Appendix II
Construction Logistics – Fjord Trail South
II-1: Construction Logistics Report (North)

Appendix II
Construction Logistics – Fjord Trail South

II-1: Construction Logistics Report (North)

ARUP SCAPE

Hudson Highlands Fjord Trail

Shoreline Trail | Schematic Design

Construction Logistics Report (North)

Reference: 295084-SLT-REP05-CLR (North)

00 | February 23, 2024

Job number 295084-00

Arup US, Inc.
77 Water Street
New York, NY 10005
USA
arup.com

Contents

Tables

Figures

Appendices

1. Introduction

The Hudson Highlands Fjord Trail is a proposed linear park in the Hudson Highlands, spanning 7.5 miles with a walkable and bikeable trail between the City of Beacon and Village of Cold Spring in New York State. The Shoreline Trail ("the Project" or "SLT") is a 2.5-mile accessible segment of the trail planned between Breakneck Bridge and Dockside Park, consisting of trail sections that are on structure and paths that are on grade.

© Scape Landscape Architecture DPC

Figure 1 – Shoreline Trail location map

The project is comprised of two sub-projects which will be constructed in two phases:

- Shoreline Trail (North) – from access point of Little Stony Point to the south abutment of Breakneck Bridge (BNB Abutment #6). This only includes the main trail through Little Stony Point and excludes all other improvements at that location. This will also include the Breakneck Lower Overlook and any landscaping elements around the south abutment, which were excluded from Breakneck Bridge.
- Shoreline Trail (South) – from the northern limit of Dockside Park to the access point of Little Stony Point.

Figure 2 – Shoreline Trail North/South Division

Hudson Highlands Fjord Trail, Inc. ("HHFT") was formed in January 2020 as an independently managed non-profit subsidiary organization of Scenic Hudson, Inc. HHFT will be responsible for operating and maintaining the entire trail, including the Shoreline Trail. HHFT and the New York State Office of Parks, Recreation and Historic Preservation ("OPRHP") are working in partnership to advance the project through environmental permitting, procurement, and construction.

HHFT has commissioned Arup US, Inc. ("Arup") to complete the schematic design of the Shoreline Trail. Scape Landscape Architecture DPC ("Scape") will serve as the lead design consultant and subconsultant to Arup. SLR Consulting Limited ("SLR") has been retained as the wetland ecologist and Manuel Miranda Practice ("MMP") for signage and wayfinding design.

About the Work ("AtW") are acting as owner's representative for HHFT and have been responsible for management and direction of Arup's services.

The scope is this report is to describe the design development, provide consideration of construction logistics for the Lower Overlook and on-grade sections of trail, and provide high-level schedules for construction of the trail.

2. Design Development

This section provides a description of the design schemes for the different sections of trail within Shoreline Trail (North).

2.1 On-Structure Trail

2.1.1 Foundations

- The base design is a centered single 36 in. driven steel tube pile is proposed at each support, except for every fourth support where a double pile is required to allow a thermal joint to be formed in the structure.
- 42-in. diameter driven steel tube piles off-centered by 1.5 ft are adopted in specific locations to minimize the number of piles that sit below the MHHW level. A larger diameter is required to resist the increase in bending and lateral forces due to eccentric loading.
- Pile lengths vary from 35 to 105 ft from pile cut off level. The typical spacing between supports is adopted as 50 ft, governed by capacities. A wall thickness of 0.75 in., which includes a sacrificial thickness of 0.2 in. for corrosion resistance, is used. The maximum distance between the mudline and pile cut off is 7 ft.

