LONG TERM MONITORING PROGRAM
FIRST FIVE YEAR IMPLEMENTATION PLAN
STUDY AREA 7 SEDIMENT REMEDY
JERSEY CITY, NEW JERSEY

Submitted to:

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1.0 INTRODUCTION

As required by the Consent Order on Sediment Remediation and Financial Assurances (Consent Order) entered by the U.S. District Court (District of New Jersey) on May 28, 2008 in the matter of *Interfaith Community Organization et al vs. Honeywell International et al, and Riverkeeper, Inc., et al vs. Honeywell International et al* (Civil Action Nos. 95-2097 and 06-0022), Honeywell conducted sediment remediation in the Hackensack River in the vicinity of Study Area (SA) 7 (Site) along Route 440 in Jersey City, New Jersey. The Consent Order, as amended in September 2013, set forth the following specific components of dredging, capping, and monitored natural recovery (MNR) for the Sediment Remedy and the requirements for a long-term monitoring program (LTMP):

- Dredging and subsequent capping in a 0.5 acre area adjacent to the SA-7 bulkhead. Sediments were dredged to a depth of 2 feet (ft) and then capped with 18 inches of sand and armoring.

- Capping of surface sediments (i.e., between depths of 0 to 1 ft) with total chromium concentrations greater than 370 parts per million (ppm) to achieve a 1 ft layer of natural sediments and/or cap material with a concentration of less than 370 ppm total chromium.

    - A six-inch cap placed over a total of 19 acres

    - A twelve-inch cap placed over a total of 18 acres

- MNR in a total areas of 33 acres where sediments less than 1 ft below the sediment surface are below 370 ppm total chromium but sediments deeper than 1 ft in these areas exceed 370 ppm.

- Long-term monitoring to assess the on-going effectiveness of the sediment remedy (i.e., maintenance and/or verification of cap integrity, data collection on nature of benthic community following implementation, erosion monitoring of MNR areas). Long-term monitoring will be performed in accordance with a Long-Term Monitoring Plan (LTMP) for a period of approximately 15 to 25 years following implementation of the remedy.

Capping of three areas (Areas 16, 22, and 28) has been deferred to a future date pending work to be performed adjacent to these areas which could result in disturbance to the cap integrity. These areas will be added to the monitoring program once they are completed.

A Long Term Monitoring Plan (LTMP) was developed as part of the *100% Design for Study Area 7* (Cornerstone/ENVIRON 2012) and defined the scope and methods to be implemented to satisfy the requirements of the Consent Order. The monitoring tasks and events outlined in the LTMP are based on the following objectives, as specified in Paragraph 29 of the Consent Order:

- Provide monitoring to ensure that the integrity of the caps is maintained.

- In areas of MNR, confirm either that i) deposition of additional sediments is continuing, or ii) the contemporaneous bathymetry of the river bottom shows an increase or less than a four-inch decrease in the measured elevation of the river bottom.

- Collect data regarding the nature of the benthic community in remediated sediments after the implementation of the remedy.

The LTMP provides for the following monitoring events:

a. "First-Five Year Monitoring Activities" will take place in Years 1, 2, and 5.

b. "Post-High Energy Event Monitoring Activities" will take place promptly following High Energy Events. The Consent Order defines "High Energy Events" as follows:

    i. "A 50-year rainfall event defined by the National Weather Service as a 24-hour period of rainfall exceeding the maximum 50-year/24-hour accumulation, as recorded at Newark Airport;

    ii. A 10-year storm surge event defined as a hurricane event (not a "nor'easter") resulting in an increase in ocean level of either 0.64 meters above normal tidal cycling at the Battery Park tide gauge or 1.40 meters above mean sea level (MSL); or

    iii. A wind event achieving 34 to 40 knots, coming from the south through the west, averaged over 6 hours, as recorded at Newark Airport."

c. "Five-Year Interval Monitoring Activities" will take place at 5-year intervals after Year 5 until either the objectives of the particular monitoring activity have been achieved and maintained for a period of 15 years and through at least two High Energy Events or the remedy has been in place for 25 years and met the objectives, whichever is shorter. According to the Consent Order, if after 25 years any of the objectives has not been met or if any of the objectives is close to being violated, monitoring will continue in 5-year intervals until it is clear that the objectives have been met.

The elements of the long term monitoring program are summarized on **Tables 1** and **2**.

The specific monitoring to be performed for the First-Five Year Monitoring Activities is defined in this First Five Year Implementation Plan (Implementation Plan). However, the tools and the schedule may be modified in the future to reflect new information or to adjust to field conditions.

Table 1: Summary of Long Term Monitoring of the Capped Areas

Monitoring Elements for Capped Areas	YEAR							LTMP Section Reference
	1	2	5	6 to 15	20	25	HEV	
Hydraulic and Hydrodynamic Evaluation								
Routine Monitoring and Analysis	X	X	X					4.1.1
Severe Event Monitoring and Analysis	X	X	X	X			Note 1	4.1.1
Bathymetry	X	X	X	X	X	X	Note 2	4.1.2
Cap Integrity Monitoring	X		X				Note 3	4.1.3
Pore Water Sampling	X	X	X	Note 4, 5				4.2.1
Surface Sediment Sampling			X	Note 5				4.2.2
Sediment Trap Sampling	Note 6							4.2.3
Biological Monitoring	X		X	Note 5				4.3

HEV: Following all High Energy Events

Note 1: After 15 years, high-event assessments will be discontinued if the monitoring objectives have been achieved and maintained for 15 years and through at least two high energy events.

Note 2: Bathymetric surveys will be conducted following up to two high-energy events (if not encountered in the first five years). No additional surveys will be performed if bathymetric surveys show no negative impacts on overall cap integrity (i.e., cap maintains coverage of target areas) for a period of 15 years and through two high-energy events, or a total period of 25 years, whichever is shorter.

Note 3: After Year 5, routine sediment cap integrity monitoring will be discontinued unless data collected during the first five years of monitoring indicate that additional monitoring is warranted. Monitoring will still be conducted following a high-energy event if two such events did not occur within the first five years. Monitoring may also be performed after Year 5 if the bathymetry survey identifies an area of potential erosion warranting further assessment (see Section 4.1.2)

Note 4: The first year of pore water sampling is limited to those areas of potential intermediate groundwater plume upwelling identified in the 2007 *Final Groundwater Investigation Report, Honeywell Study Area 7 Site*; this corresponds to portions of Cap Areas 1, 6, 8, 13, and 18 . In Year 2, sampling will be performed in Areas 1, 8, 13 and 18.

Note 5: After Year 5, sampling will be discontinued, unless the data collected during the first five years of monitoring indicate further monitoring is warranted.

Note 6: If surface sediment sampling of capped areas results in the detection of total chromium concentrations greater than 370 ppm, sediment trap sampling units may be deployed in those areas to further assess site conditions and to evaluate potential contaminant sources.

Table 2: Summary of Long Term Monitoring of the MNR Areas

Monitoring Elements for MNR Areas	YEAR							LTMP Section Reference
	1	**2**	**5**	**6 to 15**	**20**	**25**	**HEV**	
Hydraulic and Hydrodynamic Evaluation								
Routine Monitoring and Analysis	X	X	X					5.1
Severe Event Monitoring and Analysis	X	X	X	X			Note 1	5.1
Bathymetry	X	X	X	X	X	X	Note 2	5.2
Sediment Profile Imaging	X	X	X				Note 3	5.3
Sediment Core Sampling	Note 4							5.2, 7.2

HEV: Following all High Energy Events

Note 1: After 15 years, severe event assessments will be discontinued if the monitoring objectives have been achieved and maintained for 15 years and through at least two high energy events.

Note 2: Bathymetric surveys will be conducted following up to two high-energy events (if not encountered in the first five years). Following at least two high energy events, bathymetry surveys will be conducted only in MNR areas where erosion may have resulted in more than a 4-inch decrease in the elevation of the sediment surface, based on the results of the hydrodynamic evaluation.

Note 3: Following high energy events, SPI surveys will be performed in MNR areas where erosion may have resulted in more than a four-inch decrease in surface sediment elevations based on the hydrodynamic evaluation and measured observations

Note 4: In the event that a bathymetric survey identifies an Erosional Area as defined in the LTMP, sampling of top 12-inches sediment for total chromium in Erosion Areas is required to confirm that concentrations in top 12-inches remain below 370 ppm.

2.0 AS-BUILT CONDITIONS

The sediment remedy required by the Consent Order and detailed in the 100% Design Report consisted of:

- Dredging to a depth of 2 feet and then capping with 18 inches of clean soil in the area adjacent to the SA-7 bulkhead.
- Capping of 30 areas covering 37 acres of river sediment.
- MNR of 33 acres.

The as-built limits of capping are shown on **Figures 1 and 2**. The sediment remedy was completed on October 8, 2013, with the exception of Cap Areas 16, 22, and 28. Cap Areas16 and 22 are to be addressed as part of the proposed Beneficial Environmental Project at Droyers Cove. Capping of Area 28 is to be performed following the completion of repairs or replacement of a water pipeline located immediately adjacent to the cap area by the Bayonne Municipal Utilities Authority.

2.1 Cap Construction

As specified in the 100% Design Report, the sediment caps consisted of a layer of sand under the armor layer. In some cap areas, a filter layer was also installed between the sand and armor layer. Capping materials consisted of sand (i.e., grits of the quarrying process), filter (washed 0.75" stone), and armor (0.75" stone, 1.0" stone, 2.5" stone, 3.5" stone, 6" rip-rap, 10" stone). Material placement verification included confirmation of coverage, thickness verification measurements and tracking of the tonnage of material placed. A summary of the as-built cap construction for each cap area is provided on **Table 3**. For each cap area, **Table 3** provides the average sand layer thickness, average filter layer thickness (where installed), average armor layer thickness, and the armor stone size.

2.2 Long-Term Monitoring Plates

Prior to placement of capping material, long-term monitoring plates were installed at predefined locations within each cap area. These plates are to be used to evaluate potential material loss as part of the long term monitoring program. For this purpose, the plates were constructed with stick-up posts sized based on the anticipated cap thickness for each cap area (i.e., design cap thickness plus placement tolerances). Two types of long term monitoring plated deployed (Intertidal and Subtidal):

- For subtidal cap areas, the stick-up post lengths were designed to exceed the total anticipated cap thickness by at least two inches. However, due to over-placement of materials in some cap areas, it is anticipated that the stick-up posts for some long-term monitoring plates are buried entirely (e.g., Long Term Monitoring Plates 2A, 3A, 6A, 7B, 7C, 10A, 11A, 11B, 11D, 11E, 14A, 15A, 18A, 18B, 19A, 20A, 21A, 25A, and 30A).

- For intertidal cap areas, the stick-up post lengths were designed to be covered by at least two inches of capping material.

Upon placement, the GPS coordinates of the long-term monitoring plates were recorded. The as-built locations of the long-term monitoring plates are provided on **Figures 1 and 2**. Based on the as-built cap thicknesses, the estimated exposed length of the monitoring plate stickup posts are listed on **Table 3**.

2.3 Post-Construction Conditions

Records of surface water stage elevations and weather events were obtained to identify any "high energy events" that between the completion of sediment cap construction and the implementation of the LTMP. As specified in the LTMP, monitoring of hydraulic conditions near SA-7 includes collection of surface water elevations from the Battery Park gauge and wind and precipitation records from Newark Airport weather station. The water levels as measured at the Battery Park Gauge from October 2013 to April 2014 are provided on **Figure 3**; the peak height recorded during this period was1.4 meters (m) above mean sea level on January 3, 2014. The weather conditions in Newark, NJ during this same period of time are summarized on **Figure 4**; the maximum sustained wind speed during this period was 38 mph (33 knots) and the maximum precipitation was 2.3 inches.

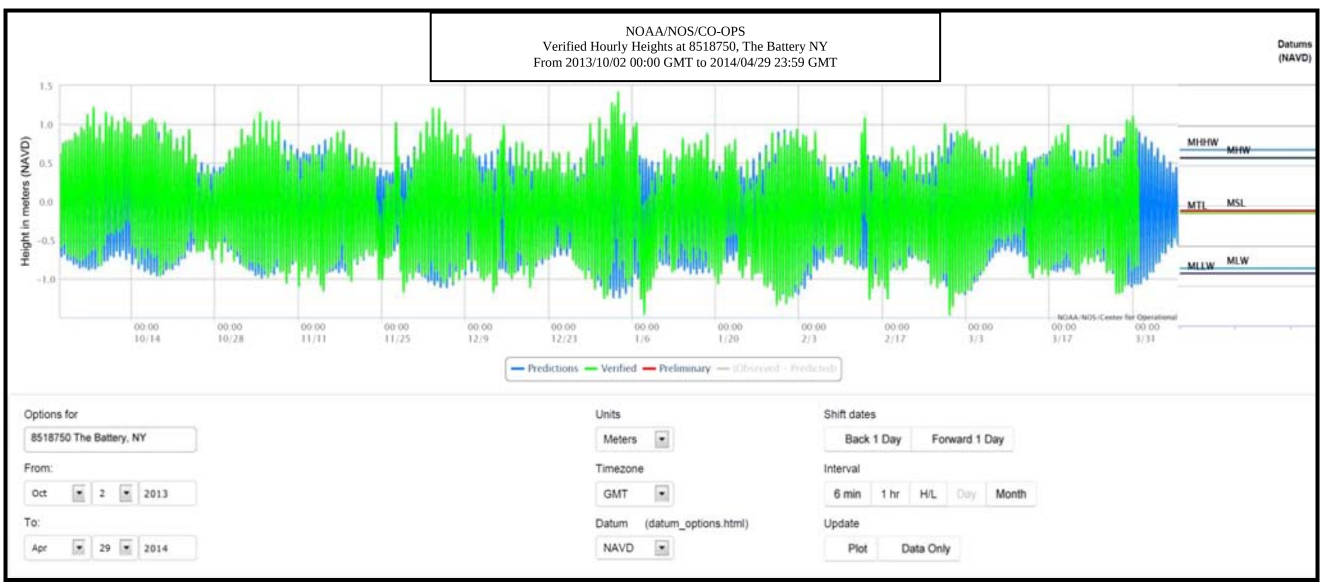

Figure 3: Water levels at the Battery Park, NY Gauge (October 2013 – April 2014).

