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October 27, 2016

Gary Klawinski
Director, Hudson River Field Office
U.S. Environmental Protection Agency, Region 2
187 Wolf Road, Suite 303
Albany, New York 12205

(Two paper copies (one unbound) and one electronic copy)

Re: Hudson River PCBs Superfund Site
Remedial Action Consent Decree (Civil Action No.1:05 CV-1270)
Revised Surface Sediment Sampling Work Plan for 2016

Dear Mr. Klawinski:

On October 17, 2016, GE submitted a *Surface Sediment Sampling Work Plan for 2016* (2016 Sediment Sampling Plan). At EPA's request, that Plan described GE's plans to conduct the first year of one component of the long-term operation, maintenance, and monitoring (OM&M) program for sediments in 2016. That component is the sampling of surface sediments in non-dredge areas. (The Plan also stated that, if weather conditions remain favorable after completion of the non-dredge area sampling, and there is sufficient time to allow completion of the sampling of dredge areas, GE and EPA will consider sampling in dredge areas in 2016.)

On October 24, 2016, EPA advised GE that the 2016 Sediment Sampling Plan is acceptable to EPA with the understanding that certain EPA comments attached to that communication would be addressed in a revised version of the Plan. Enclosed is a revised version of the 2016 Sediment Sampling Plan which addresses EPA's comments.

As we have discussed, with EPA's approval, GE will begin the 2016 sediment sampling on October 31, 2016.

Please confirm that the attached revised Plan adequately addresses EPA's comments, and let me know if you have any questions about this matter.

Sincerely yours,

Robert G. Gibson

Robert G. Gibson
Senior Project Manager

Enclosure

cc:

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WORK PLAN

SURFACE SEDIMENT SAMPLING WORK PLAN FOR 2016
HUDSON RIVER PCBS SUPERFUND SITE

Prepared for

General Electric Company

Albany, New York

Prepared by

Anchor QEA, LLC

290 Elwood Davis Road, Suite 340

Liverpool, New York 13088

October 2016 – Revised

SURFACE SEDIMENT SAMPLING WORK PLAN FOR 2016
HUDSON RIVER PCBS SUPERFUND SITE

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October 2016 – Revised

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LIST OF ACRONYMS AND ABBREVIATIONS

°F	degrees Fahrenheit
Be-7	Beryllium-7
COC	chain-of-custody
CU	Certification Unit
DDS	Downstream Deposition Study
DQO	Data Quality Objective
DSR	Data Summary Report
EPA	U.S. Environmental Protection Agency
GE	General Electric Company
GPS	Global Positioning System
MS/MSD	matrix spike/matrix spike duplicate
OM&M	operation, maintenance, and monitoring
PCB	polychlorinated biphenyl
Phase 2 OMM Scope	*Operation, Maintenance, and Monitoring Scope for Phase 2 of the Remedial Action*
Phase 2 RAM QAPP	*Phase 2 Remedial Action Monitoring Quality Assurance Project Plan*
PPE	personal protective equipment
RA	Remedial Action
RAMP	Remedial Action Monitoring Program
SOP	standard operating procedure
SOW	*Statement of Work for Remedial Action and Operations, Maintenance and Monitoring*
SSAP	Sediment Sampling and Analysis Program
TOC	total organic carbon
Tri+ PCB	PCB with three or more chlorine atoms
WFS OMM Plan	Long-Term Operation, Maintenance, and Monitoring Plan for Water, Fish, and Sediment Monitoring

1 INTRODUCTION

The revised *Statement of Work for Remedial Action and Operation, Maintenance, and Monitoring* (SOW; EPA 2010a), which was issued by the U.S. Environmental Protection Agency (EPA) in 2010 under the Consent Decree for the Hudson River PCBs Superfund Site, requires the General Electric Company (GE) to conduct a long-term operation, maintenance, and monitoring (OM&M) program following the completion of the Remedial Action (RA) at the Site, which involved dredging of sediments in the Upper Hudson River. The overall scope of the OM&M program was set forth in the *Operation, Maintenance, and Monitoring Scope for Phase 2 of the Remedial Action* (Phase 2 OMM Scope; EPA 2010b), which is Attachment E to the SOW. The required post-remediation OM&M activities described in the Phase 2 OMM Scope include long-term water column, fish, and sediment monitoring to assess long-term recovery, as well as monitoring of the sediment caps and stabilization measures installed in certain dredge areas and of the habitat replacement/reconstruction implemented in various areas of the Upper Hudson River. The OM&M activities for the caps, stabilization measures, and constructed habitats are described in separate OM&M plans that have been submitted to EPA on an annual basis during the RA. The long-term water column, fish, and sediment monitoring activities to be conducted as part of the OM&M program will be described in a Long-Term Operation, Maintenance, and Monitoring Plan for Water, Fish, and Sediment Monitoring (WFS OMM Plan), to be submitted to EPA in 2017.

In the meantime, at EPA's request, GE has agreed to conduct the first year of one component of the required OM&M sediment sampling program in 2016. As provided in the Phase 2 OMM Scope, the OM&M sediment sampling program involves the collection and analysis of surface sediment samples in both non-dredge areas and dredge areas in the Upper Hudson River. The Phase 2 OMM Scope also requires the performance of bathymetric surveys in "Select Areas" that exceeded the sediment removal criteria but were not targeted for removal because they were buried by cleaner sediments. As discussed with EPA, GE will conduct the first year of the required surface sediment sampling in non-dredge areas in 2016. This work plan describes that sampling. In the event that weather conditions remain favorable after completion of the non-dredge area sampling, and sufficient time remains that will permit completion of the sampling of dredge areas, GE and EPA will consider undertaking the sampling in the dredge areas in 2016. Otherwise, the sampling of the dredge areas will occur in 2017 under the WFS OMM Plan, as noted below.

The remainder of the long-term water, fish, and sediment OM&M program will be described in the WFS OMM Plan. Those activities will include water and fish monitoring, the other sediment-related monitoring (i.e., the backfill sampling in dredge areas [if not conducted in 2016] and the bathymetric survey of Select Areas) to begin in 2017, and the future rounds of sediment sampling in both non-dredge and dredge areas.

The 2016 surface sediment sampling in non-dredge areas, as described in this work plan, will be conducted in accordance with the requirements specified in the Phase 2 OMM Scope, with certain modifications specified by EPA or agreed upon by EPA and GE (e.g., a revision in the number of samples based on an EPA design analysis discussed below, omission of Beryllium-7 (Be-7) analysis from the initial sampling round in non-dredge areas). The primary purpose of this initial round of post-remediation sampling in non-dredge areas is to collect data to establish baseline post-dredging concentrations of polychlorinated biphenyls (PCBs) in such areas for use as a point of comparison in later sediment sampling rounds to estimate the rate of sediment recovery in such areas.

It should be noted that, although the Phase 2 OMM Scope specified that two additional rounds of surface sediment sampling would be performed at 3-year intervals after which GE would make a proposal regarding continuation of the program, it is anticipated, based on discussions with EPA, that the spacing of the future sampling rounds will be increased to 5-year intervals, consistent with a sampling design analysis provided by EPA, which is presented in Attachment A. Specifically, the next round of sediment sampling in non-dredge areas will be conducted in 2021 and the next round of sediment sampling in dredge areas will also be conducted in the same year.

2 SAMPLING AND ANALYSIS PROCEDURES

2.1 Overview of Program

This section describes the sediment sampling and analysis program that GE will perform in non-dredge areas in 2016 for the long-term OM&M. Under this program, surface sediment samples will be collected at locations outside of dredge areas in the Upper Hudson River. The number of samples and the sampling locations were selected by EPA, based on the EPA sampling design analysis presented in Attachment A. Sample collection protocols, analytical methods, and data management procedures will be generally consistent with those specified in the *Phase 2 Remedial Action Monitoring Quality Assurance Project Plan* (Phase 2 RAM QAPP; Anchor QEA and ESI 2012), with the modifications described in this work plan.

2.2 Data Quality Objectives

The Data Quality Objectives (DQOs) for the overall long-term sediment monitoring program, as specified in Section 2.3.1 of the Phase 2 OMM Scope, are as follows:

- Determine post-remediation PCB levels in sediments in non-dredge areas of the Upper Hudson River.
- Provide data on Select Areas that exceeded the removal criteria but were not targeted for removal because they were buried by cleaner sediments to assess whether the deposits have experienced erosion.
- Determine sediment recovery rates in non-dredge areas of the Upper Hudson River.
- Examine the changes to surface PCB concentrations in backfill areas.

The last 3 of these DQOs are not addressed by this work plan. Data to assess the second DQO will be collected as part of sampling efforts conducted in 2017.

As noted above, the specific objective of the 2016 round of sediment sampling described in this work plan for non-dredge areas is to obtain PCB data in such areas for the purpose of establishing baseline post-remediation PCB concentrations. These data will then be used as a point of comparison in future sediment sampling events to evaluate recovery rates in non-dredge areas. Specifically, the data collected will be used to calculate the mean surface PCB concentration in each River Section (RS1, RS2, and RS3) while attempting to meet precision targets. This will allow for comparison of future average concentrations in each River Section to those baseline levels to determine the rates of recovery in the sediments. As stated in Attachment A, the data will be used to quantify post-remedial average PCB concentrations in sediment, to quantify changes in sediment concentrations over time, and to support investigation of relationships among fish, water, and sediment during the post-remedial monitoring time period.

2.3 Measurement Performance Criteria

Surface sediment samples will be collected during the 2016 sampling event at 226 locations in non-dredge areas, as specified by EPA. The sample locations in each River Section are identified below. Samples will be collected from the top 2 inches of sediment at each location. A Van Veen sampler equipped with a landing frame will be used to collect the samples, generally consistent with the procedures used in the Remedial Action Monitoring Program (RAMP) Downstream Deposition Study (DDS) from 2011 through 2013, excluding the compositing procedure. A ponar dredge or Ekman sampler may be used if the Van Veen sampler is not successful. The analytical program will include analysis for Aroclor PCBs and total organic carbon (TOC). In addition, as described further in Section 2.5, GE will provide EPA with split samples (one for every 10 samples collected), at locations where sufficient sample volume is available, for EPA to conduct PCB congener analysis by Method 1668. As further discussed in Section 2.5, GE will also provide a split sample to EPA at every location (where sufficient sample volume is available) for archival for possible subsequent grain size analysis by GE, as determined through coordination by GE and EPA.

Measurement performance criteria for precision, accuracy/bias, representativeness, comparability, completeness, and sensitivity have been established for the sampling and analytical procedures and are summarized in Tables A4-1a through A4-1c in Attachment A to the Phase 2 RAM QAPP, as revised and re-submitted on March 29, 2016, and again on September 29, 2016 (ESI 2016). Aroclor PCB concentrations will be quantified using Method GEHR8082. The PCB Aroclor data will be converted from Total PCBs to Tri+ PCBs (PCBs with three or more chlorine atoms), using the regression model presented in *Corrective Action Memorandum No. 3 – Modification of Sediment Residual Monitoring Program – Discontinuing mGBM Analysis of Sediment Samples and Updates of the Regression*

Coefficients (Anchor QEA 2011), to estimate the Tri+ PCB concentrations in the non-dredge areas and to facilitate interpretation of the data.

2.4 Sampling Locations

EPA has specified certain changes to the number of surface sediment samples listed in the Phase 2 OMM Scope based on its revised design analysis in Attachment A. Specifically, based on its analysis in Attachment A, EPA has specified the collection of a total of 226 surface sediment samples in non-dredge areas, along with 149 samples in dredge areas, divided among the three River Sections. The target number of samples in non-dredge areas in each River Section, as specified by EPA, is shown in Table 2-1.

The specific surface sediment sample locations were selected by EPA, using a randomized sampling design, avoiding locations that are too close to (within 25 feet of) the boundary of a dredged Certification Unit (CU) to ensure that the location is in a non-dredge area. The primary target sample locations are shown in Figure 2-1, and their coordinates are provided in Table 2-2. Backup locations have also been provided in the event that samples cannot be collected at the primary locations. Those backup locations are also shown in Figure 2-1, and their coordinates are provided in Table 2-3.[1]

The selected sampling locations were designed to avoid sampling in unsafe locations, such as near dams. However, if the sampling crew determines that, at a particular location, other conditions on the river would make sampling unsafe, a backup location may be selected or the location may need to be abandoned. This will be done in consultation with EPA. The selected sampling locations were also designed to avoid bedrock areas where sediment is not present. Such bedrock areas will be incorporated into the calculation of the River Section PCB means in accordance with a methodology that will be developed at a later date.

[1] Dredge area boundaries shown in Figure 2-1 do not account for the dredge to daylight. When using a backup location, the field team will follow the SOP presented in Attachment B; however, at locations that are near CU boundaries (i.e., within 25 feet) precedence will be given to locating the point in the designated "strata" (i.e., non-dredge sediment). Therefore, the field team may select a sampling location that is further outside the CU boundary than the actual target locations, but will remain within 25 feet of the target.

2.5 Constituents

The surface sediment samples will be analyzed for Aroclor PCBs and TOC. Additionally, GE will provide EPA with split samples as sample volume permits. One split sample for every 10 samples collected will be provided to EPA for analysis by EPA of PCB congeners by Method 1668. An additional split sample will be collected at every sampling location and provided to EPA for archival at the laboratory for potential subsequent grain size analysis by GE. GE and EPA will coordinate to determine which samples will be analyzed for grain size. If sufficient sample volume is not available to fill all of the containers at a sampling station, filling the 4-oz. sample collection jar for Aroclor PCB and TOC analysis will be prioritized at all locations. As sample volume permits, a second 4 oz. jar (for congener analysis by Method 1668) will be filled at locations selected by EPA, followed by a container for grain size analysis (at all locations). If sample volume is insufficient to fill either container for the split samples, the split sample(s) will be collected at one of the next planned sampling locations where sufficient volume is available, as designated by EPA.

The analytical methods to be used for Aroclor PCBs and TOC are described in standard operating procedures (SOPs) submitted to EPA on March 29, 2016 as appendices to revised Attachment A to the Phase 2 RAM QAPP, as discussed further in Section 2.10 below. The SOP for grain size distribution analysis is presented in Attachment C to this work plan.

2.6 Sampling Methods

Surface sediment samples will be collected in accordance with the SOP presented in Attachment B, which is based generally on methods followed for the DDS, as described in Appendix 9.3.1 to the Phase 2 RAM QAPP. One notable exception is that each sample will be submitted individually for analysis (composites will not be formed). A summary of sample collection, handling, and analyses is included in Table 2-1. The sampling vessel will navigate to within approximately 10 feet of the target sampling location using a Differential Global Positioning System (DGPS), taking care to ensure that the sampling location is outside the boundary of any dredged CU. At backup locations that are near CU boundaries (i.e., within 25 feet) precedence will be given to locating the point in the designated "strata" (i.e., non-dredge sediment). Therefore, the field team may select a sampling location that is further outside the CU boundary than the actual target locations, but will remain within

25 feet of the target. The vessel will be held in position with spuds during sample collection. A Van Veen sampler equipped with a landing frame will be lowered in the open position until the landing frame comes to rest on the surface of the river bed. The landing frame will be adjusted to limit penetration to 2 inches, and the jaws of the sampler will penetrate the sediment under its own weight. The sampler will then be triggered and brought gently back to the surface for processing. A ponar dredge or Ekman sampler may be used if the Van Veen sampler is not successful.

If the sampler appears to have not functioned properly (e.g., debris prevents jaws from fully closing), the material within the sampler will be discarded, and additional attempts to collect a sample will be made. Upon collection of a satisfactory sample, any standing water on top of the material in the sampler will be removed, and the depth of material recovered will be recorded. The sampler will then be placed in a clean aluminum pan, opened, and the sediment allowed to fall into the pan. The recovered sediment will be photographed in the aluminum pan. The sediment will then be mixed prior to being transferred to sample containers using a clean utensil. Sample containers and sample handling procedures will be consistent with those specified in the Phase 2 RAM QAPP. Unused sediment will be returned to the river.

2.6.1 Inaccessible Locations

In the event that a sampling location is inaccessible due to the location being too close to shore, the field crew will navigate as close to the location as water depth will allow and attempt to collect the sample. The actual sampling coordinates will be recorded in the field database. Locations that are inaccessible due to shallow water or inaccessible due safety concerns in response to high flows will relocated to the next available backup location within the same 1-mile river subsection. This adjustment will be done in consultation with the EPA field representative.

2.6.2 Locations with Insufficient Sediment

Insufficient sediment is defined as a location where either no sediment can be recovered (e.g., bottom is bedrock) or it is impracticable to analyze the materials retained by the sampler due to size (e.g., gravel-sized stones, shale fragments). Based on input from the analytical laboratory, materials larger than approximately 1 inch will not be retained for analysis. This is because the maximum particle size that the microwave extraction apparatus can process is restricted to slightly less than 1 inch. Larger stones and rock fragments typically do not contain detectable concentrations of PCBs. If sufficient material less than 1 inch cannot be obtained in 3 attempts at a sampling location, the sampling point will be abandoned and sampling will be attempted at the next available backup location within the same 1-mile river subsection. If sufficient material less than 1 inch cannot be obtained in 3 attempts at the backup sampling location, that sampling point will be abandoned and the field crew will move on to the next primary location. The information on sediment collection attempts for both locations will be recorded in the field database. The value to be used to represent the surface PCB concentration(s) at the abandoned location(s) when calculating the River Section averages will be determined at a later date.

Field data, including the actual coordinates of each sampling location and a description of the sediment, will be recorded in the surface sediment field database. Examples of a data entry form, field log, and chain-of-custody (COC) form are provided in the Phase 2 RAM QAPP. Decontamination procedures for sampling equipment are specified in Section 2.8.

2.7 Sediment Type Characterization

A brief description of the physical characteristics of each sample will be recorded in the field database using the visual classification procedures specified in the Sediment Sampling and Analysis Program (SSAP; ESI and QEA 2002). These characteristics will include the general soil type (fine sand, medium sand, coarse sand, gravel, silt, clay, and organic/other matter such as wood chips), presence of observable biota, odor, and color. The visual classifications will be recorded in the field database, as noted in Section 2.6, and included in the data exports. In addition, a photograph of each sample will be logged. As discussed in Section 2.5, GE will provide EPA with split samples at locations with sufficient material after the collection of PCB samples for potential analysis of grain size distribution by GE. GE and EPA will coordinate to determine which samples will be analyzed for grain size.

2.8 Decontamination

Sampling equipment that comes into contact with sediment and will be reused will be decontaminated in the field prior to reuse according to the following procedures:

- Rinse with river water and a scrub brush to remove all visible sediment; and then
- Rinse with distilled water.

Disposable materials that come into contact with sediment, such as personal protective equipment (PPE), will be collected and stored prior to appropriate off-site disposal.

2.9 Equipment Testing, Inspections, and Maintenance

Specific equipment that will be tested, inspected, and maintained by the contractor for the surface sediment sampling includes:

- Van Veen dredge with landing frame
- Ponar dredge
- Ekman dredge
- PPE according to Health and Safety Plan requirements
- DGPS and depth sounder
- Sampling vessel
- Log sheets/book
- Laptop computer and printer
- Label maker
- Sediment processing materials
  - Aluminum pans
  - Stainless steel spoons or equivalent
- Camera
- Probing rod
- Decontamination supplies

- Investigation-derived waste containers
- Sample containers, coolers, and ice

Field equipment will be maintained in accordance with the manufacturers' recommendations. Critical spare parts and supplies will be supplied by the contractor and kept on hand to minimize down time during this study. These items include, but are not limited to, all of the above-mentioned items.

It is not anticipated that instrumentation that requires calibration will be used during the surface sediment sampling study; the inspection, testing, and maintenance procedures described above are expected to be sufficient to ensure that equipment is in proper working order.

2.10 Analytical Procedures

Each sample will be analyzed in the laboratory for Aroclor PCBs using Method GEHR8082 and for TOC using the Lloyd Kahn Method. Analytical procedures for those parameters are described in the SOPs submitted on March 29, 2016 as Appendices A4-1 and A4-3 through A4-7 to Attachment A to the Phase 2 RAM QAPP (ESI 2016).[2] These SOPs are generally consistent with the methods in the comparable SOPs included in the initial Attachment A to the Phase 2 RAM QAPP; however, they reflect minor updates implemented by the analytical laboratory. (As noted above, EPA will conduct the analyses for PCB congeners using Method 1668.) The samples to be analyzed for grain size distribution will be analyzed using ASTM D422-63 in accordance with the SOP presented in Attachment C.

For PCB analyses via Method GEHR8082, Performance Evaluation samples will not be prepared and analyzed as discussed in Section 11.2.1 of the Phase 2 RAM QAPP. Instead, matrix spike/matrix spike duplicate (MS/MSD) samples will be prepared and analyzed at a

[2] These SOPs were included in the March 29, 2016 revision of Attachment A of the Phase 2 RAM QAPP. Although that Attachment A was revised and re-submitted on September 29, 2016 in response to comments from EPA, these specific sediment-related SOPs were not included in that revision since no comments were received on them. Thus, the versions submitted on March 29, 2016 remain applicable. The revised Attachment A was approved by EPA on October 20, 2016.

frequency of five percent (i.e., one for every 20 samples). MS/MSD samples will be spiked with the same solution used for laboratory control spike analysis (a combination of Aroclor 1221 and Aroclor 1242 at a ratio of 3:1).

3 SAMPLE HANDLING, DATA MANAGEMENT, AND QUALITY ASSURANCE/ QUALITY CONTROL

As discussed in Section 2.1, the procedures to be followed during the 2016 sediment sampling program will be consistent with those specified in the Phase 2 RAM QAPP unless noted otherwise in Section 2. Program components that will be consistent with the Phase 2 RAM QAPP include:

- Sample Handling and Custody Requirements
- Quality Control Requirements, except as noted in Section 2.10 above
- Precision, Accuracy, Representativeness, Comparability, Completeness, and Sensitivity
- Inspection/Acceptance Requirements for Supplies and Consumables
- Data Management
- Data Validation
- Performance Audits
- Corrective Action
- Verification and Validation Methods

4 SCHEDULE, HEALTH AND SAFETY, AND REPORTING

The 2016 surface sediment sampling will be initiated within approximately 1 week of EPA approval of this work plan. To ensure consistency of the work, a single crew will be used to collect and process the samples. This crew will work 5 days per week during daylight hours. It is expected that this crew will be able to collect approximately 10 to 15 samples per day. Thus, to collect the 226 samples in non-dredge areas, it is anticipated that the field collection will take approximately 3 to 4 weeks. GE plans to complete this sampling in an entire River Section before moving to another River Section, beginning with RS1, followed by RS3, and then RS2.

Health and safety procedures will be consistent with the GE Hudson River Safety Program, as described in the *Phase 2 Remedial Action Health and Safety Plan for 2016* (Parsons 2016). Field activities will not continue after the Champlain Canal closes for the season or weather conditions prevent further activities due to safety concerns. Due to the need for extensive safety requirements, work will not be conducted after the water temperature of the river reaches 40 degrees Fahrenheit (°F). After each River Section sampling is complete, GE and EPA will reevaluate the work to determine if sampling should continue or be halted. Since a primary goal of this sampling is to obtain data to calculate the average surface concentration in each River Section, if it is determined that sampling of an entire River Section is unlikely to be completed in 2016 based on the above factors, then the work will be terminated for the season. In the event that the sampling described in this work plan cannot be completed in 2016, it will be completed in 2017 in connection with the 2017 OM&M sampling performed under the WFS OMM Plan.

Laboratory analytical results are expected within approximately 20 business days after submission of the samples to the laboratory. An electronic data export containing the most recent version of the data at the time of file creation will be made available to EPA on a periodic basis following electronic verification and a preliminary data review. Upon receipt of all of the sampling results from the sampling conducted in 2016, the results will be subject to data validation in accordance with the Phase 2 RAM QAPP and the data validation process will be completed within 45 days to document data usability. These validated data will be provided to EPA as soon as practicable after the data validation is completed. The validated results of the 2016 sampling will also be provided in a Data Summary Report (DSR) to be submitted within 60 days of receiving the 2016 sampling results (i.e., 15 days after the completion of data validation). The DSR will fully document the 2016 sampling, including a summary of the work performed, a tabulation of results, field notes, processing data, COC forms, corrective action memoranda and technical memoranda, copies of field and laboratory audits, data validation results, copies of laboratory reports, and an electronic version of the project database.

5 REFERENCES

Anchor QEA (Anchor QEA, LLC), 2011. *Corrective Action Memorandum No. 3 – Modification of Sediment Residual Monitoring Program – Discontinuing mGBM Analysis of Sediment Samples and Updates of the Regression Coefficients.* Prepared for General Electric Company, Albany, New York. August 2011.

Anchor QEA and ESI (Environmental Standards, Inc.), 2012. *Phase 2 Remedial Action Monitoring Quality Assurance Project Plan.* Hudson River PCBs Superfund Site. Prepared for General Electric Company, Albany, New York. May 2012.

EPA (U.S. Environmental Protection Agency), 2010a. *Statement of Work (SOW) for Remedial Action and Operations, Maintenance, and Monitoring*, Appendix B to the Consent Decree for the Hudson River PCBs Superfund Site. December 2010.

EPA, 2010b. *Operations, Maintenance, and Monitoring for Phase 2 of the Remedial Action*, Attachment E to the Statement of Work, Hudson River PCBs Site. December 2010.

ESI and QEA (Quantitative Environmental Analysis, LLC), 2002. *Design Support Sediment Sampling and Analysis Program – Quality Assurance Project Plan*. Prepared for General Electric Company, Albany, New York, by Environmental Standards, Inc. and Quantitative Environmental Analysis, LLC. October 2002.

ESI, 2016. Attachment A, Analytical Program and Procedures. Attachment to *Phase 2 Remedial Action Monitoring Quality Assurance Project Plan.* Prepared for General Electric Company, Albany, New York. Revised and re-submitted on March 29, 2016, and again, with the changed portions, on September 29, 2016.

Parsons, 2016. *Phase 2 Remedial Action Health and Safety Plan for 2016*, *Hudson River PCBs Superfund Site*. Prepared for General Electric Co., Albany, New York. February 2016.

TABLES

Table 2-1
2016 Surface Sediment Sample Collection Summary

River Section	No. of Sampling Locations (Non-Dredge Areas)	Analyses	Analytical Method	Container Specifications	Preservation	Turnaround Time[1]	Holding Time[2]
1	35	Aroclor PCBs	GEHR8082	4 oz glass jar	Cool, 4 °C +/- 2 °C	Standard	14 days to extraction, 40 days to analysis
		TOC	Lloyd Kahn	From same 4 oz glass jar as above	Cool, 4 °C +/- 2 °C	Standard	28 days
2	70	Aroclor PCBs	GEHR8082	4 oz glass jar	Cool, 4 °C +/- 2 °C	Standard	14 days to extraction, 40 days to analysis
		TOC	Lloyd Kahn	From same 4 oz glass jar as above	Cool, 4 °C +/- 2 °C	Standard	28 days
3	121	Aroclor PCBs	GEHR8082	4 oz glass jar	Cool, 4 °C +/- 2 °C	Standard	14 days to extraction, 40 days to analysis
		TOC	Lloyd Kahn	From same 4 oz glass jar as above	Cool, 4 °C +/- 2 °C	Standard	28 days

Notes:
1. All turnaround times (TATs) run from time of Verified Time of Sample Receipt.
2. Holding times start on the date of collection.
NA = not analyzed/applicable
oz = ounces
PCBs = polychlorinated biphenyl
TOC = total organic carbon

Table 2-2
Primary Target Surface Sediment Sampling Locations Outside of Dredge Areas

EPA Location ID	River Section	River Mile	Easting	Northing
OCU_001	1	194	735364.39	1614721.03
OCU_002	1	194	735775.17	1615522.68
OCU_003	1	194	734365.21	1616874.28
OCU_004	1	194	735397.01	1614337.63
OCU_005	1	193	733528.10	1609676.68
OCU_006	1	193	734797.45	1611013.12
OCU_007	1	193	733709.60	1610114.17
OCU_008	1	193	734437.30	1610383.58
OCU_009	1	193	735264.64	1611640.92
OCU_010	1	192	732585.95	1606973.96
OCU_011	1	192	733731.25	1609338.71
OCU_012	1	192	732582.62	1607977.31
OCU_013	1	192	732992.33	1608935.08
OCU_014	1	191	736041.56	1601329.19
OCU_015	1	191	735948.30	1601904.87
OCU_016	1	191	735410.89	1602812.16
OCU_017	1	191	734432.46	1603566.62
OCU_018	1	191	733455.41	1603783.06
OCU_019	1	191	733071.01	1604510.16
OCU_020	1	190	737529.98	1595472.72
OCU_021	1	190	737158.93	1595904.99
OCU_022	1	190	737461.31	1596168.16
OCU_023	1	190	736982.79	1596577.29
OCU_024	1	190	736909.44	1596965.48
OCU_025	1	190	737090.37	1596068.64
OCU_026	1	190	736876.48	1598348.26
OCU_027	1	190	736822.08	1599016.16
OCU_028	1	189	737288.15	1594967.28
OCU_029	1	189	736494.22	1591158.03
OCU_030	1	189	736803.16	1591710.71
OCU_031	1	189	737369.32	1594499.72
OCU_032	1	189	736510.82	1590432.03
OCU_033	1	189	736859.92	1594068.61
OCU_034	1	189	737104.07	1594360.89
OCU_035	1	189	737454.93	1595309.18
OCU_067	2	188	736853.05	1587692.16
OCU_068	2	188	736901.91	1586998.79
OCU_069	2	188	736887.58	1586658.63
OCU_070	2	188	737196.08	1586342.89
OCU_071	2	188	737284.19	1586003.75
OCU_072	2	187	736177.55	1585666.42
OCU_073	2	187	736983.29	1585070.90
OCU_074	2	187	736740.07	1584692.44
OCU_075	2	187	736602.30	1584296.92
OCU_076	2	187	736312.20	1584098.55
OCU_077	2	187	736742.81	1583865.86

Table 2-2
Primary Target Surface Sediment Sampling Locations Outside of Dredge Areas

EPA Location ID	River Section	River Mile	Easting	Northing
OCU_078	2	187	736758.70	1583667.43
OCU_079	2	187	736483.26	1583466.96
OCU_080	2	187	736430.20	1583303.71
OCU_081	2	187	736482.05	1583093.95
OCU_082	2	187	735766.91	1582879.64
OCU_083	2	187	736154.02	1582713.50
OCU_084	2	187	735351.69	1582550.37
OCU_085	2	187	735332.57	1582330.19
OCU_086	2	187	735903.57	1582118.80
OCU_087	2	187	734920.71	1581943.26
OCU_088	2	187	734872.96	1581720.28
OCU_089	2	187	736168.27	1585282.23
OCU_090	2	187	735361.72	1581237.12
OCU_091	2	186	735264.63	1580852.51
OCU_092	2	186	736020.07	1580281.57
OCU_093	2	186	736965.58	1580022.83
OCU_094	2	185	737924.40	1577028.04
OCU_095	2	185	737245.40	1576621.98
OCU_096	2	185	737298.17	1576339.45
OCU_097	2	185	737167.96	1576177.78
OCU_098	2	185	737297.37	1575962.94
OCU_099	2	185	737048.84	1575756.28
OCU_100	2	185	737300.65	1575553.83
OCU_101	2	185	737456.39	1575324.36
OCU_102	2	185	737423.97	1575223.17
OCU_103	2	185	737610.96	1575033.35
OCU_104	2	185	738005.09	1574880.78
OCU_105	2	185	737035.99	1574736.63
OCU_106	2	185	737336.51	1574519.05
OCU_107	2	185	737383.74	1574371.70
OCU_108	2	185	737412.65	1574192.67
OCU_109	2	185	737096.25	1574001.05
OCU_110	2	185	736488.70	1573801.79
OCU_111	2	185	736640.84	1573630.46
OCU_112	2	185	736541.04	1572974.21
OCU_113	2	185	736173.91	1572600.93
OCU_114	2	184	735707.81	1571737.47
OCU_115	2	184	735554.67	1571438.19
OCU_116	2	184	735077.86	1571035.53
OCU_117	2	184	735343.69	1570833.15
OCU_118	2	184	734827.67	1570641.25
OCU_119	2	184	735101.27	1570326.05
OCU_120	2	184	734890.87	1570052.50
OCU_121	2	184	734649.66	1569802.81
OCU_122	2	184	734722.03	1569522.19
OCU_123	2	184	734777.89	1569112.08

Table 2-2
Primary Target Surface Sediment Sampling Locations Outside of Dredge Areas

EPA Location ID	River Section	River Mile	Easting	Northing
OCU_124	2	184	734796.60	1568835.72
OCU_125	2	184	734585.38	1568479.24
OCU_126	2	184	734642.16	1568203.47
OCU_127	2	184	734548.74	1567878.11
OCU_128	2	184	735071.60	1567661.12
OCU_129	2	184	734760.90	1567443.17
OCU_130	2	183.5	734853.63	1567331.25
OCU_131	2	183.5	735333.93	1567025.90
OCU_132	2	183.5	734886.05	1566864.01
OCU_133	2	183.5	735320.84	1566675.77
OCU_134	2	183.5	735319.56	1566461.92
OCU_135	2	183.5	735325.19	1566278.61
OCU_136	2	183.5	735318.87	1566131.23
OCU_189	3	181	739083.88	1558437.31
OCU_190	3	181	739608.56	1556815.64
OCU_191	3	181	739801.68	1555668.06
OCU_192	3	181	739158.54	1554627.92
OCU_193	3	180	738125.37	1552946.30
OCU_194	3	180	738115.49	1551989.57
OCU_195	3	180	738881.70	1550932.68
OCU_196	3	180	738992.90	1550065.98
OCU_197	3	180	739051.08	1549038.60
OCU_198	3	179	738360.89	1547707.00
OCU_199	3	179	737848.71	1546871.92
OCU_200	3	179	737745.85	1546112.29
OCU_201	3	179	737445.46	1545082.56
OCU_202	3	179	737647.41	1543843.97
OCU_203	3	178	738100.52	1542843.82
OCU_204	3	178	738218.40	1541636.54
OCU_205	3	178	738814.32	1540582.74
OCU_206	3	178	738567.22	1539187.24
OCU_207	3	177	737013.55	1537899.48
OCU_208	3	177	736414.18	1536874.60
OCU_209	3	177	735981.82	1535722.64
OCU_210	3	177	736019.77	1534580.06
OCU_211	3	176	735500.69	1533357.34
OCU_212	3	176	735212.22	1532278.03
OCU_213	3	176	734805.50	1531240.23
OCU_214	3	176	735018.62	1529821.43
OCU_215	3	175	735593.12	1528020.11
OCU_216	3	175	734971.98	1526626.43
OCU_217	3	175	734429.79	1525414.23
OCU_218	3	175	734412.18	1524276.11
OCU_219	3	174	734105.23	1523605.75
OCU_220	3	174	733535.07	1522454.28
OCU_221	3	174	733306.75	1521456.90

Table 2-2
Primary Target Surface Sediment Sampling Locations Outside of Dredge Areas

EPA Location ID	River Section	River Mile	Easting	Northing
OCU_222	3	174	731695.74	1520383.80
OCU_223	3	173	731165.50	1519059.66
OCU_224	3	173	731188.30	1518097.95
OCU_225	3	173	730702.29	1517002.02
OCU_226	3	173	730769.72	1516012.55
OCU_227	3	173	730604.97	1515021.08
OCU_228	3	172	730649.97	1514858.06
OCU_229	3	172	730471.09	1513677.13
OCU_230	3	172	730552.40	1512739.27
OCU_231	3	172	729344.66	1512146.58
OCU_232	3	172	729172.44	1511484.07
OCU_233	3	171	727169.34	1510551.21
OCU_234	3	171	726079.59	1509914.93
OCU_235	3	171	726166.40	1509462.32
OCU_236	3	171	725710.76	1508951.13
OCU_237	3	171	724604.68	1507972.74
OCU_238	3	170	724677.84	1505985.69
OCU_239	3	170	724735.18	1506220.25
OCU_240	3	170	725251.93	1503874.10
OCU_241	3	170	724991.15	1502880.75
OCU_242	3	170	725379.25	1502993.22
OCU_243	3	169	725378.77	1501678.05
OCU_244	3	169	725474.28	1500921.96
OCU_245	3	169	725425.38	1500258.41
OCU_246	3	169	724767.00	1499438.12
OCU_247	3	169	724764.47	1498550.39
OCU_248	3	169	723721.88	1497700.78
OCU_249	3	168	722996.33	1497002.63
OCU_250	3	168	721402.08	1496785.80
OCU_251	3	168	721177.26	1496492.92
OCU_252	3	166	714997.08	1490524.71
OCU_253	3	166	713820.57	1490146.12
OCU_254	3	166	714159.49	1489728.41
OCU_255	3	166	713088.83	1489222.30
OCU_256	3	166	713580.35	1488674.22
OCU_257	3	166	713175.88	1488000.35
OCU_258	3	165	711040.83	1482836.45
OCU_259	3	164	710760.21	1482222.45
OCU_260	3	164	711412.60	1481393.53
OCU_261	3	164	710562.20	1480404.46
OCU_262	3	164	710175.47	1479591.63
OCU_263	3	164	711017.85	1478770.85
OCU_264	3	164	711602.62	1477843.06
OCU_265	3	164	711459.25	1477251.08
OCU_266	3	163	712769.19	1476948.22
OCU_267	3	163	711852.53	1476191.00

