VERDANT POWER

Before the United States of America
Federal Energy Regulatory Commission

ROOSEVELT ISLAND TIDAL ENERGY PROJECT

FERC No. 12611

Draft Kinetic Hydropower Pilot License Application

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Verdant Power, LLC
New York, NY

PILOT LICENSE APPLICATION
ROOSEVELT ISLAND TIDAL ENERGY PROJECT
FERC NO. 12611

DRAFT

EXHIBIT E

ENVIRONMENTAL REPORT

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ACRONYMS

ACOE	United States Army Corps of Engineers
BA	Biological Assessment
BO	Biological Opinion
CEQ	Council on Environmental Quality
Commission	Federal Energy Regulatory Commission
CORE	Cornwall Ontario River Energy
CR	Control Room
CZMA	Coastal Zone Management Act
D	diameter
DOE	Department of Energy
EFH	Essential Fish Habitat
EPA	Environmental Protection Agency
EPB	Environmental Policy Board
FERC	Federal Energy Regulatory Commission
FMPP	Fish Monitoring and Protection Plan
ft	feet/foot
GHT	Gorlov Helical Turbine
ICD	Initial Consultation Document
IHA	Incidental Harassment Authorization
ILP	Integrated Licensing Process
INEEL	Idaho National Engineering and Environmental Laboratory
KHPS	Kinetic Hydropower System
LOA	Incidental Harassment Authorization
LPC	Landmarks Preservation Commission
m	meter
MMPA	Marine Mammal Protection Act
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NYC	New York City
NYDOS	New York State Department of State
NYSDEC	New York State Department of Environmental Conservation
NYSERDA	New York State Energy Research and Development Authority
NYU	New York University
PATONS	Public Aides to Navigation
ppt	parts per thousand
RIBS	Rotating Intensive Basin Studies
RITE	Roosevelt Island Tidal Energy

RTE	Rare, Threatened and Endangered
s	second
SFMP	Seasonal Fishery Monitoring Plan
SHPO	State Historic Preservation Office
TEV	Test Evaluation Vessel
TLP	Traditional Licensing Process
TMDL	Total Maximum Daily Load
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USNSRDC	United States Navy's David Taylor Model Basin
Verdant	Verdant Power, LLC
WI/PWL	Waterbody Inventory and Priority Waterbody List

5.0 ENVIRONMENTAL ANALYSIS

5.1 DESCRIPTION OF PROJECT AREA

The East River is a 17-mile-long tidal strait connecting the waters of the Long Island Sound with those of the Atlantic Ocean in New York Harbor. The East River separates the New York City Boroughs of Manhattan and the Bronx from Brooklyn and Queens. The Harlem River flows from the Hudson River and connects with the East River at Hell Gate. The East River is not a freshwater river normally described in a FERC application, but a saltwater conveyance passage for tidal flow. There is some freshwater influence from the Harlem River and some direct drainage area from the surrounding metropolis, but the river is predominantly controlled by tidal influence. Figure 1.0-1 provides the project location. In 2003, Verdant submitted an Initial Consultation Document (ICD) to the Commission which summarized the available environmental information in the Project area.

5.2 SCOPE OF THE PROJECT SPECIFIC AND CUMULATIVE EFFECTS ANALYSIS

According to the Council on Environmental Quality's (CEQ) regulations for implementing National Environmental Policy Act (NEPA) (40 CFR §1508.7), an action may cause cumulative effects on the environment if its effects overlap in time and/or space with the effects of other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes the actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time, including hydropower and other land and water development activities.

Aquatic resources are the primary resource area having the potential to be cumulatively affected by the Project. The geographic and temporal scope for both Project-specific and cumulative effects are discussed below.

5.2.1 Geographic Scope

The geographic scope of the analysis defines the physical limits or boundaries of the proposed action's effect on the resources. Because the proposed action would affect resources differently, the geographic scope for each resource may vary. The geographic scope of the effects analysis broadly includes the East River in the area of the proposed Project.

5.2.2 Temporal Scope

The temporal scope of analysis includes a discussion of the past, present, and reasonably foreseeable future actions and their effects on cumulative affected resources. This Pilot License Application is for a 10-year term which would expire in 2019. This document looks to the future, to the duration of the amended license, concentrating on the effects on the resources from reasonably foreseeable future actions. The historical discussion is limited, by necessity, to the amount of available information.

5.3 PROPOSED ACTION AND ACTION ALTERNATIVES

The scope of the Proposed Action is analyzed below by resource area in standard FERC NEPA assessment format. Consideration has been given to all relevant resource areas identified for analysis in the Commission's whitepaper on hydrokinetic projects in (Appendix B of whitepaper §5.18(b)(5)(ii)(B). As stated earlier, this plan has been developed in cooperation with Resource Agencies and stakeholders and has been based on detailed environmental information collected. The plan has been designed to avoid and minimize all environmental impacts.

5.3.1 Geology and Soils

5.3.1.1 Affected Environment

The geology, bedrock lithology, stratigraphy, glacial features, unconsolidated deposits and mineral resources of the RITE project area were extensively described in Verdant Power's ICD (2003).

Geology

The Urban Core of the New York Bight[4] is situated along the boundaries of three distinct physiographic provinces: the Piedmont Province, the New England Province, and the Atlantic Coastal Plains. The convergence of these provinces provides a diversity of landforms, soils, botanical communities, and habitats within the Urban Core (USFWS, 1997).

The bedrock of New York City and the East River include the Middle Proterozoic Fordham Gneiss, the Cambrian Manhattan Formation (schist), and of the Cambrian and Ordovician Inwood Marble. Outcrops of these formations display the northeast-trending known to New York statigraphy. The Manhattan skyline owes its existence to the durability of its bedrock. Riprap, made up of Manhattan bedrock (schist, gneiss), lines the East River's shores, helping to prevent erosion with its durability (USGS, 2003).

Soils

Based on the scoping and comments provided in response to the ICD and in consultation with the NYSDEC, NMFS, the USFWS, ACOE, the New York Department of State, and the New York City Department of Environmental Protection, Verdant Power developed a study plan for two separate characterizations of the seabed substrate.

These field surveys (conducted by contractors to Verdant) included the seabed and substrate composition of both the Demonstration area in February 2005 and the larger RITE East Channel Phase 1 buildout covered by this pilot license application in April 2007. Verdant conducted these field surveys with the following objectives:

- Provide baseline information on bathymetry and channel substrates in the vicinity of the Project,
- Evaluate through side-scan sonar and video grab samples the presence and location of any seabed or other significant bottom features indicating possible historic properties (wrecks),
- Evaluate the presence of shallow littoral zone and vegetative cover in the project area that may provide valuable aquatic habitat, and
- Provide information to assist in project layout and development of the Essential Fish Habitat (EFH) Assessment.

RITE East Channel Field

In February 2005, Verdant conducted a remote sensing survey to document surficial and subsurface riverbed features in the east channel in the area of the experimental units. The survey was conducted using a high-resolution side-scan sonar device at frequencies of 500-kHz and 100-kHz respectively. Detailed images of the riverbed features were generated from data collected from the survey and was included in the report, "Acoustic Remote Sensing Survey for Roosevelt Island Tidal Energy Project," published in March 2005 (Verdant, 2005). These images allow for a detailed inspection of bottom features, presumably including shipwreck or historical structures. While this

[4] A "bight" is a mariner's term for a bend or curve in the shoreline of an open coast; in the New York region it refers to the ocean between Long Island (to the north and east) and the New Jersey Coast (to the south and west). The East River is a tidal strait that links Long Island Sound and the New York Bight.

study was conducted to characterize sediment and aid in the design of the fish movement and protection study, this study also supports the basic collection of geology in the vicinity of the project with side-scan sonar survey images of the riverbed. The study confirmed the presence of boulders and cobbles that were depicted on the side-scan sonar and sub-bottom records.

The video coverage did not show any evidence of fine grain soft sediments, thereby precluding any further requirement to obtain sediment samples for grain size and chemical analyses. This was also later confirmed when Verdant drilled the 6 piles into the bedrock for the demonstration project.

In April 2007, Verdant Power again conducted a remote sensing survey to document surficial and subsurface riverbed features in the East channel. This time the survey extended along the entire eastern edge of Roosevelt Island from the Roosevelt Island Bridge and north to include the RITE East Channel field buildout. This survey provided information on the bathymetry of the East River from the Roosevelt Island Bridge and north and as well as more information on the substrate in this region. Detailed images of riverbed features were generated from data collected from the survey and were included in the report "2007 Expanded Geophysical Survey Roosevelt Island Tidal Energy Project" (Verdant, 2007).

Figure 5.3.1.1-1 is a bathymetric contour map of the East Channel of the East River from the 2007 survey using a 1.0 ft contour interval. The mean elevation within the survey area was -28.7 feet Mean Lower Low Water (MLLW). The minimum and maximum surveyed elevations were -74.7 feet MLLW and -1.6 feet MLLW, respectively.

A mosaic was created from combined sonar files composed of gray shaded information, with the shading determined by the intensity of the returning sonar signal. In general, weak signal returns correspond to smooth riverbed substrates (*e.g.*, fine sediments with little micro-topography), soft materials that absorb the signal, or riverbed sloping away from the signal source (towfish). These features appear lighter gray in the conventional gray scale. Strong signal returns correspond to rough riverbed substrates (*e.g.*, gravel, cobble), highly reflective materials, or to a riverbed sloping towards the signal source. These features appear dark gray to black in the conventional scale (the conventional gray scale). The data evaluation was based on careful inspection of raw and projected sonar imagery for individual transects and close inspection of the sonar mosaic. Five substrate classes were identified in the survey area: ledge or exposed rock, boulders, cobbles, gravels, and sands.

Figure 5.3.1.1-2 depicts the distribution of dominant substrate classes. The vast majority of the channel appears to be dominated by boulder/cobble substrates. Exposed ledge or rock appears to be present along the western shoreline. Sands and gravels are present in Hallets Cove and along the slopes of the northernmost channels. Note that debris was widespread throughout the survey area, with the highest density of debris along the eastern shoreline and in Hallets Cove likely representing a sediment deposit (the cove at the northeastern extent of the survey area). A linear depression is approximately colocated with a former river crossing parallel to 35th Avenue. Shoreward evidence of this crossing is easily observed on the eastern shore, but no obvious relict structures were noted on the Island shore.

Figure 5.3.1.1-1. Bathymetric contour map of the East Channel of the East River New York.

