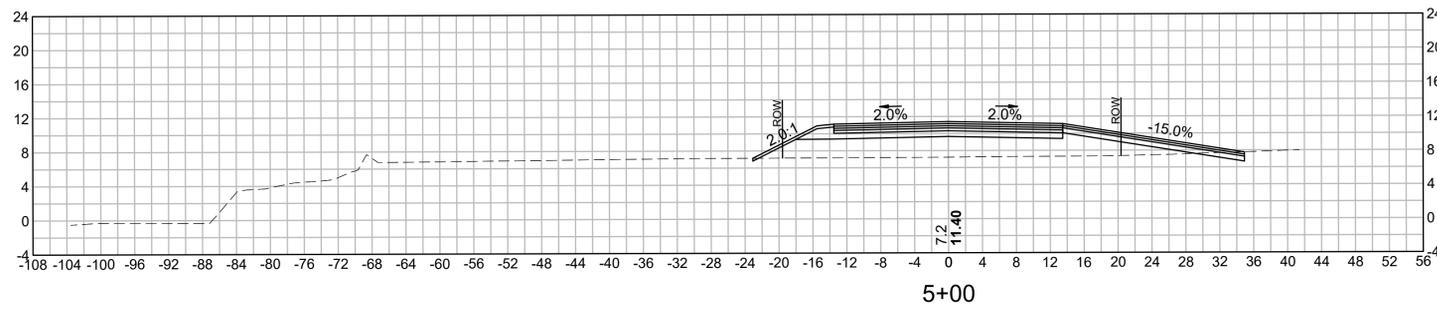
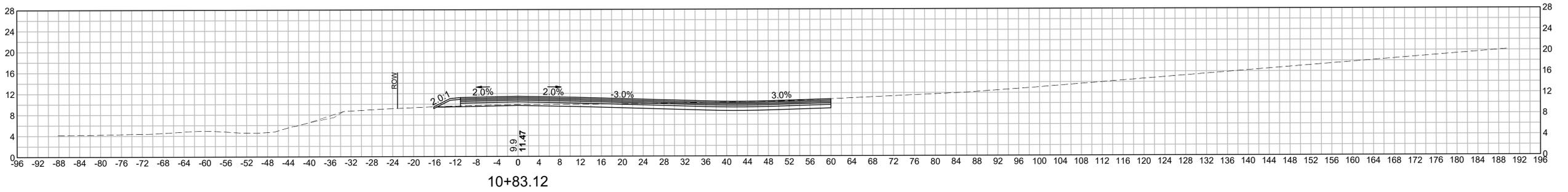
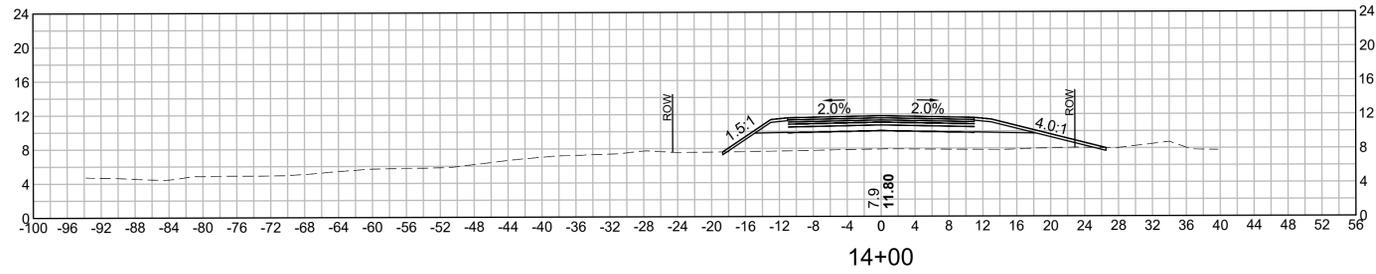
DRAWING TITLE: **LAYOUT PLANS**

PREPARED FOR:
TOWN OF WINTHROP
45 PAULINE ST
WINTHROP, MASSACHUSETTS

PREPARED BY:
GREEN INTERNATIONAL AFFILIATES, INC.
Civil and Structural Engineers (978) 923-0400
Tewksbury, Massachusetts GreenIntl.com