Table 2-2
Primary Target Surface Sediment Sampling Locations Outside of Dredge Areas

EPA Location ID	River Section	River Mile	Easting	Northing
OCU_268	3	162	713424.43	1472228.67
OCU_269	3	162	713584.76	1471151.53
OCU_270	3	162	713633.84	1470189.51
OCU_271	3	162	713607.04	1469324.82
OCU_272	3	162	713136.85	1468442.80
OCU_273	3	161	713901.94	1467063.01
OCU_274	3	161	713857.74	1466045.05
OCU_275	3	161	713620.77	1464719.74
OCU_276	3	161	713883.21	1463090.02
OCU_277	3	160	714230.25	1462230.75
OCU_278	3	160	714177.29	1461406.19
OCU_279	3	160	714664.35	1460593.93
OCU_280	3	160	715010.89	1459893.13
OCU_281	3	160	715716.14	1459012.34
OCU_282	3	160	716419.25	1458212.77
OCU_283	3	159	716142.71	1457783.08
OCU_284	3	159	715942.20	1456633.86
OCU_285	3	159	718689.23	1454518.88
OCU_286	3	159	716844.33	1453527.90
OCU_287	3	158	717298.95	1452433.49
OCU_288	3	158	718360.91	1451432.43
OCU_289	3	158	718812.93	1452949.23
OCU_290	3	158	717830.08	1449380.06
OCU_291	3	158	717738.74	1448054.25
OCU_292	3	157	717288.56	1447607.35
OCU_293	3	157	716207.10	1446535.43
OCU_294	3	157	715346.53	1445764.56
OCU_295	3	156	713688.89	1443184.57
OCU_296	3	156	713971.93	1442054.03
OCU_297	3	156	713705.31	1441135.92
OCU_298	3	156	713500.53	1440433.81
OCU_299	3	156	713033.16	1439554.15
OCU_300	3	155	712887.99	1438405.33
OCU_301	3	155	712069.81	1437505.38
OCU_302	3	155	712197.48	1436632.97
OCU_303	3	155	711337.62	1435300.29
OCU_304	3	155	711674.45	1434442.21
OCU_305	3	154	711307.23	1433945.05
OCU_306	3	154	711685.10	1433152.18
OCU_307	3	154	711745.36	1432480.47
OCU_308	3	154	711190.49	1431838.46
OCU_309	3	154	711066.82	1430891.48

Notes:

EPA = U.S. Environmental Protection Agency

Table 2-3
Backup Target Surface Sediment Sampling Locations Outside of Dredge Areas

EPA Location ID	River Section	River Mile	Easting	Northing
OCU_B_001	1	189	736310.39	1591392.88
OCU_B_002	1	189	737769.92	1595086.47
OCU_B_003	1	189	735990.44	1591061.21
OCU_B_004	1	189	736068.92	1590580.75
OCU_B_005	1	189	736184.81	1590643.13
OCU_B_006	1	189	736259.94	1592135.11
OCU_B_007	1	189	736604.73	1591755.18
OCU_B_008	1	189	737517.54	1595131.89
OCU_B_009	1	190	736550.35	1599832.06
OCU_B_010	1	190	736790.00	1598892.49
OCU_B_011	1	190	737338.41	1596925.26
OCU_B_012	1	190	737219.63	1596794.60
OCU_B_013	1	190	737564.52	1596058.64
OCU_B_014	1	190	737525.51	1596336.11
OCU_B_015	1	190	736846.26	1599345.92
OCU_B_016	1	190	737214.25	1596803.58
OCU_B_017	1	191	734177.85	1603513.38
OCU_B_018	1	191	734161.97	1603730.22
OCU_B_019	1	191	735269.25	1602900.96
OCU_B_020	1	191	734265.76	1603408.01
OCU_B_021	1	191	736047.76	1601205.64
OCU_B_022	1	191	735580.46	1601927.00
OCU_B_023	1	192	733841.72	1609475.58
OCU_B_024	1	192	732806.31	1606413.75
OCU_B_025	1	192	733474.15	1609571.41
OCU_B_026	1	192	732758.54	1606725.08
OCU_B_027	1	193	735395.72	1613836.82
OCU_B_028	1	193	734865.20	1610929.63
OCU_B_029	1	193	735328.46	1612853.98
OCU_B_030	1	193	734801.28	1611045.96
OCU_B_031	1	193	735430.43	1613784.26
OCU_B_032	1	194	735236.39	1614845.98
OCU_B_033	1	194	734311.36	1616873.02
OCU_B_034	1	194	734274.86	1615965.92
OCU_B_035	1	194	735718.70	1616071.47
OCU_B_067	2	184	734729.16	1567541.61
OCU_B_068	2	184	735116.53	1567683.63
OCU_B_069	2	184	734459.09	1567952.11
OCU_B_070	2	184	734504.04	1568527.65
OCU_B_071	2	184	734632.16	1568860.49
OCU_B_072	2	184	734675.90	1567531.01
OCU_B_073	2	184	734902.43	1568914.07
OCU_B_074	2	184	734664.06	1570284.23
OCU_B_075	2	184	734787.29	1568643.12
OCU_B_076	2	184	734637.09	1567743.96
OCU_B_077	2	184	735190.70	1567851.08

Table 2-3
Backup Target Surface Sediment Sampling Locations Outside of Dredge Areas

EPA Location ID	River Section	River Mile	Easting	Northing
OCU_B_078	2	184	735332.06	1571392.12
OCU_B_079	2	184	734531.77	1569629.12
OCU_B_080	2	184	735706.02	1571449.10
OCU_B_081	2	184	734776.39	1567780.56
OCU_B_082	2	184	735627.39	1571470.77
OCU_B_083	2	185	737095.99	1573936.64
OCU_B_084	2	185	737024.52	1575826.00
OCU_B_085	2	185	736288.85	1572534.48
OCU_B_086	2	185	738108.80	1575016.46
OCU_B_087	2	185	737248.83	1576396.52
OCU_B_088	2	185	736811.22	1573743.40
OCU_B_089	2	185	737363.59	1575234.32
OCU_B_090	2	185	737125.71	1575814.69
OCU_B_091	2	185	736941.02	1574349.49
OCU_B_092	2	185	736945.69	1576461.67
OCU_B_093	2	185	737596.16	1577322.89
OCU_B_094	2	185	737047.55	1574835.15
OCU_B_095	2	185	737932.83	1576859.46
OCU_B_096	2	185	736940.91	1574666.64
OCU_B_097	2	185	737035.36	1574306.38
OCU_B_098	2	185	737551.73	1575107.06
OCU_B_099	2	185	737507.21	1575278.86
OCU_B_100	2	185	736065.39	1572998.58
OCU_B_101	2	185	736663.50	1573496.23
OCU_B_102	2	185	737908.58	1576943.80
OCU_B_103	2	186	734782.72	1581009.48
OCU_B_104	2	186	734926.41	1580584.56
OCU_B_105	2	186	735675.56	1580177.56
OCU_B_106	2	187	736139.66	1585163.11
OCU_B_107	2	187	737036.44	1585303.26
OCU_B_108	2	187	735237.49	1582163.99
OCU_B_109	2	187	735262.08	1581980.16
OCU_B_110	2	187	734779.63	1581146.61
OCU_B_111	2	187	737006.89	1585161.34
OCU_B_112	2	187	736151.76	1584491.59
OCU_B_113	2	187	736602.08	1584080.61
OCU_B_114	2	187	734795.77	1581825.29
OCU_B_115	2	187	735482.14	1581385.72
OCU_B_116	2	187	734829.68	1581500.31
OCU_B_117	2	187	736059.46	1583610.95
OCU_B_118	2	187	736211.45	1585679.70
OCU_B_119	2	187	736263.55	1584133.19
OCU_B_120	2	187	736815.04	1583870.03
OCU_B_121	2	187	735043.72	1581425.40
OCU_B_122	2	187	735881.68	1582387.93
OCU_B_123	2	187	735091.71	1581813.99

Table 2-3
Backup Target Surface Sediment Sampling Locations Outside of Dredge Areas

EPA Location ID	River Section	River Mile	Easting	Northing
OCU_B_124	2	187	736785.06	1584582.26
OCU_B_125	2	188	736115.32	1586638.35
OCU_B_126	2	188	737047.02	1586788.70
OCU_B_127	2	188	737211.01	1586227.85
OCU_B_128	2	188	736763.32	1587497.75
OCU_B_129	2	188	737180.22	1586245.23
OCU_B_130	2	183.5	734766.18	1567060.03
OCU_B_131	2	183.5	735974.98	1566187.23
OCU_B_132	2	183.5	735034.75	1567116.55
OCU_B_133	2	183.5	735342.45	1566099.92
OCU_B_134	2	183.5	735652.44	1566152.96
OCU_B_135	2	183.5	735245.48	1567008.84
OCU_B_136	2	183.5	735639.81	1566657.79
OCU_B_189	3	154	710754.94	1433477.89
OCU_B_190	3	154	711659.47	1432106.51
OCU_B_191	3	154	710873.28	1433087.43
OCU_B_192	3	154	711078.55	1433735.28
OCU_B_193	3	154	711644.48	1434003.75
OCU_B_194	3	155	712503.31	1439001.31
OCU_B_195	3	155	712561.87	1438864.25
OCU_B_196	3	155	712045.40	1435024.35
OCU_B_197	3	155	711690.65	1436083.69
OCU_B_198	3	155	712471.58	1436923.28
OCU_B_199	3	156	713417.51	1441220.71
OCU_B_200	3	156	714006.50	1441322.22
OCU_B_201	3	156	713429.91	1441670.73
OCU_B_202	3	156	714323.37	1443383.07
OCU_B_203	3	156	714450.92	1442666.66
OCU_B_204	3	157	713887.01	1444610.93
OCU_B_205	3	157	715832.50	1446429.69
OCU_B_206	3	157	714450.48	1444912.08
OCU_B_207	3	158	717578.35	1452893.30
OCU_B_208	3	158	718186.22	1449909.05
OCU_B_209	3	158	717803.29	1452291.91
OCU_B_210	3	158	717618.62	1448764.87
OCU_B_211	3	158	717632.09	1451928.48
OCU_B_212	3	159	718428.71	1454411.98
OCU_B_213	3	159	717483.66	1453183.29
OCU_B_214	3	159	716321.05	1456519.60
OCU_B_215	3	159	716572.34	1456280.36
OCU_B_216	3	160	715247.62	1460103.85
OCU_B_217	3	160	715233.62	1459481.76
OCU_B_218	3	160	714111.09	1462190.81
OCU_B_219	3	160	716217.56	1458420.49
OCU_B_220	3	160	714056.90	1461736.69
OCU_B_221	3	160	714389.69	1461689.32

Table 2-3
Backup Target Surface Sediment Sampling Locations Outside of Dredge Areas

EPA Location ID	River Section	River Mile	Easting	Northing
OCU_B_222	3	161	713544.66	1467179.00
OCU_B_223	3	161	714073.97	1465405.16
OCU_B_224	3	161	713690.91	1467197.49
OCU_B_225	3	161	714091.34	1465356.66
OCU_B_226	3	162	713782.98	1472468.40
OCU_B_227	3	162	713316.52	1468739.33
OCU_B_228	3	162	713000.41	1469684.43
OCU_B_229	3	162	713394.36	1470676.58
OCU_B_230	3	162	713526.34	1468529.96
OCU_B_231	3	163	712405.20	1476979.80
OCU_B_232	3	163	712569.79	1477201.09
OCU_B_233	3	164	711397.65	1480053.62
OCU_B_234	3	164	710925.41	1479169.23
OCU_B_235	3	164	711196.67	1482134.56
OCU_B_236	3	164	711347.13	1477666.38
OCU_B_237	3	164	711119.91	1481952.72
OCU_B_238	3	164	711293.75	1481949.52
OCU_B_239	3	164	711455.60	1480209.29
OCU_B_240	3	165	710557.14	1482255.26
OCU_B_241	3	166	713718.93	1488703.94
OCU_B_242	3	166	715575.66	1491138.67
OCU_B_243	3	166	714127.43	1489658.29
OCU_B_244	3	166	713107.69	1489393.66
OCU_B_245	3	166	713629.79	1488280.02
OCU_B_246	3	166	713903.79	1488794.53
OCU_B_247	3	168	720980.86	1496651.96
OCU_B_248	3	168	720508.40	1496824.33
OCU_B_249	3	168	722013.34	1496998.86
OCU_B_250	3	169	723848.70	1498084.51
OCU_B_251	3	169	725059.07	1499231.24
OCU_B_252	3	169	725605.77	1501343.37
OCU_B_253	3	169	725473.12	1500948.82
OCU_B_254	3	169	725373.60	1500808.07
OCU_B_255	3	169	724532.21	1500499.52
OCU_B_256	3	170	724831.40	1507029.26
OCU_B_257	3	170	725359.08	1502815.40
OCU_B_258	3	170	724769.77	1505818.47
OCU_B_259	3	170	724591.40	1506335.17
OCU_B_260	3	170	725012.76	1506737.07
OCU_B_261	3	171	724986.95	1508829.17
OCU_B_262	3	171	725118.39	1509200.43
OCU_B_263	3	171	725775.12	1509782.34
OCU_B_264	3	171	727117.25	1510294.76
OCU_B_265	3	171	727155.98	1510664.11
OCU_B_266	3	172	730211.49	1512195.82
OCU_B_267	3	172	730430.17	1513261.81

Table 2-3
Backup Target Surface Sediment Sampling Locations Outside of Dredge Areas

EPA Location ID	River Section	River Mile	Easting	Northing
OCU_B_268	3	172	728916.03	1511580.28
OCU_B_269	3	172	730727.51	1513482.20
OCU_B_270	3	172	730946.68	1513482.93
OCU_B_271	3	173	730437.30	1515761.13
OCU_B_272	3	173	730863.82	1515724.16
OCU_B_273	3	173	730509.70	1516107.55
OCU_B_274	3	173	730749.69	1516269.58
OCU_B_275	3	173	730992.96	1517342.10
OCU_B_276	3	174	733935.64	1522357.78
OCU_B_277	3	174	733989.54	1523041.61
OCU_B_278	3	174	733515.67	1521733.12
OCU_B_279	3	174	733083.53	1521588.03
OCU_B_280	3	175	734557.95	1524484.58
OCU_B_281	3	175	735143.10	1525888.17
OCU_B_282	3	175	735372.34	1529174.70
OCU_B_283	3	175	734629.31	1526350.69
OCU_B_284	3	176	735996.23	1533907.47
OCU_B_285	3	176	735139.64	1529949.42
OCU_B_286	3	176	735064.80	1532445.17
OCU_B_287	3	176	734695.42	1530996.67
OCU_B_288	3	177	736135.72	1537338.13
OCU_B_289	3	177	736126.28	1537246.64
OCU_B_290	3	177	735944.83	1535048.47
OCU_B_291	3	177	736547.80	1537571.42
OCU_B_292	3	178	738309.53	1541496.63
OCU_B_293	3	178	737902.69	1542080.06
OCU_B_294	3	178	738681.11	1539992.21
OCU_B_295	3	178	738709.84	1540328.52
OCU_B_296	3	179	737788.98	1543666.13
OCU_B_297	3	179	737654.46	1543937.07
OCU_B_298	3	179	738508.99	1548027.19
OCU_B_299	3	179	737588.44	1544968.96
OCU_B_300	3	179	737370.35	1543663.65
OCU_B_301	3	180	738288.34	1551058.97
OCU_B_302	3	180	738584.65	1550538.78
OCU_B_303	3	180	738952.35	1550066.63
OCU_B_304	3	180	737906.52	1552380.76
OCU_B_305	3	180	739264.19	1550341.94
OCU_B_306	3	181	739164.97	1555647.83
OCU_B_307	3	181	739478.27	1556884.59
OCU_B_308	3	181	739153.24	1557287.16
OCU_B_309	3	181	738923.84	1555396.97

Notes:

EPA = U.S. Environmental Protection Agency

FIGURES

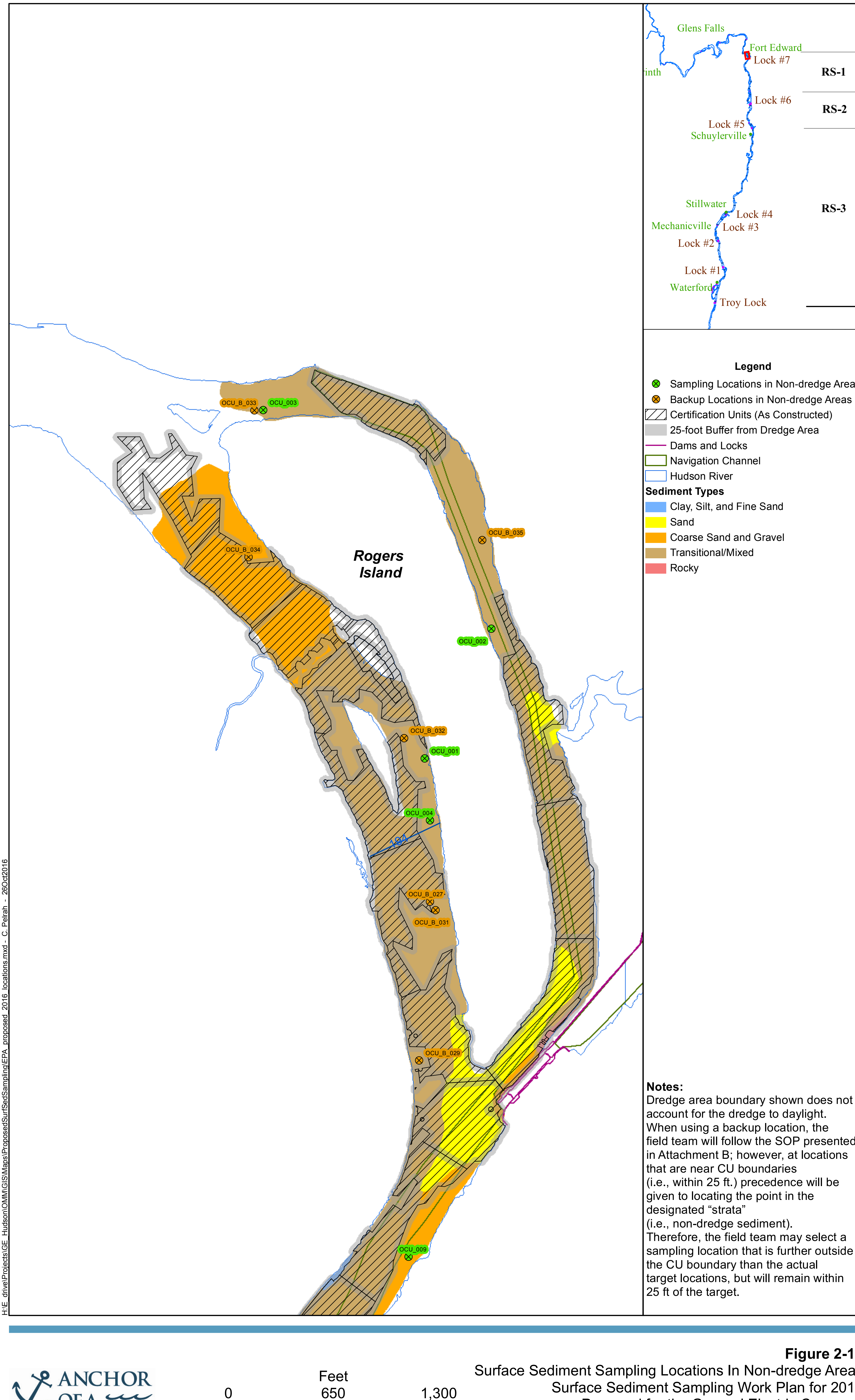

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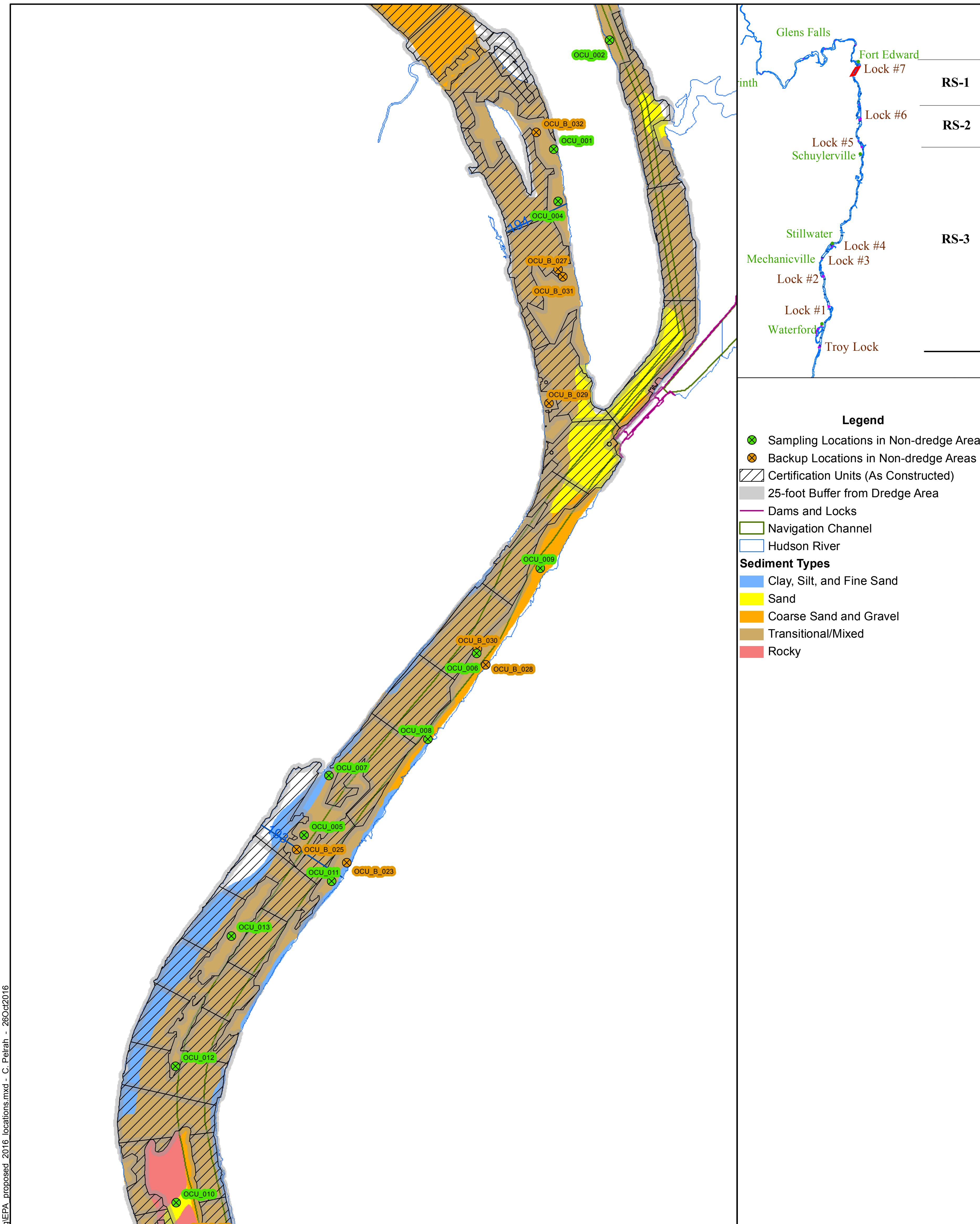
Figure 2-1a
Surface Sediment Sampling Locations In Non-dredge Areas
Surface Sediment Sampling Work Plan for 2016
Prepared for the General Electric Company



Notes:
Dredge area boundary shown does not account for the dredge to daylight. When using a backup location, the field team will follow the SOP presented in Attachment B; however, at locations that are near CU boundaries (i.e., within 25 ft.) precedence will be given to locating the point in the designated "strata" (i.e., non-dredge sediment). Therefore, the field team may select a sampling location that is further outside the CU boundary than the actual target locations, but will remain within 25 ft of the target.

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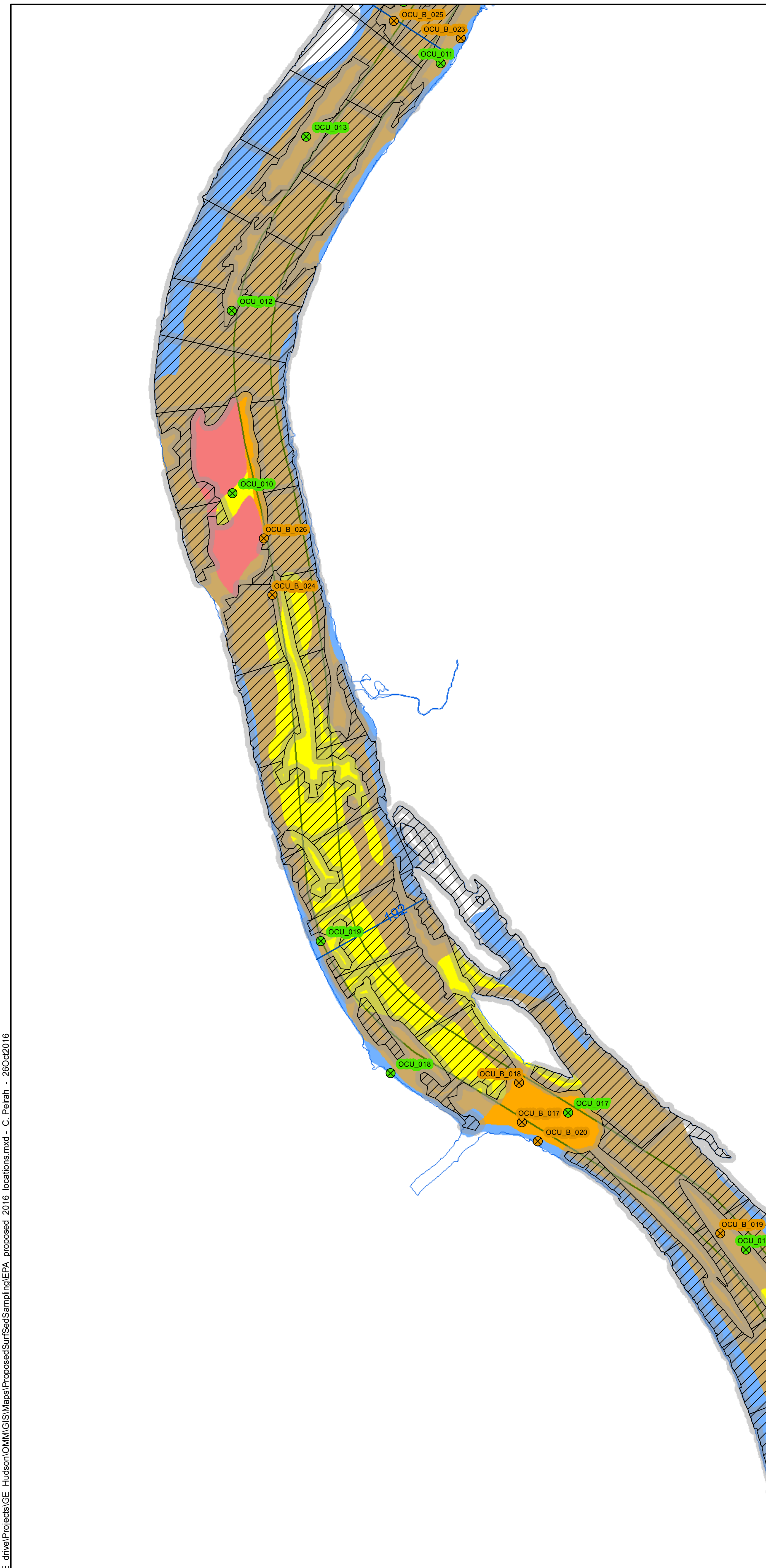
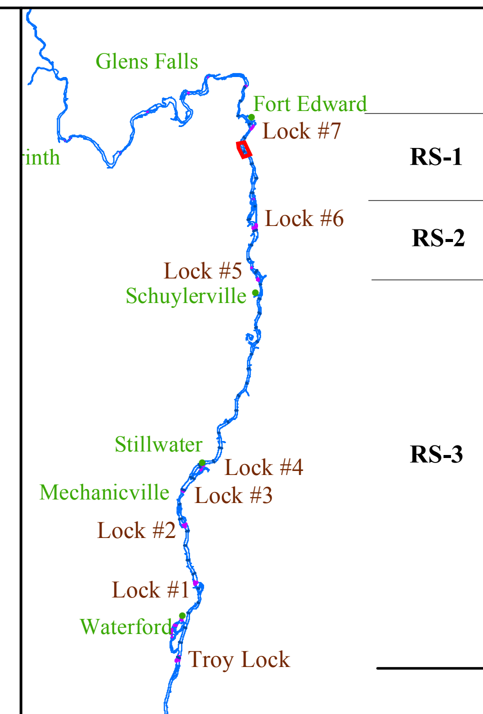
Feet
0 880 1,760

Figure 2-1b
Surface Sediment Sampling Locations In Non-dredge Areas
Surface Sediment Sampling Work Plan for 2016
Prepared for the General Electric Company





Legend

- Sampling Locations in Non-dredge Areas
- Backup Locations in Non-dredge Areas
- Certification Units (As Constructed)
- 25-foot Buffer from Dredge Area
- Dams and Locks
- Navigation Channel
- Hudson River

Sediment Types

- Clay, Silt, and Fine Sand
- Sand
- Coarse Sand and Gravel
- Transitional/Mixed
- Rocky

Notes:
Dredge area boundary shown does not account for the dredge to daylight. When using a backup location, the field team will follow the SOP presented in Attachment B; however, at locations that are near CU boundaries (i.e., within 25 ft.) precedence will be given to locating the point in the designated "strata" (i.e., non-dredge sediment). Therefore, the field team may select a sampling location that is further outside the CU boundary than the actual target locations, but will remain within 25 ft of the target.

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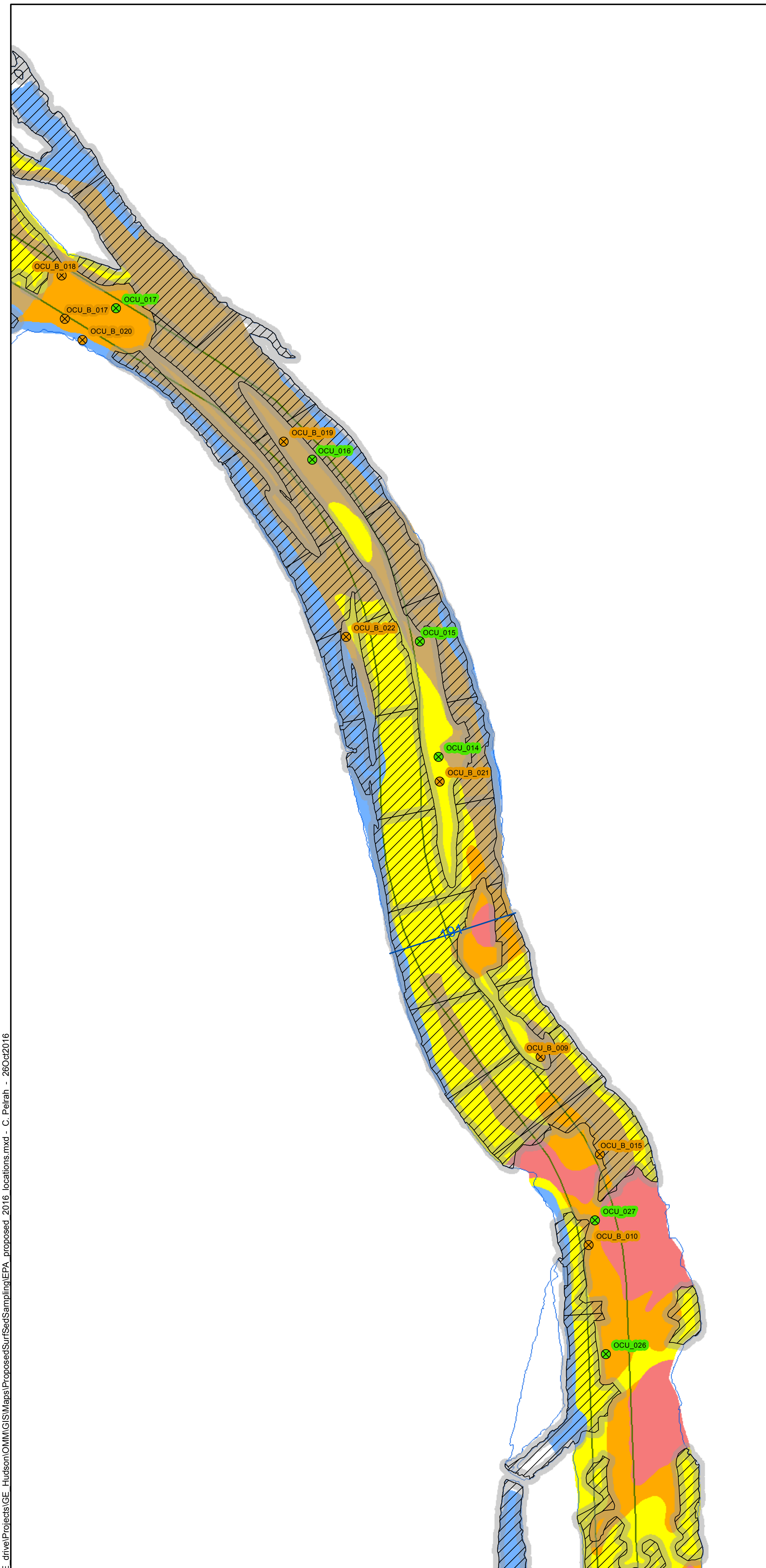
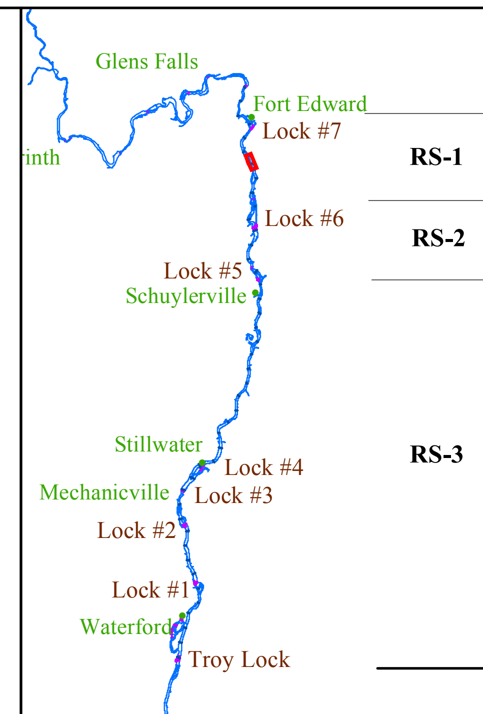
Feet
0 690 1,380

Figure 2-1c
Surface Sediment Sampling Locations In Non-dredge Areas
Surface Sediment Sampling Work Plan for 2016
Prepared for the General Electric Company





Legend

- Sampling Locations in Non-dredge Areas
- Backup Locations in Non-dredge Areas
- Certification Units (As Constructed)
- 25-foot Buffer from Dredge Area
- Dams and Locks
- Navigation Channel
- Hudson River

Sediment Types

- Clay, Silt, and Fine Sand
- Sand
- Coarse Sand and Gravel
- Transitional/Mixed
- Rocky

Notes:
Dredge area boundary shown does not account for the dredge to daylight. When using a backup location, the field team will follow the SOP presented in Attachment B; however, at locations that are near CU boundaries (i.e., within 25 ft.) precedence will be given to locating the point in the designated “strata” (i.e., non-dredge sediment). Therefore, the field team may select a sampling location that is further outside the CU boundary than the actual target locations, but will remain within 25 ft of the target.