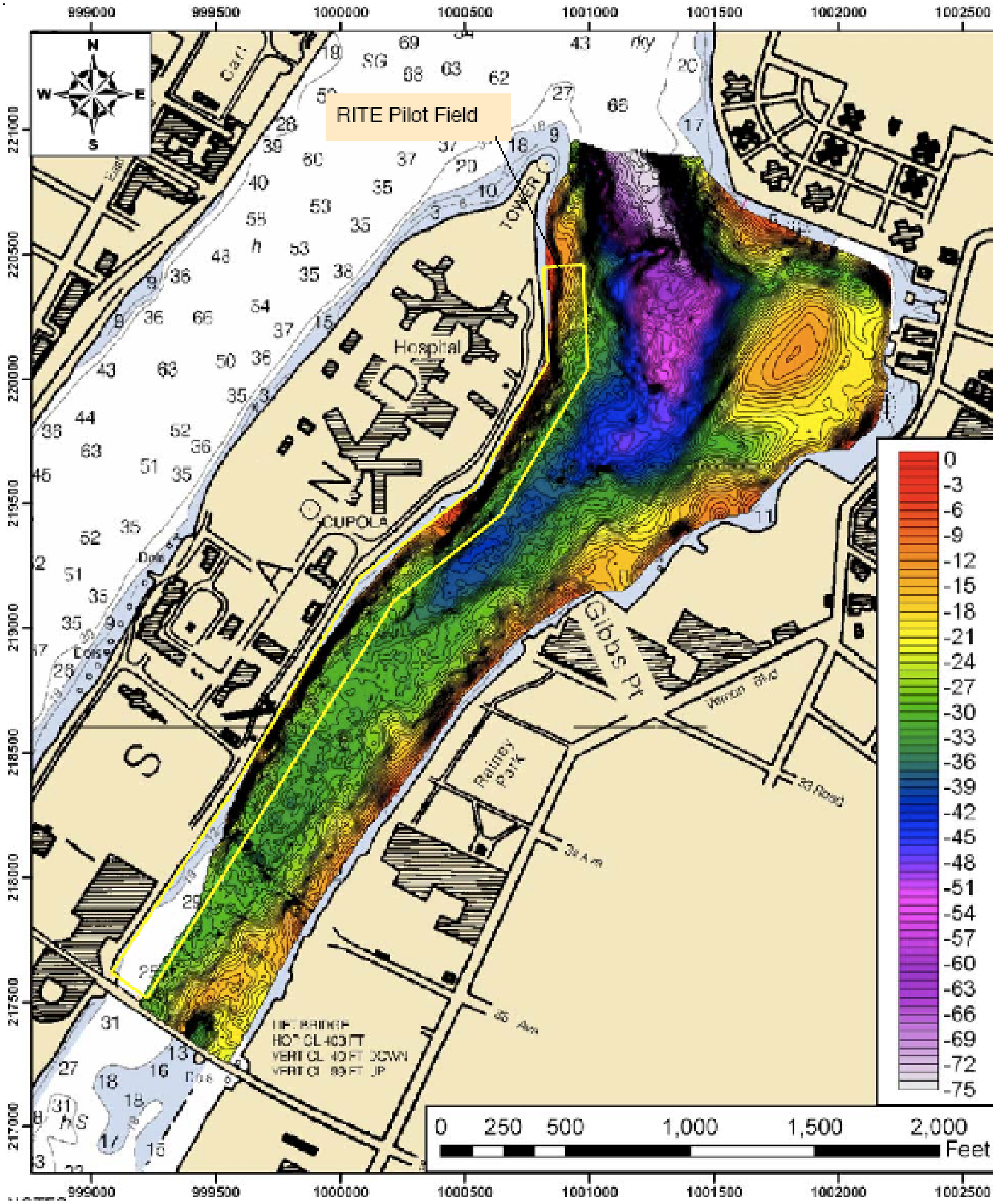
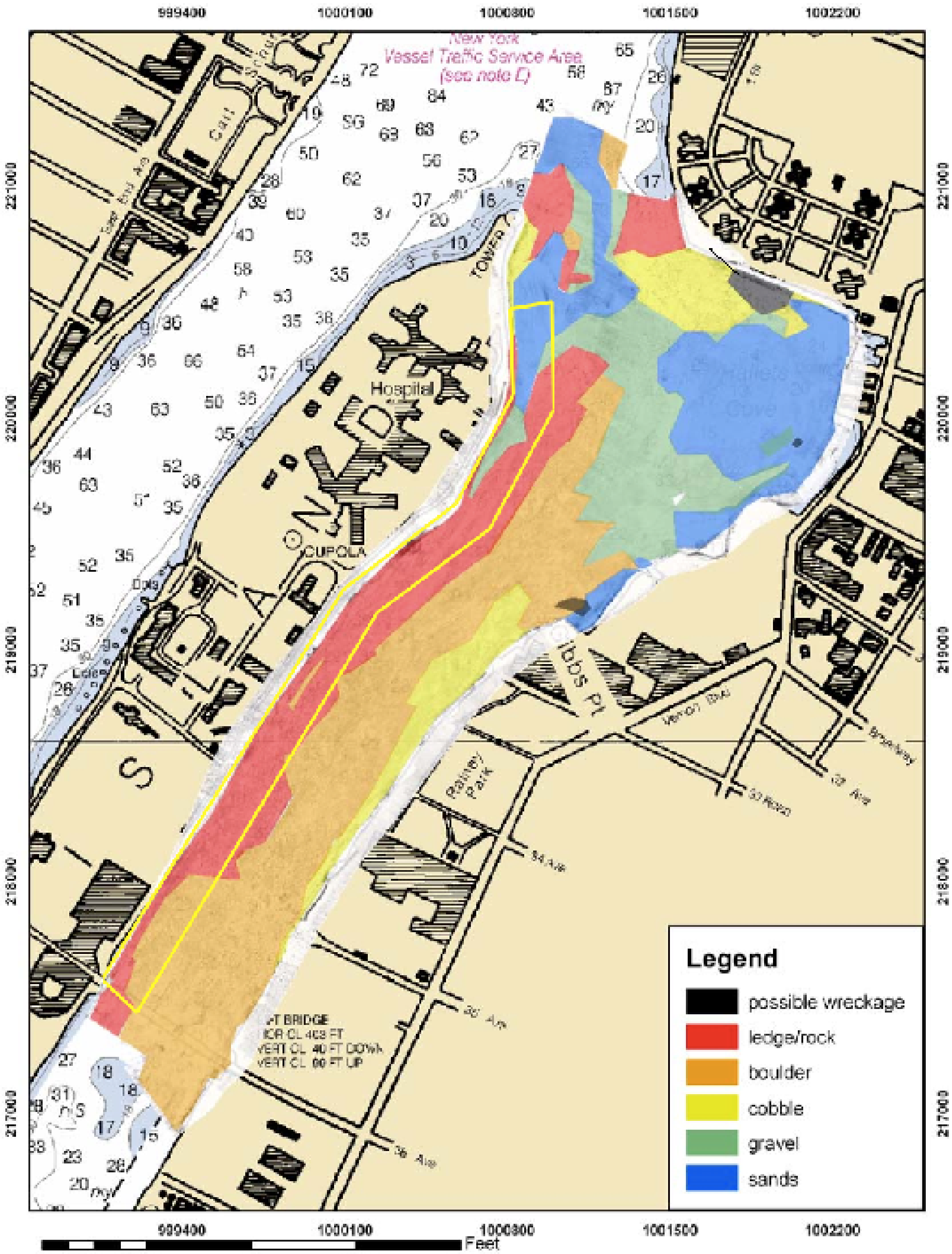


Figure 5.3.1.1-2. Distribution of dominant surficial substrate classes based on side scan sonar data East Channel of the East River New York.



5.3.1.2 <u>Environmental Effects</u>

Proposed Action

The project likely will have little effect on the geology and soils. The urban and developed setting including developed riprap and shoreline bulkhead in the vicinity of both project boundaries pose no concerns for shoreline erosion.

Geology

Based on the 2003, 2005 and 2007 reviews of the surficial geology, the proposed action does not pose any potential geologic hazards, including scouring action, slope failure, faulting, fluid and gas expulsion, or irregular topography in and around the RITE East channel field.

Soils

RITE East Channel Field

In 2005, the agencies reviewed the "Sediment Sampling Plan for the Roosevelt Island Tidal Energy Project" (DTA, 2005a) and the "Sediment Sampling and Contour Mapping Results for the Roosevelt Island Tidal Energy Project" (DT, 2005b). The report concluded that the river substrate, including the types, occurrence, physical and chemical characteristics, has little chance for erosion and potential for mass sediment movement.

Based on the surficial substrate data developed in the detailed surveys conducted during the preliminary permit term, Verdant concludes that no further studies or monitoring is required to determine potential environmental effects.

RITE West Channel Field

Under the terms of the preliminary permit, Verdant will conduct similar underwater surveys in order to obtain substrate information for the RITE West Channel field.

5.3.1.3 Unavoidable Adverse Effects

None Identified.

5.3.1.4 No Action Alternative

Under the No-Action Alternative, the geology and soils would remain unaffected.

5.3.1.5 Sources

DTA. 2005a. Sediment Sampling Plan for the Roosevelt Island Tidal Energy Project. January 21, 2005.

DTA. 2005b. Sediment Sampling and Contour Mapping Results for the Roosevelt Island Tidal Energy Project. March 2005.

USGS. 2003. Geology of New York City Region: A Preliminary Regional Field-Trip Guidebook. Website: http://3dparks.wr.usgs.gov/nyc/index.html.

Verdant Power, Inc. 2003 (October). Initial Consultation Document for the Roosevelt Island Tidal Energy Project (ICD), FERC Project Number 12178. Prepared by Devine Tarbell and Associates.

Verdant Power, Inc. 2005 (March). Acoustic Remote Sensing Survey Roosevelt Island Tidal Energy Project. Prepared by CR Environmental, Inc.

Verdant Power, Inc. 2007 (April). 2007 Expanded Geophysical Survey Roosevelt Island Tidal Energy Project. Prepared by CR Environmental, Inc.

5.3.2 Water Resources

5.3.2.1 Affected Environment - Water Quantity

Verdant described the reported water uses and existing water quality in the East River in the ICD (Verdant, 2003). A summary of these sections and additional information developed over the course of the preliminary permit is presented below.

Water Uses

Water withdrawals in the project vicinity include both industrial and commercial facilities, including thermoelectric power plants (fossil fuel), which utilize water from the East River for process/cooling water purposes. There are also several sources of water discharges from large industrial and municipal wastewater treatment plants that discharge to the East River. Table 5.3.2.1-1 below summarizes these licensed dischargers and the maximum licensed volume for each.

Table 5.3.2.1-1. Licensed dischargers to the East River.

Plant	Type	Volume
NYC Hunt's Point Sewer Treatment Plant	Municipal	200 mgd
NYC Newtown Creek Sewer Treatment Plant	Municipal	310 mgd
NYC Tallman's Island Sewer Treatment Plant	Municipal	80 mgd
NYC Red Hook Water Pollution Control Plant	Municipal	60 mgd
NYC Wards Island Sewer Treatment Plant	Municipal	250 mgd
NYC Bower's Bay Sewer Treatment Plant	Municipal	150 mgd
Consolidated Edison 60th Street Stream Gathering Station	Electric	N/A
Consolidated Edison East River Facility	Electric	541 mgd
New York Plaza Building	Cooling	26 mgd
866 UN Plaza Associates	Cooling	6 mgd
Astoria Waste Water Treatment Facility	Combined	N/A

N/A: Not Available

Source: NYSDEC, 1999, EPA, 2003

Water Quantity

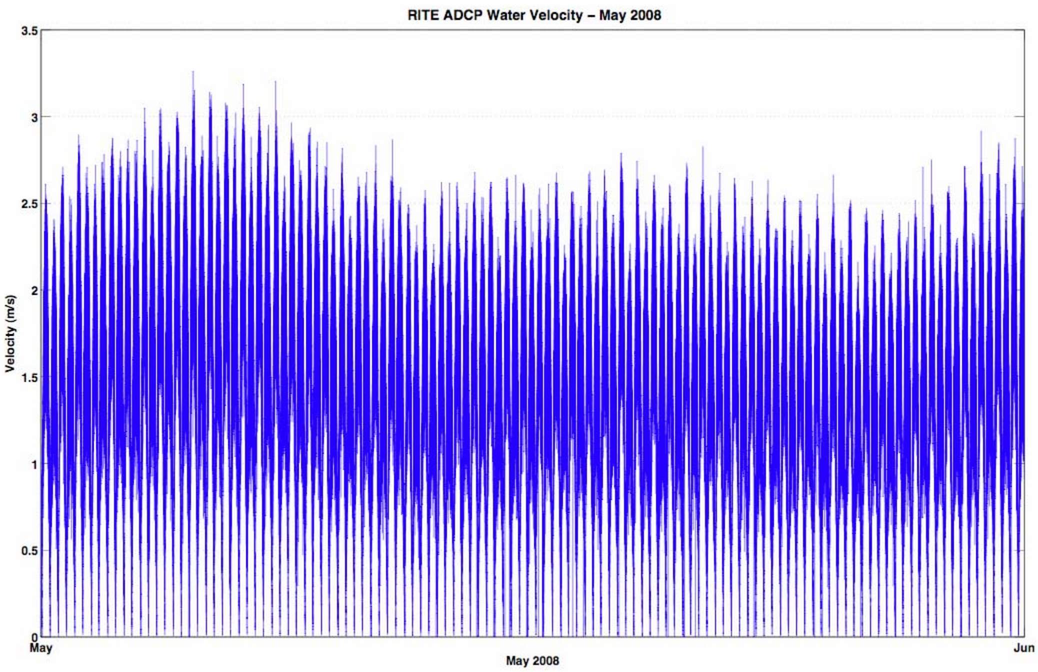
A tide is the cyclic rise and fall of the ocean water surface as a result of tide-generating forces, which are the gravitational forces between the earth, sun, and moon, and the rotational forces of the planets during their orbits. High tides are produced in the ocean waters by the elliptically-shaped "heaping" action resulting from the horizontal flow of water toward two regions of the earth representing positions of maximum attraction of combined lunar and solar gravitational forces. The low tides are produced by a corresponding withdrawal of water from regions around the earth midway between these two "humps". The alternation of high and low tides is caused by the daily (diurnal) rotation of the earth with respect to these two tidal humps and two tidal depressions.

Tidal forces are not constant, and vary with the orbits of the planet producing tides of varying magnitudes throughout a cycle. The gravitational attractions (and resultant tidal force envelopes) produced by the Moon and the Sun reinforce each other at times of new and full moon to increase the range of the tides, and counteract each other at the first and third quarters of the lunar cycle, thereby reducing the tidal range. The solar and lunar cycles reinforce each other twice a month, increasing the tidal range, which is called "Spring Tide". Also, twice a month the solar and lunar influences counteract one another to produce a lesser tide than normal, which is called the "Neap Tide".

At the RITE site a typical monthly tidal stage cycle as recorded by actual Acoustic Doppler Current Profiler (ADCP) instrumentation is represented by Figure 5.3.2.1-1.

Using NOAA Center for Operational, Oceanographic Products and Services (CO-OPS) data, the diurnal tidal elevation variations (Mean Higher High Water to Mean Lower Low Water) at the RITE site was taken to be 1.6 m (5.2 ft). The mean water level variations (Mean High Water to Mean Low Water) was estimated at 1.4 m (4.7 ft), and the maximum water level variation (Extreme High Water to Extreme Low Water) was estimated to be 2.1 m (7 ft).

Figure 5.3.2.1-1. RITE Project typical monthly tidal cycle - May 2008.



Tidal Gages

NOAA has two active tidal gages (stations) near the project site, as noted on Figure 5.3.2.1-2. One station is at the southern tip of Manhattan in Battery Park, and the other to the north on Kings Point in Long Island Sound. The Battery NOAA station (8518750) has been in service since 1920. The Kings Point NOAA Station (8516945) has been in service since October 1998.

The mean tide range at The Battery is reported as 4.5 feet (NOAA), and represents the difference between mean high water and mean low water. The mean tide range for the station at Kings Point is reported as 7.2 feet within Long Island Sound (NOAA, 2003c).

Two additional tidal current charts are used for tidal current prediction at the RITE site. These are located at the NOAA Hell Gate tidal current prediction station north of the site and at the 39th Street tidal prediction station. In addition, Verdant has maintained a permanent velocity reference instrument (an ADCP) at the RITE demonstration site since December 2006. These tidal gages are shown on Figure 5.3.2.1-2 in relation to the RITE project boundary.

Figure 5.3.2.1-2. Location of tidal gauges in vicinity of RITE Project.

Water Velocity Prediction

The complex interaction of the tides between the New York Harbor and Long Island Sound create tidal currents coincident with changes in the tidal stage. The tidal currents in the East River are semidiurnal, having two flood periods and two ebb periods per tidal day (24.84 hours). The reversing flood and ebb currents are of opposite direction, but with similar current velocity profiles. The tidal velocities are at a maximum when the tide stage is near the mean level, and are at a minimum when the tides are at high and low stages.