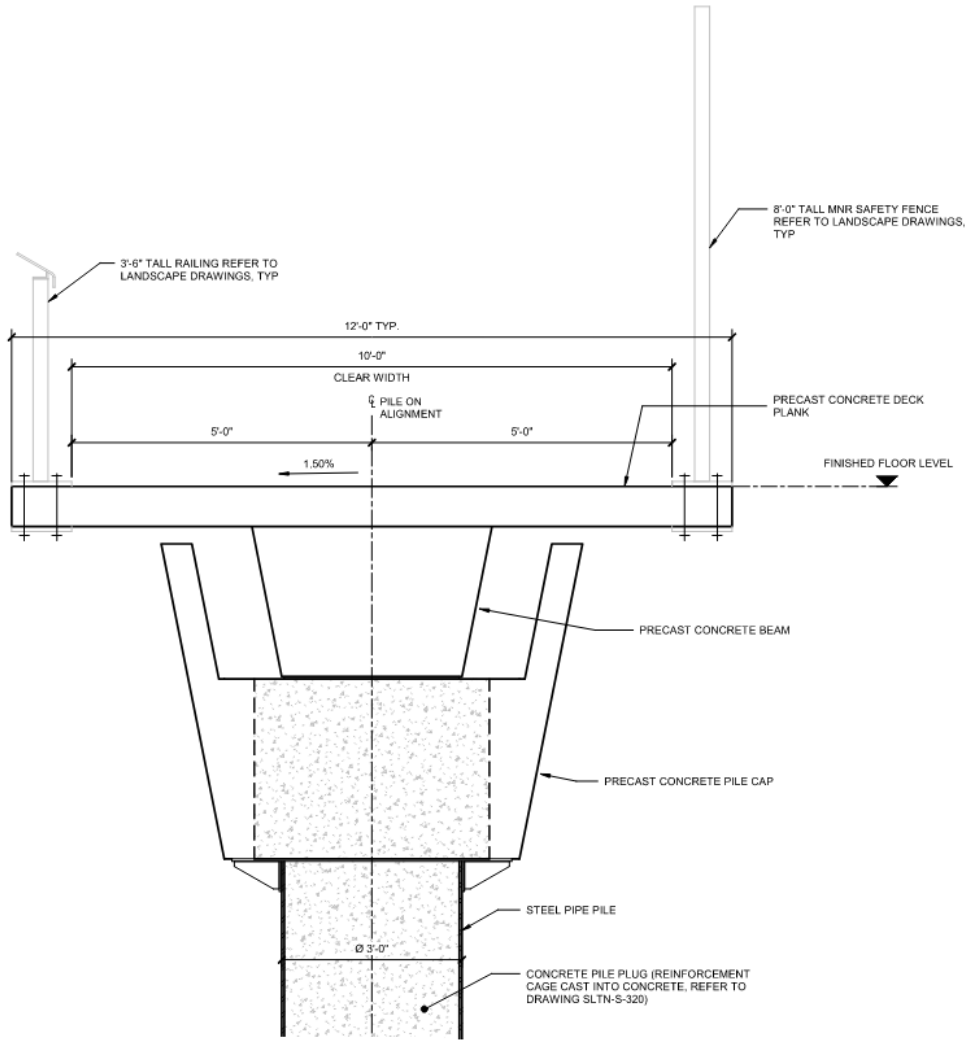


Figure 3 – Typical cross-section through on-structure trail.

2.1.2 Substructure

- A cast-in-place reinforced concrete plug extending approximately 8 ft below the mudline is used. This provides additional resistance to the pile to compensate for the loss of steel tube thickness as it corrodes over time.
- A precast concrete pile cap is adopted, with voids that are large enough to accommodate an assumed plan position tolerance of the driven steel piles of 6 in. at the pile head.
- The pile cap is temporarily supported on the pile tops by steel brackets fixed to the top of the pile, until the cast-in-place concrete stitch is constructed. Reinforcement from the pile plug extend above the pile cap to provide a moment connection with the superstructure beams.

2.1.3 Superstructure

- A single 2 ft-6 in. deep precast reinforced concrete beam is used to span between supports (typical span of 50 ft)
- An integral connection to the piles creates continuous spans. Thermal expansion and contraction are accommodated using discontinuities in the structure at typical 200 ft intervals.
- 8-in. thick precast reinforced concrete planks are supported on top of the beam with transverse cantilevers each side. The total width of the planks is 11.5 ft to provide space along each edge for a handrail and 10-ft clear width. The planks are connected to the beam using anchor rods cast into the beams and grout pockets in the deck planks.
- Where the horizontal alignment of the on-structure trail is curved, straight beams are used between caps and the curvature is accommodated in the precast deck planks.

2.1.4 Trailbanks

- The on-structure trailbank uses similar piled foundations to the main on-structure trail.
- The superstructure uses primary steel beams supported directly on the piles. The protruding threaded anchor bolts from the piles are inserted through holes in the beam’s connection plates and fastened.
- A secondary grid of steel beams forms the structural envelope of the platform. This grid is bolted to the top of the primary beams.
- A steel mesh grating is supported on the secondary grid of beams and abuts (with a small gap) the edge of the main trail deck to provide a continuous surface.

2.2 On-Grade Trail and Lower Overlook

- The trail will be graded to elevations as defined on Civil grading drawings and in accordance with project specifications. Edge transitions from the primary trail proposed elevations to meet existing grades vary along the trail alignment as defined on drawings.
- The trail fill will be graded to meet existing grades with general fill where shown on Civil grading drawings. General fill shall be sloped at a maximum of 2H:1V or 3H:1V. Maximum fill slopes are defined along the trail alignment to indicate where each apply.
- The trail fill will be retained using either a stacked stone wall or a gabion basket wall. A stacked stone wall shall have a facing slope no steeper than 1H:4V and have a minimum top width of 0.5 ft and a minimum base width of 4 ft.
- When an existing slope is either steeper than 2H:1V or shows signs of erosion or slope failure, riprap shall be used to stabilize the slope, a typical section is shown in Figure 4. Riprap sizing shall be in accordance with

NYSDOT Geotechnical Design Manual (GDM) Chapter 7. Efforts shall be made to match the new riprap with the existing riprap stone.

