TECHNICAL REPORT

South Elizabeth Channel
Silt Curtain Pilot Study

Final

U.S. Army Corps of Engineers — New York District

August 2012

Executive Summary

This report presents the results and findings of the Silt Curtain Pilot Study (Study) conducted in June 2011 to meet the requirements as outlined in Section III.B. of the Stipulation and Order of Settlement and Dismissal (ECF Case 05 Civ. 762-SAS) dated 19 October 2007 (Stipulation and Order). A silt curtain was deployed within a portion of the Newark Bay Study Area (NBSA) during dredging of the S-NB-2 Contract Area of the New York and New Jersey Harbor Deepening Project (HDP) in Newark Bay. The study area was selected based on the following criteria:

- silt curtain deployment was chosen subject to approval by the New Jersey Department of Environmental Protection (NJDEP) and consistent with the United States Army Corps of Engineers (USACE)'s Safety and Health Requirements Manual EM 385-1-1 (September 2008);
- to represent an open bay environment adjacent to a littoral zone and was chosen subject to existing and appropriate hydrodynamic conditions (i.e., at a minimum, a flow regime that was reasonably steady and of sufficient velocity to disperse sediments), such that environmental protection, safety, and navigation were not comprised;
- an evaluation of the remaining Newark Bay dredge contracts that would provide the best opportunity to conduct the study under actual navigation dredging conditions while maintaining environmental protection, safety and navigation;
- Sediments to be dredged at the site contained sufficient fines to expect generation of a distinct plume, thereby facilitating observations of interactions between the plumes and the curtain; and
- the proximity to a shallow littoral zone provided an opportunity to monitor dredge-induced resuspended sediments near an area where concerns for environmental resource protection are routinely raised by regulatory agencies.

The pilot study was developed to meet the requirements outlined in the Stipulation and Order to monitor the effectiveness of a silt curtain at limiting the transport of dredging-induced resuspended sediment and to evaluate the feasibility of silt curtain use in future HDP dredging within the NBSA. To meet these requirements, a comprehensive field study was developed that included the following five field surveys:

- SURVEY #1: AMBIENT CONDITIONS PRIOR TO SILT CURTAIN INSTALLATION
- SURVEY #2: DREDGE PLUME CHARACTERIZATION PRIOR TO SILT CURTAIN INSTALLATION
- SURVEY #3: SILT CURTAIN INSTALLATION
- SURVEY #4: DREDGE PLUME CHARACTERIZATION WITH SILT CURTAIN DEPLOYED
- SURVEY #5: SILT CURTAIN REMOVAL

Monitoring for the five surveys was conducted during ambient conditions and during normal dredging operation of the "Delaware Bay" dredge in South Elizabeth Channel within the S-NB-2 Contract Area. During the Study, dredging included the removal of non-HARS (Historic Area Remediation Site) fine-grained sediment. Water quality/Total Suspended Solids (TSS) monitoring methods were consistent with monitoring methodologies used previously by USACE within Newark Bay.

A Type III silt curtain manufactured by SiltMaster® was installed beginning on June 16, 2011 along the long axis of the South Elizabeth Channel (SEC) running in a northwest to southeast direction before turning south-southeast at the northeast corner of the South Elizabeth Flats terminating near Channel Marker #5 (Figure E-1). The initial configuration of the curtain is depicted in Figure E-2, which shows a portion of the silt curtain with the boom anchored and the curtain furled and hanging from the boom.

Shortly after unfurling the curtain, the current caused the curtain to "flare" upward toward the surface. Even at the northwestern end of the SEC, where current velocities were slower and the current was parallel to the curtain, the curtain's position was influenced by tidal forces, such that each curtain panel formed concave deflections between the anchor points adjoining each panel.

Twenty-four hours after curtain installation, a detailed inspection report determined that multiple sections of the installed curtain had been damaged beyond repair. The most obvious factor contributing to the silt curtain failure was prevailing currents. Current directions of ebbing and flooding tides applied forces against the anchored curtain. A second factor acting on the installed curtain system was floating debris. Some of the debris, which included tree limbs and large logs, an existing condition typical of the project area, had sufficient mass to cause structural damage to the curtain (Figure E-3).

