A. INTRODUCTION

This chapter presents the existing conditions and addresses the Proposed Action's potential effects on land within the Fjord Trail South Corridor. An evaluation of the proposed Fjord Trail North is provided in Chapter III.C, "Land – Fjord Trail North."

This chapter describes the existing geology, soils, and topography along the Fjord Trail South Corridor and addresses potential impacts to these resources. Bedrock geology, surface soils, and steep slopes are based on topographic surveys and data published by the U.S. Department of Agriculture – Natural Resources Conservation Service (NRCS). Impacts to these resources are based on the potential for soil erosion and impacts to geologic resources. The sections on surficial geology and soils consider the unconsolidated surficial deposits and the uppermost layer of the ground, which has been exposed to climatic and erosive forces. The bedrock geology sections consider the underlying bedrock. The topography sections address issues related to slopes, accessibility, and sea level rise.

REGULATORY CONTEXT FOR SLOPES AND ACCESSIBILITY

To the extent the proposed Fjord Trail South would be constructed on lands owned by the Metropolitan Transportation Authority (MTA)/Metro-North Railroad (MNR) or located within the Hudson Highlands State Park Preserve (HHSPP), which is under the jurisdiction of the New York State Office of Parks, Recreation, and Historic Preservation (OPRHP), local slope regulations are generally inapplicable.

The Main Trail would be designed to be Accessible, which means it will provide recreational opportunities for everyone regardless of differences in ability. The Main Trail would be 10 to 14 feet wide and gently sloped.

B. EXISTING CONDITIONS

SURFICIAL GEOLOGY AND SOILS

The surficial geology of the area of the Fjord Trail South Corridor is predominately lacustrine silt and clay, till, and recent alluvial deposits. Surficial soils along the Fjord Trail South Corridor generally consist of loamy till, sandy and gravelly loam, along with some unweathered bedrock present at Little Stony Point. Areas of the Fjord Trail South Corridor on Little Stony Point and Dockside Park are generally characterized by a mixture of glacial till, outwash, and river deposits.[1] Areas of the Fjord Trail South Corridor located within Cold Spring are mostly characterized by soils made up of coal slag fill material, and the northern portion of Little Stony Point comprises crushed rock fill from prior quarrying activity (see **Appendix III/IV.C**). Surficial soils vary in depth from less than a foot to several feet thick along the Fjord Trail South Corridor, and surficial

[1] Scape. 2019. Hudson Highlands Fjord Trail Initial Review and Analysis Report. April 8, 2019.

soils are thin or absent in some areas where bedrock outcroppings are present, including Little Stony Point and Dockside Park.

Soil types within the Fjord Trail South Corridor are shown in **Figure IV.C-1**. As described in **Table IV.C-1**, these soils are generally well-drained to somewhat excessively well-drained and have low water tables (i.e., greater depths to groundwater) and deep bedrock, except for occasional outcrops. Surficial soils along the Fjord Trail South Corridor are characterized by slopes ranging from 2 percent to 60 percent and vary from smooth to very rocky.

BEDROCK GEOLOGY

The Fjord Trail South Corridor is located in the Hudson Highlands, an area of the Hudson River Valley characterized by mountains and steep grade changes. Hard granites and gneisses are present in the northern and central portions of the Fjord Trail South Corridor, with softer biotites and gneisses found in Cold Spring. Bedrock types adjacent to the Fjord Trail South Corridor include quartz-plagioclase gneiss (qpg) and Hornblende granite and granite gneiss (hg) (see **Figure IV.C-2**). According to the soil characteristics, bedrock is generally located 10 to more than 80 inches below ground surface. However, some unweathered bedrock is present at Little Stony Point. The bedrock geology in the vicinity of the Fjord Trail South Corridor may influence construction and installation of footings or support structures for the elevated portions of the proposed trail.

Fault lines representing shifts of the earth's crust from plate tectonic forces during different eras are located along the Fjord Trail South Corridor. The fault lines mostly run northeast to southwest (see **Figure IV.C-3**). Fault lines can be seen along the Fjord Trail South Corridor with structural deformations such as folding, which is caused by compression of the rock layers that causes twists and bends within rocks over time. The faults in the region are considered inactive as they are very old. However, some plate tectonic movement can create some small minimally noticeable earthquakes.