- NYSDOT Type 1 subbase shall be used for the build-up of the on-grade trail portions beneath the upper wearing coarse. Where greater permeability is required a layer of open-graded subbase in accordance with NYSDOT GDM Chapter 7 shall be placed beneath the Type 1 subbase. It is anticipated that the fill thickness will vary from 2 to 8.5 ft along the on-grade trail.
- An aggregate pavement with a minimum subbase thickness of 1 to 2 ft and a 6 in. wearing coarse is required. An interlocking pavement grid may be used to reduce the risk of pavement wash out.
- At locations where the on-grade trail is to be constructed over existing boulder riprap, large boulders shall be removed and replaced with aggregate fill down to a depth where a level subgrade can be achieved.
- Efforts shall be made to minimize impact to mature trees and/or tree clusters along the on-grade alignment. Air spade excavation and root bridging techniques shall be used to protect mature trees. In designated preserved low-slope habitat areas, efforts shall be made during construction to minimize the impact to the existing condition.

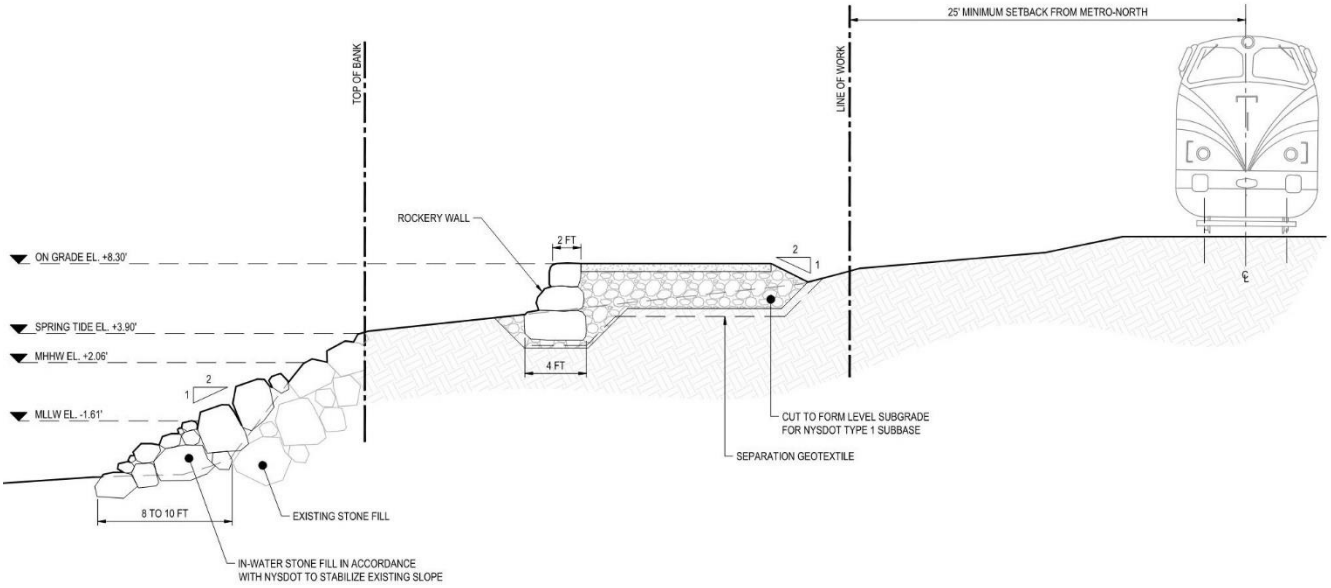


Figure 4 – Typical on-grade section showing in-water fill to stabilize existing slope

- Approximately 300-350 ft of on-grade trail on Little Stony Point utilizes a lightweight boardwalk structure to preserve existing drainage patterns. This structure is likely to comprise helical piles or micropile foundations, with simple steel or concrete framing and a concrete or timber plank decking.

3. Indicative Construction Methodology

This section describes an indicative stage-by-stage methodology for the typical construction activities.

3.1 On-Structure Trail

It is broken down into the stages described in Table 1 below.

Table 1 | Summary of Waterside construction sequence

Stage #	Stage Name	Stage Description
1	Riprap Clearance	Crane with clamshell bucket or similar moves large boulders away from the pile locations.
2	Pile Driving	Crane with diesel or hydraulic hammer attachment (including grounded hanging leads) drives the steel tube piles through overburden until termination criteria is achieved.
3	Cleaning for pile plug	Crane switches to clamshell bucket attachment and cleans out soil in steel pipe pile to 8 ft below mud line.
4	Pile Cap Construction	Crane lifts precast pile cap into place on top of piles. Cast-in-place concrete stitch and pile plug is poured.
5	Superstructure Beam Installation	Crane lifts superstructure beams onto the pile cap supports. Integral connection is made using cast-in-place concrete stitch.
6	Deck Plank Installation	Crane lifts deck planks and places onto beams.

3.1.1 Riprap Clearance

Move large riprap boulders away from the pile locations using a crane with clamshell or caisson bucket. This reduces the risk of pile obstructions during driving which may either prevent the piles from being able to be driven or displace the pile from its intended position.