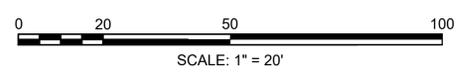
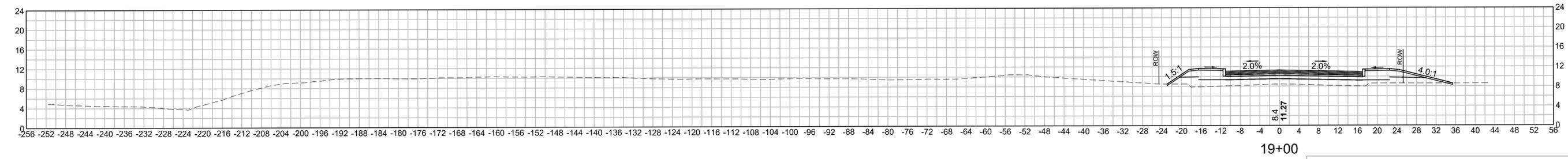
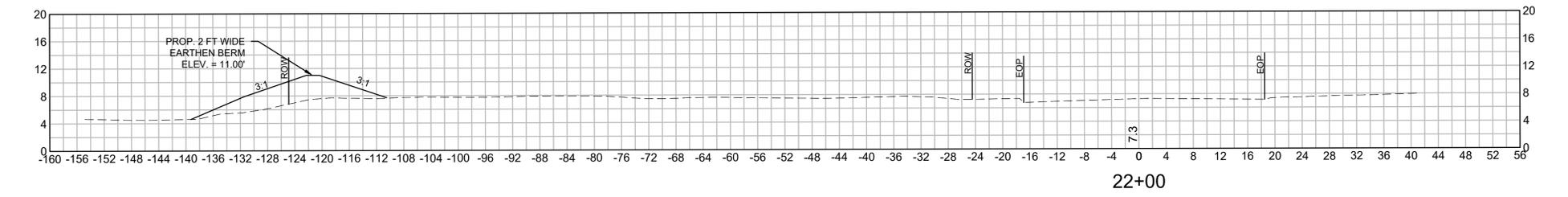
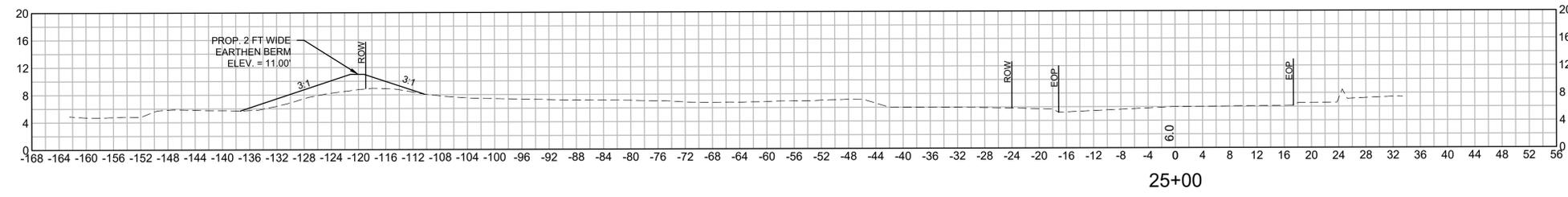
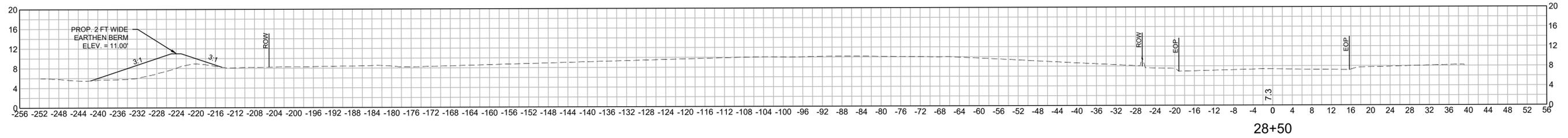
SCALE: AS NOTED	DESIGNED BY: SS	SHEET NO. 8 OF 11
DATE: 6/21/2024	DRAWN BY: SS	
PROJECT NO. 23078	CHECKED BY: DV	

NO.	DATE	REVISIONS



PROJECT: MORTON STREET RESILIENCY PROJECT		
DESIGN SUBMISSION: CONCEPTUAL PLANS (ALT #3)		
DRAWING TITLE: CRITICAL CROSS SECTIONS		
PREPARED FOR: TOWN OF WINTHROP		
45 PAULINE ST WINTHROP, MASSACHUSETTS		
PREPARED BY: GREEN INTERNATIONAL AFFILIATES, INC. Civil and Structural Engineers (978) 923-0400 Tewksbury, Massachusetts GreenIntl.com		
SCALE: AS NOTED	DESIGNED BY: SS	SHEET NO. 10 OF 11
DATE: 6/21/2024	DRAWN BY: SS	
PROJECT NO. 23078	CHECKED BY: DV	