Source:
http://tidesandcurrents.noaa.gov/waterlevels.html?id=8518750&units=metric&bdate=20131002&edate=20140429&timezone=GMT&datum=NAVD&interval=h&action=

Weather History for Newark, NJ

October 1, 2013 through April 28, 2014

October 1, 2013 through April 28, 2014

October 1 2013 - TO - April 28 2014 Go

Daily | Weekly | Monthly | **Custom**

	Max	Avg	Min	Su
Temperature				
Max Temperature	**89** °F	**50** °F	**16** °F	
Mean Temperature	**76** °F	**41** °F	**10** °F	
Min Temperature	**65** °F	**33** °F	**3** °F	
Degree Days				
Heating Degree Days (base 65)	55	24	0	5012
Cooling Degree Days (base 65)	11	0	0	55
Growing Degree Days (base 50)	26	2	0	492
Dew Point				
Dew Point	**72** °F	**28** °F	**-16** °F	
Precipitation				
Precipitation	**2.29** in	**0.13** in	**0.00** in	**22.18** in
Snowdepth	**18.0** in	**1.4** in	**0.0** in	-
Wind				
Wind	**38** mph	**10** mph	**0** mph	
Gust Wind	**51** mph	**24** mph	**16** mph	
Sea Level Pressure				
Sea Level Pressure	**30.77** in	**30.07** in	**29.02** in	

Figure 4: Weather Conditions at Newark Airport (October 2013 – April 2014).
Source:
http://www.wunderground.com/history/airport/KEWR/2013/10/1/CustomHistory.html?dayend=28&monthend=4&yearend=2014&req_city=NA&req_state=NA&req_statename=NA

Table 3: As-Built Cap Construction and Monitoring Plate Details

	CAP DETAILS					MONITORING PLATES			
Cap Area	Average Sand Layer Thickness (inches)	Average Filter Layer Thickness (inches)	Average Armor Layer Thickness (inches)	Armor Size (inches)	Average Total Thickness (inches)	Plate ID	Interdidal or Subtidal	Stickup length (inches)	Expected Exposed Length* (inches)
1	4.7	NA	6.6	0.75	11.2	1A	Subtidal	12	1
2	7.2	NA	6.7	0.75	13.9	2A	Subtidal	12	0
3	4.6	NA	6.4	0.75	11.0	3A	Subtidal	15	0
4	5.2	NA	6.3	0.75	11.5	NA	Subtidal	NA	NA
5	6.0	6.6	6.2	2.5	18.8	5A	Intertidal	8	0
6A	6.4	6.2	6.0	1	18.6	NA	Intertidal	NA	NA
6B	6.1	5.8	6.3	2.5	18.2	6A	Subtidal	8	0
7A	7.6	NA	5.6	0.75	13.3	7A	Subtidal	12	3
						7C	Subtidal	8	0
7B	6.1	8.4	10.4	2.5	24.9	7B	Subtidal	8	0
7C	5.7	6.7	11.9	3.5	24.3	NA	Subtidal	NA	NA
8A	7.6	NA	5.5	0.75	13.0	NA	Subtidal	NA	NA
8B	8.5	5.7	5.3	1	19.5	8A	Subtidal	18	5
9	6.2	4.4	6.1	1	16.7	9A	Subtidal	18	5
10	9.3	NA	4.4	0.75	13.7	10A	Subtidal	12	0
11A	6.1	8.7	9.9	2.5	24.7	NA	Subtidal	NA	NA
11B	6.8	6.6	5.9	1	19.3	11A	Subtidal	18	0
						11B	Subtidal	18	0
						11C	Subtidal	18	1
						11E	Subtidal	18	0
11C	5.4	5.9	6.7	2.5	18.0	11D	Subtidal	8	0
						11F	Intertidal	8	0
12	NA	NA	24.2	10	24.2	NA	Subtidal	NA	NA
13A	7.5	5.2	6.2	1.0	19.0	13B	Intertidal	15	0
						13D	Intertidal	15	0
13B	6.7	5.9	6.5	2.5	19.1	13A	Intertidal	15	0
						13C	Intertidal	15	0
14	10.3	NA	7.1	0.75	17.4	14A	Subtidal	15	0
15	8.6	NA	7.2	0.75	15.8	15A	Subtidal	15	0
17	9.4	7.2	7.8	2.5	24.3	17A	Subtidal	24	3
						17B	Subtidal	24	2
						17C	Subtidal	24	2
18A	8.9	NA	7.1	0.75	16	18A	Subtidal	15	0
						18B	Subtidal	15	0
18B	8.6	6.7	7.8	2.5	23.1	NA	Subtidal	NA	NA
19A	9.9	6.0	7.4	1	23.3	NA	Subtidal	NA	NA
19B	11.1	NA	7.2	0.75	18.4	19A	Subtidal	15	0
20	10.7	NA	8.0	0.75	18.6	20A	Subtidal	15	0
21	9.5	NA	7.8	0.75	17.3	21A	Subtidal	15	0
23	10.8	NA	10.3	0.75	21.1	NA	Subtidal	NA	NA
24	5.7	7.1	7.5	2.5	20.3	NA	Subtidal	NA	NA
25	6.5	NA	5.4	0.75	11.9	25A	Subtidal	12	0
26	7.0	7.1	8.0	2.5	22.1	26A	Intertidal	8	0
27	6.1	NA	7.1	0.75	13.3	27A	Subtidal	12	3
29A	8.1	8.0	8.0	2.5	24.1	29B	Subtidal	24	1
29B	7.7	6.9	6.9	1	21.5	29A	Subtidal	24	5
						29C	Subtidal	24	4
30A	3.5	7.2	5.6	1	16.3	NA	Subtidal	NA	NA
30B	6.7	6.7	7.6	2.5	20.9	30A	Intertidal	8	0

* = Expected exposed length was determined based on plate stickup length and average cap thickness measurement around the plate location.

3.0 SCOPE OF WORK

The scope of work for the first five years of the long-term monitoring program includes the following tasks:

- Hydraulic and Hydrodynamic Evaluation
- Bathymetric Survey
- Cap Integrity Monitoring
- Pore Water Sampling
- Sediment Profile Imaging (SPI)
- Biological Sampling
- Surface Sediment Sampling in Capped Areas
- High Energy Events

The scope and approach for each of the tasks is defined below.

3.1 Hydraulic and Hydrodynamic Evaluation

Records of river stage elevations and weather events will be obtained to identify "high energy events" that would warrant additional inspection of the cap and MNR areas. Monitoring of hydraulic conditions near SA-7 will include collection of surface water elevations from the Battery Park gauge and wind and precipitation records from Newark Airport weather station. The tidal gauge station established near SA-7 for the prior site investigation activities may also be used to monitor hydraulic conditions, including diurnal flows, wet-weather conditions and high-energy events.

Monitoring data will be retrieved on a quarterly basis and assessed **annually** during the first five years. The assessment will be based on a comparison with the conditions modeled as part of the Remedial Alternatives Analysis (RAA; ENVIRON 2006b) and 100% Design Report, to identify significant and sustained conditions that were not considered in the design of the sediment caps or MNR program. In the event such events are identified, then the hydrodynamic model will be updated with the latest monitoring data to evaluate and update velocities and shear stresses predicted in the capped and MNR areas. The need for updated modeling will be determined based on observed conditions relative to the modeled conditions as summarized on **Table 4**.

Appendix A provides the results from the prior modeling for the 100 year storm surge simulation and a composite map that details wind wave generated shear stress values for the various events models.[1] In terms of an erosion potential, shear stress values in excess of 140 dynes /cm^2 are estimated to initiate motion of a 0.4-inch stone; as designed, none of the cap areas are expected to erode based on the model predicted shear stress values.

[1] A 1,000 year storm surge map because this simulation actually predicts smaller shear stress values when compared with the 100 year storm. The greater depths of the 1,000 year storm surge outweigh the larger velocities predicted, giving smaller simulated shear stress values for the site.

Table 4: Summary of Hydrodynamic Modeling Conditions

High Energy Event	Modeled Condition for Remedy Design
10 year storm event: 0.64 meter rise above normal high water tidal elevation of Battery Park gage or 1.4 meters above MSL	Extreme historical 100 and 1,000 year storm surge events were evaluated as part of the sediment stability analysis for the site. **The peak surge values used for the two respective events were 3.0 meters and 3.6 meters above MSL, respectively.**
Wind event of 34 to 40 knots from south through the west, sustained over 6 hours	A wind/wave analysis was performed for the design of the sediment caps. **The analysis used 15 minute peak wind events of 58.8 knots (30.2 m/s) from west and 66.0 knots (35 m/s) from the southwest** based on the 100 year recurrence interval wind measured at Newark Airport.
50 year – 24 hour rain event	An analysis of extreme flooding events on the Hackensack River was performed for the design of the sediment caps (based on conditions observed during Hurricane Floyd). **This analysis reflected between 10 and 14 inches of rainfall in the Hackensack River watershed,** resulting in peak flows on the Hackensack that were approximately three times greater than estimated 100 year flood flows. By comparison, the 50 year - 24 hour rain event as measured at Newark Airport is estimated at 7.2 inches.

Results of the hydrodynamic evaluation will be used to assess overall cap stability and erosion patterns, if evident. If cap erosion potential is evident, those areas will be examined using the bathymetric data and/or measurements of the cap thickness. For MNR areas, results of the analyses, in combination with bathymetric data, will be used to identify and examine areas prone to erosion (defined as greater than 4 inches of bed elevation change), and confirm that the MNR processes are ongoing.

3.2 Bathymetric Survey (Multi Beam)

High-resolution multibeam bathymetric surveys will be conducted in **Years 1, 2,** and **5** over the 70-acre remedy area (see **Figures 1** and **2**). The surveys will be completed using a survey boat, R2 Sonic multibeam sonar or equivalent, and a RTK-DGPS precision positioning equipment. These surveys will be used as part of the long-term cap integrity assessment to identify whether portions of the cap are eroding or have been compromised and to monitor sediment bed elevations in MNR areas.

Bathymetric surfaces will be generated using AutoCAD and evaluated against the bathymetric survey conducted in year 1, which will serve as a baseline condition. In comparing surveys from a monitoring event with the baseline survey, the estimated difference between the two surveys will be averaged over ¼-acre subareas. In addition, thickness verification measurements (see Section 3.3 below) will be considered in evaluating differences between bathymetric surveys. This analysis will be used to identify locations requiring a more detailed evaluation and/or direct inspection. Collectively, this data will be used to define the extent of cap areas requiring repair due to compromised conditions.

When conducting this assessment, inherent survey accuracy limits, as well as native sediment consolidation in capped areas will be considered. In particular, the placement of the sediment cap can result in sediment consolidation over time, which may limit the utility of bathymetry measurements for direct measurement of cap thicknesses.

3.3 Cap Integrity Monitoring

Cap integrity monitoring will be performed by verifying cap thickness using the 38 long-term monitoring plates that were installed within capped areas during remedy implementation (see **Figures 1** and **2**). As presented on **Table 3**, the long term-monitoring plates were installed in both subtidal and intertidal areas. The long-term monitoring plates include four posts with rings spaced at 1-inch intervals.

As part of this task, the 38 long-term monitoring plates will be inspected to determine if there is any observable loss of cap material. Inspections of the monitoring plates will be performed in **Years 1** and **5**. Specifically,

a. For the 28 long-term monitoring plates located in subtidal areas, the long-term monitoring plates will be located based on their GPS coordinates, and divers or remote underwater cameras will be used to measure the exposed length of the posts on monitoring plates expected to be exposed above the cap surface. In addition, a 10-ft by 10-ft area around the GPS defined plate location will be video surveyed regardless of whether the plate posts are exposed above the cap surface. The exposed length of the posts will be compared against prior measurements to establish the amount of cap material loss.

b. For the 10 long-term monitoring plates located within intertidal areas, the long-term monitoring plates will be located based on their GPS coordinates at low tide, when the cap is exposed. If the monitoring posts are exposed, the exposed length will be measured (as exposed conditions indicate loss of cap material). Where applicable, the exposed length of the posts will be compared against prior measurements to establish the amount of cap material loss. Regardless of whether the plate posts are exposed above the cap surface, a10-ft by 10-ft area around the GPS defined plate location will be video surveyed.

Cap thickness verification locations are divided into 2 groups to be inspected in alternating events, such that only half the intertidal and half the subtidal monitoring plates will be inspected in each event. As indicated on **Figures 1** and **2**, one set of 14 subtidal locations and 5 intertidal locations will be inspected in Year 1; and the second set of 14 subtidal locations and 5 intertidal locations will be inspected in Year 5.

3.4 Sediment Profile Imaging (SPI)

SPI will be conducted in **Years 1, 2, and 5** to evaluate surface sediment deposition and sediment bed stability in MNR areas. SPI will only be performed within the top 12 inches of native sediment materials at 10 representative MNR locations uniformly spaced across the MNR area and distributed between both intertidal and subtidal areas (**Figures 1** and **2**). SPI will not be performed in capped areas.

A DGPS system will be used to navigate to and record SPI locations. It is expected that at least three images will be taken at each SPI location.

3.5 Pore Water Sampling

Pore water sampling from the capped areas will initially be conducted in those areas of potential intermediate groundwater plume upwelling identified in the 2007 *Final Groundwater Investigation Report Honeywell Study Area 7 Site*; this corresponds to portions of cap areas 1, 6, 8, 13, and 18 (locations designated 1A, 6A, 8A, 13A – 13D, and 18B). This sampling will be performed in **Year 1.** In **Years 2** and **5**, sampling will be performed at locations 1A, 8A, 13A, 13B, 13C and 18B**.** After Year 5, sampling will be discontinued, unless the data collected during the first five years of monitoring indicate further monitoring is warranted.

As shown on **Figures 1** and **2**, a total of eight (8) pore water locations will be sampled in the **Year 1** event. In Years 2 and 5, a total of six (6) locations will be sampled. Sampling will be conducted within 10 to 20 feet of the installed cap thickness monitoring plate locations, leaving room to prevent damage to the plate and biasing toward cap verification locations where the sand layer was thicker. At each location, a Solinist® Drive Point Piezometer or equivalent groundwater push point sampler will be pushed or driven into the sand layer of the cap. Once embedded, a pore water sample will be withdrawn using a peristaltic pump and polyethylene tubing from inside the piezometer. Samples will be placed in laboratory supplied glassware and sent to a New Jersey certified laboratory for hexavalent chromium analysis.

The detected concentrations will be compared with the acute and chronic ambient saline water quality criteria (AWQC) for hexavalent chromium. Sample procedures are provided in Appendix B.

3.6 Biological Sampling

Biological monitoring will be conducted in **Years 1** and **5** within capped areas and background areas to evaluate the recolonization of benthic species within the remediated areas and define whether additional biological sampling is warranted. Benthic community sampling and analysis will be conducted at locations proximate to 20 of the 38 long-term monitoring plates that were installed within capped areas (**Figures 1** and **2**) and three (3) off-site background locations (**Figure 5**). Selection of sampling locations will be based on an alternating selection process and locations will be distributed between both intertidal and subtidal capped areas described for Section 3.5.