3.1.2 Pile Driving

Change the crane attachment to the hydraulic or diesel pile driving hammer, including grounded hanging leads to guide the pile hammer, and drive pile to their final depth.

3.1.3 Cleaning for pile plug

Cut the piles to the required level and clean them out to pile plug toe level using a crane with clamshell bucket. Access to the pile head from land or water is required.

If there is water inside the piles, pump it out prior to pouring concrete inside the pile. If negligible water is present, the concrete can be poured using a tremie pipe. Any water discharge to the Hudson River will need to be coordinated with NYS DEC.

3.1.4 Pile Cap Construction

Lift the steel top bracket onto the pile, then lift the pile plug reinforcement cage into the pile. Lift the precast pile cap onto the steel top brackets that provide support. Survey and set the position and level of the cap accurately.

Seal any gaps between the pile cap void and the steel top bracket with temporary formwork. Pour the cast-in-place pile plug and stitch connection to top of pile cap level using a boom concrete pump truck on a small construction barge.

3.1.5 Superstructure Beam Installation

Lift and place the permanent superstructure beams onto the pile cap supports using the crane.

Install splice reinforcement between beams, set formwork and pour integral stitch. This stitch can be poured using a boom concrete pump truck on a small construction barge.

3.1.6 Deck Plank Installation

Lift and place the permanent deck planks onto the beams using the crane. Grout up anchor pockets to form connection.

3.2 On-Grade Trail and Lower Overlook

The anticipated construction sequence for the on-grade trail and lower overlook is broken down as follows:

1. Tree protection: install protection measures for existing trees as needed.
2. Place riprap: place riprap to stabilize the existing embankment in areas that show signs of erosion or failure or that are steeper than 2H:1V. riprap shall be in accordance with NYSDOT GDM Chapter 7.
3. Ecological enhancements: construct planted shelf, as needed.
4. Grading operations: clearance of existing vegetation, debris, organic material, soft or compressible soils, and other unsuitable material.
5. Excavate to subgrade level: After stripping and grubbing, excavate to competent subgrade depth to allow construction of the stacked stone or gabion wall, pavement, and drainage measures. At locations where the on-grade trail is to be constructed over existing cobble/boulder riprap, large boulders shall be removed and replaced with NYSDOT Type 1 subbase fill down to a depth where a level subgrade can be achieved.
6. Prepare subgrade: proof roll the subgrade to aid in locating loose or soft areas, areas to be fill should then be scarified and moisture-conditioned, any loose or soft areas shall be removed and backfilled with NYSDOT Type 1 subbase. Subgrade shall be protected from wetting following exposure and prior to placement of fill, drainage should be implemented to avoid collection of water.
7. Survey subgrade elevations: survey subgrade elevations and stake proposed-grade elevations for each subsequent layer to be placed.
8. Geotextile: place a separation geotextile between the base of retaining wall/pavement subbase and subgrade.
9. Place bedding layer: place a 6 in. granular bedding layer between the base of the retaining wall / pavement subbase and geotextile to avoid damage to the geotextile.
10. Construct retaining wall: place stacked stone or gabion baskets to required height with a minimum embedment of 2 ft at the front of the wall.
11. Place subbase: place subbase in 6 in. layers followed by compaction to 95% of the maximum dry density. Subbase shall be NYSFOT Type subbase.
12. Place wearing course: place 6 in. wearing course, either impervious or open-graded with an interlocking grid.
13. Survey final elevations: survey final finished grade elevations and notify the Engineer of any discrepancies in accordance with the project specifications.

Construction of the short length of boardwalk structure on Little Stony Point can use simple traditional methods of construction to install small scale helical piles or micropiles, followed by erection of the deck framing and planks using a small mobile crane located on the adjacent grade.

4. Outline Construction Logistics and Schedule

4.1 Construction Logistics

Construction for Shoreline Trail (North) requires the following key logistical items:

- A landing point near Breakneck for equipment and material access to on-land works for the Lower Overlook.
- A construction barge with a mounted crane for piling and erection of the precast concrete substructure and superstructure elements.
- A materials barge to supply the construction barge with materials as it progresses along the shoreline.
- A land access road through Little Stony Point for the on-grade trail construction works commencing northwards.

Figure 5 – Construction logistics concept for construction of Shoreline Trail (North).

4.1.1 Key Constraints

4.1.1.1 Closest point of barge approach

Construction must be carried out in high-tide windows. This is due to shallow bathymetry and the typical requirement from permitting agencies for a 2ft minimum clearance limit from the vessel hull, or any portion of the equipment that extends below the hull, to the river bottom. Therefore, the closest point of approach ("CPA") for a barge with 3ft of draft is (-)6.61 ft NAVD88.

The bathymetry along the site and an assumed barge of approximately 80ft x 80ft x 7ft deep, requires a crane that can complete all construction activities at an approximate reach of 90 ft. Based on this, potentially suitable cranes are identified in Table 2 below.

Table 2 | Suitable cranes for Waterside construction.