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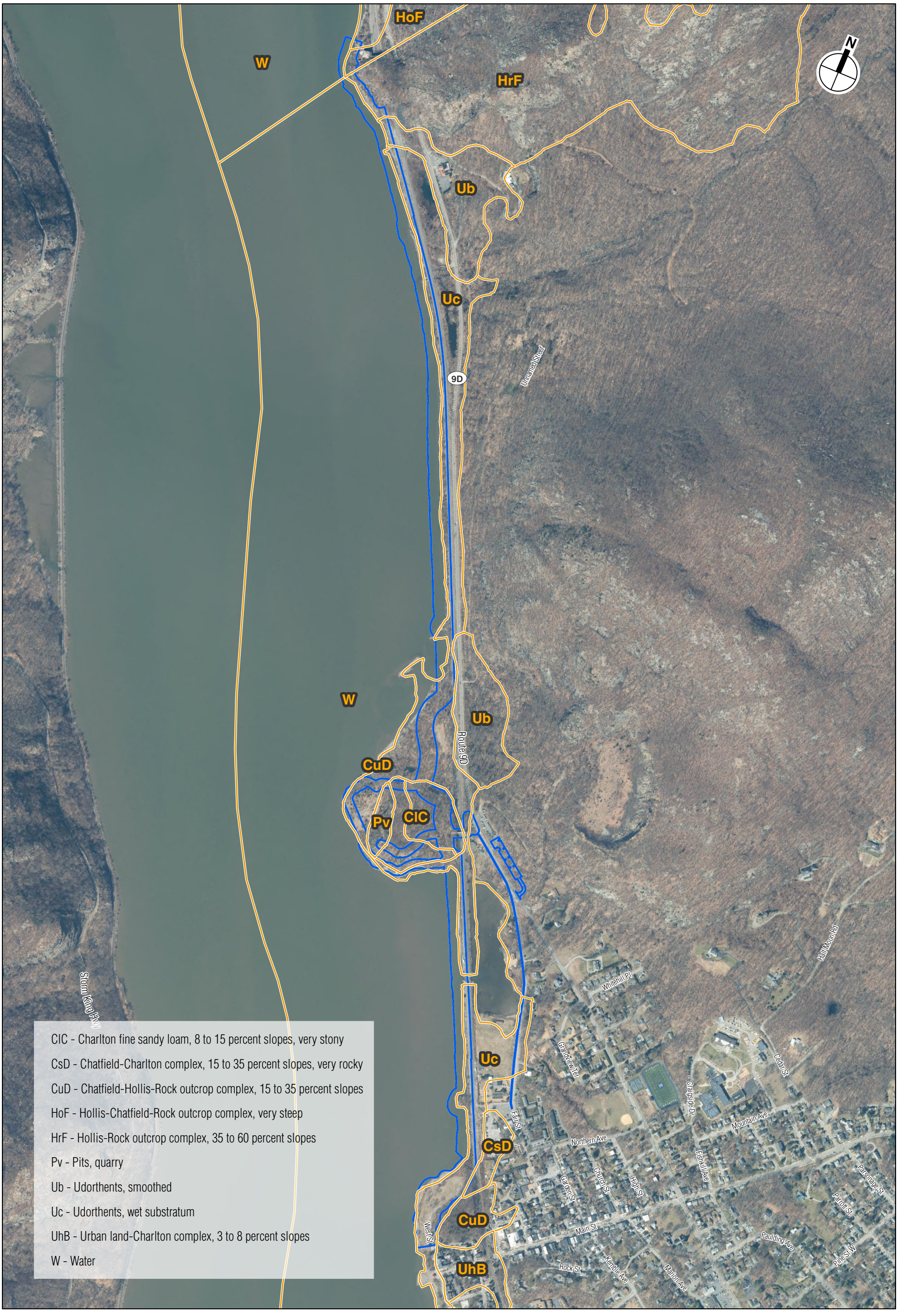