Biological sampling at subtidal locations and off-site background locations will be conducted from a pontoon vessel. Sampling at intertidal locations will be conducted at low tide, when the capped area is exposed. Sampling will be conducted using a box corer, ponar sampler, Eckman sampler, or other suitable means that provide a representative sample of the upper 12 inches of cap materials. Collected samples will be sieved using a 500 micron bucket type sieve and a manageable size of sieved sample will be containerized, field preserved, and sent to a biological laboratory for taxonomy testing. Sample procedures are provided in Appendix B.

3.7 Surface Sediment Sampling in Cap Areas

Surface sediment sampling in cap areas will be conducted in **Year 5** to measure total chromium in the upper one-foot of the sediment cap. Surface sediment sampling will be conducted at locations proximate to 20 of the 38 long-term monitoring plates that were installed within the capped areas (**Figures 1** and **2**). Selection of sampling locations will be based on an alternating selection process and locations will be distributed between both intertidal and subtidal capped areas described for Section 3.5.

Sampling in subtidal areas will be conducted using a sampling vessel using push coring or vibracoring equipment to retrieve two to four inch diameter rigid liner samples. While only the upper twelve inches of cap will be sampled, push or vibratory cores will be advanced into the underlying sediment to “plug” the core and prevent loss of sample. Push coring will be attempted first and if this methodology does not allow the collection of the sediment samples, vibracoring will be utilized. Sampling in intertidal areas will be conducted using push coring equipment at low tide, when the capped areas are exposed.

Core samples will be cut lengthwise and samples will be collected from the upper 12 inches. Sediment samples will be placed in laboratory supplied glassware and sent to a New Jersey certified laboratory for total chromium testing. Analytical results will be compared with the Consent Order specified limit of 370 ppm. Sample procedures are provided in Appendix B.

3.8 High Energy Event

Following a high energy event identified in Task 1, a bathymetric survey, cap thickness verification, and MNR area SPI survey are to be performed.

3.9 Reporting

Monitoring reports presenting the results of the long-term monitoring activities in the capped, MNR, and reference areas will be prepared following completion of each monitoring event in Years 1, 2, and 5. In Years 3 and 4, a report summarizing the hydrologic and weather data will be prepared. The report will include chemical and geotechnical analyses in tabular format. In addition, these data will be presented on maps and cross sections, as appropriate. The information presented in the monitoring reports will be used to demonstrate long term stability of the capped and MNR areas, and to assess whether modifications to the scope, location, extent, or magnitude of the monitoring activities in subsequent events is warranted.

In addition, a memorandum presenting hydraulic monitoring assessment results will be prepared and submitted on a yearly basis.

4.0 IMPLEMENTATION SCHEDULE

All field activities will be performed during the period of June through October in Years 1, 2 and 5. The first task performed will be the bathymetric survey to identify (1) areas where a cap is eroding or has been compromised, and (2) erosion may have resulted in more than a 4-inch decrease in the elevation of the sediment surface in MNR areas. The results of the survey will be reviewed to determine if specific cap and/or MNR areas require inspection during implementation of the field program.

Monitoring specified in Section 3.8 will also be conducted within 60 days following a high-energy events, unless the event occurs within 60 days or during the schedule field events defined in Sections 3.2 through 3.7.

FIGURES

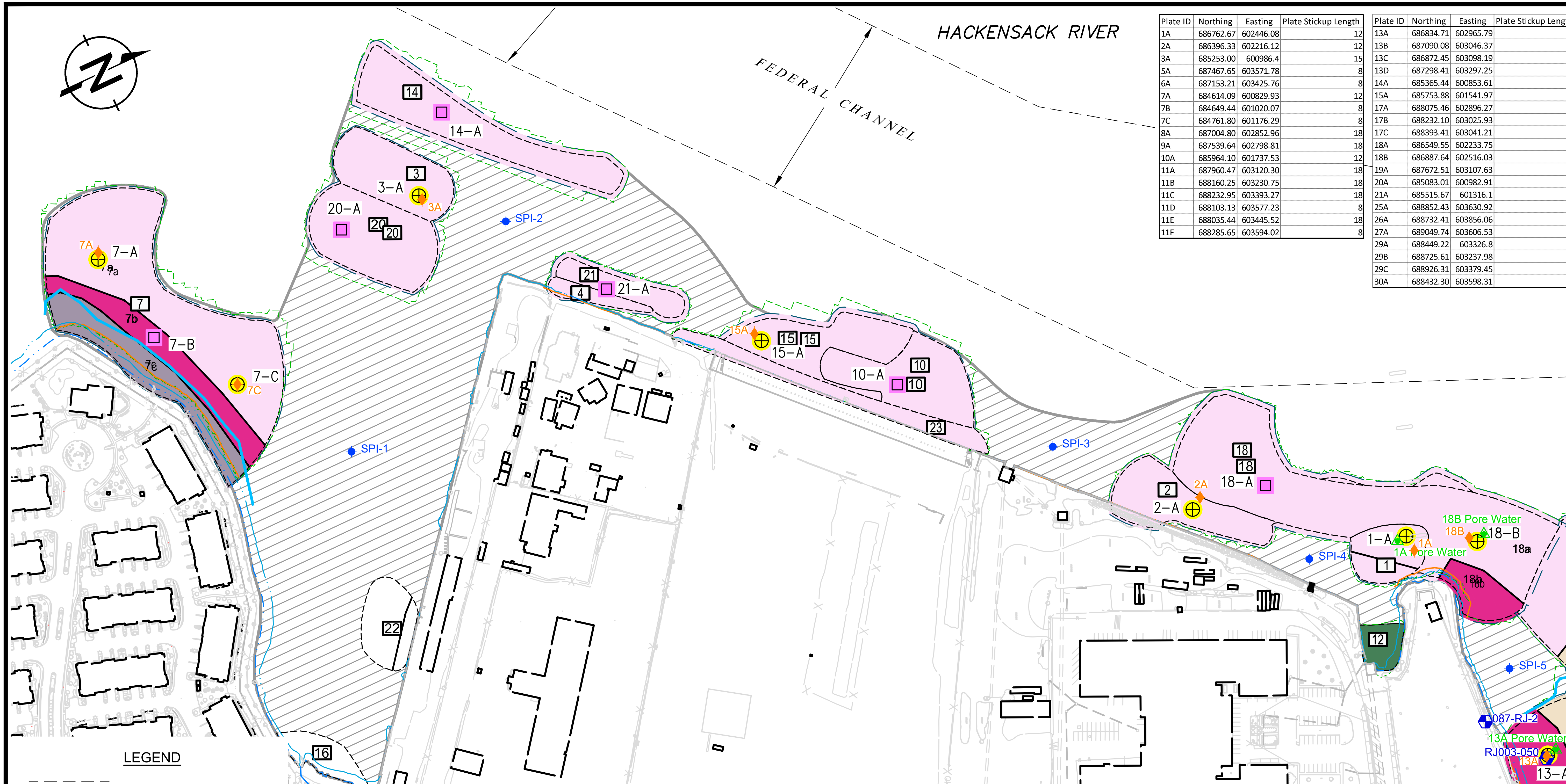

Plate ID	Northing	Easting	Plate Stickup Length
1A	686762.67	602446.08	12
2A	686396.33	602216.12	12
3A	685253.00	600986.4	15
5A	687467.65	603571.78	8
6A	687153.21	603425.76	8
7A	684614.09	600829.93	12
7B	684649.44	601020.07	8
7C	684761.80	601176.29	8
8A	687004.80	602852.96	18
9A	687539.64	602798.81	18
10A	685964.10	601737.53	12
11A	687960.47	603120.30	18
11B	688160.25	603230.75	18
11C	688232.95	603393.27	18
11D	688103.13	603577.23	8
11E	688035.44	603445.52	18
11F	688285.65	603594.02	8

Plate ID	Northing	Easting	Plate Stickup Length
13A	686834.71	602965.79	15
13B	687090.08	603046.37	15
13C	686872.45	603098.19	15
13D	687298.41	603297.25	15
14A	685365.44	600853.61	15
15A	685753.88	601541.97	15
17A	688075.46	602896.27	24
17B	688232.10	603025.93	24
17C	688393.41	603041.21	24
18A	686549.55	602233.75	15
18B	686887.64	602516.03	15
19A	687672.51	603107.63	15
20A	685083.01	600982.91	15
21A	685515.67	601316.1	15
25A	688852.43	603630.92	12
26A	688732.41	603856.06	8
27A	689049.74	603606.53	12
29A	688449.22	603326.8	24
29B	688725.61	603237.98	24
29C	688926.31	603379.45	24
30A	688432.30	603598.31	8

LEGEND

FEDERAL CHANNEL

MEAN HIGH WATER LINE (3.52 FT NGVD29)

EXISTING SHORELINE PROTECTION LIMITS (AS SURVEYED BY SEVENSON ENVIRONMENTAL SERVICES, INC. ON 11/30/2012)

LOW WATER LINE (APPROXIMATE)

7–A AS-BUILT LONG TERM MONITORING PLATE - YEAR 1

7–B AS-BUILT LONG TERM MONITORING PLATE - YEAR 5

GROUNDWATER SAMPLE LOCATION

BIOLOGICAL SAMPLE LOCATION

0.75" ARMOR PLACEMENT

1.0" ARMOR PLACEMENT

2.5" ARMOR PLACEMENT

3.5" ARMOR PLACEMENT

10.0" ARMOR PLACEMENT

MONITORED NATURAL RECOVERY AREA

PROPOSED SPI INVESTIGATION LOCATIONS - YEARS 1, 2, & 5

7 CAP AREA

7a SUB CAP AREAS

PORE WATER SAMPLING LOCATION

0 200
SCALE IN FEET

RAMBOLL ENVIRON

DRAFTED BY: BJK/MSB/KPM | DATE: 05/22/2015

LONG TERM MONITORING PLAN - SOUTHERN AREA

STUDY AREA 7
JERSEY CITY, NEW JERSEY

FIGURE
1

0220255F3

MSETTER 6/10/15 [0220255_LONG TERM MONITORING PLANS]
F:\0220255\DESIGN 100 PERCENT

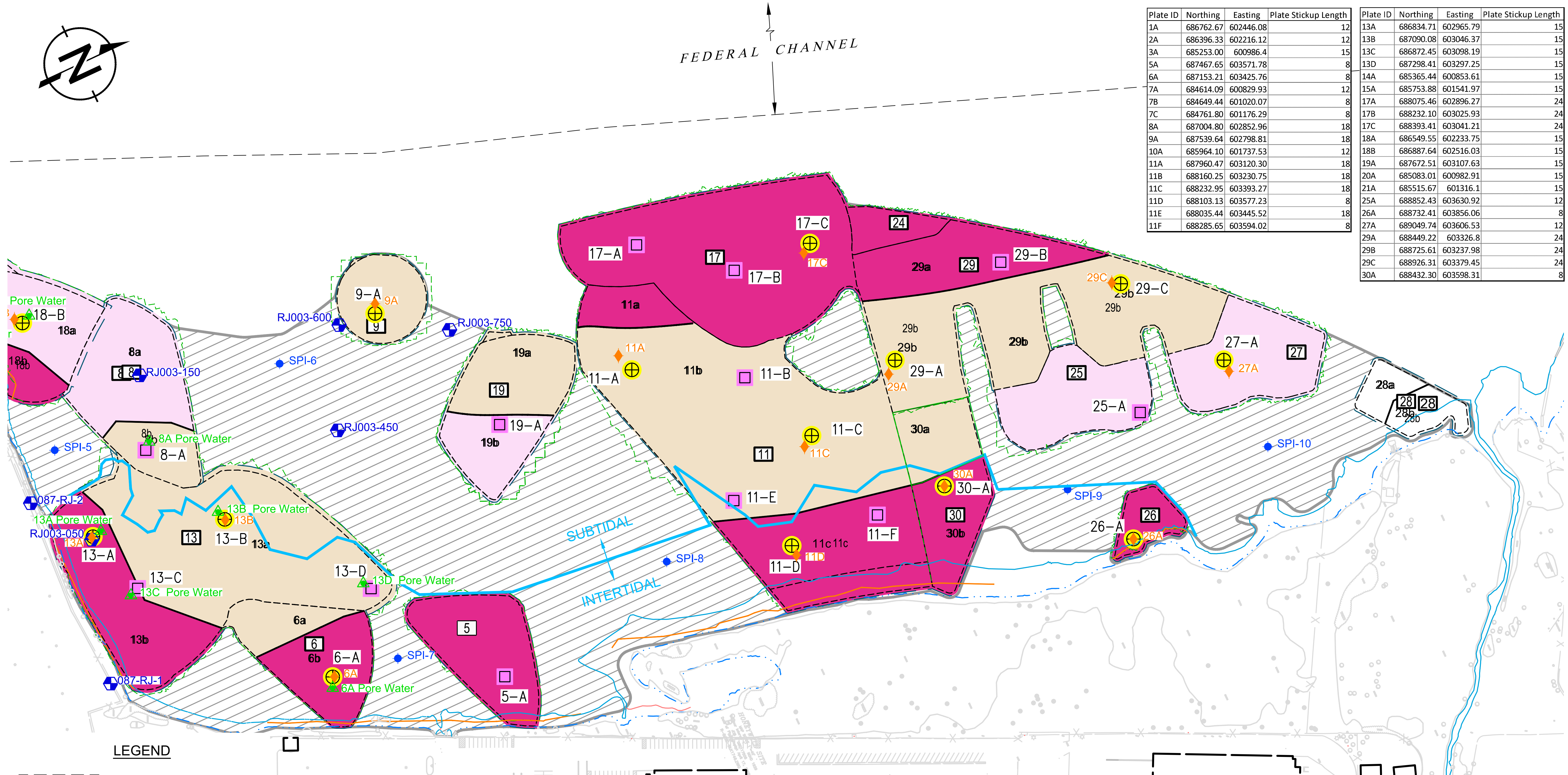

Plate ID	Northing	Easting	Plate Stickup Length
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9A	687539.64	602798.81	18
10A	685964.10	601737.53	12
11A	687960.47	603120.30	18
11B	688160.25	603230.75	18
11C	688232.95	603393.27	18
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13B	687090.08	603046.37	15
13C	686872.45	603098.19	15
13D	687298.41	603297.25	15
14A	685365.44	600853.61	15
15A	685753.88	601541.97	15
17A	688075.46	602896.27	24
17B	688232.10	603025.93	24
17C	688393.41	603041.21	24
18A	686549.55	602233.75	15
18B	686887.64	602516.03	15
19A	687672.51	603107.63	15
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26A	688732.41	603856.06	8
27A	689049.74	603606.53	12
29A	688449.22	603326.8	24
29B	688725.61	603237.98	24
29C	688926.31	603379.45	24
30A	688432.30	603598.31	8