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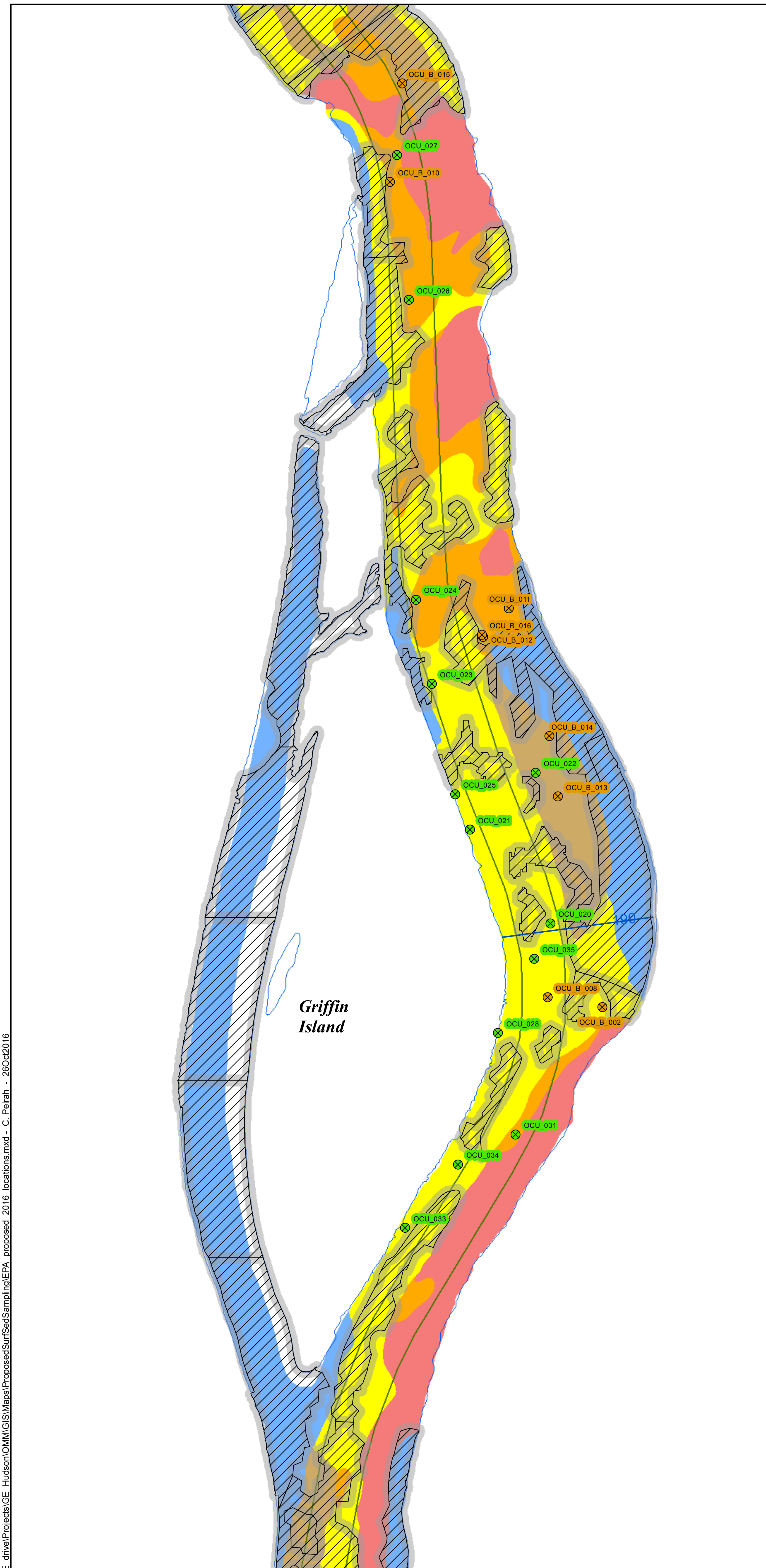
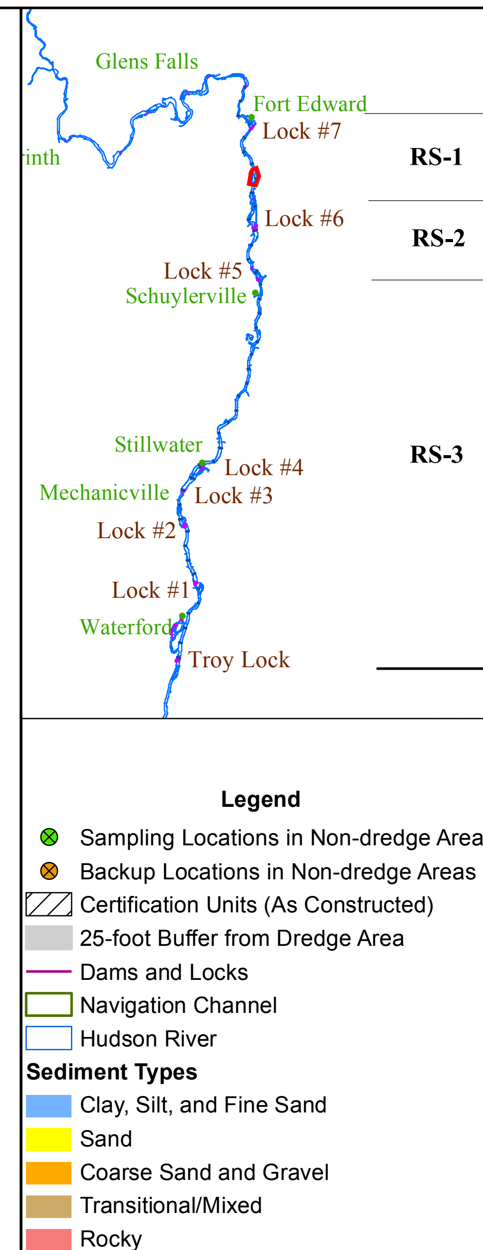
Feet
0 625 1,250

Figure 2-1d
Surface Sediment Sampling Locations In Non-dredge Areas
Surface Sediment Sampling Work Plan for 2016
Prepared for the General Electric Company





Notes:
Dredge area boundary shown does not account for the dredge to daylight. When using a backup location, the field team will follow the SOP presented in Attachment B; however, at locations that are near CU boundaries (i.e., within 25 ft.) precedence will be given to locating the point in the designated "strata" (i.e., non-dredge sediment). Therefore, the field team may select a sampling location that is further outside the CU boundary than the actual target locations, but will remain within 25 ft of the target.

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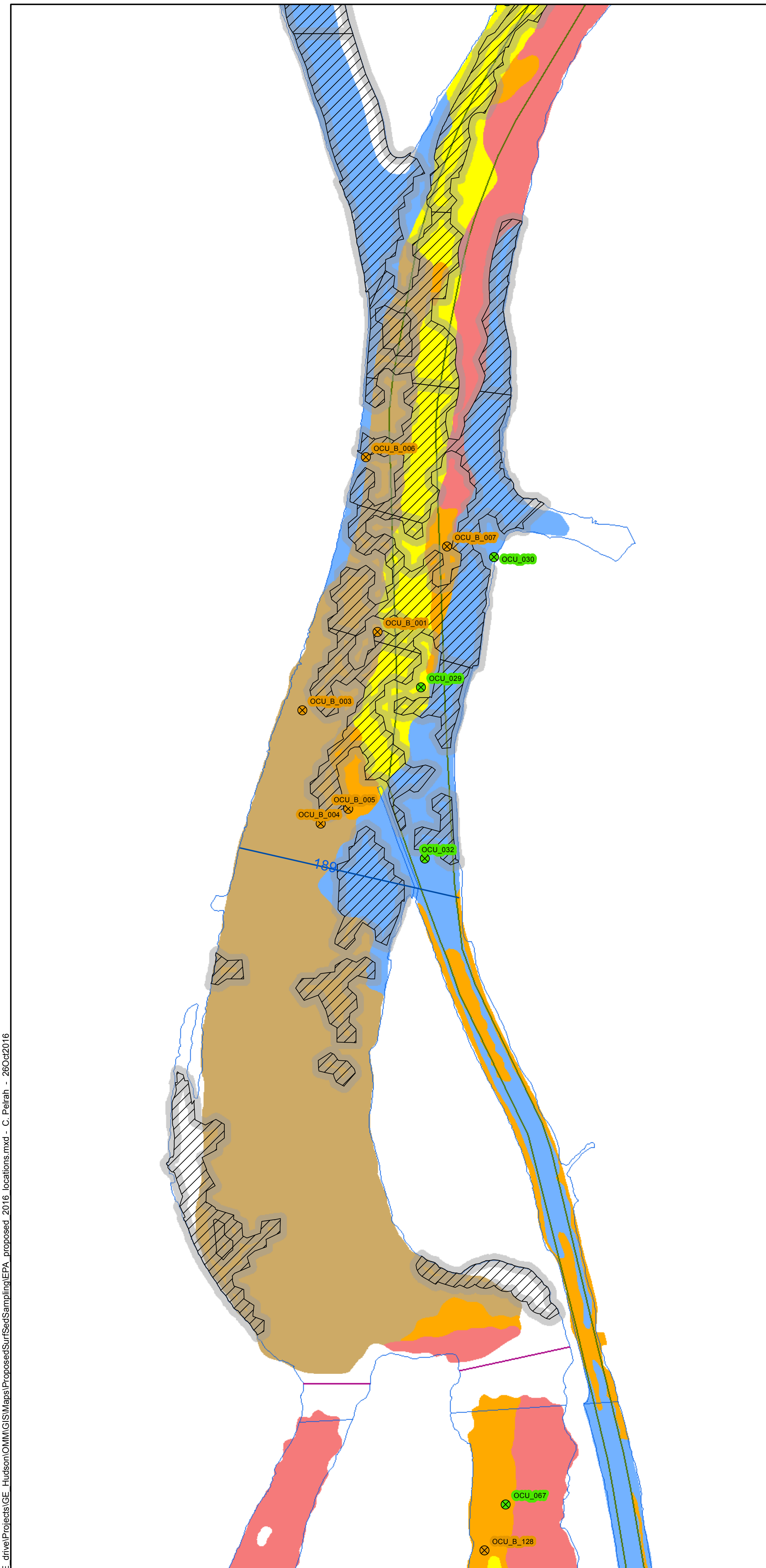
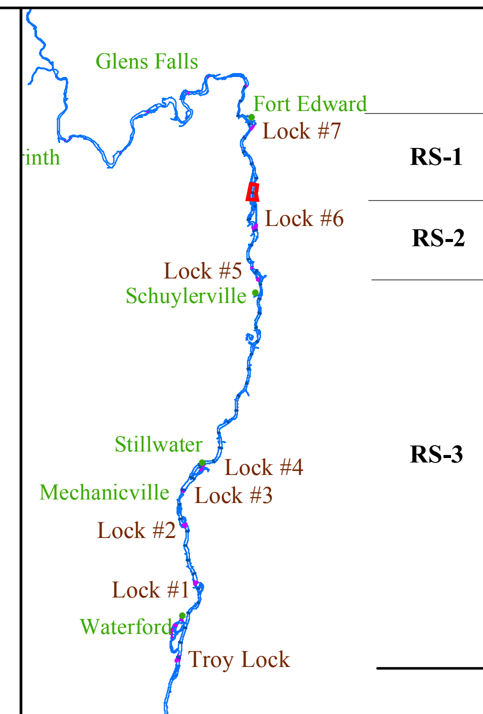
Feet
0 580 1,160

Figure 2-1e
Surface Sediment Sampling Locations In Non-dredge Areas
Surface Sediment Sampling Work Plan for 2016
Prepared for the General Electric Company





Legend

- Sampling Locations in Non-dredge Areas
- Backup Locations in Non-dredge Areas
- Certification Units (As Constructed)
- 25-foot Buffer from Dredge Area
- Dams and Locks
- Navigation Channel
- Hudson River

Sediment Types

- Clay, Silt, and Fine Sand
- Sand
- Coarse Sand and Gravel
- Transitional/Mixed
- Rocky

Notes:
Dredge area boundary shown does not account for the dredge to daylight. When using a backup location, the field team will follow the SOP presented in Attachment B; however, at locations that are near CU boundaries (i.e., within 25 ft.) precedence will be given to locating the point in the designated "strata" (i.e., non-dredge sediment). Therefore, the field team may select a sampling location that is further outside the CU boundary than the actual target locations, but will remain within 25 ft of the target.

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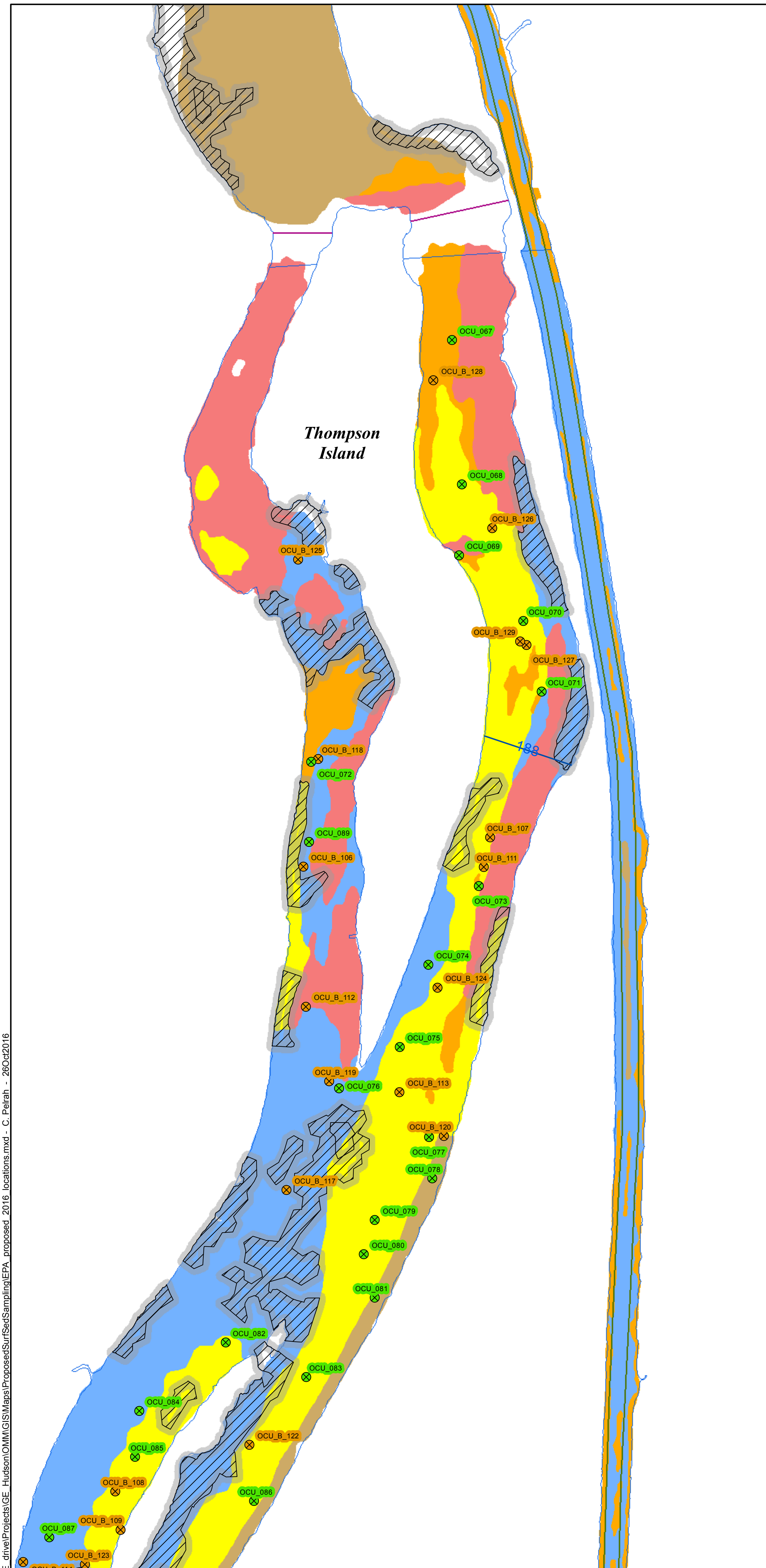
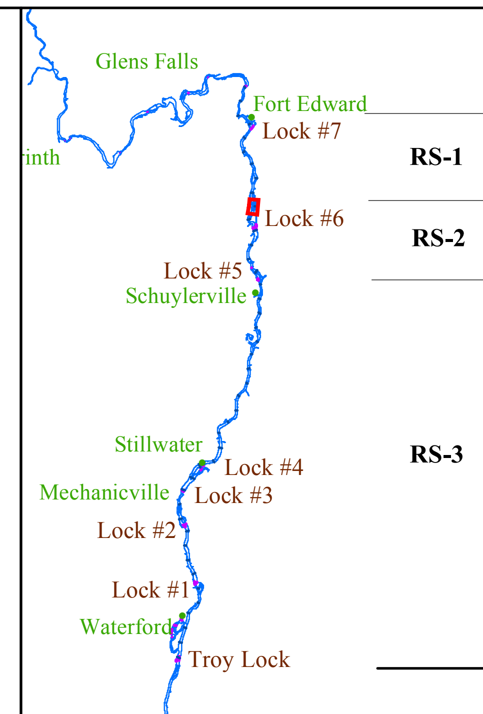
ANCHOR QEA

Feet
0 530 1,060

Figure 2-1f
Surface Sediment Sampling Locations In Non-dredge Areas
Surface Sediment Sampling Work Plan for 2016
Prepared for the General Electric Company





Legend

- Sampling Locations in Non-dredge Areas
- Backup Locations in Non-dredge Areas
- Certification Units (As Constructed)
- 25-foot Buffer from Dredge Area
- Dams and Locks
- Navigation Channel
- Hudson River

Sediment Types

- Clay, Silt, and Fine Sand
- Sand
- Coarse Sand and Gravel
- Transitional/Mixed
- Rocky

Notes:
Dredge area boundary shown does not account for the dredge to daylight. When using a backup location, the field team will follow the SOP presented in Attachment B; however, at locations that are near CU boundaries (i.e., within 25 ft.) precedence will be given to locating the point in the designated "strata" (i.e., non-dredge sediment). Therefore, the field team may select a sampling location that is further outside the CU boundary than the actual target locations, but will remain within 25 ft of the target.

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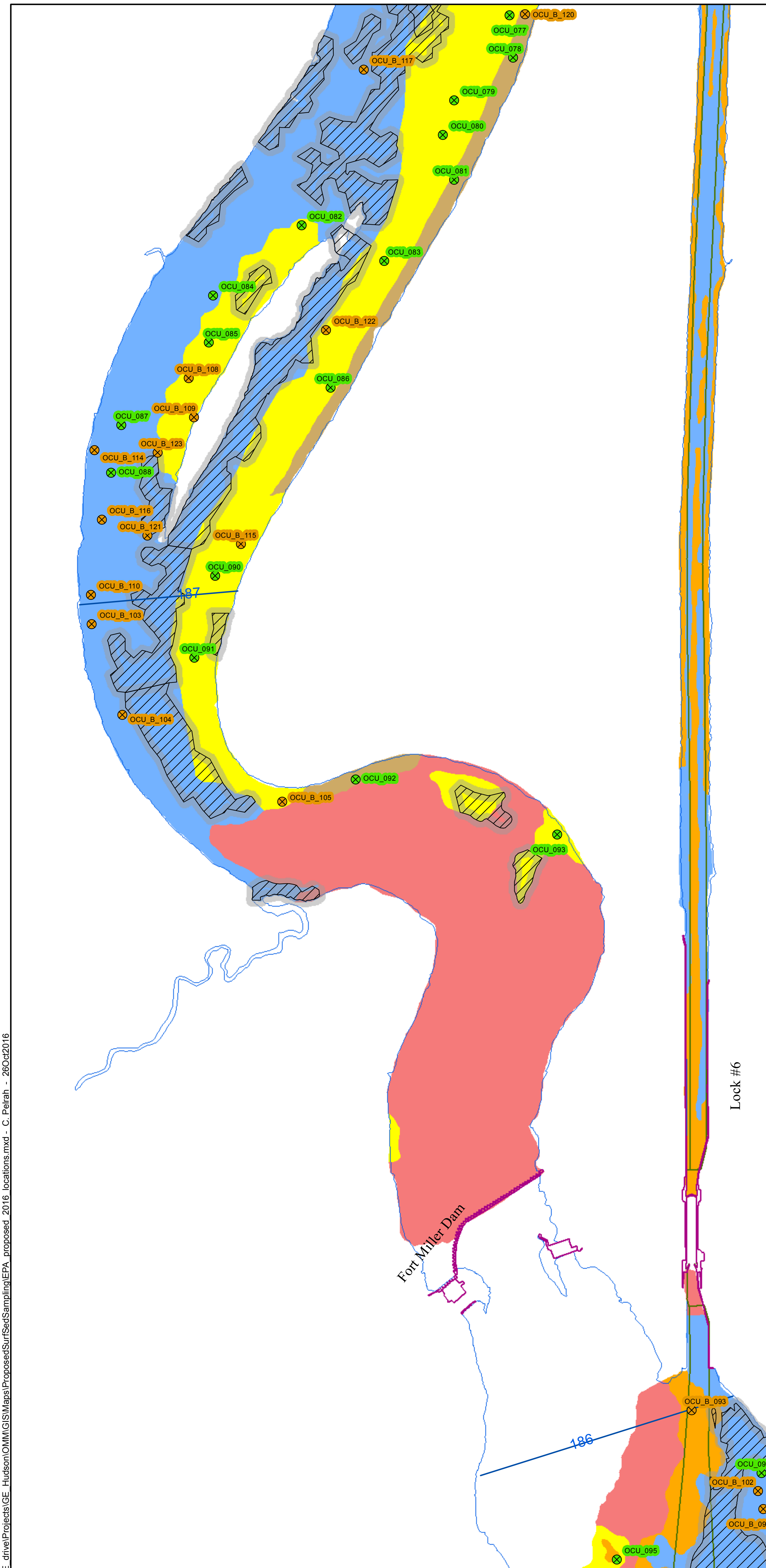
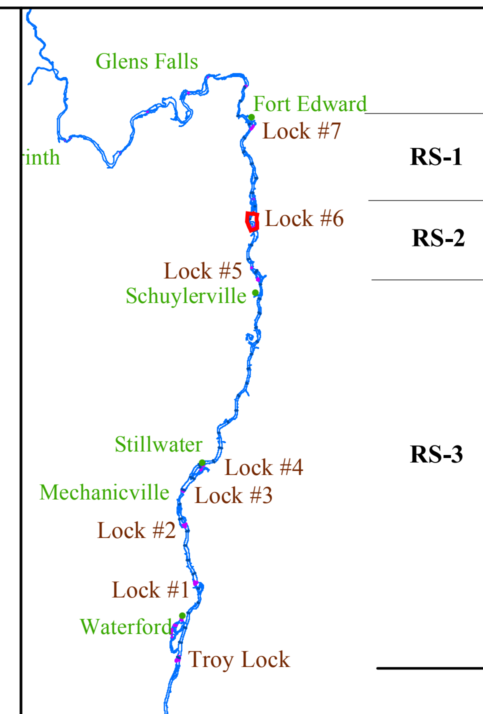
ANCHOR QEA

Feet
0 600 1,200

Figure 2-1g
Surface Sediment Sampling Locations In Non-dredge Areas
Surface Sediment Sampling Work Plan for 2016
Prepared for the General Electric Company





Legend

- Sampling Locations in Non-dredge Areas
- Backup Locations in Non-dredge Areas
- Certification Units (As Constructed)
- 25-foot Buffer from Dredge Area
- Dams and Locks
- Navigation Channel
- Hudson River

Sediment Types

- Clay, Silt, and Fine Sand
- Sand
- Coarse Sand and Gravel
- Transitional/Mixed
- Rocky

Notes:
Dredge area boundary shown does not account for the dredge to daylight. When using a backup location, the field team will follow the SOP presented in Attachment B; however, at locations that are near CU boundaries (i.e., within 25 ft.) precedence will be given to locating the point in the designated "strata" (i.e., non-dredge sediment). Therefore, the field team may select a sampling location that is further outside the CU boundary than the actual target locations, but will remain within 25 ft of the target.

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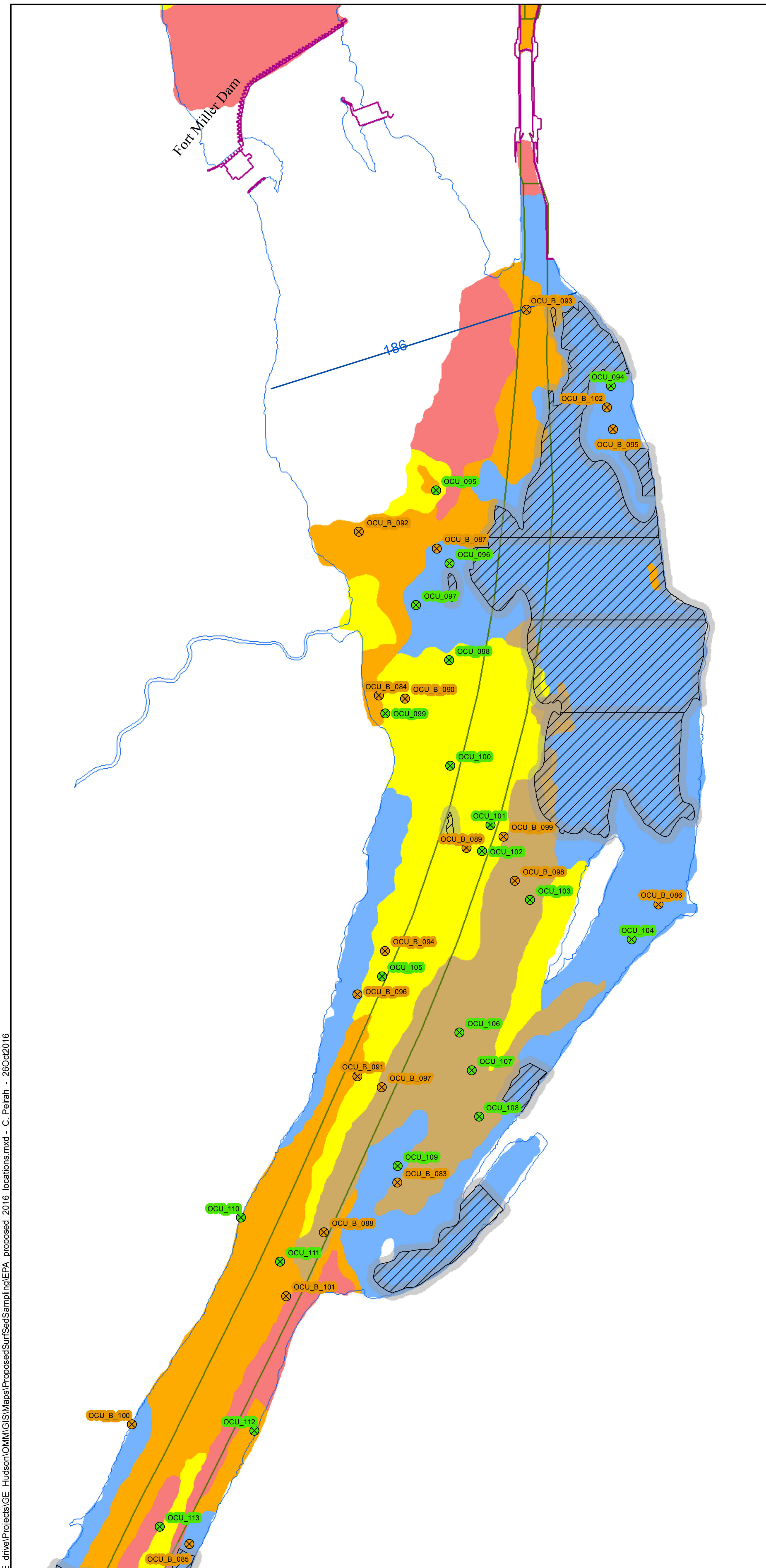
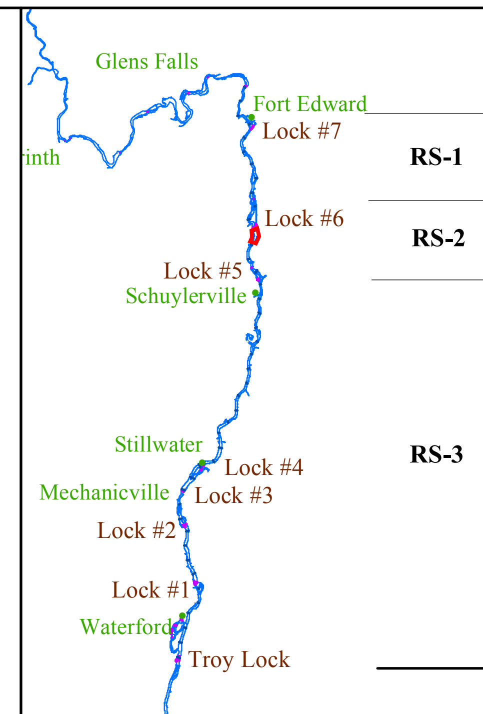
ANCHOR QEA

Feet
0 590 1,180

Figure 2-1h
Surface Sediment Sampling Locations In Non-dredge Areas
Surface Sediment Sampling Work Plan for 2016
Prepared for the General Electric Company





Legend

- Sampling Locations in Non-dredge Areas
- Backup Locations in Non-dredge Areas
- Certification Units (As Constructed)
- 25-foot Buffer from Dredge Area
- Dams and Locks
- Navigation Channel
- Hudson River

Sediment Types

- Clay, Silt, and Fine Sand
- Sand
- Coarse Sand and Gravel
- Transitional/Mixed
- Rocky

Notes:
Dredge area boundary shown does not account for the dredge to daylight. When using a backup location, the field team will follow the SOP presented in Attachment B; however, at locations that are near CU boundaries (i.e., within 25 ft.) precedence will be given to locating the point in the designated "strata" (i.e., non-dredge sediment). Therefore, the field team may select a sampling location that is further outside the CU boundary than the actual target locations, but will remain within 25 ft of the target.

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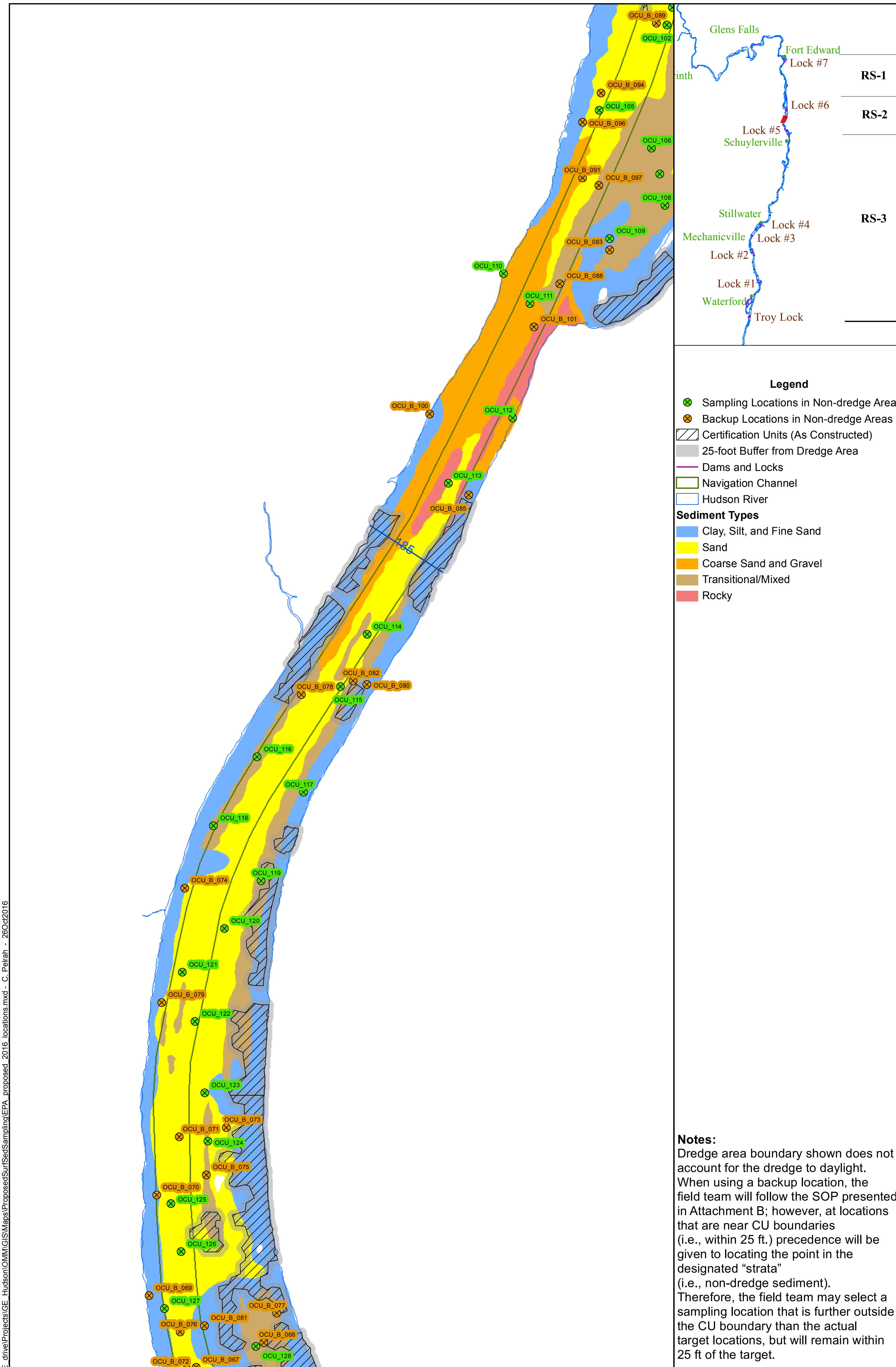
ANCHOR QEA

Feet
0 500 1,000

Figure 2-1i
Surface Sediment Sampling Locations In Non-dredge Areas
Surface Sediment Sampling Work Plan for 2016
Prepared for the General Electric Company



Legend

- Sampling Locations in Non-dredge Areas
- Backup Locations in Non-dredge Areas
- Certification Units (As Constructed)
- 25-foot Buffer from Dredge Area
- Dams and Locks
- Navigation Channel
- Hudson River

Sediment Types

- Clay, Silt, and Fine Sand
- Sand
- Coarse Sand and Gravel
- Transitional/Mixed
- Rocky

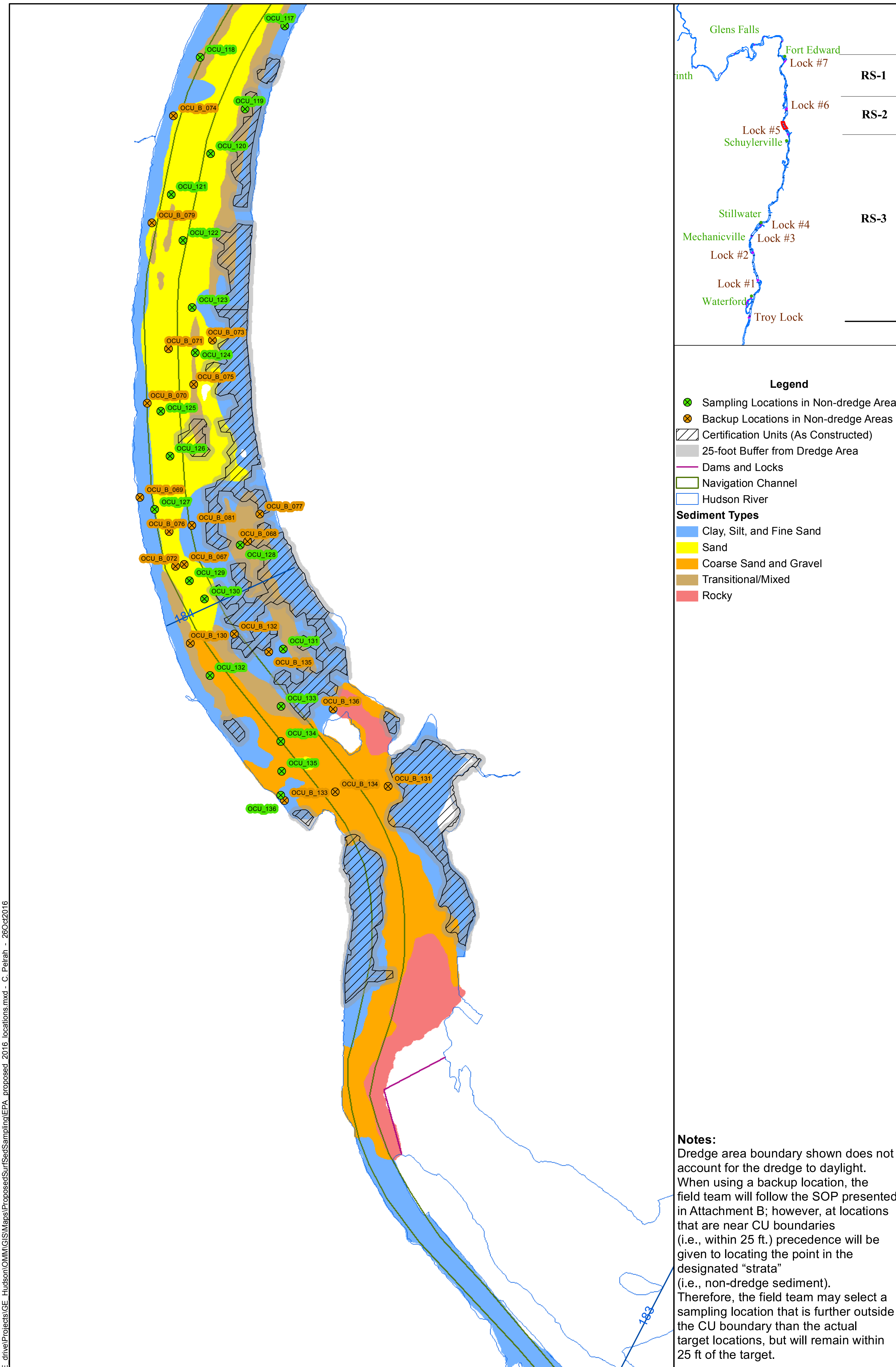
Notes:
Dredge area boundary shown does not account for the dredge to daylight. When using a backup location, the field team will follow the SOP presented in Attachment B; however, at locations that are near CU boundaries (i.e., within 25 ft.) precedence will be given to locating the point in the designated "strata" (i.e., non-dredge sediment). Therefore, the field team may select a sampling location that is further outside the CU boundary than the actual target locations, but will remain within 25 ft of the target.