NO.	DATE	REVISIONS



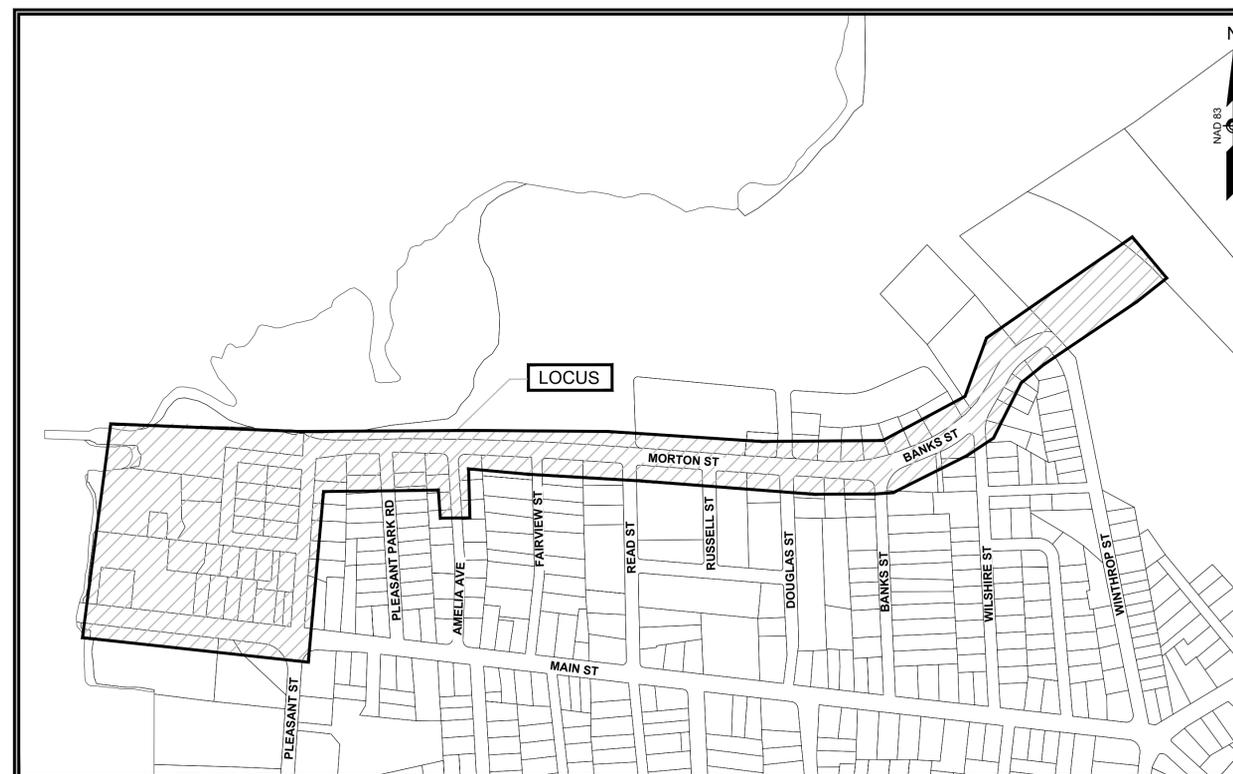
PROJECT: MORTON STREET RESILIENCY PROJECT		
DESIGN SUBMISSION: CONCEPTUAL PLANS (ALT #3)		
DRAWING TITLE: CRITICAL CROSS SECTIONS		
PREPARED FOR: TOWN OF WINTHROP		
45 PAULINE ST WINTHROP, MASSACHUSETTS		
PREPARED BY: GREEN INTERNATIONAL AFFILIATES, INC.		
Civil and Structural Engineers (978) 923-0400 Tewksbury, Massachusetts GreenIntl.com		
SCALE: AS NOTED	DESIGNED BY: SS	SHEET NO. 11 OF 11
DATE: 6/21/2024	DRAWN BY: SS	
PROJECT NO. 23078	CHECKED BY: DV	

NO.	DATE	REVISIONS

TOWN OF WINTHROP, MASSACHUSETTS

MORTON STREET RESILIENCY PROJECT

ALTERNATIVE 4



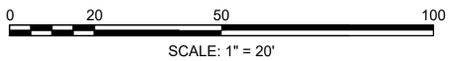
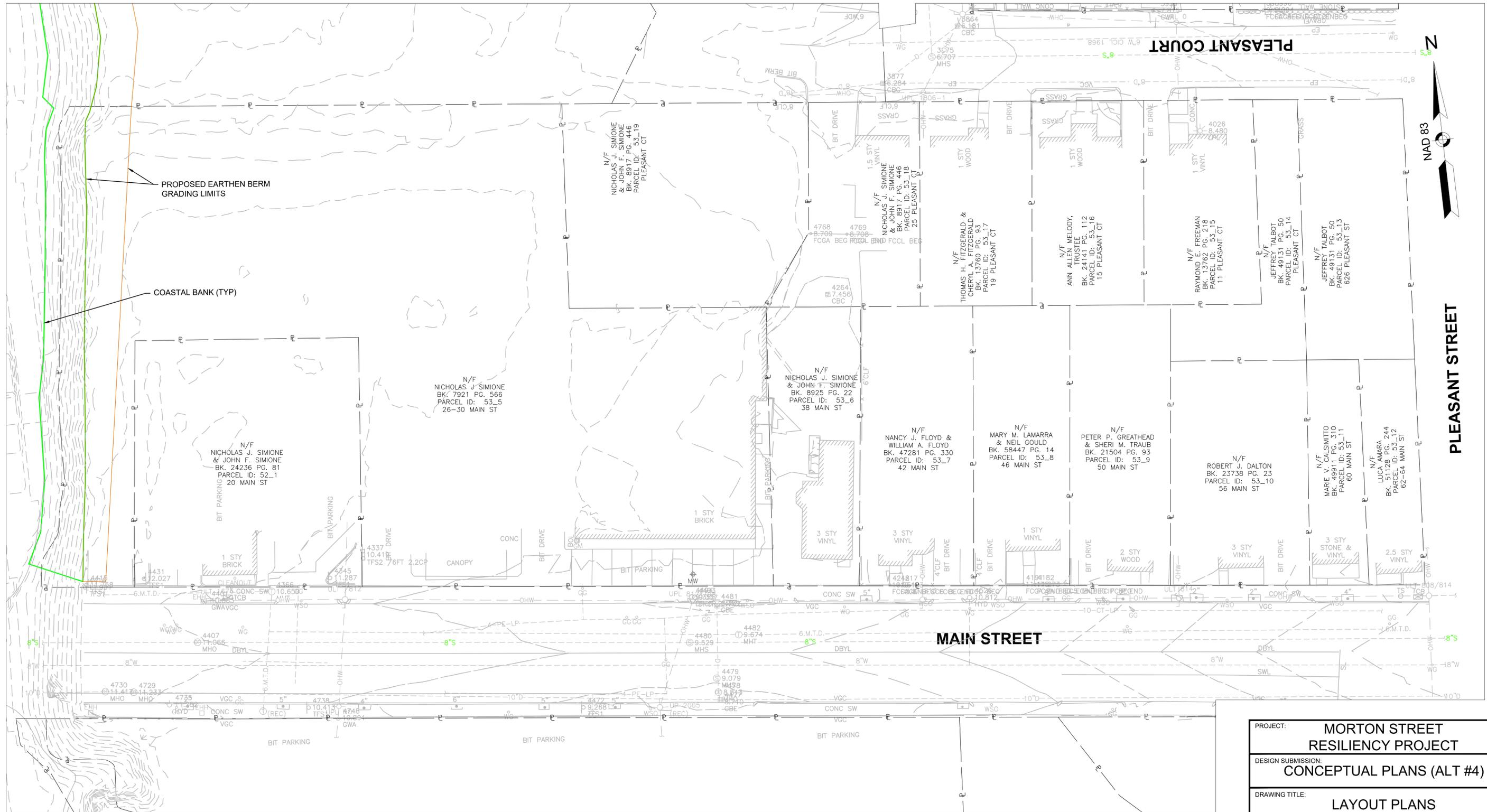
SCALE: 1" = 1000'
LOCATION PLAN