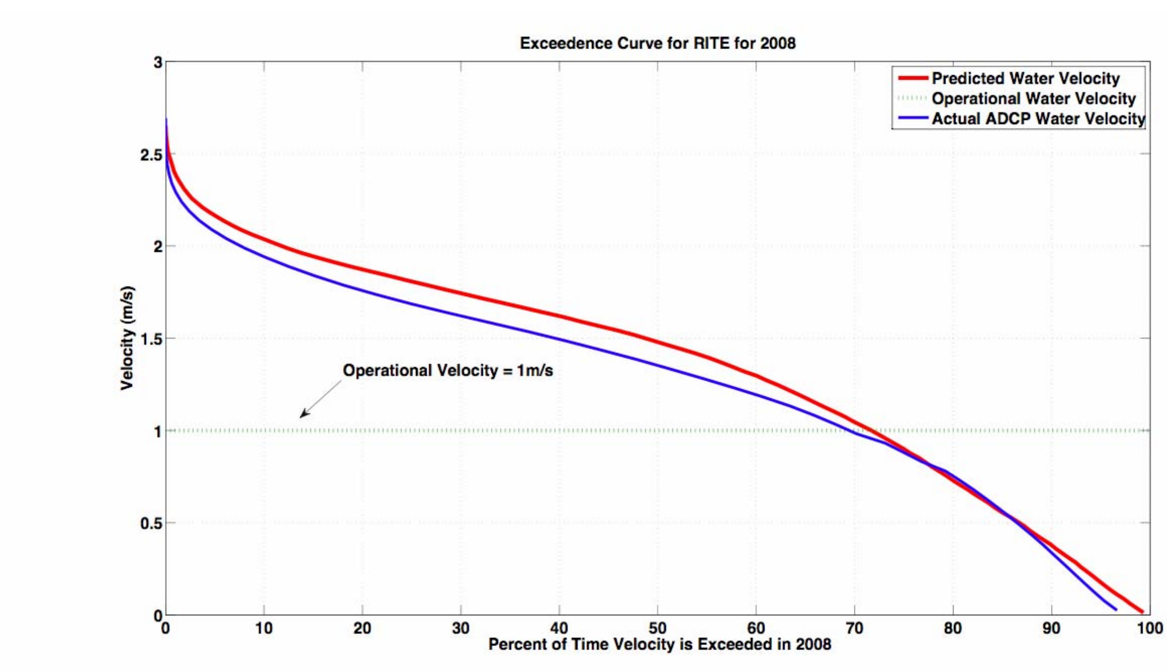
Tidal current data are available from NOAA (2003c) at the two sites distant to the RITE project as described above. These predictions of tidal ranges were empirically transferred from the NOAA tidal station to the actual RITE project site, using harmonic constituent analysis. For several years, Verdant has maintained a stationary recording Acoustic Doppler Current Profiler (ADCP) instrument within the RITE field to record the instantaneous current velocity (in m/s). This instrumentation allows Verdant to accurately quantify and calibrate the currents and tidal current data, facilitates the transfer of actual tidal measurements and predictions at a distant site to the project site, and also is a necessary instrument for understanding operational data from the KHPS machines.

In order to fully understand and predict the velocity patterns within the proposed RITE project field array, Verdant integrated mobile ADCP and stationary ADCP data. While the mobile data is a “snap shot” of velocity at the time of the field survey (both temporally and spatially), the stationary ADCP provides a continuous record of velocity but only at one location in the array. The stationary ADCP data set was analyzed to determine the harmonic constituents of the tidal prediction specifically for the RITE field array. Once the harmonic constituents of the tidal cycle at RITE are known, through empirical integration with the mobile data; it is possible to predict the water velocity at the RITE field for any date in the past or future with relative accuracy.

Twenty-one harmonic constituents were used to predict the water velocity at RITE for the entire 2008 year, in 30 minutes intervals. These yearly tidal velocity predictions were used to calculate the Tidal Velocity Exceedance Curve, which is presented as Figure 5.3.2.1-3. The maximum predicted tidal current velocity at the RITE site during this period is approximately 2.7 m/s; with 1 m/s exceeded 72% of the time.

During the preliminary permit term of the RITE West Channel field, similar data collection methods - both mobile and stationary ADCP analysis - will be needed to support detailed design. The shape of the exceedance curve in Figure 5.3.2.1-3, however, applies generally to the West Channel site.

Figure 5.3.2.1-3. Tidal velocity exceedance curve - RITE East Channel Field (2008 data).



Hydrodynamics

Resource agencies expressed concern about the installation of the proposed field of submerged tidal turbines potentially affecting flow patterns in the vicinity of the RITE project and possibly beyond. Two separate concerns were raised by resource agencies during consultation and study scoping meetings. One issue is related to near-field effect of the rotating blades on flow patterns in regards to increased turbulence or creation of small flow disturbances (eddies) which may affect aquatic life predator-prey relationships. The second issue of concern is in regards to a possible modification of flow through the East River (*i.e.*, if the turbines are removing kinetic energy from the system and how that might affect transport flows).

5.3.2.2 Environmental Effects - Water Quantity/Hydrodynamics

Verdant conducted both numerical and in-water hydrodynamic evaluations over the last several years (2005 – Present) to better understand these issues. Verdant has used a combination of in-house computational tools, advanced external computational resources, and on-water surveys to understand and predict these complex hydrodynamic occurrences.

In brief, the discussions that follow are focused on three levels of hydrodynamic modeling and analysis: Micro-Scale, Meso-Scale, and Macro-Scale. In these three cases, the scale - an important factor to the accuracy and applicability of any model - is non-dimensional, related to the Diameter (D) of a kinetic hydropower rotor. For example, at the RITE Project, the rotor diameter is 5 meters; and so the spatial applicability of results will vary from less than 0.1D (0.5 m) to 700D (3,500 m) and greater.

Micro-Scale Hydrodynamics: ~0.1D to ~2D (D is the Rotor Diameter)

This level of hydrodynamic modeling describes the hydrodynamics in and around an individual turbine, rotor, nacelle, pylon or mounting structure that may affect the structural performance of the machine or the energy extraction performance of the rotor. Commercial modeling software can be generally used for this type of analysis, as well as simplified in-house written codes for these complex problems. Simplifications can be made based on system symmetry, single blade approximations, and/or 2-dimensional (2-d) assumptions.

Verdant Power used ANSYS CFX to model the micro-scale hydrodynamics of a single Gen 4 Turbine with Gen 5 Rotor at the RITE site. This work centered on structural integrity and blade hydrodynamics, but information about the near field wake was also obtained, both from the rotating blades and the stationary structures. This work focused on the proprietary design and technology development of the Verdant Power Free-Flow turbine™ and is only discussed generally here.

Meso-Scale Hydrodynamics: ~2D to 200D

This level of hydrodynamic analysis includes the interactions (downstream, laterally, and vertically) between two or more turbines in an array. These interactions include kinetic energy extraction (sometimes termed energy extraction or energy production), structural requirements, and potentially fish behavior in and around an operating turbine. Specifically, these interactions relate to the recovery and interaction of the 3-dimensional (3-d) wake generated as a result of the turbine (rotating or stationary) in the water body and the vortex generation associated with blade rotation and energy extraction. Several levels of field data collection and modeling can be used, including commercially available software, in-house written codes that solve the 3-d interactions directly, or model the interactions in 2-d.

In consultation with the resource agencies, Verdant Power and its consultant, DTA, developed and executed the East River Hydrodynamic Survey (Study Plans, 2006), a series of on-water data collection operations to measure the meso-scale hydrodynamics in the RITE array. These measurements were made before deployment of demonstration KHPS units November 15, 2005 and repeated during Deployment #2 with 4 KHPS turbines operational simultaneously, May 17, 2007, on both ebb and flood tides. The objective of this study was to determine how the turbines affect the flow patterns in the East River, both near-field and far-field; and develop some information on the comparison of velocity and circulation patterns in the deployment area prior to and after installation of the turbines. The results of this work are described below.

Macro-Scale Hydrodynamics: ~200D to the Largest River/Estuary/Channel Dimension

This level of hydrodynamic analysis describes the effect of the placement of a field (assume 30 or more) of KHPS structures in a natural water body, and the estimates of the far field effects related to energy extraction, and potential changes in natural water conditions with the operation of kinetic hydropower turbines. These models often are developed to examine macro effects of large projects, such as dredging, contaminant dispersal, and sediment transport on large reaches of water bodies (>100 acres or >1 mile). Models in this category include 1-dimensional (1-d) and 2-d riverine models adapted to tidal conditions, or more complex 3-d calibrated models that require significant investment of time in field data and modeling expertise to produce relevant results.

As part of the East River Hydrodynamic Study discussed above, the plan included two hydrodynamic field surveys (pre and post deployment #2) to collect flow velocity and direction (as a measure of turbulence) measurements in and around the operating KHPS turbines in the RITE demonstration project.

Two transects bounding the build out site in the East Channel were selected for replicate flow measurements. Similar to the near-field study a level logger was deployed near each site to measure the changes in the water surface elevation throughout the study.

The velocity data was collected with the same equipment as the near-field study and linked to a Trimble XRS GPS. Data was collected following the near-field survey over a range of tidal flows. After deployment of the study units, a second survey was performed on the same two bounding transects over a range of tidal flows that best represent the pre-deployment conditions. This data was collected in November 2005 (60-day report, 2007) and May 2007 (DTA, 2008) respectively by Verdant's Contractor and is discussed below.

To evaluate a larger pilot field area and evaluate potential changes associated with operation of a large number of tidal energy turbines, the study plan proposed the development of an empirical model to better understand possible effects on the total flow through the East River. Verdant Power developed and calibrated a 1-d model based on standard open channel flow equations and total energy flux to model the macro-scale hydrodynamics of the 30 turbine (1 MW) build out proposed in this pilot license application.

Modeling, In-Field Methods, and Results

Micro-Scale Hydrodynamic Modeling

To investigate the micro-scale hydrodynamics in and around the turbine rotor, nacelle, and pylon, Verdant engaged a consultant to provide ANSYS CFX modeling of the Generation 5 KHPS turbine rotors. ANSYS CFX is a commercial software package designed to solve computational fluid dynamics problems. This package was chosen due to the ease of importing CAD drawings of the KHPS units into the solution domain. Further, the ANSYS CFX package offers a wide range of modeling tools, including advanced turbulence models and 3-d, time-dependent solutions. The package is comprised of: the pre-processor, which handles the object geometry and the solution grid (or mesh); the CFX solver; and the post-processor, which handles graphic displays, *etc*.

As shown in the three summary Figures 5.3.3.2-1, 5.3.3.2-2 for stationary and 5.3.3.2-3 for rotating KHPS below, the micro-scale hydrodynamics help inform the interactions between the KHPS wake (for both stationary and rotating blade conditions, the nacelle, and pylon) and the natural channel properties.

Figure 5.3.3.2-1 shows the mean axial velocity around a stationary turbine in a flow with VW = 2.5 m/s. The bluff body wake downstream of the tail cone and the pile are apparent, with velocities below 1.25 m/s. Notice the stationary turbine produces almost no flow acceleration, except for a small increase in velocity around the blade tips. This increased velocity is a localized phenomenon, well above the river bed. Some additional acceleration must occur around the turbine pile; however, the natural turbulent boundary layer just above the river bed reduces this impact significantly.

The pressure distribution on the stationary turbine, not shown, is directly related to the velocity distribution seen in Figure 5.3.3.2-1. The largest pressures on the stationary turbine occur at the nose cone, pylon leading edge, and blade faces. Low pressure regions behind these stationary objects lead to the wake regions seen. The larger the pressure difference, the stronger the wake. As such, the largest pressure drop across the turbine can be seen behind the tail cone and with a smaller drop behind the turbine pile. Further, the lowest pressures predicted for the non-rotating turbines are well above the ambient vapor pressure, and therefore, cavitation is not a concern.

The inherent 3-d nature of the turbulent wake, seen in the velocity profile, Figure 5.3.3.2-1 below, confirms the need for advanced computational resources to accurately model the turbulent mixing in and around a single KHPS. Figure 5.3.3.2-2 presents the Turbulent Kinetic Energy, a common measure of the "strength" of the turbulence. It is clear from 5.3.3.2-2 that the most turbulent mixing occurs behind the stationary objects, in the wake region described above. Specifically, the base of the faired pylon shows enhanced turbulent mixing, which is approximately 2 meters from the river bottom.

The micro-scale hydrodynamic modeling of a single, non-rotating KHPS confirms the bluff-body behavior. Regions of relatively high and low pressure are created across the pile, pylon, nacelle, and cones. These small differences in pressure lead to the wake regions seen, with reduced water velocity downstream, but do not lead to cavitation. Some local flow acceleration is seen, specifically at the blade tip and around the pile/pylon. Turbulent mixing is increased near the stationary blades and the base of the faired pylon, both well above the river bottom. Additional mixing is seen around the pile; however, the natural turbulent boundary layer dampens flow disturbances near the river bottom, significantly reducing the impact of the pile.

Figure 5.3.3.2-3, below, presents an instantaneous snapshot of the streamlines around a single rotating KHPS. Flow is from bottom-left to top-right, and the 3-d, twisting nature of the flow is clearly visible beyond the rotor. This behavior is as expected, given the tip vortex that is generated as a result of blade rotation. This tip vortex is shed continuously from the trailing edge tip of each blade. This tip vortex is helical in nature – hence the necessity of a 3-d solver. Further, the decay rate of this vortex, as well as any vortex merging that may occur, is mainly a function of the turbulent properties of the flow. As such, any model must include 3-d, time-dependent turbulence modeling to accurately capture the near field wake behavior. Figure 5.3.3.2-3 also highlights a short coming of micro-scale hydrodynamic modeling. Given the intense computational demands, the size of the flow domain must be reduced to gain resolution. As a result, the far field behavior is modeled incorrectly. The streamlines in Figure 5.3.3.2-3 appear to straighten immediately downstream of the first and only "twist". The result is likely inaccurate and due entirely to the loss of grid resolution beyond the near-turbine field. As such, meso-scale hydrodynamic analysis is essential to understand the vortex/wake behavior beyond a single KHPS unit.

Figure 5.3.3.2-1. ANSYS CFX Results – Velocity field (m/s) around non-rotating Gen 5 KHPS (Micro-Scale Hydrodynamics).