LEGEND

- FEDERAL CHANNEL
- MEAN HIGH WATER LINE (3.52 FT NGVD29)
- EXISTING SHORELINE PROTECTION LIMITS (AS SURVEYED BY SEVENSON ENVIRONMENTAL SERVICES, INC. ON 11/30/2012)
- LOW WATER LINE (APPROXIMATE)
- 7–A AS-BUILT LONG TERM MONITORING PLATE - YEAR 1
- 7–B AS-BUILT LONG TERM MONITORING PLATE - YEAR 5
- GROUNDWATER SAMPLE LOCATION
- BIOLOGICAL SAMPLE LOCATION
- 0.75" ARMOR PLACEMENT
- 1.0" ARMOR PLACEMENT
- 2.5" ARMOR PLACEMENT
- 3.5" ARMOR PLACEMENT
- 10.0" ARMOR PLACEMENT
- MONITORED NATURAL RECOVERY AREA
- PROPOSED SPI INVESTIGATION LOCATIONS - YEARS 1, 2, & 5
- 7 CAP AREA
- 7a SUB CAP AREAS
- PORE WATER SAMPLING LOCATION

0 200
SCALE IN FEET

MSETTER 6/10/15 [0220255_LONG TERM MONITORING PLANS]
F:\0220255\DESIGN 100 PERCENT

RAMBOLL ENVIRON

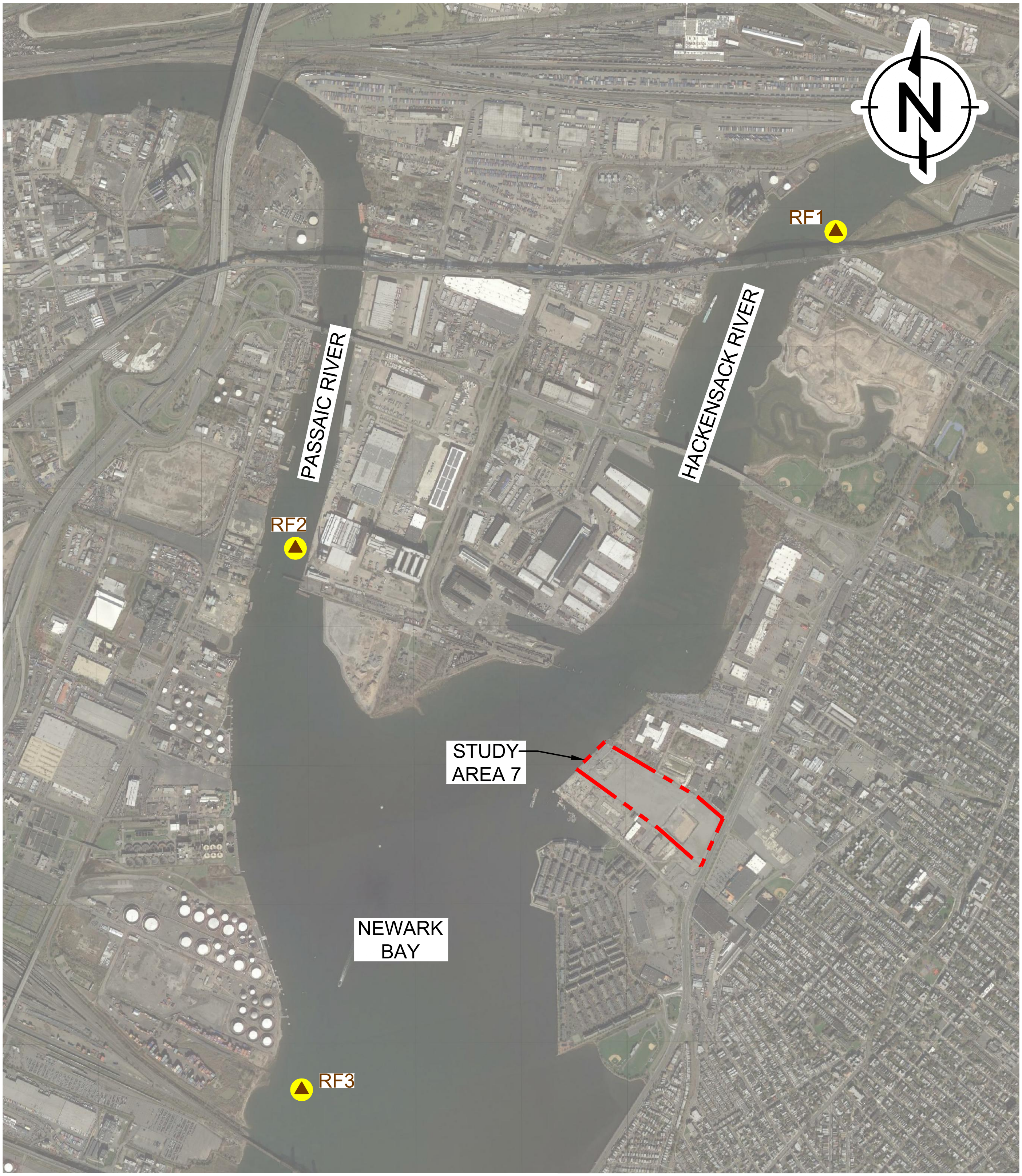
DRAFTED BY: BJK/MSB | DATE: 05/22/2015

LONG TERM MONITORING PLAN - NORTHERN AREA

STUDY AREA 7
JERSEY CITY, NEW JERSEY

FIGURE 2

0220255F3



LEGEND

▲ OFF-SITE BIOLOGICAL BACKGROUND LOCATIONS

0 2000
SCALE IN FEET

SOURCE:
1. AERIAL IMAGE: Google Earth Pro™ , IMAGERY DATED 11/03/2012.

RAMBOLL ENVIRON

OFF-SITE BIOLOGICAL BACKGROUND LOCATIONS
STUDY AREA 7
JERSEY CITY, NEW JERSEY

FIGURE
5

DRAFTED BY: MSB | DATE: 05/22/2015

0220255F3

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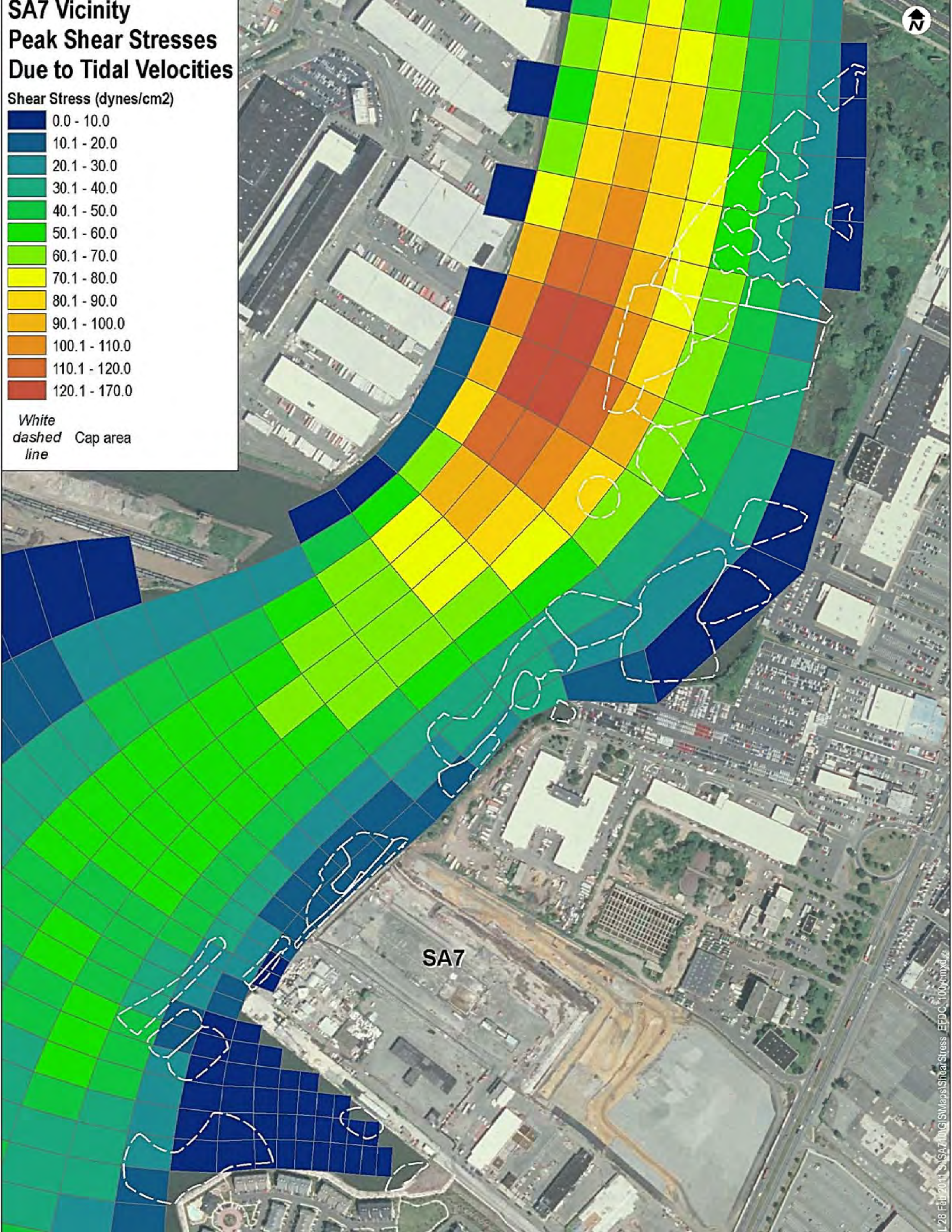
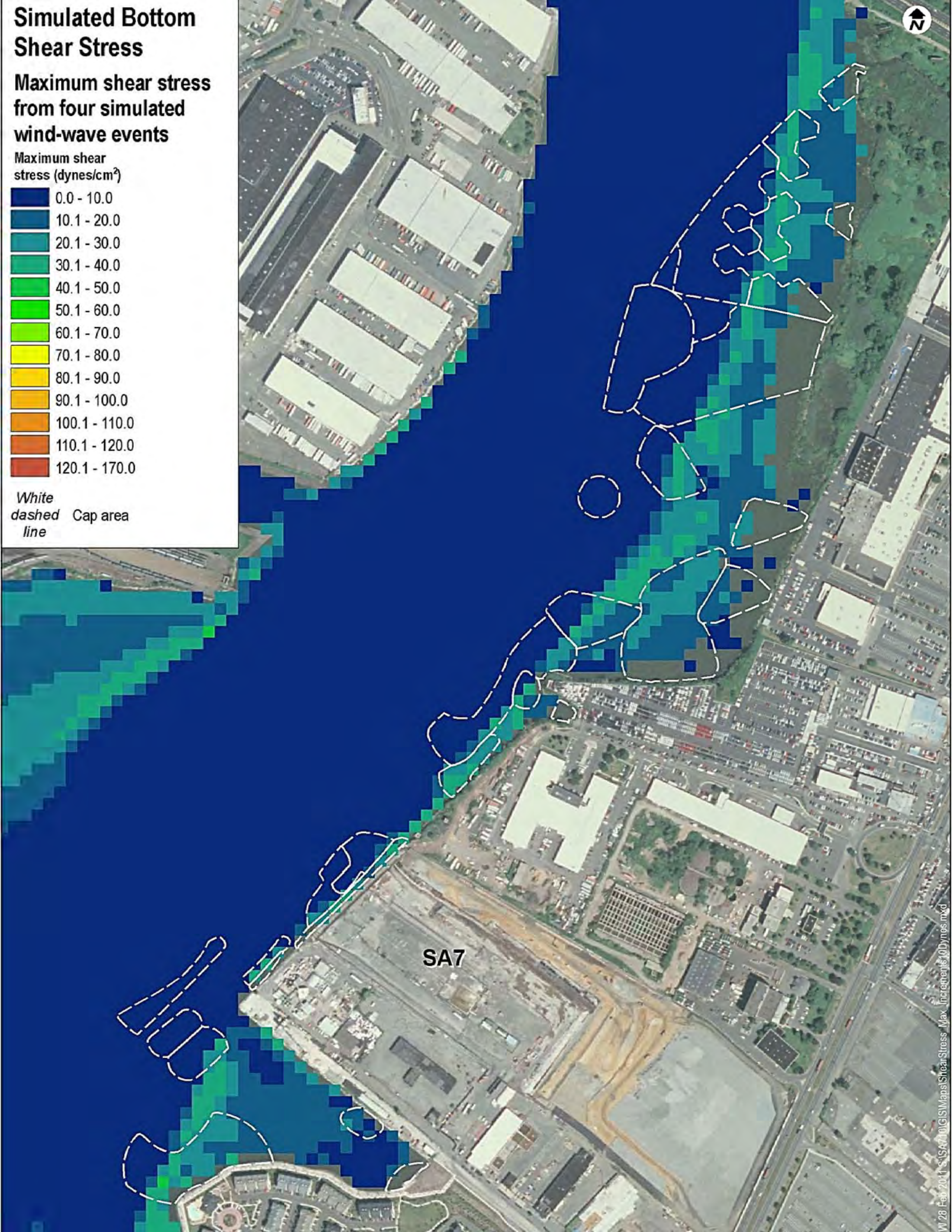
APPENDIX A
Hydrodynamic Modeling Results


SA7 Vicinity
Peak Shear Stresses
Due to Tidal Velocities
Shear Stress (dynes/cm2)
0.0 - 10.0
10.1 - 20.0
20.1 - 30.0
30.1 - 40.0
40.1 - 50.0
50.1 - 60.0
60.1 - 70.0
70.1 - 80.0
80.1 - 90.0
90.1 - 100.0
100.1 - 110.0
110.1 - 120.0
120.1 - 170.0
White dashed line
Cap area
N
SA7
28 Feb 2011 S:\SA7\10\GIS\Maps\ShearStress_EFDC_100yr.mxd



Simulated Bottom Shear Stress
Maximum shear stress from four simulated wind-wave events
Maximum shear stress (dynes/cm²)
0.0 - 10.0
10.1 - 20.0
20.1 - 30.0
30.1 - 40.0
40.1 - 50.0
50.1 - 60.0
60.1 - 70.0
70.1 - 80.0
80.1 - 90.0
90.1 - 100.0
100.1 - 110.0
110.1 - 120.0
120.1 - 170.0
White dashed line
Cap area
N
SA7
W 28 Feb 2011 S:\SA7\10\GIS\Maps\ShearStress_Max_Increments10Dynes.mxd

APPENDIX B
Standard Operating Procedures

ENVIRON International Corporation
STANDARD OPERATING PROCEDURE
#001

DECONTAMINATION PROCEDURE

1.0 DECONTAMINATION OF PUMPS AND BAILERS

Decontamination of sampling equipment is vital in the prevention of cross-contamination. The method used will vary depending on the analytes which are being sampled. Decontamination becomes most significant when sampling for constituents present in the parts per billion or parts per trillion range.