H:\E_drive\Projects\GE_Hudson\OMM\GIS\Maps\ProposedSurfSedSampling\EPA_proposed_2016_locations.mxd - C. Pelrah - 26Oct2016

ANCHOR QEA

Feet
0 625 1,250

Figure 2-1j
Surface Sediment Sampling Locations In Non-dredge Areas
Surface Sediment Sampling Work Plan for 2016
Prepared for the General Electric Company



Notes:
Dredge area boundary shown does not account for the dredge to daylight. When using a backup location, the field team will follow the SOP presented in Attachment B; however, at locations that are near CU boundaries (i.e., within 25 ft.) precedence will be given to locating the point in the designated “strata” (i.e., non-dredge sediment). Therefore, the field team may select a sampling location that is further outside the CU boundary than the actual target locations, but will remain within 25 ft of the target.

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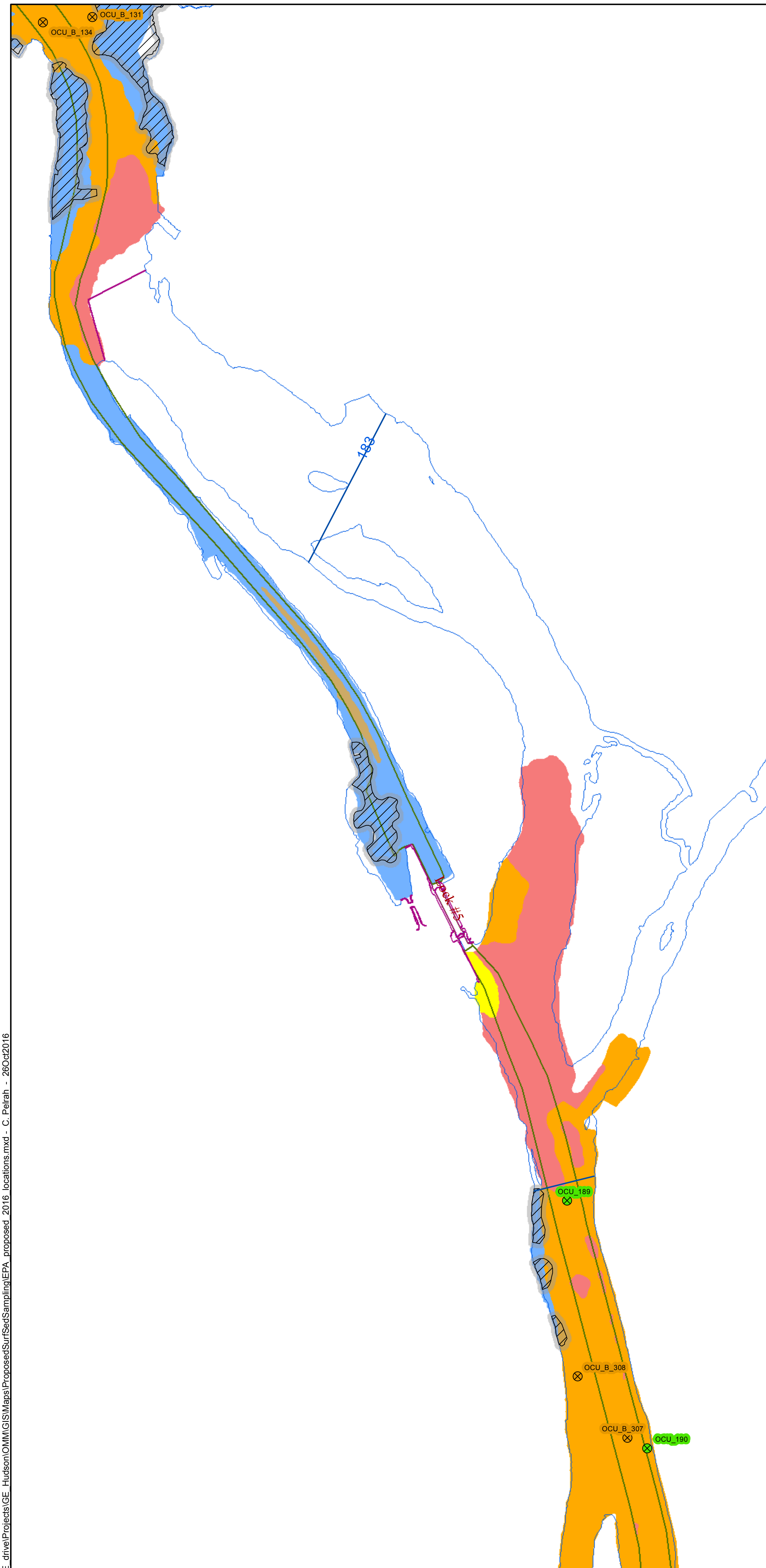
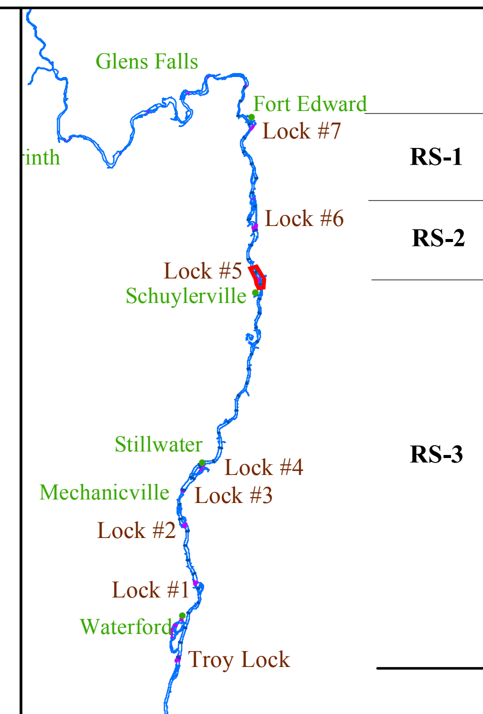
Figure 2-1k
Surface Sediment Sampling Locations In Non-dredge Areas
Surface Sediment Sampling Work Plan for 2016
Prepared for the General Electric Company





Legend

- Sampling Locations in Non-dredge Areas
- Backup Locations in Non-dredge Areas
- Certification Units (As Constructed)
- 25-foot Buffer from Dredge Area
- Dams and Locks
- Navigation Channel
- Hudson River

Sediment Types

- Clay, Silt, and Fine Sand
- Sand
- Coarse Sand and Gravel
- Transitional/Mixed
- Rocky

Notes:
Dredge area boundary shown does not account for the dredge to daylight. When using a backup location, the field team will follow the SOP presented in Attachment B; however, at locations that are near CU boundaries (i.e., within 25 ft.) precedence will be given to locating the point in the designated "strata" (i.e., non-dredge sediment). Therefore, the field team may select a sampling location that is further outside the CU boundary than the actual target locations, but will remain within 25 ft of the target.

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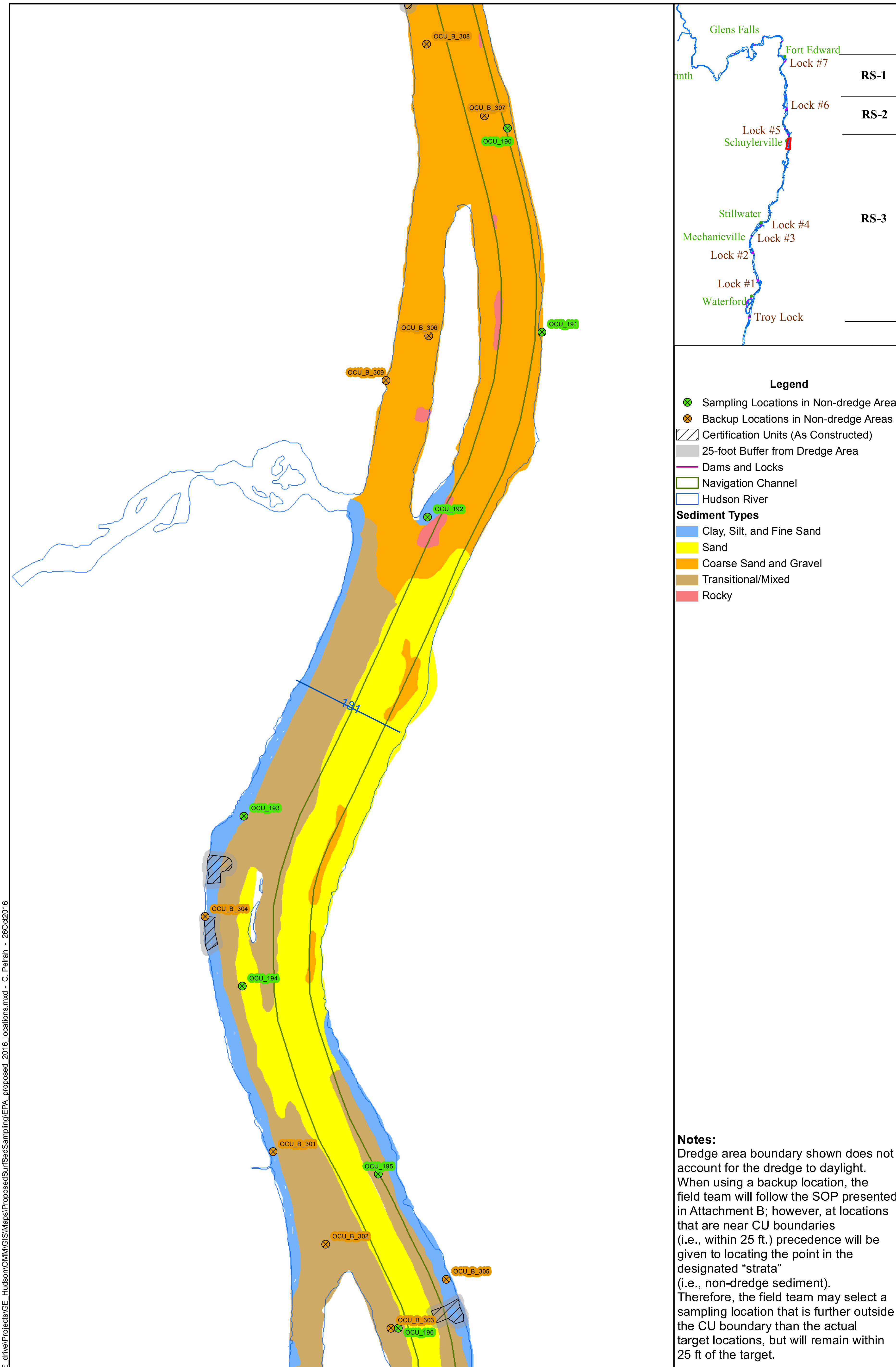
ANCHOR QEA

Feet
0 825 1,650

Figure 2-1l
Surface Sediment Sampling Locations In Non-dredge Areas
Surface Sediment Sampling Work Plan for 2016
Prepared for the General Electric Company

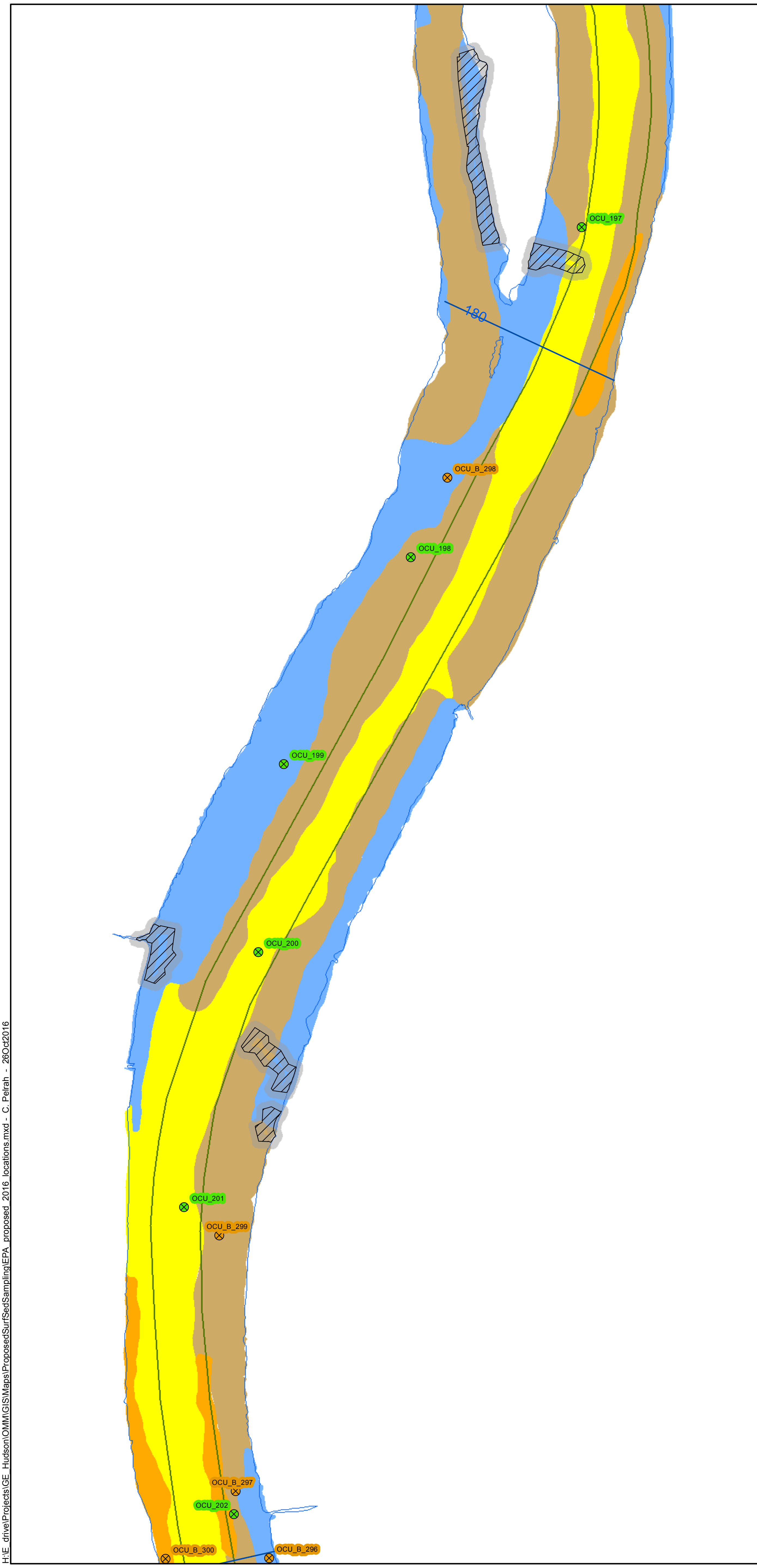


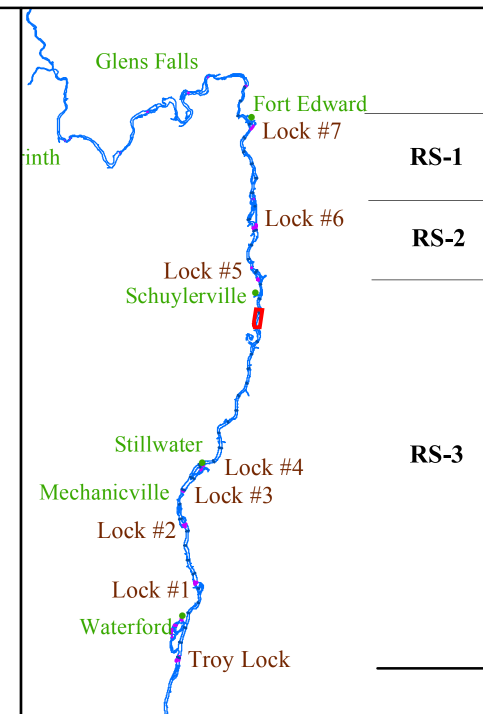
Notes:
Dredge area boundary shown does not account for the dredge to daylight. When using a backup location, the field team will follow the SOP presented in Attachment B; however, at locations that are near CU boundaries (i.e., within 25 ft.) precedence will be given to locating the point in the designated "strata" (i.e., non-dredge sediment). Therefore, the field team may select a sampling location that is further outside the CU boundary than the actual target locations, but will remain within 25 ft of the target.

H:\E_drive\Projects\GE_Hudson\OMM\GIS\Maps\ProposedSurfSedSampling\EPA_proposed_2016_locations.mxd - C. Pelrah - 26Oct2016

ANCHOR QEA

Figure 2-1m
Surface Sediment Sampling Locations In Non-dredge Areas
Surface Sediment Sampling Work Plan for 2016
Prepared for the General Electric Company





Legend

- Sampling Locations in Non-dredge Areas
- Backup Locations in Non-dredge Areas
- Certification Units (As Constructed)
- 25-foot Buffer from Dredge Area
- Dams and Locks
- Navigation Channel
- Hudson River

Sediment Types

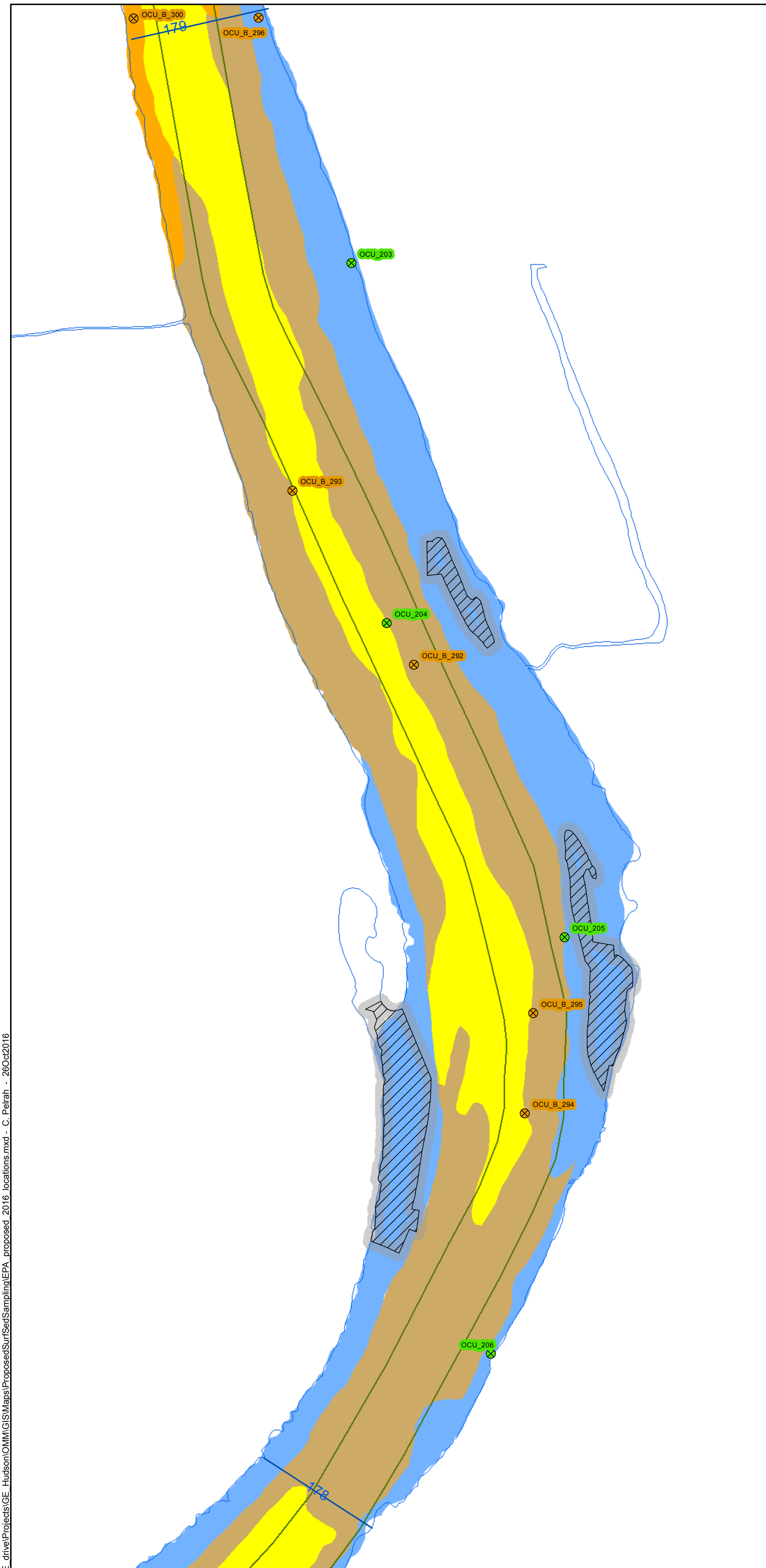
- Clay, Silt, and Fine Sand
- Sand
- Coarse Sand and Gravel
- Transitional/Mixed
- Rocky

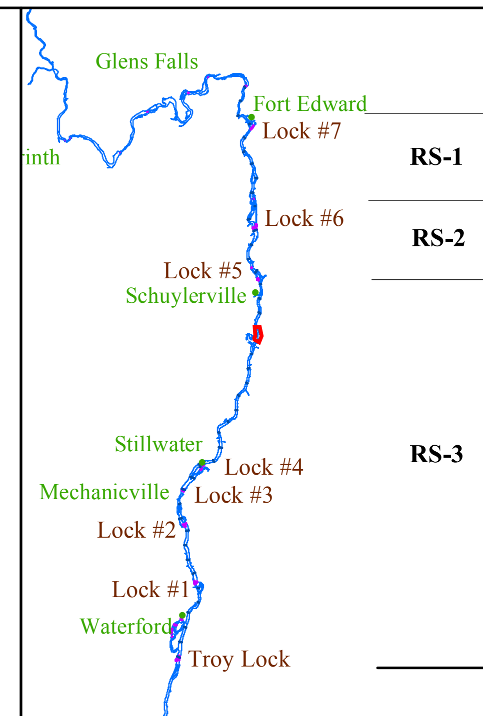
Notes:
Dredge area boundary shown does not account for the dredge to daylight. When using a backup location, the field team will follow the SOP presented in Attachment B; however, at locations that are near CU boundaries (i.e., within 25 ft.) precedence will be given to locating the point in the designated "strata" (i.e., non-dredge sediment). Therefore, the field team may select a sampling location that is further outside the CU boundary than the actual target locations, but will remain within 25 ft of the target.

ANCHOR QEA

Feet
0 500 1,000

Figure 2-1n
Surface Sediment Sampling Locations In Non-dredge Areas
Surface Sediment Sampling Work Plan for 2016
Prepared for the General Electric Company





Legend

- Sampling Locations in Non-dredge Areas
- Backup Locations in Non-dredge Areas
- Certification Units (As Constructed)
- 25-foot Buffer from Dredge Area
- Dams and Locks
- Navigation Channel
- Hudson River

Sediment Types

- Clay, Silt, and Fine Sand
- Sand
- Coarse Sand and Gravel
- Transitional/Mixed
- Rocky

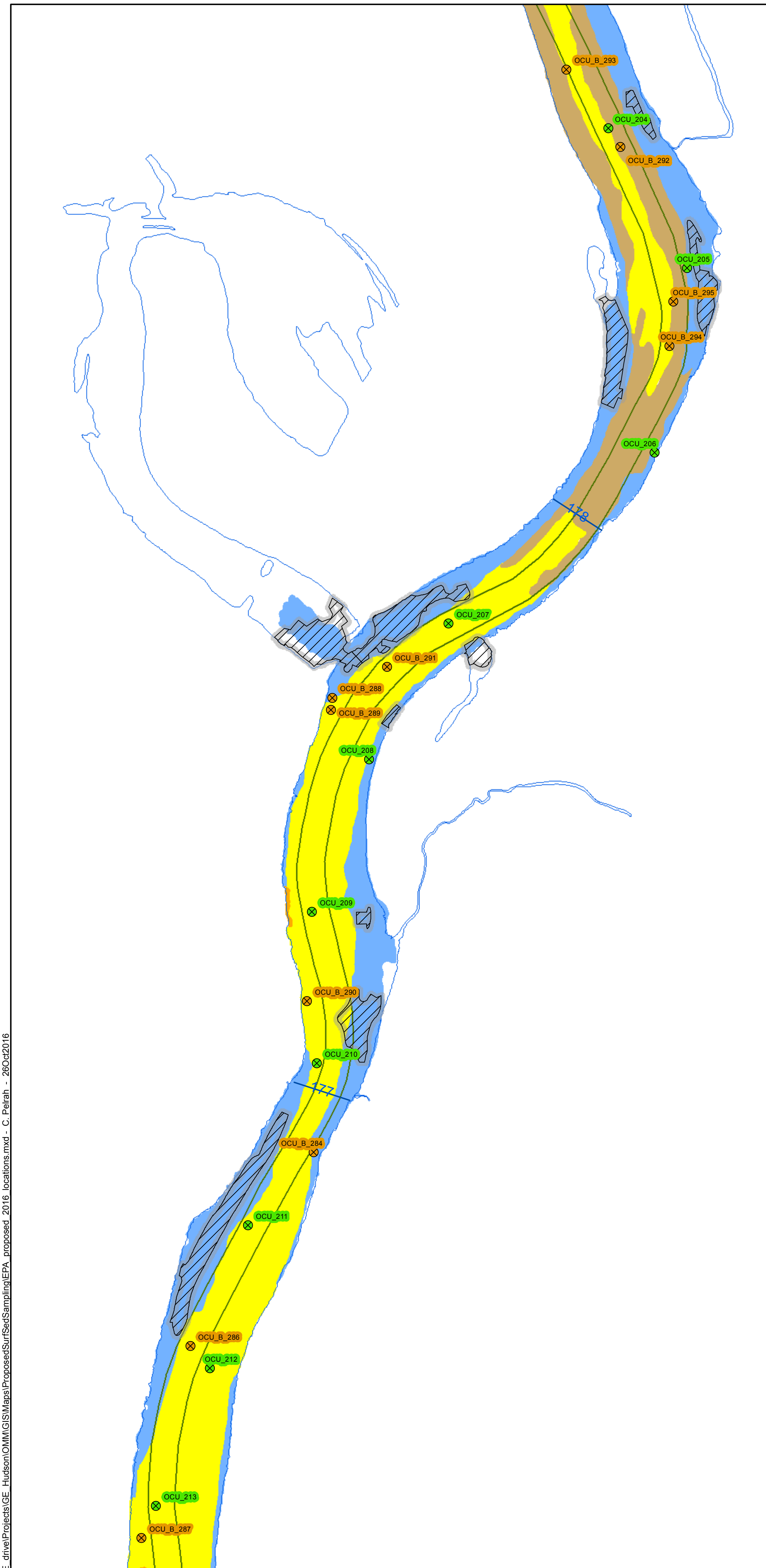
Notes:
Dredge area boundary shown does not account for the dredge to daylight. When using a backup location, the field team will follow the SOP presented in Attachment B; however, at locations that are near CU boundaries (i.e., within 25 ft.) precedence will be given to locating the point in the designated "strata" (i.e., non-dredge sediment). Therefore, the field team may select a sampling location that is further outside the CU boundary than the actual target locations, but will remain within 25 ft of the target.

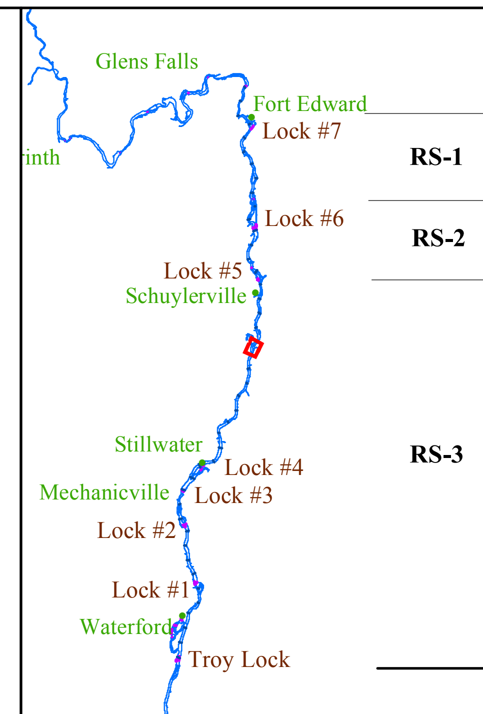
H:\E drive\Projects\GE Hudson\OMM\GIS\Maps\ProposedSurfSedSampling\EPA proposed 2016 locations.mxd - C. Pelrah - 26Oct2016

ANCHOR QEA

Feet
0 430 860

Figure 2-1o
Surface Sediment Sampling Locations In Non-dredge Areas
Surface Sediment Sampling Work Plan for 2016
Prepared for the General Electric Company





Legend

- Sampling Locations in Non-dredge Areas
- Backup Locations in Non-dredge Areas
- Certification Units (As Constructed)
- 25-foot Buffer from Dredge Area
- Dams and Locks
- Navigation Channel
- Hudson River

Sediment Types

- Clay, Silt, and Fine Sand
- Sand
- Coarse Sand and Gravel
- Transitional/Mixed
- Rocky

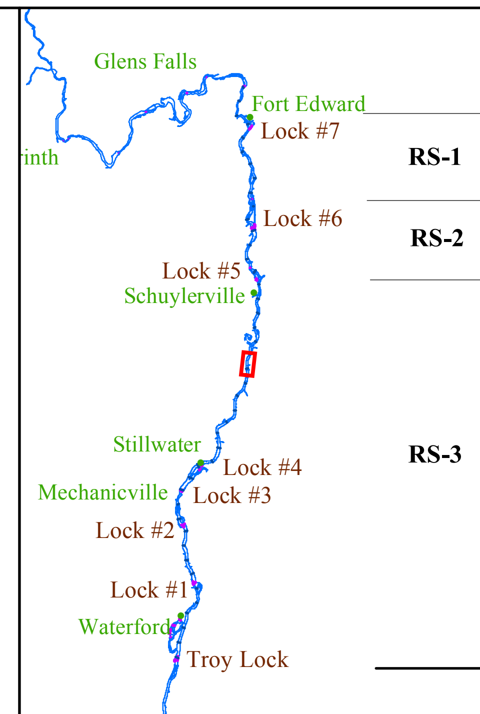
Notes:
Dredge area boundary shown does not account for the dredge to daylight. When using a backup location, the field team will follow the SOP presented in Attachment B; however, at locations that are near CU boundaries (i.e., within 25 ft.) precedence will be given to locating the point in the designated "strata" (i.e., non-dredge sediment). Therefore, the field team may select a sampling location that is further outside the CU boundary than the actual target locations, but will remain within 25 ft of the target.

H:\E_drive\Projects\GE_Hudson\OMM\GIS\Maps\ProposedSurfSedSampling\EPA_proposed_2016_locations.mxd - C. Pelrah - 26Oct2016

ANCHOR QEA

Feet
0 950 1,900

Figure 2-1p
Surface Sediment Sampling Locations In Non-dredge Areas
Surface Sediment Sampling Work Plan for 2016
Prepared for the General Electric Company



Legend

- Sampling Locations in Non-dredge Areas
- Backup Locations in Non-dredge Areas
- Certification Units (As Constructed)
- 25-foot Buffer from Dredge Area
- Dams and Locks
- Navigation Channel
- Hudson River

Sediment Types

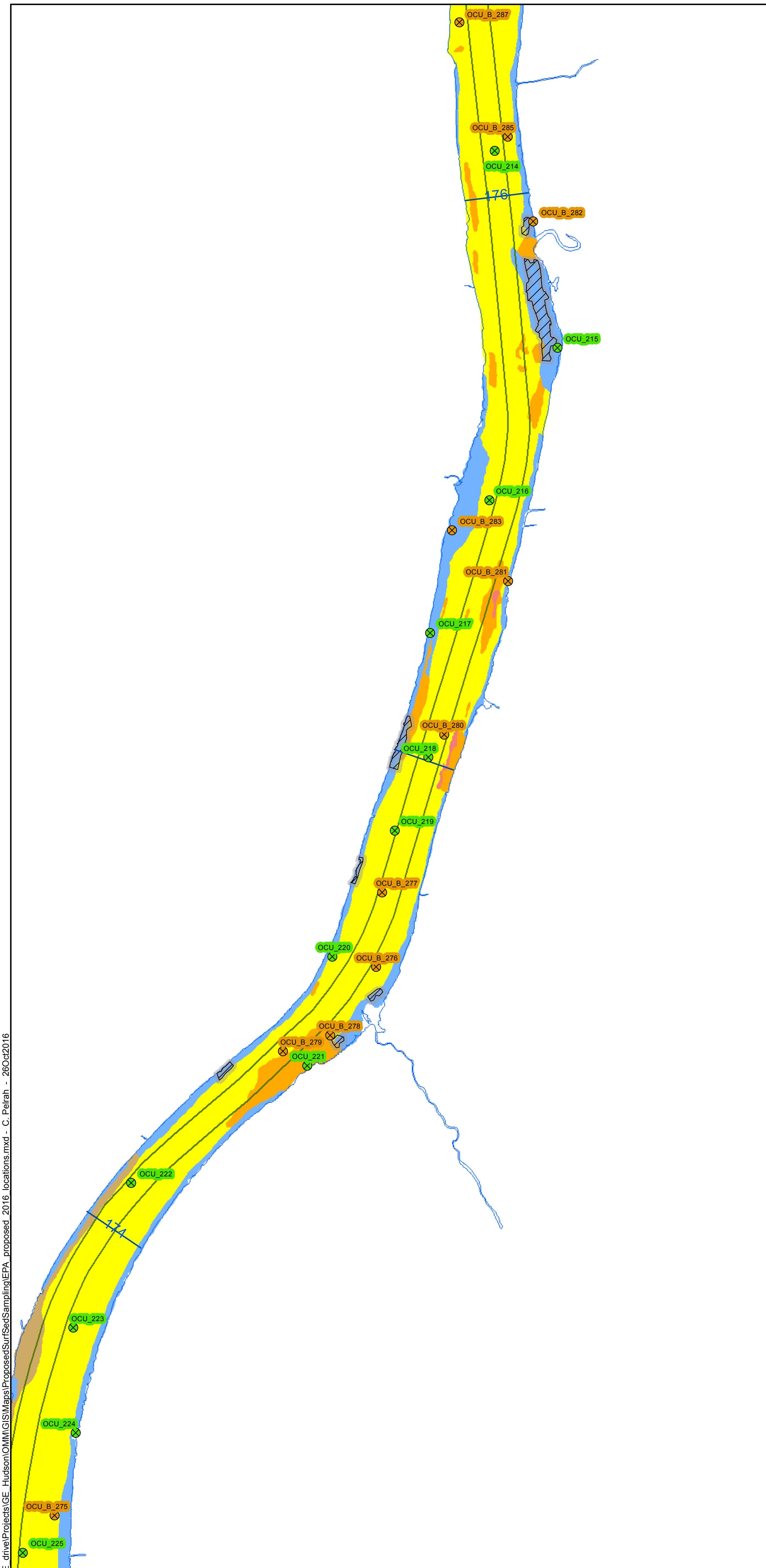
- Clay, Silt, and Fine Sand
- Sand
- Coarse Sand and Gravel
- Transitional/Mixed
- Rocky

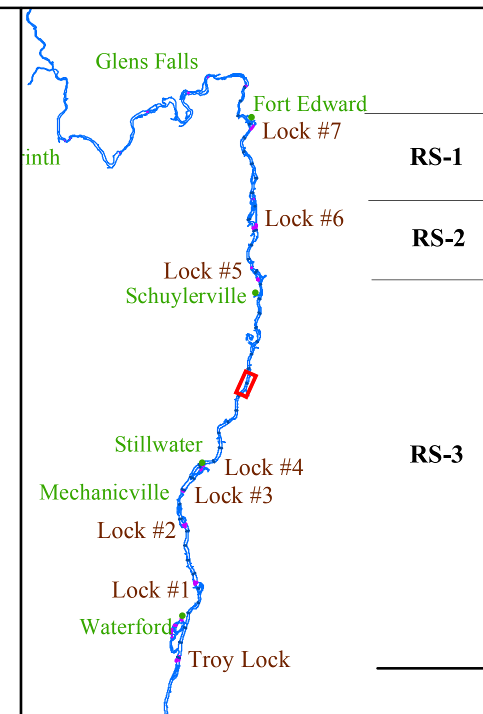
Notes:
Dredge area boundary shown does not account for the dredge to daylight. When using a backup location, the field team will follow the SOP presented in Attachment B; however, at locations that are near CU boundaries (i.e., within 25 ft.) precedence will be given to locating the point in the designated "strata" (i.e., non-dredge sediment). Therefore, the field team may select a sampling location that is further outside the CU boundary than the actual target locations, but will remain within 25 ft of the target.

