Appendix D

Sediment Transport Study

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Sediment Transport Study

Environmental Report
in support of the
Port Ambrose Project Application

February 2014

Topic Report 3 – Water and Sediment Quality

Appendix B

Modeling Evaluation of Sediment Dispersion and Deposition during Construction of the Port Ambrose Deepwater Port Project

Modeling Evaluation of Sediment Dispersion and Deposition during Construction of the Port Ambrose Deepwater Port Project

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1. Introduction

1.1 Project Overview

Liberty Natural Gas, LLC (Liberty) is proposing to construct, own, and operate a deepwater port, known as Port Ambrose (Port Ambrose, or the Project) in the New York Bight. The Port's two Submerged Turret Loading™ buoy (STL Buoy) systems will be located in water depths of approximately 103 feet [ft] (31 meters [m]), in federal waters roughly 19 miles [mi] (30 kilometers [km]) off Jones Beach, New York, and approximately 31 mi (50 km) from the entrance to New York Harbor (Figure 1-1).

The Port Ambrose Project will consist of two basic sets of components:

Offloading Buoys: two STL Buoy systems (collectively, the Port), which will receive and transfer natural gas from purpose-built liquefied natural gas (LNG) regasification vessels (LNGRVs) to the pipeline system; and

Offshore Pipeline Facilities: two offshore subsea lateral pipelines (Laterals) connected to a subsea natural gas mainline (the Mainline).

Natural gas will be delivered through the STL Buoy systems and Laterals into a buried, 21.67 mi (34.87 km) subsea Mainline, which will connect offshore with the existing Transcontinental Gas Pipe Line Company's (Transco's) Lower New York Bay Lateral for delivery to shore. When not in use, each STL Buoy will be lowered to rest on a landing pad on the ocean floor.

Installation of the Mainline pipeline, Lateral pipelines, and tie-in appurtenances and the associated lowering of the pipelines and appurtenances to a target depth beneath the sea floor, will disturb bottom sediments, resulting in generation of suspended sediment plumes in the vicinity of the disturbance. Suspended sediments will be transported by ambient currents as the sediment particles (primarily sands) settle through the water column and redeposit on the sea floor.

The evaluation that follows assesses the duration, extent and magnitude of excavation and lowering-related suspended sediment plumes and associated sediment deposition based on predictions derived from Project-specific implementation of hydrodynamic and particle tracking models.

1.2 General Overview of Project Construction

The Port Ambrose project is expected to be constructed, commissioned and placed into service over an approximate 12-month period. A general overview of Project construction activities is as follows:

- There are five relic out-of-service communications cables that will be potentially crossed by the Mainline pipeline. If possible, pending discussions and agreements with utility owners, these cables will be cut and removed from the pipeline corridor. If removal is not possible, pre-lay lowering of the utility will be undertaken using supplemental lowering methods (submersible pump, air-lift and/or hand jetting);
- Bridging and/or lowering of an active high voltage direct current (HVDC) cable array that will be crossed by the Mainline;
- Excavation (near MP [Milepost] 21.67) to expose the Transco Lateral and allow subsequent installation of hot-taps and the subsea tie-in (SSTI) assembly (using submersible pump);

- Excavation (near MP 0.0) to allow subsequent installation of the collocated Y assembly (CYA)(using submersible pump);
- Pipelay of the Mainline pipeline and tie-in to the CYA;
- Pipelay of the Laterals and installation of the Pipeline End Manifolds (PLEMs);
- Lowering of the Mainline and Laterals using mechanical plowing technology;
- Backfilling the plowed trench using backfill plowing technology;
- Tie-in of the Mainline to the SSTI and tie-in of the Laterals to the CYA;
- Lowering of transitions along the Mainline (near SSTI, near CYA, and spanning cable crossings) using supplemental lowering methods;
- Lowering of transitions along the Laterals (near CYA and near PLEMs) using supplemental lowering methods;
- Installation of deepwater port (DWP) facilities (buoy anchors, anchor wires and chains, buoy landing pad, flexible risers, buoys); and
- Commissioning of the Port.

The activities presented above are generally in chronological order; however, there will be "overlap" periods where multiple activities are on-going concurrently.

While many of the construction activities will potentially disturb bottom sediments, pipeline lowering activities, utility lowering (if implemented), and excavations at the hot-tap/SSTI and CYA locations will result in the greatest displacement of bottom sediments and larger impacts relative to sediment dispersion and deposition. This modeling evaluation, therefore, focuses on these specific activities.

1.3 Specific Overview of Pipeline Construction

A detailed description of the Port Ambrose Project offshore pipeline facilities is provided in the Port Ambrose Pipeline Construction Plan, as provided in the DWP Application, Volume III, Attachment D.2 (Confidential). The following section provides an overview of Project construction activities, specifically as related to disturbance of bottom sediments, generation of suspended sediment plumes, sediment transport, and sediment deposition.

As shown in Figure 1-1, the Port Ambrose Mainline will be a 26-inch (660 mm) diameter pipeline approximately 21.67 miles (34.87 km) long. The Project's two 26-inch diameter Lateral pipelines are approximately 0.88 miles (1.42 km) (Lateral 1) and 1.77 miles (2.85 km) (Lateral 2) in length, respectively. Laterals 1 and 2 will be connected to the Mainline at a CYA located at MP 0.00. Each Lateral will connect to a PLEM that is part of the STL Buoy system. The Mainline will transport gas to an SSTI assembly that will provide the connection between the Mainline and the hot-taps installed on the existing Transco pipeline located approximately 2.2 miles (3.5 km) off the Long Island coastline.

The Project schedule (as presented in DWP Application Volume II, Topic Report 1), proposes an approximate 12-month construction schedule, beginning in December 2014 with initial preparations for pipelaying activities and culminating in December 2015 with the commissioning of the Port and commencement of commercial operations. Liberty is anticipating that these dates will slide to 2016. Therefore this report will consider construction beginning in December 2015 with initial preparations for pipelaying activities and culminating in December 2016. The sediment disturbing activities that are the subject of this modeling evaluation are anticipated to begin in late-January with the initiation of foreign utility cable lowering activities and end in early-September with the lowering of Mainline and Laterals transition areas.

The sediment disturbing activities evaluated in this modeling assessment include the following:

1. Excavation at the Transco hot-tap location and in the vicinity of the planned SSTI assembly. It is anticipated that this excavation will be achieved using a submersible pump, sometimes referred to as a mud-pump. The submersible pump will create suction near the sea floor removing sediment and routing a sediment laden flow of water via a flexible hose to a location outside of the excavation area. The modeling evaluation assumes that discharge from the pump, anticipated to be comprised of up to 20 percent solids by weight, will be discharged at a distance of approximately 100 ft (30 m) beyond the edge of the excavated area and at a height of approximately 5 ft (1.5 m) above the sea floor. The depth of excavation in the hot-tap/SSTI area is expected to be approximately 10 ft (3 m) in order to accommodate the various hot-tap and SSTI spool pieces and appurtenances and provide for a minimum of 4 ft (1.2 m) of cover. Excavation activities at the hot-tap/SSTI area are anticipated to take place in a February/March timeframe.

2. The Project's shallow hazards survey indicated that six foreign utilities will be encountered along the Mainline pipeline corridor. Five of these foreign utilities are understood to be out-of-service cables and one is understood to be in-service. The specific actions to be taken at these various crossings are still being assessed. The preferred method would be to cut and remove the five out-of-service cables and to use a combination of bridging and concrete mats to provide separation between the Mainline pipeline and the in-service utility. This modeling evaluation is based on the most conservative assumption relative to sediment disturbance. This evaluation assumes that all six utilities will be lowered prior to the laying of the Mainline pipeline so that the Mainline pipeline will have separation from the cables while maintaining a minimum of 4 ft (1.2 m) of cover at each of the crossings. Supplemental lowering methods could include use of air-lift methods, implementation of diver-assisted hand jetting or use of submersible pumps. The modeling evaluation conservatively assumes that hand jetting will be used, as hand jetting presents the highest degree of impact relative to displacement of sediment into the water column. Hand jetting involves a diver using a stream of high-pressure water aimed towards the sea floor, washing sediment from around and beneath the utility and lowering it in the process. Lowering of foreign utilities will be performed prior to pipelay activities and is anticipated to occur from late-January through the end of April.

3. The area of the planned CYA will be excavated to a suitable depth to accommodate the assembly and the spool pieces that will connect the CYA to the Laterals and to provide for a minimum of 4 ft (1.2 m) of cover. The modeling evaluation assumes that the CYA area will be excavated to an approximate depth of 10 ft (3 m) using a submersible pump (i.e., using methods similar to those assumed at the hot-tap/SSTI area). Excavation activities at the CYA area are anticipated to take place in a March/April timeframe.

4. Laying of the Mainline pipeline is anticipated to take place over a five-month period from early-December 2015 through the end of April 2016. Laying of the Laterals is anticipated to take place over a two-week period extending from the end of April to mid-May. Disturbance of bottom sediment as a result of pipelaying activities is anticipated to be minor and, therefore, sediment dispersion/deposition impacts associated with laying of pipelines are not addressed in this modeling evaluation.

5. Subsequent to the laying of the Mainline and Lateral pipelines, they will be lowered to achieve a minimum cover depth of 4 ft (1.2 m). The primary lowering method that will be

used for the Project will be a plowing method where a specially designed plow structure will be positioned around and beneath the pipeline and will be pulled across the seafloor by a Dynamically Positioned (DP) plow vessel, creating a furrow beneath the pipe and lowering the pipe into the furrowed trench. It is anticipated that two passes of the plow will be required to achieve the target 4 ft (1.2 m) cover depth. It is anticipated that plowing will not be performed in the vicinity of the SSTI, CYA location, PLEMs, or foreign utility crossings. At each of these locations, a transition area approximately 410 ft (125 m) in length will be required in order to transition the plow into or out of the seabed. At foreign utility crossings, this transition area is anticipated to extend 410 ft (125 m) in either direction from the centerline of the utility to be crossed. As a result of this need for transition areas, the Project will have a total of nine plowed segments: seven along the Mainline and one along each Lateral. Plowing of the Mainline is anticipated to take place from mid-May through early-July and plowing of the Laterals from early- through mid-July.

6. Once plowing is completed, pipelines will be flooded and the plowed trenches will be backfilled using a DP backfill plow. Backfill plowing will take place across the same nine plowed segments and it is assumed that backfill plowing will be accomplished in a single pass. It is anticipated that backfill plowing will take place from mid-July through early August.

7. Supplemental lowering methods will be used to lower the pipelines in the transition areas where plowing did not occur. The modeling evaluation conservatively assumes that lowering in transition areas will be achieved using diver-assisted hand jetting (i.e., methods similar to those assumed used for lowering of foreign utilities). It is anticipated that lowering of transition areas will take place from mid-August through early-September.

1.4 Modeling Evaluation Approach

The modeling evaluation that follows is founded upon available information on ambient water quality, oceanographic conditions, and sediment characteristics of the New York Bight in the Project area. This information includes oceanographic, water quality, and sediment characteristic data described in the Project's September 2012 DWP application, including data in Volume II, Topic Report 3 (Water and Sediment Quality) and Topic Report 4 (Biological Resources) and Volume III, Attachment A.6 (Shallow Hazards Survey Report), as supplemented by the Project's additional "response to comments" filings of September 2013 through January 2014. This modeling evaluation involves the development of a hydrodynamic model of New York Bight in the Project area and the development of a sediment dispersion model, to assess the extent, magnitude and duration of the resultant suspended sediment plume and the extent and thickness of the resultant sediment deposition.

2. Model Description

The sediment disturbing activities associated with the installation and lowering of the Mainline and Lateral pipelines will include excavation at the hot-tap/SSTI and CYA locations primarily utilizing a submersible pump, lowering of pipelines using mechanical plowing, and backfilling of plowed trenches using a backfill plow. Supplemental lowering activities, including pre-pipelay lowering at utility crossings and post-pipelay lowering at pipeline transition areas will be performed by means of submersible pumping, hand jetting, and/or the use of an air-lift. The modeling evaluation conservatively assumes that all supplemental lowering will be performed by hand jetting, as it results in the greatest impact relative to uncontrolled movement of disturbed sediments. When sediment is suspended by any of the excavation methods, the sediment that does not immediately settle is transported away from the pipeline by advection. In order to understand the transport, it is necessary to understand the current patterns in the Project area. In this modeling evaluation the advection process is simulated by means of a hydrodynamic model of the Project area that was developed using the Advanced Circulation Model (ADCIRC).

2.1 Hydrodynamic Model: ADCIRC

ADCIRC is a hydrodynamic circulation model that simulates water levels and currents over a finite element grid. The model can be used to evaluate hydrodynamic behavior in both two and three dimensions. ADCIRC was developed by Rick Luettich and Joannes Westerink (2004) in conjunction with the United States Army Corps of Engineers (USACE) Engineer Research and Development Center (ERDC) and has been certified by the Federal Emergency Management Agency (FEMA) for evaluating storm surge (USACE 2013a). ADCIRC has also been historically used for modeling tides and wind driven circulation, dredging feasibility and material disposal studies, as well as near shore marine operations (USACE 2013b)).

ADCIRC was selected for use in this modeling evaluation because of the flexibility it provides relative to the assignment of boundary conditions. The Project area is in the New York Bight and, therefore, part of the hydrodynamic model must be an open-water boundary condition. ADCIRC can simulate open-water boundaries based on tidal constituents, and ADCIRC can incorporate reversing flow (for example flow at the mouth of the river into a coastal bay) as a specified normal flow boundary condition. ADCIRC meets the technical requirements to develop a representative hydrodynamic model of the Project area due to the availability of these boundary condition options. In addition to being appropriate for use in evaluating the hydrodynamics, ADCIRC is also readily linked to the Particle Tracking Model (PTM).

2.2 Sediment Dispersion Model: PTM

PTM is a Lagrangian particle tracker developed to simulate particle (i.e. sediment) transport processes. The model was developed by ERDC as a part of the Coastal Inlets Research Program and the Dredging Operations and Environmental Research Program (MacDonald et al. 2006). Suspended sediment in PTM is modeled as a discretized finite number of particles that are transported by advection. These particles are representative of all particles coming from a sediment source. Each particle is assigned a mass of sediment to represent and each particle has individual characteristics including mean grain size and density. The transport and eventual deposition of these representative particles can then be used to determine suspended sediment concentrations and deposition thicknesses.

3. Hydrodynamic Model Application

3.1 Model Setup

Figure 3-1 shows the limits of the model domain as well as each boundary condition applied to the hydrodynamic model. The model domain includes all of Raritan Bay, all of Lower New York Bay, and extends approximately 90 mi (145 km) out into the New York Bight. The model has one tidal boundary in the New York Bight which is driven by tidal constituents K1, M2, N2, O1, and S2. This modeling evaluation used the Atlantic Ocean ADCIRC tidal constituent database (ADCIRC 2013) to determine the amplitude and phase for each constituent. Table 3-1 summarizes the tidal constituents that were applied at the open boundary. The open boundary is approximately 182 mi (293 km) long and the representative tidal constituents change over this distance. The tidal constituents were assigned every 5.7 mi (9.1 km) along the open boundary in the model. The amplitudes and phases shown in Table 3-1 indicate the range of values for each assignment along the open boundary.

Table 3-1 Hydrodynamic Model Tidal Constituents

Tidal Constituent	Amplitude (range) (ft)	Amplitude (range) (m)	Phase (range) (degrees)
K1	0.280 – 0.310	0.085 – 0.095	166.8 – 174.3
M2	1.515 – 1.885	0.462 – 0.575	341.8 – 351.5
N2	0.356 – 0.434	0.108 – 0.132	329.6 – 337.9
O1	0.164 – 0.1266	0.050 – 0.069	175.9 – 185.3
S2	0.306 – 0.382	0.093 – 0.116	3.1 – 13.0

The hydrodynamic model also includes three normal flow boundaries. These flow boundaries represent the mouth of the Raritan River, the mouth of the Hudson River, and the mouth of the Arthur Kill. The Arthur Kill is a tidal strait connecting Newark Bay to Raritan Bay. The model domain excludes the Raritan River and truncates the Hudson River downstream of where the Hudson River is joined by the Kill Van Kull and the East River (both tidal straits). The Raritan River is tidally influenced miles upstream of its mouth and flow at the mouth may reverse based on the interaction of river flow and tides. The effective flow rate and direction of flow at the boundary depends on the complex interaction between the various bays in the New York Harbor system. In order to appropriately simulate flow at each of the flow boundaries, it would be necessary to develop a circulation model of the entire New York Harbor.

The National Oceanic and Atmospheric Administration (NOAA) has developed and maintains the New York and New Jersey Operational Forecast System (NYOFS) model as a part of the Center for Operation Oceanographic Products and Services (CO-OPS). The NYOFS model simulates currents and water levels throughout the New York Harbor (NOAA 2014a) and results from this model take into account the complex interaction between the various bays in the New York Harbor system as well as tidal reversing in rivers. This modeling evaluation assigned historical model results from the NYOFS model to the reversing flow boundaries (Raritan River, Arthur Kill, and Hudson River) in the hydrodynamic model.

The model domain shown in Figure 3-1 is subdivided into a finite element unstructured grid. Near the open-water boundary grid cells are approximately 5.5 mi (8.8 km) on a side whereas near the

Mainline they are approximately 328 ft (100 m) on a side. The hydrodynamic model resolution is appropriately scaled to simulate circulation patterns in the model domain and provide the necessary current speed information for the sediment dispersion model.

This modeling evaluation assigned the hydrodynamic model bathymetry based on a series of National Ocean Service (NOS) hydrographic surveys for New York Harbor and the New York Bight (NOAA 2014b). The bathymetric data was collected from the NOAA National Geophysical Data Center, processed, and used to interpolate bottom elevations to the model grid. This modeling evaluation also incorporated wind data recorded at the NOAA meteorological buoy at the New York Harbor Entrance Station (also known as the Ambrose Light Station) (Station ID: 44065) (NOAA 2014c) and applied the time varying wind uniformly across the entire model domain.

3.2 Hydrodynamic Model Predictions

Construction activities that are included in the sediment dispersion model are scheduled to occur at different times between January 1, 2016 and October 1, 2016. Since it is not feasible to forecast future hydrodynamic conditions, this modeling evaluation used historical data from the same period in 2013 to assess the likely hydrodynamic behavior. Given the extended time frame of sediment disturbing activities, model results using 2013 data are anticipated to be sufficiently representative of conditions in any given year, including 2015, 2016 or any future year.

Figure 3-2 shows the estimated tidal elevation near the midpoint of the Mainline for a one week period in June. Figure 3-2 shows that the tide varies with time during the one-week period and the water level ranged between -1.9 ft mean sea level (MSL) (-0.58 m MSL) and 2.4 ft MSL (0.73 m). A tidal range of 4.3 ft (1.3 m) is consistent with anticipated values. Figure 3-3 shows modeled current speed and direction for the same location and time period as Figure 3-2. Figure 3-3 demonstrates that there is a regular tidal influence on current direction. During this period, the currents in the vicinity of the Mainline and Laterals flowed predominantly to the east; however, occasional reversals towards the west are evident. This modeling evaluation did not identify any publically available field measurements of currents or water levels in the Project area that were concurrent with the modeled time period. Therefore, this modeling evaluation cannot quantitatively assess the hydrodynamic model performance relative to observed conditions. The hydrodynamic model was adjusted based on professional judgment and knowledge of the general hydrodynamic behavior of the New York Bight.

4. Sediment Dispersion Model Application

4.1 Model Setup

The sediment dispersion model uses the results from the hydrodynamic model as an input and incorporates the same model bathymetry. Setting up the sediment dispersion model involves establishing how the operation of the various sediment disturbing activities will be simulated and establishing how to best characterize the physical properties of the sediment expected to be suspended by these activities. The sediment disturbing activities and how they are incorporated in the sediment dispersion model are summarized in Table 4-1. The description of each activity includes rate of progress, loss rate, and an explanation of assumptions. The sediment “loss rate” used in the model represents the estimated percentage of disturbed sediment that is assumed to be suspended into the water column and available to be transported away from the Mainline, Laterals, existing utility, and the hot-tap/SSTI and CYA excavation areas.

The trench dimension assumptions noted in Table 4-1 represent conservative estimates developed to ensure achievement of a target minimum burial depth of 4 ft (1.2 m) of cover over the top of the Mainline and Laterals. During mechanical plowing, the plow shears will push sediment out of the trench and distribute it to both sides of the trench, creating linear spoil piles. The majority of the sediment will remain alongside the trench in these spoil piles, with only a minor loss of sediment (assumed 20 percent loss rate) to the water column. During backfilling, the spoil alongside the trench will be pushed back into the trench on top of the pipe and it is assumed that the loss rate will be similar to the plowing operation.