1.1 Portable Pumps (Peristaltic Pump)

Disassemble the pump by unscrewing the discharge-hose adaptor and removing the inlet screen; then, remove the four Phillips screws which secure the pumphead to the motor case (Do not remove the single screw at the base of the motor housing).

Clean the Teflon rotors and the stainless steel in warm detergent solution, using a stiff bristled brush to clean the parts. The hose adaptor, pumphead, screen and screws should also be cleaned and, if deemed necessary, they too may be scoured with a brush. Rinse all parts with tap water. Rinse all parts with 10 percent nitric acid solution. Rinse all parts with distilled water. Reassemble pump and rinse internally and externally with ASTM Type IV or better reagent grade water.

1.2 Submersible Pump

Since these pumps usually remain dedicated to one well, cross-contamination is not a problem. If for any reason the pump is removed or relocated to another well, the decontamination procedures described above should be followed, except that the pump need not be disassembled.

1.3 Bailers

1.3.1 Non-Disposable Bailers

Clean bailer and rope or wire line with warm detergent solution. Rinse with tap water. Rinse bailer with 10 percent nitric acid solution. Rinse bailer and rope twice with distilled water, once with ASTM Type IV or better reagent grade water, drain, and air dry in an uncontaminated area. Place clean bailers and ropes in clean transportation tubes or wrap in clean aluminum foil.

1.3.1 Disposable Bailers

No cleaning is required for the disposable apparatus since it is only used one time and then disposed. Care should be taken to properly dispose of the apparatus.

2.0 DECONTAMINATION OF SAMPLING DEVICES AND TOOLS

2.1 Field Filtration Apparatus

2.1.1 Non-Disposable Filtration Apparatus

Disassemble permanent filtration kit parts, then wash all parts in warm detergent solution, then rinse all parts with tap water, then rinse all parts with 10 percent nitric acid solution, then rinse all parts twice with distilled water, once with ASTM Type IV or better reagent grade water, and then air dry.

2.1.2 Disposable Filtration Apparatus

No cleaning is required for the disposable apparatus since it is only used one time and then disposed. Care should be taken to properly dispose of the apparatus. However, the plastic hose connecting the vacuum pump to the filtration apparatus should be cleaned, as described above, whenever hose contamination is suspected.

2.2 Sample Bottles

All sample bottles should be pre-cleaned at the central laboratory (bacteria bottles, special organic bottles, etc.) and do not require cleaning. The disposable plastic sample bottles should be used directly as obtained from the laboratory, but should receive a field rinse with sample water prior to actual sample collection.

2.3 Water Level Indicator

This device should be cleaned in the office with detergent solution followed by tap water rinse and a final distilled water rinse. Between wells, the level indicator should be rinsed with distilled water.

2.4 Miscellaneous Equipment

For non-dedicated equipment composed of glass, stainless steel, metal or plastic, the following procedure may be used.

Remove gross soil/material with stiff brush and tap water and wash/scrub with non-phosphate detergent and tap water. Rinse thoroughly with deionized water. Complete the final rinse with distilled water, deionized, or organic-free water as appropriate. (Note: Steam cleaning may be substituted and/or added during the decontamination of Hollow Stem Augers or Geoprobe sampling equipment)

SPECIAL NOTE: Whenever sampling equipment is severely contaminated with organics such as oil, special decontamination procedures should be followed. A detergent solution should be used first, if visible contamination remains on the equipment, it may be necessary to use a solvent rinse. Laboratory grade hexane will usually be sufficient to remove most organics. The equipment should then be subjected to the normal cleaning procedure once the solvent residue has been air-dried. Normally, this cleaning procedure will be done in the lab.

ENVIRON International Corporation
STANDARD OPERATING PROCEDURE
#002

PROCEDURE FOR SAMPLING LIQUIDS USING A BAILER OR OTHER TRANSFER DEVICE

1.0 TRANSFER DEVICES

A bailer or other container constructed of inert material, such as stainless steel or Teflon, can be used to transfer liquids from their sources to a sample bottle. Depending upon the sampling application, the transfer vessel can be either disposed or reused. If reused, the vessel should be thoroughly decontaminated prior to sampling a different source.

1.1 Advantages

A bailer or other transfer device is portable and simple to use. The transfer device prevents unnecessary contamination of the outer surface of the sample bottle that would otherwise result from direct immersion into the liquid. Use of this device also prevents sampling personnel from having to physically contact the sample source.

1.2 Disadvantages

Using a bailer makes it difficult to ascertain where within the water column the sample is collected. The disturbance of the water column by the samplers also allows for oxidation of the sample. Due to the low volume that is collected by the bailer, these transfer devices are impractical for removing large volumes of water.

2.0 USES

A bailer/transfer device can be utilized in most sampling situations except those where aeration must be eliminated, such as volatile organic analysis or where significant material may be lost due to adhesion to the transfer container.

3.0 PROCEDURE FOR USE

1. Submerge the bailer or other suitable device with minimal surface disturbance.
2. Allow the device to fill slowly and continuously.
3. Retrieve the device from the liquid with minimal disturbance.

4. Remove the cap from the sample bottle and slightly tilt the mouth of the bottle below the bailer edge.
5. Empty the bailer slowly, allowing the sample stream to flow gently down the side of the bottle with minimal entry turbulence.
6. Continue delivery of the sample until the bottle is almost completely filled.
7. Preserve the sample if necessary as per guidelines/requirements.
8. Check that a Teflon liner is present in the cap (if required). Secure the cap tightly.
9. Label the sample bottle with an appropriate sample tag. Be sure to label the tag carefully and clearly, addressing all the categories or parameters. Record the information in the field logbook and complete a Chain-of-Custody Form.
10. Place the properly labeled sample bottle in an appropriate carrying container maintained at 4°C

ENVIRON International Corporation
STANDARD OPERATING PROCEDURE
#003

SEDIMENT/BIOLOGICAL SAMPLING

Suspended and bedded sediments are defined as particulate organic and inorganic matter that suspend in or are carried by the water, and/or accumulate in a loose, unconsolidated form on the bottom of natural water bodies (USEPA, 2003). For the purpose of this SOP, sediments are generally defined as the materials situated beneath an aqueous or intermittently aqueous layer and can be collected from static (e.g. lake, reservoir, pond, wetland), flowing (e.g. river, stream, estuary), and/or marine systems. Analysis of sediments may be biological, chemical, or physical in nature and may be used to evaluate toxicity, benthic biota, extent and magnitude of chemical contamination, bioavailability of chemical components, contaminant sources, migration pathways,, sediment physical properties (e.g., grain size, plasticity, density, compressibility, strength, etc.), and/or sediment hydraulic characteristics (e.g., porosity, permeability, erodability, etc.).

1.0 EQUIPMENT/MATERIALS

Below is a general checklist of equipment that may be required for typical sediment sampling efforts. Additional equipment may be specified in the project-specific HASP. This checklist includes an overall summary of general equipment for different types of sediment sampling efforts (e.g. grab sampling, core sampling).

1. General Sediment Sampling Equipment Checklist
    - Appropriately-equipped, United States Coast Guard (USCG) certified sampling platform or vessel (e.g., boat or barge equipped with oars, anchor, motor, marine radio, gas tank, tow vehicle, trailer, sampling davit, a-frame, moon pool, etc., as may be required)
    - Appropriate Personal Flotation Devices (PFDs)
    - GPS or other locating device
    - Trash Bags - used to dispose of gloves and any other non-hazardous waste generated during sampling
    - Appropriate waste container – used to dispose of any Investigation Derived Wastes (IDW) and/or decontamination wastes.
    - Lead line or other measuring device for determining water depth at proposed sampling location
    - Local tide chart (if tidal) for establishing water depth to standardized datum (e.g., Mean Lower Low Water **[**MLLW])
    - Tape measure for measuring core length

- Soils classification guidance chart and color chart.

2. Project or Task Specific Sediment Sampling Equipment Checklist
    - Spade, Shovel, Trowel or bucket auger - used for collecting sediment samples from shallow locations
    - Ekman, Van Veen, or Ponar grab sampler
    - Appropriate line (Kevlar, Nylon rope, steel cable, etc.) - for raising and lowering Ekman, Van Veen, or Ponar grab sampler
    - Sediment coring device (tubes, points, drive head, drop hammer)
    - Core liners if appropriate
    - Equipment appropriate tools for adjusting samplers (pliers, wrench, etc.)
    - Mixing bowl/bucket and spoons (stainless steel unless metal analysis will be performed)
3. Miscellaneous Additional Suggested Equipment
    - Extra vehicle keys
    - Waders
    - First aid kit
    - Mobile phone
    - Credit card for gas and emergencies
    - Road and site maps
    - Field notebook and all-weather or permanent pens
    - Camera and extra batteries
    - Field measurement equipment (temperature, dissolved oxygen, etc.)
    - Sample containers (appropriate for various analysis to be performed)
    - Sample labels
    - Labels for Investigation Derived Waste (IDW) containers

A description of sediment sampling equipment is provided in **Attachment A**.

2.0 PROCEDURES

2.1 General Sediment Sampling Guidelines

The following provides a recommended list of practices for sediment sampling activities:

- Where applicable, contact the identified key site personnel upon arrival to the Site and assess proposed work areas.
- Ensure that all equipment/materials required to complete the work have been packed
- Each grab or core attempt, whether for a single sample, composite sample, or replicates, should be taken from undisturbed sediment. Avoid disturbing sediments in the vicinity of the sampling area prior to sampling (e.g., propeller action, equipment use or transiting over sediment surfaces). If possible, approach sites from down current. These practices will help to prevent disturbing and suspending sediment into the water column over the sampling area.

- In general, sediment samples will be collected from beneath an aqueous layer either directly, using a hand held device such as a shovel, trowel, or auger; or indirectly, using a grab sampler or core samplers (refer to **Attachment A** for descriptions of typical sediment sampling equipment).
    - Trowel, or Shovel
        - Ensure that the steel scoop, trowel, or shovel has been decontaminated prior to sample collection.
        - Using the pre-cleaned stainless steel scoop, trowel, or shovel remove equal portions of sample from the sediment surface and immediately below the sediment surface from the sample area using caution not to lose fine grained materials in the transport from sediment across the water column.
    - Bucket Auger
        - Ensure that the bucket auger has been decontaminated prior to sample collection.
        - Remove rocks, twigs, and other non-soil materials from selected sampling area.
        - Position auger bucket barrel on the sediment surface and turn in a clockwise motion until the desired sampling depth is obtained. Unless sampling the surface sediment, this initial augering is only intended to advance the hole to the target depth.
        - Use a second auger to collect the sample at the target depth.
        - When collecting samples at depths greater than 12 inches, it is advisable to discard the upper half of materials in the auger barrel due to material cave in.
    - Ponar/Van Veen/Ekman/box corer grab sampler
        - Ensure that the ponar, Van Veen, Ekman or box corer shovel has been decontaminated prior to sample collection.
        - Set closing mechanism on the grab sampler.
        - Lower the grab sampler through the water column by the nylon rope/line to sediment surface, being careful to avoid tripping the closure mechanism before hitting the bottom. Note that for larger sampling equipment a hoist (i.e., winch, crane, or A-frame) along with a hydraulic or electric winch may also be required.
        - Release the closure mechanism of grab sampler. Closure mechanism differs for different types of grab samplers. Some closures are triggered by a button, others by a slack in the line; others by a sharp tug – read and understand tripping mechanism as part of the Pre-Field Work Preparation activities.
        - Slowly raise the grab sampler to allow adequate time for the clamshell shape to fill with sediment and raise at a steady rate until reaching the surface.
        - Drain excess liquid through screen.
        - Immediately position grab sampler over large tub. If jaws are not completely closed due to obstructions, (i.e. the sampler over-penetrated the sediment (losing material through the top of the sampler), or the sampler otherwise appears disturbed), discard entire grab contents away from the sampling area and re-attempt the sampling. Make sure to move the sampling site several feet away from the previous attempt(s) to avoid sampling a disturbed area.

        - Collect sample from sampling device with decontaminated stainless steel spoon or equivalent and place into the appropriate sample container. Care should be taken to collect material, which has not contacted the sampling equipment's sides.
    - Corer samplers.
        - Detailed instructions for use of these types of sampling devices vary based on the specifications of the equipment manufacturer. Please refer to the standard procedures instruction manual provided with your specific sampling equipment for operating instructions.
        - Transfer the sample into an appropriate sample jar. If sample will be homogenized, see homogenization guidelines in **Section 2.2**.
- Following collection, either in the field or in a field office/laboratory, sediments are transferred from the sampling device to a pre-determined sample container generally provided by the analytical laboratory.
    - Collect samples so as to represent either a grab or composite. A grab sample consists of a single point collected at a specific time. A composite sample consists of two or more homogenized grab samples (see homogenization guidelines in **Section 2.2**).
    - Place appropriate volume of sediment into sample container(s) and store in an ice-filled insulated cooler until end of sampling day (see sample container guidelines in **Section 2.3** and sample transport and storage guidelines in **Section 2.4**).
- Classify soils.

To minimize potential cross-contamination of samples among stations, decontaminate non-dedicated sampling equipment between sampling locations.

2.2 Sample Homogenization Procedures

Homogenization refers to the complete mixing of sediment to obtain uniform color and consistency throughout the sample prior to analyses. Homogenization is typically performed on discrete samples (e.g., several intervals within a core or several cores within a specific sampling interval) to create composite samples and can be done either in the field or the laboratory. Generally, individual samples will not be homogenized in the field.

a. Place grab samples to be homogenized into a large, decontaminated or dedicated container constructed of inert material (i.e., glass, Teflon, or stainless steel) appropriate for the analyses requested.
b. Prior to homogenization, remove large, unrepresentative materials such as twigs, large shells, leaves, stones, wood chips, and seagrass and document materials removed from the sample in the field log.
c. Mix sediment as quickly and efficiently as possible using a clean glass, high density polyethylene, or stainless steel spoon until textural, color, and moisture homogeneity are achieved. Prolonged mixing can alter the particle-size distribution in a sample and cause oxidation of the sediments. Oxidation of the sediments can alter the chemical speciation and bioavailability of constituents.

d. When mixing large amount of sediments, mechanical mixers can be used as long as they are made of stainless steel.

Note that the homogenization procedure should not be used if sediments will be analyzed for volatile organic compounds (VOCs), used for toxicity testing, or would otherwise have the potential to be altered in some fashion by homogenization. Rather, discrete sediment samples shall be collected directly from the sampler.