Given the presence of a current eddy circulating within the SEC, dredging as conducted in the SEC produced plumes that tended to travel up- or down-channel, staying within the confines of the SEC itself or extending toward the port bulkhead. During peak flows a small plume was detected, but generally confined to the lower portion of the water column. These plumes also faded to background levels before encountering the silt curtain and the channel side slope (18-ft depth contour). Transects occupied "inside" the curtain detected one small area of TSS exceeding ambient by 10 to 15 mg/l. It is uncertain if this was caused by dredge resuspension or sediment disturbed by increased flows though breaks in the silt curtain. In general, Turbidity and TSS monitoring results were consistent with previous studies of plume concentrations created during mechanical dredging operations.

The hydrodynamic conditions at the Silt Curtain Pilot Study location are representative of typical conditions found throughout the NBSA. Based on the Pilot Study, silt curtains deployed in similar locations, areas of moderate current velocities (0.4 to 0.7 m/s), have high likelihood of failure. In addition, the presence of substantial floating or submerged debris has drastic effects on curtain performance, especially in highly urbanized and industrialized setting such as the NBSA. Either by direct impingement on the curtain or by accumulation of debris "wrack lines" against the surface portion of the curtain, debris had a demonstrable impact on curtain performance and the occurrence of substantial amount of debris, including large objects such as logs, contributed to the rapid failure of several curtain panels in this pilot study. The site placement for the silt curtain in this pilot study was chosen to meet the requirements of the Stipulation and Order and was selected to represent the best possible location for success based upon existing hydrodynamic conditions, environmental protection and navigation safety within the NBSA. Based on these findings, any future deployment of a silt curtain within the NBSA for HDP construction or maintenance is considered infeasible.

ACRONYMS

ADCP – Acoustic Doppler Current Profiler

BMP - Best Management Practice

ERDC – Engineer Research and Development Center

ft/s – Feet per Second

HARS – Historic Area Remediation Site

HDP – NY and NJ Harbor Deepening Project

m/s – Meters per Second

MLW – Mean Low Water

MLLW – Mean Low Low Water

NBSA – Newark Bay Study Area

NJDEP – New Jersey Department of Environmental Protection

NTU – Nephelometric Turbidity Units

OBS – Optical Back Scatter

SEC – South Elizabeth Channel

TSS – Total Suspended Solid

USACE – United States Army Corps of Engineers

USEPA – U.S. Environmental Protection Agency

Table of Contents

Appendices

List of Figures

1.0 Introduction

This report presents the results and findings of the Silt Curtain Pilot Study (Study) conducted in June 2011 to meet the requirements as outlined in Section III.B. of the Stipulation and Order of Settlement and Dismissal (ECF Case 05 Civ. 762-SAS) dated 19 October 2007 (Appendix A)[1]. A silt curtain was deployed within a portion of the Newark Bay Study Area (NBSA) during dredging of the S-NB-2 Contract Area of the New York and New Jersey Harbor Deepening Project (HDP) in Newark Bay. The goal of the Study was to "monitor its effectiveness at limiting the transport of any dredging-induced resuspended sediment and evaluate the feasibility of its use in future HDP dredging within the NBSA."

Study Area

South Elizabeth Channel is located adjacent to and south of the Port Elizabeth Marine Terminal in Elizabeth, New Jersey. It is a narrow, maintained channel measuring approximately 200 meters across at its widest (at the time of the pilot study) and 1,000 meters in distance from its terminus on the western shore of Newark Bay to the mouth where it intersects with the Newark Bay South Reach Channel. South and west of the South Elizabeth Channel and north of the Arthur Kill Channel is an extensive area of shallow water flats, generally known as the Elizabeth Flats, which range in depths between one to eight feet at Mean Low Low Water (MLLW). The mean tidal range at the southern end of Newark Bay off the Port Elizabeth Marine Terminal is 5.1 feet (1.6 meters) (USACE 1999).