The sediment loss rate for hand jetting activities is assumed to be 100 percent, because although a minor portion of sediment displaced during jetting activities may be pushed aside and remain in contact with the sea floor, a majority of the displaced sediment will become suspended in the water column and be available for advective transport.

The assumed loss rates for plowing and hand jetting are consistent with assumptions made in previous sediment dispersion modeling studies conducted in the New York Bight. Previous evaluations citing loss rates associated with backfill plowing operations or submersible pump excavation activities were not identified and may not exist. This modeling evaluation assumes that backfill plowing will result in a loss rate equivalent to the excavation plowing, as both activities are similar in that they push sediment laterally without inducing significant upward momentum.

The loss rate for submersible pumping is conservatively assumed to be 100 percent. While it is likely that some portion of the sediment discharged from flexible hose would immediately settle to the sea floor, the modeling conservatively assumes that all of the sediment will enter the water column and be available for advective transport.

Regardless of activity, the rate of suspended sediment generation (on a volume basis) is the product of trench width, trench depth, progression rate, and the sediment loss rate. In order to calculate the rate of suspended sediment production on a mass basis it is necessary to have an understanding of the sediments that will be disturbed. AECOM collected grab samples of surficial sediments (maximum depth of 3.9 inches [in] [10 cm]) as part of a January/February 2012 offshore marine survey field program (see DWP Application Volume II, Topic Report 4 Appendix C). Grain size analyses indicated that in 32 of 33 locations sampled in the Project area, surficial sediments were comprised of more than 97 percent sands and/or sands and gravels.

Table 4-1 Sediment Disturbing Activity Characterization

Pipeline and Utility Lowering Activities				
Activity	**Progress Rate**		**Loss Rate**	**Assumptions**
	ft/hr	**m/hr**	**%**	
Plowing	220	67	20%	Lowering by plowing will be achieved by two passes of the plow. The cross-section of sediment displaced by plowing is assumed to be triangular, 25 ft (7.6 m) wide at the surface and extending to a depth of 8 ft (2.4 m). Each pass of the plow is assumed to remove 50 percent of the sediment.
Backfill Plowing	275	84	20%	Backfilling of the plowed trench will be achieved in one pass. It is assumed that 80 percent of the sediment originally excavated will be returned to the trench during backfilling.
Supplemental Lowering of the Mainline and Laterals Transition Areas (assumed by hand jetting)	15	4.6	100%	It is assumed that supplemental lowering at pipeline transition areas will be achieved by diver assisted hand jetting and that hand jetting will displace 100 percent of sediment in triangular trench 25 ft (7.6 m) wide at the surface and extending to a depth of 8 ft (2.4 m).
Supplemental Lowering at Utility Crossings (assumed by hand jetting)	15	4.6	100%	It is assumed that supplemental lowering of the utility crossings will be achieved by diver assisted hand jetting and that hand jetting will displace 100% of sediment in variable width and depth excavation. The assumed volume of displaced sediment for each crossing is 2,228 cubic yards (yd^3) (1,702 cubic meters [m^3]).
Excavation Activities				
Activity	**Sediment Removal Rate**		**Loss Rate**	**Assumptions**
	ft^3/hr	**m^3/hr**	**%**	
Areal Excavation at hot-tap/SSTI and CYA Locations	2,563	72.6	100%	It is assumed that excavation at the hot-tap/SSTI and CYA locations will be achieved using a submersible pump. The assumed removal rate is based on the use of a 3,200 gallons per minute (gpm) submersible pump (Toyo or similar) with a discharge with a maximum 20 percent sediment content by weight. The estimated displaced volumes are: hot-tap/SSTI - 3,717 yd^3 (2,841 m^3) and CYA - 2,805 yd^3 (2,144 m^3). The assumed loss rate is based on complete fluidization of sediments.

Deeper sediment samples were collected in the Project area using vibracore methods as part of two separate marine sampling programs. As a component of its Shallow Hazards Survey (see DWP Application Volume III, Attachment A.6 [confidential]), Ocean Surveys, Inc. (OSI) collected vibracore samples at 25 stations in the Port area and along the Project's proposed pipeline corridors. The May 2012 vibracore program collected sediment samples to depths of up to 14.5 ft (4.4 m) below the sea floor. AECOM collected vibracore samples at 13 stations located in State waters (north of MP 19.3) as part of an October 2013 marine field survey program. The AECOM vibracores were generally shallower than the OSI vibracores, extending to depths of up to 7.2 ft (2.2 m) beneath the sea floor.

Figure 4-1 shows the sample collection locations of each of the OSI and AECOM vibracores. Vibracore samples collected during both the OSI and AECOM studies were sent to laboratories for analysis and comprehensive sediment characterizations were performed for each sample. Table 4-2 provides a summary of this characterization including the sediment type (gravel, sand, and fines), specific gravity and median grain size (D50). Note that the information for OSI sediment cores shown in Table 4-2 was developed using data from the vibracores that extended to a maximum depth of 8.5 ft (2.6 m), which is consistent with the depth of sediment anticipated to be disturbed during modeled activities.

Table 4-2 Vibracore Sample Sediment Characterization Data

Station Name	Approx. MP	Depth Interval (ft)	Specific Gravity	Dry Density (lb/ft^3)	Gravel %	Sand %	Fines %	D50 (mm)
OSI Vibracore Data (cores >8.5 ft in depth not included)								
VC026-3 (top)	Buoy 1	2.5 to 3.0	2.68	n/a	2	97	1	0.32
VC027-2 (top)	Buoy 2	2.5 to 3.0	2.68	n/a	0	99	1	0.34
VC001-1 (top)	0	3.5 to 3.9	2.67	n/a	1	96	3	0.41
VC001-1 (bottom)	0	7.0 to 8.0	2.68	110 to 111	0	99	1	0.24
VC002-1 (top)	1.7	2.5 to 3.0	2.68	n/a	0	99	1	0.17
VC002-1 (middle)	1.7	7.5 to 8.0	2.69	n/a	2	67	31	0.08
VC003-1 (top)	2.7	2.5 to 3.0	2.68	n/a	0	97	3	0.2
VC004-1 (top)	3.4	2.5 to 3.0	2.68	n/a	0	96	4	0.27
VC004-1 (bottom)	3.4	7.5 to 8.0	2.71	93 to107	4	67	29	0.15
VC005-1 (top)	4.0	2.5 to 3.0	2.69	n/a	1	97	2	0.24
VC006-1 (top)	5.0	3.25 to 3.75	2.67	n/a	45	54	1	2.95
VC006-1 (middle)	5.0	7.5 to 8.75	2.68	n/a	0	63	37	0.14
VC007-1 (top)	6.0	2.0 to 2.5	2.68	n/a	7	92	1	0.32
VC008-1 (top)	6.5	2.5 to 3.0	2.67	n/a	0	98	2	0.4
VC009-1 (top)	8.7	1.5 to 2.0	2.68	n/a	0	96	4	0.16
VC009-1 (bottom)	8.7	6.0 to 6.5	2.68	91 to 99	0	97	3	0.33
VC010-1 (top)	8.0	2.5 to 3.0	2.69	n/a	0	96	4	0.23
VC011-1 (top)	8.9	1.5 to 2.0	2.7	n/a	0	97	3	0.18
VC011-1 (bottom)	8.9	4.5 to 5.0	2.68	97 to 100	1	95	4	0.14
VC012-1 (top)	10.0	2.5 to 3.0	2.67	n/a	0	99	1	0.29
VC013-1 (top)	11.2	2.5 to 3.0	2.69	n/a	1	44	55	0.06
VC014-1 (top)	12.0	0.5 to 1.0	2.69	n/a	0	99	1	0.39
VC014-1 (bottom)	12.0	1.75 to 3.0	2.78	n/a	2	42	56	0.05
VC015-1 (top)	12.9	2.5 to 3.0	2.67	n/a	0	95	5	0.37
VC016-1 (top)	14.0	2.0 to 2.5	2.67	n/a	7	93	0	0.41
VC016-1 (bottom)	14.0	8.0 to 8.5	2.69	97 to 107	3	96	1	0.3
VC017-1 (top)	14.9	1.5 to 2.0	2.68	n/a	3	97	0	0.52
VC017-1 (bottom)	14.9	4.5 to 5.0	2.68	105 to 106	1	97	2	0.25
VC020-1 (top)	16.1	2.0 to 2.5	2.68	n/a	0	34	66	0.03
VC021-1 (top)	18.1	2.0 to 2.5	2.7	n/a	0	98	2	0.26
VC021-1 (bottom)	18.1	7.5 to 8.0	2.68	114	0	98	2	0.61
VC022-1 (top)	19.1	2.25 to 2.75	2.67	n/a	0	98	2	0.5
VC022-1 (bottom)	19.1	5.5 to 6.0	2.66	104	0	99	1	0.65
VC023-1 (top)	20.25	0 to 2.0	2.69	100	0	71	29	0.11

Station Name	Approx. MP	Depth Interval (ft)	Specific Gravity	Dry Density (lb/ft^3)	Gravel %	Sand %	Fines %	D50 (mm)
VC023-1 (middle)	20.25	2.5 to 3.0	2.49	n/a	0	9	91	0.01
VC024-1 (top)	21.4	2.5 to 3.0	2.68	n/a	8	83	9	0.44
VC024-1 (bottom)	21.4	7.5 to 8.0	2.66	130	14	82	4	1.82
VC025-1 (top)	21.5	2.5 to 3.0	2.65	n/a	0	99	1	1.33
AECOM Vibracore Data								
PA-01	19.3	0.0 to 3.5	n/a	n/a	10.11	71.07	18.82	0.27
PA-02	19.5	0.0 to 2.5	n/a	n/a	3.84	74.80	21.36	0.16
PA-03	20	0.0 to 3.4	n/a	n/a	2.12	69.78	28.1	0.12
PA-04	20.5	0.0 to 2.1	n/a	n/a	0.47	77.75	21.78	0.14
PA-04D (duplicate)	20.5	0.0 to 2.1	n/a	n/a	0.43	78.86	20.71	0.14
PA-05	20.9	0.0 to 3.9	n/a	n/a	25.93	63.4	10.67	0.82
PA-06	21.4	0.0 to 2.5	n/a	n/a	3.85	69.29	26.86	0.15
PA-07	21.6	0.0 to 3.0	n/a	n/a	27.32	61.28	11.4	1.5
PA-08 (top)	north of Transco	0.0 to 1.0	n/a	n/a	2.31	96.82	0.87	0.23
PA-08 (bottom)	north of Transco	0.0 to 4.7	n/a	n/a	0.23	83.45	16.32	0.2
PA-ARCHY 8 (top)	20.4	0.0 to 3.2	n/a	n/a	18.23	64.73	17.04	0.6
PA-ARCHY 8 (bottom)	20.4	3.2 to 7.0	n/a	n/a	0.42	60.54	39.04	0.1
PA-ARCHY 9	20.1	0.0 to 3.5	n/a	n/a	2.34	76.4	21.26	0.19
PA-VC023 (top)	20.25	0.0 to 1.5	n/a	n/a	0.46	76.14	23.4	0.14
PA-VC023 (bottom)	20.25	1.5 to 3.0	n/a	n/a	1.84	27.76	70.4	--
PA-VC024 (top)	21.4	0.0 to 2.6	n/a	n/a	11.78	71.59	16.63	0.25
PA-VC024 (middle)	21.4	2.6 to 4.5	n/a	n/a	0	53.39	46.61	0.08
PA-VC024 (bottom)	21.4	4.5 to 6.2	n/a	n/a	0.34	77.11	22.55	0.15
PA-VC025	21.5	0.0 to 3.3	n/a	n/a	9.53	73.79	16.68	0.52

The specific gravity of solids within the sediment samples ranged from 2.49 to 2.78. Vibracore sample dry densities ranged from 91 pounds per cubic foot (lb/ft^3) (1,460 kilograms per cubic meter [kg/m^3]) to 130 lb/ft^3 (2,086 kg/m^3). The dry density has more variability than the specific gravity of the sediment itself; however, there is no distinct pattern of variability along the length of the Mainline and Laterals.

Figure 4-2 shows a graph of the grain size distribution of each vibracore location based on percent of sediment type (gravels, sands, and fines). Where vibracore samples were subdivided by depth, the values shown in Figure 4-2 are depth weighted averages. Based on the data presented in Table 4-2 and Figure 4-2, this modeling evaluation concluded that there are effectively two zones with distinct sediment characterizations. The boundary between these two zones appears to roughly coincide with the boundary between waters as separated by the three nautical mile offshore Federal/State waters boundary line. Note that the fact that Federal/State waters line serves as the approximate divide between the somewhat finer nearshore sediments and coarser offshore sediments is coincidental and does not have any significance from any type of territorial/regulatory perspective. However, for purposes of this report, reference to “State waters” sediments shall be synonymous with the finer grained nearshore sediments and “Federal waters” sediments shall be synonymous with coarser grained offshore sediments. Table 4-3 summarizes the sediment characterization used as inputs for the sediment dispersion model for these two zones.

Table 4-3 Disturbed Sediment Characterization

Characteristic	State Waters (Approximately North of MP 19.32)	Federal Waters (Approximately South of MP 19.32)
Specific Gravity	2.67	2.67
Dry Bulk Density (lb/ft^3)	110	110
Gravel (%)	2	0
Sand (%)	73	95
Fines (%)	25	5

4.2 Sediment Dispersion Model Predictions

Sediment disturbing activities are scheduled to occur at different locations and different time periods throughout the year. This modeling evaluation involves separate runs of the sediment dispersion model for each distinct activity (lowering of existing utilities, excavation of the SSTI area, excavation of the CYA area, the first plow pass along the Mainline, the second plow pass along the Mainline, the plowing of the Laterals, backfill plowing, and supplemental lowering of transition areas). Each activity is modeled at the appropriate time in the year, consistent with the schedule described previously in Section 1.3.

The sediment dispersion model assumes a background suspended sediment concentration of 0 mg/L. Therefore, suspended sediment concentrations indicated in this Report are concentrations above background suspended sediment concentrations which are attributable to the Project’s sediment disturbing activities. Depositional thicknesses indicated in the Report are primary depositional thicknesses and do not take into account potential re-suspension of sediments following initial deposition. Model runs for each activity were extended for a period of time after the end of each activity in order to allow all sediments to settle and allow suspended sediment concentrations to return to ambient, pre-disturbance conditions.

Figure 4-3 shows the entire Project area and presents the maximum predicted suspended sediment concentration at any given location throughout all modeled sediment disturbing activities. Figures 4-4a through 4-4d show individual sections of the Project area, as delineated in the map key provided in the bottom left corner of each figure. As expected, the highest suspended sediment concentrations occur in the immediate vicinity of sediment disturbing activities, near the Mainline, Laterals and excavation areas. Moving away from the Mainline and the Laterals, two processes are occurring that reduce the predicted suspended sediment concentration: the settling of sediment out of the water column and the dispersion of suspended sediment.

Table 4-4 and Table 4-5 present the predicted lateral extent of the 100 mg/l, 50 mg/l and 25 mg/l suspended sediment plumes in State waters (assumed 25 percent fines) and Federal waters (assumed 5 percent fines), respectively. The distances provided in the tables represent the distance from the disturbance (centerline of Mainline or of Laterals) to the outer edges of the respective plume. The maximum distance represents the maximum extent of the plume for all activities and the mean distance represents the mean distance as estimated by averaging individual lateral distances predicted at an average of 33 ft (10 m) intervals along the outer edge of the plume.

As anticipated, elevated suspended sediment concentrations (in excess of 50 mg/l) exist primarily in the immediate vicinity of the disturbing activity, generally within 800 ft (244 m) of the pipeline centerline in State waters and within 600 ft (183 m) in Federal waters. The suspended sediment plume extends a greater distance in State waters because the sediment has a greater proportion of fine-grained particles and these fines settle more slowly allowing the sediment to travel greater distances. The “maximum” sediment plume travel distances presented in Table 4-4 and Table 4-5 are predicted at a few isolated locations in the Project area and can be attributed to a combination of the nature of the disturbance activity, unique localized bathymetric conditions and/or unique hydrodynamic conditions that occurred during the modeled timeframe. The “mean” distances should be considered representative of the “typical” (yet conservative) predicted extent of the plume.

This evaluation assumes that an excess suspended sediment concentration of 25 mg/l represents the significance threshold relative to potential suspended sediment plume impacts. The lateral extent of the 25 mg/l suspended sediment plume is predicted to be limited, on average, to within 1,700 ft (518 m) of the pipeline centerline in State waters and within 800 ft (244 m) in Federal waters.

As exemplified in the selection of 100 percent loss rates for modeling purposes, hand jetting and submersible pump excavation represent the two activities with the greatest potential impact relative to the generation of suspended sediment plumes. However, as seen in Table 4-5, plowing and backfill plowing activities can result in sediment plumes of similar magnitude and areal extent. This is because plowing is a continuous activity that occurs over large areas over an extended period of time and, as a result, plowing related sediment plumes are affected by a wider range of changing hydrodynamic conditions than exist during the shorter timeframe hand jetting and submersible pump excavation activities. As noted above, the combined activities result in turbidity plumes of limited magnitude and areal extent.

Table 4-4 Extent of Suspended Sediment Plumes – State Waters (Assumed 25% Fines)

Excavation Method	25 mg/L				50 mg/L				100 mg/L			
	maximum		mean		maximum		mean		maximum		mean	
	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m
Highest Predicted Max./ Mean Distances	5,355	1,632	1,701	519	3,638	1,109	761	232	1,247	380	398	121
Plow / Plow Backfill	5,128	1,563	1,500	457	3,638	1,109	676	206	1,096	334	334	102
Submersible Pump	3,521	1,073	1,503	458	1,463	446	680	207	1,247	380	547	167
Hand Jet	5,355	1,632	1,423	434	3,091	942	749	228	1,086	331	385	117

Table 4-5 Extent of Suspended Sediment Plumes – Federal Waters (Assumed 5% Fines)

Excavation Method	25 mg/L				50 mg/L				100 mg/L			
	maximum		mean		maximum		mean		maximum		mean	
	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m
Highest Predicted Max./ Mean Distances	4,352	1,326	762	232	3,244	989	557	170	2,430	741	380	116
Plow / Plow Backfill	4,352	1,326	741	226	3,244	989	553	168	2,430	741	376	115
Submersible Pump	1,548	472	542	165	1,227	374	561	171	1,046	319	590	180
Hand Jet	2,042	622	505	154	1,155	352	368	112	898	274	314	96

It is also important to note that Figure 4-3, Figures 4-4a through 4-4d, Table 4-4, and Table 4-5 present the maximum predicted suspended sediment concentrations at various locations over the course of the approximate nine-month timeframe that was modeled. At no single time will increases in suspended sediment concentrations approach the cumulative impact shown across the model domain in Figure 4-3. The sandy characteristics of sediments that will be displaced ensure that increases in suspended sediment concentrations will be of short duration. Suspended sediment concentrations are generally predicted to return to ambient conditions within 24 hours of completion of the relevant construction activity.

As an example, Figure 4-5 shows a time series of suspended sediment concentrations in the vicinity of a utility lowering at MP 9.9, in the model assumed to be performed by hand jetting. Sediment displacement was assumed to be a continuous activity completed over a 32-hour timeframe. The top left window shows model results immediately prior to the initiation of the lowering activity. Moving down the left hand column of the figure, time progresses while jetting continues and a suspended sediment plume is established. The right column shows model results immediately prior to and following the completion of the lowering activity. Within nine hours of the cessation of the hand jetting activity, the sediment plume has dissipated and suspended sediment concentrations in the Project area have returned to ambient conditions.

In addition to their limited duration, the impacts relative to elevated suspended sediment concentrations predominantly occur near the sea floor. Figure 4-6 shows the predicted maximum suspended sediment concentrations resulting from the first pass of the plow between MP 11 and MP 9. The model results are shown for four vertical bins throughout the water column. The top left window shows suspended sediment concentrations from the sea floor to 16.4 ft (5 m) above the sea floor. The bottom left window shows suspended sediment concentrations from the 16.4 ft (5 m) to 32.8 ft (10 m) above the sea floor. The top right shows the same results for 32.8 ft (10 m) to 49.2 ft (15 m) and the bottom right shows the same results for 49.2 ft (15 m) to 65.6 ft (20 m) above the sea floor. The model results shown in Figure 4-6 demonstrate a pattern that is consistent throughout all sediment disturbing activities, that the highest suspended sediment concentrations occur near the sea floor. The concentrations and distance from the Mainline and Laterals decrease with height above the sea floor.

Figure 4-7 shows the entire Project area and presents the predicted areal extent and thickness of sediment deposition due to all modeled sediment disturbing activities. Figures 4-8a through 4-8d show individual sections of the Project area.