ANCHOR QEA

Feet
0 810 1,620

Figure 2-1q
Surface Sediment Sampling Locations In Non-dredge Areas
Surface Sediment Sampling Work Plan for 2016
Prepared for the General Electric Company





Legend

- Sampling Locations in Non-dredge Areas
- Backup Locations in Non-dredge Areas
- Certification Units (As Constructed)
- 25-foot Buffer from Dredge Area
- Dams and Locks
- Navigation Channel
- Hudson River

Sediment Types

- Clay, Silt, and Fine Sand
- Sand
- Coarse Sand and Gravel
- Transitional/Mixed
- Rocky

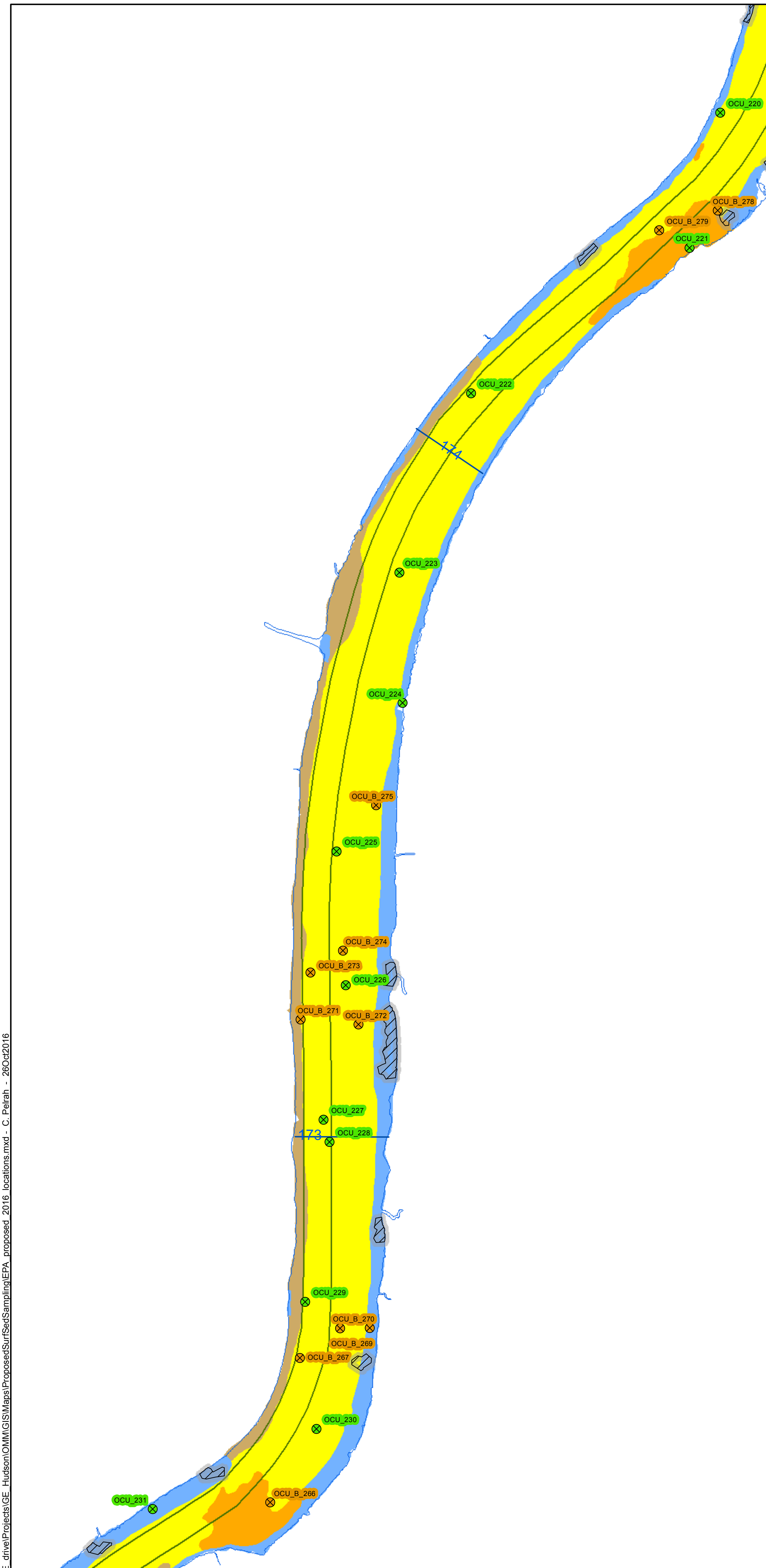
Notes:
Dredge area boundary shown does not account for the dredge to daylight. When using a backup location, the field team will follow the SOP presented in Attachment B; however, at locations that are near CU boundaries (i.e., within 25 ft.) precedence will be given to locating the point in the designated "strata" (i.e., non-dredge sediment). Therefore, the field team may select a sampling location that is further outside the CU boundary than the actual target locations, but will remain within 25 ft of the target.

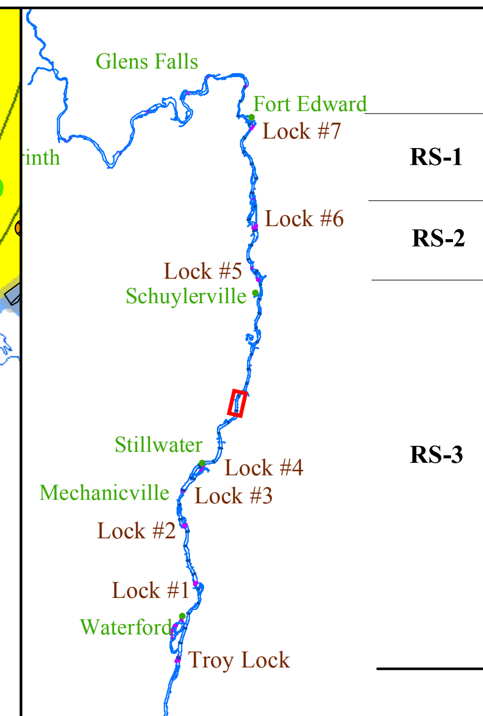
H:\E_drive\Projects\GE_Hudson\OMM\GIS\Maps\ProposedSurfSedSampling\EPA_proposed_2016_locations.mxd - C. Pelrah - 26Oct2016

ANCHOR QEA

Feet
0 1,100 2,200

Figure 2-1r
Surface Sediment Sampling Locations In Non-dredge Areas
Surface Sediment Sampling Work Plan for 2016
Prepared for the General Electric Company





Legend

- Sampling Locations in Non-dredge Areas
- Backup Locations in Non-dredge Areas
- Certification Units (As Constructed)
- 25-foot Buffer from Dredge Area
- Dams and Locks
- Navigation Channel
- Hudson River

Sediment Types

- Clay, Silt, and Fine Sand
- Sand
- Coarse Sand and Gravel
- Transitional/Mixed
- Rocky

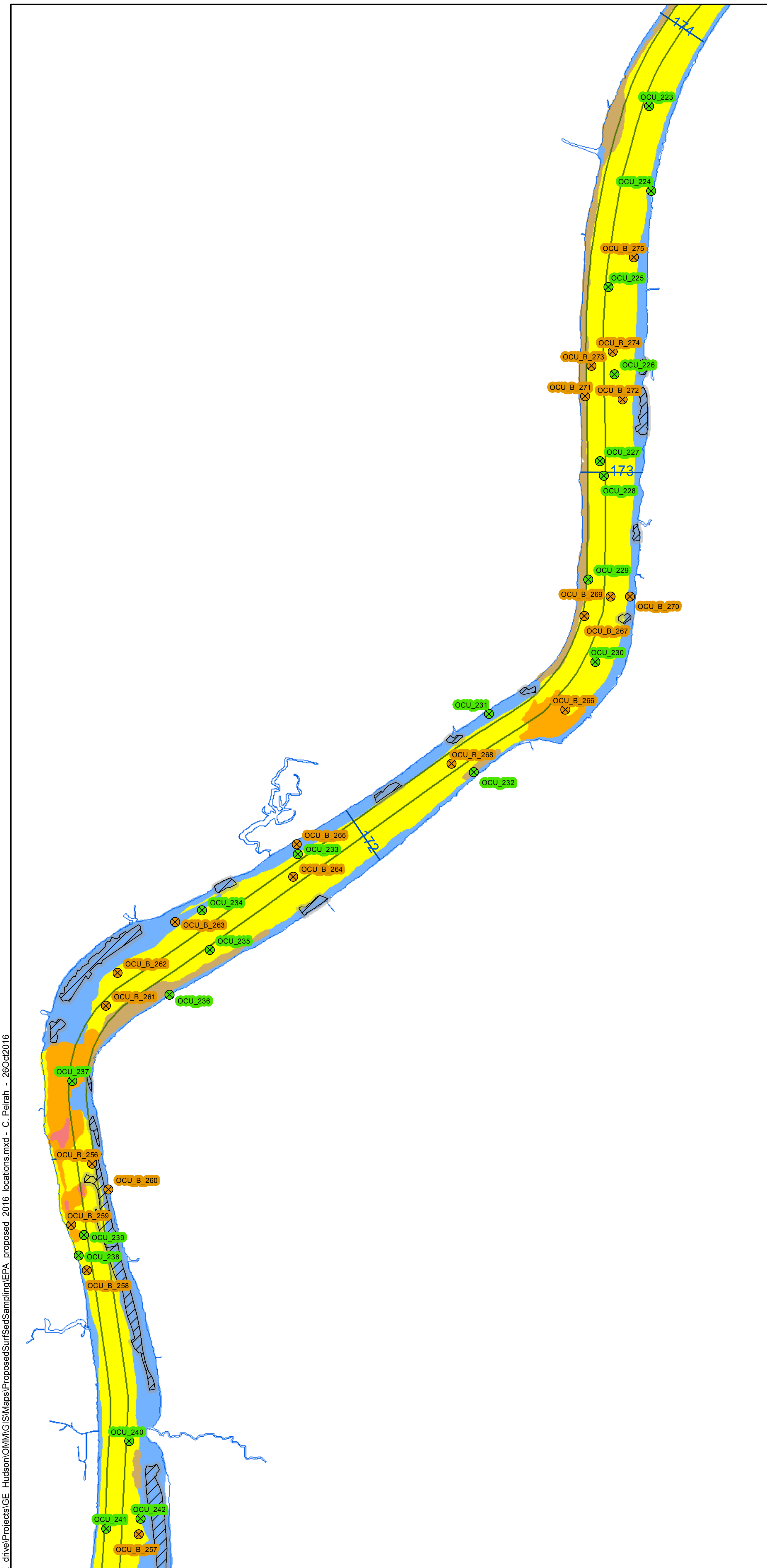
Notes:
Dredge area boundary shown does not account for the dredge to daylight. When using a backup location, the field team will follow the SOP presented in Attachment B; however, at locations that are near CU boundaries (i.e., within 25 ft.) precedence will be given to locating the point in the designated "strata" (i.e., non-dredge sediment). Therefore, the field team may select a sampling location that is further outside the CU boundary than the actual target locations, but will remain within 25 ft of the target.

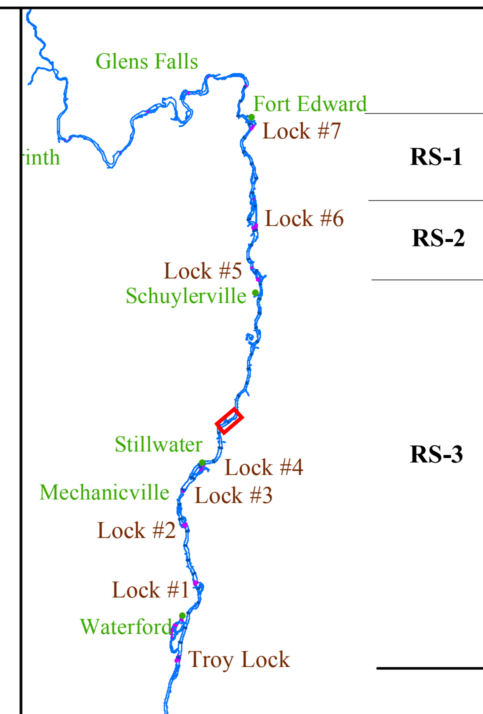
H:\E_drive\Projects\GE_Hudson\OMM\GIS\Maps\ProposedSurfSedSampling\EPA_proposed_2016_locations.mxd - C. Pelrah - 26Oct2016

ANCHOR QEA

Feet
0 925 1,850

Figure 2-1s
Surface Sediment Sampling Locations In Non-dredge Areas
Surface Sediment Sampling Work Plan for 2016
Prepared for the General Electric Company





Legend

- Sampling Locations in Non-dredge Areas
- Backup Locations in Non-dredge Areas
- Certification Units (As Constructed)
- 25-foot Buffer from Dredge Area
- Dams and Locks
- Navigation Channel
- Hudson River

Sediment Types

- Clay, Silt, and Fine Sand
- Sand
- Coarse Sand and Gravel
- Transitional/Mixed
- Rocky

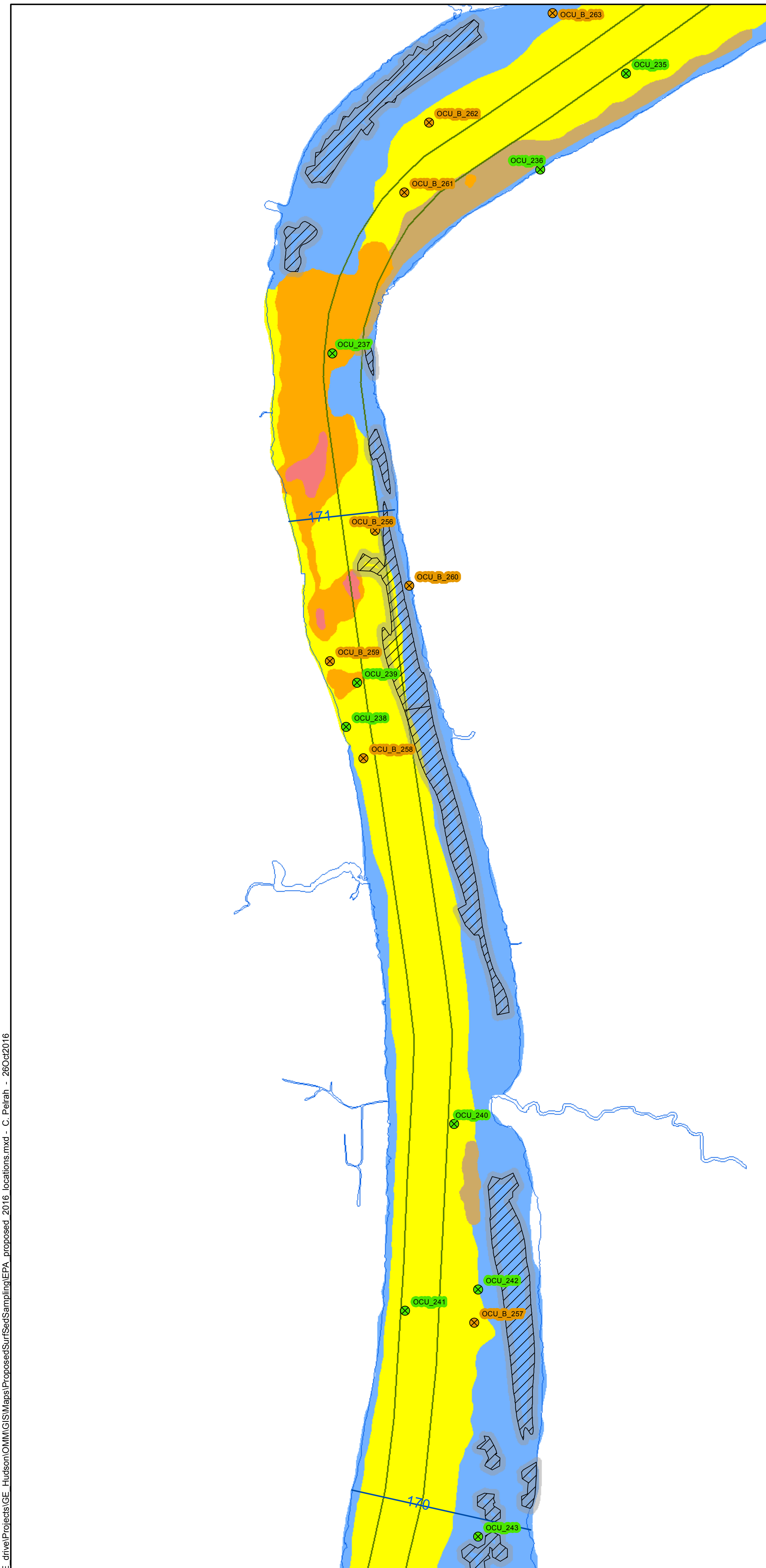
Notes:
Dredge area boundary shown does not account for the dredge to daylight. When using a backup location, the field team will follow the SOP presented in Attachment B; however, at locations that are near CU boundaries (i.e., within 25 ft.) precedence will be given to locating the point in the designated “strata” (i.e., non-dredge sediment). Therefore, the field team may select a sampling location that is further outside the CU boundary than the actual target locations, but will remain within 25 ft of the target.

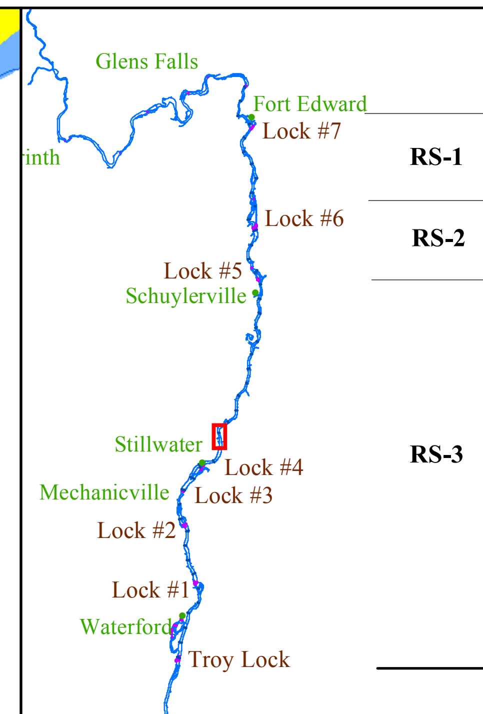
H:\E_drive\Projects\GE_Hudson\OMM\GIS\Maps\ProposedSurfSedSampling\EPA_proposed_2016_locations.mxd - C. Pelrah - 26Oct2016

ANCHOR QEA

Feet
0 1,400 2,800

Figure 2-1t
Surface Sediment Sampling Locations In Non-dredge Areas
Surface Sediment Sampling Work Plan for 2016
Prepared for the General Electric Company





Legend

- Sampling Locations in Non-dredge Areas
- Backup Locations in Non-dredge Areas
- Certification Units (As Constructed)
- 25-foot Buffer from Dredge Area
- Dams and Locks
- Navigation Channel
- Hudson River

Sediment Types

- Clay, Silt, and Fine Sand
- Sand
- Coarse Sand and Gravel
- Transitional/Mixed
- Rocky

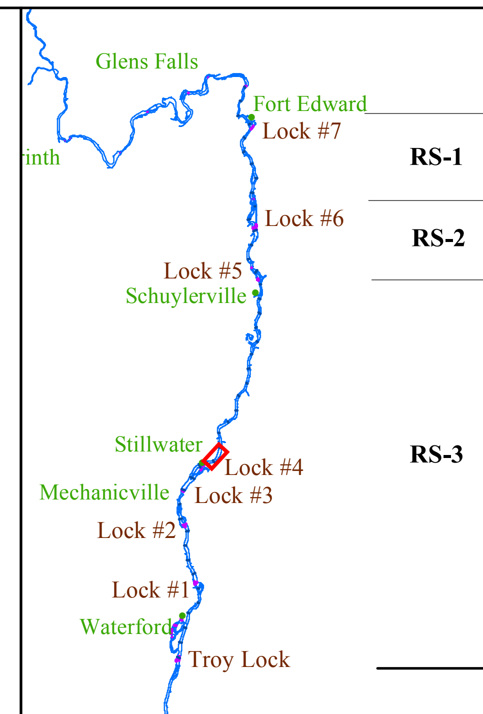
Notes:
Dredge area boundary shown does not account for the dredge to daylight. When using a backup location, the field team will follow the SOP presented in Attachment B; however, at locations that are near CU boundaries (i.e., within 25 ft.) precedence will be given to locating the point in the designated “strata” (i.e., non-dredge sediment). Therefore, the field team may select a sampling location that is further outside the CU boundary than the actual target locations, but will remain within 25 ft of the target.

H:\E_drive\Projects\GE_Hudson\OMM\GIS\Maps\ProposedSurfSedSampling\EPA_proposed_2016_locations.mxd - C. Pelrah - 26Oct2016

ANCHOR QEA

Feet
0 670 1,340

Figure 2-1u
Surface Sediment Sampling Locations In Non-dredge Areas
Surface Sediment Sampling Work Plan for 2016
Prepared for the General Electric Company



Legend

- Sampling Locations in Non-dredge Areas
- Backup Locations in Non-dredge Areas
- Certification Units (As Constructed)
- 25-foot Buffer from Dredge Area
- Dams and Locks
- Navigation Channel
- Hudson River

Sediment Types

- Clay, Silt, and Fine Sand
- Sand
- Coarse Sand and Gravel
- Transitional/Mixed
- Rocky

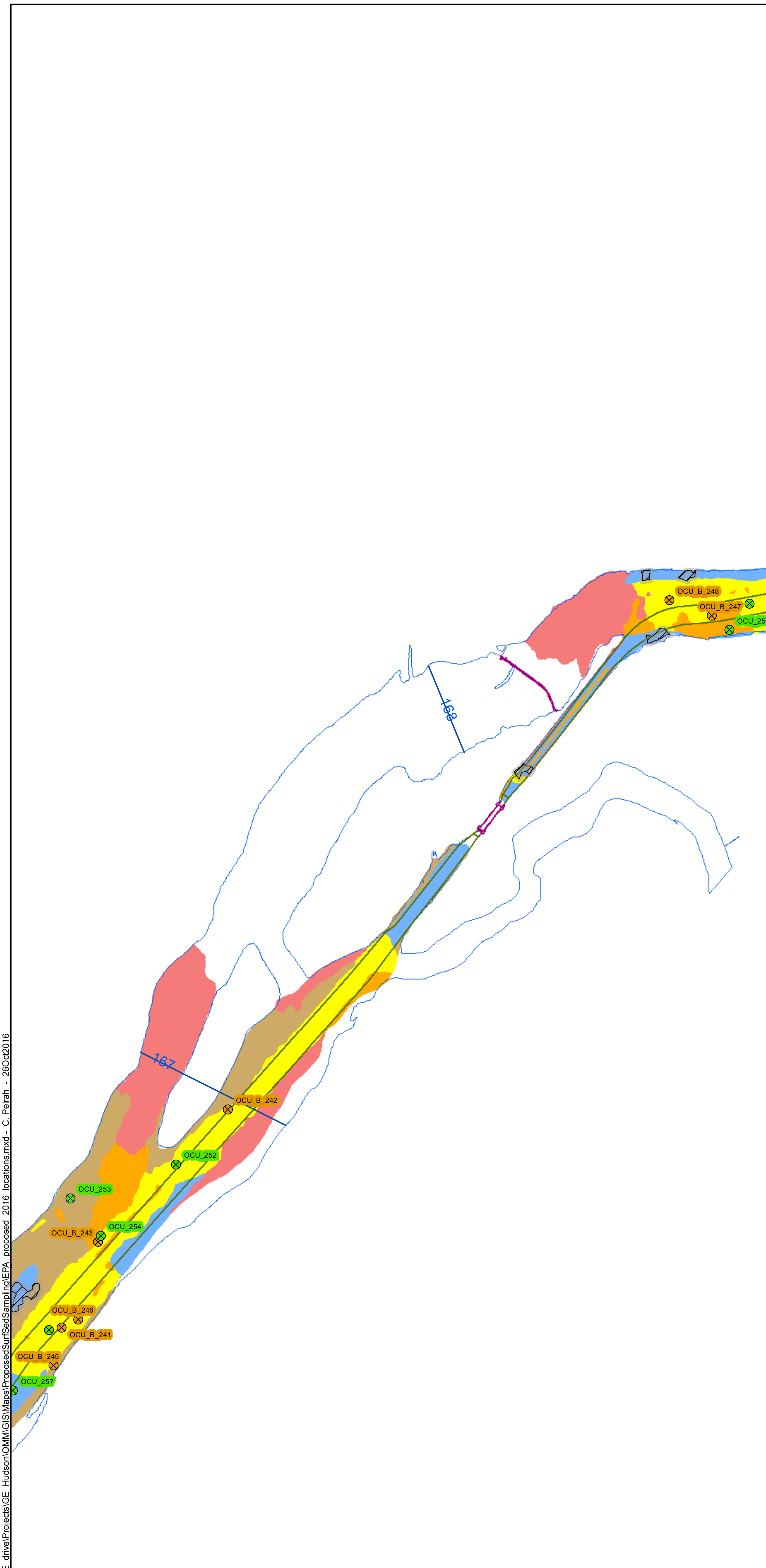
Notes:
Dredge area boundary shown does not account for the dredge to daylight. When using a backup location, the field team will follow the SOP presented in Attachment B; however, at locations that are near CU boundaries (i.e., within 25 ft.) precedence will be given to locating the point in the designated "strata" (i.e., non-dredge sediment). Therefore, the field team may select a sampling location that is further outside the CU boundary than the actual target locations, but will remain within 25 ft of the target.

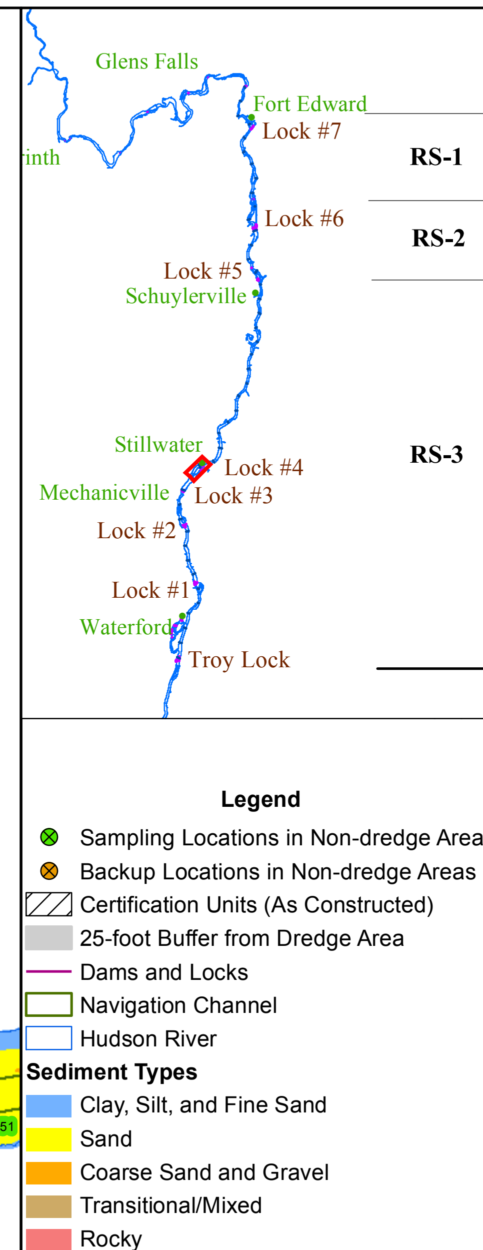
H:\E_drive\Projects\GE_Hudson\OMM\GIS\Maps\ProposedSurfSedSampling\EPA_proposed_2016_locations.mxd - C. Pelrah - 26Oct2016

ANCHOR QEA

Feet
0 1,300 2,600

Figure 2-1v
Surface Sediment Sampling Locations In Non-dredge Areas
Surface Sediment Sampling Work Plan for 2016
Prepared for the General Electric Company



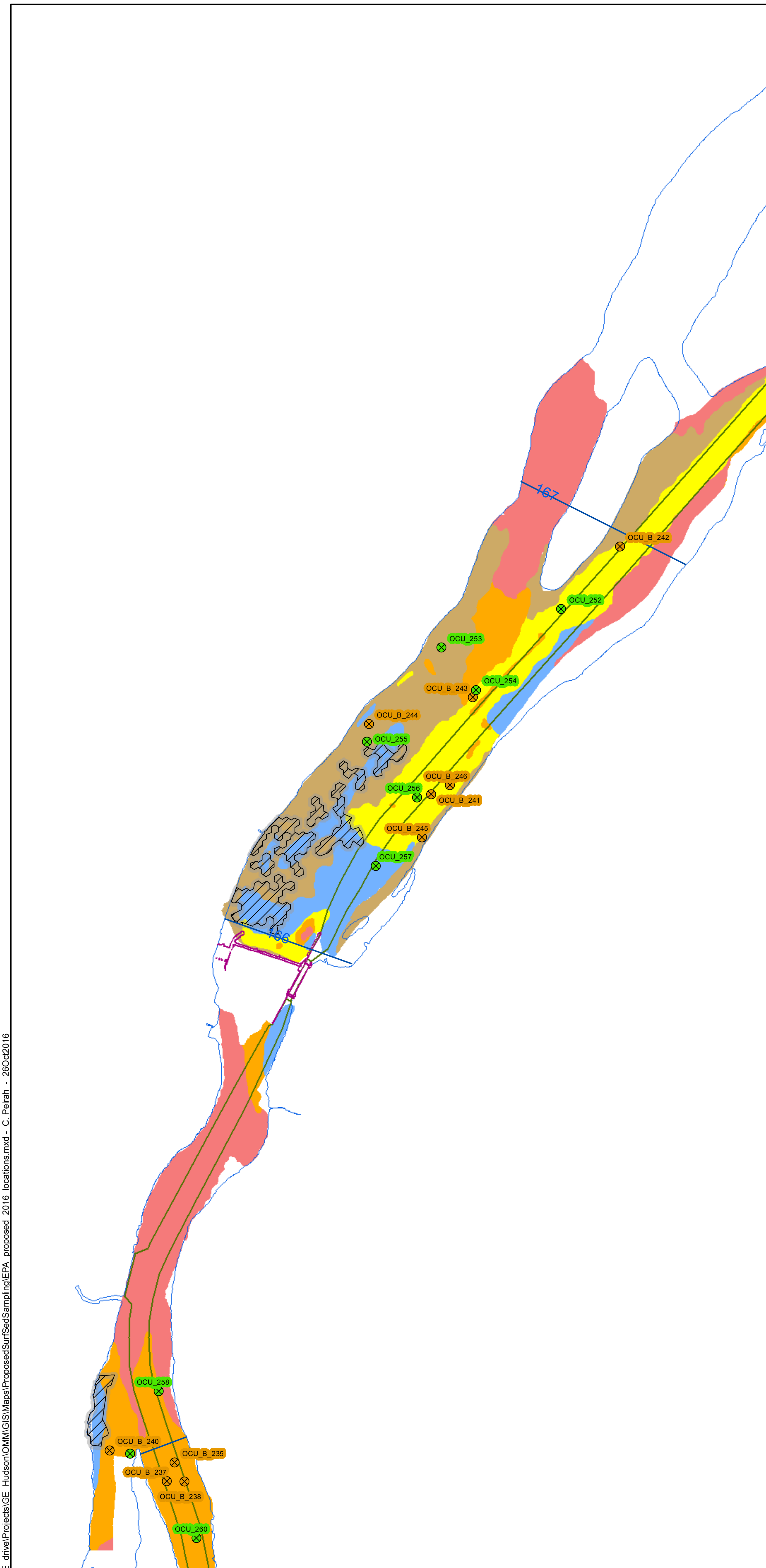


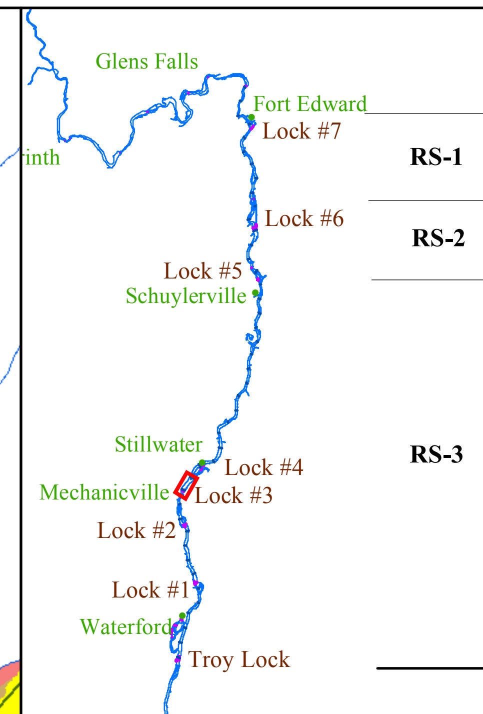
Notes:
Dredge area boundary shown does not account for the dredge to daylight. When using a backup location, the field team will follow the SOP presented in Attachment B; however, at locations that are near CU boundaries (i.e., within 25 ft.) precedence will be given to locating the point in the designated "strata" (i.e., non-dredge sediment). Therefore, the field team may select a sampling location that is further outside the CU boundary than the actual target locations, but will remain within 25 ft of the target.