GENERAL NOTES

1. THE EXISTING CONDITIONS SHOWN ON THIS BASE MAP ARE THE RESULT OF AN ON-THE-GROUND INSTRUMENT SURVEY PERFORMED BETWEEN NOVEMBER 6, 2023 AND MARCH 12, 2024 BY GREEN INTERNATIONAL AFFILIATES, INC. (GREEN).
2. HORIZONTAL AND VERTICAL CONTROL WAS ESTABLISHED BY GREEN INTERNATIONAL AFFILIATES, INC. BETWEEN NOVEMBER 6, 2023 AND NOVEMBER 16, 2023. HORIZONTAL DATUM IS BASED ON THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM (MAINLAND) NAD83 (2011), 2010.00 EPOCH. VERTICAL DATUM IS NAVD88 (COMPUTED USING GEOID18).
3. THE RIGHT OF WAY LINES SHOWN HERE ARE RESULT OF GIS. PRIVATE PROPERTY LINES HAVE NOT BEEN SURVEYED AND SHOULD BE CONSIDERED APPROXIMATE.

PROJECT: MORTON STREET RESILIENCY PROJECT	
DESIGN SUBMISSION: CONCEPTUAL PLANS (ALT #4)	
DRAWING TITLE: TITLE SHEET	
PREPARED FOR: TOWN OF WINTHROP	
45 PAULINE ST WINTHROP, MASSACHUSETTS	
PREPARED BY: GREEN INTERNATIONAL AFFILIATES, INC. Civil and Structural Engineers (978) 923-0400 Tewksbury, Massachusetts Greenintl.com	
SCALE: AS NOTED	DESIGNED BY: SS
DATE: 6/21/2024	DRAWN BY: SS
PROJECT NO. 23078	CHECKED BY: DV
NO.	DATE
REVISIONS	
SHEET NO.	1 OF 10

CONTINUED ON SHEET NO. 4



PROJECT: **MORTON STREET RESILIENCY PROJECT**

DESIGN SUBMISSION: **CONCEPTUAL PLANS (ALT #4)**

DRAWING TITLE: **LAYOUT PLANS**

PREPARED FOR: **TOWN OF WINTHROP**

45 PAULINE ST
WINTHROP, MASSACHUSETTS

PREPARED BY: **GREEN INTERNATIONAL AFFILIATES, INC.**
Civil and Structural Engineers (978) 923-0400
Tewksbury, Massachusetts GreenIntl.com

SCALE: AS NOTED DESIGNED BY: SS

DATE: 6/21/2024 DRAWN BY: SS SHEET NO.

PROJECT NO. 23078 CHECKED BY: DV **3** OF 10

NO.	DATE	REVISIONS



WILLIS AVENUE

BELLE ISLE TERRACE

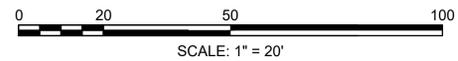
PLEASANT COURT

PROPOSED EARTH BERM GRADING LIMITS

COASTAL BANK (TYP)

PROPOSED EARTH BERM

PROPOSED EARTH BERM GRADING LIMITS



PROJECT: **MORTON STREET RESILIENCY PROJECT**

DESIGN SUBMISSION: **CONCEPTUAL PLANS (ALT #4)**

DRAWING TITLE: **LAYOUT PLANS**

PREPARED FOR: **TOWN OF WINTHROP**

45 PAULINE ST
WINTHROP, MASSACHUSETTS

PREPARED BY: **GREEN INTERNATIONAL AFFILIATES, INC.**
Civil and Structural Engineers (978) 923-0400
Tewksbury, Massachusetts GreenIntl.com

SCALE: AS NOTED DESIGNED BY: SS

DATE: 6/21/2024 DRAWN BY: SS SHEET NO.