Table 4-6 and Table 4-7 present the predicted lateral extent of the 5 mm (0.2 in) and 20 mm sediment deposition areas in State waters (assumed 25 percent fines) and Federal waters (assumed 5 percent fines), respectively. The distances provided in the tables represent the distance from the disturbance (centerline of Mainline or of Laterals) to the outer edges of the respective depositional area. The maximum distance represents the maximum extent of the plume for either all activities or for an individual activity and the mean distance represents the mean distance as estimated by averaging individual lateral distances predicted at an average of 33 ft (10 m) intervals along the respective depth contour line.

Table 4-6 Extent of Sediment Deposition Areas – State Waters (Assumed 25% Fines)

Excavation Method	5 mm (0.2 in) Deposition				20 mm (0.8 in) Deposition			
	maximum		mean		maximum		mean	
	ft	m	ft	m	ft	m	ft	m
Highest Max./ Mean Distances Based on Cumulative Deposition	2,604	794	456	139	1,187	362	141	43
Plow / Plow Backfill	2,278	694	313	95	835	255	90	27
Submersible Pump	1,319	402	729	222	1,182	360	542	165
Hand Jet	1,748	533	459	140	656	200	140	43

Table 4-7 Extent of Sediment Deposition Areas – Federal Waters (Assumed 5% Fines)

Excavation Method	5 mm (0.2 in) Deposition				20 mm (0.8 in) Deposition			
	maximum		mean		maximum		mean	
	ft	m	ft	m	ft	m	ft	m
Highest Max./ Mean Distances Based on Cumulative Deposition	2,446	746	218	66	1,066	325	66	20
Plow / Plow Backfill	2,446	746	202	62	1,054	321	63	19
Submersible Pump	263	80	134	41	166	51	90	28
Hand Jet	1,383	422	240	73	245	75	97	29

Based on mean distance values, the area of substantial sediment deposition (in excess of 20 mm [0.8 in]) is limited primarily to within approximately 150 ft (46 m) of the pipeline centerline in State waters and within 100 ft (30 m) in Federal waters. The mean distance for submersible pumping activities at the hot-tap/SSTI location (in State waters) is an exception to this characterization, as deposition in excess of 20 mm (0.8 in) extends 542 ft (165 m) from the excavation. The extent of sediment deposition extends a greater distance in State waters because the sediment has a greater proportion of fine-grained particles and these fines settle more slowly allowing the sediment to travel greater distances.

This evaluation considers a sediment deposition thickness of 5 mm (0.2 in) as representative of the maximum measurable and practical extent of Project-related sediment deposition. Based on mean distance values, the lateral extent of the 5 mm (0.2 in) sediment deposition area is predicted to be limited, on average, to within approximately 500 ft (152 m) of the pipeline centerline in State waters and within approximately 250 ft (76 m) in Federal waters. The mean distance for submersible pumping activities at the hot-tap/SSTI location (in State waters) is again an exception to this characterization, as deposition in excess of 5 mm (0.2 in) extends 729 ft (222 m) from the excavation.

As with “maximum” plume concentrations, the “maximum” sediment deposition distances presented in Table 4-6 and Table 4-7 are predicted to occur at a few isolated locations in the Project area. These isolated areas of localized high depositional thickness are often associated with the pre-lay lowering of utility crossings, which is an activity which may not occur if cutting/removal of relic cable lines is allowed. Also, in certain areas elevated depositional thickness can stem from anomalies in localized current patterns and/or bathymetry. As the suspended sediments move with currents, they are also settling. In areas where the sea floor slopes upwards, settling sediments will preferentially settle on the upslope as opposed to surrounding areas that are deeper, resulting in localized increased thickness. The “mean” distances provided in Table 4-6 and Table 4-7 should be considered representative of the “typical” (yet conservative) predicted extent of sediment deposition.

5. Conclusions

The construction of the Port Ambrose Project will involve numerous activities that will result in the disturbance of bottom sediments, generation of suspended sediment plumes, and re-deposition of sediment in the vicinity of the construction footprint. Of the many construction activities, pipeline lowering activities, utility lowering, and excavations at the hot-tap/SSTI and CYA locations will cause the greatest displacement of bottom sediments resulting in sediment dispersion and deposition and were, therefore, selected as the subject of this modeling evaluation.

The Port Ambrose Project will include lowering by mechanical plowing of approximately 22.9 mi (36.8 km) of pipeline trench and supplemental excavation and lowering of an additional approximate 2.0 mi (3.1 km) through various other methods including hand jetting, the use of submersible pump, and/or air-lift. The Project also includes the excavation of the hot-tap/SSTI and CYA areas using similar supplemental methods, likely primarily submersible pumps. The Project extends out into the New York Bight approximately 19 mi (30 km) south of Jones Beach, New York. This modeling evaluation has conducted an analysis of the transport and deposition of the sediment that will be disturbed during the construction phase of the Project. The evaluation was performed by first developing a hydrodynamic model of the Project area using the ADCIRC model and then applying this hydrodynamic model to develop a sediment dispersion model using PTM.

The sediment dispersion model simulates the transport of suspended sediments associated with pipeline lowering activities along the length of the Mainline and Laterals, lowering of existing utilities, and the excavation of the hot-tap/SSTI and CYA areas. Based on the assumptions described in this Report, the model predicted suspended sediment concentrations and depositional thicknesses as a result of the advective transport of sediment away from active construction. The various sediment disturbing activities are anticipated to occur at different points throughout the calendar year. The model simulated these activities as if they were to occur throughout 2013. This modeling evaluation assumes that the hydrodynamic behavior that occurred in 2013 is comparable to hydrodynamic behavior that will exist in 2016 when the construction of the Port Ambrose Project is scheduled to occur.

The results of the analysis indicate that elevated levels of suspended sediment, in concentrations in excess of 50 mg/L, are predicted to occur mainly in the immediate vicinity (within 600 to 800 ft [183 to 244 m]) of the sediment disturbing activity. In isolated instances, suspended sediment concentrations in excess of 50 mg/l could potentially extend to a distance of up to approximately 3,650 ft (1,113 m) away from the pipeline trench centerline. However, along a majority of the construction corridor, suspended sediment plumes are expected to drop below an excess concentration of 25 mg/L within approximately 800 to 1700 ft (244 to 518 m) of the pipeline centerline. The duration of suspended sediment plumes is expected to be short, with conditions in the vicinity of the Project predicted to return to ambient within 24 hours of the end of sediment disturbing activities. This is due to the mostly sandy sediment that is present in the Project area. Suspended sediments are expected to readily settle out of the water column.

Substantial sediment deposition (greater than 20 mm [0.8 in]) is predicted to generally be limited to the immediate vicinity of the pipeline (within approximately 150 ft [46 m] in State waters and within 100 ft (30 m) in Federal waters). Sediment deposition in excess of 5 mm (0.2 in) is predicted to be limited to within approximately 500 ft (152 m) of the pipeline in State waters and within 250 ft (76 m) in Federal waters. Isolated areas of elevated deposition may occur at greater distances, up to approximately 1,200 ft (366 m) for 20 mm (0.8 in) thickness and up to approximately 2,600 ft (792 m) for 5 mm (0.2 in) thickness. In general measurable depositional thicknesses are predicted to occur in close proximity to the Mainline and the Laterals.

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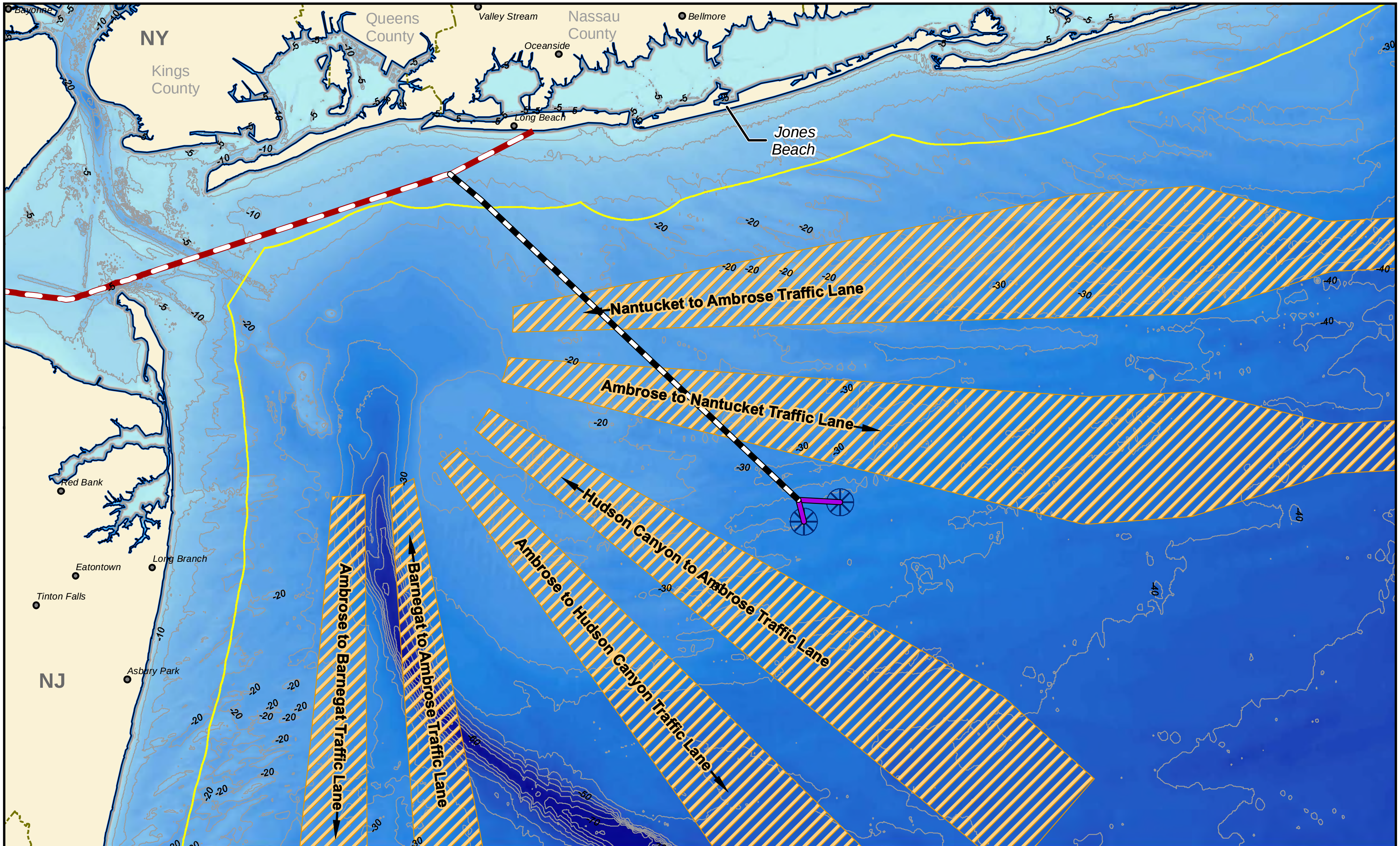
FIGURES



Map Location

Legend

- Mainline
- Laterals
- Existing TRANSCO New York Bay Lateral
- Three Nautical Mile Line
- Traffic Lane
- Bathymetry (5 meter)
- Buoys

Source:
ESRI, MMS, NOAA
Projection: NAD83 State Plane New Jersey FIPS 2900 Feet

N

Site Plan

Port Ambrose Project

AECOM
PORTAMBROSE

Date September 2012

Scale 1:400,000

0 2.5 5 10 Nautical Miles

0 2.5 5 10 Nautical Miles

Figure 1-1

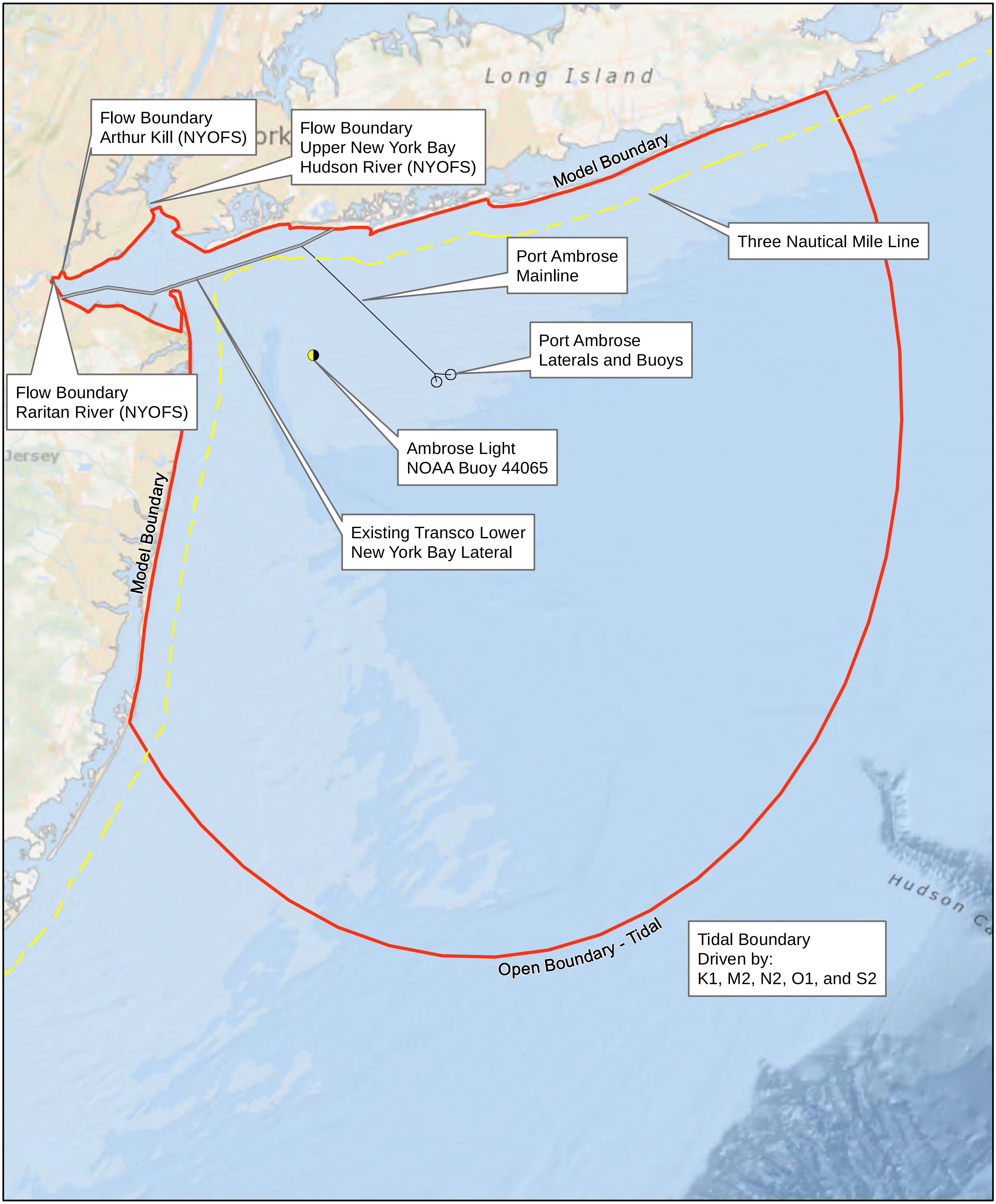


Figure 3-1 Model Domain

Hodge WaterResources

Date: February 2014

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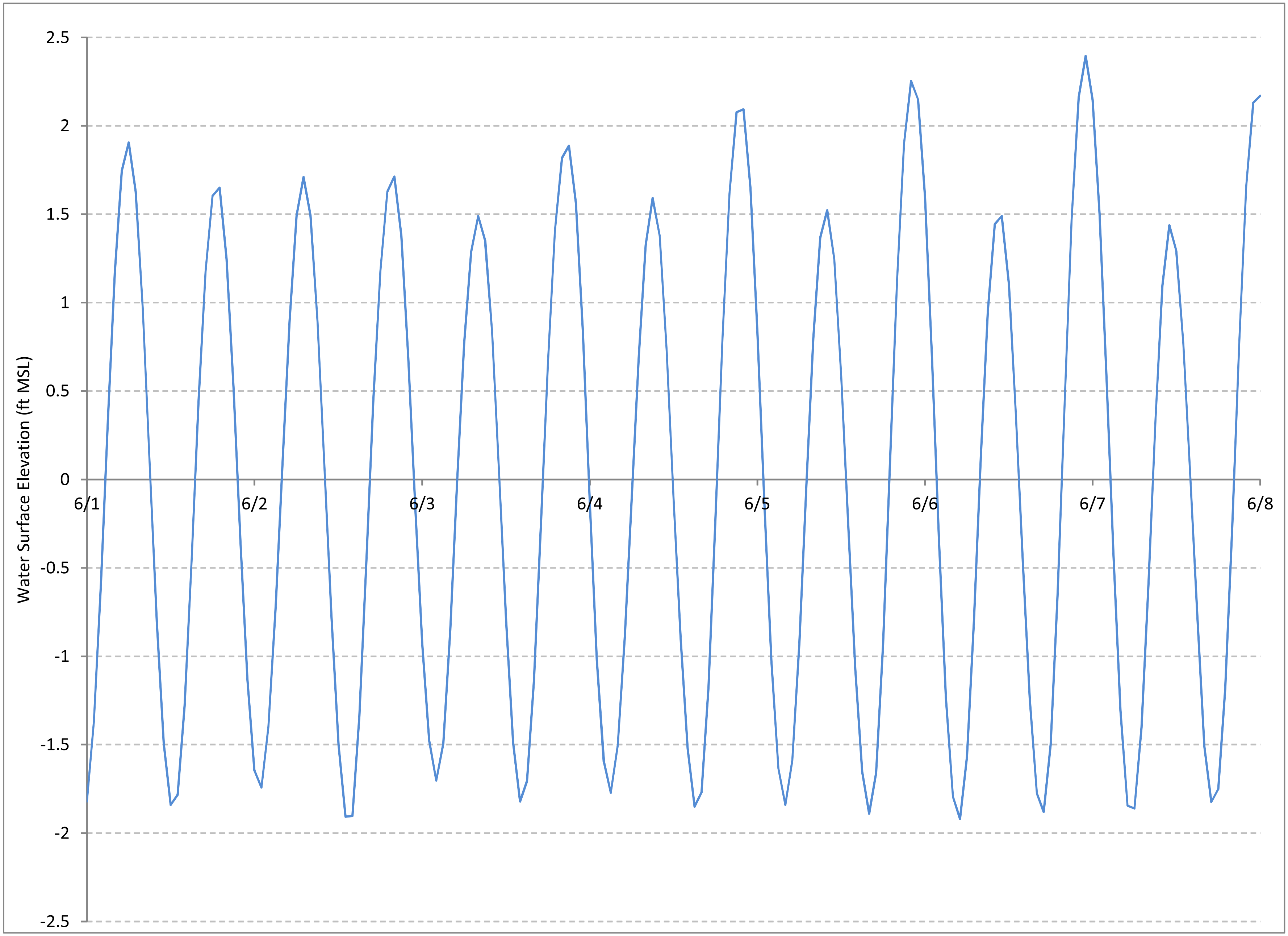

