BENTHIC AND SEDIMENT MONITORING PRE- AND POST-ENERGIZING STANDARD OPERATING PROCEDURE

1. Introduction

This *Pre- and Post-Energizing Benthic Monitoring and Sediment Sampling Standard Operating Procedure* is developed pursuant to Certificate Condition 163 (CC 163) (NYSPSC 2013). CC 163 states: Within six (6) months after issuance of this Certificate, the Certificate Holders shall submit to the Department of Public Service (DPS) Staff for review, comment, and approval in consultation with New York State Department of Environmental Conservation (NYSDEC) and the New York State Department of State (NYSDOS), detailed Standard Operating Procedures ("SOP") for compliance monitoring studies to be conducted in the Hudson River. The SOPs shall be consistent with the Scopes of Study attached to this Certificate:

- Benthic and Sediment Monitoring Scope of Study (Attachment 2 to the Certificate)
- Bathymetry, Sediment Temperature and Magnetic Field Scope of Study (Attachment 3 to the Certificate)
- Atlantic Sturgeon Pre-Installation and Post-Energizing Hydrophone Scope of Study (Attachment 4 to the Certificate)

In compliance with CC 163, the Certificate Holder will conduct a *Pre- and Post-Energizing Benthic and Sediment Monitoring Study* in the Hudson River Estuary and Lake Champlain.

Per CC 163 Attachment 2 –Benthic sampling will occur in Lake Champlain and the Hudson River and sediment chemistry surveys will be conducted to characterize existing and post-energizing sediment conditions proximate to the cable in Lake Champlain and the Hudson, Harlem, and East Rivers. For each program, pre-installation surveys will be conducted. The benthic post-energizing surveys will be conducted at the following milestones: (a) 3 years after installation assuming cable energizing; and (b) when the transmission system is operating at 500 to 1,000 MW if it is not doing so 3 years after installation. Sediment post-energizing sampling will be conducted 3 years after installation during the same season as the first benthic sampling event.

2. Quality Assurance Project Plan

A *Quality Assurance Project Plan* (QAPP) will be developed to document planned sediment sampling activities for chemical analysis and benthic community sampling and to establish the criteria for performing these activities at a predetermined quality for the work to be conducted. The principal purpose of this document is to specify quality assurance/quality control (QA/QC)

procedures for the collection, analysis, and evaluation of data that will be consistent with the requirements of the Certification (NYSPSC, 2013).

The QAPP will provide specific information applicable to the l sampling program. This information includes definitions and specific goals for data quality and required types and quantities of QA/QC samples. The procedures address field documentation; sample handling, custody, and shipping; instrument calibration and maintenance; auditing; data reduction, validation, and reporting; recommended corrective action requirements; and QA reporting specific to the analyses performed by the laboratories. The QAPP will be developed and provided as a separate document for review and approval prior to initiation of the work.

3. Benthic Sample Collection and Laboratory Analysis

Benthic community sampling will occur in Lake Champlain and Hudson River per CC163 Attachment 2. The sampling methodology of Maher and Cerrato (2006) was used to refine the sampling effort for each biotope (i.e., an area with homogenous environmental and biotic characteristics) selected for benthic macroinvertebrate monitoring, where previously collected geophysical data is used to direct subsequent environmental and faunal sampling. The benthic macroinvertebrate and sediment sampling locations will be selected so as to represent the primary sediment environments and characteristic sediment types traversed by the cable.

In Lake Champlain, geophysical surveys and sediment cores were collected in 2010. Geophysical surveys described surficial sediments as relatively fine grained, with some areas containing coarse grain sediments. It is anticipated that up to 30 locations will be sampled within Lake Champlain; however, a review of existing literature will be performed that may allow for additional stratification of potential sample locations

In the Hudson River (from Cementon to Yonkers, excluding Haverstraw Bay), sediment characteristics were based on the sediment provinces identified by the NYSDEC Benthic Mapping Project (Bell et al. 2006). This reach of the estuary is highly influenced by tidal action and subsequent daily advance and retreat of salt water into the river. The salinity gradient from Cementon to Yonkers varies from a relatively freshwater segment near Cementon to an area of much higher salinity near Yonkers. In order to account for the changes in salinity and habitat preferences of fauna, for study design purposes the study reach will be divided into three salinity zones: freshwater, low salinity, and high salinity, in order to reflect the expected benthic faunal differences associated with the salinity gradient.