Name	Type	Max Lifting Capacity (tons)	Track Footprint (ft in)
Manitowoc 2250	Crawler Crane	300	31' x 27'
Liebherr LR1300	Crawler Crane	330	32' x 27'

A summary of the required crane lifts is given in Table 3 below.

Table 3 | Summary of required lifts for Waterside construction.

Lift Description	Load (lbs)	Reach (ft)	Height (ft)	Capacity (lbs)
Riprap clearance (assumes maximum boulder size of 64 ft^3)	15,000	90	-	88,400 – 97,600
100 ft 36 in. pile section with hydraulic hammer	65,000	90	100	86,900 – 97,600
100 ft 42 in. pile section with hydraulic hammer	69,000	90	100	86,900 – 97,600
Precast RC Abutment	35,000	90	-	88,400 – 97,600
Precast RC Pile Cap	9,700	90	-	88,400 – 97,600
Precast RC Beam	70,000	90	-	88,400 – 97,600
Precast RC Deck Planks	4,600	90	-	88,400 – 97,600

There are two locations of shallow riverbed that despite tidal working, are extremely difficult to get close enough to the shoreline without infringing on the 2ft clearance requirement. This should be discussed with the permitting agencies and construction at these locations should be planned in detail around the periods of highest tide.

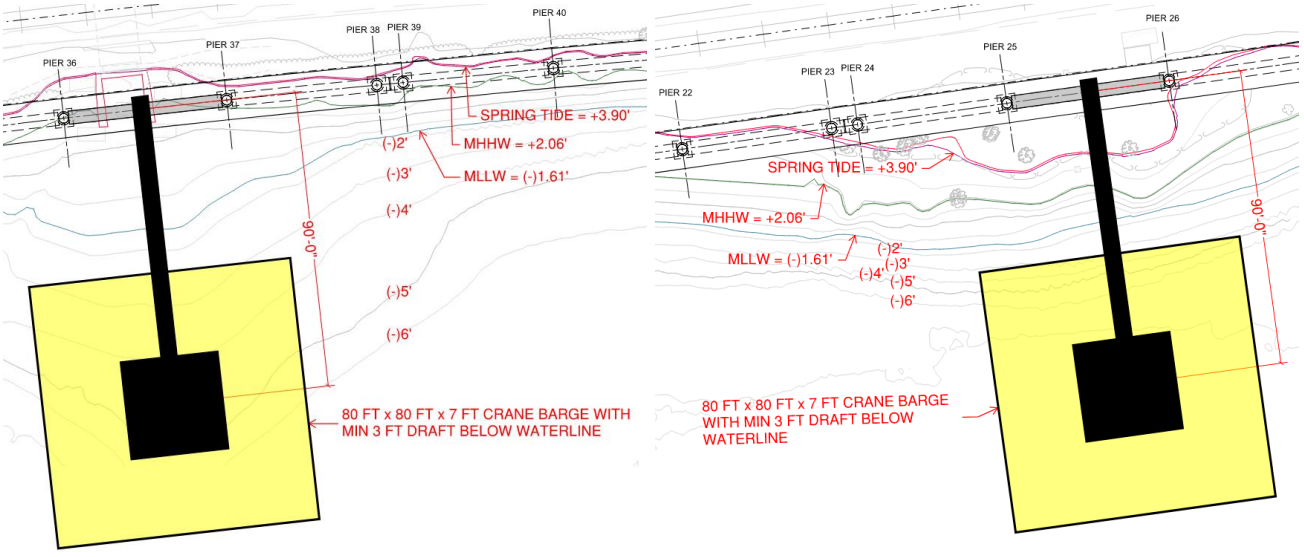


Figure 6 – Shallow riverbed locations for Waterside construction.

4.1.1.2 Tidal window working

The crane barge cannot operate at low tide and must remove its spud piles and move away from the shoreline to deeper water. Once the tidal level is sufficiently high, the crane barge may approach the shoreline again to set up and commence work. Working on tidal windows presents logistical challenges and as a result, construction will progress slowly.

A critical aspect to tidal window working is the tidal window duration. Figure 7 shows tide predictions from the National Oceanic and Atmospheric Administration ("NOAA") for the first week of May 2024. A threshold of 1 ft above Mean Lower Low Water ("MLLW") is applied so that the tidal windows with sufficient depth to support construction are filled in red. From this, the approximate duration of an average tidal window is estimated to be 7 hours. In this time, a crane barge would need to float into position, set its spud piles, perform

its construction activities, lift its spud piles, and float out before the under-hull clearance dropped to less than 2 ft.

Another aspect is whether these tidal windows occur during suitable times of day for construction. As can be seen in Figure 7 which uses tide predictions for the period of May 2024 through October 2024, suitable tidal windows are not necessarily aligned with the hours of a typical working day. To illustrate this, two scenarios are considered:

- Typical working day of 7:00am to 5:00pm. The max high tide should occur between 10:30am and 1:30pm for a full 7-hour tidal window to fall within the typical working day. Expected to occur on 51 out of 356 high tide events.
- Typical working day of 7:00am to 5:00pm. The max high tide should occur between 7:00am and 5:00pm for a 3.5-hour tidal window to fall within the typical working day. Expected to occur on 149 out of 356 high tide events.