Figure 1-1 shows the location of the deployed silt curtain and the area of the Silt Curtain Pilot Study within the South Elizabeth Channel and the S-NB-2 Contract Area of Newark Bay, New Jersey. Prior to selecting the silt curtain deployment location, hydrodynamic conditions within the NBSA were reviewed using DHI Software's MIKE3 hydrodynamic model predictions generated for Newark Bay in the 1999 Harbor Navigation Study (USACE 1999). Based on this

---

[1] Appendix A: B. South Elizabeth Channel Silt Curtain Study and Report

10. Defendants shall, consistent with United States Army Corps of Engineers Safety and Health Regulations EM 385-1-1, and subject to any necessary approval by NJDEP, deploy a silt curtain in a portion of the South Elizabeth Channel (an element of the S-NB-2 contract area), subject to appropriate hydrodynamic conditions (i.e. at a minimum, a flow regime that is reasonably steady and is of sufficient velocity to disperse sediments), such that environmental protection, safety and navigation are not compromised. While the Silt Curtain is deployed, Defendants shall monitor its effectiveness at limiting the transport of any dredging-induced resuspended sediment and evaluate the feasibility of its use in future HDP dredging within the NBSA.

11. Defendants shall document in a written report ("Silt Curtain Pilot Study Report") their monitoring of the silt curtain's effectiveness at reducing the transport of any dredging-induced resuspended sediment, and their assessment of the feasibility of its use for that purpose in future HDP dredging within the NBSA

review, three areas (S-AK-1, S-AK-2 and S-NB-2) within the NBSA were identified as potential study areas as the hydrodynamic conditions were subject to a flow regime that is reasonably steady and is of sufficient velocity to disperse sediments. The study area was selected based on the following:

- silt curtain deployment was chosen subject to approval by the New Jersey Department of Environmental Protection (NJDEP) and consistent with the United States Army Corps of Engineers (USACE)'s Safety and Health Requirements Manual EM 385-1-1 (September 2008);
- to represent an open bay environment adjacent to a littoral zone and was chosen subject to existing and appropriate hydrodynamic conditions (i.e., at a minimum, a flow regime that was reasonably steady and of sufficient velocity to disperse sediments), such that environmental protection, safety, and navigation were not comprised;
- an evaluation of the remaining Newark Bay dredge contracts that would provide the best opportunity to conduct the study under actual navigation dredging conditions while maintaining environmental protection, safety and navigation;
- Sediments to be dredged at the site contained sufficient fines to expect generation of a distinct plume, thereby facilitating observations of interactions between the plumes and the curtain; and
- the proximity to a shallow littoral zone provided an opportunity to monitor dredge-induced resuspended sediments near an area where concerns for environmental resource protection are routinely raised by regulatory agencies.

A subsequent hydrodynamic survey of the South Elizabeth Channel and adjacent Elizabeth Flats during the week of a spring tide in November 2008 (USACE 2009) was conducted to confirm model predictions. Hydrodynamic conditions observed during the November 2008 survey were generally consistent with the MIKE3 model, which predicted currents in the area to be as high as 0.6 meters per second (m/s) in the South Elizabeth Channel during an ebb tide, and along the eastern side of the Elizabeth Flats and in the adjacent Newark Bay South Reach Channel during both ebb and flood tides. Maximum observed current velocities for both the ebb and flood tides during the 2008 survey were typically less than 0.5 m/s, which translates to a maximum velocity of approximately 1.6 feet per second (ft/s). These maximum velocities were typically observed at the surface during both the flood and the ebb and in the shallow areas on the northeast corner of Elizabeth Flats. Typically, in the deeper areas of South Elizabeth Channel proper and on the more western (interior) portions of Elizabeth Flats maximum currents did not exceed 0.25 m/s and were often less than 0.10 m/s. During the 2008 survey, velocities rarely exceeded 0.25

m/sec in the South Elizabeth Channel and were frequently less than 0.15 m/sec due to a shielding effect from the Port Elizabeth bulkhead.

The current circulation characterization suggested that this location would be suitable for a curtain performance test. Of concern, however, were higher current velocities at or near 0.40 m/sec across the flats as well as peak velocities of 0.7 m/sec in the main navigation channel in Newark Bay. As stated by the manufacturer, the Type III silt curtain can be deployed in areas where considerable currents (up to 3 knots, 1.53 m/s) existed, where tidal action was present, and/or where the curtain was potentially subject to wind and wave action.