ANCHOR QEA

Feet
0 1,400 2,800

Figure 2-1w
Surface Sediment Sampling Locations In Non-dredge Areas
Surface Sediment Sampling Work Plan for 2016
Prepared for the General Electric Company





Legend

- Sampling Locations in Non-dredge Areas
- Backup Locations in Non-dredge Areas
- Certification Units (As Constructed)
- 25-foot Buffer from Dredge Area
- Dams and Locks
- Navigation Channel
- Hudson River

Sediment Types

- Clay, Silt, and Fine Sand
- Sand
- Coarse Sand and Gravel
- Transitional/Mixed
- Rocky

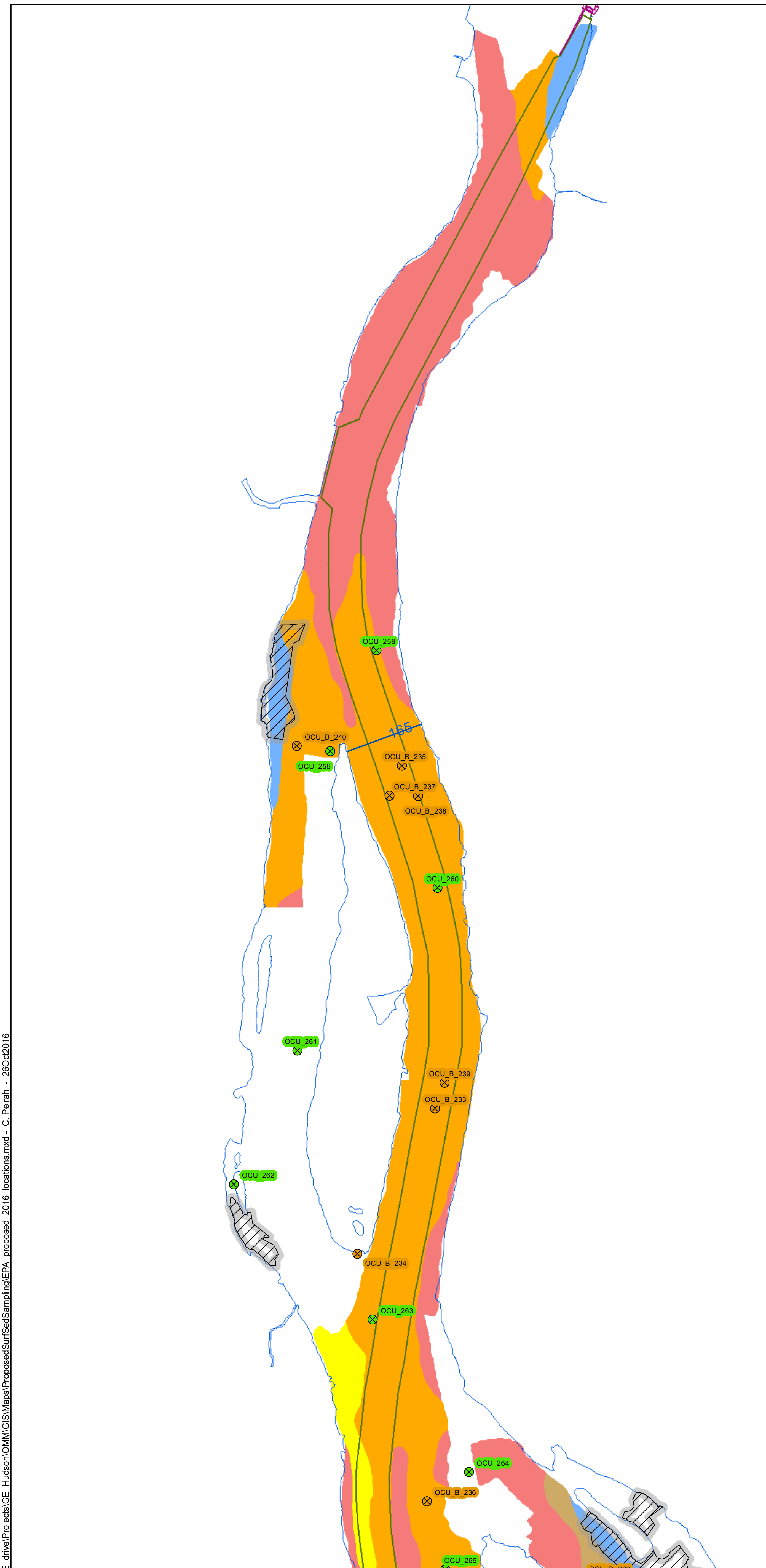
Notes:
Dredge area boundary shown does not account for the dredge to daylight. When using a backup location, the field team will follow the SOP presented in Attachment B; however, at locations that are near CU boundaries (i.e., within 25 ft.) precedence will be given to locating the point in the designated “strata” (i.e., non-dredge sediment). Therefore, the field team may select a sampling location that is further outside the CU boundary than the actual target locations, but will remain within 25 ft of the target.

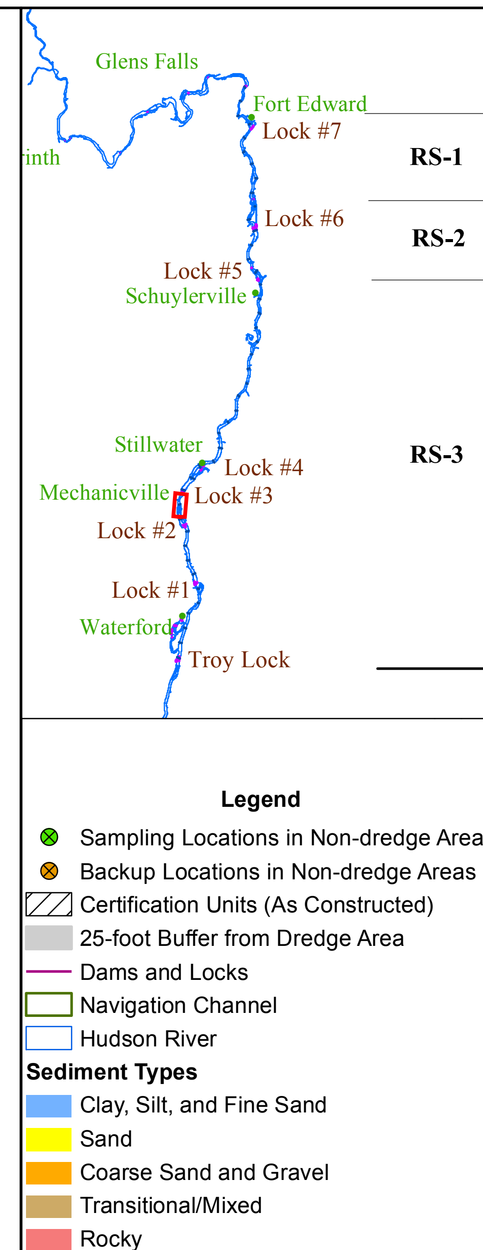
H:\E_drive\Projects\GE_Hudson\OMM\GIS\Maps\ProposedSurfSedSampling\EPA_proposed_2016_locations.mxd - C. Pelrah - 26Oct2016

ANCHOR QEA

Feet
0 1,200 2,400

Figure 2-1x
Surface Sediment Sampling Locations In Non-dredge Areas
Surface Sediment Sampling Work Plan for 2016
Prepared for the General Electric Company





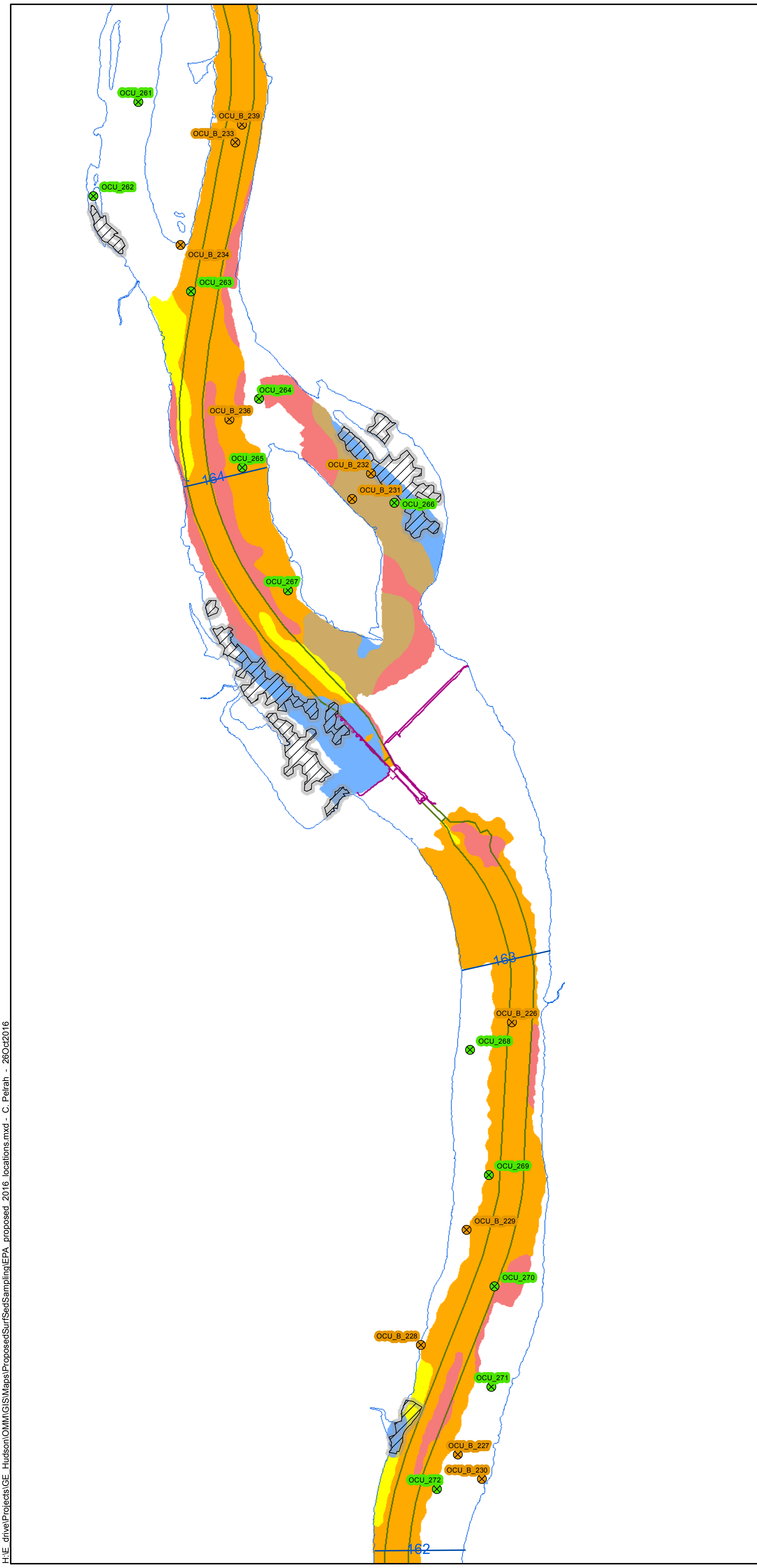
Notes:
Dredge area boundary shown does not account for the dredge to daylight. When using a backup location, the field team will follow the SOP presented in Attachment B; however, at locations that are near CU boundaries (i.e., within 25 ft.) precedence will be given to locating the point in the designated “strata” (i.e., non-dredge sediment). Therefore, the field team may select a sampling location that is further outside the CU boundary than the actual target locations, but will remain within 25 ft of the target.

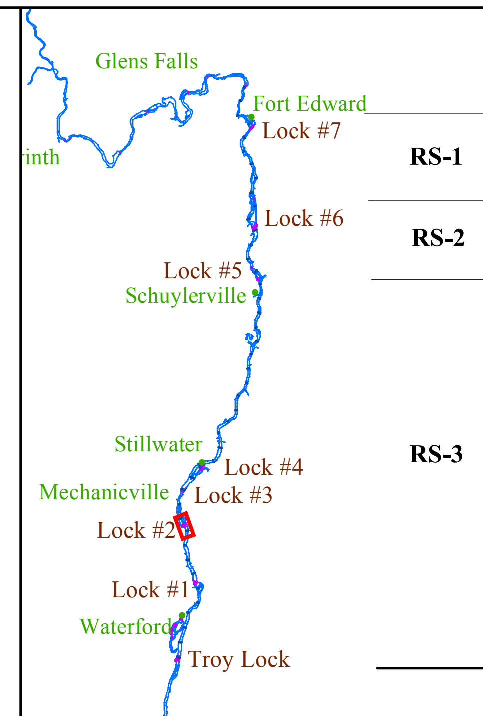
H:\E_drive\Projects\GE_Hudson\OMM\GIS\Maps\ProposedSurfSedSampling\EPA_proposed_2016_locations.mxd - C. Pelrah - 26Oct2016

ANCHOR QEA

Feet
0 760 1,520

Figure 2-1y
Surface Sediment Sampling Locations In Non-dredge Areas
Surface Sediment Sampling Work Plan for 2016
Prepared for the General Electric Company





Legend

- Sampling Locations in Non-dredge Areas
- Backup Locations in Non-dredge Areas
- Certification Units (As Constructed)
- 25-foot Buffer from Dredge Area
- Dams and Locks
- Navigation Channel
- Hudson River

Sediment Types

- Clay, Silt, and Fine Sand
- Sand
- Coarse Sand and Gravel
- Transitional/Mixed
- Rocky

Notes:
Dredge area boundary shown does not account for the dredge to daylight. When using a backup location, the field team will follow the SOP presented in Attachment B; however, at locations that are near CU boundaries (i.e., within 25 ft.) precedence will be given to locating the point in the designated "strata" (i.e., non-dredge sediment). Therefore, the field team may select a sampling location that is further outside the CU boundary than the actual target locations, but will remain within 25 ft of the target.

H:\E_drive\Projects\GE_Hudson\OMM\GIS\Maps\ProposedSurfSedSampling\EPA_proposed_2016_locations.mxd - C. Pelrah - 26Oct2016

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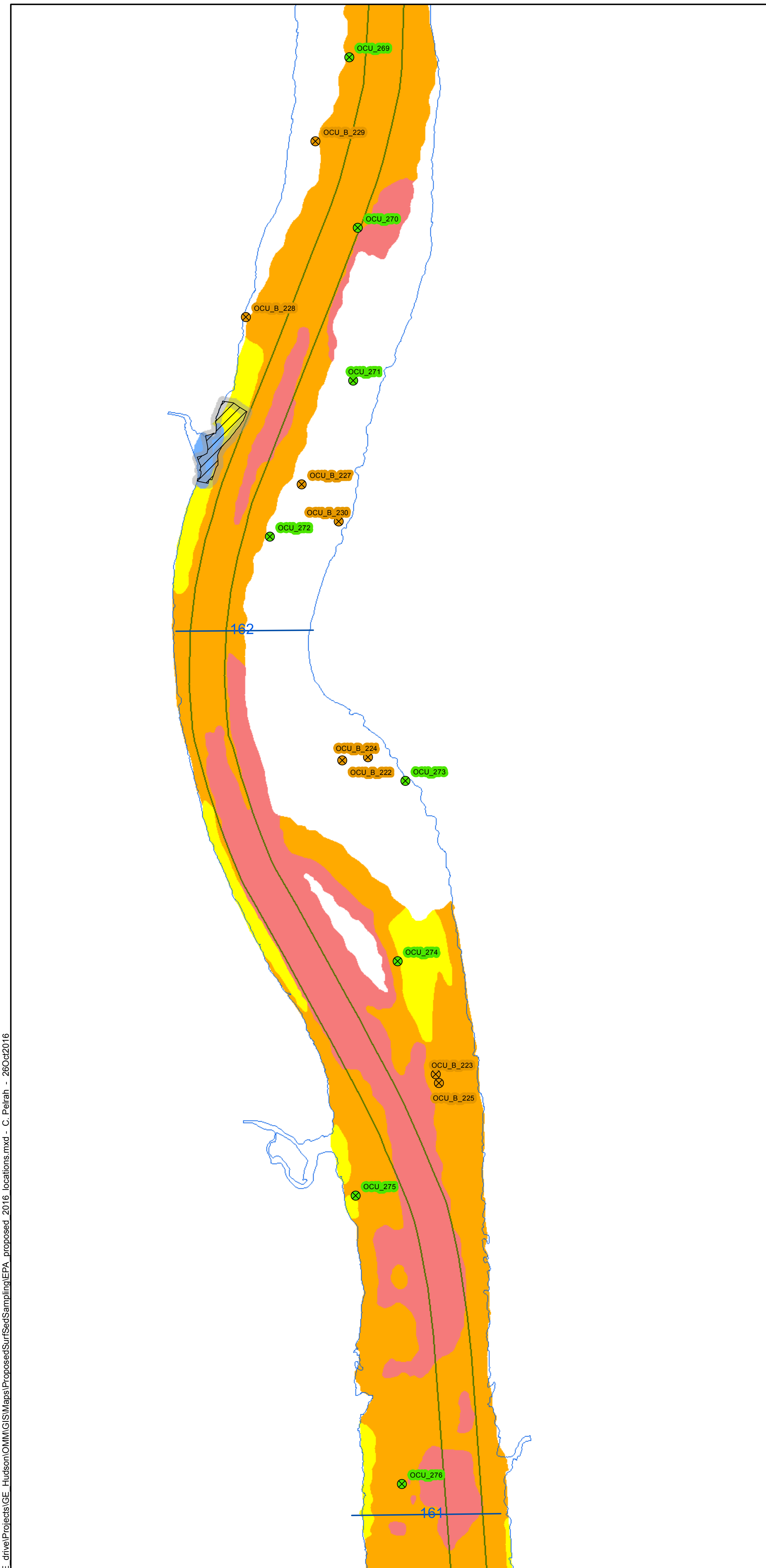
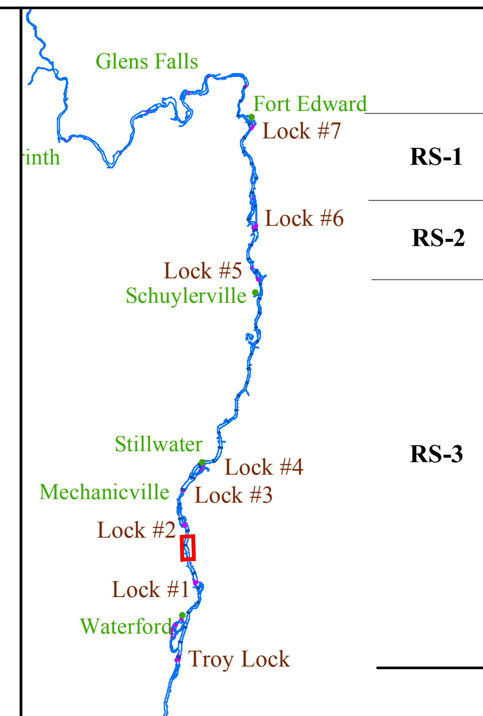
Figure 2-1z
Surface Sediment Sampling Locations In Non-dredge Areas
Surface Sediment Sampling Work Plan for 2016
Prepared for the General Electric Company





Legend

- Sampling Locations in Non-dredge Areas
- Backup Locations in Non-dredge Areas
- Certification Units (As Constructed)
- 25-foot Buffer from Dredge Area
- Dams and Locks
- Navigation Channel
- Hudson River

Sediment Types

- Clay, Silt, and Fine Sand
- Sand
- Coarse Sand and Gravel
- Transitional/Mixed
- Rocky

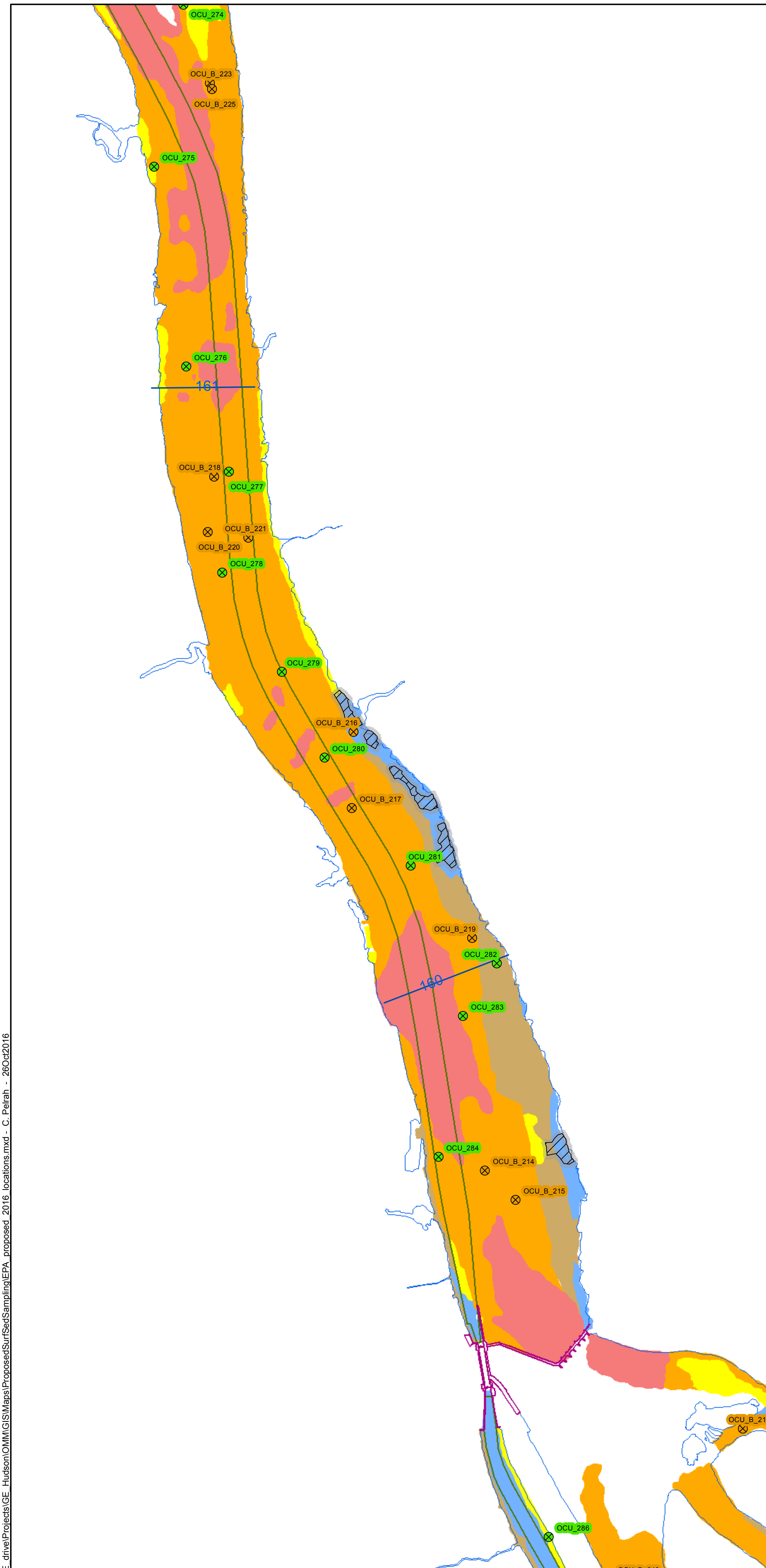
Notes:
Dredge area boundary shown does not account for the dredge to daylight. When using a backup location, the field team will follow the SOP presented in Attachment B; however, at locations that are near CU boundaries (i.e., within 25 ft.) precedence will be given to locating the point in the designated "strata" (i.e., non-dredge sediment). Therefore, the field team may select a sampling location that is further outside the CU boundary than the actual target locations, but will remain within 25 ft of the target.

H:\E_drive\Projects\GE_Hudson\OMM\GIS\Maps\ProposedSurfSedSampling\EPA_proposed_2016_locations.mxd - C. Pelrah - 26Oct2016

ANCHOR QEA

Feet
0 710 1,420

Figure 2-1aa
Surface Sediment Sampling Locations In Non-dredge Areas
Surface Sediment Sampling Work Plan for 2016
Prepared for the General Electric Company



Legend

- Sampling Locations in Non-dredge Areas
- Backup Locations in Non-dredge Areas
- Certification Units (As Constructed)
- 25-foot Buffer from Dredge Area
- Dams and Locks
- Navigation Channel
- Hudson River

Sediment Types

- Clay, Silt, and Fine Sand
- Sand
- Coarse Sand and Gravel
- Transitional/Mixed
- Rocky

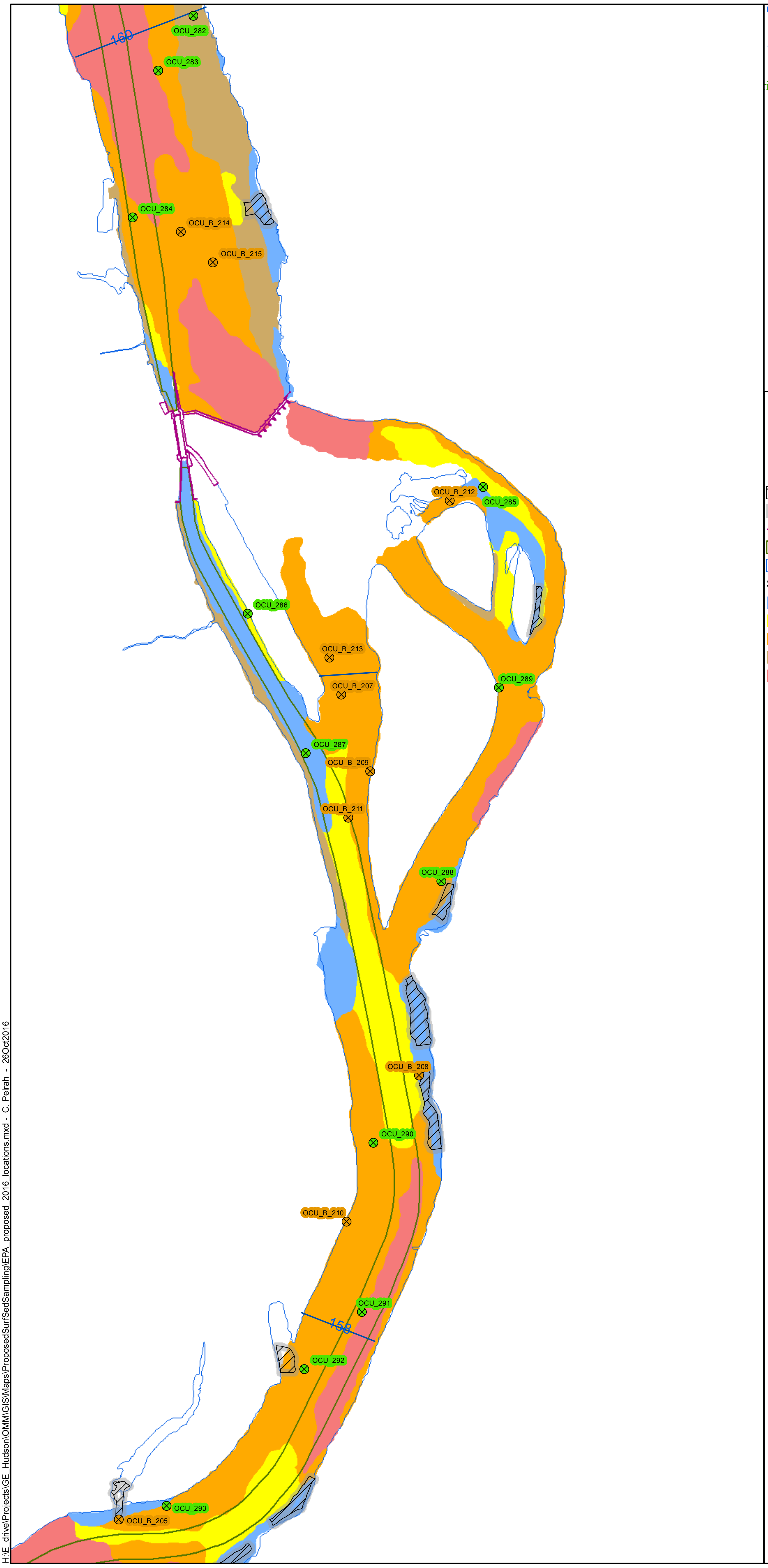
Notes:
Dredge area boundary shown does not account for the dredge to daylight. When using a backup location, the field team will follow the SOP presented in Attachment B; however, at locations that are near CU boundaries (i.e., within 25 ft.) precedence will be given to locating the point in the designated "strata" (i.e., non-dredge sediment). Therefore, the field team may select a sampling location that is further outside the CU boundary than the actual target locations, but will remain within 25 ft of the target.

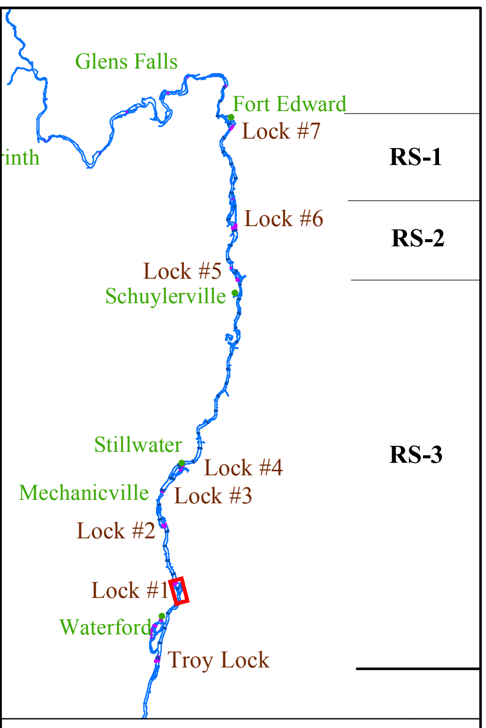
H:\E_drive\Projects\GE_Hudson\OMM\GIS\Maps\ProposedSurfSedSampling\EPA_proposed_2016_locations.mxd - C. Pelrah - 26Oct2016

ANCHOR QEA

Feet
0 1,000 2,000

Figure 2-1ab
Surface Sediment Sampling Locations In Non-dredge Areas
Surface Sediment Sampling Work Plan for 2016
Prepared for the General Electric Company





Legend

- Sampling Locations in Non-dredge Areas
- Backup Locations in Non-dredge Areas
- Certification Units (As Constructed)
- 25-foot Buffer from Dredge Area
- Dams and Locks
- Navigation Channel
- Hudson River

Sediment Types

- Clay, Silt, and Fine Sand
- Sand
- Coarse Sand and Gravel
- Transitional/Mixed
- Rocky

Notes:
Dredge area boundary shown does not account for the dredge to daylight. When using a backup location, the field team will follow the SOP presented in Attachment B; however, at locations that are near CU boundaries (i.e., within 25 ft.) precedence will be given to locating the point in the designated “strata” (i.e., non-dredge sediment). Therefore, the field team may select a sampling location that is further outside the CU boundary than the actual target locations, but will remain within 25 ft of the target.

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Feet
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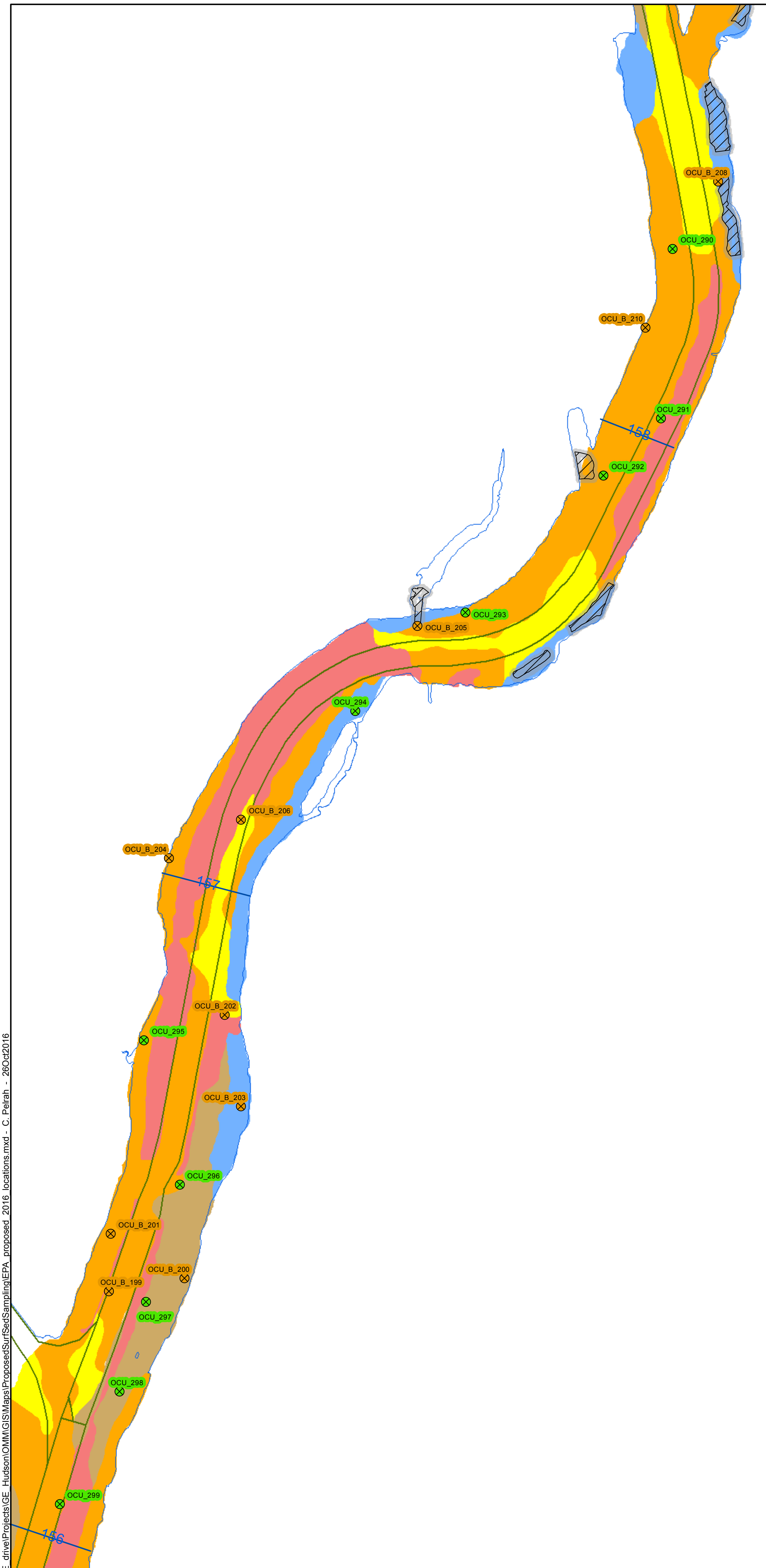
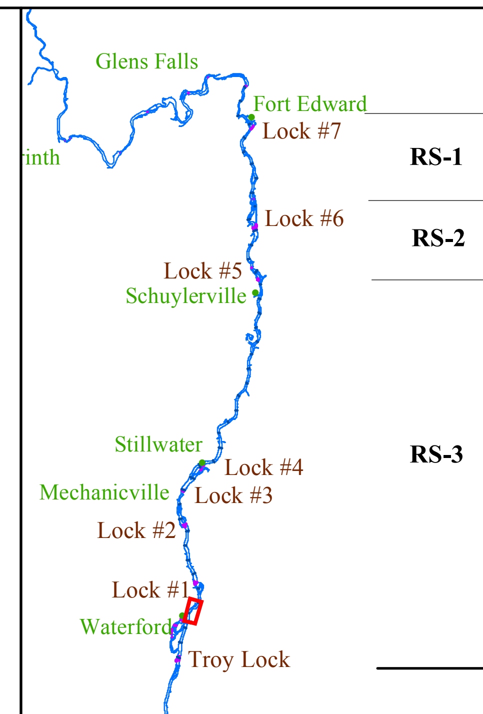
Figure 2-1ac
Surface Sediment Sampling Locations In Non-dredge Areas
Surface Sediment Sampling Work Plan for 2016
Prepared for the General Electric Company





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Feet
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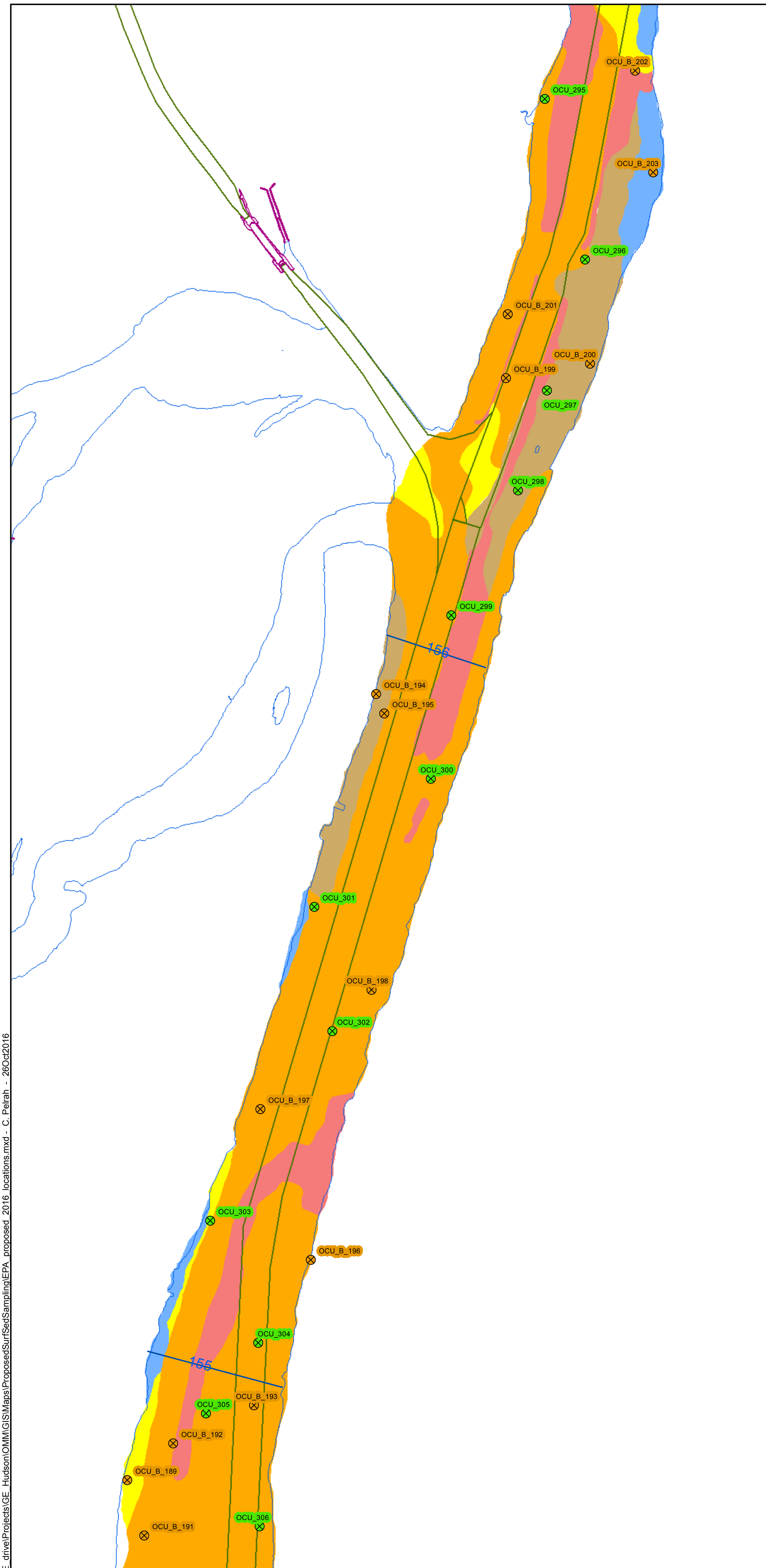
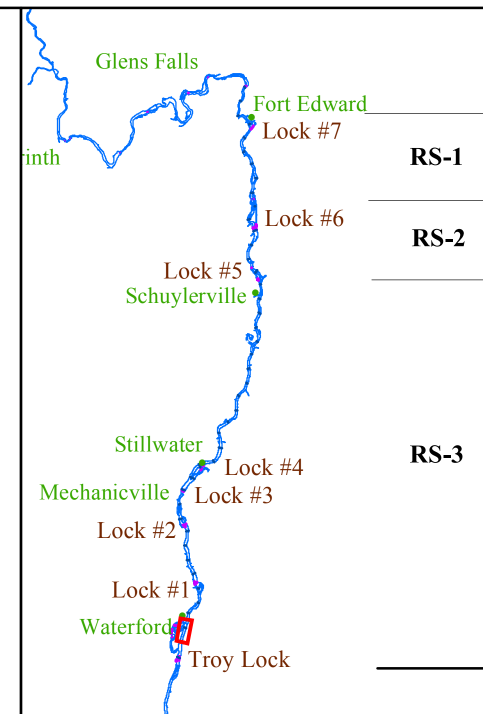
Figure 2-1ad
Surface Sediment Sampling Locations In Non-dredge Areas
Surface Sediment Sampling Work Plan for 2016
Prepared for the General Electric Company