2.3 Sample Containers

Equipment and sample containers that will come into contact with collected sediments should be constructed of materials that will not affect the concentration of constituents in the sediment sample. The level of care that needs to be taken with the materials used will depend on the level and types of constituents associated with the sediment and the quality assurance needs and study goals. This should be outlined in the project-specific Work Plan/sampling plan or QAPP.

The laboratory will provide appropriate sample containers, however if not provided, pre-cleaned wide-mouth glass jars with Teflon-lined caps are standard for sediment samples. The sample volume is a function of the analytical requirements and will be specified in the Work Plan/sampling plan or QAPP. If possible, jars should be filled to capacity allowing no headspace (unless samples are to be stored frozen in which case some head space is required to allow for sample expansion).

For toxicity testing and bioaccumulation testing sometimes HDPE bags are used to accommodate the large volume requirements and reduce the potential for breakage during shipment. If bags are used, it is generally recommended that samples be double bagged as a precaution against tears.

2.4 Sample Transport and Storage

Samples shall be handled, transported and stored to maintain structural and chemical qualities of sediment samples. If sediment cores are not sectioned or subsampled in the field, they should be covered with site water and stored upright in the core liner for intact transport to the laboratory. Both ends of the core liner should be completely sealed to prevent mixing of the sediments inside. All cores should be kept in an ice-filled transport container during fieldwork and covered to limit light penetration. If the transport container cannot accommodate long core samples such as cores from vibracorers or piston corers, then the core samples can be cut into lengths of 1 meter (3 feet) or less, and the ends securely capped such that no air is trapped inside the liners.

2.5 QA/QC

Quality Assurance/Quality Control (QA/QC) procedures described in the project-specific Work Plan/sampling plan and/or QAPP must be followed throughout the sample collection, processing, handling, and analysis process.

3.0 PRECAUTIONS

All field activities require recording sufficiently detailed information throughout the implementation of field work. However, certain precautions should be taken to ensure safety while sediment sampling.

- Follow USCG approved safety procedures, including the use of PFDs.
- Pay close attention to weather reports and weather advisories issued by the National Weather Service.
- Be cautious of shore or bank failure when collecting samples near the edge of water bodies. It is important to always remain alert and aware of your surroundings.
- Keep any sampler or mooring lines untangled and be cautious of slips, trips, and falls while working on boats and near water.
- When working on or near water, all field staff should utilize the "buddy system" and should ensure that the project-specific HASP includes safety measures and procedures for water work.
- If surface water sampling is to be performed, sediment samples must be collected after all overlying water samples have been collected.
- If the Work Plan/sampling plan requires metals analysis, the sample can be collected from the central portion of the sampling device (i.e., not touching the metal part of the sampler) with a clean glass, high density polyethylene, or stainless steel spoon, and the rest of the sample discarded.
- The homogenization procedure should not be used if sediments will be analyzed for VOCs, used for toxicity testing or would otherwise have the potential to be altered in some fashion by homogenization. In this case, multiple grab samples of sediment should be transferred directly from the sample collection device to the sample container.

4.0 RECORDKEEPING

Document all sampling locations and record all information in accordance with ENVIRON's SOP

ATTACHMENT A - SEDIMENT SAMPLING EQUIPMENT

Sediment sampling equipment can be broadly categorized as grab samplers or core samplers. Grab samplers are typically used to collect surface or near-surface sediment samples, while cores are normally used to collect subsurface sediment samples. Following are brief descriptions of the more commonly used sediment sampling equipment.

Grab Samplers

There are two general categories of grab samplers: hand held samplers (trowels, shovels, buckets augers, etc.) and mechanical samplers (e.g., Ponar, Van Veen, Ekman samplers, box corers, etc.). Grab samplers, unlike corers, generally disturb the soil structure and may result in mixing of the upper sediments with that at lower depths within the sampling device. As such, they are not suitable for collection of samples for volatile organic analysis or some geotechnical testing.

- Hand trowels and shovels are generally used for surface sampling. They are available in different sizes and makes. Non-coated or non-plated stainless steel is generally the preferred material of construction (if appropriate for the analysis to be conducted), however other materials may be applicable in certain cases (e.g., polyethylene for trace element sampling in sediments). Care should be exercised to avoid using devices plated with chrome or other materials to prevent metals contamination of the collected samples.

Figure 1 Hand Augers
Source: NJDEP Field Sampling Procedures Manual (2005)

- Hand or bucket augers are typically used to collect samples within the upper foot. The bucket or hand auger consists of an enclosed or partially enclosed stainless steel cylindrical body with sharpened spiral blades on the bottom. The top of the auger has a stainless steel frame that allows installation of threaded extension rods and a T-handle. The auger cylinder diameter varies, but is generally 12 inches long. Samples are collected in the cylindrical body by rotating the auger clockwise by its T-handle. This motion moves loosened soil upward within the auger barrel as it cuts into the soil.

Figure 2: Ponar Dredge
Source: NJDEP Field Sampling Procedures Manual (2005)

- The Ponar dredge is a center pivot device used for collection of surface sediment samples. They are best suited for hard bottoms (sand, gravel, consolidated marl or clay) and are made of stainless steel construction. The shell is opened and latched in place prior to deployment and then slowly lowered to the sediment surface. When tension is released on the lowering cable, the latch releases and the lifting action of the cable attached to the center pivot closes the device. The sampling action of these devices may temporarily suspend some settled solids; however, disturbance of sediments can be minimized by controlling the rate at which the sampler the contacts the sediment surface.

Figure 3 Van Veen Sampler
Source: GrabCAD.

- The Van Veen grab sampler is a clamshell pivot device used for collection of soft surface sediment samples. The Van Veen sampler has long lever arms and a screened top with a neoprene rubber flap (to allow water flow during deployment and prevent sample loss during retrieval). The levers and buckets at their ends are opened and locked in place prior to deployment and then slowly lowered to the sediment surface. When the sampler comes in contact with the sediment surface, the lever arms are unlocked, and when the lowering cable is tensed again, the levers close the device. The long lever arms allow the Van Veen sampler to cut deep into sediment.

- The Ekman grab sampler is a center pivot device used for collection of surface sediment samples. They are best suited for soft, debris-free sediments (i.e., vegetation and coarse materials may prevent the sampler from properly closing) and environments with shallow water and little current. As the sampler is lowered into the water column, the two thin, hinged overlapping lids open to let water pass through. The flaps close when a drop-weight is dropped (cable operated) or a button is pressed (rod operated). During retrieval, the overlapping lids closed and are held shut by water pressure to reduce washout. The Ekman grab samplers are made of stainless steel and vary in size.

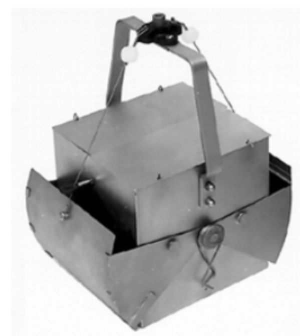


Figure 4: Ekman Sampler
Source: NJDEP Field Sampling Procedures Manual (2005)

- The box corer is a box-shaped center pivot device designed to work in hard bottoms more easily and safely than spring-powered grab samplers. The corer is deployed within a frame, which is brought to rest at the sediment surface. Heavy weights are then added to the frame to lower the open-ended box into the sediment. Due to its weight (the device can weigh over 100 lbs.) the box corer requires the use of a winch. Upon retrieval, a bottom door or spade swings underneath the sample to prevent sample loss.

Figure 4 Box Sampler
Source: Wildco.com

Core Samplers

Core samplers (corers) are used to obtain sediment samples: (a) for geological characterizations and dating; (b) to investigate the historical input of contaminants to aquatic systems; (c) for geotechnical testing; (d) to vertically delineate contamination at a site; and/or (e) where it is important to maintain an oxygen-free environment, because core samplers limit sediment contact with the atmosphere. Core samplers are generally less disruptive than grab samplers and are used for projects in which it is critical to maintain the integrity of the sediment profile (e.g., some geotechnical testing or volatile organic analysis). Unlike grab samplers, core samplers allow for discrete sampling of intervals of interest and collection of samples at greater depths. However, core samplers provide less sample volume than grab samplers.

- Push corers consist of a replaceable clear rigid core barrel (Lexan® or polycarbonate) secured to a stainless steel, carbon steel or PVC body, which houses the one-way check valve. The one-way check valve permits the barrel to free flush during deployment and also by creating a partial vacuum to prevent sample wash out during retrieval through overlying water. Thus, the corer retains the sample without using core catchers and nosepieces. Extension rods can be used to sample sediments in up to 20 feet of water. Sediment samples are collected by manually driving the device into the sediment. Since neither core catchers not nosepieces are used with this sampling equipment, if granular materials are being sampled, the core will need to be pushed until a cohesive soil "plug" is captured at the bottom of the core. Thus, they are best suited for soft cohesive sediments.

Figure 5 Push or Hand Corer
Source: Rickly Hydrological Co.

- Gravity corers consist of a stainless steel or carbon steel pipe (i.e., barrel) with a replaceable core liner made of stainless steel, Lexan®, or PVC (among others). The bottom of the barrel consists of a sharpened replaceable carbon steel core cutter (to ensure minimal sample disturbance), which is fitted with a core catcher (to minimize sample loss). A set of heavy weights that sit on top of the pipes and are the driving mechanism during sampling (i.e., head weight). For sample collection, the corer is attached to a winch using a wire rope and allowed to free-fall into the sediments. Gravity corers can be used for recovering up to 3 meter-long cores (approximately 10 feet) from soft, fine-grained sediments. For studies in which metals are a concern, stainless steel liners should not be used.

Figure 6 Garvity Corer
Source: Mooring Systems, Inc.

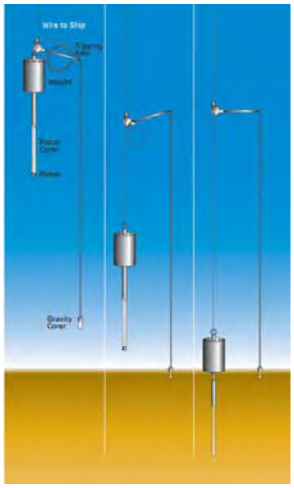


Figure 8 Piston Corer
Source: Woods Hole Oceanographic Institution

- Piston corers are enhanced gravity corers differing in that they incorporate a release mechanism that triggers the final free fall penetration, allowing the collection of longer, less disturbed and more complete sediment samples. The release mechanism consists of a trigger weight or core that extends beyond the end of the core barrel. The trigger weight is connected to the head weight on the barrel core through a trigger arm. When the trigger weight touches the sediment bed, the trigger arm releases the weight on the main barrel allowing it to free fall into the sediment. Piston corers are especially useful when sampling softer sediments and a higher level of precision is required for evaluating depositional layers.

- Vibracorers consist of a hydraulic, pneumatic or electric-powered, mechanical vibrating mechanism to a sampling core is attached. The core, which could consist of clear rigid cores (Lexan® or polycarbonate) or a stainless steel, carbon steel or aluminum barrel with a replaceable soft or rigid liner, is driven into sediment by the force of gravity, enhanced by vibration energy. The vibrator, located at the head end of the corer, creates a high frequency (8,000 to 11,000 vibrations per minute), low amplitude (few millimeters) pattern of vertical vibrations which enhances core penetration into the sediment. Vibracores are appropriate for collecting thick sediment samples (up to approximately 15 meters). Vibracoring is generally quicker, less labor intensive, and allows for collection of longer and more representative cores than other sediment sampling equipment

Figure 7 Vibracore
Source: Aqua Survey, Inc.

Detailed instructions for use of these types of sampling devices vary based on the specifications of the equipment manufacturer. Please refer to the standard procedures instruction manual provided with your specific sampling equipment for operating instructions.

ENVIRON International Corporation
STANDARD OPERATING PROCEDURE
#004

SURFACE WATER SAMPLE COLLECTION

1.0 Scope and Application

The purpose of this Standard Operating Procedure (SOP) is to provide protocols for collecting representative surface water samples. This procedure can be applied to the collection of surface water samples from ponds, streams, rivers and other surface water bodies.

If multiple surface water samples are to be collected from a flowing surface water body, samples will be collected from the furthest point downstream, moving upstream as the sampling progresses to minimize water turbidity. Surface water samples will be collected before sediment samples to minimize the turbidity of the surface water.

2.0 Materials

- Laboratory-provided, contaminant-free sample bottles
- Multi-probe water quality meter for measuring pH, temperature, conductivity, and turbidity
- Global Positioning System (GPS)
- Marine vessel for deep surface water collection
- Hip or chest waders for shallow surface water collection
- Field Log book
- Indelible ink pen

3.0 Procedure

Unpreserved sample containers will be rinsed with the sample water prior to collection.

3.1 Hold the bottle upside down and immerse the top of the bottle several inches under the water, then turn the bottle upright to fill. This will prevent floating debris or surface film from entering the sample.

3.2 Remove the bottle from the water, transfer the appropriate sample volumes to the pre-preserved sample bottles, and cap.

3.3 Surface water samples should be immediately stored at 4°C.

3.4 Conductivity, pH, temperature, DO, ORP, and turbidity will be measured before and after sample collection using a multi-probe water quality meter.

3.5 For the surface water samples, mark the sampling locations on a site map. Photograph (if desired) and describe each location. Record the following: depth of water at the location, as-built coordinates of the sampled location, and other field observations.

3.6 If samples are to be collected at specific depths, other surface water sampling devices such as Van Dorn Bottles, HydraSleeves, or peristaltic pumps should be used.

4.0 Precautions

4.1 Use PFDs during surface water sampling

4.2 Personnel wearing waders and entering water bodies should be certain of their footing so not to slip while in the water.

4.3 Decontaminate the sampling equipment between sampling locations.

4.4 Avoid disturbing the surface water during submersion of the sample bottles.

4.5 Refer to Health and Safety Plan (HASP) for appropriate health and safety precautions during surface water sample collection activities.

5.0 References

NJDEP, 2005. NJDEP Field Sampling Procedures Manual.

New Jersey "Technical Requirements for Site Remediation (N.J.A.C. 7:26E, November 4, 2009)"

ENVIRON International Corporation
STANDARD OPERATING PROCEDURE
#005

PORE WATER SAMPLING

The purpose of this Standard Operating Procedure (SOP) is to provide protocols for collecting representative pore water samples. This procedure can be applied to the collection of pore water samples from ponds, streams, rivers and other surface water bodies.

1.0 Materials

- Laboratory-provided, contaminant-free sample bottles
- Global Positioning System (GPS)
- Multi-meter probe
- Marine vessel
- Hip or chest waders for collection of pore water samples in shallow areas
- Solinist® Drive Point Piezometer or equivalent groundwater push point
- Peristaltic pump
- Polyethylene or Teflon®-lined tubing
- Sampler Field Log book
- Indelible ink pen

2.0 Procedure

Unpreserved sample containers will be rinsed with the sampled pore water prior to collection.