Silt Curtain

The plans and specifications for the silt curtain and its deployment were described in the Silt Curtain Maintenance Plan (Appendix B) prepared by the dredge contractor, Northeast Dredging Equipment Company, LLC (Northeast Dredging) for the Newark Bay/Arthur Kill Channel Contract 11 (Contract No. W912DS-10-C-0023) prior to the installation. A Type III silt curtain was used in accordance with the manufacturer's (Parker Systems, Inc.) recommendation for areas where considerable current (up to 3 knots or 1.5 m/s) may be present, where tidal action may be present, and/or the curtain is potentially subject to wind and wave action as was anticipated within the deployment area. Therefore the study incorporated the most robust curtain and deployment design based on industry standards.

Generic guidance for the project specific construction and deployment of the Type III silt curtain was provided in USACE's Engineer Research and Development Center (ERDC) technical note TN-DOER-E21 (Appendix B). Specifications of the pilot study silt curtain either met or exceeded the manufacturer's recommendations for a Type III deployment. In addition the deployment met the recommendations set forth in the referenced ERDC technical note.

Specifically, the pilot study silt curtain measured 1,500 feet in length (comprised of 15 panels) and was installed between the -10 and -15 foot Mean Low Water (MLW) bathymetric contour by Northeast Dredging on 16 June 2011. The bottom of the curtain was designed to be approximately 2 feet off the bottom at mean low tide and was anchored every 100 feet using 40 pound Danforth standard marine anchors with 3/8-inch galvanized steel chain. The mooring bridle consisted of a 16-inch standoff buoy with 5/8-inch line as shown in Appendix B. Coast Guard compliant lighted buoys (Jim Buoy No. 9000-X series) were installed every one hundred feet along the entire length of the flotation boom to illuminate the silt curtain during hours of darkness and to ensure marine traffic safety.

An inspection program included nearly continuous daylight observations of the silt curtain's performance during the water quality monitoring program and twice daily maintenance inspections by Northeast Dredging using the manufacturer installed curtain furling system.

Dredge Plant

The dredge contractor for this pilot study was Northeast Dredging operating the Dredge Delaware Bay configured with an eight (8) cubic-yard capacity Cable Arm® environmental bucket. This bucket features an over-square design with greater width than length to reduce sediment loss during bucket closing. The Cable Arm® environmental bucket produces a level cut when removing bottom sediment, thereby enhancing vertical as well as horizontal control. Overlapping steel side plates with rubber seals reduce sediment squeezing out of the side. Rubber flaps on the face of the bucket allow air to escape during descent while sealing the top during ascent, thereby slowing the inflow of water and reducing the loss of material due to washout. In addition, best management practices (BMPs), as contained with the FedCon certification issued by NJDEP, such as restricted hoist speed and the use of dredging instrumentation and software to ensure full bucket closure, were employed by the operator to reduce overall sediment re-suspension.

2.0 Technical Approach

The pilot study was developed to meet the requirements outlined in the Stipulation and Order to monitor the effectiveness of a silt curtain at limiting the transport of dredging-induced resuspended sediment and to evaluate the feasibility of silt curtain use in future HDP dredging within the NBSA. To meet this goal, a comprehensive field study was developed that included five survey events as described below.

SURVEY #1: AMBIENT CONDITIONS PRIOR TO SILT CURTAIN INSTALLATION

Prior to the installation of the silt curtain, turbidity and Total Suspended Solid (TSS) monitoring was conducted during a two-day period (June 12 – June 13, 2011) when no active dredging was occurring in the project area so as to ascertain ambient or background conditions.

SURVEY #2: DREDGE PLUME CHARACTERIZATION PRIOR TO SILT CURTAIN INSTALLATION

Prior to the installation of the silt curtain, turbidity and TSS monitoring was conducted during a two-day period (June 14 – June 15, 2011) when active dredging of non- Historic Area Remediation Site (HARS) fine-grained sediment was occurring in the project area using the Dredge Delaware Bay equipped with the Cable Arm environmental bucket.