Figure 3-2 Model Predicted Water Level

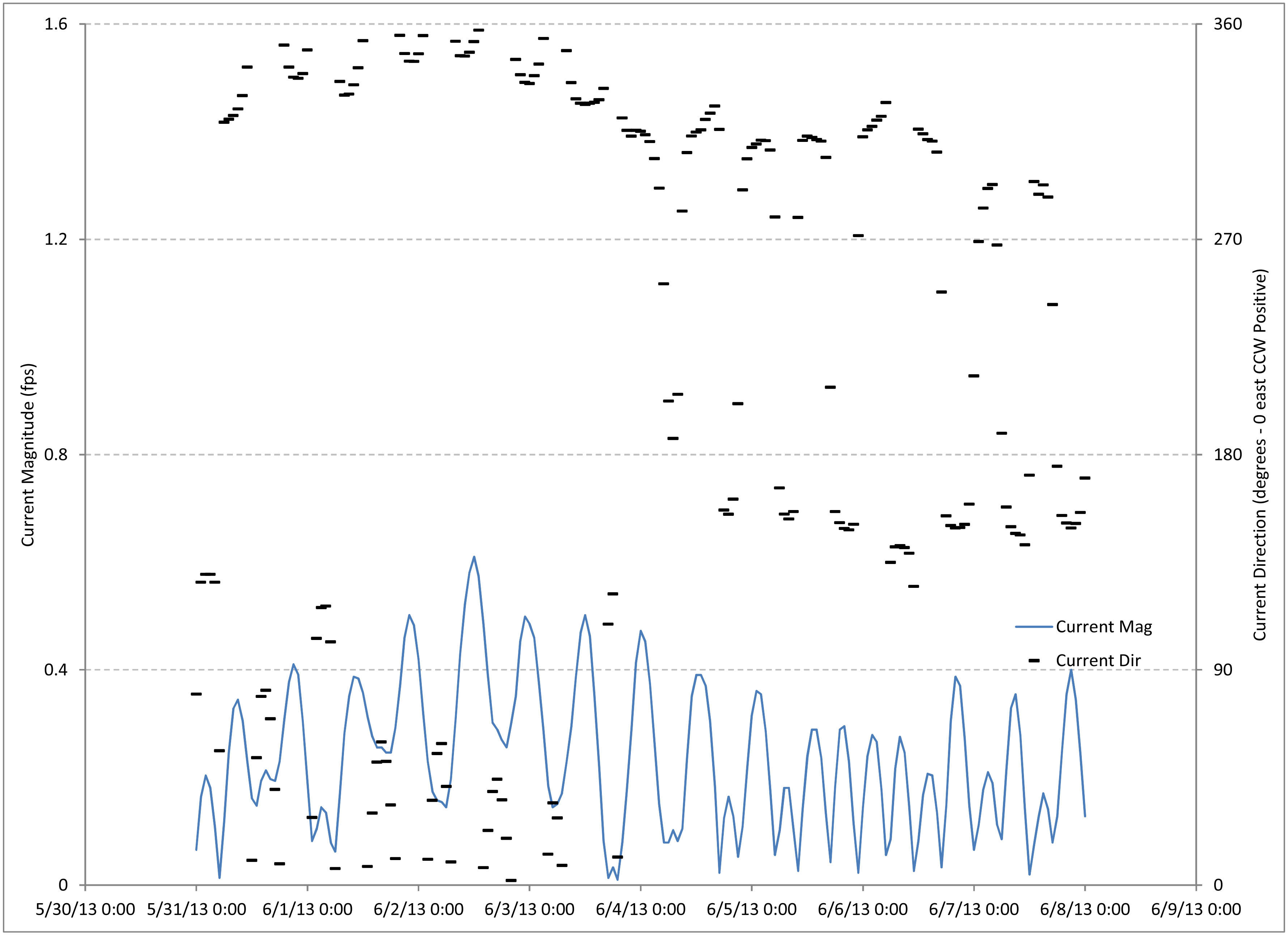

Figure 3-3 Time Series Predicted Current Magnitudes and Direction in Vicinity of Mainline

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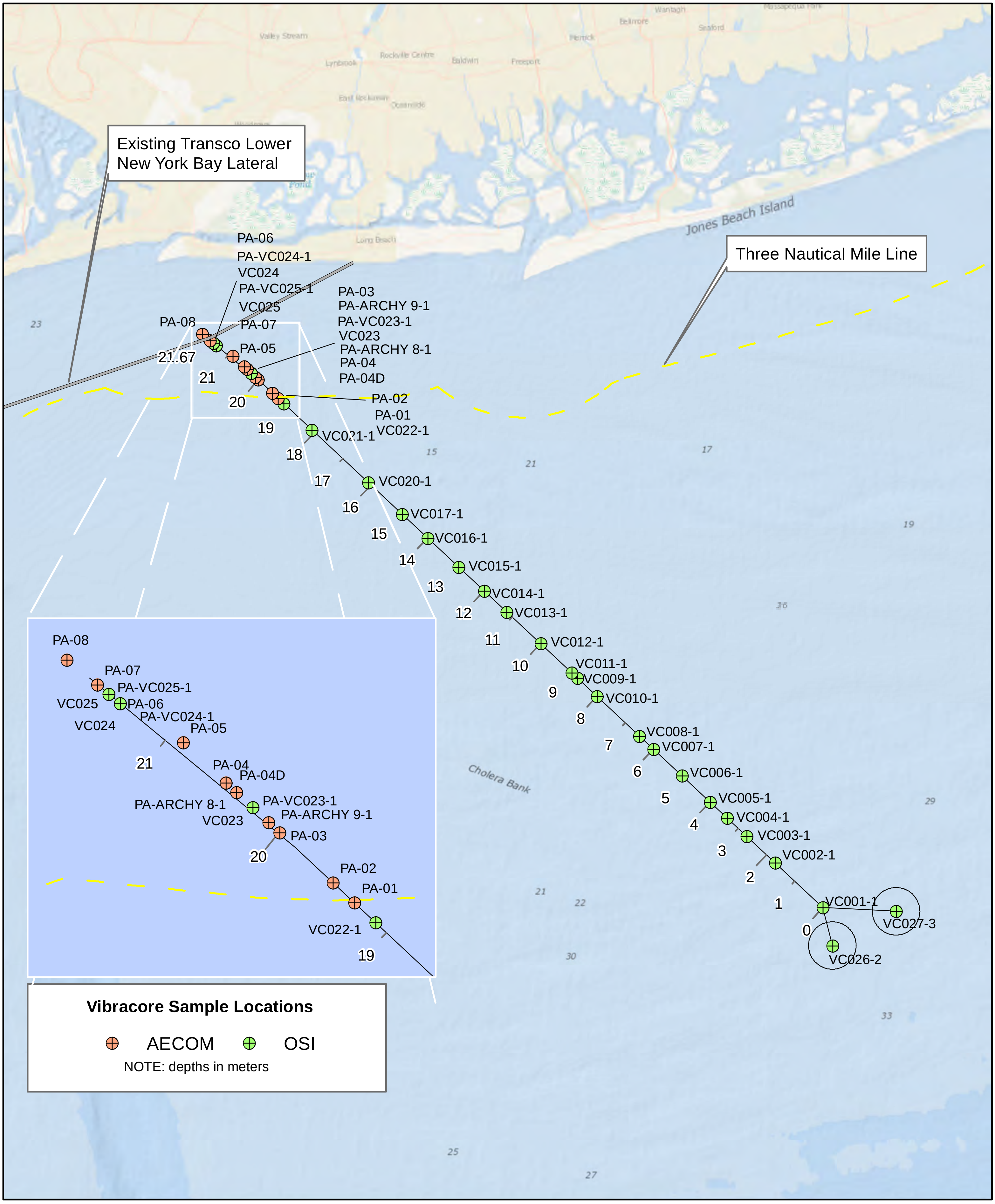

Figure 4-1 Vibracore Sample Locations

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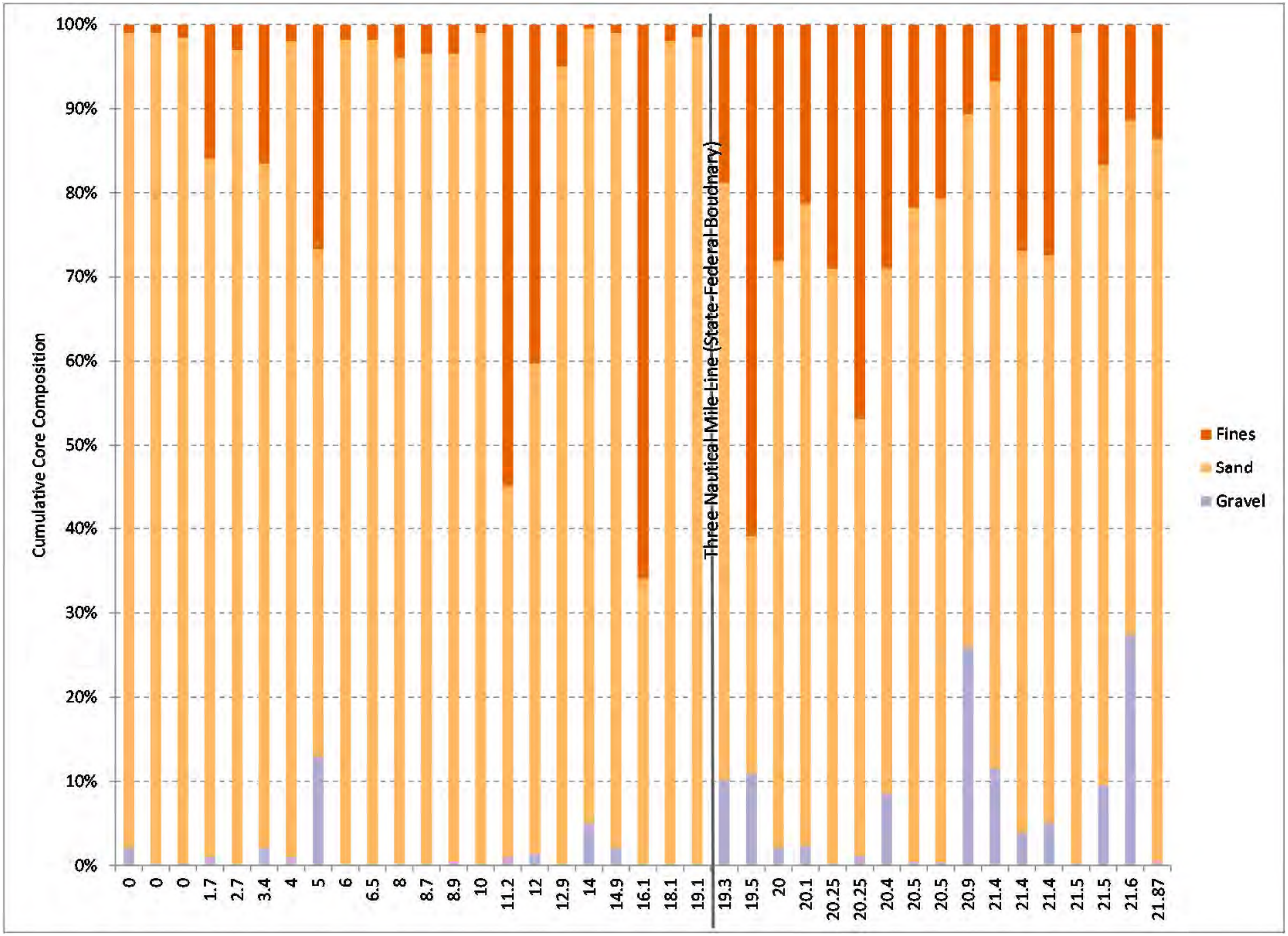

Figure 4-2 Vibracore Sample Sediment Type Characterization

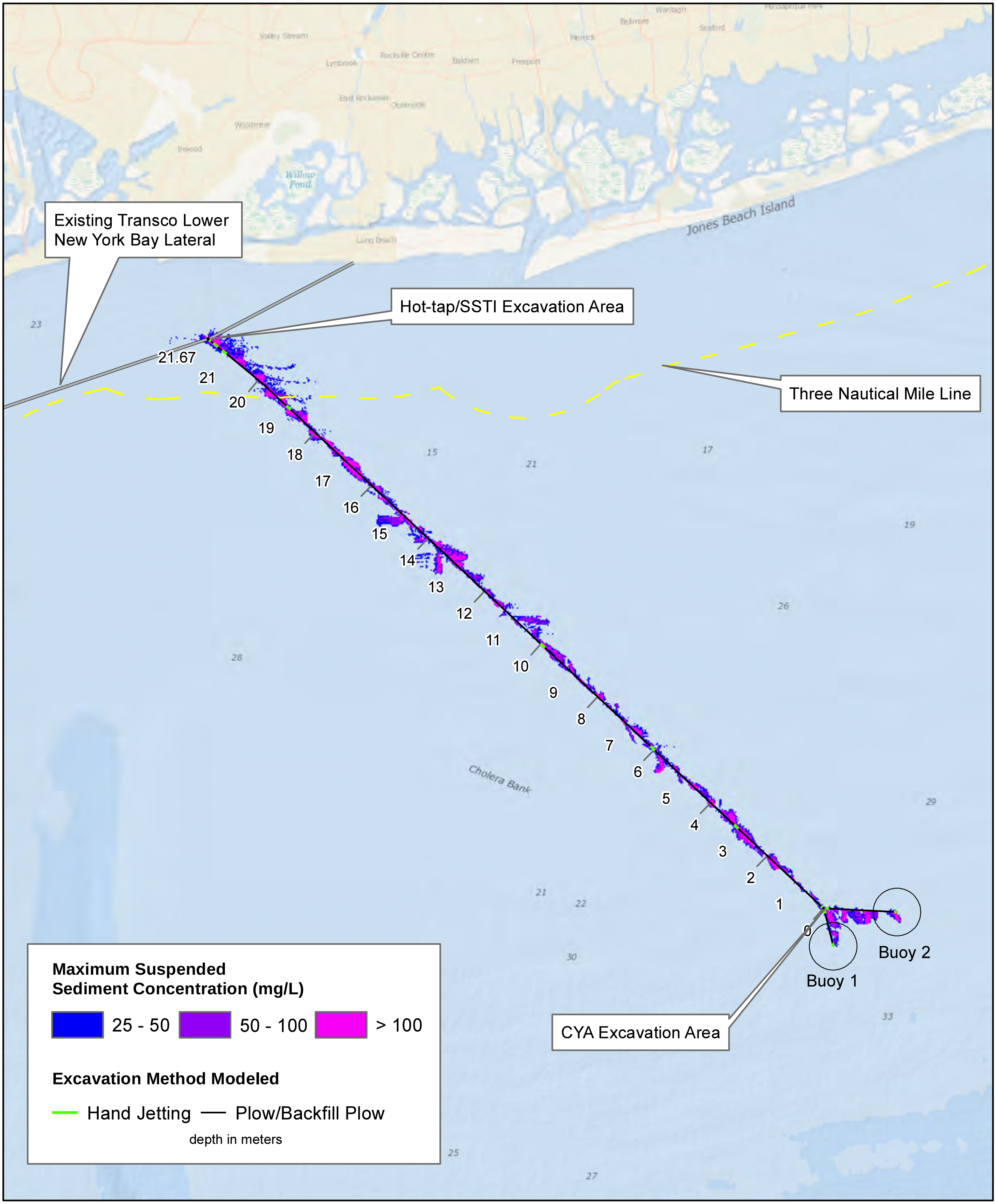

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Figure 4-3 Maximum Suspended Sediment Concentration (All Modeled Activities) – Entire Model Domain

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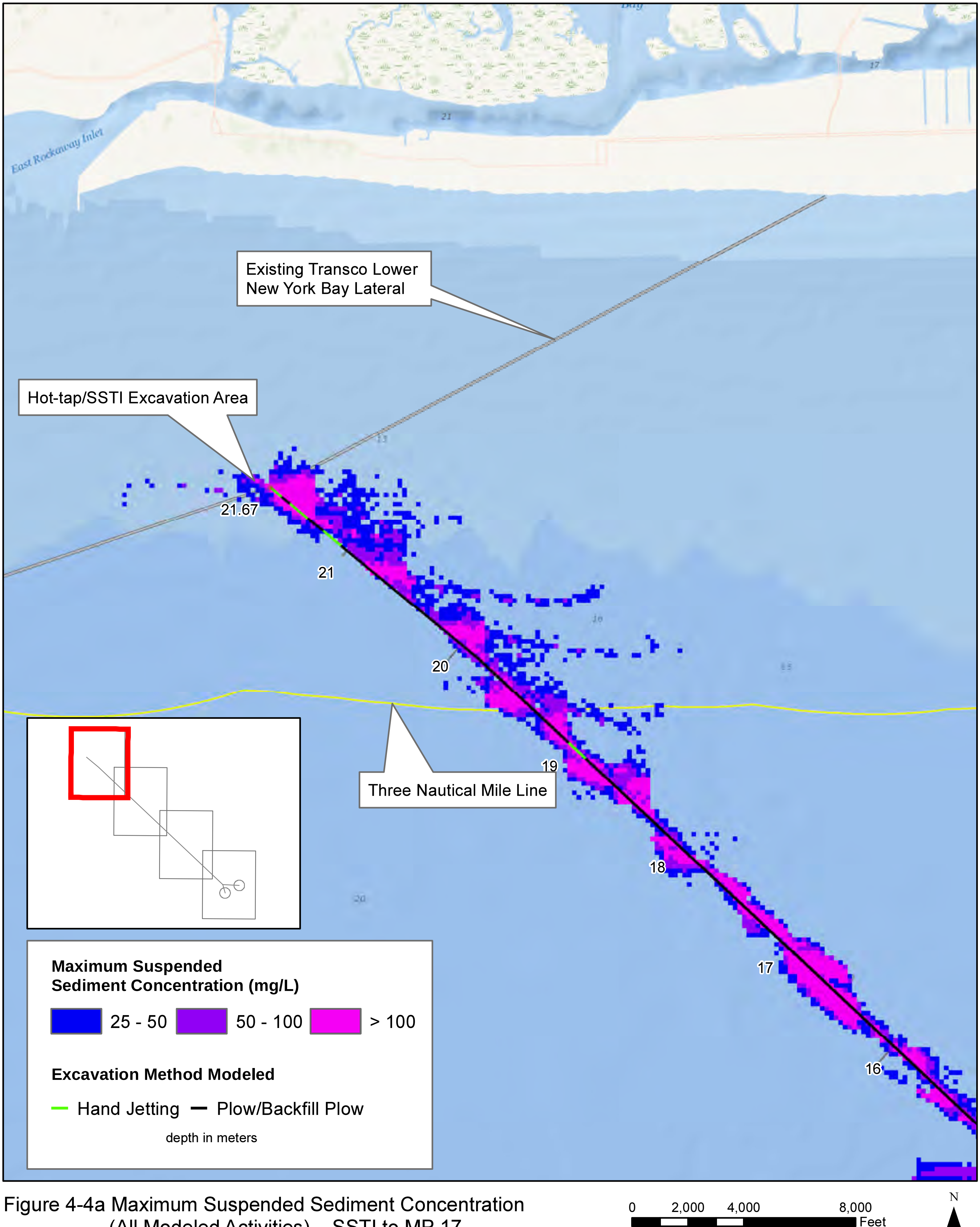

Figure 4-4a Maximum Suspended Sediment Concentration (All Modeled Activities) – SSTI to MP 17

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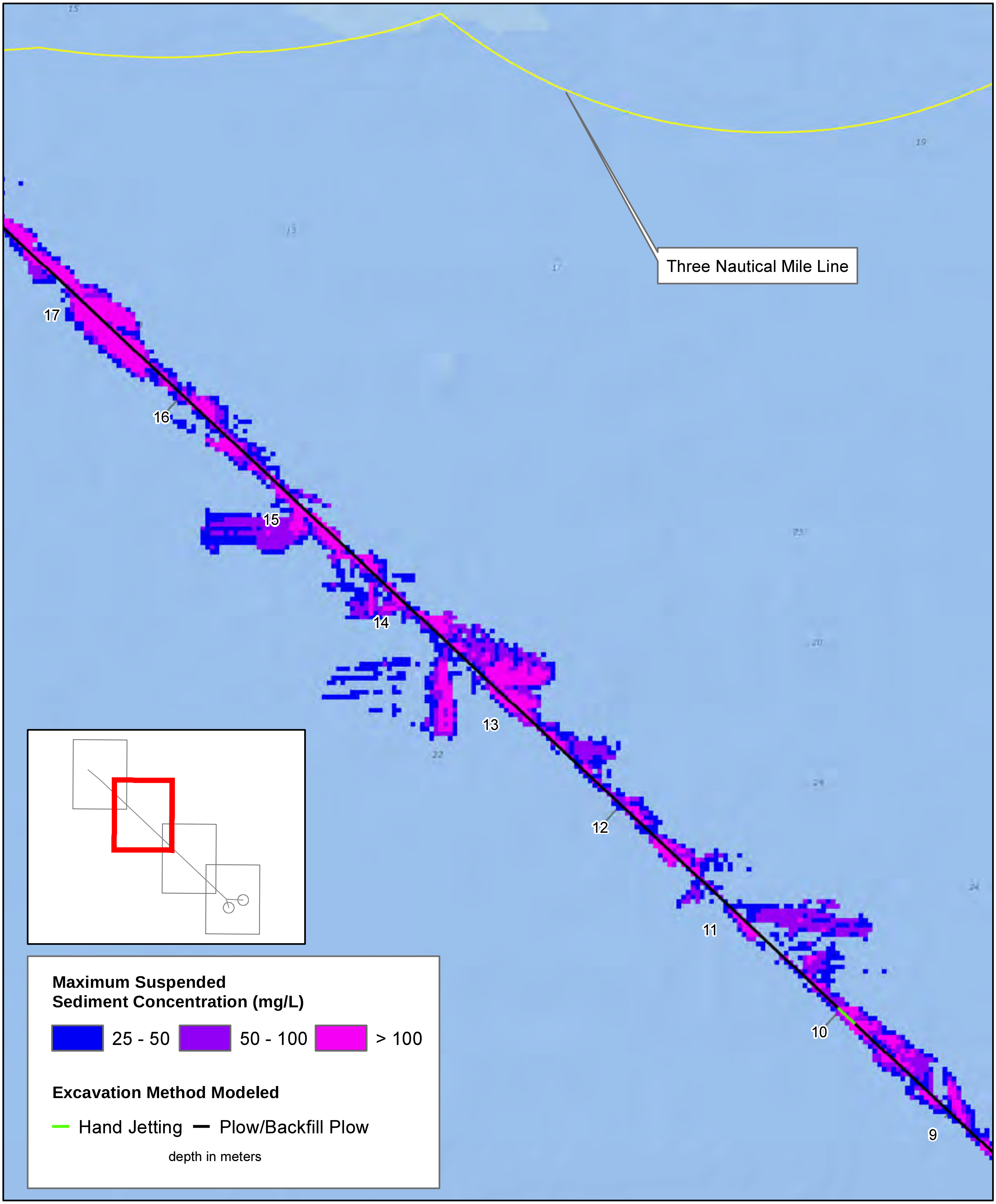