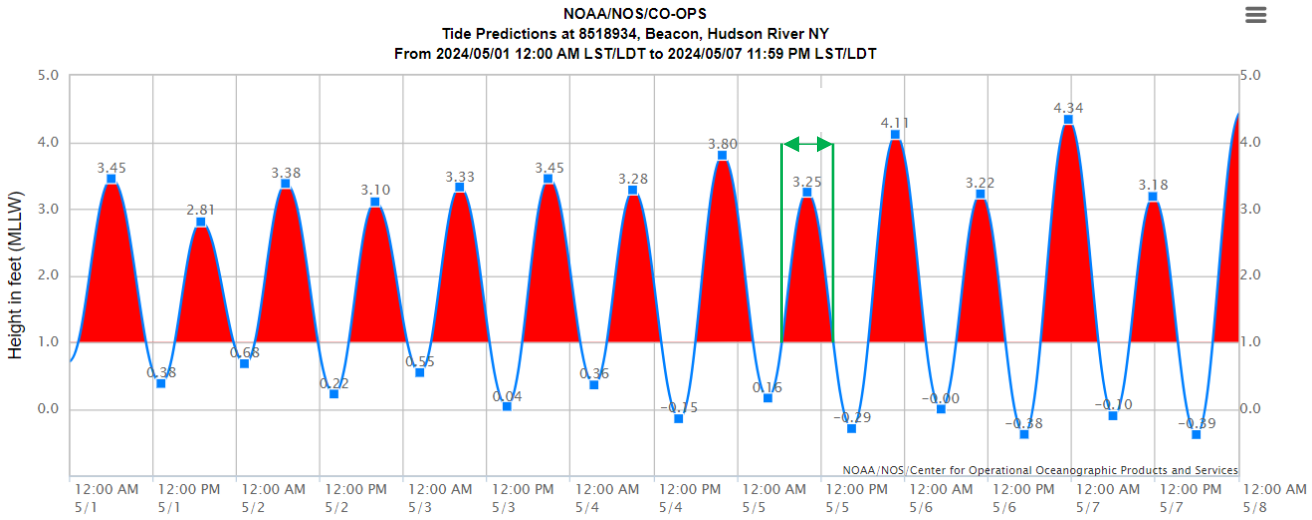


Figure 7 – Approximate length of tidal window for Waterside construction based on tide predictions for May 2024. Data from NOAA/NOS/CO-OPS extracted on 07/17/2023[G].

The intention of the data provided is to help quantify the issue to aid understanding at this stage. However, it will be the remit of the contractor to establish their own working schedule. This might include work outside of typical working hours to accommodate the best tidal cycle, where permitted.

4.1.1.3 Submerged Aquatic Vegetation (SAV)

NYS DEC mapped SAV (2018) shows small areas of SAV present along Shoreline Trail (North) where Waterside construction of the on-structure trail is required.

Where practically possible, placement of construction equipment within the SAV zone should be avoided. The USACE will require a survey of SAV extents to be submitted prior to the start of construction, typically within 2 years. This is to confirm minimal to no impacts to the ecological resource.

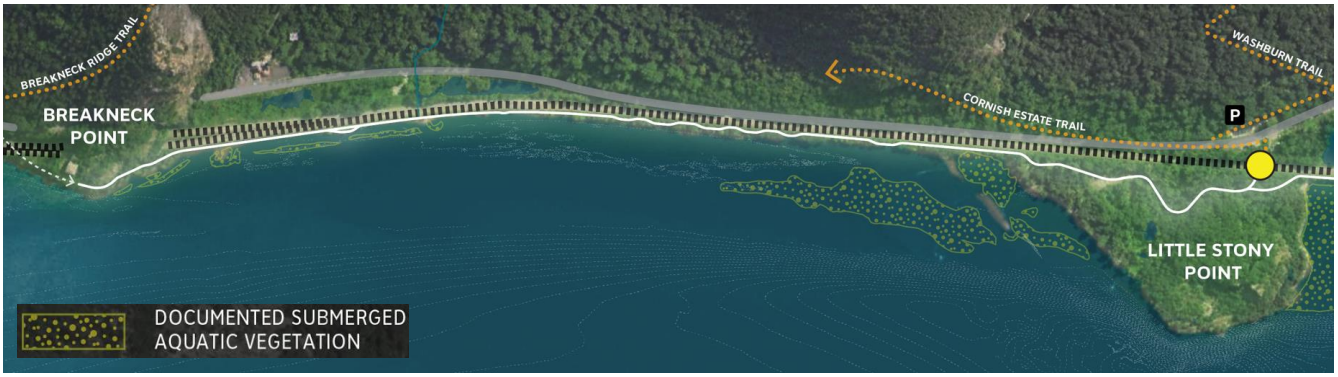


Figure 8 – NYS DEC mapped SAV (2018)

4.1.1.4 Access through Little Stony Point

Access to complete the on-grade trail construction north of Little Stony Point (LSP) is required via LSP itself. A construction access road will need to be established through LSP to service these works. This is likely to require some amount of temporary fill to form a level and firm route through the existing terrain.