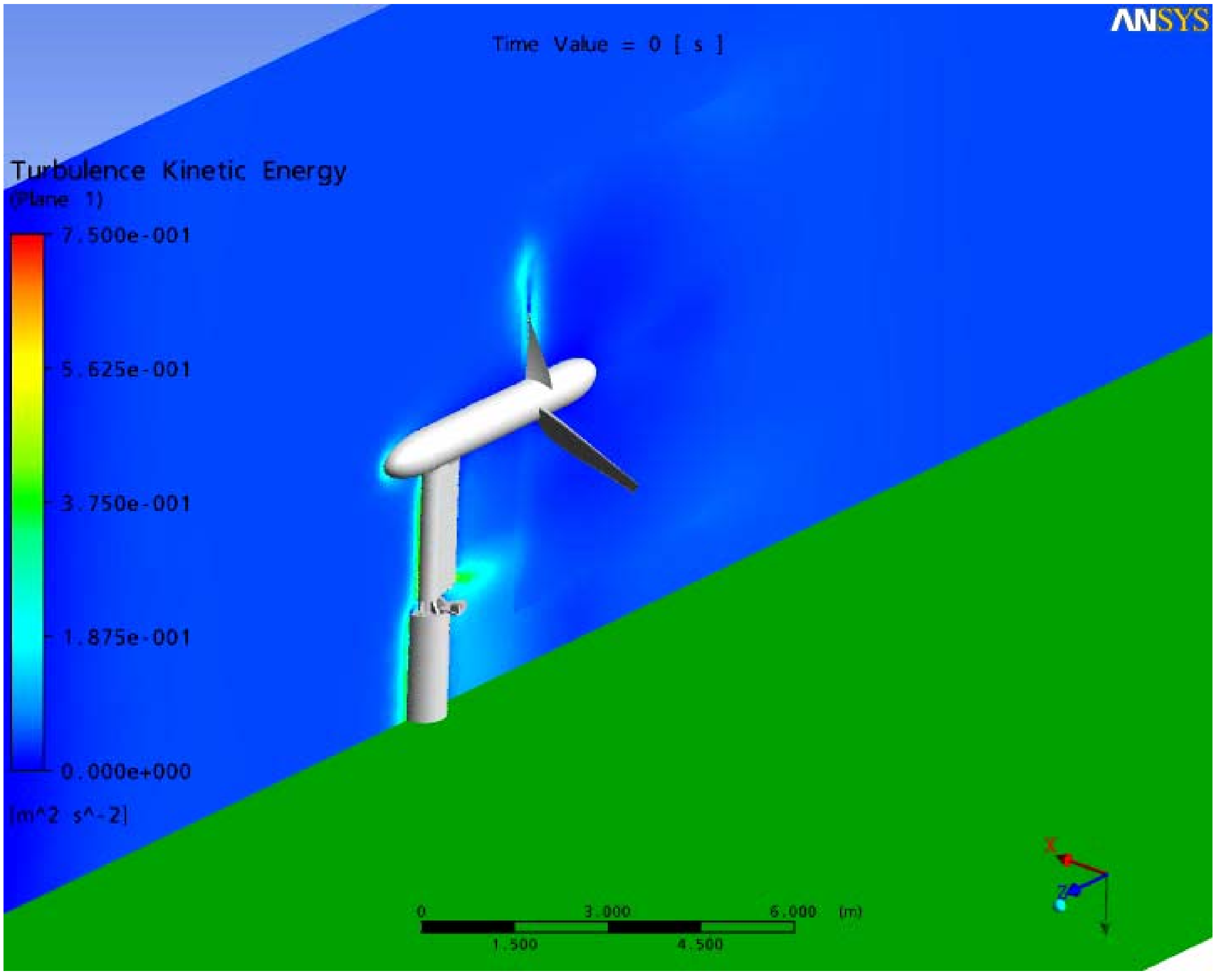


Figure 5.3.3.2-2. ANSYS CFX Results – Turbulent kinetic energy (m^2/s^2) around Non-Rotating Gen 5 KHPS (Micro-Scale Hydrodynamics).

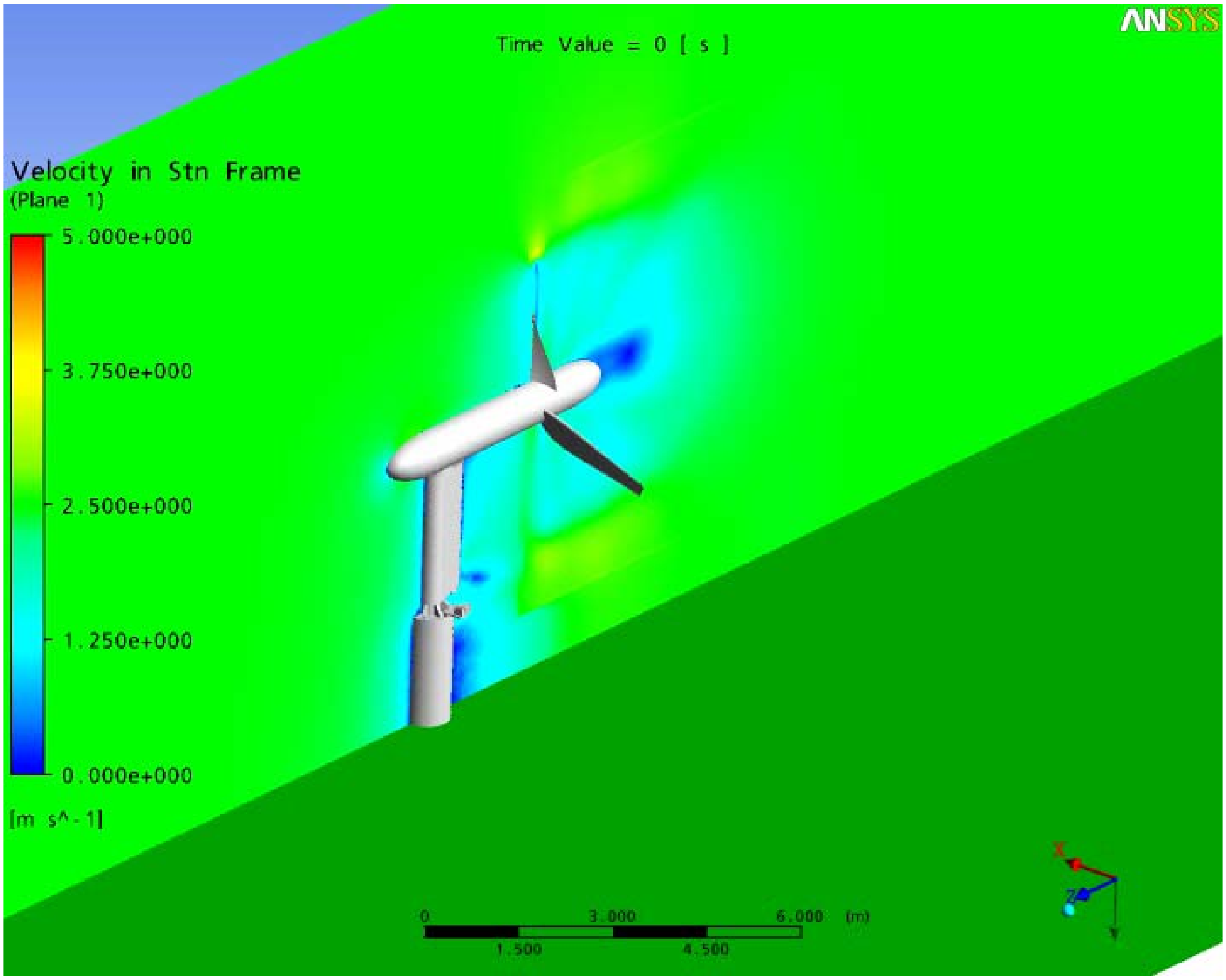
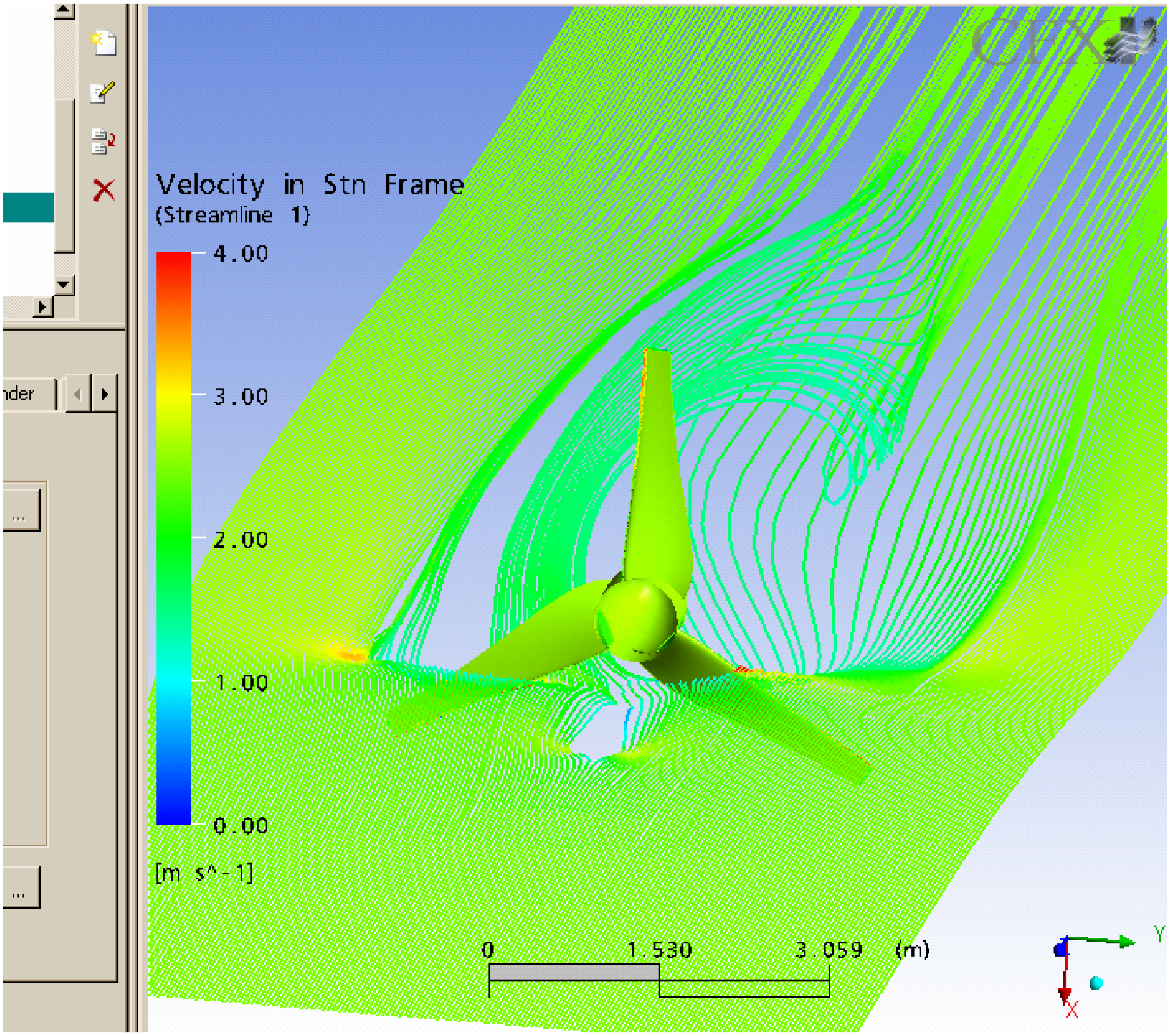


Figure 5.3.3.2-3. ANSYS CFX Results – Velocity streamlines (m/s) around rotating Gen 5 KHPS (Micro-Scale Hydrodynamics).



Meso-Scale Hydrodynamic Studies

In accordance with the NYSDEC and ACOE permits, Verdant Power through its Contractor completed the hydrodynamic survey outlined by the "East River Hydrodynamic Survey" Study Plan (revised October 25, 2006) in November 2005 and then again in May 2007. The following is a discussion of the general methodology, and a discussion of the pertinent results; as well as modeling performed by Verdant to extend the analysis to analyze the field of 30 turbines proposed in the pilot license application.

Methodology for Pre-and post Deployment Surveys (Verdant, 2007)

- **Transects -** In order to collect data consistent with the transects depicted in the study plan, a laptop with Hypack Navigation software and receiving DGPS signals was placed in the view of the boat skipper to aid in following the pre-planned transects. Hypack displayed a visual location of the boat relative to the individual transects and also showed the continuous coverage. A total of approximately 58 transects were performed. Figures 5.3.3.2-4 and 5.3.3.2-5 below provide definition of the pre-planned transects, flood and ebb respectively.

- **Measured Currents -** Optimum data collection times were selected from current data (in knots) using NobleTec's Tides and Currents software for the East River. Several days were identified as ideal for the purposes of this study. Based on the statistical analysis, the East River currents exceed 3 knots more than 33.2 percent of the time. Ideal days, therefore, consist of a tidal range where the flood strength is greater than 3.0 knots and the ebb strength is greater than 3.0 knots. Data collection took approximately three hours per tidal period.

- **Equipment -** Velocity data was collected with a RDI 1200kh Rio Grande Acoustic Doppler Current Profiler (ADCP) and was displayed onboard with a laptop. The ADCP was attached to the port gunnel, mid-ship, using a specialized mounting clamp. The face of the transducers was placed approximately 1 foot below the water surface. Data was recorded with WinRiver software from RDI which also infer-faced with a Trimble Pro XRS GPS for Sub-meter tracking.

- **Data Management and Analysis -** Initially, data was analyzed onboard with RDI's Win River software to ensure quality. Subsequent to data collection, utilities were used to further analyze, error check, and format the data for final post processing. The data was then imported into Tecplot, a 3-d visualization software. Each data point incorporated into Tecplot contained velocity magnitude for X, Y, and Vertical, as well as coordinates in Easting and Northing. Tecplot employs an industry-wide method of data interpolation to develop a complete velocity field for the study area. Each measured point is then placed on to a grid where the results show each point equally spaced. A 3-d bed profile was also developed using the bed elevations collected by the ADCP.