NRCS Soils

HUDSON HIGHLANDS FJORD TRAIL

Figure IV.C-1

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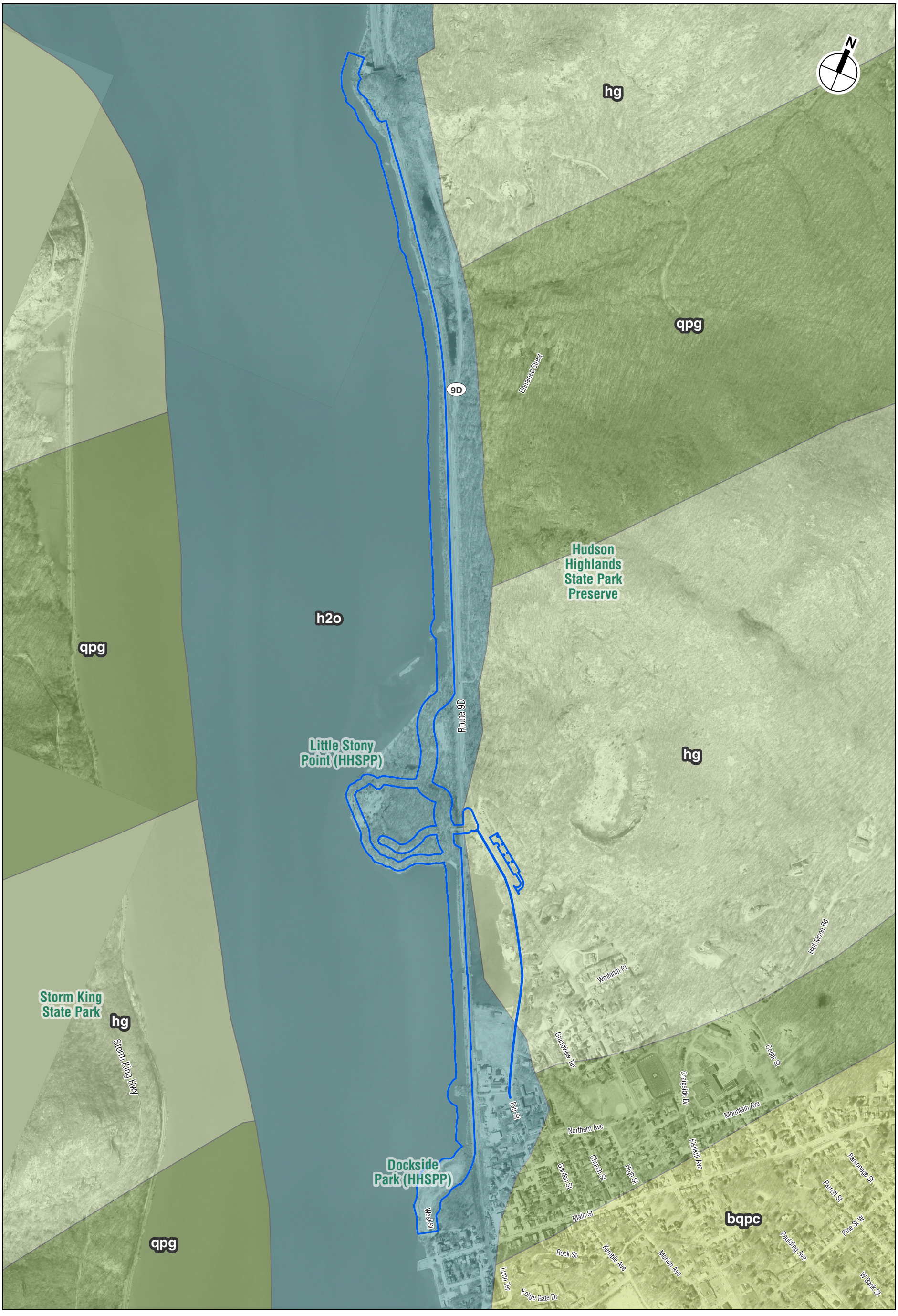