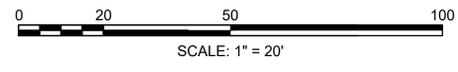
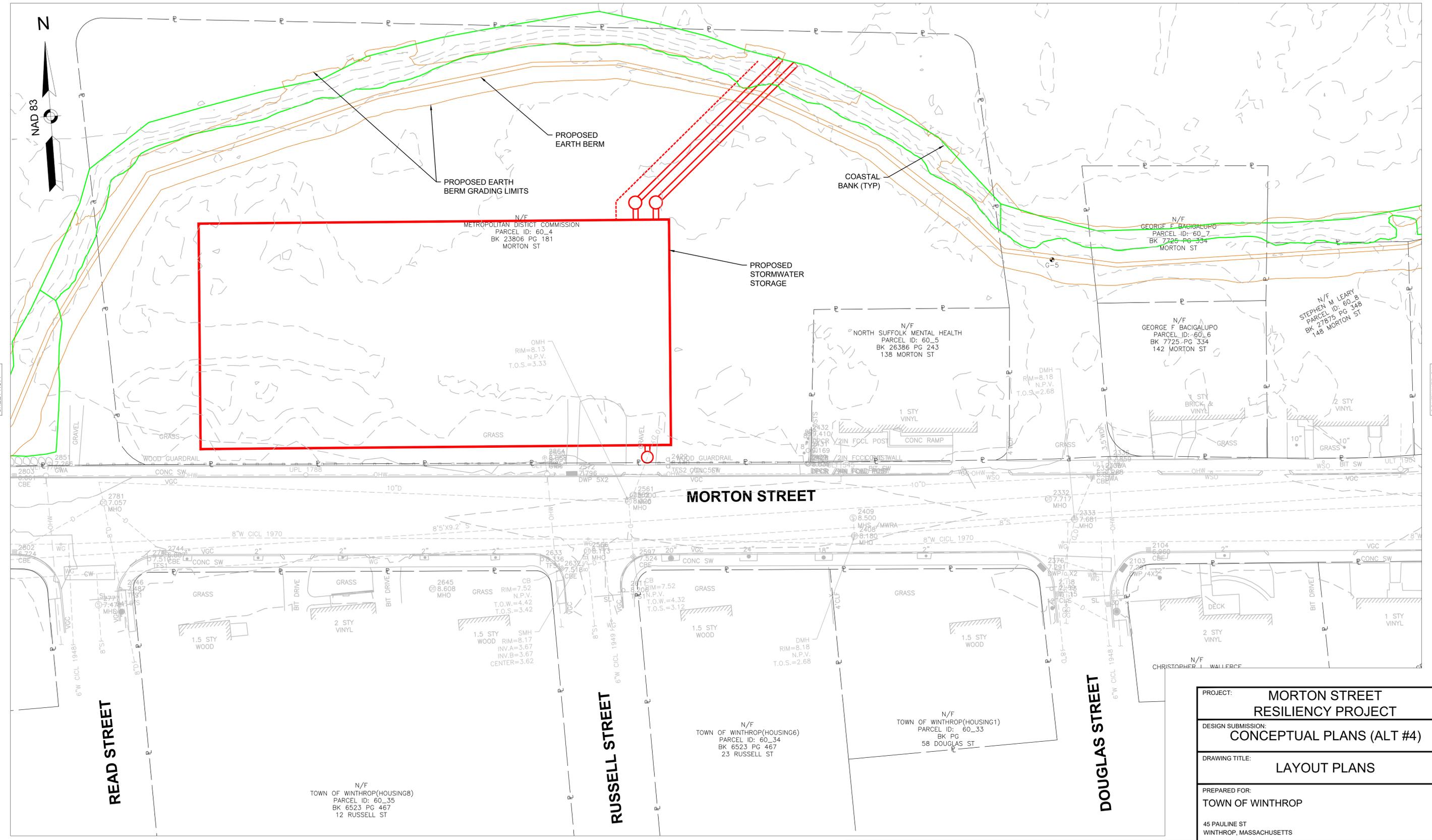
PROJECT NO. 23078 CHECKED BY: DV **5** OF 10