SURVEY #3: SILT CURTAIN INSTALLATION

Turbidity and TSS monitoring was conducted during the silt curtain installation on June 16 and 17 to measure the sediment re-suspension that would result from the silt curtain installation. Dredging was not conducted within the project area during sit curtain installation.

SURVEY #4: DREDGE PLUME CHARACTERIZATION WITH SILT CURTAIN DEPLOYED

Turbidity and TSS monitoring was conducted while the silt curtain was deployed during periods of active dredging from June 18 to June 22, 2011. Data were collected on both the inside and outside of the curtain to measure dredge-induced plumes and the effectiveness of the curtain at limiting the transport of dredge induced resuspended sediment.

SURVEY #5: SILT CURTAIN REMOVAL

Turbidity and TSS monitoring was conducted during the silt curtain removal on June 24, 2011 to measure the sediment re-suspension that would result from the silt curtain removal.

Monitoring for the five surveys was conducted during ambient conditions and during normal dredging operation of the "Delaware Bay" dredge in South Elizabeth Channel within the S-NB-2 Contract Area. During the Study, dredging included the removal of non-HARS (Historic Area Remediation Site) fine-grained sediment. Water quality/Total Suspended Solids (TSS) monitoring methods were consistent with monitoring methodologies used previously by USACE within Newark Bay (USACE 2007a, USACE 2007b, USACE 2008, USACE 2009 and USACE 2010). During each survey event, data were collected during flood and ebb tidal stages and included the following basic components; detailed methods can be found in Appendix C:

1. Mobile surveys using a vessel-mounted Acoustic Doppler Current Profiler (ADCP) to measure acoustic backscatter and hydrodynamic conditions (current velocity).
2. Measurement of turbidity using optical backscatter sensors (OBS)
3. Collection of discrete water samples for the gravimetric analysis of TSS concentrations and laboratory measurement of turbidity.
4. Sediment sample collection for the laboratory analysis of sediment grain size distribution, bulk density, and Atterberg Limits.
5. Visual observations of the silt curtain installation and performance

3.0 Silt Curtain Deployment in South Elizabeth Channel

A Type III silt curtain manufactured by SiltMaster® was installed beginning on June 16, 2011 along the long axis of the South Elizabeth Channel (SEC) running in a northwest to southeast direction before turning south-southeast at the northeast corner of the South Elizabeth Flats terminating near Channel Marker #5. The initial configuration of the curtain is depicted in Figure 3-1, which shows a portion of the silt curtain with the boom anchored and the curtain furled and hanging from the boom. Installation was completed on June 17, 2011 when the curtain was unfurled (Figure 3-2). Within a couple of hours after unfurling the curtain, the current caused the curtain to "flare" upward toward the surface. Flaring of the curtain is shown in Figure 3-3. Even at the northwestern end of the SEC, where current velocities were slower, the curtain's original unfurled position was influenced by tidal forces (Figure 3-4). Each curtain panel formed concave deflections between the anchor points adjoining each panel. Each 100 foot panel between anchors was deflected in the direction of tidal flow.

Twenty-four hours after curtain installation, at approximately 0830 hours on 18 June, an inspection by the curtain support crew determined that multiple sections of the installed curtain had been damaged overnight beyond repair. The most obvious factor contributing to the almost immediate silt curtain failure was prevailing currents. Current directions of ebbing and flooding tides applied damaging forces in excess of design conditions against the anchored curtain. In addition, floating debris struck and collected within the concavities formed by the panels which exacerbated the current forces applied to the individual curtain panels. Some of the debris, which included tree limbs and large logs, which are common in the NBSA, had sufficient mass to cause structural damage to the curtain (Figure 3-5).

A summary of the findings of the silt curtain inspection (Appendix D) concluded the following from west to east: Section 1, the far northwest end of the curtain, had separated from its anchor; Section 2 was largely intact with only one tear on its eastern end; Section 3 had a 50 foot tear completely separated from the boom; Sections 4-7 were fully intact, but the curtain was floating on the surface and was not functioning properly; Section 8 had a 20 foot section separated from the boom; and Sections 9-15, nearest the main navigation channel were damaged beyond repair (Figure 3-6). In sections where current velocities were highest, large sections of the silt curtain were separated from the boom (Figure 3-7). Thus, within 24 hours following full deployment, a total of at least 800 linear feet of the curtain was damaged beyond repair, particularly among panels deployed between Channel Marker #1 and Channel Marker #7. A five hundred foot section of the curtain deployed toward the northwestern end of the SEC remained relatively intact, with the exception of separated seams between individual 100 foot panels and a small number of tears scattered among individual panels. Damage to this section was minimized due to slower prevailing current velocities. Nevertheless, this section of the curtain was not functioning properly because the majority of the curtain flared upward to the surface.