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Feet
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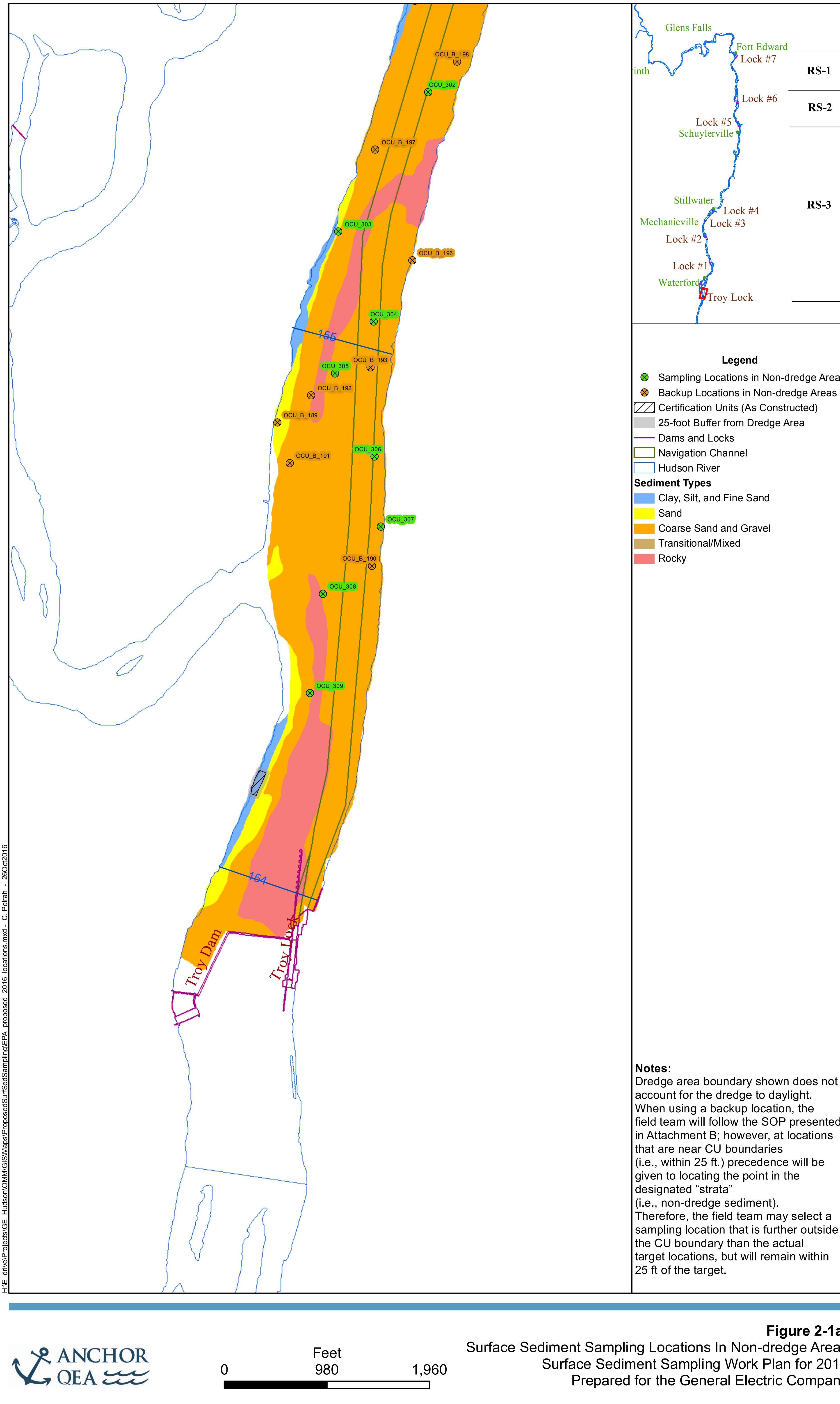
Figure 2-1ae
Surface Sediment Sampling Locations In Non-dredge Areas
Surface Sediment Sampling Work Plan for 2016
Prepared for the General Electric Company



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ANCHOR QEA

Figure 2-1af
Surface Sediment Sampling Locations In Non-dredge Areas
Surface Sediment Sampling Work Plan for 2016
Prepared for the General Electric Company

ATTACHMENT A
OM&M SEDIMENT SAMPLING DESIGN

OM&M Sediment Sampling Design

Objective

The primary objective of this sampling[1] design is to develop a statistically-based sediment collection plan supporting unbiased estimates of overall river section average Total PCB (TPCB) concentrations in surface sediments, and associated uncertainty bounds in each of three river sections (i.e., RS1, RS2, and RS3) in the Upper Hudson River. These data will be used to quantify post-remedial average TPCB concentration in sediment, to quantify changes in sediment concentration over time and to support investigation of relationships between fish, water and sediment during the post remedial monitoring time period.

Overview

A stratified random sampling design was implemented, with sampling locations selected so that the design is both unbiased and provides a degree of spatial balance along the length of the upper river. The sampling design method incorporates three domains of potential interest: 1) dredged and filled areas, 2) undredged areas, and 3) areas which are unsafe to sample, such as along or near the faces of dams, or where no sediment recovery is expected, such as submerged rocky areas. To accommodate these separate populations where mean and variance of PCB concentrations may differ, a stratified random sampling design (Cochran, 1997) is proposed.

This sampling design provides representative sampling locations selected independently within dredged and undredged areas excluding rock—the first two of the three domains identified above. For each river section, the overall estimate of the average and its sampling variance will be based on the area-weighted average of the dredged and undredged area averages respectively. To maximize accuracy and precision, samples will be allocated proportionally to the size of each stratum within each designated river-mile segment. For example, if a particular one-mile segment contains 10% of the undredged area, then 10% of the samples for undredged areas will be allocated to that segment.

An important objective of the OM&M program is to estimate changes in mean PCB concentration through time. This will be achieved through comparison of estimated mean PCB concentrations based on samples collected at multiple points in time through the monitoring program. Temporal comparisons are anticipated based on the overall river section average as well as averages estimated within dredged and undredged areas separately.

Because an unbiased sampling design was implemented, it is expected that spatial gradients in physical characteristics such as sediment texture and organic carbon content will be accurately represented. However, despite this unbiased design, it is possible to draw an "unlucky" set of locations that may represent some physical conditions disproportionately.

[1] For purposes of this document, “sampling design” refers to the number, layout and selection procedure for identifying locations at which sediment will be collected. In this context a “sample” is a collection of locations at which sediment is to be collected for measurements. A statistical procedure is unbiased if the individual members of the population being sampled are available to be selected for measurement with known quantifiable probability and statistical calculations incorporate those probabilities as weighting factors.

Sensitivity of comparisons to such a situation can be controlled in the experimental design by re-occupying the same locations for each time step in the monitoring program, or through statistical adjustments provided a suite of covariates including sediment grain size, total organic carbon and other potentially confounding variables is measured at all locations for each event as appropriate.

It is recommended that GE re-occupy the same sediment monitoring locations each year to control for interannual variation in potentially confounding variables. However, in addition, to allow for flexibility in the future, should there be a need to change monitoring locations, EPA requests that GE measure a suite of potentially confounding variables to include grain size (as needed to confirm visual classifications) and total organic carbon analyses at each location analyzed for TPCB. GE may propose other variables as appropriate.

Approach

This sampling plan is designed to support estimates of the mean over relatively large spatial extents composed of miles of river, so adequate sampling density is much lower than was necessary for remedial investigation and design, for which high resolution maps of contaminant distributions were needed to direct remedial efforts. In these previous efforts, a regularly spaced grid was used to allocate sampling effort. A regular grid for allocating this sparse sample would be very coarsely spaced and sensitive to sampling artifacts reducing spatial balance and potentially causing bias. This problem was avoided through stratification of the sampling design.

A stratified random sampling approach was used so that;

1) Sampling locations are spatially balanced along the length of the river in proportion to the area to be sampled,
2) All locations within each of the two domains of interest have equal likelihood of entering into the set of sampled locations (i.e., resulting in an unbiased and representative design), and
3) Probability of inclusion of each member of the sample is equal, so that the resultant data can be analyzed as either a stratified random sampling design or the stratum boundaries can be ignored and the data can be analyzed as if it originated from a simple random sample[2] within dredged and undredged areas respectively.

The study is stratified naturally into investigations of dredged and undredged areas with separate independent sampling designs within each of these two physically meaningful strata. As a device for allocating samples in a spatially balanced way, each of these two primary strata are further subdivided into one-mile long river segments which are also referred to from here forward as strata. Sampling effort was allocated proportionally to the area to be sampled within each one-mile sub-segment.

This proportional allocation yields two statistically valid unbiased alternatives for estimating the mean within the dredged and undredged areas, respectively. Ideally, investigators using these data

[2] Monitoring data are commonly shared among many data users, and information documenting the methods of sample selection are often ignored, so a sampling plan that emits unbiased estimates from naïve analyses based on equal weighting are desirable to minimize potential misuse of resultant data.

would be aware of the details of the stratified sampling design and, as such, would apply stratified random sampling formulas (Cochran, 1977) for the most statistically accurate and precise estimates. Therefore, this design provides a measure of robustness to current and potential future data users.

To satisfy the primary objective to estimate the overall mean total PCB concentration in surface sediments while meeting the three constraints above, a stratified random sampling design is recommended with samples allocated proportionally to the size of each stratum. As mentioned above, strata are defined as one-mile subsections divided in the north-south direction, and are used to balance sampling density along the river axis. Additionally the fraction of the total number of samples allocated within each one-mile subsection is proportional to the area to be sampled in that subsection (Figure 1). Note that these subsections are arbitrary constructs that are not intended to be scientifically meaningful, but rather to facilitate layout of a spatially balanced sampling design, while also maintaining the ability to analyze the resultant data using basic statistical formulae. The sampling method was applied separately to each of the two domains of interest, the dredged areas and then again to the undredged areas.

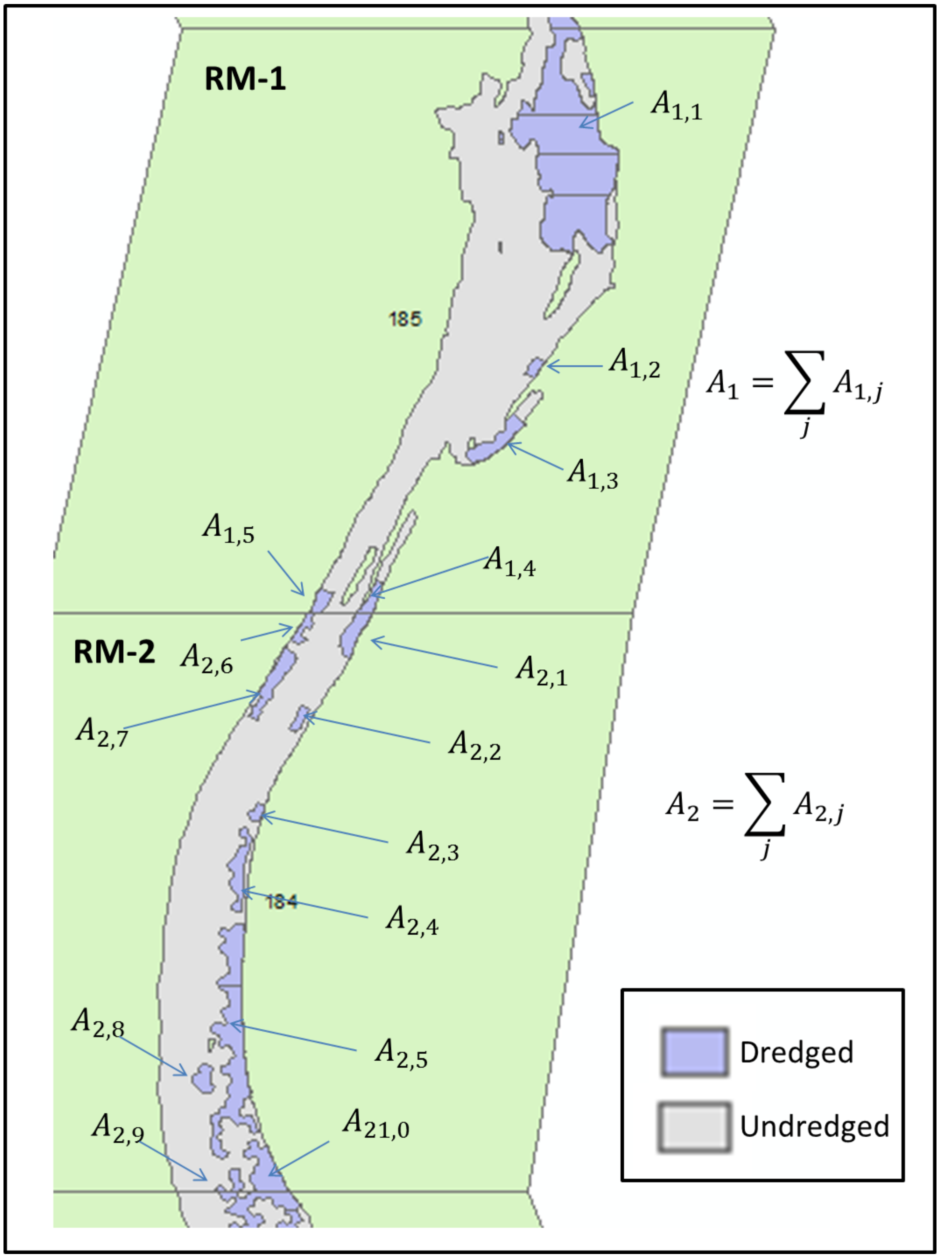

Figure 1. Schematic illustrating strata (subsections) and domains of interest (dredged, undredged).

Steps for Sampling Plan Layout

Figure 1 provides a conceptual drawing showing two river subsections, overlaid on the river composed of dredge and undredged areas respectively. The formulae shown in the figure describe the dredged areas. A similar set of formulae were constructed for the undredged areas. This discussion describes the procedure for selecting sampling locations in the dredged areas. The mathematical notation used in this description for dredged areas is defined in Table 1, below. The exact same procedure was applied independently to the dredged and undredged areas.

Prior to layout of the sampling plan, the number of subsections (strata) and the overall number (N) of samples to be collected per domain in each river section was determined. The number of samples to be allocated to dredged and undredged areas was selected so that precision of the estimated mean would be expected to be approximately 50% in RS1, 40% in RS2 and 25% in RS3. These precision targets reflect increasing interest in current conditions in RS 2 and more so in RS3 where remedial actions were less laterally extensive than in RS1. These precision targets were treated as inputs to the sample selection procedure. Justification of sample sizes associated with these inputs is discussed in greater detail in a subsequent section.

Define N to be the total number of sampling locations to be allocated among i=1, 2, 3, ….., s strata (S_i), each with area A_i to be sampled. The fraction of samples to be allocated to the i^{th} river-mile is to be

$$\mathrm{f}_i = \frac{A_i}{A_T}$$

where A_T is the sum of the A_i – the total area to be sampled within the dredged stratum. The number of samples to be collected from the i^{th} stratum is

$$N_i = \mathrm{f}_i \times N.$$

This procedure is termed proportional allocation, or sampling proportional to stratum size (Cochran 1977). Sampling locations were identified within each river-mile (i.e., statistical stratum) using four steps:

1) Randomly select 5,000 x-y coordinates within each green parallelogram in Figure 1; call these "trial" points,
2) Clip the set of trial points to the dredged or undredged area of interest,
3) Sort the clipped trial points from north to south, and
4) Draw a systematic sample with random start[3] from the sorted list of trial points.

The purpose of the method used in step 4 was to balance the distribution of sampling locations spatially within each one-mile segment relative to what could be expected with a fully random selection procedure. Stronger control of the spatial balance is possible through a variety of options, but all of the options we considered were more labor intensive and operationally cumbersome,

[3] Systematic sampling is a type of probability sampling method in which sample members from a larger population are selected according to a random starting point and a fixed periodic interval. This interval, called the sampling interval, is calculated by dividing the population size by the desired sample size.

while providing little additional statistical value. The systematic approach with random start provides a reasonable degree of spatial balance while also being operationally efficient to lay out.

Table 1. Mathematical notation.

Symbol	Definition	Comments
N	Total number of samples allocated to dredged area domain	The allocation of these N samples to subsections is determined based on the dredged area within the subsection.
RM_i (i=1,2,3,….s)	Label for the i-th river subsection, assuming there are s of them.	The River was divided into one-mile subsections in the North-South direction.
A_{ij} (i=1,2,3,….s, j=1,2,…m_i)	Area of the j-th dredged polygon within the ith subsection.	There are m_i, possibly zero, such polygons in each subsection.
A_i (i=1,2,3,….s)	Total area of dredged polygons within a subsection.	$A_i = \sum_j A_{ij}$
A_T	Total dredged area within a river section.	River sections of interest need to be identified based on pools, or other administrative boundaries of interest. This is the section of river over which exposures are assumed to occur and for which the average concentration is to be estimated. $A_T = \sum A_i$
$f_i = \frac{A_i}{A_T}$	Fraction of the total number of samples allocated to the i-th stratum.	Samples are allocated proportionally to the stratum size. This is called proportional allocation and is often referred to as a self-weighting design.
$N_i = f_i \times N$	Number of samples allocated to each stratum.	

Statistical Analysis of Resultant Data

The objective of this program is to estimate the overall mean PCB concentration based on independent samples from dredged and undredged areas—a stratified sampling design. The overall mean is obtained by area-weighted averaging of the stratum means (i.e., means in dredged and undredged areas). For stratified sampling designs, approximate confidence intervals can be based on a Z interval when stratum sample sizes are relatively large, or when data are normally distributed. When data are right skewed, which is expected in this situation, more accurate confidence limits based on the balanced bootstrap method with importance sampling (Davison et al, 1986) will likely be preferred.

Sample Size Determination

Approximate equations for sample size determination are available for analyzing data from stratified sampling designs, although they depend on the assumption of relatively large sample sizes, or normally distributed data. Initial calculations based on these formulas indicated prohibitively large sample sizes, so a more accurate approach based on a simulation study was used to estimate adequate numbers of sample locations for each river section. The theoretical equations were likely conservative because they are sensitive to deviations from the assumption of normality of the PCB concentrations.

The simulation study proceeded by simulating data similar to the distribution of actual data from the DDS studies for the undredged areas and similar to post-dredging data from the Fox River as a surrogate for the dredged areas. The DDS data were identified as a model for data to be generated in the future because they are the most recent data, and because sediment was collected with equipment similar to that which will be used in the OM&M program.

Simulated data were analyzed as a stratified random sample, estimating the overall mean, using a non-parametric bootstrap with importance sampling (Davison et al., 1986). The process was repeated 1000 times for combinations of sample sizes ranging from 20 to 60 by increments of 5 and from 60 to 120 by increments of 20. The average relative error of the confidence intervals, defined as the difference between the upper confidence limit and estimated mean and then divided by the mean, was contoured. These contour maps were inspected visually to identify approximate combinations of sample sizes for dredged and undredged areas expected to provide 40% to 50% relative error. Figures 2 through 4 show these contour maps of relative error vs. sample size for each river section. These results should be interpreted cautiously as the general patterns are not strong, with precision decreasing with sample size relatively gradually. Generally one can expect that with sample sizes summarized in Table 2, relative error can be expected to be no greater than approximately 50%, 30% and 20% in RS1, RS2 and RS3, respectively.

Table 2. Approximate sample sizes and expected relative error for confidence intervals on the mean in each river section.

River Section	Number of Samples			Expected Relative Error (fraction of mean)
	Undredged Areas	Dredged Areas	Total	
1	35	31	66	0.5
2	70	52	122	0.3
3	121	66	187	0.2
Grand Total	226	149	375	-

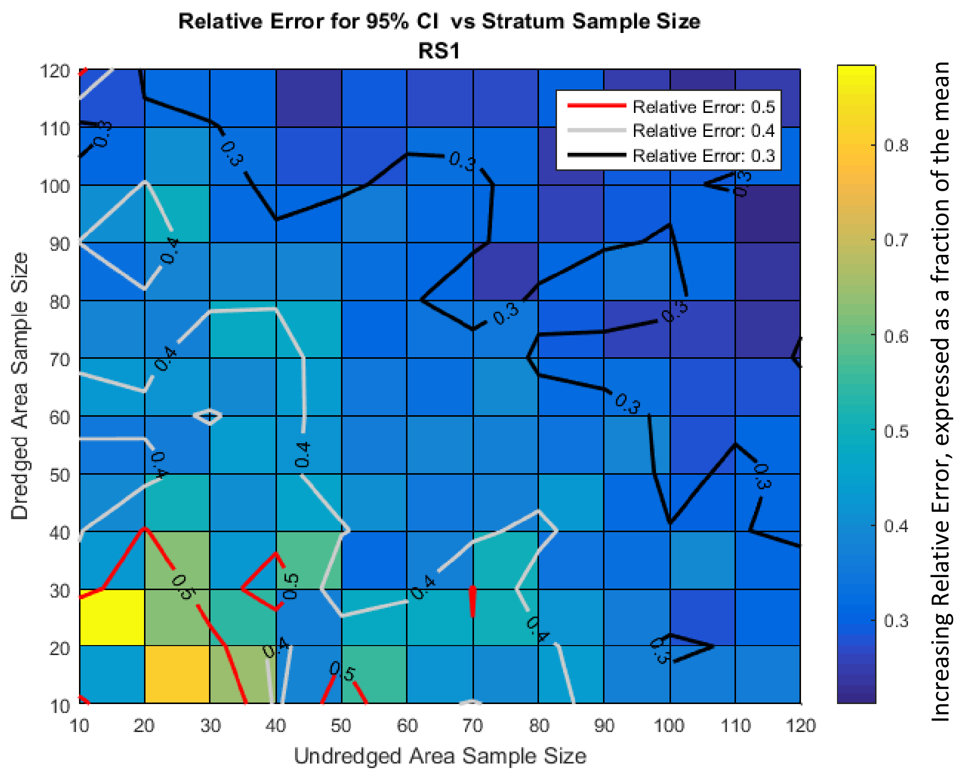

Figure 2. Relative precision of bootstrap confidence intervals *vs.* sample size in dredged and undredged areas in River Section 1.

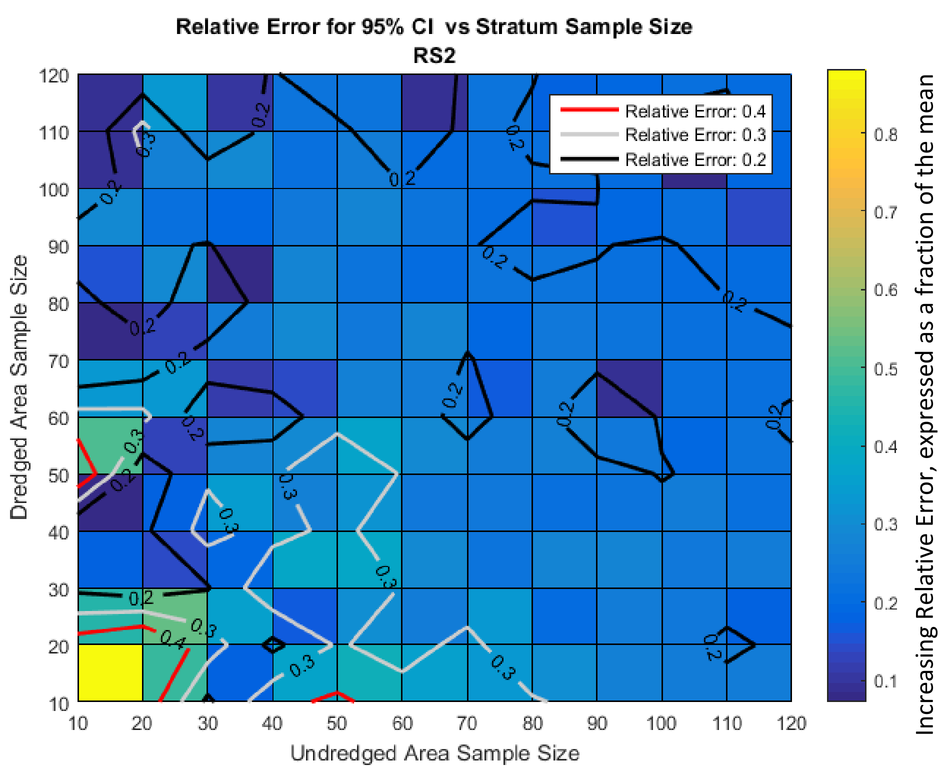

Figure 3. Relative precision of bootstrap confidence intervals *vs.* sample size in dredged and undredged areas in River Section 2.

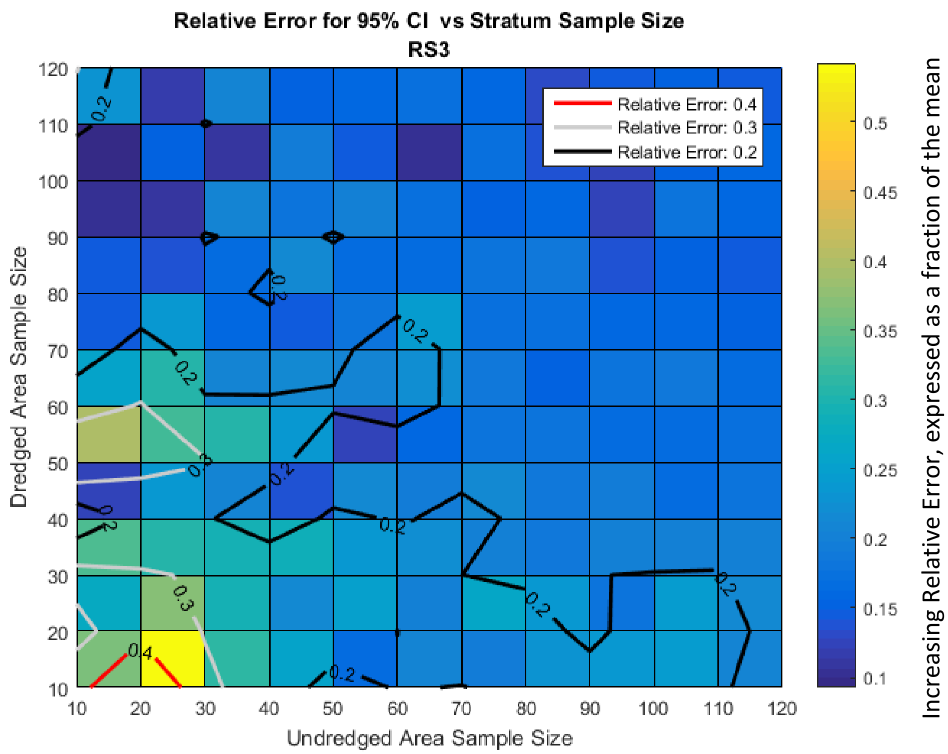

Figure 4. Relative precision of bootstrap confidence intervals *vs.* sample size in dredged and undredged areas in River Section 3.

Temporal Trends

Sediment PCB concentration data generated through repeated application of this monitoring program through time will be used to support estimates of temporal change in surface sediment concentrations. Because sediment PCB concentrations may vary with the physical characteristics it is anticipated that trends may be estimated and interpreted in multiple ways which may include statistical adjustments for potentially confounding variables such as sediment grain size distribution and organic carbon—to be measured at each sampling location as appropriate.

One particular way in which trends are likely to be estimated will be for changes in concentration within undredged areas irrespective of measured covariates. To evaluate the adequacy of the planned study design for such trend analyses, an additional simulation study was conducted to estimate the probability of detecting an approximate 5% annual change in total PCBs over a 10-year monitoring time period (i.e., after three time steps in the monitoring program, year 0, year 5 and year 10). Based on this simulation study, it is anticipated that such a decline in total PCBs within the undredged areas will be detectable with approximately 30%, 95% and 85% probabilities in RS1, RS2 and RS3 respectively. The power to detect change in the overall river section mean (as opposed to the undredged areas alone) will be somewhat higher, particularly in RS1, where over half of the samples are located in dredged areas. The amount of increase in power is difficult to anticipate because the rate of decline in undredged areas may be offset to a degree by what are likely to be slower recovery rates in dredged and backfilled areas. It is anticipated that if PCB concentrations correlate reasonably with physical sediment characteristics, these would be incorporated into the analysis in the form of a multiple regression such as $\log(pcb) = b_0 + b_1 toc + b_2 fines + b_3 time$, where these or other physical variables may explain a proportion of the variation in PCB concentrations, enabling the coefficient on time (b_3) to be estimated with greater precision—equivalently higher statistical power. To realize this increased resolution to detect temporal trends, it is necessary to collect as many of these potential confounders as possible—at a minimum to include grain size distribution and total organic carbon as appropriate.

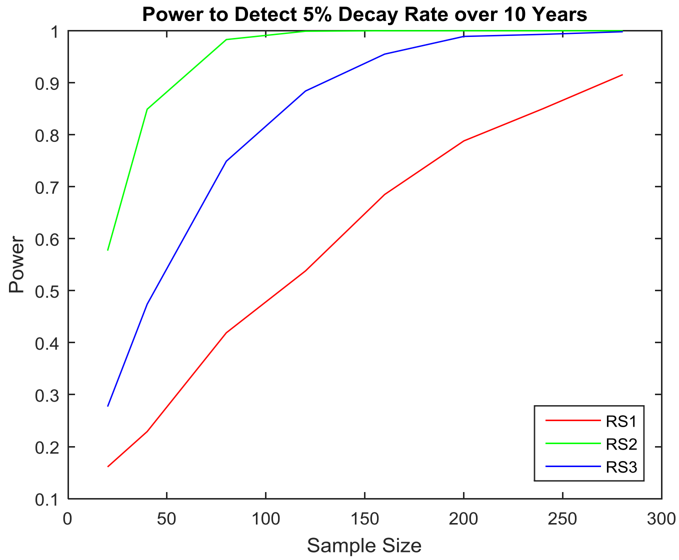

Figure 5. Power to detect a 5% annual change in total PCBs in surface sediment in undredged areas over a 10-year time frame with three monitoring time steps, year 0, year 5 and year 10.

Field Considerations

Sediment collection locations provided with this sampling design are located within the river, and target dredged and undredged areas with the understanding that the electronic files defining these locations are imperfect. With this understanding it is expected that some points that are located within one stratum on electronic maps may actually reside in another stratum or potentially not even in the river at all.

To account for this spatial uncertainty it is recommended that a sediment collection location should be identified within a reasonable distance of the target location. The specific tolerance to be required will be discussed with EPA and included in GE work plans. This tolerance will provide field crews with adequate flexibility to complete the sampling program under existing time constraints. With this flexibility in spatial locations, the sediment collection crews would be able to search for locations that are within the proper stratum in the field and so that multiple attempts to recover sediment can be made. In the event that sediment cannot be collected within this "reasonable" distance of the planned location, a series of alternative locations is also provided. It is expected that multiple attempts (minimum of three attempts) to recover sediment at the planned location will be made prior to relocating to alternate locations. Alternate locations should be selected from lists provided by EPA and should be within the same one-mile river subsection as the location at which no recovery was obtained. Alternate locations are identified by simply selecting the next alternate location in the list, and not by selecting the alternate location closest to the original failed location. This is essential to maintain the unbiased nature of the sampling design. Field personnel should maintain records of all locations at which sampling was attempted and the number of attempts at all locations—irrespective of successful recovery of sediment. The number of attempts and the nature of material recovered, including potentially no-recovery, must be recorded for all primary and backup locations occupied. It is anticipated that the backup location will be attempted. If attempts are not successful in recovering sediment at the backup location the sample collection crew will advance to the next primary location (i.e. do not select an additional backup location for this sample). Usage of these data is dependent on the nature of particular objectives and parameters being estimated. The EPA will provide guidance on appropriate usage of these data in consultation with GE in subsequent discussions and technical memoranda. EPA will coordinate with NYS and the Trustees regarding appropriate usage of the data. Other field method specifications will be provided in work plans and standard operating procedures for review by EPA prior to initiating the sampling program.

Discussion

This sampling plan provides for unequal sampling density within the two domains of interest, dredged and undredged, while constraining sample locations to be spatially balanced in the north-south direction. The design procedure could be further refined to increase balance laterally across the river (east to west) by slicing the river into longitudinal ribbons and applying this procedure separately to each longitudinal ribbon. This level of balance would require many more samples to represent each ribbon and so was not developed by EPA. In general, spatial balance is not necessary for unbiased estimation of mean TPCB. However, when data are positively spatially correlated, estimates based on a spatially balanced design are more precise than those based on a fully randomized design of equal level of sampling effort. Spatial balance is also intuitively appealing to data users, and thus has been implemented here.

References

Cochran, W.G. 1977. Sampling Techniques, John Wiley and Sons. New York.

Davison, A.C., Hinkley, D.V. and Schechtman, E. (1986) Efficient bootstrap simulation. Biometrika, 73, 555–566

ATTACHMENT B
STANDARD OPERATING PROCEDURE FOR SURFACE SEDIMENT SAMPLE COLLECTION

1 PROCEDURES

1.1 Scope and Application

This Standard Operating Procedure (SOP) is applicable to the collection of surface sediment samples and is based on the procedures specified in Appendix 9.3-1 of the *Phase 2 Remedial Action Monitoring Quality Assurance Project Plan* (Phase 2 RAM QAPP; Anchor QEA and ESI 2012), with appropriate modifications for the collection of surface sediment samples in accordance with the *Surface Sediment Sampling Work Plan for 2016* (2016 Sediment Sampling Plan; Anchor QEA 2016).

2 SUMMARY OF METHOD

The crew will use a Differential Global Positioning System (DGPS) to navigate to the pre-determined sampling locations. The sampling vessel will be secured into place at each target location and surface samples will be collected using a Van Veen dredge equipped with a landing frame or, if field conditions indicate that that will not be successful, an Ekman dredge or a Ponar dredge.

3 HEALTH AND SAFETY WARNINGS

Health and safety issues are addressed in the *Phase 2 Remedial Action Health and Safety Plan* (HASP; Parsons 2016).

4 CONTAMINATION AND INTERFERENCES

Potential sources of contamination and interferences during sampling include the presence of residual analytes and/or accumulation of solids on the sample collection equipment. Sampling equipment that comes into contact with sediment and will be reused will be decontaminated in the field prior to reuse according to the following procedures:

- Rinse with river water and a scrub brush to remove all visible sediment.
- Rinse with distilled water.

Other conditions that may affect the ability to collect representative samples include:

- High flows
- Deep water
- Inclement weather
- Sediment type

5 PERSONNEL QUALIFICATIONS

All field personnel are required to take a 40-hour Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations (HAZWOPER) training course and annual refresher courses, and participate in a medical monitoring program prior to engaging in any field collection activities as required in 29 CFR 1910.120. Additionally, field personnel will be under the direct supervision of qualified professionals who are experienced in performing the tasks required for sample collection.