This route is likely to follow a similar alignment to the permanent trail through LSP. Consequently, construction of the on-grade trail through LSP should be completed after all other works requiring the use of this construction access road are completed.

4.2 Construction Schedules

4.2.1 Assumptions

The indicative construction schedule is based on the following assumptions:

- Construction season duration due to environmental restrictions of six months, four weeks per month, for any in-water work. All work that requires a crane barge is subject to this restriction.
- Based on tidal restrictions and assuming normal working hours, only 25% of workdays can be fully utilized for in-water work, and only 50% can be partially utilized. As such, it is generally assumed that there will be 1.5 weeks of productive work in any four week period. It should be noted that there are other weather events and circumstances that may reduce the number of available working days in a given week and prolong the schedule.
- Standard working week of five days.
- One large barge mounted crane to progress pile driving and heavy lifting operations for superstructure beams. Two smaller support cranes supporting deck placement and any cast-in-place concrete activities.
- Finishing work for on-structure components can progress in parallel with structural work since all work is progressed from waterside. This work can progress at all times, since materials can be stored on the structure from barges during in-water work periods.
- Structural steel and grating deck sections can be installed at the on-structure trailbank from the structure during restricted periods for on in-water work.
- On-grade trail construction from Little Stony Point to the north can begin as soon as construction access is established at Little Stony Point.
- On-Grade trail construction from the Lower Overlook can proceed as temporary barge access is established at Breakneck Ridge.

- The on-grade trail through Little Stony Point cannot be constructed until all on-grade construction is completed to the north.

4.2.2 Outline Schedule

Based on this average production rate, it is assumed that it will take five construction seasons to construct Shoreline Trail (North). The sequence is summarized as follows:

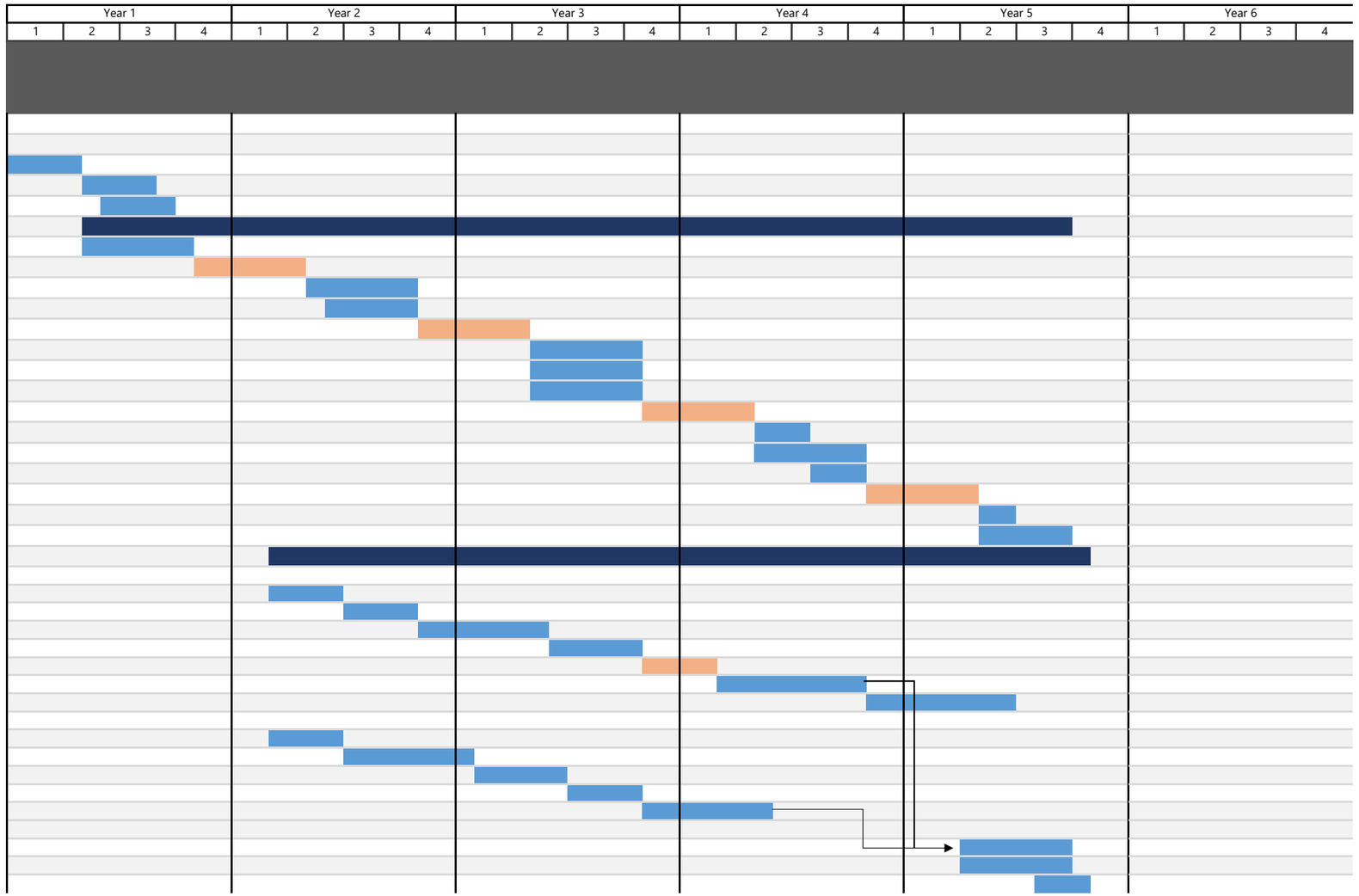
1. Mobilization
    a. Establish access points through Little Stony Point and at Breakneck ridge near the Lower Overlook
    b. Clear and grub as necessary at Little Stony Point to the north and at Lower Overlook.
2. On-structure trail construction
    a. Install all pipe piles in first construction season, generally progressing from north to south.
    b. In subsequent seasons, install superstructure beams with primary marine crane. As beams are installed, begin installing deck plans with secondary crane following behind.
    c. After a sufficient number of deck panels have been installed, begin installing fencing and railing sections with secondary crane following behind.
3. On-grade trail construction
    a. Construct on-grade trail from Little Stony Point in parallel with waterside on-structure construction, including subgrade preparation and compaction, placement of subbase material over separation geotextile, placement of wearing coarse and interlocking grid if required, installation of trail edge protection, drainage, revetment improvements, and stacked stone or gabion walls where required.
    b. Construct on-grade trail at the Lower Overlook in parallel with waterside on-structure construction, including subgrade preparation and compaction, placement of subbase material over separation geotextile, placement of wearing coarse and interlocking grid if require, installation of trail edge protection, drainage, revetment improvements, and stacked stone or gabion walls where required.
    c. Perform final site seeding, planting, and cleanup.