Benthic community, depth measurements and sediment grain size samples (see Section 4 below) will be collected at each of the sediment environments and substrate types based on the current Project route (Table 1). This listing will be updated once the final routing has been selected based on the construction marine route survey. The sampling locations will be situated such that the samples are representative of a specific biotope. The sampling locations will avoid transitional areas between markedly different sediment environments (e.g. erosion, deposition and dynamic, as well as substrate types).

Table 1

Benthic and Sediment Sampling Locations.

Salinity Zone	Sediment Environment	Substrate Types
Freshwater	Dynamic-Waves	sand
	Deposition-Unrestricted Thickness	muddy sand
	Dynamic-Scour	sand
	Deposition-Thin	muddy sand
	Dynamic Lineation	muddy sand
Low Salinity between 0.3 $‰_o$ and 10 $‰_o$)	Dynamic-Waves	sandy mud
	Deposition-Thin	mud
	Dynamic-Drift	sandy mud
	Dynamic-Scour	sandy mud
High Salinity (>10 $‰_o$)	Dynamic-Scour	gravelly mud
	Dynamic-Waves	sand
	Dynamic-Drift	sandy mud
	Deposition-Unrestricted Thickness	mud

Ten samples in triplicate will be collected at each location during the pre- and post-energizing programs. Samples will be allocated among disturbed (i.e., within 100 feet of the proposed cable route) and undisturbed (i.e., outside of the proposed cable route) locations for suitable comparison. Benthic grabs will be obtained with a $0.1m^2$ Smith-McIntyre Grab. Sampling will take place during late spring and early summer for the pre-installation survey and as close as possible to the same late spring / early summer time period for the post-energizing survey to allow for comparison. Along with biological and grain size analysis for each station, water quality parameters (i.e., salinity, dissolved oxygen, conductivity, temperature and total suspended solids) will be measured at each sampling location during each sampling event.

A stringent Quality Control (QC) program will be followed during sample sorting, enumeration, identification, and collection of water quality parameters to ensure accuracy. These procedures will be detailed in the Quality Assurance Project Plan.

3.1 Benthic Community and Sediment Grain Size Sampling Procedure

The following procedures will be used when collecting the ten samples in triplicate per location:

- Record sample location using a Global Positioning System (GPS) unit.
- Collect in situ water quality measurements (i.e., temperature, dissolved oxygen, and salinity) at surface and near bottom. Probes will be calibrated daily.

- Attach Smith-McIntyre sampler to the necessary length of sample line/cable.
- Use winch for hoisting and lowering the sampler.
- Record the depth to the top of the sediment from boat depth finder.
- Mark the distance to top of sediment on the sample line with a proximity mark at 1 meter above the sediment.
- Open sampler jaws until latched. From this point, support the sampler by its lift line, or the sampler will be tripped and the jaws will close.
- Lower the sampler until the proximity mark is reached.
- Lower the sampler at a slow rate of descent (<1 ft per second) through last meter until contact is felt.
- Allow sample line to slack several inches. In strong currents, more slack may be necessary to release mechanism.
- Slowly raise Smith-McIntyre grab sampler to clear surface.
- Place Smith-McIntyre sampler into a stainless steel or Teflon® tray and open.
- Lift Smith-McIntyre sampler clear of the tray.
- Split sample in two and prepare one half of the sample for laboratory analysis species composition and abundance and the other half of the sample for laboratory analysis of sediment grain size (per CC163 Attachment 2).
- Place sample for grain size analysis in separate sample bottle.
- Wash sample for species composition sample into a No. 35 mesh (0.5mm) sieving bucket or sieve and wash with a hose to remove all sediment.
- Remove sample from bucket/sieve and place in sample bottle.
- Preserve in 70 percent ethyl alcohol and apply biologic stain (i.e., rose Bengal).
- Label the sample bottles with the appropriate sample label.
- Complete all chain-of-custody documents and field sheets and record information in the field logbook.
- Ship to a laboratory for identification to the lowest practicable taxon and to grain size laboratory.
- Rinse the grab, the containers and the sieves between each sample.