Trail Corridor - Fjord Trail South

bqpc Biotite-quartz-plagioclase gneiss

hg Hornblende granite and granite gneiss

h2o Water

qpg Quartz-plagioclase gneiss

0 2,000 FEET

Bedrock Geology

HUDSON HIGHLANDS FJORD TRAIL

Figure IV.C-2

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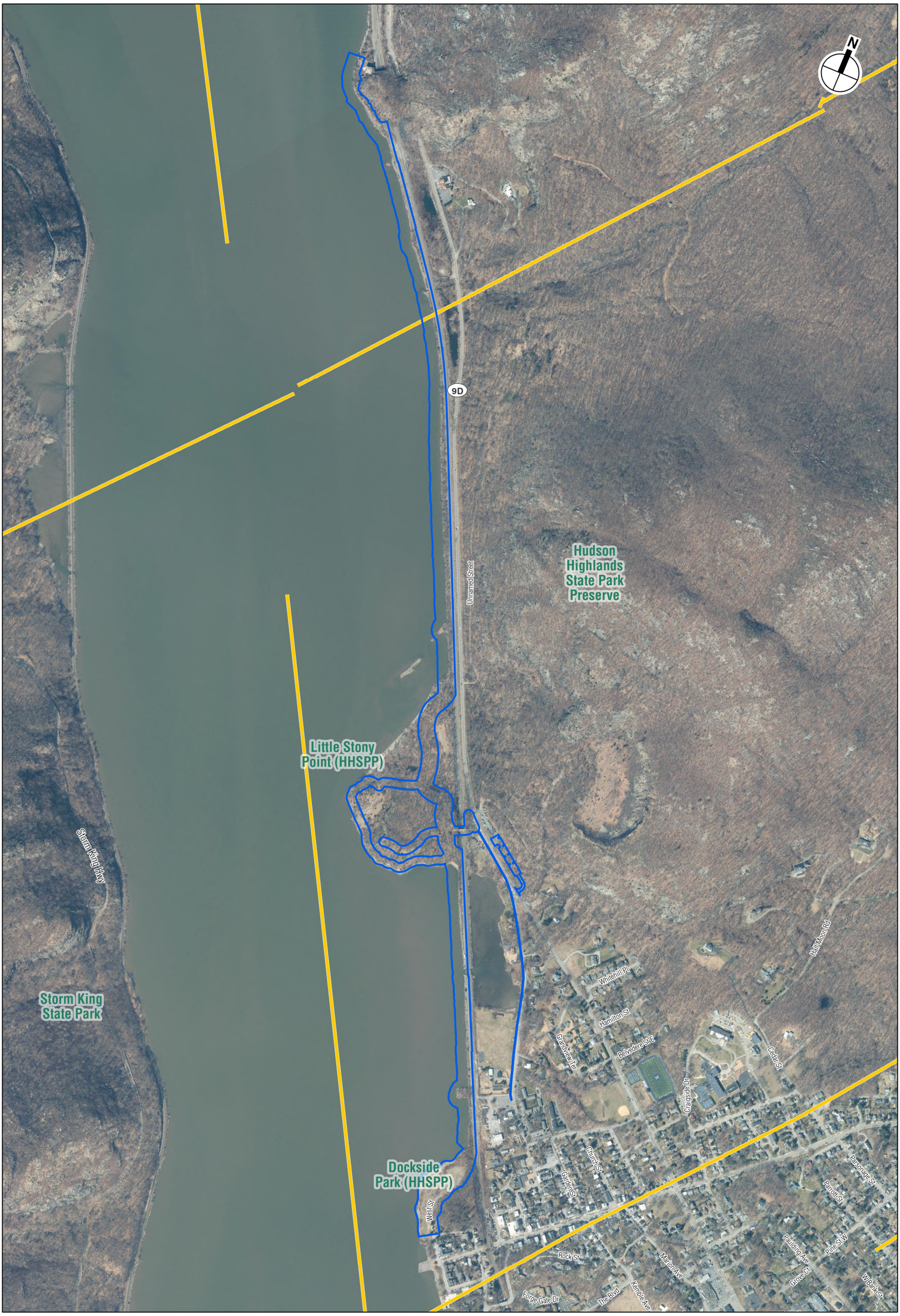

Trail Corridor - Fjord Trail South

Fault Lines

HUDSON HIGHLANDS FJORD TRAIL

Fault Line Locations

Figure IV.C-3

Table IV.C-1
Soils underlying the Fjord Trail South Corridor

Symbol	Soil Series name	Drainage Class	Depth to bedrock	Depth to seasonal high water	Characterization
ClC	Charlton fine sandy loam, 8 to 15 percent slopes, very stony	Well drained	More than 80 inches	More than 80 inches	Moderately low to high capacity of the most limiting layer to transmit water (Ksat = 0.14 to 14.17), moderate available water storage (about 8.7 inches). Hydric Soil Group: B.
CsD	Chatfield-Charlton complex, 15 to 35 percent slopes, very rocky	Well drained	20 to 41 inches to lithic bedrock	More than 80 inches	High runoff class. Very low capacity of the most limiting layer to transmit water (Ksat = 0.0 in/hr). Low available water storage (about 4.3 inches). Hydrologic Soil Group: B.
CuD	Chatfield-Hollis-Rock outcrop complex, 15 to 35 percent slopes	Well drained	20 to 41 inches to lithic bedrock	More than 80 inches	High runoff class. Very low capacity of the most limiting layer to transmit water (Ksat = 0.0 in/hr). Low available water storage (about 4.3 inches). Hydrologic Soil Group: B.
HoF	Hollis-Chatfield-Rock outcrop complex, very steep	Somewhat excessively drained	10 to 20 inches to lithic bedrock	More than 80 inches	Very low to high capacity of the most limiting layer to transmit water (Ksat = 0.00 to 5.95 in/hr). Very low available water storage (about 1.9 inches). Hydrologic Soil Group is D.
HrF	Hollis-Rock outcrop complex, 35 to 60 percent slopes	Somewhat excessively drained	8 to 23 inches to lithic bedrock	More than 80 inches	Very low capacity of the most limiting layer to transmit water (Ksat = 0.00 in/hr). Very low available water storage (about 2.7 inches). Hydrologic Soil Group is D.
Pv	Pits, quarry	--	0 to 60 inches to unweathered bedrock	--	--
Ub	Udorthents, smoothed	Moderately well drained	40 to 60 inches to lithic bedrock	About 18 to 48 inches	Moderately low to high limiting layer to transmit water (Ksat = 0.06 to 5.95 in/hr). Low available water storage (about 4.6 inches). Unranked Hydrologic Soil Group.
Uc	Udorthents, wet substratum	Well drained	40 to 60 inches to lithic bedrock	About 6 to 24 inches	Moderately low to high limiting layer to transmit water (Ksat = 0.06 to 5.95 in/hr). Low available water storage (about 4.6 inches). Unranked Hydrologic Soil Group.
UhB	Urban land-Charlton complex, 2 to 8 percent slopes	Well drained	More than 80 inches	More than 80 inches	Moderately high to high limiting layer to transmit water (Ksat = 0.56 to 5.95 in/hr). Moderate available water storage (about 7.5 inches). Unranked Hydrologic Soil Group.