NO.	DATE	REVISIONS



CONTINUED ON SHEET NO. 7

CONTINUED ON SHEET NO. 9



PROJECT: **MORTON STREET RESILIENCY PROJECT**

DESIGN SUBMISSION: **CONCEPTUAL PLANS (ALT #4)**

DRAWING TITLE: **LAYOUT PLANS**

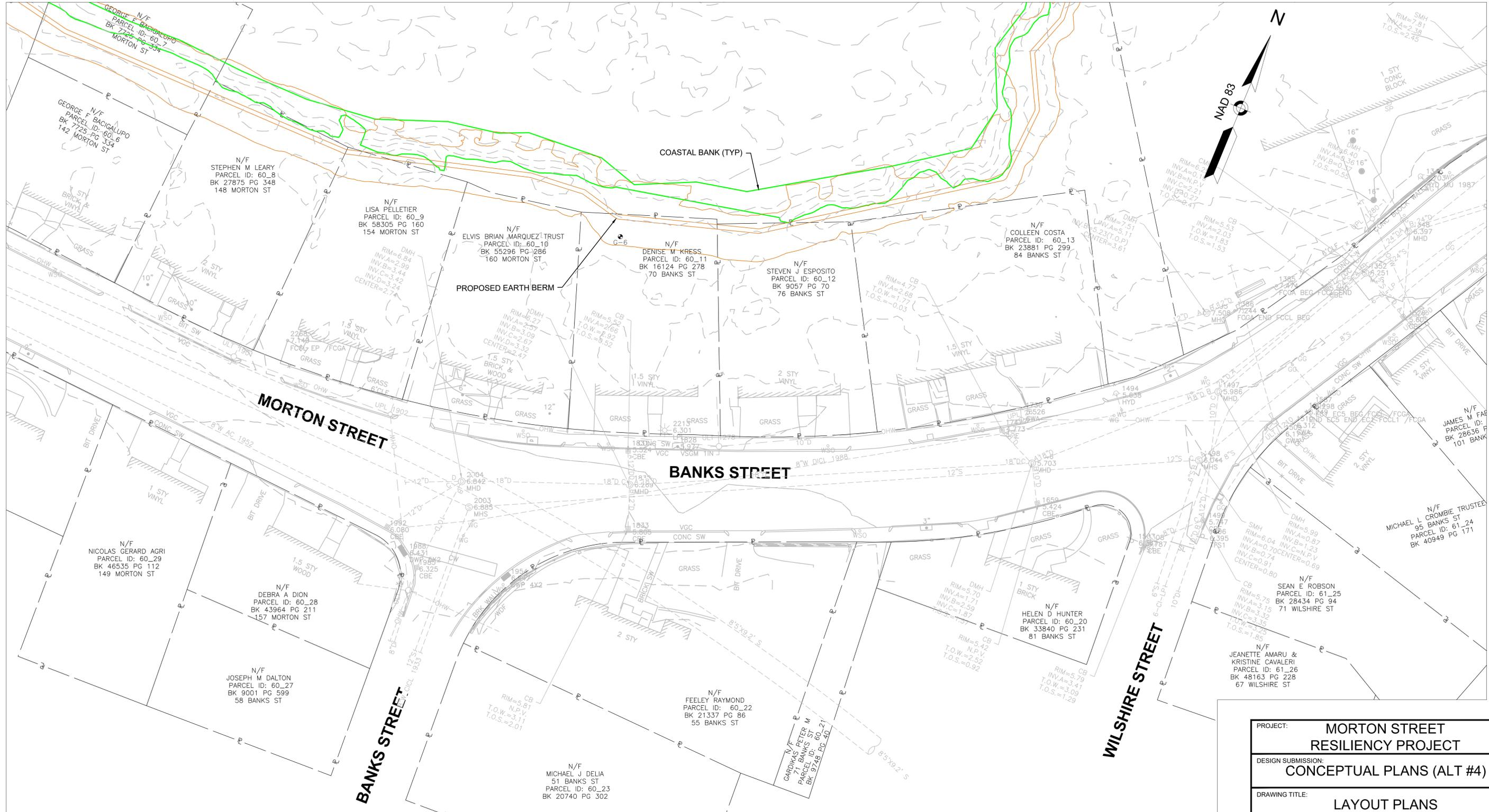
PREPARED FOR: **TOWN OF WINTHROP**

45 PAULINE ST
WINTHROP, MASSACHUSETTS

PREPARED BY: **GREEN INTERNATIONAL AFFILIATES, INC.**
Civil and Structural Engineers (978) 923-0400
Tewksbury, Massachusetts GreenIntl.com

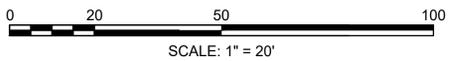
SCALE: AS NOTED	DESIGNED BY: SS	SHEET NO. 8 OF 10
DATE: 6/21/2024	DRAWN BY: SS	
PROJECT NO. 23078	CHECKED BY: DV	

NO.	DATE	REVISIONS



CONTINUED ON SHEET NO. 8

CONTINUED ON SHEET NO. 10



PROJECT: **MORTON STREET RESILIENCY PROJECT**

DESIGN SUBMISSION: **CONCEPTUAL PLANS (ALT #4)**

DRAWING TITLE: **LAYOUT PLANS**

PREPARED FOR: **TOWN OF WINTHROP**

45 PAULINE ST
WINTHROP, MASSACHUSETTS

PREPARED BY: **GREEN INTERNATIONAL AFFILIATES, INC.**
Civil and Structural Engineers (978) 923-0400
Tewksbury, Massachusetts GreenIntl.com

SCALE: AS NOTED	DESIGNED BY: SS	SHEET NO. 9 OF 10
DATE: 6/21/2024	DRAWN BY: SS	
PROJECT NO. 23078	CHECKED BY: DV	

NO.	DATE	REVISIONS



Appendix D. Preliminary Construction Cost Sheets

**Winthrop Morton Street
Winthrop, MA
Woods Hole Group - Town of Winthrop
ENGINEER'S ESTIMATE - Conceptual Design - Alternative 1**