During the laboratory analysis, if the number of organisms in a sample is large (>500), the samples will be sub-sampled. Replicate samples will be collected and archived. Archived samples will be analyzed if needed based on power analysis (i.e., the process for determining the sample size for a research study to define the probability of detecting a "true" effect when it exists) and the Maher and Cerrato (2006) method.

The sediment grain size samples will be sorted into standard phi sizes (Wentworth, C. K., 1922) and the mean and standard deviation will be determined. The reports will include a table showing the percentage value of each phi class present in each sample (percentages total 100%).

3.2 Surface Water Sampling for Total Suspended Solids

A standard Kemmerer or Van Dorn sampler will be used to collect the near bottom (e.g., 1 foot from bottom) surface water for TSS analysis. A Kemmerer sampler is a brass cylinder with rubber stoppers that leave the ends of the sampler open while being lowered in a vertical position, thus allowing free passage of water through the cylinder. The Van Dorn sampler is plastic and is lowered in a horizontal position.

The following procedures will be used when collecting the TSS samples:

- Determine the depth of the water in the sampling location.
- Using a properly decontaminated Kemmerer or Van Dorn bottle, set the sampling device so that the sampling end pieces are pulled away from the sampling tube, allowing the water to be sampled to pass through this tube.
- Lower the pre-set sampling device to the predetermined depth. Avoid bottom disturbance.
- When the sampler is at the required depth (e.g., 1 foot from bottom), send down the messenger, closing the sampling device.
- Retrieve the sampler and discharge the first 10 to 20 mL to clear any potential contamination on the valve.
- Transfer the sample to the appropriate sample container.
- If necessary, preserve the sample according to guidelines in the QAPP In most cases, place preservatives in sample containers before sample collection to avoid overexposure of samples and overfilling of bottles during collection.
- Check that a Teflon liner is present in the cap, if required. Secure the cap tightly.
- Label the sample bottle with an appropriate sample tag. Be sure to label the tag carefully and clearly, addressing all the categories or parameters. Record the information in the field logbook, and complete the chain-of-custody form.

4. Sediment Sample Collection and Laboratory Analysis

Sediment sampling in Lake Champlain and the Hudson River will be made at or within 30 ft of the benthic macroinvertebrate sampling stations as described above. In the Harlem and East Rivers, it is anticipated up to three samples will be collected during each sample event. The post-energizing survey will be made following cable installation and sampling locations will be made at or near pre-installation survey locations.

Surficial sediment grabs will take (as nearly as possible) the upper 2 centimeters of the substrate. Three samples will be obtained at each location; one sample will be collected along the Project route and two samples will be collected approximately 100 feet on both sides of the Project route for a total of three samples per location.

All analyses will be performed by a NYSDOH ELAP approved Laboratory using the analytical methods shown in Table 2. One QC sample will be analyzed for every 10 samples collected. Laboratory analysis of sediments will include:

- In Lake Champlain - the following two parameters: arsenic and copper.
- In the East River, Harlem and Hudson Rivers - the following parameters; arsenic, cadmium, copper, lead, mercury, zinc, total PCBs (22 congeners), and total PAHs.