Source: USDA Web Soil Survey, accessed March 2024 (https://nrcs.app.box.com/v/soils)

TOPOGRAPHY

The Fjord Trail South Corridor is located primarily along the existing Metro-North Railroad (MNR) tracks and the Hudson River; therefore, much of the Trail Corridor is relatively flat. However, the Trail Corridor sits at the base of the Hudson Highlands, with steeper topography immediately to the east. From Breakneck Ridge to Little Stony Point, the upland topography is more varied with mountainous areas to the east (see **Figures IV.C-4a through IV.C-4c**). Some areas of the Fjord Trail South Corridor, particularly near Little Stony Point, include steep slopes of greater than 25 percent (see **Figure IV.C-5**). The Fjord Trail South Corridor between Little Stony Point and Dockside Park travels along the MNR causeway and is relatively flat.

Elevations along the Fjord Trail South Corridor range from 0 feet (sea level) at the Hudson River shoreline to approximately 70 feet above sea level (asl) at Little Stony Point. The area around Cold Spring is mostly flat, with maximum elevations of approximately 21 feet asl. The elevation of the Hudson River shore between Little Stony Point and Breakneck Ridge ranges from approximately 0 feet to 10 feet asl. As such, this area is subject to ice impacts and inundation from sea level rise, flooding, and storm surge. Sea level rise and flooding is discussed in detail in Chapter IV.D, "Water Resources – Fjord Trail South."

C. FUTURE WITHOUT THE PROPOSED ACTION

Without the proposed Fjord Trail South, current conditions are expected to remain with no substantial disturbance to surficial geology and soils, bedrock geology, or topography anticipated in the Fjord Trail South Corridor. Steep slopes along the Fjord Trail South that have not yet been disturbed would remain undisturbed.

D. FUTURE WITH THE PROPOSED ACTION

Components of Fjord Trail South that have the potential to affect geology, soils, or topography include construction activities associated with earthwork, cut and fill, and alteration of steep slopes, and any potential for erosion from the completed trail. Construction of Fjord Trail South would begin with land surveying, followed by clearing, grubbing and tree/shrub removal, then pile installation, soil stabilization, and installation of the trail. Once pile installation activities are completed, trail construction would include concrete and precast plank installation using cranes.

As the design of Fjord Trail South progresses, geotechnical borings would be conducted at key locations along the alignment. Once available, these borings would enable determination of depths, compositions, and qualities of soils, as well as the depth of rock and assessments of slope stabilities. Potential impacts of Fjord Trail South on geology, soils, or topography are discussed in the sections below.

SURFICIAL GEOLOGY AND SOILS

Fjord Trail South has limited potential to affect geology and soils, as it would be constructed mostly on previously disturbed land adjacent to the MNR tracks or would be elevated above the ground surface. The proposed Meanders at Little Stony Point would be constructed on existing trails and crushed rock fill, while the Main Trail would follow an artificial embankment from Little Stony Point to Dockside Park. Fjord Trail South may require minimal export of excavated soil from earthwork associated with its construction. Any soils removed as "cut" generated through proposed earth moving activities would be stored, stockpiled, and re-used on-site where proposed earth moving activities require additional "fill." To ensure the trail is Accessible with respect to slope and other characteristics, the Proposed Action would require a net increase of

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Trail Corridor - Fjord Trail South