Figure 4-4b Maximum Suspended Sediment Concentration (All Modeled Activities) – MP 17 to MP 10

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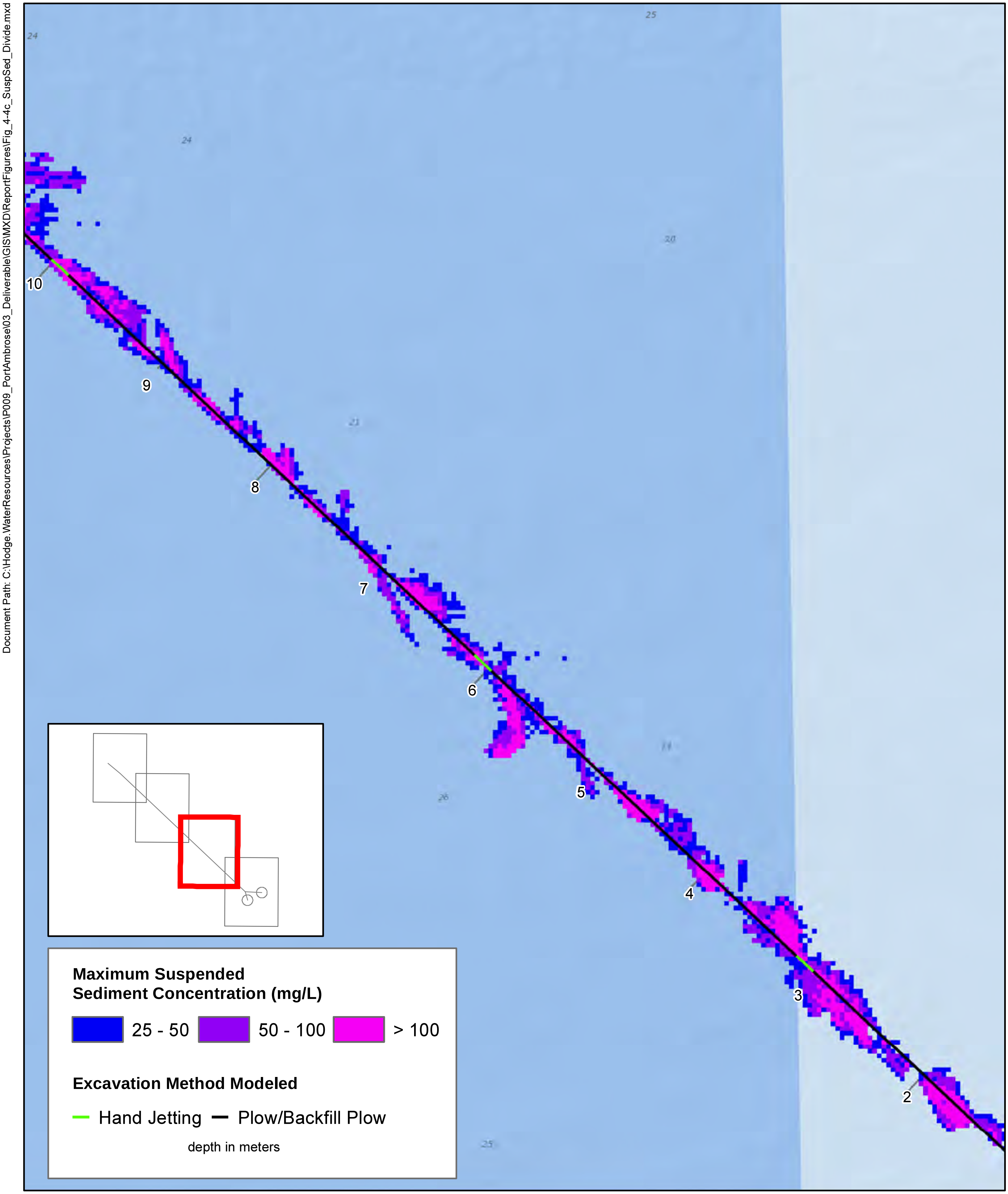

Figure 4-4c Maximum Suspended Sediment Concentration (All Modeled Activities) – MP 10 to MP 3

0 2,000 4,000 8,000 Feet

N

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Date: February 2014

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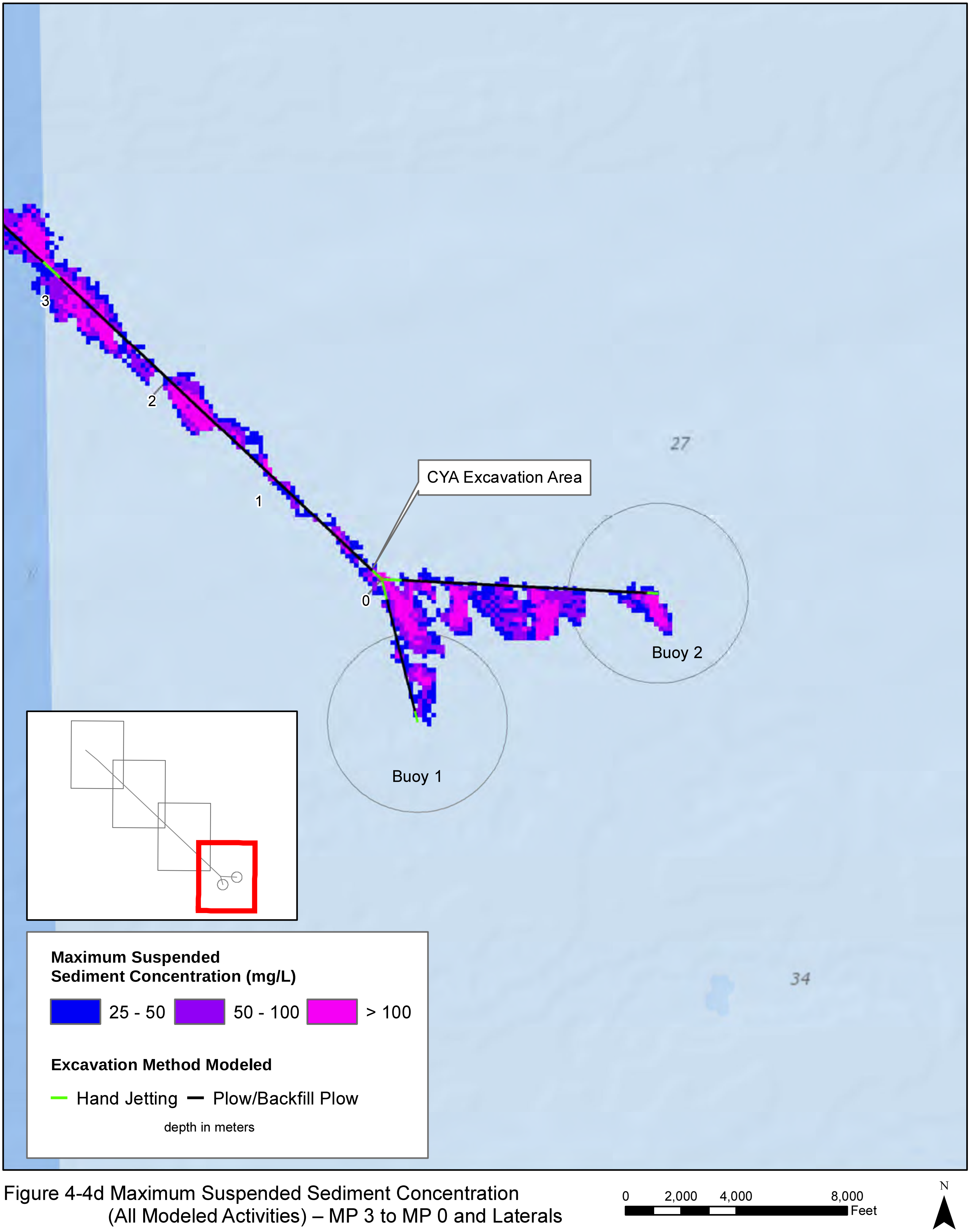

Figure 4-4d Maximum Suspended Sediment Concentration (All Modeled Activities) – MP 3 to MP 0 and Laterals

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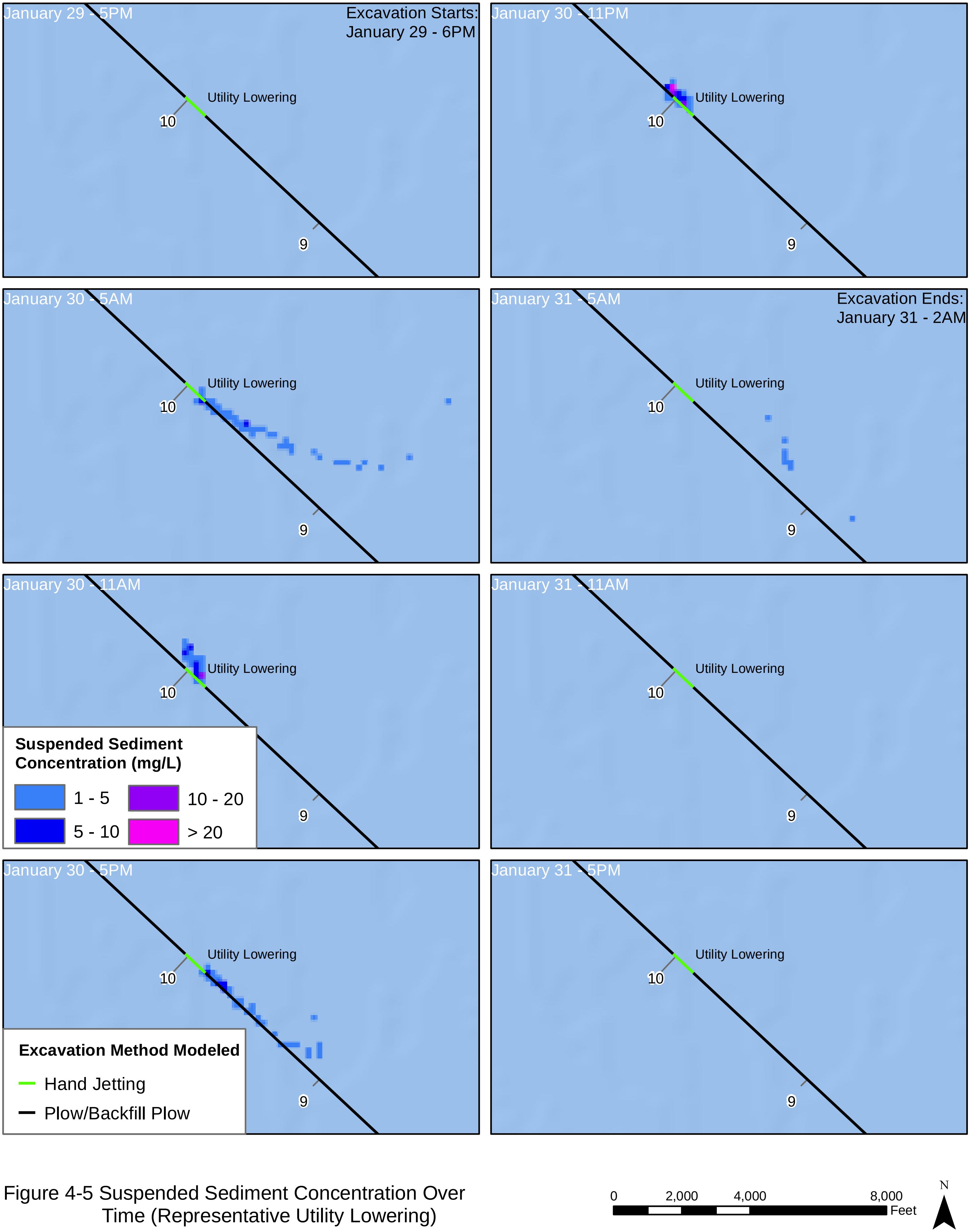

Figure 4-5 Suspended Sediment Concentration Over Time (Representative Utility Lowering)

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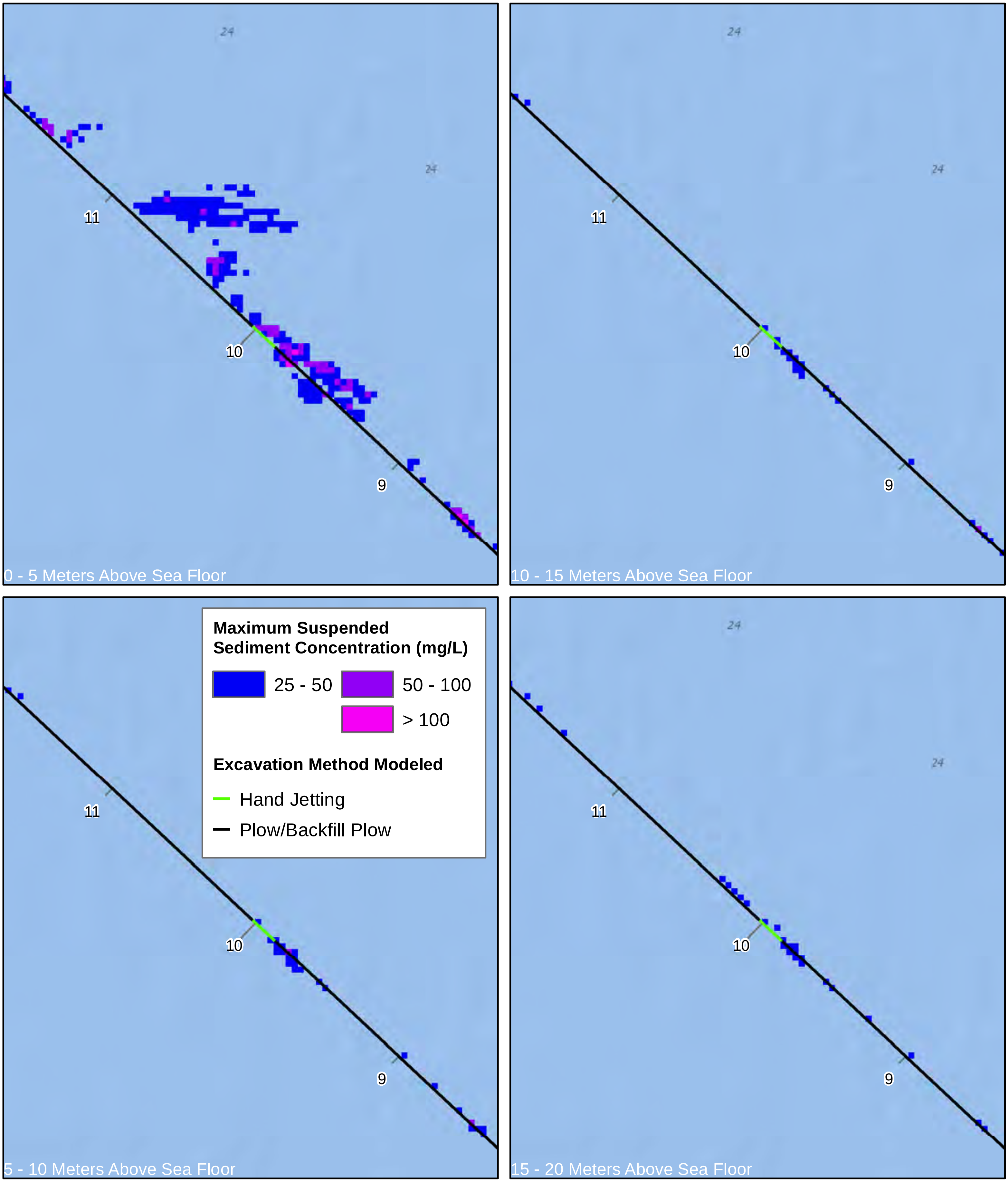

Figure 4-6 Variation in Maximum Suspended Sediment Concentration with Depth (Representative Section Plowing)

0 2,000 4,000 8,000 Feet

N

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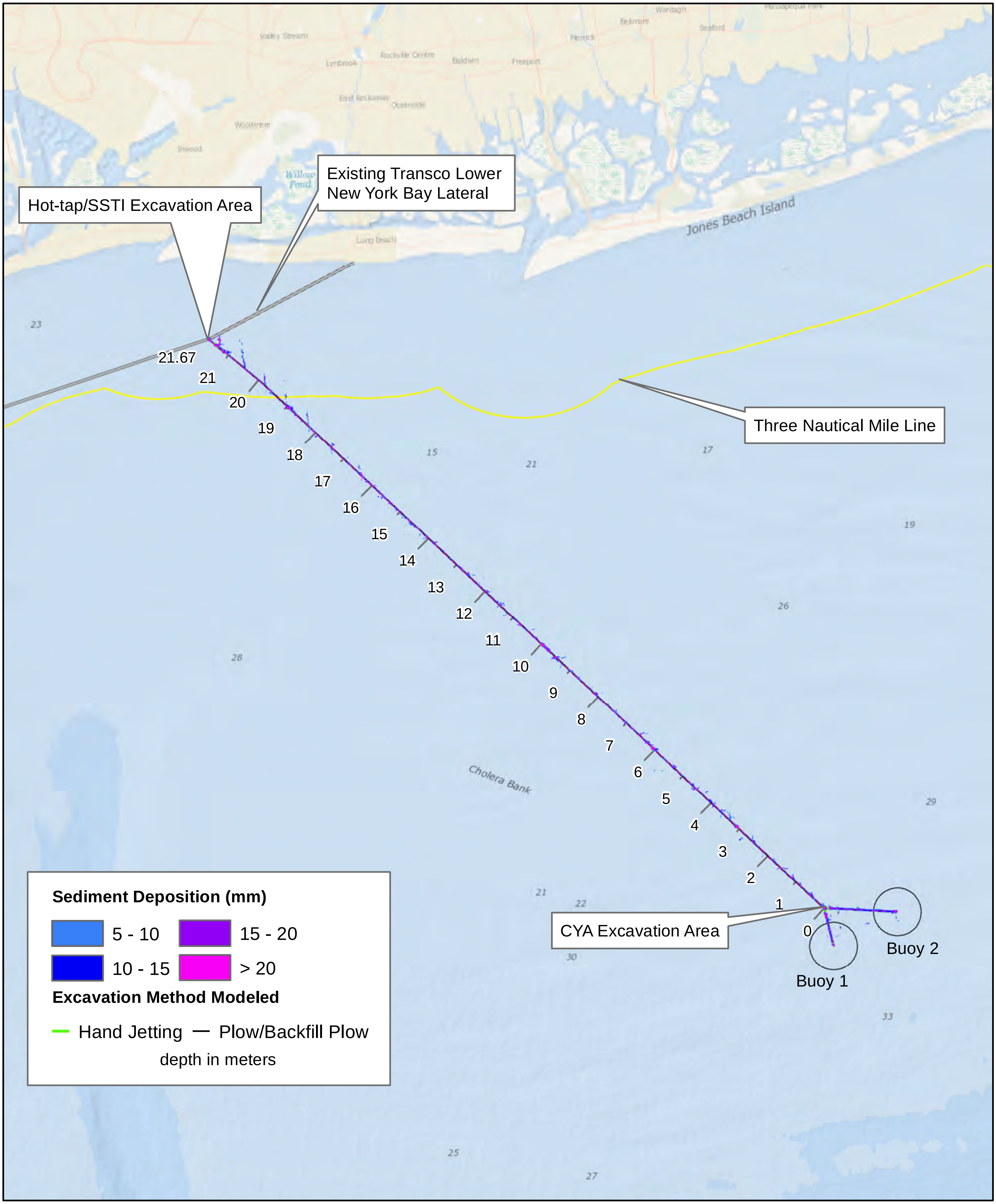