Figure 5.3.3.2-4. Hydrodynamic survey transect definitions – Flood tide (Verdant and DTA, 2006).

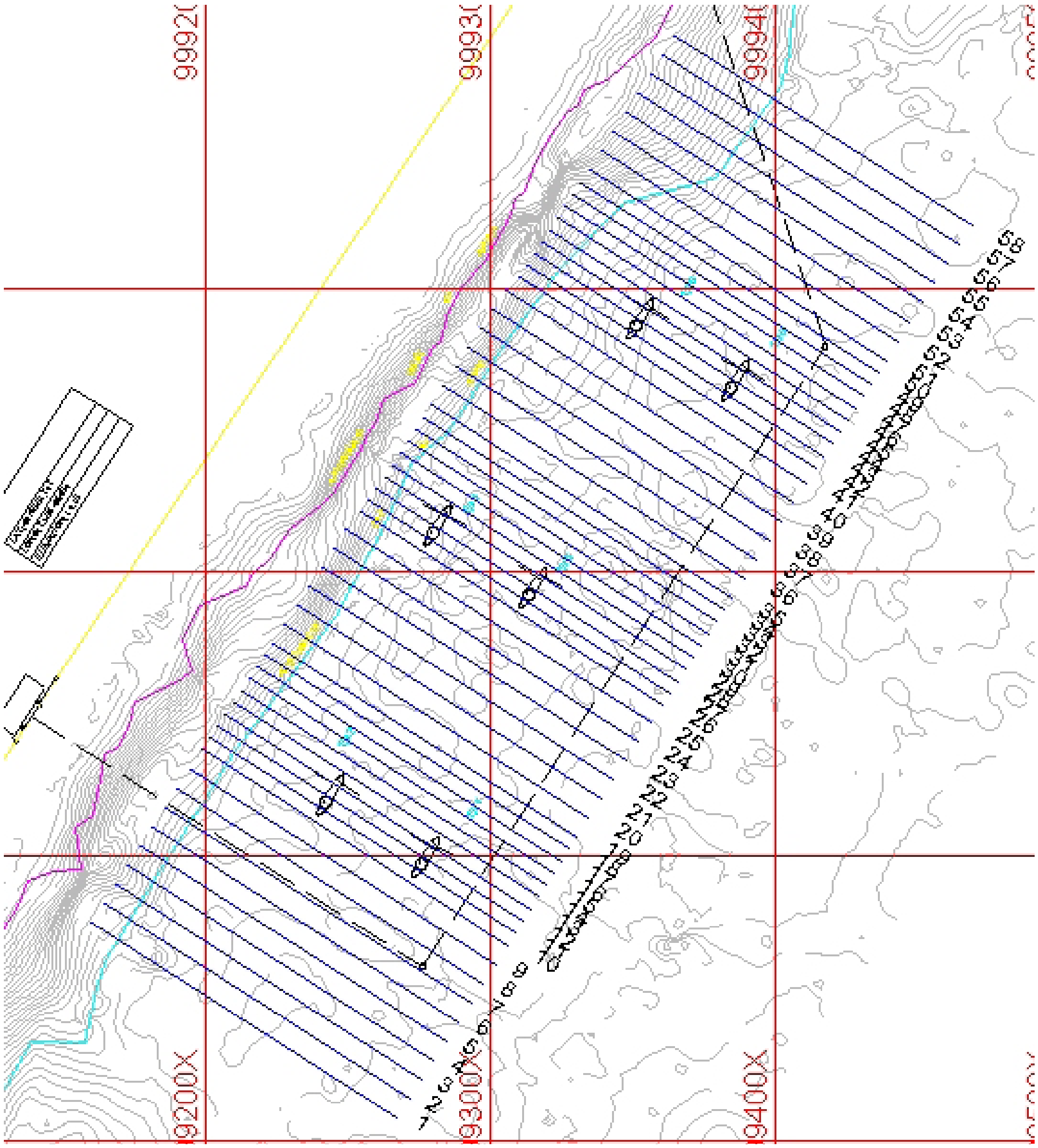
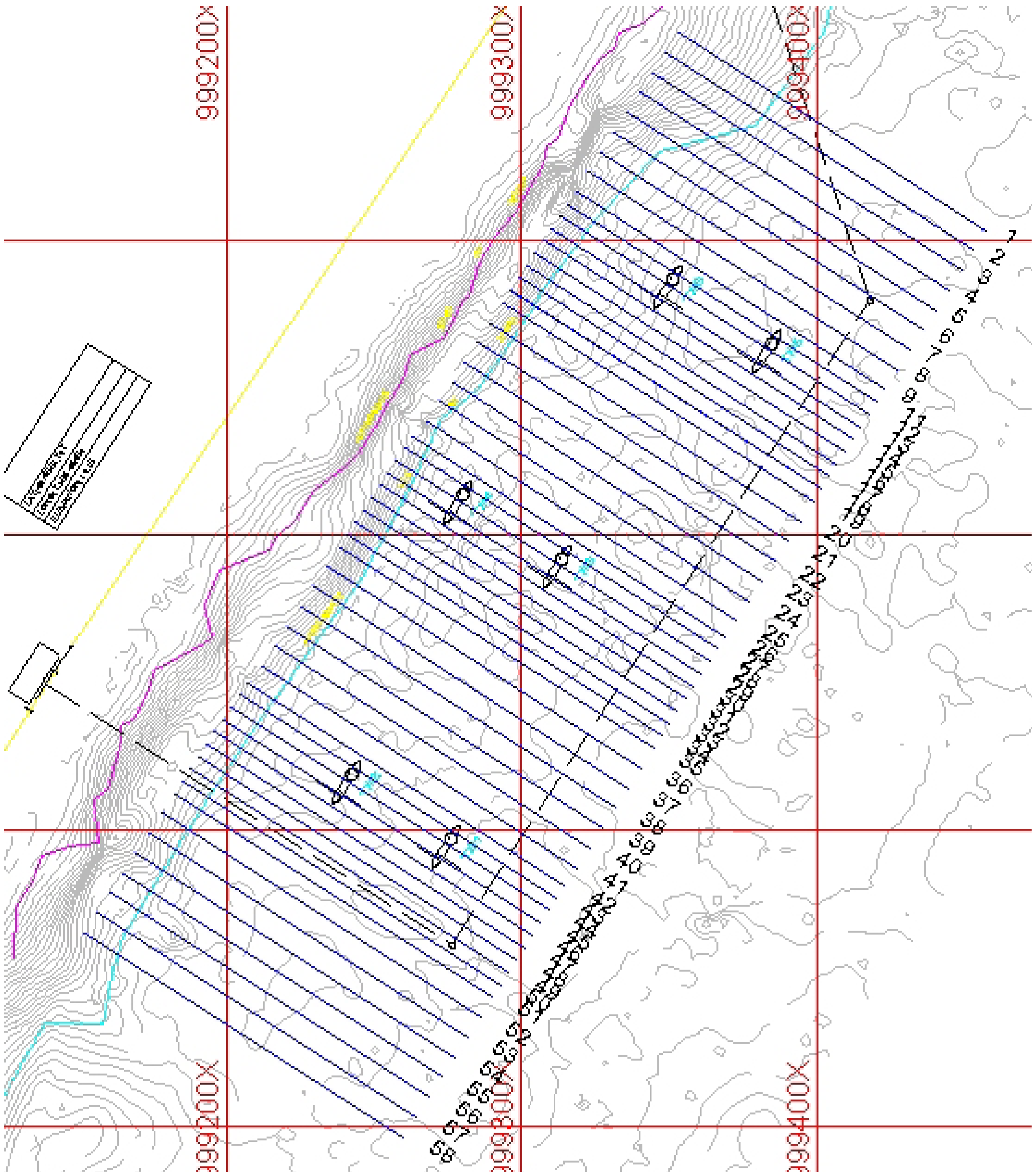


Figure 5.3.3.2-5. Hydrodynamic survey transect definitions – Ebb tides (Verdant and DTA, 2006)



Results and Discussion for Pre-Deploy Survey (2005)

As discussed in the 60-day report and summarized here, the pre-deployment hydrodynamic survey was conducted on November 14 to 16, 2005 in the RITE demonstration area adjacent to Roosevelt Island in the East River. While an attempt was made to equally cover all predetermined transects, the ebb survey was shortened slightly due to time constraints. Therefore, there is little data beyond the locations of Turbines 1 and 2 in the RITE 6-pack (the southernmost row) and the total area of coverage is not equal for the ebb and flood data sets.

For visual clarity, slices of information have been extracted from the velocity field in 5-foot increments from MLLW to the channel bed. All results are shown in a New York State Plane-Feet coordinate system. Velocity magnitudes described by the legend are in ft/sec. Vectors displayed on each slice describe the direction (angle) and the magnitude (length) of the water velocity at that point.

For reference, the top of the rotor blades are 5 feet below MLLW, the rotor centerline is approximately 13 feet below MLLW, and the bottom of the rotor is 21 feet below MLLW. Pre-deploy survey data was not extracted at 13 feet below MLLW, so results from the 10 foot below MLLW slice are presented in Figures 5.3.3.2-6 and 5.3.3.2-7 below, flood and ebb tides respectively.

These two figures confirm the tidal nature of the East River, as well as the quality of the channel as a resource for tidal energy production. The flow in both the ebb and flood tide is very unidirectional, with the natural slowing of the channel velocity near the west shore. At the 10 foot depth shown, velocities near the channel center are around 8-9 ft/sec on a flood and 6-8 ft/sec on an ebb tide. This data matches energy generation results quite well, with higher peak power on a flood tide compared with an ebb tide. Further asymmetries are also seen. In Figure 5.3.3.2-6, for example, the fastest velocities are clearly in the NE corner of the survey. Energy generation during the RITE 6-pack buildout confirmed that the turbine in the NE position outperformed other turbines. The presence of the Roosevelt Island west caisson is clearly visible in the figures below, with reduced velocities in the SW corner of the survey on both ebb and flood tides.

Figure 5.3.3.2-6. Pre-deploy survey results – Flood Flow (Meso-Scale Hydro) (Verdant, 2007)

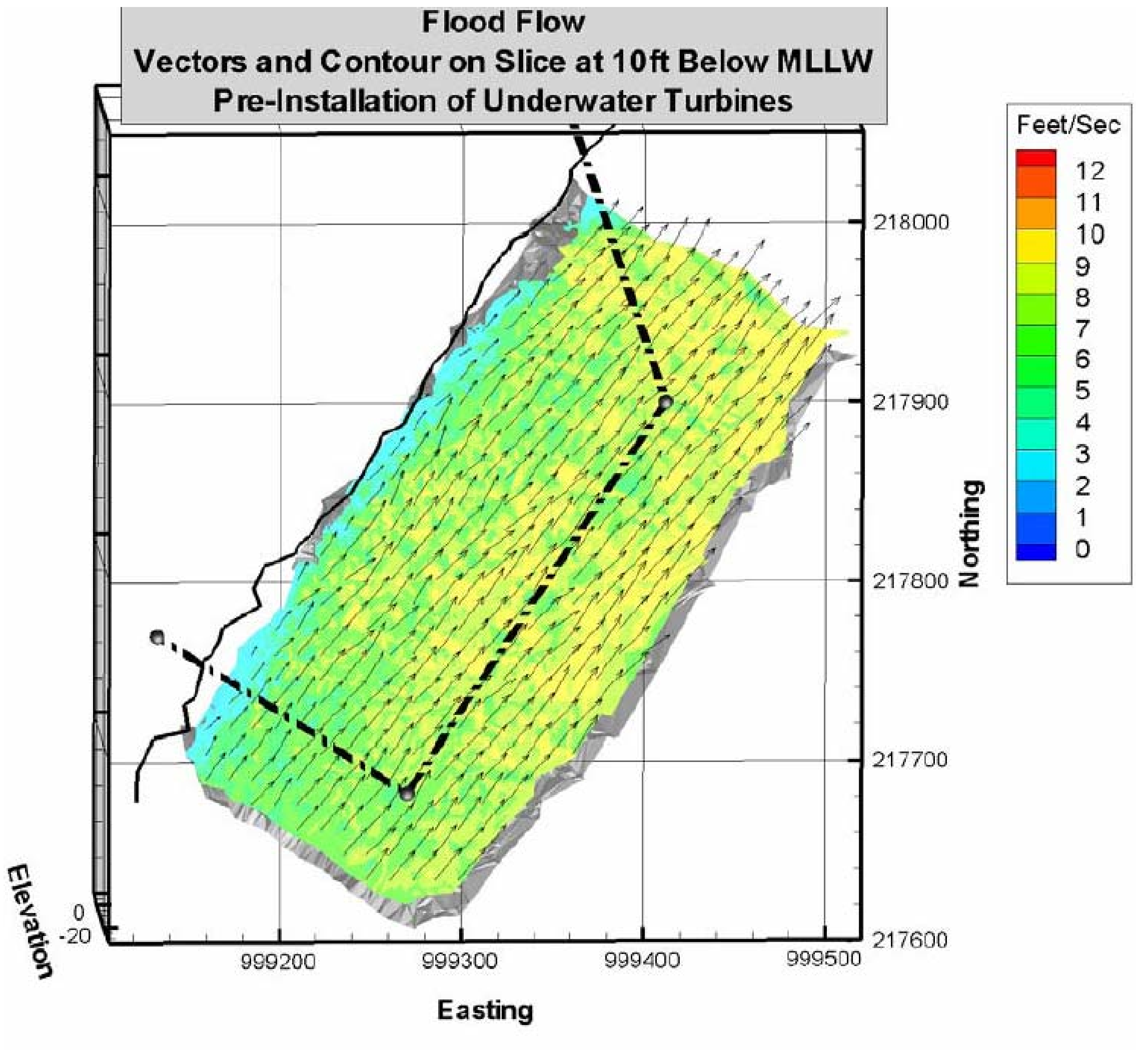
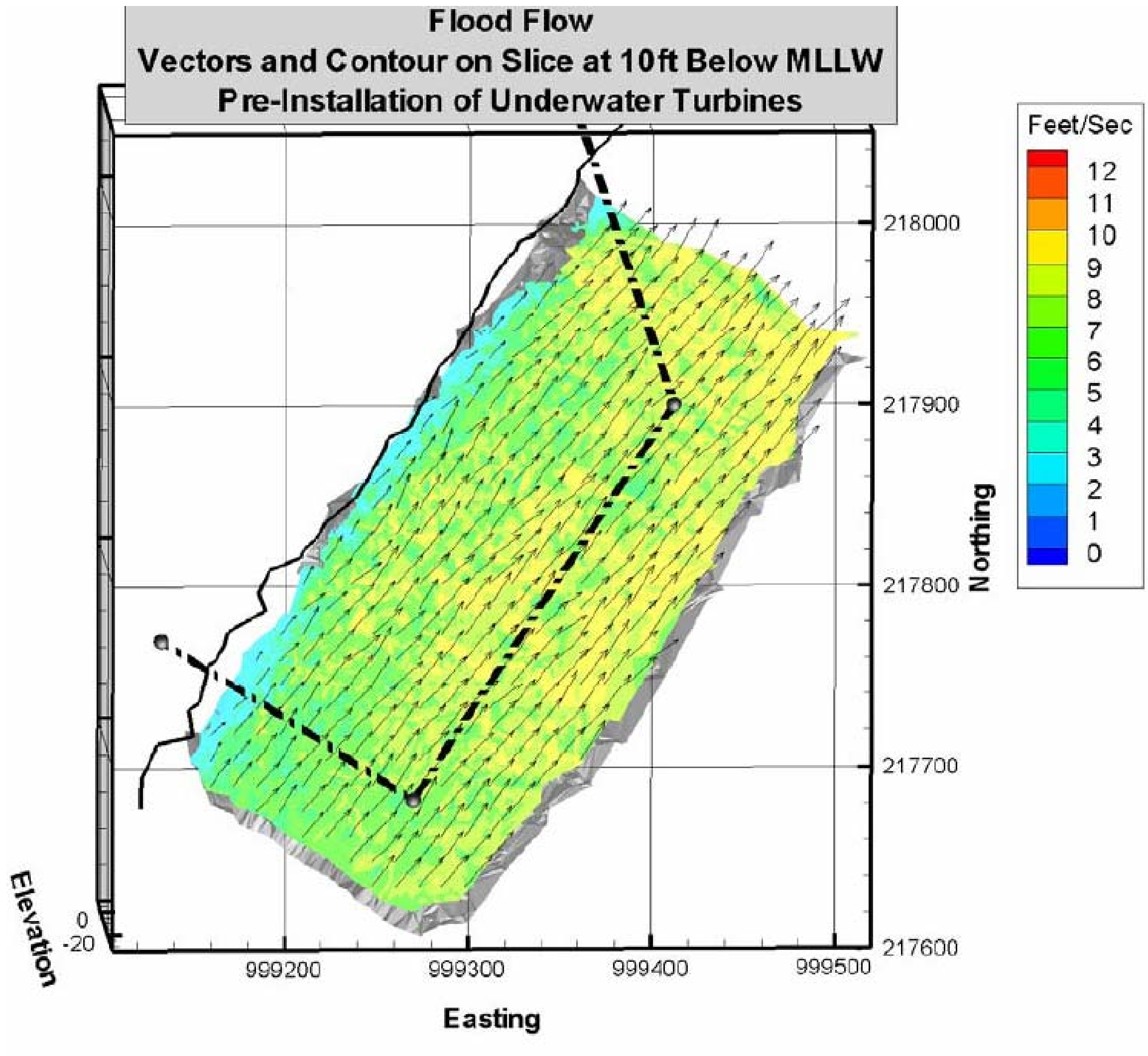