Contours

10 foot

2 foot

HUDSON HIGHLANDS FJORD TRAIL

Topography

Figure IV.C-4a

9.22.24

Trail Corridor - Fjord Trail South

Contours

10 foot

2 foot

HUDSON HIGHLANDS FJORD TRAIL

Topography

Figure IV.C-4b

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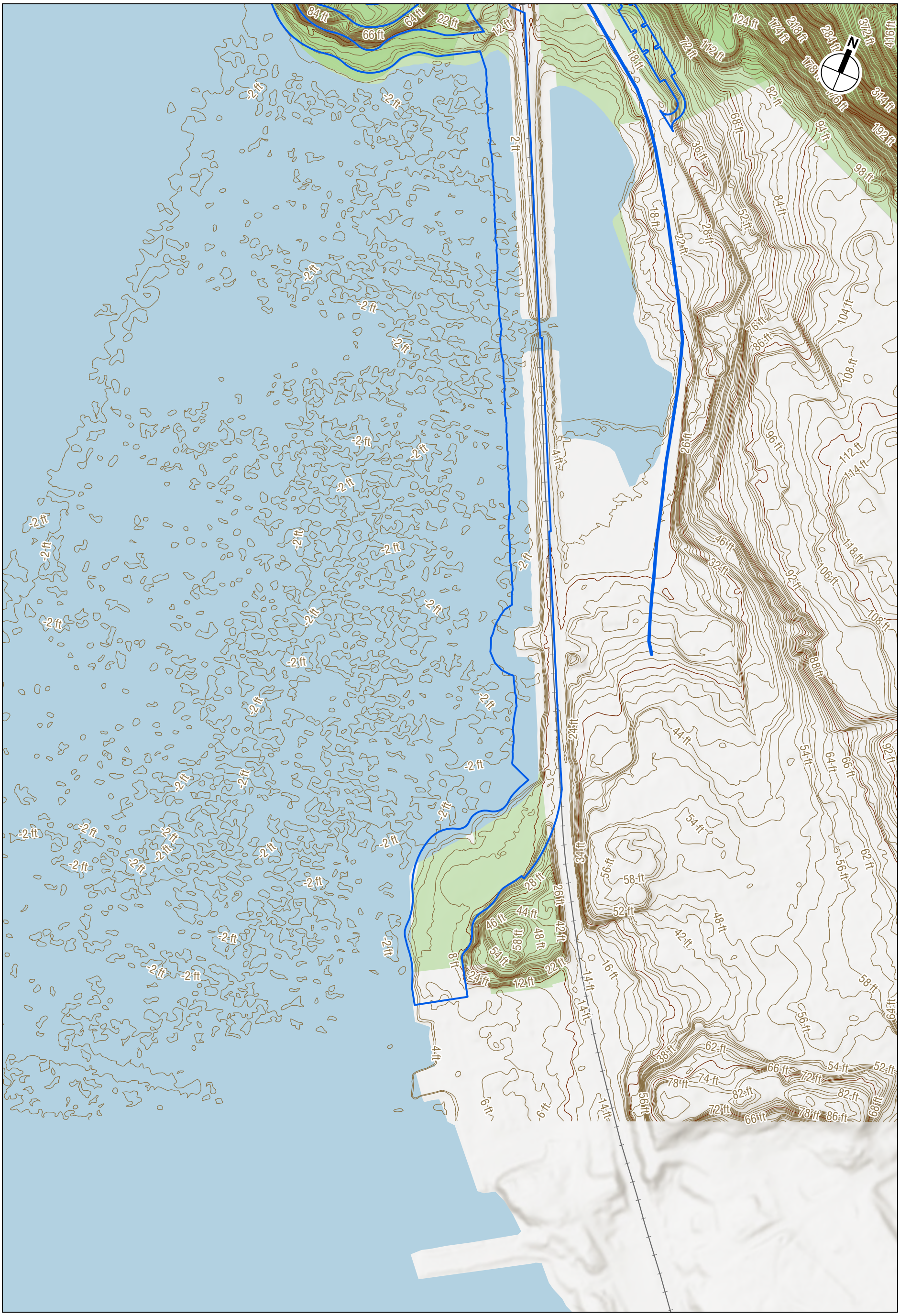