6 EQUIPMENT AND SUPPLIES

The following equipment will be used to conduct sediment sampling:

1. Sampling vessel equipped with spuds
2. Real Time Kinematic (RTK) DGPS capable of sub-meter accuracy
3. Calibrated steel rod for probing
4. Van Veen dredge with landing frame
5. Ekman dredge
6. Ponar dredge
7. Personnel protective equipment (PPE) – including steel toe boots and disposable gloves (refer to HASP requirements for full PPE requirements)
8. Laptop computer and field database
9. Aluminum or plastic tubs
10. New disposable aluminum pans with lids

11. Sample transfer tools (disposable spoons or equivalent)
12. Digital camera
13. Decontamination supplies
14. Containers for holding investigation derived wastes
15. Laboratory containers, coolers, and ice
16. Tools
17. Media for preparing equipment blanks

7 SAMPLE COLLECTION

7.1 Sampling Locations

Sampling locations are presented in Section 2.4 and associated figures and tables of the 2016 Sediment Sampling Plan.

7.2 Navigation and Probing

1. Using the on-board DGPS, maneuver the sampling vessel to within 10 feet of the pre-programmed target coordinates for each sample location. At backup locations that are near CU boundaries (i.e., within 25 feet) precedence will be given to locating the point in the designated “strata” (i.e., non-dredge sediment). Therefore, the field team may select a sampling location that is further outside the CU boundary than the actual target locations, but will remain within 25 feet of the target. The target coordinates will be in northing and easting format, using the North American Datum of 1983 (NAD 83). Secure the vessel in place using spuds and/or anchors.
    a. In the event that a sampling location is inaccessible due to the location being too close to shore, navigate as close to the location as water depth will allow and attempt to collect the sample. The actual sampling coordinates will be recorded in the field database.
    b. If locations are inaccessible due to shallow water or due to safety concerns in response to high flows, attempt sampling at the next available backup location

within the same 1-mile river subsection (in consultation with the EPA field representative), as provided in the 2016 Sediment Sampling Plan.

c. If a sampling location is located in an area where using spuds or anchors are not feasible (e.g., hard bottom with water depth exceeding 20 feet), sample collection may still be attempted if field conditions permit. Maintaining the position of the boat using the engine during sampling may be possible under low flow, calm conditions.

2. Use a sharpened 0.5-inch diameter steel rod marked in 6-inch intervals (or equivalent) to probe the sediment surface 3 to 5 feet away from the target location to determine the surficial sediment type. Advance the probe into the river bed approximately 6 to 12 inches, noting the ease of penetration and type of resistance met by the probe. Record the estimated sediment type (e.g., rock, fine-grained, coarse-grained) as the most representative one of the three attempts in the field database.

3. Identify the appropriate sampling method. At most locations, a Van Veen dredge equipped with a landing frame will be used. Sample collection with a ponar dredge or Eckman dredge may be attempted if field conditions indicate that such a sampler will be more effective than the Van Veen dredge.

7.3 Van Veen Dredge Guidelines

The procedures for collecting a sample using a Van Veen dredge are as follows:

1. Navigate the sampling vessel to the target location and conduct probing in accordance with the procedures presented in Section 7.2.

2. Don clean nitrile gloves prior to assembling the apparatus, retrieval of the device, and when collecting the sample.

3. Decontaminate the Van Veen dredge in accordance with the procedures specified in Section 4 before each use.

4. Adjust the landing frame so that the jaws of the sampler will be 2 inches below the frame when in the closed position.

5. Lower the Van Veen dredge until the landing frame comes to rest on the river bed using an electric winch and allow approximately 1 foot of slack in the suspension cable.
6. Reverse the winch and tighten the cable, which will engage the jaws of the Van Veen dredge and collect a sediment sample.
7. Retrieve the Van Veen dredge using the electric winch and place it in an aluminum pan, plastic tub, or equivalent on the deck of the sampling vessel.
8. Remove any standing water from the sample using a 2 or 3 foot section of clean flexible tubing. Fill the tubing with river water, and start a siphon to remove the standing water from the dredge box. Pinch the tubing as needed to control the rate of discharge from the siphon tube. Be careful not to remove surface sediment.
9. Inspect the material recovered in the sampler to determine whether sufficient sediment has been recovered to allow laboratory analysis.
    a. Sufficient sediment is defined as an adequate volume of material with particle size less than approximately 1 inch to fill a sample container approximately half full (approximately 2 ounces).
    b. Stones, rock fragments, and debris that are larger than approximately 1 inch should be segregated from finer grained materials and not included in the sample.
10. If sufficient sediment cannot be collected after 3 attempts at a sample location, the sampling location will be abandoned and sampling will be attempted at the next available backup location within the same 1-mile river subsection, as provided in the 2016 Sediment Sampling Plan. If sufficient sediment cannot be obtained in 3 attempts at the backup sampling location, that sampling point will be abandoned, and the field crew will move on to the next primary sampling location. The information on all sediment collection attempts will be documented in the field database.
11. Use a sample transfer tool (disposable spoons or equivalent) to remove the upper 2 inches of sediment and place it in a new disposable aluminum pan. To confirm that the sample depth is no more than 2 inches, mark the spoon at 2 inches. Scoop down to this mark. Document changes in strata, if possible.

12. Describe the physical characteristics of each sample using the visual classification procedures specified in the *Design Support Sediment Sampling and Analysis Program* (ESI and QEA 2002). These characteristics will include the general soil type (i.e., fine sand, medium sand, coarse sand, gravel, silt, clay, and organic/other matter such as wood chips), presence of observable biota, odor, and color. The visual classifications will be recorded in the field database.

13. Take a photograph of the sediment collected in at each location, including any materials collected at locations that are abandoned due to insufficient sediment.

14. If the sediment type is significantly different from the sediment type anticipated based on prior sediment mapping (if any), conduct additional probing to confirm sediment texture. If the GE and EPA field teams determine that it is necessary to submit samples for quantitative grain size analysis, collect additional sample volume (if needed) with the Van Veen sampler, as described in Step 15 below.

15. One sample should be sufficient to provide the analytical volume requirements. If additional sediment is needed, collect up to two additional sediment grabs to obtain sufficient material to fulfill the analytical requirements, taking care to relocate the sampler within 3 to 4 feet of the original location. Place the contents of each subsequent grab sample in the aluminum pan in accordance with Step 11 above. Record the number of additional attempts required. Use the sample collection tool to thoroughly homogenize the sample. The following method should be followed to assure that the sample is thoroughly mixed (based on ASTM method D6051 - 96(2006) Standard Guide for Composite Sampling and Field Subsampling for Environmental Waste Management Activities):

    a. Mix the entire sample in the bowl for 15 seconds.

    b. Divide the sample into quarters in the bowl.

    c. Mix each quarter for 15 seconds, or longer if necessary.

    d. Combine opposite quarters (i.e., 1 and 3, and then 2 and 4) and mix each of these half samples for 15 seconds each.

    e. Combine each of these halves and mix the final single pile for 15 seconds.

f. The sample should have the appearance of a thoroughly mixed and homogenized sample with no streaks, dark spots, or granular inconsistency. If any of these are observed, increase the mixing time for each of the steps above.

16. Transfer the homogenized sediment into sample containers appropriate for the analyses requested.
17. Unused sediment will be returned to the river after sample collection at that location is complete.
18. Data from the surface sediment sample collection will be recorded in the field database using a laptop computer on the sampling vessel. Upon completion of sampling at one location, the field data will be entered into the database, as described in Section 9.

7.4 Ekman Dredge Guidelines

1. Don clean nitrile gloves prior to assembling the apparatus, retrieval of the device, and when collecting the sample.
2. Attach the mounting brackets and extension rod securely to the Ekman dredge using the bolts provided for this purpose.
3. Decontaminate the Ekman dredge in accordance with the procedures specified in Section 4 before each use.
4. Release the spring wires from around the jaw pins on the side of the dredge. This will keep the dredge from accidentally closing, possibly causing finger or hand injury.
5. Cock the Ekman. To do this, attach the springs to both sides of the jaws. Fix the jaws so that they are in the fully opened position by placing the trip cables over the release studs located near the base of the extension handle. Ensure that the hinged doors on the dredge top are free to open. Note: The top screen provided with the Ekman dredge should not be installed, however, the two top doors need to remain attached as is.
6. Prior to deploying the Ekman dredge, probe the sediment surface near, but not at, the location where the dredge will positioned, using the procedures specified in Step 2 of

Section 7.2. Take caution to not disturb the sediment near the location to be sampled or to allow the river current to redeposit this material at the sampling location.

7. Determine the approximate water depth using an electronic depth finder, or from the probing exercise. Attach sufficient extension rods to the dredge as the dredge is being deployed. Minimize overhead hazards by minimizing the length of rod above the personnel. Be aware of electrical overhead hazards and do not sample near them.
8. Lower the sampler so that the sediment surface is gently contacted. In deeper water, attach sufficient lengths of pipe extension including internal triggering rod to accommodate positioning of the sampler. Do not use a rope or cable since maintaining a vertical orientation of the dredge may not be possible, or known. In river currents that make it difficult to maintain a vertical orientation of the sampler, use a holder mounted to the boat that will permit maintaining proper orientation. A holder may be as simple as mounting a 2-inch by 6-inch vertical board and attaching two 3-foot by 2-inch by 2-inch posts creating a channel to stabilize the Ekman extensions. U-bolts, or other similar devices, can then be used to hold the extension pipe within the channel as the sampler is being deployed.
9. Once contact with the bottom is made, determine where 4 to 5 inches above the water is on the extension rod. Firmly and deliberately push the sampler into the sediment making sure not to exceed the 5 inch mark. Note: The box of the Ekman dredge has a maximum length of 6 inches. Approaching or exceeding this height will jeopardize the retention of the very fine surface sediments. If the box is overtopped, or if after retrieval fines appear to have been lost, dispose of this sample by returning it to the river, a few feet downstream of the sampling location; rinse the sampler with river water, and reattempt retrieval.
10. Trigger the jaw release mechanism by depressing the button or inner rod on the upper/exposed end of the extension handle. It may be necessary to tap the end with a hammer to get the triggering mechanism to release.
11. Slowly raise the sampler while maintaining the dredge in a vertical orientation. If necessary, carefully remove excess extension handles so that they do not pose a safety hazard. Jerking or tipping motions or excessive speed upon retrieval may disturb the sample.

12. Place the Ekman dredge in an aluminum pan, plastic tub, or equivalent on the deck of the sampling vessel. While maintaining the sample in a vertical position: open the top doors of the dredge.
13. Follow Steps 8 through 18 in Section 7.3 above.

7.5 Ponar Dredge Guidelines

1. Attach a rope or steel cable to the ring provided on top of the dredge.
2. Arrange the Ponar dredge with the jaws in the open position, set the trip bar so the sampler remains open when lifted from the top. If the dredge is so equipped, place the spring loaded pin into the aligned holes in the trip bar.
3. Slowly lower the sampler to a point approximately two inches above the sediment.
4. Drop the sampler to the sediment. Slack on the line will release the trip bar or spring loaded pin; pull up sharply on the line to close the dredge.
5. Place the Ponar dredge in an aluminum pan, plastic tub, or equivalent on the deck of the sampling vessel. While maintaining the sample in a vertical position: open the top doors of the dredge. Care should be taken to retain the fine sediment fraction during this operation.
6. Maintain the vertical orientation of the sample while in the dredge. Document the condition of the sample surface and discard any sample retrieved that has overtopped the dredge, or is sloped indicating that the dredge may have been on its side when closed.
7. Follow the procedures specified in Steps 8 through 18 in Section 7.3 above.

8 SAMPLE HANDLING AND PRESERVATION

Sample containers will be labeled in accordance with labeling requirements specified in Section 10.1 of the Phase 2 RAM QAPP. Samples will be collected and placed in containers in accordance with the procedures described above. Each container will be placed in a resealable food storage bag and placed in a cooler. The samples will be chilled with ice to approximately 4 °C.

The samples will be transported to the analytical laboratory as soon as practicable after collection. A temperature blank will be placed in each cooler for use by the laboratory to measure the temperature of samples upon submittal. Chain-of-custody procedures will be followed, as specified in Section 10.1 of the Phase 2 RAM QAPP.

9 DATA AND RECORDS MANAGEMENT

All data from sample collection will be recorded in the field database using a laptop computer. Upon completion of sampling at one location, all data from the location will be entered into the database. Blank field log sheets can also be used to record information manually in case difficulties with data entry using the computer are encountered. Manually recorded data will be transcribed into the field database at the end of each day.

10 QUALITY ASSURANCE AND QUALITY CONTROL

Quality assurance and quality control (QA/QC) procedures are defined in Section 10.2 of the Phase 2 RAM QAPP, with one exception. As described in Section 2.10 of the 2016 Sediment Sampling Plan, Performance Evaluation samples will not be prepared and analyzed. Instead, matrix spike/matrix spike duplicate (MS/MSD) samples will be prepared and analyzed at a frequency of 5% (i.e., one for every 20 samples). MS/MSD samples will be spiked with the same solution used for laboratory control spike (LCS) analysis (a combination of Aroclor 1221 and Aroclor 1242 at a ratio of 3:1).

QA/QC samples will include blind duplicate samples, equipment blank samples, and MS/MSD samples. One set of QA/QC samples will be collected at the rates defined in Section 10.2.1 of the Phase 2 RAM QAPP. Blind duplicate samples will be prepared by filling additional appropriately marked containers. Samples that will be used for MS/MSD will be designated in the field database and chain-of-custody forms. After collection, QA/QC samples will be handled in a manner that is consistent with all other environmental samples. Equipment blanks will be prepared in the field by processing a sample of clean sand in the same manner that environmental samples are processed, including placing sand in the sample collection device, transfer the sand to a new disposable aluminum pan with a clean sample removal tool, mix the sand, and place in appropriate laboratory containers.

11 REFERENCES

Anchor QEA (Anchor QEA, LLC), 2016. *Surface Sediment Sampling Work Plan for 2016*. Hudson River PCBs Superfund Site. Prepared for General Electric Company, Albany, New York. October 2016.

Anchor QEA and ESI (Environmental Standards, Inc.), 2012. *Phase 2 Remedial Action Monitoring Quality Assurance Project Plan.* Hudson River PCBs Superfund Site. Prepared for General Electric Company, Albany, New York. May 2012.

ESI (Environmental Standards, Inc.) and QEA (Quantitative Environmental Analysis, LLC), 2002. *Design Support Sediment Sampling and Analysis Program – Quality Assurance Project Plan*. Prepared for General Electric Company, Albany, New York. October 2002.

Parsons, 2016. *Phase 2 Remedial Action Health and Safety Plan, Hudson River PCBs Superfund Site for 2016.* Prepared for General Electric Company, Albany, New York. February 2016.

ATTACHMENT C
STANDARD OPERATING PROCEDURE FOR GRAIN SIZE DISTRIBUTION ANALYSIS

Title: Particle Size Analysis (ASTM D 2217 and D422-63)

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Approval Date: February 6, 2014

Facility Distribution No. Electronic **Distributed To: Facility Intranet**

The controlled copy of this SOP is the PDF copy of the SOP that is posted to the laboratory's SOP Directory. Printed copies of this SOP or electronic copies of this SOP distributed outside the facility are considered uncontrolled.

1.0 Scope and Application

This SOP describes the laboratory procedure for the determination of particle size distribution in soils.

2.0 Summary of Method

A portion of sample is soaked in a dispersing agent then partitioned into separate portions, material retained on a #10 sieve and material passing the #10 sieve. The material retained on the #10 sieve is dried to constant weight then passed through a large size sieve stack; the material retained on each sieve is measured and recorded. Material passing the #10 sieve is subject to hydrometer analysis then passed through a small size sieve stack, the material retained on each sieve is measured and recorded. All measurements, large and small sieves and hydrometer readings and the hygroscopic moisture are used to establish the particle size distribution of the sample.

This SOP is based on the following reference methods:

- ASTM Standard D 2217 – 85 (Rapproved 1998) "Standard Practice for Wet Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants", ASTM International, West Conshohocken, PA 2003, DOI: 10.1520/C0033-03, www.astm.org

- ASTM Standard D 422-63 (Rapproved 2007) "Standard Test Method for Particle-Size Analysis of Soils", ASTM International, West Conshohocken, PA 2003, DOI: 10.1520/C0033-03, www.astm.org

NOTE: ASTM D2217 was withdrawn without replacement by ASTM in 2007. A withdrawn standard is an ASTM standard that has been discontinued by the ASTM Sponsoring Committee responsible for the standard.

If the laboratory has modified the procedure from the reference method(s) a list of modifications will be provided in Section 16.0.

3.0 Definitions

Not Applicable

4.0 Interferences

Not Applicable

5.0 Safety

Employees must abide by the policies and procedures in the Corporate Environmental Health and Safety Manual (CW-E-M-001) and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.1 Specific Safety Concerns or Requirements

None

5.2 Primary Materials Used

Not Applicable

6.0 Equipment and Supplies

Catalog numbers listed in this SOP are subject to change at the discretion of the vendor. Analysts are cautioned to be sure equipment used meets the specification of this SOP.

- Top-Loading Balance, capable of weight measurement to 0.01 g
- Mechanical Stirring Device and Dispersion Cup
- Thermometer: Accurate to 0.5℃
- Mortar and Rubber Tipped Pestle
- Sedimentation Cylinder(s) 1000 mL
- Hydrometer: ASTM 151H in specification E 100.
- Sieves, of the following size(s): Gilson Company, Inc. or equivalent
  3.0" (75.00 mm)
  2.0" (50.00 mm)
  1.5" (37.50 mm)
  1.0" (25.00 mm)
  3/4" (19.00 mm)
  3/8" (9.50 mm)
  # 4 (4.75 mm)
  #10 (2.00 mm)
  #20 (850.0 um)
  #40 (425 um)
  #60 (250.0 um)
  #80 (180.0 um)
  #100 (150.0 um)
  #200 (75.0 um)
- Drying Oven with temperature range of 60-110℃
- Stainless Steel Spatulas & Spoons
- Metal & Bristle Brushes
- Ro-Tap Sieve Shaker, W. S. Tyler or equivalent.
- Timing Device with second hand and capable of counting up to 25 hours

7.0 Reagents and Standards

- Reverse Osmosis (RO) water: In-House System
- Sodium Hexametaphosphate: ELE International or equivalent.

<u>Sodium Hexametaphosphate Solution:</u> Add 120 g of sodium hexametaphosphate and 2940 g of reagent water to a 1-gallon bottle. Add a stir rod to the container and place on a stir plate. Mix the solution until it is homogeneous. Assign an expiration date of 30 days from the date made unless the parent reagent expires sooner in which case use the earliest expiration date. Store the prepared solution at ambient temperature.

8.0 Sample Collection, Preservation, Shipment and Storage

The laboratory does not perform sample collection so these procedures are not included in this SOP. Sampling requirements may be found in the published reference method.

Listed below are minimum sample size, preservation and holding time requirements:

Matrix	Sample Container	Minimum Sample Size	Preservation	Holding Time	Reference
Solid	Glass Jar w/ Teflon Lid	500 g	None	None	ASTM D422-63

Unless otherwise specified by client or regulatory program, after analysis, samples and extracts are retained for a minimum of 30 days after provision of the project report and then disposed of in accordance with applicable regulations.

9.0 Quality Control

Not Applicable

10.0 Procedure

10.1 Equipment Calibration

Check the calibration of the balance on each day of use prior to use using at least 2 Class S weights that bracket the range of use. Record in the logbook designated for this purpose.

Check the temperature of the drying oven(s) each day of use, prior to use. Record in the logbook designated for this purpose.

NOTE: The QA Manager or her designee checks the calibration of liquid in glass thermometers annually against a NIST-traceable thermometer following the procedures given in laboratory SOP BR-QA-004. Electronic / digital thermometers that are battery-operated are checked quarterly using the same procedure.

Calibrate the hydrometers every two years following the procedure given in BR-GT-008.

Calibrate the sieves 6 months following the procedure given in BR-GT-008.

10.2 Hygroscopic Moisture Determination

Label an aluminum pan with the Lab ID for each sample. Tare the balance, weigh each pan and record the weight measurement in the spreadsheet.

Mix the sample with a stainless steel spatula. Measure at least 10-15 g of each sample into the labeled aluminum pan and record the weight of sample in the spreadsheet.

Place the pan + sample in an oven maintained at a temperature of 110ºC and dry the sample for at least 16 hours. Reweigh each pan and record the weight measurement in the spreadsheet.

Percent solids are calculated using the equation given in Section 11.0.

10.3 Sample Preparation

Use the calculated percent solids and the sample characteristic for each sample to determine the amount needed for analysis using Table 2. For example, if the calculated percent solids for a sample are 50% and the sample characteristic is sand, use 200 g for analysis. If there is an insufficient amount of sample available, initiate a nonconformance memo (NCM) and contact the PM for further instruction.

Place a 1000 mL plastic beaker on the balance and tare the balance. Weight the amount of sample for analysis and record the weight in the bench sheet.

Add 125 mL of sodium hexametaphosphate solution to each beaker. Stir to mix and soak the sample in this solution for 16 hours

10.4 Sample Partition

Rinse the sample slurry into a dispersion cup using reagent water. Fill the dispersion cup ½ full with reagent water and place the cup on the blender to mix for one minute.

NOTE: Some samples may not be amendable to using the blender examples include but not limited to large gravel, sands, or organic material. If the sample is not amenable, initiate a NCM to notify the PM of the anomaly and proceed to the next step without blending the sample.

Place a #10 sieve on a 1000 mL graduated cylinder. Pour the sample through the sieve. Rinse the dispersion cup with reagent water and pour the rinse through the sieve. Repeat until transfer is complete. Bring the volume in the graduated cylinder to 1000 mL with reagent water. Cover the cylinder with a rubber stopper and equilibrate the sample to ambient temperature in preparation for hydrometer analysis.

Label a medium size aluminum dish with the sample's LAB ID then transfer the sample material that was retained on the #10 sieve to the dish. Place the aluminum dish in the drying oven set at 110 ± 5° C and dry the sample material for at least 16 hours or until constant weight. Set aside for sieve analysis.

10.5 Hydrometer Analysis

Prepare a hydrometer rinse bath by adding 1000 mL of reagent water to a 1000 mL graduated cylinder

Record the hydrometer ID and start time on the worksheet. Set the timer for the elapsed time and perform each task as listed in Table 1: Hydrometer Reading Table.

To shake the cylinder, rotate the flask up and down for one minute approximating at least 60 turns. One turn down and one turn up equals two turns.

To take a hydrometer reading, gently insert the hydrometer into the graduated cylinder and wait ~ 20 seconds. Read the hydrometer from the top of the meniscus to the nearest 0.0005. Enter the reading on the worksheet. After each reading, clean the hydrometer by twisting and dropping the hydrometer into the hydrometer rinse bath.

Insert a temperature probe into the cylinder to the same depth used for the hydrometer reading. Read the temperature to the nearest 0.5℃ and enter the temperature measurement on the worksheet. Rinse the temperature probe in the hydrometer rinse bath.

Repeat the above process taking hydrometer readings every 2, 5, 15, 30, 60, 240 and 1440 minutes as per Table 1 then proceed to small sieve analysis.

10.6 Sieve Analysis

Inspect the sample material in the aluminum pan and record a description of the non-soil material (e.g.- sticks, grass, wood, plastic), hardness of material and shape of material in the worksheet.

Hardness qualifiers include hard, soft or brittle. Shape qualifiers include well rounded, rounded, subrounded, subangular, and angular.

Large Sieves

Weigh the 3/4”, 3/8”, #4 and #10 sieves and enter the weight measurements in the worksheet as the tare weight.

Stack the sieves then transfer the sample material from the aluminum dish to the sieve stack. If the sample material is less than 30 g, manually shake the sieve stack for 2 minutes. If the sample material is greater than 30 g, place the sieve stack into the Ro-tap machine and shake the sieve stack for 10 minutes.

Weigh each sieve and record these measurements in the worksheet.

Small Sieves

Quantatively transfer the sample from the graduated cylinder to a #200 wet wash sieve. Ensure all of the sample has been transferred to the #200 wet wash sieve by rinsing the graduated cylinder several time with RO water. Using RO water, wash the sample through the #200 sieve until the water runs clear then transfer the material retained on the sieve into a 250 mL glass beaker labeled with the sample’s LAB ID.

Place the beaker in the drying oven and dry at a temperature of 110ºC for at least 16 hours. After 16 hours, remove the beaker from the oven and allow it to cool.

Gently mix the dried contents of the beaker with a rubber-tipped pestle to break any soil aggregates that may have formed during the drying stage.

Tare the balance and weigh the sieve stack sized between #20 and #200 and record the tare weights.

Transfer the sample to the sieve stack and ensure complete transfer. Use hair or wire brushes to clean the beaker. Place the sieve stack on the RoTap machine and shake for ten minutes.

Weigh each sieve and record these measurements in the worksheet.

11.0 Calculations / Data Reduction

11.1 Calculations

Sample Used (SU): Dry Preparation

$$SU = (pan + dry\ sample\ \text{-}\ pan)\ \text{-}\ (pan + non\ \text{-}\ soil\ material\ \text{-}\ pan) \otimes HMCF$$

Where:
HMCF = Hygroscopic moisture correction factor.

Sieve Analysis (Percent Finer = PF)

Large Sieves:

3 inch: PF = 100-100 (Sieve and Sample (3 inch) - Sieve (3 inch))/SU*

2 inch: PF = PF (3 inch) - 100(Sieve and Sample (2 inch) - Sieve (2 inch))/SU and so on through the #10 Sieve.*

Small Sieves:

#20: PF = PF(#10) - 100(mass passing #10/sample mass (Hyd))*(sieve and sample (#20) - sieve(#20))/sample used*

#40: PF = PF (#20) - 100(mass passing #10/sample mass (Hyd))*(sieve and sample (#40) - sieve (#40))/sample used and so on up through #10 sieve.*

Hydrometer Analysis

Particle size, Micron

1000*sqrt [930*viscosity/980*(SG-1))*(effective depth/time)]

Viscosity at sample temperature, poises
Effective Depth, cm = 16.29-264.5*(actual Hydrometer reading - 1) above equation for effective depth based on equation found with table 2 in method, in which 16.29 = 0.5*(14.0-67.0/27.8)+10.5 and 264.5 = (10.5-2.3)/0.031
Time, minutes = Time of hydrometer reading from beginning of sedimentation
Sqrt - square root
SG - Specific Gravity of soil
Viscosity - is the resistance of a liquid to flow
Percent Finer (PF):

PF = Constant*(actual hydrometer reading - hydrometer correction factor - 1)

Where:
Constant = (100,000/W)*SG/(SG-1)
W = (Total sample used *sample used for hydrometer analysis*HMCF)/Amount of total sample passing #10 sieve
Hydrometer Correction = slope*sample temperature + Intercept
Slope = ((low temp. reading -1)-(high temp. reading -1)/(low temp. - high temp.))

Intercept = (low temp. reading -1) - (low temp. * slope)

11.2 Data Reduction

11.2.1 Primary Data Review

Review project documents such as the Project Plan (PP), Project Memo or any other document/process used to communicate project requirements to ensure those project requirements were met. If project requirements were not met, immediately notify the project manager (PM) to determine an appropriate course of action.

Upload the batch information into LIMS and complete the batch editor and worksheet. Initiate NCMs for any anomalies observed during the preparation process. Set the status of the batch to 1^{st} level review.

11.2.2 Secondary Data Review

Review project documents such as the Project Plan (PP), Project Memo or any other document/process used to communicate project requirements and verify those project requirements were met. If project requirements were not met, immediately notify the project manager (PM) to determine an appropriate course of action.

Check the batch editor and worksheet to verify the batch is complete and any outages are documented with an NCM along with the results of any corrective actions taken. Set the status of the batch to second level review.

11.2.3 Lab Complete

Review the batch, run QC checker as appropriate and set the status to lab complete.

11.2.4 Data Reporting

Sample results are reported from the laboratory's LIMS system using the formatter specified by the Project Manager.

11.2.5 Data Archival

Data are stored in the laboratory's LIMS system.

12.0 <u>Method Performance</u>

Not Applicable

13.0 <u>Pollution Control</u>

It is TestAmerica's policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, ordering chemicals based on quantity needed, preparation of reagents based on anticipated usage and reagent stability). Employees must abide by the policies in Section 13 of the Corporate Safety Manual for "Waste Management and Pollution Prevention."

14.0 Waste Management

Waste management practices are conducted consistent with all applicable rules and regulations. Excess reagents, samples and method process wastes are disposed of in an accepted manner. Waste description rules and land disposal restrictions are followed. Waste disposal procedures are incorporated by reference to BR-EH-001. The following waste streams are produced when this method is carried out.

- Solid Waste-Satellite Container: Solid Waste 5 Gallon Plastic Bucket (inside fume hood)
- Liquid Waste- 55 gallon poly drum

15.0 References / Cross-References

- ASTM Standard D 2217 – 85 (Reapproved 1998) "Standard Practice for Wet Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants", ASTM International, West Conshohocken, PA 2003, DOI: 10.1520/C0033-03, www.astm.org

- ASTM Standard D 422-63 (Rapproved 2007) "Standard Test Method for Particle-Size Analysis of Soils", ASTM International, West Conshohocken, PA 2003, DOI: 10.1520/C0033-03, www.astm.org

16.0 Method Modifications

- The laboratory prepares samples for ASTM D422 using ASTM method D2217 rather then the suggested method ASTM D421.

17.0 Attachments

- Table 1: Hydrometer Reading Table (For up to 12 Sedimentation Cylinders)
- Table 2: Percent Solids Table for Weight Determination for D422.

18.0 Revision History

BR-GT-006, Revision 7:
- Title Page: Updated approval signatures and Copyright Date.
- Section 10.1: Removed calibration of RoTap machine
- Section 10.6: Updated language to better describe process to transfer sample to the #200 wet wash sieve.
- Section 16.0: Removed a modification

BR-GT-006, Revision 6:
- Title Page: Updated approval signatures
- All Sections: Removed references to dry preparation by ASTM D421; Added procedure for wet preparation.
- Attachments: Inserted Percent Solids Tab

Table 1: Hydrometer Reading Table (For up to 12 Sedimentation Cylinders)

Elapsed Time (hr:min)	Task	Cyl. No.	Actual Time (min)	Elapsed Time (hr:min)	Task	Cyl. No.	Actual Time (min)
0:00	Shake	1		1:01	Read	10	5
0:01	**Place**	**1**		**1:02**	Shake	11	
0:01	**Shake**	**2**		**1:03**	Place	11	
0:02	Place	2		1:04	Read	9	15
0:03	Read	1	2	1:05	Read	11	2
0:04	Read	2	2	1:06	Read	7	31
0:06	Read	1	5	1:07	Read	3	58
0:07	Read	2	5	1:08	Read	11	5
0:08	Shake	3		**1:09**	Shake	12	
0:09	**Place**	**3**		**1:10**	Place	12	
0:09	**Shake**	**4**		1:11	Read	10	15
0:10	Place	4		1:12	Read	12	2
0:11	Read	3	2	1:13	Read	4	63
0:12	Read	4	2	1:14	Read	8	32
0:14	Read	3	5	1:15	Read	12	5
0:15	Read	4	5	1:18	Read	11	15
0:16	Read	1	15	1:19	Read	9	30
0:17	Read	2	15	1:21	Read	5	60
0:20	Shake	5		1:25	Read	12	15
0:21	Place	5		1:26	Read	10	30
0:23	Read	5	2	1:27	Read	6	59
0:24	Read	3	15	1:33	Read	11	30
0:25	Read	4	15	1:34	Read	7	59
0:26	Read	5	5	1:41	Read	12	31
0:27	Shake	6		1:42	Read	8	60
0:28	Place	6		1:52	Read	9	63
0:30	Read	6	2	1:53	Read	10	57
0:31	Read	1	30	2:06	Read	11	63
0:32	Read	2	30	2:07	Read	12	57
0:33	Read	6	5	4:17	Read	1	256
0:34	Shake	7		4:18	Read	2	256
0:35	Place	7		4:19	Read	3	250
0:36	Read	5	15	4:20	Read	4	250
0:37	Read	7	2	4:21	Read	5	240
0:38	Read	3	29	4:22	Read	6	234
0:39	Read	4	29	5:00	Read	7	265
0:40	Read	7	5	5:01	Read	8	259
0:41	Shake	8		5:02	Read	9	253
0:42	Place	8		5:03	Read	10	247
0:43	Read	6	15	5:04	Read	11	241
0:44	Read	8	2	5:05	Read	12	235
0:47	Read	8	5	24:01	Read	1	1440
0:48	Shake	9		24:02	Read	2	1440
0:49	Place	9		24:03	Read	3	1434
0:50	Read	7	15	24:04	Read	4	1434
0:51	Read	9	2	24:05	Read	5	1424
0:52	Read	5	31	24:06	Read	6	1418
0:54	Read	9	5	24:07	Read	7	1412
0:55	Shake	10		24:08	Read	8	1406
0:56	Place	10		24:09	Read	9	1400
0:57	Read	8	15	24:10	Read	10	1394
0:58	Read	10	2	24:11	Read	11	1388
0:59	Read	6	31	24:12	Read	12	1382
1:00	**Read**	**1**	**59**				
1:00	**Read**	**2**	**58**				

Source: Laboratory Prepared Reference Document

Table 2: Percent Solids Table for Weight Determination for D422.

Percent Solid Table

Quantities of sample (in grams) to be utilized in Wet method version of ASTM D854 and D422

% Sol	Spec Grav 25	Hydrometer Slt/Cl 50	Hydrometer Slt/Snd 75	Snd 100	Snd/Gr 200	% Sol	Spec Grav 25	Hydrometer Slt/Cl 50	Hydrometer Slt/Snd 75	Snd 100	Snd/Gr 200
1	2500	5000	7500	10000	20000	51	49	98	147	196	392
2	1250	2500	3750	5000	10000	52	48	96	144	192	385
3	833	1667	2500	3333	6667	53	47	94	142	189	377
4	625	1250	1875	2500	5000	54	46	93	139	185	370
5	500	1000	1500	2000	4000	55	45	91	136	182	364
6	417	833	1250	1667	3333	56	45	89	134	179	357
7	357	714	1071	1429	2857	57	44	88	132	175	351
8	313	625	938	1250	2500	58	43	86	129	172	345
9	278	556	833	1111	2222	59	42	85	127	169	339
10	250	500	750	1000	2000	60	42	83	125	167	333
11	227	455	682	909	1818	61	41	82	123	164	328
12	208	417	625	833	1667	62	40	81	121	161	323
13	192	385	577	769	1538	63	40	79	119	159	317
14	179	357	536	714	1429	64	39	78	117	156	313
15	167	333	500	667	1333	65	38	77	115	154	308
16	156	313	469	625	1250	66	38	76	114	152	303
17	147	294	441	588	1176	67	37	75	112	149	299
18	139	278	417	556	1111	68	37	74	110	147	294
19	132	263	395	526	1053	69	36	72	109	145	290
20	125	250	375	500	1000	70	36	71	107	143	286
21	119	238	357	476	952	71	35	70	106	141	282
22	114	227	341	455	909	72	35	69	104	139	278
23	109	217	326	435	870	73	34	68	103	137	274
24	104	208	313	417	833	74	34	68	101	135	270
25	100	200	300	400	800	75	33	67	100	133	267
26	96	192	288	385	769	76	33	66	99	132	263
27	93	185	278	370	741	77	32	65	97	130	260
28	89	179	268	357	714	78	32	64	96	128	256
29	86	172	259	345	690	79	32	63	95	127	253
30	83	167	250	333	667	80	31	63	94	125	250
31	81	161	242	323	645	81	31	62	93	123	247
32	78	156	234	313	625	82	30	61	91	122	244
33	76	152	227	303	606	83	30	60	90	120	241
34	74	147	221	294	588	84	30	60	89	119	238
35	71	143	214	286	571	85	29	59	88	118	235
36	69	139	208	278	556	86	29	58	87	116	233
37	68	135	203	270	541	87	29	57	86	115	230
38	66	132	197	263	526	88	28	57	85	114	227
39	64	128	192	256	513	89	28	56	84	112	225
40	63	125	188	250	500	90	28	56	83	111	222
41	61	122	183	244	488	91	27	55	82	110	220
42	60	119	179	238	476	92	27	54	82	109	217
43	58	116	174	233	465	93	27	54	81	108	215
44	57	114	170	227	455	94	27	53	80	106	213
45	56	111	167	222	444	95	26	53	79	105	211
46	54	109	163	217	435	96	26	52	78	104	208
47	53	106	160	213	426	97	26	52	77	103	206
48	52	104	156	208	417	98	26	51	77	102	204
49	51	102	153	204	408	99	25	51	76	101	202
50	50	100	150	200	400	100	25	50	75	100	200