Figure 4-7 Deposition Thickness (All Modeled Activities) - Entire Model Domain

0 10,000 20,000 40,000 Feet

N

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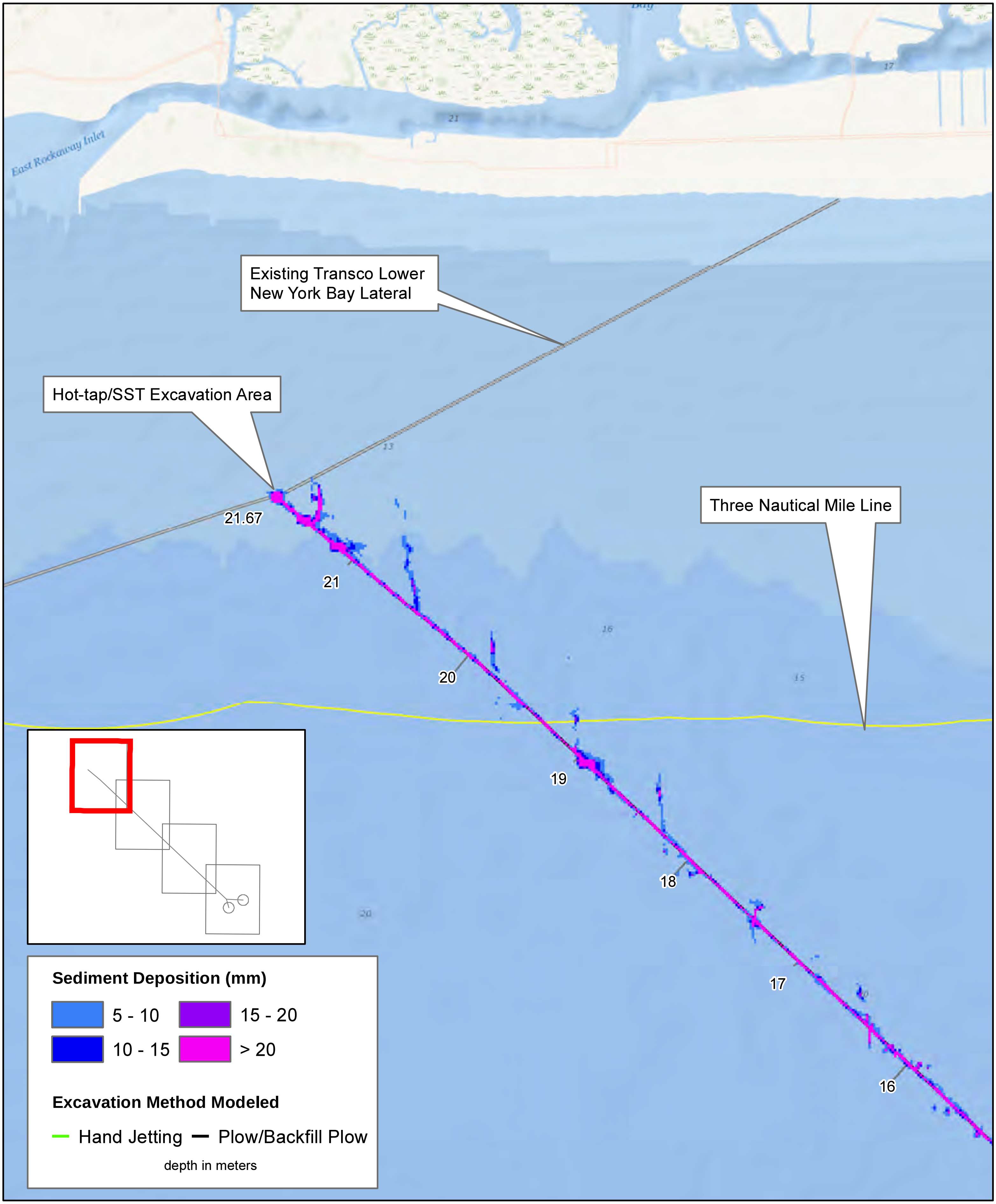

Figure 4-8a Deposition Thickness
(All Modeled Activities) – SSTI to MP 17

0 2,000 4,000 8,000 Feet

N

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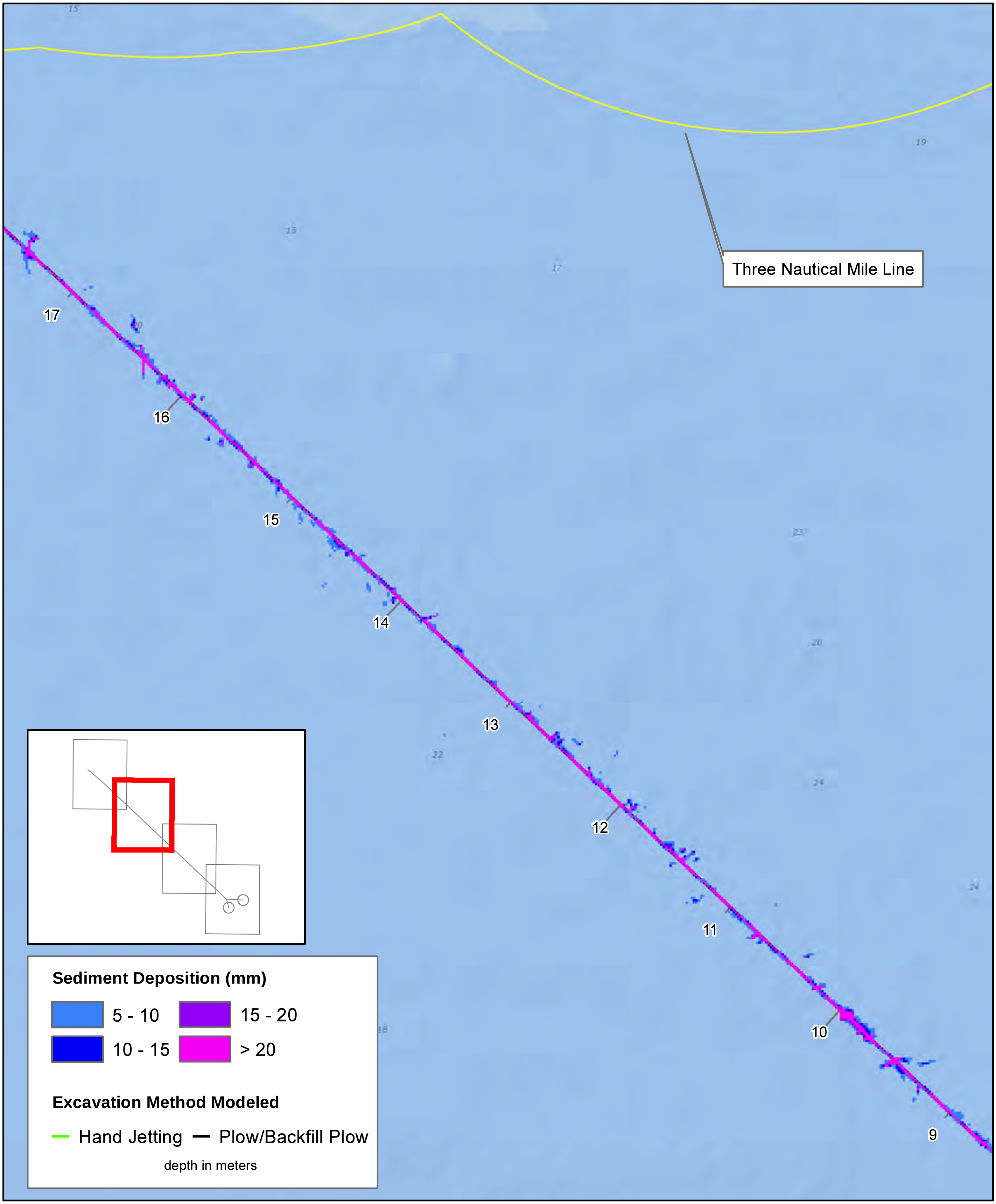

Figure 4-8b Deposition Thickness
(All Modeled Activities) – MP 17 to MP 10

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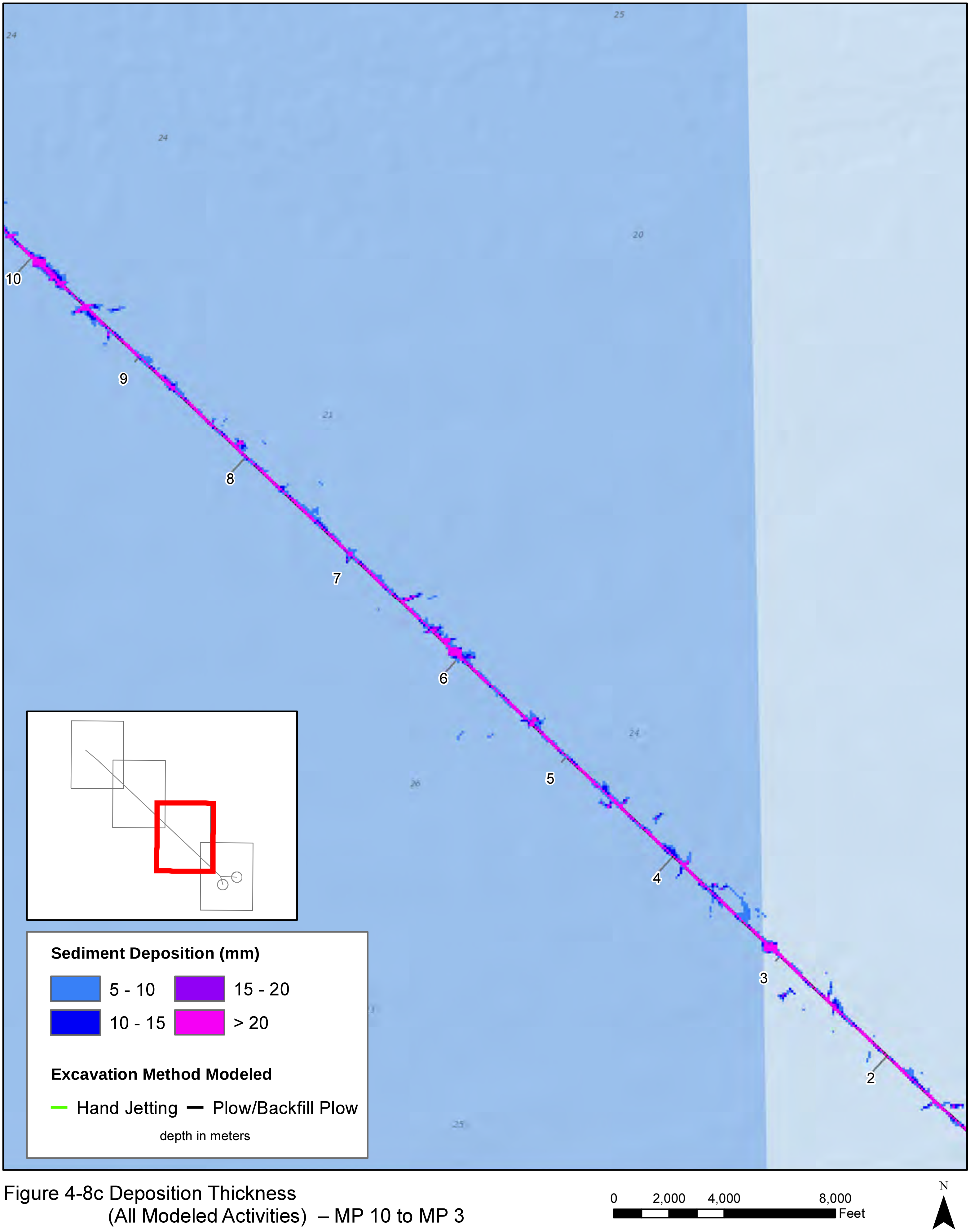

Figure 4-8c Deposition Thickness
(All Modeled Activities) – MP 10 to MP 3

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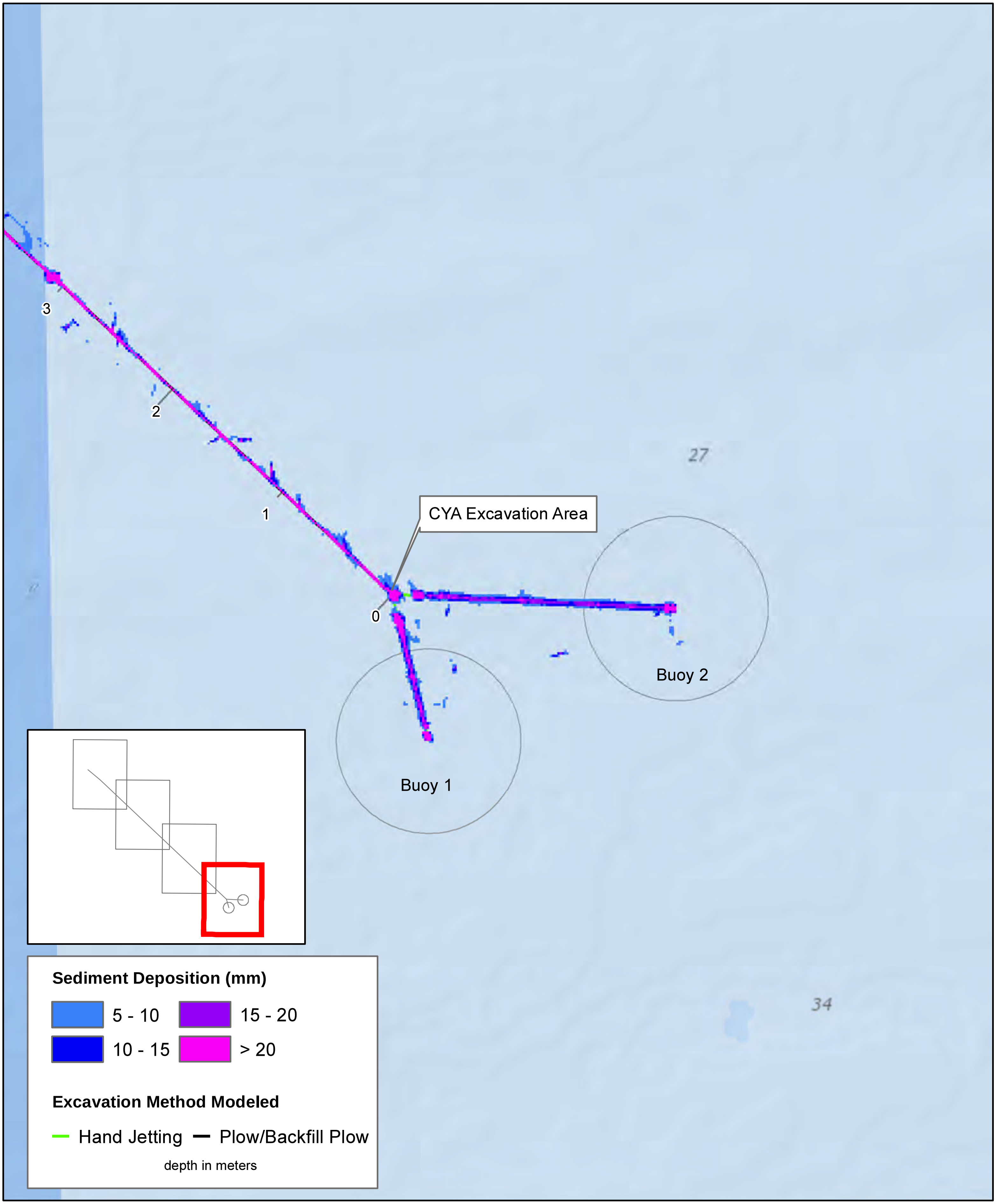

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Figure 4-8d Deposition Thickness
(All Modeled Activities) – MP 3 to MP 0 and Laterals

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Appendix D-2

Sediment Transport Study - Addendum

Environmental Report
in support of the
Port Ambrose Project Application

May 2014

Topic Report 3 – Water and Sediment Quality

Appendix B

Modeling Evaluation of Sediment Dispersion and Deposition during Construction of the Port Ambrose Deepwater Port Project

Addendum 1:
Modeling of Supplemental Lowering of Mainline from MP 17.0 to MP 20.1

Modeling Evaluation of Sediment Dispersion and Deposition during Construction of the Port Ambrose Deepwater Port Project

Addendum 1:

Modeling of Supplemental Lowering of Mainline from MP 17.0 to MP 20.1

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May 2014

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1. Introduction

1.1 Project Activity Update

Liberty Natural Gas, LLC (Liberty) is proposing to construct, own, and operate a deepwater port, known as Port Ambrose (Port Ambrose, or the Project) in the New York Bight. In February, 2014 Liberty submitted to the United States Coast Guard (USCG) the Environmental Report in Support of the Port Ambrose Project Application, Topic Report 3 – Water and Sediment Quality, Appendix B: Modeling Evaluation of Sediment Dispersion and Deposition during Construction of the Port Ambrose Deepwater Port Project (the Report). The Report provided an analysis of the predicted impacts of Project construction activities relative to suspended sediment concentration in the water column and sediment deposition.

The Report findings were based on the assumption that lowering of the Project's Mainline and Lateral pipelines would be achieved primarily by mechanical plowing. The Report also assumed that the lowering activity would be performed to achieve a target 4 foot (ft) (1.2 meters [m]) of cover above the top of the pipelines. It was assumed that the plowing activity, performed in two passes, would excavate a trench with a maximum depth of approximately 7 ft (2.1 m) below the sea floor.

Subsequent to submittal of the Report, Liberty received correspondence from the U.S. Army Corps of Engineers (Corps or USACE) indicating the Corps will require a minimum of 7 ft (2.1 m) of bottom cover within the open-water anchorage area that extends along the Mainline from approximately milepost (MP) 17.0 to MP 20.1. To achieve this greater burial depth the lowering activities would be required to achieve a maximum trench depth of approximately 10 ft (3.1 m) in the anchorage area. To achieve this additional cover, Liberty is proposing to use a jet sled in the anchorage area to lower the Mainline an additional 3 ft (0.9 m) over that previously proposed. To achieve this greater burial depth additional lowering activities would be required to achieve a maximum trench depth of approximately 10 ft (3.1 m) in the anchorage area. Liberty has determined that it is not feasible to achieve the additional trenching depth by means of a third mechanical plow pass and is proposing to lower the Mainline an additional 3 ft (0.9 m) in the anchorage area using a jet sled.

1.2 Additional Lowering Construction Methods

Several supplemental construction activities and methods will be implemented to achieve the required 7 ft (2.1 m) of cover along the approximate 3.1-mile long segment of the Mainline that will pass through the anchorage area (MP 17.0 to MP 20.1). These additional activities include:

- Additional pre-lay lowering of the out-of-service foreign utility cable located at MP 18.93;
- Additional lowering of the 3.1-mile Mainline segment; and
- Supplemental backfilling of the 3.1-mile Mainline segment.

The preferred method to address the out-of-service foreign utility cable at MP 18.93 would be to cut and remove the cable. If this is not possible, the cable will be lowered using supplemental lowering methods (e.g., air-lift methods, implementation of diver assisted hand jetting or use of submersible pumps), which are addressed in previous environmental evaluations. The additional lowering will require the presence of a support vessel at this location for approximately one additional day, likely in the February or March 2016 timeframe.

The supplemental lowering along the 3.1-mile segment will be achieved using a pipeline jet sled that will be deployed after the plowing operation has been completed. The jet sled operation will utilize a Dynamic Positioned (DP) vessel similar to the vessel used in the mechanical plowing operation. The DP vessel will:

- Lift and position the jet sled over the pipeline;
- Support a diving operation for the deployment and recovery of the jet sled;
- Apply a pulling force on the jet sled; and
- Provide the pumps and equipment to manage and operate the jet sled.

In order to achieve the depth of lowering, it is expected that two passes of the jet sled will be required. It is estimated that the jetting operation will be performed over an 8 day timeframe, likely in mid-July 2016. It is further expected that this jetting operation will occur concurrent with backfill plowing operations occurring in other areas outside the 3.1-mile segment.

Supplemental backfilling of the jetted segment will commence after surveys confirm the pipeline has been successfully lowered, likely beginning in mid-August 2016. It is anticipated that the DP vessel used for jetting operations will be outfitted with a tremie system to perform the backfilling activities. Once this backfill vessel (BV) is on location, clean and acceptable backfill material (sand), similar to the extent practicable with native materials (i.e., sands, with low fines and organics content), will be loaded onto hopper barges and transported to the BV for placement in the trench. The backfilling operations are anticipated to be completed over an approximate 21-day period, beginning in mid-August 2016. The BV will be equipped with seabed profiling equipment that will monitor the trench and progress of the backfilling operation.