Trail Corridor - Fjord Trail South

Contours

10 foot

2 foot

HUDSON HIGHLANDS FJORD TRAIL

Topography

Figure IV.C-4c

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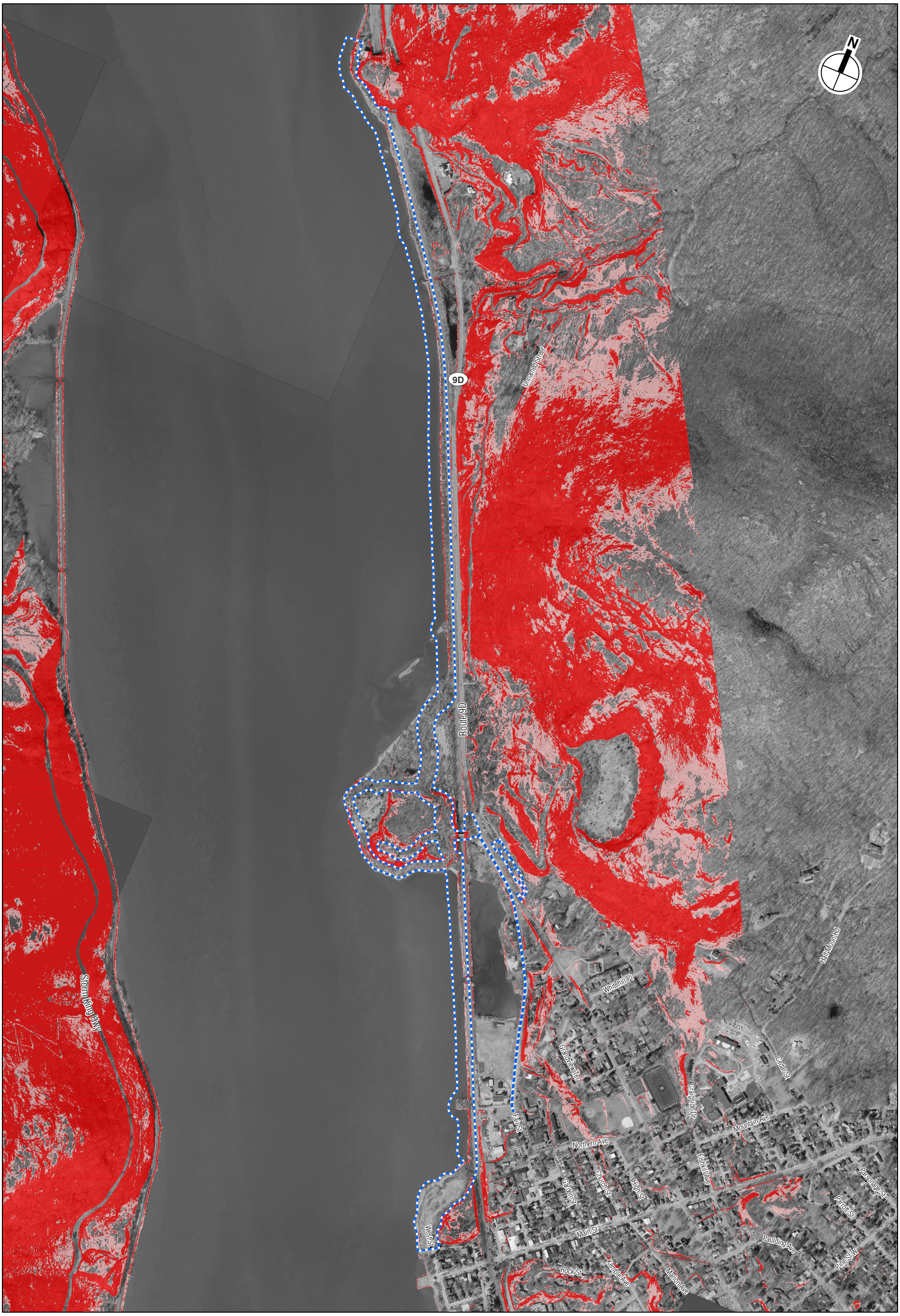

0 2,000 FEET

Trail Corridor - Fjord Trail South

Slope

15 to 25%

Over 25%

HUDSON HIGHLANDS FJORD TRAIL

Steep Slopes

Figure IV.C-5

approximately 6,060 cubic yards in fill. The increase in fill would be distributed over the length of Fjord Trail South for the on-grade portions and would be minimized to the extent possible as the design continues to be refined. The potential for soil erosion would be minimized through the implementation of erosion and sediment control measures in accordance with a Stormwater Pollution Prevention Plan (SWPPP) and Erosion and Sediment Control Plan prepared for review and approval in accordance with the requirements of the NYSDEC SPDES General Permit for Stormwater Discharges from Construction Activities. During construction, a water tanker would be used to spray exposed soil to manage dust, and where necessary, contractors would utilize truck tracking pads and wheel washing stations to minimize the transport of soil onto nearby roadways. Other measures that may be used, as needed in accordance with the SWPPP, would include filter stone, silt fence, stabilized construction access, temporary mulches, and straw bales. Additional sediment control measures would be implemented where the construction of Fjord Trail South would be completed using barges, as discussed in Chapter IV.D, "Water Resources – Fjord Trail South."

Any excavated soil requiring off-site disposal would be managed in accordance with applicable regulatory requirements, including any testing requirements of the intended receiving facility. A soil management plan and disposal protocol would be prepared by the selected construction contractor to ensure that all soil handling and disposal is conducted in accordance with regulations and proper disposal facilities. This would include providing contingency plans for soil disturbance/removal in the event contamination is unexpectedly encountered. Excavation and removal of soil is expected to be minimal and would not result in changes in volume or composition that would lead to adverse impacts to surficial geology or soils.

Fjord Trail South would result in an increase in impervious surfaces of approximately 1.5 acres, which includes approximately 0.75 acres of crushed stone path with limited permeability and approximately 0.75 acres of impervious surface with the Washburn Lot expansion. The path widths would be minimized to the extent possible to limit the increase in impervious surface while meeting Accessibility needs. Elevated trail sections are considered pervious because they would be elevated above the ground or water surface, allowing water to run through the gaps in the material and infiltrate into the ground or water below. This increase in impervious surface is not expected to result in significant adverse impacts to surficial geology or soils given the narrow linear nature of the trail and its distribution over the length of the Fjord Trail South alignment.