Prepared by:



Green Project No: 23078

Date: 6/14/2024

ITEM NO.	QUANTITY	UNIT	ITEM DESCRIPTION	UNIT PRICE	AMOUNT
120.	550	CY	EARTH EXCAVATION	\$50.00	\$27,500.00
150.	1050	CY	ORDINARY BORROW	\$35.00	\$36,750.00
151.	600	CY	GRAVEL BORROW	\$55.00	\$33,000.00
170.	2465	SY	FINE GRADING AND COMPACTING - SUBGRADE AREA	\$15.00	\$36,975.00
201.	4	EA	CATCH BASIN	\$8,900.00	\$35,600.00
202.	2	EA	MANHOLE	\$8,800.00	\$17,600.00
220.5	6	EA	DRAINAGE STRUCTURE REMODELED	\$942.00	\$5,652.00
220.8	2	EA	SANITARY STRUCTURE REMODELED	\$997.00	\$1,994.00
241.12	100	FT	12 INCH REINFORCED CONCRETE PIPE CLASS III	\$135.00	\$13,500.00
358.	2	EA	GATE BOX ADJUSTED	\$950.00	\$1,900.00
354.12	2	EA	12 INCH AND UNDER GATE BOX REMOVED AND RESET	\$658.00	\$1,316.00
376.2	1	EA	HYDRANT - REMOVED AND RESET	\$4,967.00	\$4,967.00
402.	220	CY	DENSE GRADED CRUSHED STONE FOR SUB-BASE	\$100.00	\$22,000.00
450.42	900	TON	SUPERPAVE BASE COURSE - 37.5 (SBC - 37.5)	\$160.00	\$144,000.00
702.	130	TON	HOT MIX ASPHALT SIDEWALK OR DRIVEWAY	\$340.00	\$44,200.00
740.	8	MO	ENGINEER'S FIELD OFFICE AND EQUIPMENT (TYPE A)	\$5,320.00	\$42,560.00
748.	1	LS	MOBILIZATION	\$190,000.00	\$190,000.00
751.1	90	CY	LOAM FOR LAWNS	\$90.00	\$8,100.00
765.	800	SY	SEEDING	\$3.00	\$2,400.00
997.01	1	LS	SUBSURFACE STORAGE SYSTEM 1	\$924,700.00	\$924,700.00
997.02	1	LS	SUBSURFACE STORAGE SYSTEM 2	\$1,841,100.00	\$1,841,100.00
997.03	1	LS	SUBSURFACE STORAGE SYSTEM 3	\$3,178,800.00	\$3,178,800.00
999.001	1300	HR	POLICE DETAIL	\$100.00	\$130,000.00

SUBTOTAL: \$6,744,614.00
35% Contingency & Inflation: \$2,360,615.00
TOTAL: \$9,105,229.00

**Winthrop Morton Street
Winthrop, MA
Woods Hole Group - Town of Winthrop
ENGINEER'S ESTIMATE - Conceptual Design - Alternative 2**

Prepared by:



Green Project No: 23078

Date: 6/14/2024

ITEM NO.	QUANTITY	UNIT	ITEM DESCRIPTION	UNIT PRICE	AMOUNT
120.	3800	CY	EARTH EXCAVATION	\$50.00	\$190,000.00
150.	9425	CY	ORDINARY BORROW	\$35.00	\$329,875.00
151.	6375	CY	GRAVEL BORROW	\$55.00	\$350,625.00
170.	12500	SY	FINE GRADING AND COMPACTING - SUBGRADE AREA	\$15.00	\$187,500.00
201.	24	EA	CATCH BASIN	\$8,900.00	\$213,600.00
202.	12	EA	MANHOLE	\$8,800.00	\$105,600.00
220.5	44	EA	DRAINAGE STRUCTURE REMODELED	\$728.00	\$32,032.00
220.8	19	EA	SANITARY STRUCTURE REMODELED	\$997.00	\$18,943.00
241.12	1200	FT	12 INCH REINFORCED CONCRETE PIPE CLASS III	\$135.00	\$162,000.00
358.	25	EA	GATE BOX ADJUSTED	\$950.00	\$23,750.00
376.2	5	EA	HYDRANT - REMOVED AND RESET	\$4,967.00	\$24,835.00
354.12	23	EA	12 INCH AND UNDER GATE BOX REMOVED AND RESET	\$658.00	\$15,134.00
402.	1100	CY	DENSE GRADED CRUSHED STONE FOR SUB-BASE	\$100.00	\$110,000.00
450.42	4400	TON	SUPERPAVE BASE COURSE - 37.5 (SBC - 37.5)	\$160.00	\$704,000.00
504.	4400	FT	GRANITE CURB TYPE VA4 - STRAIGHT	\$85.00	\$374,000.00
594.	4400	FT	CURB REMOVED AND DISCARDED	\$10.00	\$44,000.00
620.12	1300	FT	GUARDRAIL, TL-2 (SINGLE FACED)	\$425.00	\$552,500.00
701.	2000	SY	CEMENT CONCRETE SIDEWALK	\$105.00	\$210,000.00
702.	450	TON	HOT MIX ASPHALT SIDEWALK OR DRIVEWAY	\$340.00	\$153,000.00
740.	8	MO	ENGINEER'S FIELD OFFICE AND EQUIPMENT (TYPE A)	\$5,320.00	\$42,560.00
748.	1	LS	MOBILIZATION	\$300,000.00	\$300,000.00
751.1	550	CY	LOAM FOR LAWNS	\$90.00	\$49,500.00
765.	5000	SY	SEEDING	\$3.00	\$15,000.00
769.	1300	FT	PAVEMENT MILLING MULCH UNDER GUARD RAIL	\$12.00	\$15,600.00
999.001	2600	HR	POLICE DETAIL	\$100.00	\$260,000.00
997.01	1	LS	SUBSURFACE STORAGE SYSTEM 1	\$924,700.00	\$924,700.00
997.02	1	LS	SUBSURFACE STORAGE SYSTEM 2	\$1,841,100.00	\$1,841,100.00
997.03	1	LS	SUBSURFACE STORAGE SYSTEM 3	\$3,178,800.00	\$3,178,800.00