1.3 Construction Method Assumptions Applied in Sediment Modeling

The construction-related assumptions as applied to the sediment dispersion and deposition modeling, are as follows:

- There is one relic out-of-service communications cable that will be potentially crossed by the Mainline pipeline (located at approximately MP 18.93). This cable will be treated in the same manner described in the Report, but would require additional lowering due to the increased excavation depth in the anchorage area.
- Additional lowering of the Mainline will be completed in two passes of the jet sled. Jet sledding will begin after the completion of the plowing of the Mainline and after the beginning of the backfill plowing, but prior to any backfill plowing in the vicinity of the anchorage area. Jet sledding is assumed to be completed in 8 days in mid-July 2016.
- Supplemental backfilling will be accomplished by the use of a tremie positioned between 10 ft (3.1 m) and 15 ft (4.6 m) above the sea floor. The backfilling material will be primarily sand (assumed to be 90 percent sand and 10 percent fine material) and will be used to supplement backfill plowing in the anchorage area. The supplemental backfilling is assumed to be completed in 21 days, after completion of backfill plowing, and between mid-August and early September 2016.

This Addendum to the Report provides the findings of additional modeling of sediment dispersion and deposition as pertains to the additional excavation and backfilling in the anchorage area. The Project background, Project schedule, and model assumptions described in the Report remain unchanged unless specifically mentioned in this Addendum. The Addendum includes updates to Figure 4-3 Maximum Suspended Sediment Concentration (All Modeled Activities) – Entire Model Domain and Figure 4-7 Deposition Thickness (All Modeled Activities) – Entire Model Domain. The Addendum also includes predictions of the extent of various suspended sediment concentration levels and deposition thicknesses as a result of jet sledding and supplemental backfilling.

1.4 Modeling Approach

The additional modeling evaluation that follows is founded upon available information on ambient water quality, oceanographic conditions, and sediment characteristics of the New York Bight in the Project area. This information includes oceanographic, water quality, and sediment characteristic data described in the Project's September 2012 DWP application, including data in Volume II, Topic Report 3 (Water and Sediment Quality) and Topic Report 4 (Biological Resources), and Volume III, Attachment A.6 (Shallow Hazards Survey Report), as supplemented by the Project's additional "response to comments" filings of September 2013 through February 2014. The sediment dispersion model was extended to assess the extent, magnitude, and duration of the resultant sediment plume and the extent and thickness of the resultant sediment deposition from increased lowering of the relic cable at MP 18.93, excavation by jet sledding (between MP 17 and MP 20.1), and supplemental backfilling (between MP 17 and MP 20.1).

2. Sediment Dispersion Model Application

2.1 Model Modifications

The hydrodynamic model results used in this additional modeling evaluation are unchanged from those described in the Report. The hydrodynamic model described in the Report was an implementation of the Advanced Circulation (ADCIRC) model. The ADCIRC model was bounded by the coastline, flow boundaries at the mouth of the Hudson River, the mouth of Arthur Kill, the mouth of Raritan River, and an open boundary representing the tides in the New York Bight.

The sediment dispersion model uses the results from the hydrodynamic model as an input and incorporates the same model bathymetry. Setting up the additional sediment dispersion modeling involves establishing how the operation of the various sediment disturbing activities will be simulated. The characterization of the disturbed sediment remains unchanged from the Report. The sediment disturbing activities and how they are incorporated in the sediment dispersion model are summarized in Table 2-1. The description of each activity includes rate of progress, loss rate, and an explanation of assumptions. The sediment “loss rate” used in the model represents the estimated percentage of disturbed sediment that is assumed to be suspended into the water column and available to be transported away from the Mainline and foreign utility crossings.

The excavated volume assumptions noted in Table 2-1 represent conservative estimates developed to ensure achievement of a target minimum burial depth of 7 ft (2.1 m) of cover over the top of the Mainline in the anchorage area. During jet sledding, excavated sediment will be ejected through the jet sled eductors. The eductors will release the sediment approximately 18 ft (5.5 m) above the bottom of the jet sled. This modeling evaluation assumes that the bottom of the jet sled will be approximately 10 ft (3.1 m) below the sea floor and therefore, the release point of sediment will be 8 ft (2.4 m) above the sea floor. The assumed loss rate for jet sledding is 100 percent. While it is likely that some portion of the sediment discharged from the eductors would immediately settle to the sea floor, the modeling conservatively assumes that all of the sediment will enter the water column and be available for transport away from the Mainline.

The assumed loss rate for hand jetting activities (foreign utility cable lowering) is assumed to be 100 percent which is consistent with the Report and previous sediment dispersion modeling studies in the New York Bight.

Supplemental backfilling activities represent a controlled release of material into the water column which will be directed and managed in order to achieve the goals of the backfilling. At the same time, the material will temporarily enter the water column. This modeling evaluation assumes that 100 percent of the fine material (10 percent of the total volume) will have a loss rate of 100 percent, but 90 percent of the total volume will enter the trench as backfill material.

Table 2-1 Sediment Disturbing Activity Characterization

Pipeline and Utility Lowering Activities				
Activity	Progress Rate		Loss Rate	Assumptions
	ft/hr	m/hr	%	
Supplemental Lowering at Utility Crossing at MP 18.93 (assumed by hand jetting)	15	4.6	100%	It is assumed that supplemental lowering of the utility crossing at MP 18.93 will be achieved by diver assisted hand jetting and that hand jetting will displace 100 percent of sediment in variable width and depth excavation. The assumed volume of displaced sediment for this crossing is 4,123 cubic yards (yd^3) (3,152 cubic meters [m^3]).
Lowering by Jet Sled	750	229	100%	Lowering by jet sledding will be achieved by two passes of the jet sled. The cross-section of the sediment displaced by the jet sled is assumed to be 146 square feet (sq. ft.) (13.6 square meter [sq. m.]). Each pass of the sled is assumed to remove 50 percent of the sediment.
Supplemental Backfilling by Tremie	50	15	100%	Supplemental backfilling will be achieved in one pass. It is assumed that all of the sand material (90 percent of the backfill material) will enter the trench and that all of the fine material will enter the water column and be available for transport away from the Mainline, i.e. a loss rate of 100 percent for fine material.

2.2 Sediment Dispersion Model Predictions

Sediment disturbing activities are scheduled to occur at different locations and different time periods throughout the year. This modeling evaluation involves separate runs of the sediment dispersion model for each distinct activity: lowering of existing utility at MP 18.93, the first pass of the jet sled, the second pass of the jet sled, and additional backfilling. Each activity is modeled at the appropriate time in the year, consistent with the schedule described previously in Section 1.3.

The sediment dispersion model assumes a background suspended sediment concentration of 0 milligrams per liter (mg/L). Therefore, suspended sediment concentrations indicated in the Report and this Addendum are concentrations above background suspended sediment concentrations which are attributable to the Project's sediment disturbing activities. Depositional thicknesses indicated in the Report are primary depositional thicknesses and do not take into account potential re-suspension of sediments following initial deposition. Model runs for each activity were extended for a period of time after the end of each activity in order to allow all sediments to settle and allow suspended sediment concentrations to return to ambient, pre-disturbance conditions.

Figure 2-1 shows the entire Project area and presents the updated maximum predicted suspended sediment concentrations including all sediment disturbing activities discussed in the Report and the additional sediment disturbing activities described in this Addendum. Figure 2-1 is an updated version of Figure 4-3 from the Report. Figure 2-2 shows the increase in maximum predicted suspended sediment concentrations above what was originally shown in the Report. Figure 2-2 focuses exclusively on the Mainline between MP 17.0 and MP 20.1 because increases in maximum suspended sediment concentrations are limited to this area. Consistent with the findings of the

Report, the highest suspended sediment concentrations occur in the immediate vicinity of the sediment disturbing activities, near the Mainline. The predictions shown in Figure 2-2 highlight an increase in extent of the suspended sediment plume from the jet sledding activities. The initial excavation of the Mainline trench will have been performed using a mechanical plow. Mechanical plowing generates a sediment plume at or near the sea floor. Jet sledding will generate a sediment plume that originates approximately 8 ft (2.4 m) above the sea floor. Releasing the sediment at an increased height in the water column allows the suspended sediment to travel farther before it settles back to the sea floor. This results in increases in the maximum predicted suspended sediment concentrations away from the Mainline.

Table 2-2 and Table 2-3 present the predicted lateral extent of the 100 mg/L, 50 mg/L, and 25 mg/L suspended sediment plumes in State waters (assumed 25 percent fines) and Federal waters (assumed 5 percent fines), respectively. The distances provided in the tables represent the distance from the disturbance (centerline of Mainline or of Laterals) to the outer edges of the respective plume. The maximum distance represents the maximum extent of the plume for all activities and the mean distance represents the mean distance as estimated by averaging individual lateral distances predicted at an average of 33 ft (10 m) intervals along the outer edge of the plume.

The distances reported in Table 2-2 and Table 2-3 confirm the observation that releasing sediment at a height above the sea floor serves to increase the lateral extent of the maximum predicted sediment plume. The maximum value for each contour increases by approximately 100 percent for the overall project. Mean values for each contour increase as well, but not as much as the maximum value for each contour. Elevated suspended sediment concentrations (in excess of 50 mg/l) exist primarily in the immediate vicinity of the disturbing activity, generally within 1,400 ft (427 m) of the pipeline centerline in State waters and within 800 ft (244 m) in Federal waters. The suspended sediment plume extends a greater distance in State waters because the sediment has a greater proportion of fine-grained particles and these fines settle more slowly allowing the sediment to travel greater distances. The “maximum” sediment plume travel distances presented in Table 2-2 and Table 2-3 are predicted to occur exclusively in the vicinity of the anchorage area and are attributable to the increased height of release of sediment from the jet sled. The “mean” distances should be considered representative of the “typical” (yet conservative) predicted extent of the plume.

Consistent with the Report, this evaluation assumes that an excess suspended sediment concentration of 25 mg/l represents the significance threshold relative to potential suspended sediment plume impacts. The lateral extent of the 25 mg/l suspended sediment plume is predicted to be limited, on average, to within 10,500 ft (3,200 m) of the pipeline centerline in State waters and within 7,800 ft (2,377 m) in Federal waters.

Table 2-2 and Table 2-3 include lateral extent distances for hand jetting related construction activities. The majority of areas that would be hand jetted are not affected by the construction schedule changes evaluated in this Addendum. Only one pre-lay foreign utility lowering has changed. The foreign utility at MP 18.93 will now be an additional 3 ft (0.9 m) deeper. This additional hand jetting will delay by approximately one day the lowering of two other foreign utilities that are in State waters. The hand jetting at MP 18.93 results in minor increases in suspended sediment concentrations in the water column in Federal waters attributable to hand jetting activities. There is no change to the maximum predicted suspended sediment concentrations in State waters attributable to hand jetting.

Table 2-2 Extent of Suspended Sediment Plumes – State Waters (Assumed 25% Fines)

Excavation Method	25 mg/L				50 mg/L				100 mg/L			
	maximum		mean		maximum		mean		maximum		mean	
	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m
All Activities Highest Predicted Max./ Mean Distances	10,452	3,186	2,739	835	5,473	1,668	1,354	413	3,512	1,070	736	224
Jet Sled	10,452	3,186	3,739	1,140	5,473	1,668	1,895	578	3,512	1,070	919	280
Backfill by Tremie	4,501	1,372	1,139	347	1,623	495	692	211	449	137	449	137
Hand Jet	5,355	1,632	1,423	434	3,091	942	749	228	1,086	331	385	117

Table 2-3 Extent of Suspended Sediment Plumes – Federal Waters (Assumed 5% Fines)

Excavation Method	25 mg/L				50 mg/L				100 mg/L			
	maximum		mean		maximum		mean		maximum		mean	
	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m
All Activities Highest Predicted Max./ Mean Distances	7,715	2,352	1,241	378	3,787	1,154	719	219	2,778	847	425	130
Jet Sled	7,715	2,352	2,384	727	3,787	1,154	1,178	359	2,778	847	485	148
Backfill by Tremie	3,952	1,204	993	303	1,590	485	680	207	1,019	311	1,016	310
Hand Jet	2,121	646	539	164	1,371	418	380	116	898	274	315	96

To facilitate comparison of the results provided in the Report and the Addendum, Table 2-4 provides a side by side comparison of the All Activities, Highest Predicted Maximum/Mean Distances for the 25 mg/L contour, the 50 mg/L contour, and the 100 mg/L contour.

Table 2-4 Extent of Suspended Sediment Plumes (All Activities) – Revised vs. Original

Evaluation	25 mg/L				50 mg/L				100 mg/L			
	maximum		mean		maximum		mean		maximum		mean	
	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m
State Waters												
Revised	10,452	3,186	2,739	835	5,473	1,668	1,354	413	3,512	1,070	736	224
Original	5,355	1,632	1,701	519	3,638	1,109	761	232	1,247	380	398	121
Federal Waters												
Revised	7,715	2,352	1,241	378	3,787	1,154	719	219	2,778	847	425	130
Original	4,352	1,326	762	232	3,244	989	557	170	2,430	741	380	116

It is important to note that Figure 2-1, Table 2-2, Table 2-3, and Table 2-4 present the maximum predicted suspended sediment concentrations at various locations over the course of the approximate nine-month timeframe that was modeled. Similarly, Figure 2-2 presents the maximum predicted suspended sediment concentrations above the results described in the Report for the entire period of additional foreign utility cable lowering, jet sledding, and additional backfilling. At no single time will increases in suspended sediment concentrations approach the cumulative impact shown across the model domain in Figure 2-1 or Figure 2-2. The sandy characteristics of sediments that will be displaced ensure that increases in suspended sediment concentrations will be of short duration. Suspended sediment concentrations are generally predicted to return to ambient conditions within 24 hours of completion of the relevant construction activity.

Figure 2-3 shows the entire Project area and presents the predicted areal extent and thickness of sediment deposition due to all modeled sediment disturbing activities including the activities discussed in this Addendum. Figure 2-3 is an updated version of Figure 4-3 from the Report. Figure 2-4 shows the increase in deposition thickness above what was originally described in the Report. Figure 2-4 focuses exclusively on the Mainline between MP 17.0 and MP 20.1 because increases in deposition thickness are limited to this area. Consistent with the findings of the Report, the highest depositional thicknesses occur in the immediate vicinity of the sediment disturbing activities, near the Mainline.

In contrast to the increases in suspended sediment concentrations, the increase in deposition thickness from the additional activities does not dramatically increase the lateral extent of depositional impacts. The jet sled releases sediment at a height above sea floor which allows it to stay in the water column longer, therefore increasing suspended sediment concentrations, but the elevated release point also gives the suspended sediment more time to spread out. Therefore, when it does settle to the sea floor, it settles over a larger area with less thickness. The most notable change shown in Figure 2-2 is the line of deposition to the northeast of the Mainline which extends the length of the anchorage area. The majority of the sediment plume moves northeast of the Mainline and this parallel line of sediment is the predominant distance at which the sandy sediments from the jet sled settles to the sea floor.

Table 2-5 and Table 2-6 present the predicted lateral extent of the 5 millimeter (0.2 inches [in]) and 20 mm (0.8 in) sediment deposition areas in State waters (assumed 25 percent fines) and Federal waters (assumed 5 percent fines), respectively. The distances provided in the tables represent the distance from the disturbance (centerline of Mainline or of Laterals) to the outer edges of the respective depositional area. The maximum distance represents the maximum extent of the plume for either all activities or for an individual activity and the mean distance represents the mean distance as estimated by averaging individual lateral distances predicted at an average of 33 ft (10 m) intervals along the respective depth contour line.

Table 2-5 and Table 2-6 include lateral extent distances for hand jetting related construction activities. The majority of areas that would be hand jetted are not affected by the construction schedules changes evaluated in this Addendum. Only one pre-lay foreign utility lowering has changed. The foreign utility at MP 18.93 will now be an additional 3 ft (0.9 m) deeper. This additional hand jetting will delay by approximately one day the lowering of two other foreign utilities that are in State waters. The delay means that the modeled lowering in State waters occurs at a different time and with different hydrodynamics than were used in determining the results provided in the Report. The alternative scenario in this Addendum shows sediments being deposited at a greater distance from the Mainline in State waters as well as Federal waters. In Federal waters, there is also more sediment available for deposition on the sea floor. This modeling evaluation concludes that the increases in hand jetting deposition are not significant relative to the changes in deposition for all activities.

Table 2-5 Extent of Sediment Deposition Areas – State Waters (Assumed 25% Fines)

Excavation Method	5 mm (0.2 in) Deposition				20 mm (0.8 in) Deposition			
	maximum		mean		maximum		mean	
	ft	m	ft	m	ft	m	ft	m
All Activities Highest Max./ Mean Distances Based on Cumulative Deposition	2,541	775	578	176	1,241	378	186	57
Jet Sled	1,538	469	351	107	349	106	78	24
Backfill by Tremie	681	208	495	151	618	188	607	185
Hand Jet	2,366	721	624	190	658	201	169	52

Table 2-6 Extent of Sediment Deposition Areas – Federal Waters (Assumed 5% Fines)

Excavation Method	5 mm (0.2 in) Deposition				20 mm (0.8 in) Deposition			
	maximum		mean		maximum		mean	
	ft	m	ft	m	ft	m	ft	m
All Activities Highest Max./ Mean Distances Based on Cumulative Deposition	2,485	757	281	86	1,496	456	107	33
Jet Sled	2,483	757	411	125	1,001	305	144	44
Backfill by Tremie	700	213	608	185	616	188	604	184
Hand Jet	1,879	573	363	110	1,485	453	139	42

To facilitate comparison of the results provided in the Report and the Addendum, Table 2-7 provides a side by side comparison of the All Activities, Highest Predicted Maximum/Mean Distances for the 5 mm (0.2 in) contour and the 20 mm (0.8 in) contour. Table 2-7 demonstrates that the typical deposition area increases slightly due to the additional construction activities. There is one exception to this finding. The maximum lateral extent of the 5 mm (0.2 in) contour in State waters actually decreases slightly in the revised modeling. This minor discrepancy is directly attributable to the same one day delay in foreign utility lowering. In the revised modeling, deposition from lowering the foreign utility at MP 21.13 extends approximately 60 ft (18 m) less than the original modeling. This modeling evaluation concludes that this difference is not significant to the overall assessment.

Table 2-7 Extent of Deposition Thickness (All Activities) – Revised vs. Original

Excavation Method	5 mm (0.2 in) Deposition				20 mm (0.8 in) Deposition			
	maximum		mean		maximum		mean	
	ft	m	ft	m	ft	m	ft	m
State								
Revised	2,541	775	578	176	1,241	378	186	57
Original	2,604	794	456	139	1,187	362	141	43
Federal								
Revised	2,485	757	281	86	1,496	456	107	33
Original	2,446	746	218	66	1,066	325	66	20

Based on mean distance values, the area of substantial sediment deposition (in excess of 20 mm [0.8 in]) is limited primarily to within approximately 190 ft (58 m) of the pipeline centerline in State waters and within 110 ft (34 m) in Federal waters. The extent of sediment deposition extends a greater distance in State waters because the sediment has a greater proportion of fine-grained particles and these fines settle more slowly allowing the sediment to travel greater distances.

This evaluation considers a sediment deposition thickness of 5 mm (0.2 in) as representative of the maximum measurable and practical extent of Project-related sediment deposition. Based on mean distance values, the lateral extent of the 5 mm (0.2 in) sediment deposition area is predicted to be limited, on average, to within approximately 590 ft (177 m) of the pipeline centerline in State waters and within approximately 290 ft (88 m) in Federal waters.

Consistent with the findings of the Report, the “maximum” sediment deposition distances presented in Table 2-5 and Table 2-6 are predicted to occur at a few isolated locations in the Project area. These locations are associated with the pre-lay lowering of utility crossings, which is an activity which may not occur if cutting/removal of relic cable lines is practicable.

3. Conclusions

The construction of the Port Ambrose Project will involve numerous activities that will result in the disturbance of bottom sediments, generation of suspended sediment plumes, and re-deposition of sediment in the vicinity of the construction footprint. There will be multiple types of construction activities. This Addendum provides a modeling evaluation of the additional lowering of the relic utility at MP 18.93, jet sledding, and supplement backfilling all occurring in the anchorage area that extends along the Mainline from approximately MP 17.0 to MP 20.1.

The general findings that were provided in the Report remain valid even after including the additional activities listed above. The updated results of the analysis indicate that elevated levels of suspended sediment, in concentrations in excess of 50 mg/L, are predicted to occur mainly in the immediate vicinity (within 800 to 1,400 ft [244 to 427 m]) of the sediment disturbing activity. In isolated instances, suspended sediment concentrations in excess of 50 mg/l could potentially extend to a distance of up to approximately 5,475 ft (1,669 m) away from the pipeline trench centerline. However, along a majority of the construction corridor, suspended sediment plumes are expected to drop below an excess concentration of 25 mg/L within approximately 1,250 to 2,750 ft (381 to 838 m) of the pipeline centerline. The duration of suspended sediment plumes is expected to be short, with conditions in the vicinity of the Project predicted to return to ambient within 24 hours of the end of sediment disturbing activities. This is due to the mostly sandy sediment that is present in the Project area. Suspended sediments are expected to readily settle out of the water column.