Table 2 Analytical Methodology

Parameter	SW-846 Method
PAHs	8310
Pesticides	8081
Total PCBs (Aroclors and congeners)	8082A
Mercury	7471B
Arsenic	6010C
Mercury	6010C

4.1 Sediment Analytical Chemistry Sampling Procedure

The sampling protocols will be performed in accordance with the USACE/Environmental Protection Agency Regional Testing Manual for Dredged Materials. As such the following procedures will be used when sampling sediments with a Smith-McIntyre sampler:

- Record sample location using a Global Positioning System (GPS) unit.
- Record the depth to the top of the sediment from boat depth finder.
- Attach Smith-McIntyre sampler to the necessary length of sample line/cable.

- Mark the distance to top of sediment on the sample line with a proximity mark 1 meter above the sediment.
- Use winch for hoisting and lowering the sampler.
- Open sampler jaws until latched. From this point, support the sampler by its lift line, or the sampler will be tripped and the jaws will close.
- Lower the sampler until the proximity mark is reached.
- Lower the sampler at a slow rate of descent through last meter until contact is felt.
- Allow sample line to slack several inches. In strong currents, more slack may be necessary to release mechanism.
- Slowly raise Smith-McIntyre grab sampler to clear surface.
- Place Smith-McIntyre sampler into a stainless steel or Teflon® tray and open.
- Lift Smith-McIntyre sampler clear of the tray.
- With gloved hands, begin sampling top 2 centimeters with a stainless steel spoon with as little disturbance as possible to the sediment.
- Repeat these steps until sufficient sample volume has been collected for all parameters. If compositing is required, transfer discrete samples to stainless steel bowl for mixing. Thoroughly mix remaining sample as appropriate, collect suitable aliquots with a stainless steel laboratory spoon or equivalent, and transfer into an appropriate sample bottle.
- Label the sample bottle with the appropriate sample label. Be sure to complete the label carefully and clearly, addressing all the categories or parameters.
- Immediately place filled sample containers on ice and cool to 4º C
- Complete all chain-of-custody documents and field sheets and record information in the field logbook.

Decontaminate sampling equipment after use and between sample locations using appropriate procedures.

5. Equipment Decontamination

To avoid cross contamination, sampling equipment (defined as any piece of equipment that may contact a sample) will be decontaminated according to the following procedures:

- Field equipment rinsate blanks will be prepared and analyzed to monitor the effectiveness of field decontamination procedures.

- Use vendor-decontaminated, dedicated, disposable equipment to minimize cross contamination.

Small equipment decontamination for non-disposable equipment such as a stainless steel bowls and spoons will be accomplished using the following procedures:

- Alconox (or equivalent) and potable water wash;
- Potable water rinse; and,
- Distilled/deionized water rinse.

Solvents will not be used in the field decontamination of such equipment. Decontamination will include washing with a laboratory grade detergent (e.g., Alconox) to remove visible contamination, followed by potable (tap) water and analyte-free water rinses. Tap water may be used from any treated municipal water system; the use of an untreated potable water supply is not an acceptable substitute. Equipment will be allowed to dry prior to use.

Decontamination of the Smith-McIntyre sampler will be accomplished by removal of all visible sediment using either lake or river water.

6. Field Records and Documentation

The objective of this subsection is to establish consistent procedures and formats by which field records will be kept and activities documented, and a methodology by which field records will be managed. Field records and documentation to be used during field activities include field log books and chain-of-custody (COC) forms.

6.1 Field Log Books

Field log books will be prepared and maintained throughout the course of the investigation. Only bound, weatherproof field log books will be used. Log book entries will be recorded in indelible, waterproof ink. If errors are made in any field log book, field record (form), COC records, or any other field record document, corrections will be made by crossing a single line through the error, entering the correct information, and initialing and dating the correction.

Entries will be made in the following format:

- Documentation and reporting of events and activities will be made in chronological order on the right page of an open log book.
- The left page of the log book will be used for extemporaneous reporting, such as sketches, tables, providing details or comments on events reported sequentially, or interpretations, and notes identifying use of any other field documentation such as COCs.
- The date will be placed at the top of every page in the left-hand corner of the right page.