Figure 5.3.3.2-7. Pre-deploy survey results – Ebb tide (Meso-Scale Hydro) (Verdant, 2007)



Provisional Results and Discussion for Post-Deployment Survey (May 2007)

As planned in the East River Hydrodynamic Survey Plan, a post-deployment #2 survey was executed by Verdant's contractor and documented in provisional results of June 2007 (DTA, 2008). At the time of this survey, May 17, 2007, both Turbines 1 and 2 had failed. However, Turbines 3, 4, 5, and 6 were still rotating and generating. This behavior is clearly visible in both Figures 5.3.3.2-8 and 5.3.3.2-9 below. Figure 5.3.3.2-8 below shows the Tecplot interpolation of ADCP data collected during the post-deployment survey on a flood tide, while Figure 5.3.3.2-9 shows similar data on an ebb tide, both along the rotor centerline, 13 feet below MLLW. Both the reduction in flow velocity and change in flow direction downstream of an operating KHPS are apparent. Velocity magnitudes approach zero immediately behind the rotating rotors, evidence of the significant wake behind a generating turbine.

The velocity direction is clearly modified, with velocities up to 90^{o} out of phase with the natural channel velocity. The 3-d nature of the helical vortex wake requires some portion of the flow to be traveling at 180^{o} to the natural channel. However, given the limited resolution, sampling biases, and necessary interpolation to generate Figures 5.3.3.2-8 and 5.3.3.2-9, this behavior is not visible. Within the obvious wake regions seen, it is certain that parts of the flow are traveling against the natural flow direction.

Further, each turbine wake clearly propagates downstream and potentially interacts with the subsequent turbine. Not only does this introduce structural concerns, but energy extraction may be compromised downstream. This behavior is clearly evident in both flood and ebb tides, with some asymmetry in wake strength inshore vs. outshore. This wake propagation was not captured in the micro-scale modeling above, and confirms the need for multiple analyses based on the corresponding flow scales of interest.

To improve upon the meso-scale modeling work above, Verdant Power is currently working on in-house post processing of the on-water hydrodynamic survey data. This work includes fine tuning of the interpolation scheme, velocity averaging studies, as well as general quality control of the data. Additional graphics and conclusions will be addressed in the Final License Application, following the completion of this work.

The on-water surveys presented above provide an excellent visualization of the impact of operating and non-operating KHPS on the meso-scale hydrodynamics. From the results above, it is apparent that ample wake recovery distance between turbines is essential and both vertical and lateral spacing of turbine rotors may improve individual performance.

Figure 5.3.3.2-8. Post-deploy survey results – Flood tide (Meso-Scale Hydro) (DTA, 2008)

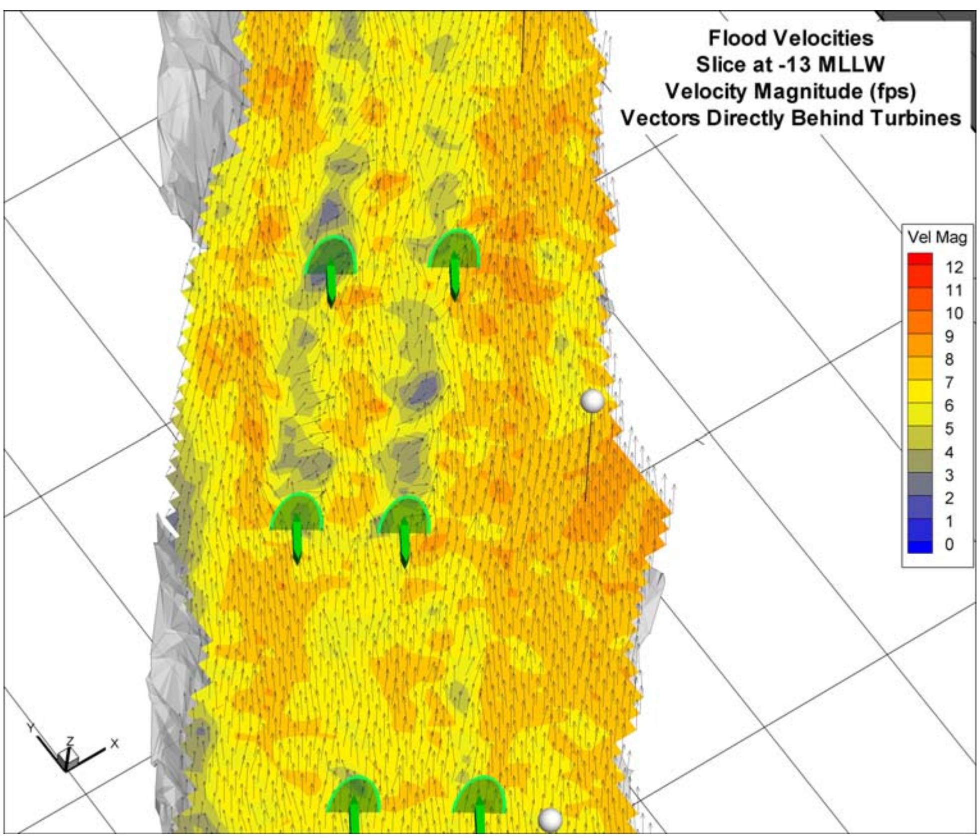
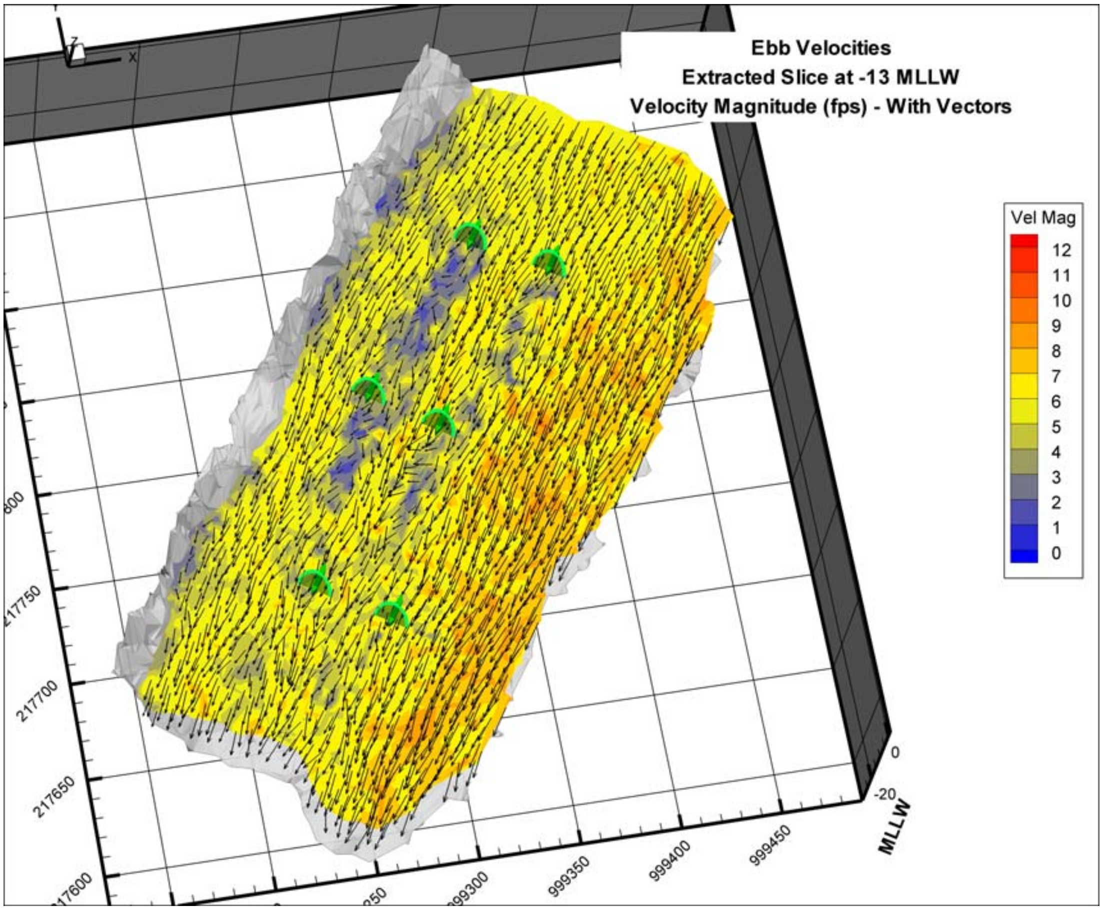


Figure 5.3.3.2-9. Post-deploy survey results – Ebb tide (Meso-Scale Hydro) (DTA, 2008)



However, due to the experimental limitations addressed, these survey results do not provide calibration or validation data for subsequent modeling of the complex, 3-d, and time-dependent meso-scale hydrodynamic phenomena. Instead, Verdant Power developed a macro-scale model to more accurately predict the effects of a proposed 30 unit KHPS buildout field in the East Channel with the larger water body, to answer the concern as to possible modification of flow through the East River.

Macro-Scale Hydrodynamic Modeling

Given the in-water field results discussed above, to model the influence of the RITE Pilot Project East Channel buildout of 30 KHPS units (1 MW), a 1-d hydrodynamic model was developed internally by Verdant based on the work of Ian Bryden *et al.* (4) (5) (6). Before presenting the results of this model, a brief outline of the methodology is discussed.

The 1-d model used to examine the influence of kinetic energy extraction on the macro-scale hydrodynamics is based on a simple channel linking to oceans (or water bodies) of infinite size, shown schematically in Figure 5.3.3.2-10 below.

Figure 5.3.3.2-10. Reprint of Fig. 4 from Bryden and Couch.

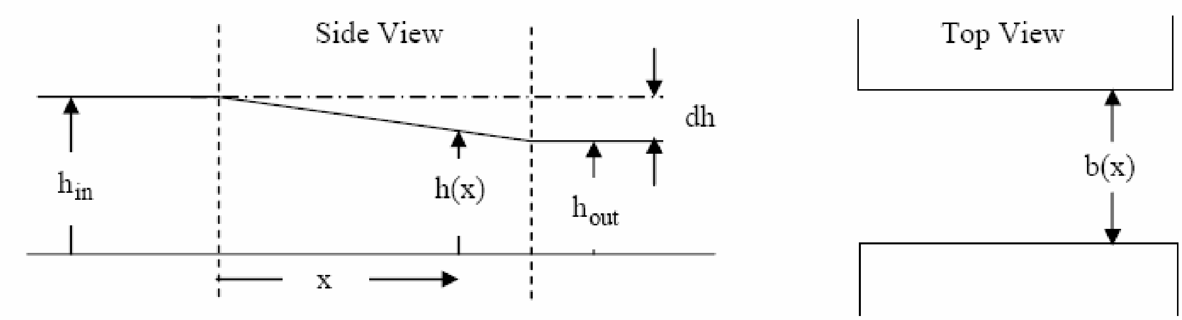


Fig. 4. Schematic diagram of a hypothetical channel linking two oceans.