The damaged curtain sections were removed and five damaged panels from the section south and west of the corners of berths 94 and 96 were replaced on 18 June, The curtain remained unfurled overnight to prevent any possible damage to the new sections and dredging within the Silt Curtain Pilot Study Area did not occur during this time. The new sections were unfurled and the side panels attached to the previously installed silt curtain on the morning of 19 June before dredging recommenced adjacent to the corner of berths 94 and 96.

Northeast Dredging continued to monitor the silt curtain system and observed continued deterioration of the entire system from June 20-23 (Appendix D) due to the existing conditions within the study area. Northeast Dredging continued to make repairs to the curtain whenever possible during this period but the system continued to be damaged beyond repair. During this time, turbidity and TSS monitoring and dredging continued. As the curtain was not performing either effectively and there were mounting environmental, human health and safety and navigation concerns, USACE coordinated with NJDEP and the dredgers and a mutual decision was made to remove the curtain on June 24.

4.0 Monitoring of Silt Curtain Effectiveness in Limiting Dredging-Induced Resuspended Sediments

Silt curtains are designed to control dispersal of suspended sediments or turbid water either outside of a containment area or into a sensitive or protected habitat. Conventional silt curtains are basically impervious floating barriers that extend vertically from the water surface to a specified depth. The barrier is maintained in a vertical orientation by a floating boom at the top and a ballast chain along the bottom. However, as occurred in this Pilot Study, the curtain exhibited extensive damage within a single tidal cycle following deployment. Thereafter, essentially from the onset of the deployed curtain phase, monitoring effort focused on documenting how the plumes interacted with the damaged as well as partially intact portions of the curtain.

Curtain damage was typically manifested as ripping apart of fabric at the adjoining panels (Figure 4-1), particularly where the two adjoining panels were connected by interlacing lines through grommets aligned vertically on each opposing panel. This had the effect of allowing water to move through the gaps formed as panels parted. The gaps in effect impacted the integrity of the curtain by allowing flows of both ambient or plume waters through the barrier. In fact, flows through the gaps may have had increased velocities due to a jetting effect, and could be responsible for re-suspending sediment. This was evident during the analysis of Turbidity and TSS monitoring data, as ADCP transects conducted “inside” the curtain detected one small area of TSS exceeding ambient by 10 to 15 mg/l. Based on ADCP transect results “outside” the curtain, it is likely that this was sediment disturbed by increased flows though breaks in the silt curtain and not dredge induced. A summary timeline of the monitoring events associated with the silt curtain pilot study is presented in Figure 4-2. Results from the turbidity and TSS surveys can be found in Appendix C. The following paragraphs focus on monitoring that took place while the silt curtain was installed.

Ambient Conditions

Three moored OBS sensor arrays were deployed on both sides of the silt curtain, forming three pairs directly opposite each other (Figure 4-3). Each of the three outside arrays consisted of two turbidity sensors (1 upper and 1 lower). Due to the shallow water depths over the flats, each of the three inside arrays had only one turbidity sensor. One additional turbidity sensor was deployed at the northwestern end of the SEC channel to monitor background conditions. Ambient turbidities at the study site were consistently relatively low. Optically measured ambient turbidity peaked at 12.8 Nephelometric Turbidity Units (NTU) (average < 6.5 NTU) over the SEC flats during ebbing tides. Peak (26.5 NTU) and average (≤ 9 NTU) turbidities were somewhat higher over the SEC flats during a flooding tide. Ambient turbidities measured in the SEC were essentially equivalent to those measured over the flats (differing by less than 1 NTU).