BEDROCK GEOLOGY

The proposed Fjord Trail South alignment intersects with one inactive fault line. Fjord Trail South has been designed to utilize a combination of elevated structures and at-grade sections and blasting is not anticipated to be necessary. Therefore, the project would not have the potential to affect bedrock geology or interact with the inactive fault line. As the design of Fjord Trail South progresses, geotechnical borings would be conducted at key locations along the alignment to confirm this assumption.

TOPOGRAPHY

Most of the Fjord Trail South components would be constructed on slopes generally less than 25 percent. A small portion of the Trail would traverse steeper slopes at Little Stony Point, north of Dockside Park, and at Breakneck Ridge (see **Figure IV.C-5**). Within the 8-acre limit of disturbance for the Fjord Trail South, there are approximately 0.13 acres with slopes between 15 and 25 percent and approximately 0.04 acres with slopes greater than 25 percent. As the design of Fjord Trail South is advanced, areas of steep slopes would be avoided to the extent possible. Boulder embankments would be used to stabilize steeper slopes adjacent to the Main Trail, and

where the trail cannot avoid steep slopes, elevated trail sections may be constructed to avoid potential impacts. A portion of Fjord Trail South near Little Stony Point would use elevated structures to achieve a 5-percent trail grade in areas of varied terrain. Walking surfaces of Fjord Trail South would also be designed to be Accessible with a minimum of 10 feet in width and with consideration of surface characteristics and cross slope. All sections of the trail would be designed to minimize the potential for erosion through stabilization of the adjacent soils. Incorporation of these design measures would avoid or minimize the potential impacts of Fjord Trail South on the existing topography.

Fjord Trail South has been designed with consideration of 10-year, 50-year, and 100-year storm return periods, and includes resiliency measures to reduce the risk of damage from flooding. These measures may include the use of flood resilient structural and pathway materials, stabilization of the trail and supporting piles with vegetation and boulder edges, and adequate freeboard to allow for the passage of ice[2] and debris beneath the elevated sections. Materials used for the pathway would be designed to be floodable and easily repaired when the flood water recedes As described in detail in Chapter IV.D, "Water Resources – Fjord Trail South," the elevated trail would remain above both the floodplain and mean higher high water (MHHW) elevations for the 2100 High Scenario throughout the 50-year lifespan of materials used for trail construction and would not be susceptible to inundation from sea level rise. Measures would also be incorporated to ensure Fjord Trail South can withstand ice shear forces with adequate freeboard to allow for passage of ice and debris beneath the elevated sections. With these design measures in place, the elevated trail sections would be resilient to ice impacts and inundation from flooding, storm surge, and sea level rise.

E. CONCLUSIONS

As set forth above, several measures would be incorporated into the final design of Fjord Trail South to avoid, minimize, or mitigate impacts to geologic, topographic, or soil conditions, including the following:

- A SWPPP would be prepared for review and approval in accordance with the requirements of the NYSDEC SPDES General Permit for Stormwater Discharges from Construction Activities (GP-0-20-0001) that would be obtained for the project. The SWPPP would include an Erosion and Sediment Control Plan with erosion and sediment control measures developed in accordance with the New York State Stormwater Management Design Manual (NYSSMDM).
- Construction of Fjord Trail South would include temporary erosion and sediment control measures implemented during construction to minimize erosion and sedimentation, including: a water tank to spray exposed soil, truck tracking pads and wheel washing stations, a soil management plan, filter stone, silt fence, stabilized construction access, temporary mulches, and straw bales. Erosion and sedimentation specifications would be developed to incorporate MNR requirements in coordination with MNR, as applicable.
- Limits of site clearing and grading would be established prior to site clearing operations to protect adjacent soils and vegetation. In accordance with the SWPPP, erosion and sediment control measures would minimize erosion and soil movement, and construction would not result in any unplanned changes to plant species composition or coverage in adjacent areas.
- Topsoil removed from areas of land disturbance would be stockpiled and reused as planting medium, as appropriate.

[2] U.S. Army Corps of Engineers Cold Regions Research Labs (CRREL) design standards.

- A soil management plan and disposal protocol would be prepared to ensure that all soil handling and disposal is conducted in accordance with regulations and proper disposal facilities.
- Elevated trail structures would be used in areas where steep slopes cannot be avoided.
- Fjord Trail South would be sited above the projected MHHW elevation for the 2100 High Scenario and would use resilient materials and design practices to minimize impacts from sea level rise.
- Materials used for the pathway would be designed to be floodable and easily repaired when the flood water recedes.
- At-grade sections would be supported by stabilizing vegetation and boulder edges along the river side to minimize potential damage to the trail resulting from flood waters or associated shoreline erosion.

No significant adverse land impacts would be anticipated to result from construction of Fjord Trail South. Therefore, no additional mitigation is proposed. ✷