Appendix A

Indicative Construction Schedule

HHFT SHORELINE NORTH TRAIL - INDICATIVE CONSTRUCTION SCHEDULE

WBS	Status	Task Name	Task Type	Resource
0		**NTP**	**Milestone**	
1		***Mobilization***	***Summary***	
1.1		Site Mobilization	Detailed	
1.2		Site Clearing	Detailed	
1.3		Establish access in Little Stony Point & Breakneck	Detailed	
2		***On Structure Trail Construction***	***Summary***	
2.1		Pile Driving	Detailed	
2.2		Seasonal Restriction on In-Water Work	Detailed	
2.3		Superstructure Installation - Abut A, Piers 1 to 35	Detailed	
2.4		Deck Installation - Piers 1 - 30	Detailed	
2.5		Seasonal Restriction on In-Water Work	Detailed	
2.6		Superstructure Installation - Abut B, Piers 36 to 70	Detailed	
2.7		Deck Installation - Piers 31 to 60	Detailed	
2.8		Fencing and Railing Installation - Pier 1 - 30	Detailed	
2.9		Seasonal Restriction on In-Water Work	Detailed	
2.1		Deck Installation - Piers 61 to 70	Detailed	
2.11		Fencing and Railing Installation - Pier 31 to 60	Detailed	
2.12		Fencing and Railing Installation - Pier 61 to 70	Detailed	
2.13		Seasonal Restriction on In-Water Work	Detailed	
2.14		Amenities, benches	Detailed	
2.15		Trailbanks	Detailed	
3		***On Grade Construction***	***Summary***	
3.1		***Little Stony Point to North***	***Summary***	
3.1.1		Establish construction road through LSP	Detailed	
3.1.2		Revetment Improvements and Slope Stabilization	Detailed	
3.1.3		Prepare Subgrade (Excavate / Fill)	Detailed	
3.1.4		Install trailbanks and Quarry Stone	Detailed	
3.1.5		Shutdown for winter eathworks	Detailed	
3.1.6		Install trail base and wearing course	Detailed	
3.1.7		Install Fencing On-Grade	Detailed	
3.2		***Lower Overlook to South***	***Summary***	
3.2.1		Revetment Improvements and Slope Stabilization	Detailed	
3.2.2		Prepare Subgrade (Excavate / Fill)	Detailed	
3.2.3		Install trailbanks and Quarry Stone	Detailed	
3.2.4		Install trail base and wearing course	Detailed	
3.2.5		Install Fencing On-Grade	Detailed	
3.3		***Site Wide***	***Summary***	
3.3.1		Seeding	Detailed	
3.3.2		Planting	Detailed	
3.3.3		Cleanup	Detailed	



This is intended to be an indicative schedule to provide an order of magnitude estimate on the duration of construction. The actual duration can be influenced by the means and methods of the Contractor, equipment sizing and availability, finalization of environmental restrictions and weather.