Turbidity-Fixed OBS Arrays

Due to the hydrodynamics in the area during the flood tide, sediment resuspened by the dredging operation was carried away from the turbidity sensors and measured turbidities were in the range of ambient conditions. In general, during the ebb tide, turbidity readings outside the silt curtain increased above background levels, whereas turbidity readings inside the silt curtain were not above background.

Six turbidity sensors deployed "outside" the silt curtain during four days of monitoring recorded short duration peaks which exceeded ambient levels by as much as 23.7 NTU. Typically these peaks exceeded ambient by 10 to 15 NTU. On the "inside" of the curtain turbidity exceeded ambient by less than 13 NTU in short duration spikes observed over four days of monitoring. As discussed above this was observed where the curtain was damaged.

Mobile Plume Surveys (TSS-ADCP)

ADCP plume characterization surveys were conducted in conjunction with the fixed OBS arrays (Figure 4-3). In general, with the exception of a few near-bottom 'bins" with TSS concentrations between 60 and 70 mg/l, TSS concentrations remained primarily in the 25 to 33 mg/l range, consistent with background conditions in the lower water column (6.5 to 10.5 m). Higher concentrations detected near the channel bottom likely represented sediments resuspended during the previous flood tide. Several transects were conducted "inside" the curtain (i.e. between the flats and the curtain) to assess whether the plume had breached the curtain. Transect SCXB19 ran in a northwesterly direction across the SEC flats, 200 m from the dredging operation, "inside" (down-current) the curtain. TSS concentrations did not exceed background levels with the exception of two small areas (maximum TSS = 64 mg/l) (Figure 4-4). It is unclear if this represented a pulse of dredged sediment moving past the curtain or sediment disturbed by the increased flows passing through the damaged sections of the silt curtain as during this span of time the dredge was shut down temporally.

TSS concentrations generally increased at transects conducted close to the Newark Bay Navigation channel (eastern end of the pilot study area). Due to hydrodynamics, the plume remained largely intact to a distance of 80 m from the dredging operation. At 100 m from the dredge and only 20 m from the "outside" of the curtain, the plume had diminished considerably in spatial extent with only a small number of bins of higher concentrations located along the immediate channel bottom within the 18 ft depth contour. Transects occupied "inside" the curtain detected one small area of TSS exceeding ambient by 10 to 15 mg/l. It is uncertain if this was caused by dredge resuspension or sediment disturbed by increased flows though breaks in the silt curtain. Regardless of the direction of plume movement concentrations in the upper water column were generally within the range of background values with the exception of where the bucket exited the water.

In general, Turbidity and TSS monitoring results were consistent with previous studies of plume concentrations created during mechanical dredging operations (USACE 2007a, USACE 2007b, USACE 2008, USACE 2009, and USACE 2010).

5.0 Feasibility Evaluation of Silt Curtain Use in Future HDP Dredging within the NBSA

Very little documentation of silt curtain guidance or performance exists in the scientific literature. An analysis of the functional capabilities and performance of silt curtains was reported by JBF Scientific Corporation (1978). The authors concluded that high currents and energy environments cause silt curtains to flare, thus reducing a curtain's effective depth. At a current speed of 1 knot (0.51 m/sec), the effective skirt depth of a 1.5 m curtain is reduced to approximately 0.9 m. In the present study, significant flaring of the curtain was noted. The JBF Scientific Corporation (1987) report also concluded that "With respect to overall effectiveness and deployment considerations a current velocity of approximately 1 knot (0.51 m/s) appears to be a practical limiting condition for silt curtain use". Of note, these findings from field surveys, including this Study, appear to differ from the specifications of the Type III curtain which is rated for areas of tidal action and considerable current up to 3 knots or 1.5 m/s. In 1994, the USEPA published a remediation guidance document as part of the Assessment and Remediation of Contaminated Sediments Program (USEPA, 1994). They concluded that silt curtains and screens were most effective in relatively shallow, quiescent water and that as water depth increased and turbulence caused by currents and waves increased, it became increasingly difficult to effectively isolate the dredging operation from the surrounding water body.