In this schematic, the variation in channel width is assumed a function of the downstream location (x) only. The driving force for this flow is the head difference, dh = $h_{out} - h_{in}$, seen above, where the elevation of both oceans is assumed known. The governing hydraulic equations can be solved for the water elevation, h(x), and velocity, V_W, along the length of the channel given the inlet height, h_{in}, and outlet height, h_{out}, are known.

The following open channel flow equation was used, along with additional equations given in (4) (5) and (6):

$$[1-\frac{Q^2}{h^3b^2g}]\frac{\partial h}{\partial x}=-\frac{1}{\rho gbh}P_W\tau_{eff}$$

Equation 1. General Hydraulic Equation for Open Channel Flow
Where: b = channel width, h = water depth, Q = volumetric flow rate, g = acceleration due to gravity, ρ = fluid density, P_W = 2h + b = wetted perimeter, and

$$\tau_{eff}=\tau_O+\tau_{ext}(f)$$

Equation 2. Definition of Effective Shear Stress

The effective shear stress (τ_{eff}) represents frictional losses, and the extraction term (τ_{ext}) can be represented by f, the fraction of energy extracted, seen in Eq. 2 above. When f = 0, the effective shear stress is equal to the natural shear stress and the channel is considered undisturbed. The extraction of energy, *i.e.* increasing f, is modeled as an increase in effective shear stress at the extraction plane along the channel.

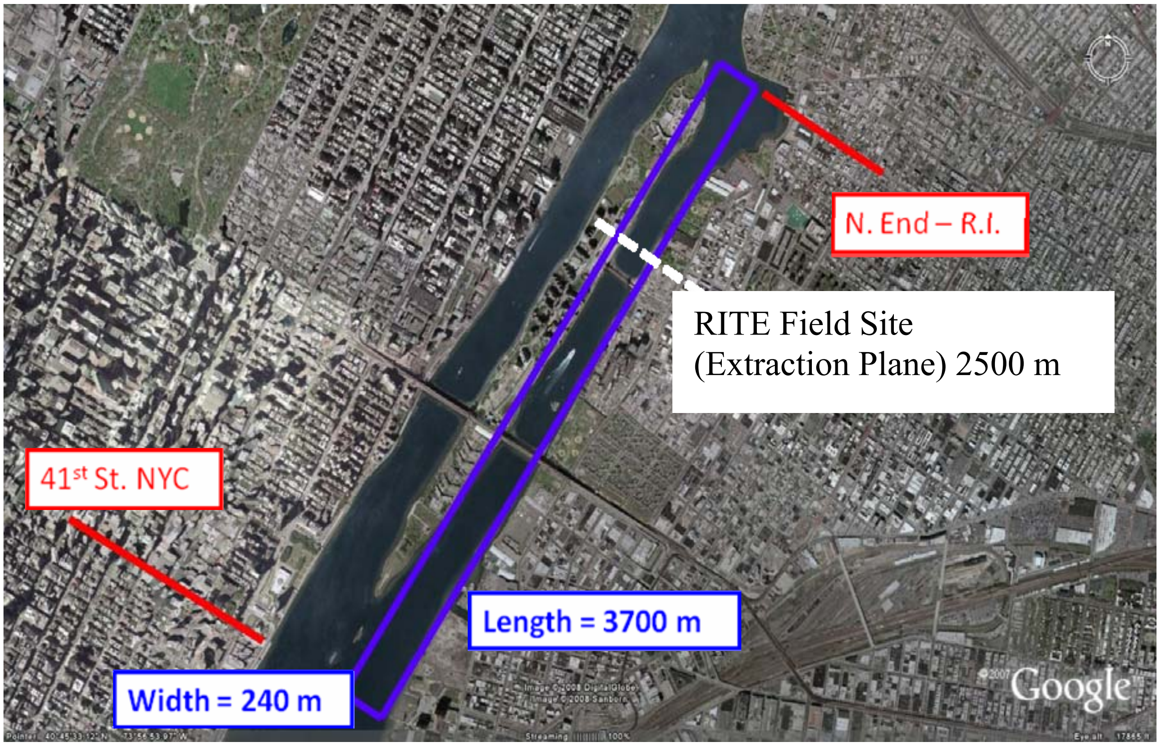
Given these definitions for the governing equations and the model for energy extraction, an iterative solution can be found for Q, the volumetric flow rate through the channel, if h_{in} and h_{out} are known. Once Q is known, the water elevation and velocity profiles at each location along the channel can be determined. Initially, undisturbed channel profiles were determined with f = 0, followed by disturbed channel profiles with f > 0. Since these solutions are iterative, the influence of energy extraction at a single plane, or multiple planes, is felt throughout the model domain – true in a river or tidal application as well.

Simulations were run using MATLAB 7.6.0 R2008b and solved these equations for the specific application at the RITE project. For the specific application of this model, a number of parameters and assumptions must be defined, as seen below. Following the discussion of model parameters, results for 30 turbines, each delivering 35 kW of usable energy, for a 1 MW buildout, are presented with discussion.

To accurately model the RITE 6-pack, known water level differences at the north and south end of the island were required. In addition, water velocity measurements at the turbine location were essential to calibrate the model to ensure an accurate solution. To determine the water level difference between the north and south ends of Roosevelt Island, the University of South Carolina tide predictor, T-Bone was used[5]. The "*East 41st Street, New York City, East River, New York, New York*" and the "*Roosevelt Island, north end, East River, New York, New York*" were used for the south and north, respectively. These can be seen in Figure 5.3.3.2-11, highlighting the modeling extent used in this work and the RITE Field Site.

[5] http://tbone.biol.sc.edu/tide/index.html

Figure 5.3.3.2-11. Modeling extent for the East Channel of the East River, NY, NY.



Given the known elevation above the mean lower low-water (MLLW) datum at every high and low tide at each station, the intermediate water levels could be found by interpolation. Then, the elevation at the northern end was subtracted from the elevation at the southern end to compute the elevation difference across the modeling extent for any given Flood (dh >0) or Ebb (dh<0).

Over a week period in March, 2008, the maximum "instantaneous" elevation difference on a flood tide was determined between the south and north end of Roosevelt Island, equal to 0.224 meters (22.4 cm). Further, based on NOAA Survey-H11353, a water elevation of 15.24 meters was determined to be the datum for MLLW at 41st St., NYC. At the time of the maximum difference, a flood tide, March 21st, 2008 19:00 EST, the measured water velocity from the ADCP at the turbine site was determined, $V_W = 2.1$ m/s. This information provided the baseline data necessary to begin and calibrate the model. A flood tide was chosen based on Verdant Power's experience with systematically elevated velocity values on the flood tide.

The model results are shown on Table 5.3.3.2-1 below and graphically on Figure 5.3.3.2-12 at a greatly expanded scale to show detail. Without this zoom in, the differences in elevation and velocity are difficult to discern.

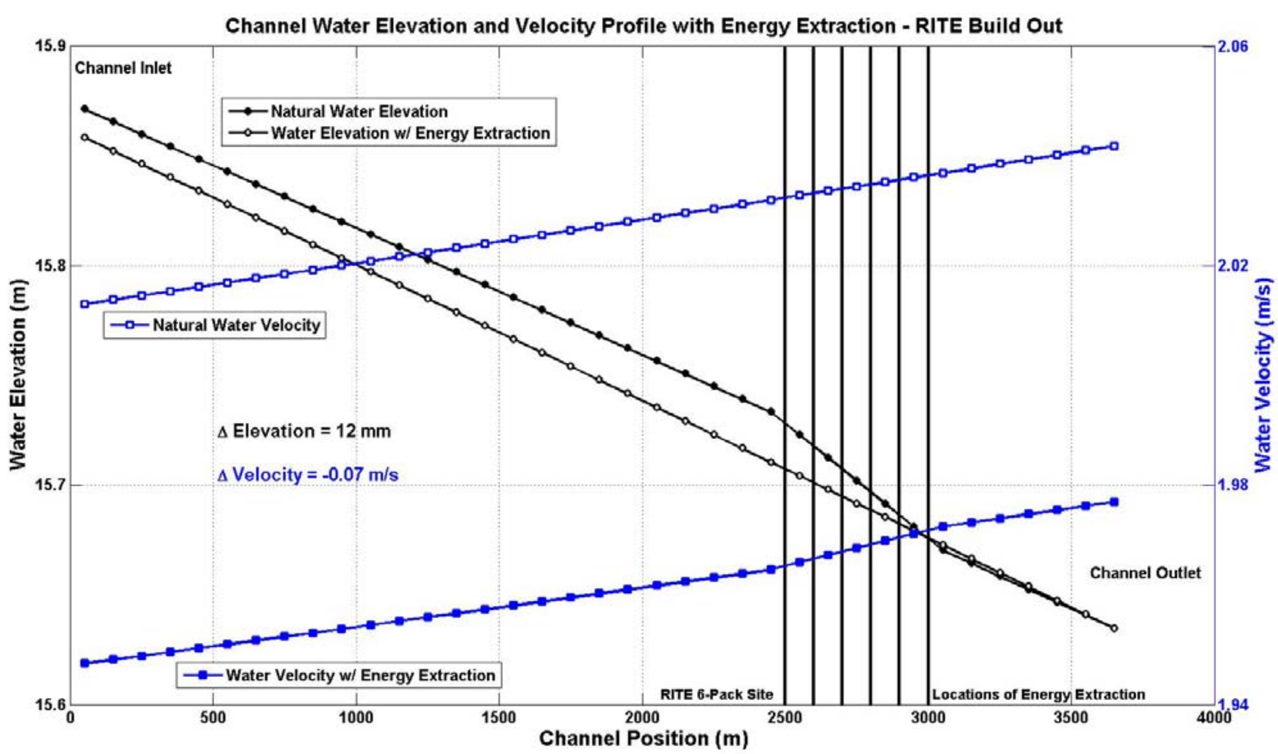
Table 5.3.3.2-1. East Channel conditions with 1-D model results: Natural Channel and extraction.

Parameter (values assessed on Flood Tide - flow moving south to north)	**Actual/Measured (March 2008 at North and South End of RI**	**1-D Model – No Extraction - Natural Channel**	**1-D Model – with Extraction = to 30 KHPS RITE Pilot Project**
South Inlet Elevation (m)	15.859	15.859	15.871
Extraction plane Site of RITE Field	No Extraction	No Extraction	30 KHPS units at 12D
North Outlet Elevation (m)	15.635	15.635	15.635
Site Elevation (m)	0.224	0.224	0.236
Δ Elevation (m)			0.012 m (Increase)
Inlet Velocity (m/s)	Not Known	2.013	1.948
Site Velocity (m/s)	2.10	2.04	1.97
Δ Site velocity m/s			-0.07 m/s (Decrease)
Flow Rate (m^3/s)	Not Known	7,662	7,419

As seen in the table above and Figure 5.3.3.2-12, the first energy extraction plane was 2,500 meters beyond the southern end of the model extent, just north of the Roosevelt Island bridge, *i.e*. the current location of the RITE 6-pack demonstration project. To simulate the extraction of 1 MW (equivalent to 30, 35 kW turbines) six energy extraction planes were used to simulate the presence of 30 turbines, 3 per row, at 12D spacing. With a 5 m rotor, the total length of the array would be 600 m. Since the model resolution along the channel was 100 m for all work presented, six extraction planes most closely captured the real geometry, and therefore influence, of the buildout.

Given the elevation difference and MLLW datum above, a Manning Coefficient, n = 0.022, was used. This value, comparable to a clean earth channel discussed in (7), produced a natural channel velocity at the extraction plane of V_W = 2.04 m/s with a net water level change of 0.217 meters (21.7 cm). Both of these values match the real data presented above quite well, and are shown in text along with the results below.

Figure 5.3.3.2-12. 1-d model results for RITE 1 MW buildout - Natural Channel properties



Disturbed Channel Properties for Comparison – Detailed Image

From Figure 5.3.3.2-12 above, the fraction of kinetic energy flux removed from the disturbed channel at each of the 6 extraction planes is 2.3% - corresponding to 2 MW removed from the river and 1 MW usable to the grid, assuming a rotor efficiency equal to 50%. Given the impact on the channel velocity with extraction, the natural channel energy flux is reduced by only 2%. This is well below the suggested maximum of 10% from Bryden *et al.* (2004). With each turbine rated at 35 kW near peak, this model corresponds to the simultaneous operation of 30 turbines near peak. Based on this 1-d model, the river sees an increase in water level of only 0.012 m at the channel inlet, and a reduction in mean water velocity at the first extraction plane of approximately 0.07 m/s. The effect of this on the overall river is highlighted in Table 5.3.3.2-1.

These calibrated, predicted changes in the East Channel properties of the order mentioned above are not within measurement capabilities of water instruments. The inlet water level changes by less than 0.08% while the inlet water velocity changes by approximately 3%. From this, it is clear that the extraction of 1 MW of usable power changes the East Channel of the East River in a subtle but insignificant manner. Notice from Figure 5.3.3.2-12 above the influence of extraction throughout the channel. This result agrees with riverine hydrodynamics, where "information" is transmitted in all directions from the source. In this case, the extraction of energy locally modulates the channel properties globally.

Based on the studies discussed above, Verdant Power believes the following;

Micro-Scale Hydrodynamics

Non-Rotating units create small wake regions, especially behind the pylon, pile, blades, and tail cone. Very little flow acceleration is visible; generally well above the river bottom. Pressure differences across the stationary and rotating structures lead to wake regions. However, pressures below the vapor pressure are not seen and cavitation is not a concern.