2.1 At the sampling location, install new polyethylene or Teflon®-lined tubing and drive the Solinist® Drive Point Piezometer to the target depth.

2.2 Connect a peristaltic pump to the tubing from the Solinist® Drive Point Piezometer.

2.3 Measure field sampling parameters (pH, conductivity, dissolved oxygen, temperature, and oxidation-reduction potential) connecting a multi-meter probe in-line the pore water being sampled.

2.4 Before collecting the pore water sample, purge any air or surface water sample in the tubing.

2.5 Withdraw the pore water sample into laboratory supplied bottles.

2.6 New tubing should be used and decontamination procedures should be performed on sampling equipment before a new sample is collected.

2.7 Pore water samples should be immediately stored at 4°C.

2.8 For the pore water samples, mark the sampling locations on a site map. Photograph (if desired) and describe each location. Record the following: depth of water at the location, as-built coordinates of the sampled location, and other field observations.

3.0 Precautions

3.1 Use PFDs during pore water sampling

3.2 Personnel wearing waders and entering water bodies should be certain of their footing so not to slip while in the water.

3.3 Decontaminate the sampling equipment between sampling locations.

3.4 Refer to Health and Safety Plan (HASP) for appropriate health and safety precautions during surface water sample collection activities.

ENVIRON International Corporation
STANDARD OPERATING PROCEDURE
#006

GENERAL SOILS DESCRIPTIONS AND CLASSIFICATIONS

1.0 INTRODUCTION

Soil types may vary drastically at a site, and proper soil(s) identification can be essential to the completion of many projects. Monitoring well constructions and soil borings usually involve some sort of soil sampling. This sampling can be very useful toward determining potential contaminants, their concentrations, the extent of contaminant dispersion within the soil medium, likely routes of contaminant migration (including surface runoff) and the threat to human health by ingestion (both directly as soil and/or uptake into food crops).

2.0 SOIL DESCRIPTIONS

All field samples should be described according to color, texture, type, moisture condition and consistency or degree of compactness. The attached table is provided as an aid to making the proper soil identifications in the field.

2.1 Recording Procedures

Soil description should be recorded in the field logbook in accordance with the QAPP. In addition to the parameters listed above and those in the attached soil characteristics table, field personnel should be aware of and record in the field log book specific details with respect to sampling, such as: the method of soil sampling and/or drilling methods used; the percentage of recovery for soils and rock; caving of the borehole; depth where water was encountered during soil boring; depth of water at completion of soil boring; and difficulties encountered during the drilling process.

3.0 IMPORTANCE

In addition to the determination of potential contaminants in the soil matrix, selected samples may be analyzed for physical properties. This is often accomplished as an aid to engineering design. Such analyses are often for grain size, Atterberg limits, plasticity, in-situ permeability and moisture content. Proper description in the field can aid these laboratory determinations.

SOIL CHARACTERISTICS

COLOR	PARTICLE	SIZE (mm)	COMPOSITION	SHAPE/ SORTING	MODIFIERS	MOISTURE	CONSISTENCY	BLOWS/6"	CHARACTERISTICS
							CLAYS		
Grey	Clay	< 0.002	Trace 1-10%	Well	Stratified	Dry	Very Soft	2	Easily Squeezed
Brown	Silt	0.2 - 0.002	Some 11 - 25%	Poor	Laminated	Damp	Soft	2 - 4	Molded by light finger pressure. Molded by strong finger pressure.
Blueish	Sand	2.0 - 0.2	With 26 - 40%	Flat	Fissured	Wet	Med. Stiff	4 - 8	Can be indented by thumb. Can be indented by thumbnail.
Yellowish	Gravel	20 - 2.0	And 41 - 50%	Elongated	Polished	Saturated	Stiff	8 - 15	
Greenish	Cobbles	60 - 200		Angular	Blocky		Very Stiff	15 - 30	
Reddish	Boulders	> 200		Subangular	Lensed		Hard	> 30	
Mottled				Subrounded	Weathered		SANDS		50 mm peg easy to drive. 50 mm peg difficult to drive.
Light				Rounded	Cemented		Very Loose	4	Need pick for excavation. 50 mm peg very hard to drive.
Dark				Rough	Odor (Describe)		Loose	5 - 10	
				Smooth	Homogenous		Med. Dense	11 - 30	
					Heterogenous		Dense	31- 50	
					Plastic		Very Dense	> 50	

Soil Descriptions:
Descriptions may include all or some of the items listed above. Order may be rearranged.

Example: Stiff, mottled grey-brown silty clay with trace of sand, damp, plastic, with slight petroleum odor.

ENVIRON International Corporation
STANDARD OPERATING PROCEDURE
#007

FIELD RECORDS

1.0 INTRODUCTION

An important component of field investigations is the proper documentation of activities, observations, field measurements, calibration verification, etc. The following section is intended to give direction as to what the physical nature of a field record should be, suggestions for content and management and eventual disposition of records.

An accurate, at hand, up-to-the-moment (not at the end of the day) diary is essential for:

- Regulatory requirements;
- Problem identification;
- Report preparation;
- Accuracy; and
- Voucher to client.

2.0 PROCEDURES OF USAGE

2.1 Directives

For all field activities, you must

- Obtain a hard-bound field logbook from the field investigation manager.
- Use one field logbook per site/survey, i.e., do not use the same logbook for concurrent different projects.
- Store the field logbook in the vehicle only when in the field; otherwise store it in the office.
- Never keep personal records as opposed to "official" records.
- Never give your field logbook to anyone (NOTE: You may, however, have to provide it and copies to regulatory representatives).
- Photocopy or scan each days log as a back-up.

2.2 Requirements for Field Logbooks and Entries

- Field logbooks should be hard-bound, containing sequentially numbered pages.
- All entries should be made using non-erasable waterproof ink.

- Once generated, field logbooks should not be discarded or replaced.
- Pages should never be torn out of field logbooks.
- All errors should be corrected by crossing out the mistake with a single line. The correction should then be dated and initialed by the person correcting the error.
- All entries should be direct and succinct. Do not speculate.
- One field logbook per site is preferred; however, several logbooks may be needed for each piece of field analytical equipment (e.g., pH, DO, HNu, CGI, conductivity) or field personnel.

2.3 Calibration Book

A separate calibration book should be maintained for each instrument that requires routine calibration. Page 1 of each calibration book should list a unique instrument ID No., manufacturer and model, date purchased, date in service, a maintenance schedule by the manufacturer or appropriate technician, and calibration procedures and specifications. Thereafter, calibration data should be entered as follows:

Date/Hour (24 hour clock-military time), location, person, appropriate environmental data (e.g., wind, temp ^{o}C), calibration method, reading, and OK or no, depending upon whether or not calibration procedures were successful.

Field Measurements should be entered in the following manner:

Date, hour, person, location, reading(s), comments.

Calibration requirements are specified in the operating procedures for the specific instrument. These requirements may be clarified or amplified in the QAPP for the particular site.

2.4 Field Logbook Entry Requirements

Field Logbook Entries must include, when appropriate:

- date and time of entry
- purpose of sampling
- name and address of field contacts (Federal, State, Local)
- producer of waste and address (e.g., drum labels)
- type of process producing waste
- sketch of site - use to make base maps, locate sample site, photos, etc.
- type of waste (sludge, soil, wastewater, locate sample site, photos, etc.)
- description of sample
- waste components and concentrations
- number and size of sample taken
- description of sample point and markers

- date and time of sample collection
- collector's sample identification numbers
- references
- maps
- field observations
- field measurements (e.g., pH, DO)
- C-O-C seal numbers; and comments

ENVIRON International Corporation
STANDARD OPERATING PROCEDURE
#008

SAMPLE IDENTIFICATION SYSTEM

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to define protocols for the use of sample labels. Every sample will have a sample label uniquely identifying the sampling point and analysis parameters.

2.0 MATERIALS

- Laboratory Sample Label
- Indelible black ink pen
- Clear tape

3.0 PROCEDURE

The following steps describe how to use the sample labeling system:

1. Fill out a sample label. Enter the following information on each label in indelible black ink:

    - Project name and two digit site identifier, if applicable (e.g., ABC-BI);
    - Sample location/sample ID;
    - Sampling date and time;
    - Analyses to be performed;
    - Preservative; and
    - Sampler.

    Field personnel will be required to write the sample ID on the sample label. The sample ID will consist of an alphanumeric describer that will identify the site name, sample type, sample location, sample depth (for non-aqueous media) and sample date (for aqueous media). The first three identifiers in the sample name will consist of a three-letter acronym for the Site, as detailed in the QAPP. This will be followed by a dash and a two digit code corresponding to the property at which samples are being collected (e.g., "BI" for Button Industries), if appropriate per the QAPP. This will be followed by a dash and two or three digit code designating the type of sample. Some of the codes that will be used are:

    - Monitoring Well (permanent) – MW;
    - Monitoring Well (temporary) – TW;

- Rinse Blanks – RB;
- Sediment Sample – SED;
- Soil Boring – SB;
- Trip Blank – TB; and
- Rinse Blanks – RB.

Following the sample location code will be a two digit numeric designation indicating a unique location for that type of sample (e.g., SB01 or MW02). For aqueous media (i.e., groundwater, surface water, QA/QC samples), this will be followed by a six digit numeric code indicating the date the sample was collected (yymmdd). For example, a groundwater sample collected from temporary well number 8 at Button Industries on February 6, 2010 would be designated as "*ABC-BI-TW08-100206*". Non-aqueous samples such as soil and sediment samples will utilize a four digit SS01, SS02, SS03, etc. designation which corresponds to the sample depth. For example, shallow and deep soil samples collected from soil boring location 12 at Button Industries would be designated as "*ABC-BI-SB12-SS01*" and "*ABC-BI-SB12-SS02*", respectively.

In the event that multiple samples are collected on the same day from the same location (for example a duplicate), additional digit(s) will be added to the end of the date for both samples. A second sample collected from temporary well number 8 on February 6, 2010 would be designated as "*ABC-BI-TW08-100206-2*".

Additional sample volumes collected for matrix spike (MS) and matrix spike duplicate (MSD) analysis will be noted on the chain-of-custody (COC) forms, and the associated additional sample containers will be labeled with the appropriate suffix (MS or MSD). Field duplicates will be labeled as ordinary field samples with a unique identification number. Duplicate samples will not be identified and the laboratory will analyze them as "blind" quality control samples.

2. Double-check the label information to make sure it is correct. Detach the label, remove the backing and apply the label to the sample container. Cover label with clear tape.

3. Record the sample ID in the field logbook, along with the following sample information:

   - Time of sample collection (each logbook page should be dated).
   - The location of the sample in relation to reference points.
   - Field screening measurements (e.g., PID readings), when appropriate.
   - Any unusual or pertinent observations (e.g., staining, odors, apparent presence of oily sheen, etc.)
   - Whether the sample is a QC sample (i.e., split sample or field duplicate).
   - The laboratory chain of custody number.

4. Place the sample in the designated sample cooler. Make sure there is plenty of ice in the cooler at all times. Maintain the samples at 4±2°C from the time of sample collection until delivery to the laboratory.

ENVIRON International Corporation
STANDARD OPERATING PROCEDURE
#009

CHAIN OF CUSTODY PROCEDURES

1.0 INTRODUCTION

Possession of samples must be traceable from container storage, sample collection, transportation, and laboratory receipt to and through lab handling. To maintain and document sample possession, Chain-of-Custody (C-O-C) procedures are as follows.

2.0 SAMPLE CUSTODY DEFINITIONS

A sample is under custody if:

- it is in your possession, or
- it is in your view, after being in your possession, or
- it was in your possession and you locked it up, or
- it is in a designated secure area.

3.0 FIELD CUSTOY PROCEDURES

- Obtain appropriate containers for the collection and transport of samples (e.g. from locked storeroom or laboratory supplied).
- The field sampler is personally responsible for the care and custody of the samples collected until they are properly transferred or dispatched.
- The field sampler is personally responsible for generating the C-O-C form (Figure 1) <u>as samples are collected</u>.
- Sample labels/tags must be completed for each sample using waterproof ink, unless prohibited (notation required).
- The lead investigator or field operations manager determines whether proper custody procedures were followed and if additional samples are required.

4.0 TRANSFER OF CUSTODY AND SHIPMENT

- All samples are to be accompanied by a C-O-C record. Sections A-F must be completed at the time of sample collection.
- When transferring possession, individuals relinquishing and receiving will sign, date, and note the military time on the record.
- The original C-O-C form shall stay with the receiver and a copy (whenever possible) should be retained by the relinquisher.
- Samples will be packaged properly for shipment and dispatched to the appropriate lab for analysis with a separate C-O-C for each shipment. The containers may need to be

sealed/locked in some cases (see Custody Seals). The method of shipment, courier name(s), and other pertinent information is entered in the "Remarks" section of the C-O-C form.

5.0 SPLIT SAMPLES

Whenever samples are split with a source or government agency, a separate Receipt for Samples form shall be prepared for those samples and marked to indicate with whom the samples are being split. The person relinquishing the samples to the facility or agency should request the signature of a representative of the appropriate party acknowledging receipt of the samples. If a representative is unavailable or refuses to sign, this shall be noted in the "Received by" space of the C-O-C form. When appropriate, as in the case where the representative is unavailable, the custody record shall contain a statement that the samples were delivered to the designated location at the designated time.

6.0 LABORATORY CUSTODY PROCEDURES

- A designated sample custodian shall accept custody of the shipped samples and verify that the information on the sample tags matches those on the C-O-C records.
- Pertinent information as to shipment, pickup, courier, etc., entered in the "Remarks" section.
- The custodian should enter the sample tag data into a bound logbook per laboratory procedures.
- Lab custodian will use the sample tag number or assign a unique number to each tag and assume that all samples are transferred to the proper analyst or stored in the appropriate secure area.
- Lab personnel are responsible for the care and custody of the samples from the time they are received until the sample has been exhausted or returned to the custodian.
- When analyses and necessary QA checks have been completed the unused portion of the sample must be disposed of properly. All identifying data sheets and lab records shall be retained as part of the permanent documentation. Samples will be retained until after analyses and QA checks are completed.

7.0 CUSTODY SEALS

- Custody seals may be specified by the client and/or regulatory agency but are not a standard requirement. Possible methods are padlocks, serially numbered seals, unnumbered seals, and evidence tape. Where appropriate numbers should be cross-referenced between field notebook and C-O-C form(s). If unnumbered or evidence tape, it should be signed and dated by the field sampler.
- When samples are shipped, two or more seals are placed on each shipping container (such as a cooler), with at least one at the front and one at the back, located in a manner that would indicate if the container were opened in transit. Wide, clear tape should be placed over the seals to ensure that seals are not accidentally broken during shipment. Nylon packaging tape may be used providing that it does not completely cover the

custody seal. Completely covering the seal with this tape may allow the label to be peeled off. Alternatively, evidence tape may be substituted for custody seals.