Deployment of the silt curtain in this study was followed rapidly by failure in terms of curtain integrity. Within one complete tidal cycle clear evidence of structural failure occurred. The damaged silt curtain remained in the water and Turbidity and TSS monitoring was conducted for several days before it was pulled due to safety and navigation concerns. Critical factors in the loss of structural integrity were primarily current speed and flow direction, with debris an aggravating factor. Significant damage occurred to substantial linear portions of the curtain in areas of higher flows. Joints between panels were susceptible to tearing and disruption, contributing to flaring of the panels. Vertical lifting and flaring of the panels by current forces rendered the curtain non-functional for at least two-thirds of its deployed length. Flaring was observed even under moderate flow velocities.

During peak flows a small plume was detected, but generally confined to the lower portion of the water column. These plumes also faded to background levels before encountering the silt curtain and the channel side slope (18-ft depth contour). Given the presence of a current eddy circulating within the SEC, dredging as conducted in the SEC produced plumes that tended to travel up- or down-channel, staying within the confines of the SEC itself or extending toward the port bulkhead. Plumes of elevated TSS that were observed to move southerly across the SEC towards silt curtain and the flats consistently dissipated completely before reaching the flats. Very little evidence of plume excursion over the flats was observed.

The hydrodynamic conditions at the Silt Curtain Pilot Study location are representative of typical conditions found throughout the NBSA. Based on the Pilot Study, silt curtains deployed in similar locations, areas of moderate current velocities (0.4 to 0.7 m/s), likely have high likelihood of failure. In addition, floating or submerged debris which is typically present in highly urbanized and industrialized setting such as the NBSA had drastic effects on curtain performance. Either by direct impingement on the curtain or by accumulation of debris “wrack lines” against the surface portion of the curtain, debris had a demonstrable impact on curtain performance and the occurrence of substantial amount of debris, including large objects such as logs, contributed to the rapid failure of several curtain panels in this pilot study. The site placement for the silt curtain in this pilot study was chosen to meet the requirements of the Stipulation and Order and was selected to represent the best possible location for success based upon existing hydrodynamic conditions, environmental protection and navigation safety within the NBSA. Based on these findings, any future deployment of a silt curtain within the NBSA for the HDP construction and/or maintenance is considered infeasible..

6.0 Literature Cited

JBF Scientific Corporation. 1978. An analysis of the functional capabilities and performance of silt curtains. Technical Report D-78-39, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

United States Army Corps of Engineers (USACE) – New York District (NYD). 1999. Feasibility Report for New York and New Jersey Harbor Navigation Study. Final Environmental Impact Statement (FEIS).

United States Army Corps of Engineers (USACE) – New York District (NYD). 2007a. Suspended Sediment Plumes Associated With Navigation Dredging In The Arthur Kill Waterway, New Jersey**.** Appendix 3-1 of the Final Environmental Assessment: Effects of the NY/NJ Harbor Deepening Project on the Remedial Investigation/Feasibility Study of the Newark Bay Study Area. June 2007.

United States Army Corps of Engineers (USACE) – New York District (NYD). 2007b. Assessment of Ship-Induced Suspended Sediment Plumes in Newark Bay, New Jersey**.** Appendix 4-1 of the Final Environmental Assessment: Effects of the NY/NJ Harbor Deepening Project on the Remedial Investigation/Feasibility Study of the Newark Bay Study Area. June 2007.

United States Army Corps of Engineers (USACE) – New York District (NYD). 2008. Far-field Surveys of Suspended Sediment Plumes Associated With Harbor Deepening Dredging In Newark Bay. September 2008.

United States Army Corps of Engineers (USACE) – New York District (NYD). 2009. Far-field Surveys of Suspended Sediment Plumes Associated With Harbor Deepening Dredging In Newark Bay. S-NB-1 Contract Area. S-NB-1 Contract Area Survey #2. June 2009.

United States Army Corps of Engineers (USACE) – New York District (NYD). 2010. Far Field Surveys of Suspended Sediment Plumes Associated With Harbor Deepening Dredging In Newark Bay. S-E-1 Contract Area. S-NB-1 Contract Area (Port Elizabeth Channel Survey #1 & #2. February 2010.

United States Environmental Protection Agency (USEPA). 1994. Great Lakes Contaminated Sediments: ARCS Remediation guidance Document, Chapter 4 (EPA-905-B94-003).