- The time of entry recordings will be in columnar form down the left-hand side of the right page.
- If an entry is made in a non-dedicated log book, then the date, project name, and project number will be entered left to right, respectively, along the top of the right page. Entries will be dated, and time of entry recorded.
- At the beginning of each day, the first two entries will be "Personnel/Contractors on Site" and "Weather."
- At the end of each day's entry or particular event, if appropriate, the person entering the field notes will draw a diagonal line originating from the bottom left corner of the page to the conclusion of the entry and sign along the line indicating the conclusion of the entry or the day's activity.

Entries in field log books will be legible (printing is preferable) and will contain accurate and inclusive documentation of project activities (e.g., surface water monitoring). Information pertaining to health and safety aspects, personnel on site, visitor's names, association, and time of arrival/departure, etc., should also be recorded. Language should be objective, factual, and free of personal feelings or other terminology that might prove inappropriate, since field records are the basis for later written reports. Once completed, these field log books become accountable documents and must be maintained as part of the project files.

Sample collection and handling activities, as well as visual observations, will be documented in the field log books and applicable field records (forms) (e.g., calibration logs). The sample collection equipment (where appropriate), field analytical equipment, and equipment used to make physical measurements will be identified in the field log books. Calculations, results, and calibration data for field sampling, field analytical, and field physical measurement equipment will also be recorded in the field log books applicable field records. Field analyses and measurements must be traceable to the specific piece of field equipment utilized and to the field investigator collecting the sample, making the measurement, or conducting analyses. Log books will be updated as field work progresses.

When an individual log book is full, the log book will be submitted to the project manager for final cataloging and filing. The log books will be stored in the project file.

6.2 Sample Identification

A unique sample identifier will be used to designate each sample collected, generally consisting of the sample location and depth of sample collected. Field blanks will be labeled for the day of collection. For MS/MSD samples, the MS/MSD will be added to the sample ID and included on the COC as a note.

6.3 Sample Labeling

A non-removable label will be affixed to each sample container. Labels will be either computer generated or hand marked with permanent marker pens.

6.4 Sample Chain of Custody

At the time of the sampling, a field team member will record the sample information in the field log book and on a COC form. The sample information recorded in the log books will be at least as detailed as that recorded on labels, and should indicate the type of sample (e.g., surface water), sample preservation, and sampling location, in sufficient detail as to allow re-sampling at the same location.

After samples are collected, the field team member will immediately place the filled containers in coolers and iced to 4^{o} C. Samples will be preserved as required and specified in the QAPP. The field team will maintain custody of the samples until they are shipped to the laboratory. The entries on the COC form will correspond to the field log book, standard forms, and sample labels.

Original copies of COC forms will be forwarded to the laboratory. Copies and associated shipping air bills will be maintained by the field supervisor with all other documentation until provided to the project manager. COC forms will be copied to the field file weekly or as otherwise specified. A copy of the COC forms will be filed by the project manager or designated representative on a weekly basis (at a minimum) in the project file for permanent storage.

6.5 Sample Packaging and Shipping

Samples collected for chemical analysis will be shipped to the laboratory on the day of collection (if possible; otherwise samples will be shipped on the day after collection), following proper identification, preparation of the COC, preservation, and packaging procedures. Samples which require maintenance at 4º C (essentially all aqueous and non-aqueous samples submitted for chemical analysis) which are collected and shipped on a Friday must be delivered to, and accepted by, the laboratory on Saturday; note that it may be necessary to arrange this in advance.

Sample packaging and shipping procedures are summarized as follows: a properly completed COC form will accompany each sample shipment. The sample identifiers will be listed on the COC form. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents transfer of custody of samples from the sampler to another person, to the laboratory, or to/from a secure storage area.