- If samples are subject to interim storage before shipment, custody seals or evidence tape may be placed over the lid of the jar or across the opening of the storage box. Custody during shipping would be the same as described above. Evidence tape may also be used to seal the plastic bags or metal cans that are used to contain samples in the cooler or shipping container. Sealing individual sample containers assures that sample integrity will not be compromised if the outer container seals are accidentally broken.

8.0 FIGURE 1: CHAIN OF CUSTODY

CHAIN OF CUSTODY / ANALYSIS REQUEST

Page ____ of ____

Name (for report and invoice)	Samplers Name (Printed)	Site/Project Identification
Company	P. O. #	State (Location of site): NJ: ☐ NY: ☐ Other Regulatory Program:
Address	Analysis Turnaround Time Standard ☐ Rush Charges Authorized For: 2 Week ☐ 1 Week ☐ Other ☐ ____	ANALYSIS REQUESTED (ENTER 'X' BELOW TO INDICATE REQUEST)
City State		LAB USE ONLY Project No:
Phone Fax		Job No:

Sample Identification	Date	Time	Matrix	No. of. Cont.											Sample Numbers
Preservation Used: 1 = ICE 2 = HCl, 3 = H_2SO_4, 4 = HNO_3, 5 = NaOH 6 = Other ____ 7 = Other ____				Soil: Water:											

Special Instructions ____ Water Metals Filtered (Yes/No)? ____

Relinquished by 1)	Company	Date / Time	Received by 1)	Company
Relinquished by 2)	Company	Date / Time	Received by 2)	Company
Relinquished by 3)	Company	Date / Time	Received by 3)	Company
Relinquished by 4)	Company	Date / Time	Received by 4)	Company

184045

ENVIRON International Corporation
STANDARD OPERATING PROCEDURE
#010

PROCEDURES FOR PERFORMING UNDERGROUND UTILITY MARKOUT

1.0 PURPOSE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to define protocols for clearing an area of utilities and other potential subsurface hazards prior to drilling and other intrusive subsurface activities. This work will be conducted using site knowledge and a combination of ground penetrating radar and radiodetection methods. Ground penetrating radar (GPR) systems produce cross-sectional images of subsurface features and layers by continuously emitting pulses of radar-frequency energy from a scanning antenna as it is towed along a survey profile. The radar pulses are reflected by interfaces between materials with differing dielectric properties. The reflections return to the antenna and are printed on a strip chart recorder or displayed on a video monitor as a continuous cross section in real time. Since the electrical properties of metallic tanks, pipes, and wastes are distinctly different from soil and backfill materials, metallic targets produce dramatic and characteristic reflections. Fiberglass, plastic, concrete, and terracotta targets as well as subsurface voids, rock surfaces, soil type changes and concentrations of many types of non-metallic wastes also produce recognizable, but less dramatic reflections. Radiodetection methods include: (a) CAT & Genny pipe and cable location system; and (b) a Radiodetection RD400 digital PDL-2 cable and pipe locator and RD433HCTx-2 transmitter. The CAT & Genny detects any electrically conductive materials by creating an electromagnetic field with a transmitting coil. The field strength is measured by a receiving coil at a fixed separation from the transmitter. As the instrument is swept along the ground surface, subsurface conductive bodies distort the transmitted field. The change in field strength is sensed by the receiver, setting off an audible alarm. The RD400/RD433 can be directly coupled to exposed portions of a pipe, or indirectly (inductively) to a subsurface metallic utility of known location/orientation. RD433 transmitter produces an electromagnetic field around the metallic utility at a frequency selected by the operator (512 Hz, 8 kHz, 33 kHz, or 65 kHz), which is received at the ground surface by the PDL-2 locator.

2.0 MATERIALS

- Geophysical Survey Systems, Inc. (GSSI) Subsurface Interface Radar (SIR)-2 or SIR-2000 GPR digital control unit with a liquid crystal display and an internal hard drive, and a 500 or 200 mega Hertz scanning antenna, depending on site conditions.
- Radiodetection CAT & Genny Pipe and Cable Locator
- Radiodetection RD400 digital PDL-2 Pipe and Cable Locator and RD433HCTx-2 transmitter
- Spray Paint

- Wire-Stem Vinyl Flags

3.0 PROCEDURE

The following procedure shall be adhered to for clearing an area of utilities and other potential subsurface hazards prior to drilling and other intrusive subsurface activities:

1. Contact One-Call service to identify utility lines entering the property.
2. Contact property owner and obtain site drawings/maps/b1ueprints showing buried utilities, pipes, underground storage tanks, and other potential subsurface hazards.
3. Walk property with property owner and discuss possible drilling and excavation locations and potential access problems or subsurface hazards.
4. Use information from above to select specific sites for drilling/excavation.
5. Before drilling or excavation begins, drilling contractor will survey for underground utilities and structures the area within a 10-foot diameter of the proposed subsurface exploration point. GPR and/or pipe and cable locators capable of penetrating to a depth of at least 6 feet will be used. Potential drilling sites with suspected subsurface metal present will be avoided, and a new location at least five feet away will be similarly cleared.
6. If GPR or radiodetection targets are identified, they will be marked on the ground surface using wire-stem vinyl flagging and/or semi-permanent spray paint.
7. Drilling will proceed at a location only after clearance has been completed.

ENVIRON International Corporation
STANDARD OPERATING PROCEDURE
#011

TRIMBLE PATHFINDER PRO XRS GLOBAL POSITIONING SYSTEM

1.0 INTRODUCTION

The Trimble Pathfinder Pro XRS Global Positioning System (GPS) is a versatile, real-time GPS mapping tool that combines a GPS receiver, an MSK beacon differential receiver, and a satellite differential receiver in a single housing.

The GPS is a satellite-based positioning system operated by the United States Department of Defense. Over 24 operational NAVSTAR satellites orbit the earth every 12 hours, providing worldwide, all-weather, 24-hour time and position information.

GPS can be useful for a number of geographical position and mapping data collection, including wetland plots and boundaries, ecological, archaeological, historical or geological features of interest, relocation of previously sampled plots, area calculations and mapping, etc.

2.0 PROCEDURES FOR USE

Refer to the attached GPS Pathfinder Systems Receiver Manual for specific operating instructions and detailed specifications for the Trimble Pathfinder XRS GPS receiver.

ENVIRON International Corporation
STANDARD OPERATING PROCEDURE
#012

WASTE HANDLING PROCEDURES

1.0 OBJECTIVES

The objective of this standard operating procedure is to establish consistent methods to handle and manage all Investigation-Derived Waste (IDW), including:

- Solid waste, both hazardous and non-hazardous (e.g., soil cuttings, contaminated debris or equipment)
- Liquid waste both hazardous and non-hazardous (e.g., purge water, rinse water from decontamination, product removal)
- Personal Protective Equipment (e.g., gloves, spent respirator cartridges, chemical resistant coveralls)

This SOP provides procedures and standards that are in addition to applicable regulatory requirements and industry standards.

2.0 APPLICABILITY

Investigation sampling activities may generate solid, liquid, and Personal Protective Equipment (PPE) waste. The IDW Handling Procedures SOP will be implemented primarily on-site.

3.0 RESPONSIBILITY

The *Project Manager*, or designee, will have the responsibility to oversee and ensure that the IDWs are properly handled and managed in accordance with this SOP and any site-specific or project-specific planning documents.

Field personnel will be accountable for the comprehension and implementation of this SOP during all field activities, as well as obtaining the appropriate field logbooks, forms, labels, records and equipment needed to complete the field activities.

4.0 DEFINITIONS

<u>Designated Waste</u>: A solid or liquid waste which is not defined as hazardous, but which still may present a threat to groundwater, and which requires handling differently than a non-hazardous inert waste.

D.O.T.: – Department of Transportation. Typically referred to when specifying a type of container that is approved for transporting hazardous substances, either materials or waste, on streets.

Hazardous Waste: Soil, liquid, or other wastes generated from site investigations that exhibit toxic (human or ecological effects), ignitable, corrosive, or reactive characteristics as defined by applicable state or federal regulation or which is otherwise classified as hazardous. Such waste requires special handling and documentation of disposal.

IDW: – Investigation Derived Waste. Typically solid (e.g., soil) or liquid (e.g. groundwater, decontamination fluids) wastes resulting from field activities.

Non-hazardous Waste: A waste that does not exhibit characteristics of a hazardous waste and which is not otherwise classified as hazardous. Non-hazardous waste can be designated as inert waste.

PPE: – Personal Protective Equipment. Worn by workers when potential for exposure to hazardous materials exists.

HASP: – Health and Safety Plan. Plan written to coordinate and outline precautions that will be taken to initiate and monitor worker safety.

5.0 REQUIRED MATERIALS

The equipment and supplies required for implementation of this SOP include the following:

- Containers for waste (e.g., 55-gallon open and closed top drums) and material to cover waste to protect from weather (e.g., plastic covering)
- Equipment (i.e., pumps, generators, water/interface level indicators, safety monitoring equipment)
- Hazardous /non-hazardous waste drum labels (weatherproof)
- Permanent marking pens
- Inventory forms for project file
- Plastic garbage bags, zip lock storage bags, roll of plastic sheeting
- Steel-toed boots, chemical resistant gloves, coveralls, safety glasses, and any other PPE required in the site-specific HASP.

6.0 PROCEDURES

6.1 Labeling

Containers used to store IDW must be properly labeled. Two general conditions exist: 1) from previous studies or on-site data, waste characteristics are known to be either hazardous or nonhazardous; or 2) waste characteristics are unknown until additional data are obtained.

For situations where the waste characteristics are known, the waste containers should be packaged and labeled in accordance with state and federal regulations that may govern the labeling of waste.

The following information shall be placed on all non-hazardous waste labels:

- Description of waste (i.e., purge water, soil cuttings);
- Contact information (i.e., contact name and telephone number);
- Date when the waste was first accumulated.

The following information shall be placed on all hazardous waste labels:

- Description of waste (i.e., purge water, soil cuttings);
- Generator information (i.e., name, address, contact telephone number);
- EPA identification number (supplied by on-site client representative);
- Date when the waste was first accumulated.

When the final characterization of a waste is unknown, a notification label should be placed on the drum with the words "waste characterization pending analysis" and the following information included on the label:

- Description of waste (i.e., purge water, soil cuttings);
- Contact information (i.e., contact name and telephone number);
- Date when the waste was first accumulated.

Once the waste has been characterized, the label should be changed as appropriate for a nonhazardous or hazardous waste.

Waste labels should be constructed of a weatherproof material and filled out with a permanent marker to prevent being washed off or becoming faded by sunlight. It is recommended that waste labels be placed on the side of the container, since the top is more subject to weathering. However, when multiple containers are accumulated together, it also may be helpful to include labels on the top of the containers to facilitate organization and disposal.

Each container of waste generated shall be recorded in the field notebook used by the person responsible for labeling the waste. After the waste is disposed of, either by transportation off-site or disposal on-site in an approved disposal area, an appropriate record shall be made in the same field notebook to document proper disposition of IDW.

6.2 Solid Waste

Soil cuttings from boreholes will typically be shoveled back into the borehole after drilling is complete and do not require special handling. Drilling mud generated during investigation activities shall be collected in containers. Covers should be included on the containers and must be secured at all times and only open during filling activities. The containers shall be labeled in accordance with this SOP. An inventory containing the source, volume, and description of material put in the containers shall be logged on prescribed forms and kept in the project file. Non-hazardous solid waste can be disposed on-site in the designated site landfill or in a designated evaporation pond if it is liquefied. Hazardous wastes must be disposed off-site at an approved hazardous waste landfill.

6.3 Liquid Waste

Groundwater generated during monitoring well development, purging, and sampling can be collected in truck-mounted containers and/or other transportable containers (i.e., 55-gallon drums). Lids or bungs on drums must be secured at all times and only open during filling or pumping activities. The containers shall be labeled in accordance with this SOP. Non-hazardous liquid waste can be disposed of in one of the designated lined evaporation ponds on-site. Hazardous wastes must be handled separately and disposed off-site at an approved hazardous waste facility.

6.4 Personal Protective Equipment (PPE)

PPE that is generated throughout investigation activities shall be placed in plastic garbage bags. If the solid or liquid waste that was being handled is characterized as hazardous waste, then the corresponding PPE should also be disposed as hazardous waste. If not, all PPE should be disposed as non-hazardous waste in the designated on-site landfill. Trash that is generated as part of field activities may be disposed of in the landfill as long as the trash was not exposed to hazardous media.

6.5 Waste Accumulation On-Site

Solid, liquid, or PPE waste generated during investigation activities that are classified as nonhazardous or “characterization pending analysis” should be disposed of as soon as possible. Until disposal, such containers should be inventoried, stored as securely as possible, and inspected regularly, as a general good practice.

Solid, liquid, or PPE waste generated during investigation activities that are classified as hazardous shall not be accumulated on-site longer than 90 days. All hazardous waste containers shall be stored in a secured storage area. The following requirements for the hazardous waste storage area must be implemented:

- Proper hazardous waste signs shall be posted as required by any state or federal statutes that may govern the labeling of waste;

- Secondary containment to contain spills;
- Spill containment equipment must be available;
- Fire extinguisher;
- Adequate aisle space for unobstructed movement of personnel.

Weekly storage area inspections shall be performed and documented to ensure compliance with these requirements. Throughout the project, an inventory shall be maintained to itemize the type and quantity of the waste generated.

6.6 Waste Disposal

Solid, liquid, and PPE waste will be characterized for disposal through the use of client knowledge, laboratory analytical data created from soil or groundwater samples gathered during the field activities, and/or composite samples from individual containers.

All waste generated during field activities will be stored, transported, and disposed of according to applicable state, federal, and local regulations. All wastes classified as hazardous will be disposed of at a licensed treatment storage and disposal facility or managed in other approved manners.

In general, waste disposal should be carefully coordinated with the facility receiving the waste. Facilities receiving waste have specific requirements that vary even for non-hazardous waste, so characterization should be conducted to support both applicable regulations and facility requirements.

6.7 Waste Transport

A state-certified hazardous waste hauler shall transport all wastes classified as hazardous. Typically, the facility receiving any waste can coordinate a hauler to transport the waste. Shipped hazardous waste shall be disposed of in accordance with all RCRA/USEPA requirements. All waste manifests or bills of lading will be signed either by the client or the client’s designee, which can in special circumstances be the project manager if acting as an authorized agent for the client.