Substantial sediment deposition (greater than 20 mm [0.8 in]) is predicted to generally be limited to the immediate vicinity of the pipeline (within approximately 190 ft [58 m] in State waters and within 110 ft [34 m] in Federal waters). Sediment deposition in excess of 5 mm (0.2 in) is predicted to be limited to within approximately 590 ft (177 m) of the pipeline in State waters and within 290 ft (88 m) in Federal waters. Isolated areas of elevated deposition may occur at greater distances, up to approximately 1,500 ft (457 m) for 20 mm (0.8 in) thickness and up to approximately 2,600 ft (792 m) for 5 mm (0.2 in) thickness. In general measurable depositional thicknesses are predicted to occur in close proximity to the Mainline and the Laterals.

The findings in this Addendum should be considered an addition to those described in the Report, and this document should be reviewed within the context of the approach and project details described in the Report.

FIGURES

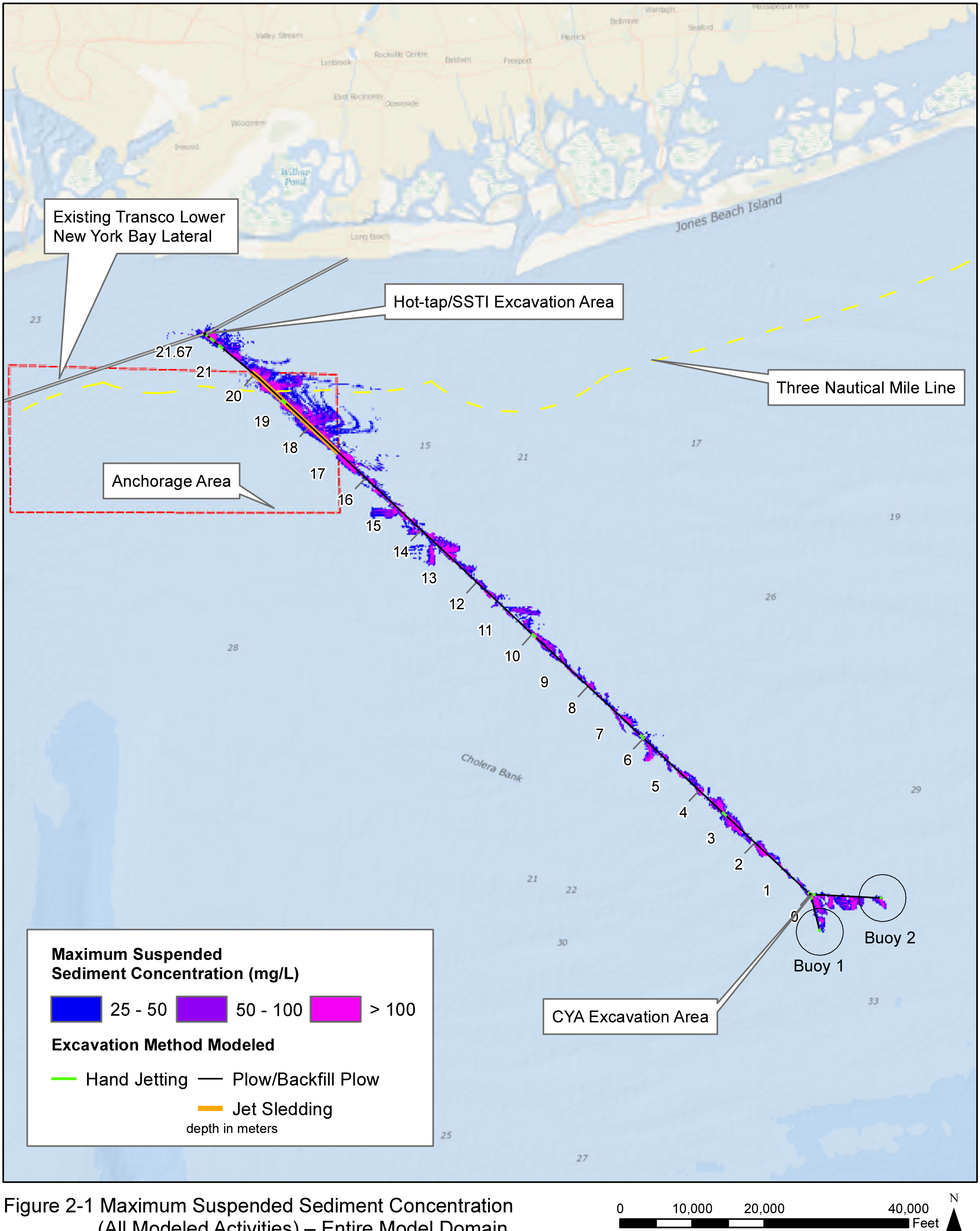

Figure 2-1 Maximum Suspended Sediment Concentration (All Modeled Activities) – Entire Model Domain

Hodge Water Resources

Date: May 2014

Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, NAVTEQ, Geonames.org, and other contributors

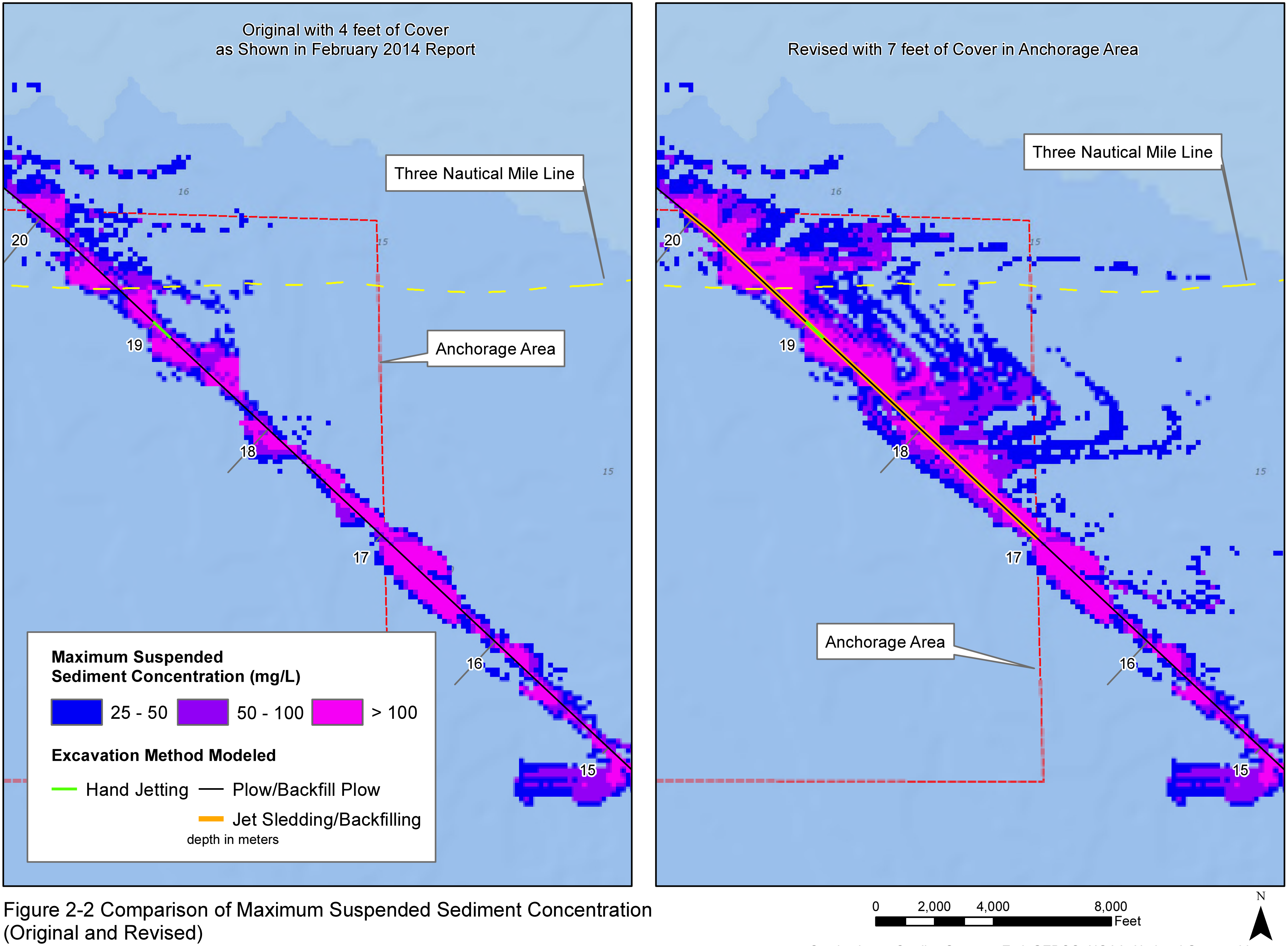

Figure 2-2 Comparison of Maximum Suspended Sediment Concentration (Original and Revised)

HodgeWaterResources

Date: May 2014

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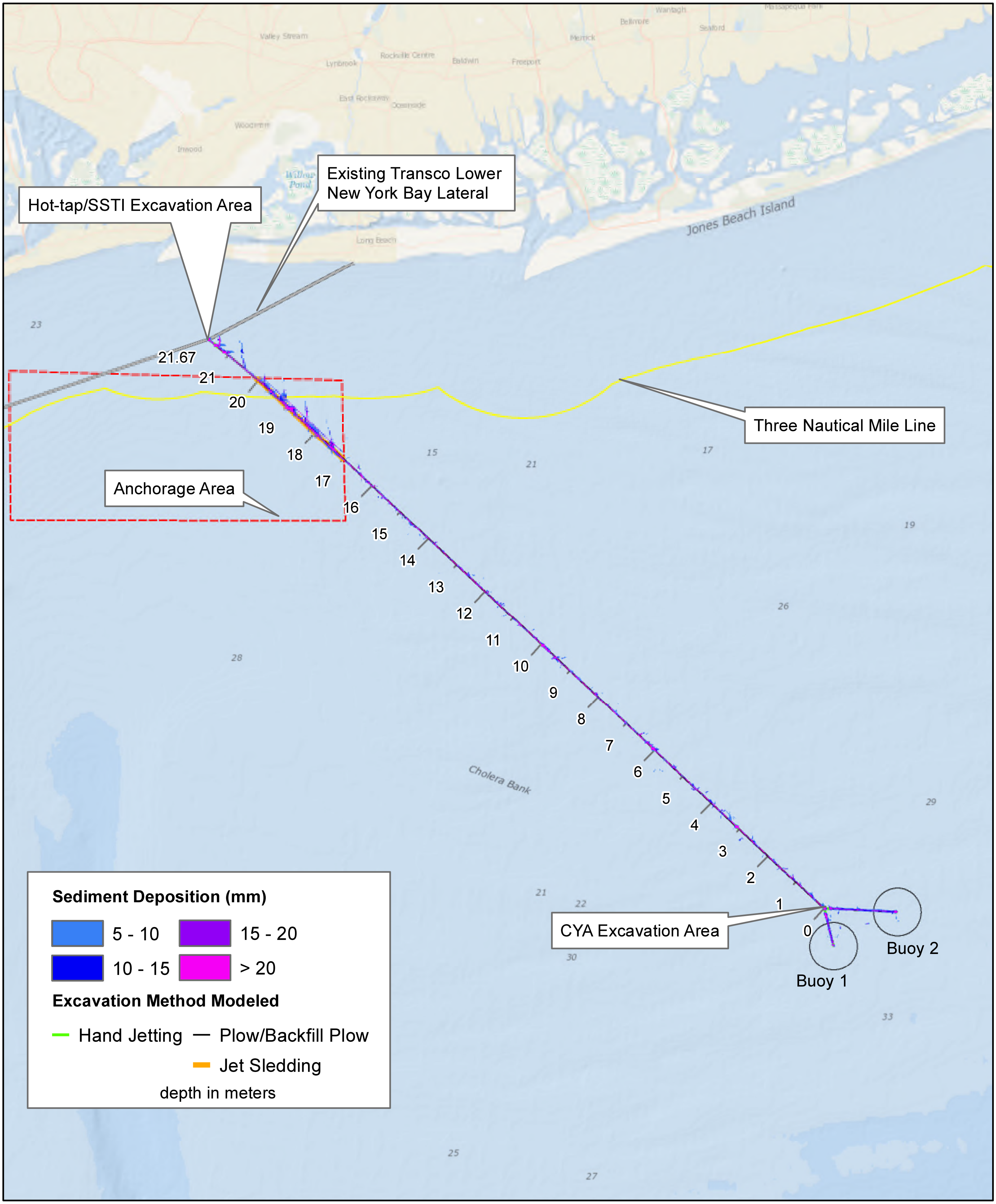

Figure 2-3 Deposition Thickness (All Modeled Activities) - Entire Model Domain

Hodge Water Resources

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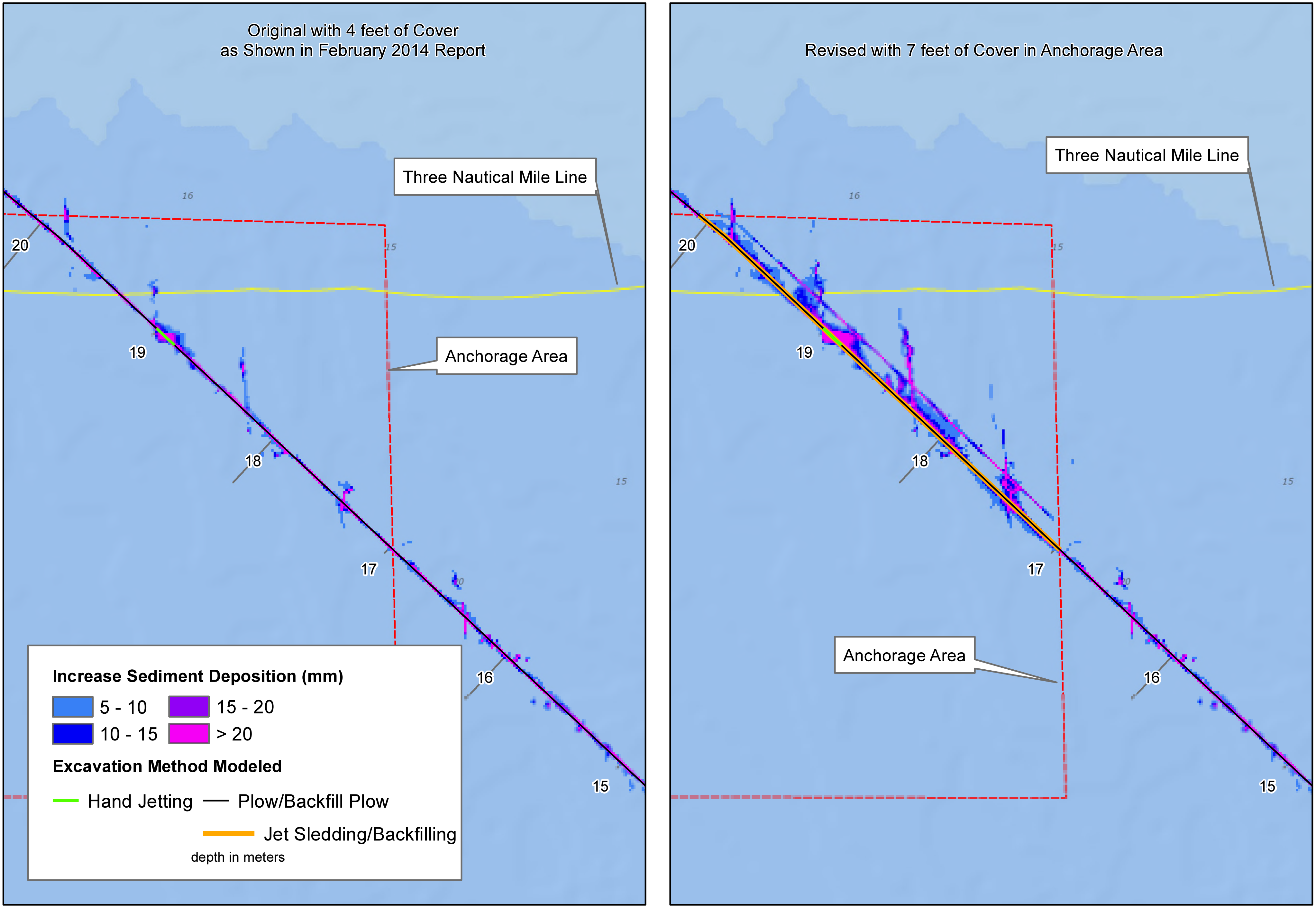

Figure 2-4 Comparison of Deposition Thickness (Original and Revised)

HodgeWaterResources

Date: May 2014

0 2,000 4,000 8,000 Feet

N

Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, NAVTEQ, Geonames.org, and other contributors

Appendix D-3

Sediment Transport Study – Figure Addendum

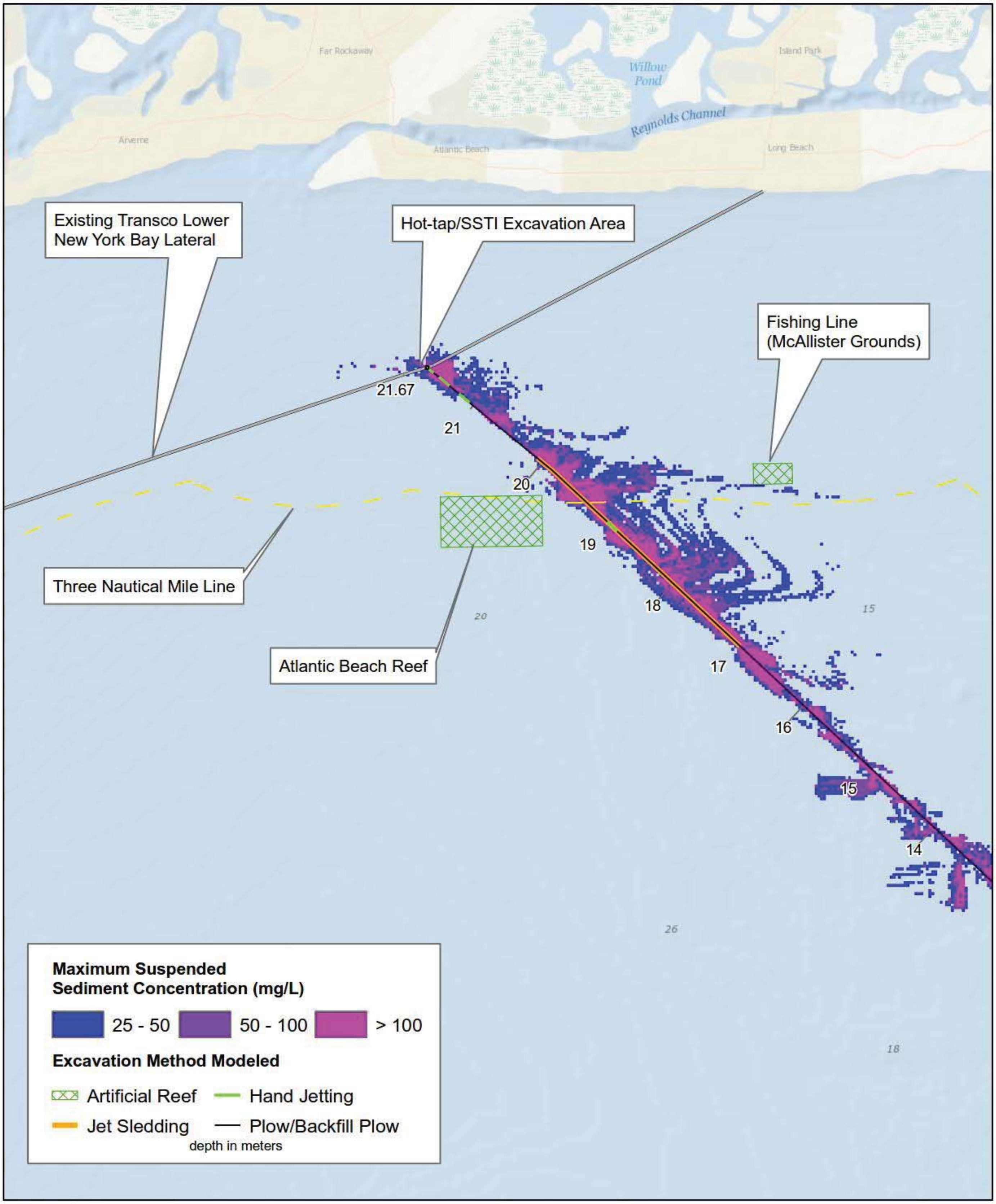

Figure 2-1 Maximum Suspended Sediment Concentration (All Modeled Activities) – Artificial Reefs

Hodge WaterResources

Date: May 2015

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