Samples will be properly packaged to avoid breakage, stored on ice at 4° C for shipment and dispatched to the appropriate laboratory for analysis. (In the event that samples must be held overnight prior to shipment, the temperature of the cooler and presence of sufficient ice will be checked and new ice added prior to shipment.) A signed COC form will be enclosed and secured to the inside top of each sample box or cooler. The original COC, a cooler receipt form (if applicable), and any additional documentation will be placed in a plastic bag to prevent them from getting wet, and one copy will be retained by the field supervisor.

Shipping containers will be secured with strapping tape and custody seals for shipment to the laboratory. Signed custody seals will be covered with clear plastic tape. The cooler will be taped shut with strapping tape in at least two locations.

Samples will be transported to the laboratory by a commercial overnight carrier (e.g., FedEx®) unless other arrangements are made on a project-specific basis (e.g., laboratory courier sample pickup; or hand delivery of samples to the laboratory by AECOM personnel).

7. Reporting

A report will be prepared for the pre- and post-energizing sampling programs. The reports will include a description of procedures followed during the monitoring program, field sampling results, analytical testing data results, and accompanying QA/QC data and interpretation. The post-energizing final report will also include a comparison of existing and post-energizing benthic communities and sediment characteristics.

Benthic community biodiversity will be reported via taxa richness, the Shannon-Wiener Diversity Index, and evenness (or equitability). Benthic community comparisons will be made using Analysis of Variance (ANOVA) to test for significant differences among groups of sample means. A Before-After-Control-Impact design will be used to test for a significant interaction effect between Period (i.e., before and after) and Location (i.e., Control and Impacted) (Thomas et al. 1978, Green 1979, Smith et al. 1993, Smith 2002).

As benthic community composition, abundance and diversity are highly dependent on water quality and sediment properties, a multivariate discriminant analysis (MDA) will also be used as appropriate to analyze the physical and chemical data collected regarding water quality and sediment temperature. Sediment characteristics will also be compared to applicable standards or criteria.

The final reports summarizing the results of the *Pre- and Post-Energizing Benthic Monitoring and Sediment Sampling Programs* will be submitted to the NYSDEC, NYSDOS, NYSDPS Staff, and the Secretary of the New York State Public Service Commission within 1 year of completing the sample collection.

8. References

Bell, R.E., R.D. Flood, S. Carbotte, W.B.F. Ryan, C. McHugh, M. Cormier, R. Versteeg, H. Bokuniewicz, V.L. Ferrini, J. Thissen, J.W. Ladd, E. A. Blair, 2006, Benthic habitat mapping in the Hudson River Estuary, in J. Levinton and J. Waldman (editors), The Hudson River Estuary, Cambridge Univ Press., pp 51-64.

Green, R.H. 1979. Sampling design and statistical methods for environmental biologists. John Wiley and Sons, New York, NY.

Maher, N.P. and R.M. Cerrato. 2006. Using Species Richness to Estimate Sampling Effort, a report prepared for the Hudson River Estuary program, NYSDEC.

NYS Public Service Commission (NYSPSC) (2013). Revised Appendix C. Champlain Hudson Power Express, Inc. Proposed Certificate Conditions. January 18, 2013.

Smith, E.P. 2002. BACI Design. Pages 141-148 In Encyclopedia of Environmetrics (A.H.El-Shaarawi and W.W. Piegorsch), Vol. 1. John Wiley & Sons, Ltd., Chichester.

Smith, E.P., D.R. Orvos, and J.J. Cairns. 1993. Impact assessment using the before-after-control-impact (BACI): Comments and concerns. Can. J. Fish. Aquat. Sci., 50:627-637.

Thomas, J.M., J.A. Mahaffey, K.L. Gore, and D.G. Watson. 1978. Statistical methods used to assess biological impact at nuclear power plants. Journal of Environmental Management, 7:260-290.

Wentworth**,** C.K. 1922**.** A scale of grade and class terms for clastic sediments. Journal of Geology, 30: 377-392.