SUBTOTAL: \$10,428,654.00
35% Contingency & Inflation: \$3,650,029.00
TOTAL: \$14,078,683.00

**Winthrop Morton Street
Winthrop, MA
Woods Hole Group - Town of Winthrop
ENGINEER'S ESTIMATE - Conceptual Design - Alternative 3**

Prepared by:



Green Project No: 23078

Date: 6/14/2024

ITEM NO.	QUANTITY	UNIT	ITEM DESCRIPTION	UNIT PRICE	AMOUNT
120.	1920	CY	EARTH EXCAVATION	\$50.00	\$96,000.00
150.	6500	CY	ORDINARY BORROW	\$35.00	\$227,500.00
151.	3100	CY	GRAVEL BORROW	\$55.00	\$170,500.00
170.	7350	SY	FINE GRADING AND COMPACTING - SUBGRADE AREA	\$15.00	\$110,250.00
201.	1	EA	CATCH BASIN	\$8,900.00	\$8,900.00
202.	7	EA	MANHOLE	\$8,800.00	\$61,600.00
220.5	22	EA	DRAINAGE STRUCTURE REMODELED	\$728.00	\$16,016.00
220.8	9	EA	SANITARY STRUCTURE REMODELED	\$997.00	\$8,973.00
220.	5	EA	DRAINAGE STRUCTURE ADJUSTED	\$523.00	\$2,615.00
220.7	1	EA	SANITARY STRUCTURE ADJUSTED	\$1,200.00	\$1,200.00
241.12	700	FT	12 INCH REINFORCED CONCRETE PIPE CLASS III	\$135.00	\$94,500.00
354.12	3	EA	12 INCH AND UNDER GATE BOX REMOVED AND RESET	\$658.00	\$1,974.00
358.	14	EA	GATE BOX ADJUSTED	\$950.00	\$13,300.00
376.2	3	EA	HYDRANT - REMOVED AND RESET	\$4,907.00	\$14,721.00
402.	800	CY	DENSE GRADED CRUSHED STONE FOR SUB-BASE	\$100.00	\$80,000.00
450.42	3250	TON	SUPERPAVE BASE COURSE - 37.5 (SBC - 37.5)	\$160.00	\$520,000.00
504.	1650	FT	GRANITE CURB TYPE VA4 - STRAIGHT	\$85.00	\$140,250.00
594.	1650	FT	CURB REMOVED AND DISCARDED	\$7.00	\$11,550.00
620.12	1300	FT	GUARDRAIL, TL-2 (SINGLE FACED)	\$425.00	\$552,500.00
701.	1250	SY	CEMENT CONCRETE SIDEWALK	\$105.00	\$131,250.00
702.	200	TON	HOT MIX ASPHALT SIDEWALK OR DRIVEWAY	\$340.00	\$68,000.00
740.	8	MO	ENGINEER'S FIELD OFFICE AND EQUIPMENT (TYPE A)	\$5,320.00	\$42,560.00
748.	1	LS	MOBILIZATION	\$255,000.00	\$255,000.00
751.1	375	CY	LOAM FOR LAWNS	\$90.00	\$33,750.00
765.	3400	SY	SEEDING	\$3.00	\$10,200.00
769.	1300	FT	PAVEMENT MILLING MULCH UNDER GUARD RAIL	\$12.00	\$15,600.00
983.1	450	TON	RIPRAP	\$110.00	\$49,500.00
999.001	2000	HR	POLICE DETAIL	\$100.00	\$200,000.00
997.01	1	LS	SUBSURFACE STORAGE SYSTEM 1	\$924,700.00	\$924,700.00
997.02	1	LS	SUBSURFACE STORAGE SYSTEM 2	\$1,841,100.00	\$1,841,100.00
997.03	1	LS	SUBSURFACE STORAGE SYSTEM 3	\$3,178,800.00	\$3,178,800.00

SUBTOTAL: \$8,882,809.00
35% Contingency & Inflation: \$3,108,983.00
TOTAL: \$11,991,792.00