The turbulent wake, both bluff-body and tip-vortex, lead to increased mixing and flow disturbance. However, these regions of increased mixing/scouring/sediment transport are generally well above the river bottom. The impact of the pile wake, which is near the river bottom, is reduced by the natural presence of a strong turbulent boundary layer.

Computational limitations due to blade/rotor resolution requirements prevent the accurate modeling of the macro-scale wake behavior.

Meso-Scale Hydrodynamics

The in-water data was confirmation of the influence of KHPS turbines on a meso-scale and is reflected in the quality of energy production during the timeframe and largely informs Verdant of the correct lateral and longitudinal spacing of KHPS units.

Velocity magnitudes are greatly reduced downstream of a generating unit, while velocity directions are shown up to 90^{o} out of phase with the natural channel direction. These 3-d, rotating, vortex structures convect downstream, centered on the shaft centerline. Their general influence is maintained in a slowly expanding cone downstream from the rotor, and is unlikely to affect the river bottom.

With regard to localized effects; the presence of the pylon and the areas of lower velocity (reductions up to 50%) behind the stationary KHPS pylon during ebb and flood flows do present a potential area of protection and/or habitation. However, as discussed in the Aquatic Resources sections, the fish abundance and population observations generally tend to indicate that fish (both large and small) are not present in the high current zones of the KHPS; nor are present in general, during the ebb and flood cycles; and so the decrease in localized velocities would not be likely to effect the predator-prey relationship within the field.

Macro-Scale Hydrodynamics

A 1-d model for the extraction of kinetic energy, as an additional source of frictional losses, from an open channel can accurately predict the depth and velocity in the East Channel of the East River. The influence of energy extraction is to slightly increase (12 mm) the overall water depth from the inlet of the channel to the extraction planes. As a result, the water velocity is decreased slightly (-0.07 m/s) throughout the channel.

These modifications to the channel properties are minimal and below the precision available for most measurement devices. As such, the generation of 1 MW from the East Channel of the East River is unlikely to modify the natural channel properties in any way.

5.3.2.3 <u>Affected Environment - Water Quality (Sediment)</u>

Based on 2003-2005 consultation with agency personnel, potential concerns associated with water quality in conjunction with the RITE Demonstration Project included:

1) Erosion and sedimentation during deployment activities;
2) An increase in suspended solids during operation activities; and
3) The presence of toxic constituents in the channel substrates within the project area;

Since the Verdant Power KHPS design has no hydraulic components, the concern of releases of oil or other chemicals from the underwater units is not an issue.

Prior to deploying, Verdant conducted a literature review and desktop study for the preparation of the ICD (2003) as well as subsequent agency submittals in support of deployment and operation of the RITE demonstration project.

RITE Field

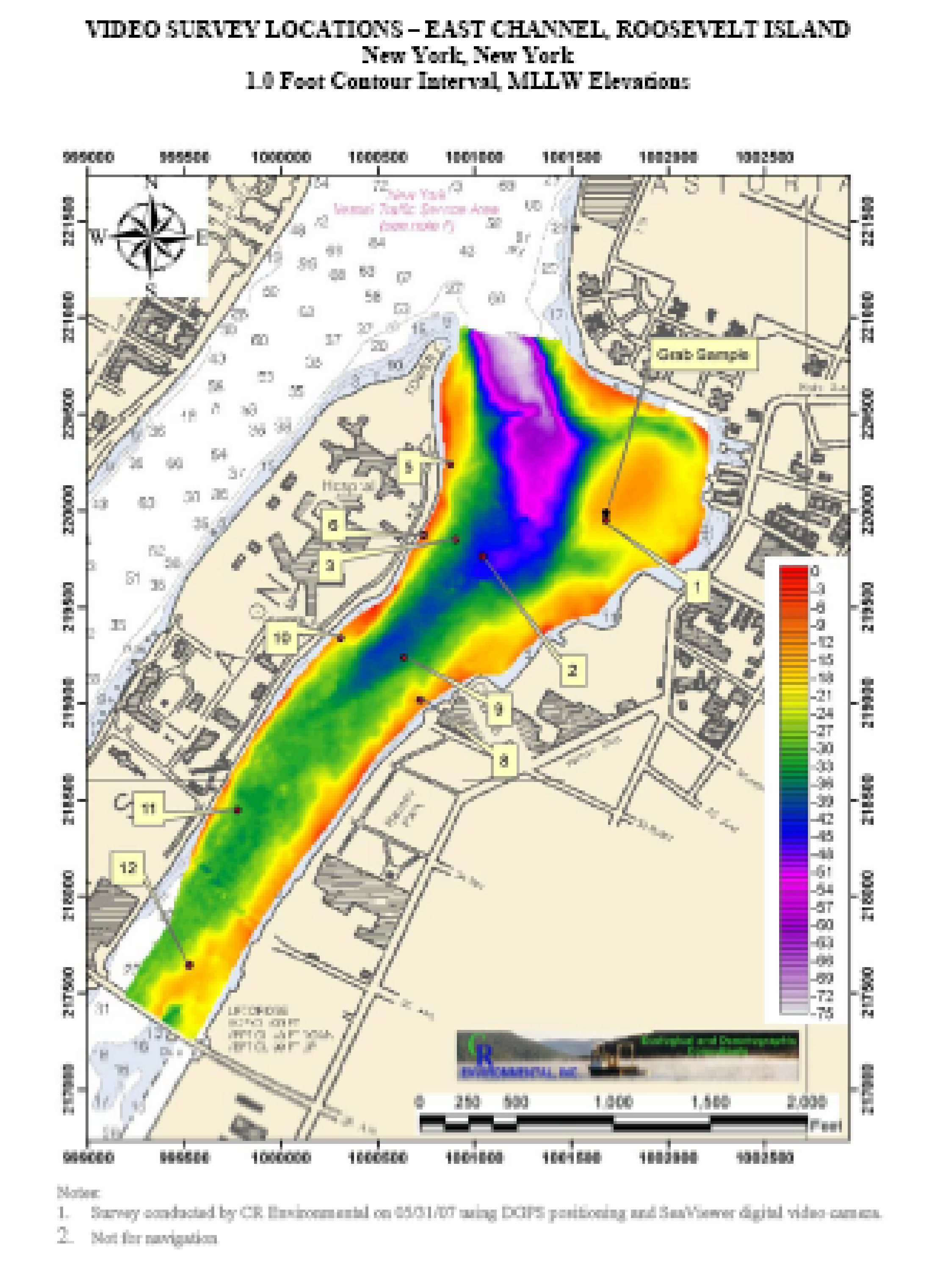
In conjunction with the RITE Demonstration Project, Verdant developed a Sediment Sampling Plan for the proposed Project based on information and consultation with the New York State Department of Environmental Conservation (NYSDEC), NOAA/fisheries, the United States Fish and Wildlife Service, Army Corps of Engineers, the New York Department of State, and the New York City Department of Environmental Protection. Throughout the substrate analysis activities, Verdant and its contractors consulted with the NYSDEC and other applicable parties to ensure compliance with applicable water quality standards and regulations. The results of the sampling event were presented in the Sediment Sampling and Contour Mapping Results for the Roosevelt Island Tidal Energy Project (DTA, 2005b). This report was submitted to the consulting agencies in March 2005 for review and approval.

The results of the sediment characterization and presence of fine sediments were mapped in the study area and grab sample locations identified (if enough sediment was present to sample).

Verdant performed "Acoustic Remote Sensing Survey Roosevelt Island Tidal Energy Project" in March 2005. The survey used a high-resolution side-scan sonar device at frequencies of 500 kHz and 100 kHz, and sub-bottom sonar using a SyQwest 10 kHz Stratabox sub-bottom profiling system. Groundtruthing was done using video inspection of riverbed conditions adjacent to the demonstration site. Detailed images of the riverbed features were generated from the side-scan sonar data collected; a mosaic was assembled from the files which allowed accurate identification of surficial riverbed texture. The mosaic suggests that the substrate of the entire survey area is composed of cobbles, boulders, and ledge. This characterization is supported by sub-bottom sonar data, which documented a highly reflective riverbed and abundant parabolic reflections typically associated with boulders. Neither the side-scan or sub-bottom sonar surveys identified or suggested the presence of fines sediment (*i.e.* particles smaller than gravel) within the survey area.

The system used was designed to allow benthic inspection and simultaneous retrieval of fine sediments. Based on a review of side-scan sonar data, two stations were selected for video inspection to locate and collect fine sediment. These locations were chosen based on the absence of large boulders and the likelihood that fine sediment would be present and are shown in Figure 5.3.2.3-1. The video, which was recorded directly onto VHS tape and DVD, confirmed the presence of boulders and cobbles that were depicted on the side-scan sonar and sub-bottom records. The video coverage did not show any evidence of fine grain soft sediments, therefore, precluding any further opportunity to obtain sediment samples for grain size and chemical analyses.

Figure 5.3.2.3-1. Location of video surveys.



Based on agency recommendations, detailed depth and bottom substrate information were collected in April 2007 for the proposed RITE Project East Channel buildout. The survey was called "2007 Expanded Geophysical Survey Roosevelt Island Tidal Energy Project" (CR Environmental, 2007). Side scan sonar data was evaluated in order to classify the composition of surface substrates. The data evaluation was based on careful inspection of raw and projected sonar imagery for individual transects and close inspection of the sonar mosaic. Five substrate classes were identified in the survey area:

1) Ledge or exposed rock,
2) Boulders,
3) Cobbles,
4) Gravels, and
5) Sands.

A map representing dominant substrate classes can be seen in Figure 5.3.1.1-2. Groundtruthing of the data was done using underwater video and bottom grab samples. The vast majority of the channel appeared to be dominated by boulder/cobble substrates. Exposed ledge or rock appeared to be present along the western shoreline. Sands and gravels are present in Hallets Cove and along the slopes of the northernmost channels. Debris was widespread throughout the survey area, with the highest density of debris along the eastern shoreline and in Hallets Cove (the cove at the northeastern extent of the survey area). Sub-bottom sonar data did not suggest the presence of discernable thicknesses of sediment in any portion of the survey area other than Hallets Cove.

5.3.2.4 Environmental Effects – Water Quality (Sediment)

Verdant determined that the east channel of the East River is located within a larger area that has the potential for toxic contaminants to exist within the underlying substrates. However, based on site-specific information acquired during the 2005 surveys it is not likely that toxic contaminants will be disrupted during deployment and/or operation of the RITE Project East Channel field 1 because no resuspendable sediment was found at the site. The same surveys done for the RITE East Channel field will be done at the RITE West Channel field under the preliminary permit. .

5.3.2.5 Affected Environment - Water Quality

Water Quality Standards

As reported in the ICD; according to the NYSDEC, the reaches of the East River are classified as saline I and SB as follows:

- River Mile 0 to 14.5 Class I
- River Mile 14.5 to 17.0 Class SB
- The RITE Project is approximately at River mile 14.5

Table 5.3.2.5-1. Lists the New York State Water Quality Standards for Classes I and SB.

PARAMETER	NARRATIVE STANDARD	
	Class I	**Class SB**
Uses	Secondary contact recreation and fishing	Primary and secondary contact recreation and fishing
Aquatic Habitat	Shall be suitable for fish propagation and survival	Shall be suitable for fish propagation and survival
Dissolved Oxygen	4.0 mg/L	5.0 mg/L
Fecal Coliform Bacteria	The monthly geometric mean from a minimum of five examinations shall not exceed 2000 per 100 ml.	The monthly geometric mean from a minimum of five examinations shall not exceed 200 per 100 ml.

Sources: NYCDEP, 2003; NYSDEC, 2000

Existing Water Quality
Water Quality in Proposed Project Area

Verdant collected water quality data in conjunction with a sediment and substrate survey in 2005. The water column at the RITE demonstration site was isothermal on February 16 2005, with a temperature of approximately 3.3 degrees C. Salinity ranged from approximately 19.6 to 20 PPT (parts per thousand). Turbidity ranged from approximately 16 to 17 FTU. Dissolved oxygen was highest near the surface (approximately 11.4 mg/L) and steadily decreased with depth, to a minimum of about 7.7 mg/L.

In the sediment survey, discussed in Section 5.3.2.3, Verdant and the consulting parties agreed that no sediment or organic material exists within the initial demonstration area, and therefore, additional sampling activities, including water column monitoring was not necessary for deployment and operation of the demonstration units. In July 2006, the NYSDEC once again confirmed in a letter, listed in the consultation log, that water quality analysis was not needed at the RITE demonstration site because of the lack of sediment.

Regional Water Quality

The NYCDEP conducts annual monitoring of the waters of New York Harbor for four indicator parameters: dissolved oxygen; fecal coliform; chlorophyll a; and turbidity. This monitoring has been conducted since 1908 and currently includes 53 stations. The data obtained is used to monitor water quality trends and to correlate improvements with advances in wastewater treatment and other environmental protection measures. Overall, the program has documented significant improvements in all parameters due largely to the construction and upgrade of wastewater treatment plants that discharge to the harbor (NYCDEP, 2003).

In the inner harbor (which includes the lower East River Hudson River, Upper New York Bay, Arthur Kill, and Kill Van Kull), bottom dissolved oxygen levels have risen from approximately 3 mg/l in the early 1970s to 5 mg/l presently. Since 1992, summer surface dissolved oxygen levels have averaged 6.1 to 6.5 while mean bottom levels have ranged from 5.3 to 5.8 mg/l. In this region, a site near Newtown Creek in the East River has historically had the lowest dissolved oxygen levels, with average summer levels of 4.7 and 4.6 mg/l respectively. Fecal coliform levels in the inner harbor have improved from summer geometric means in excess of 2,000/100 ml in the early 1970s to below 100/100ml currently. Chlorophyll *a* levels throughout the inner harbor have generally been below 10 ug/l since 1992 and have shown no discernable trends. Turbidity in the inner harbor, measured as secchi depth, has shown variability between areas. Data collected since 1986 shows that the Hudson River has secchi transparency to depths of two to four feet, the lower East River and Upper Bay to four to seven feet, and the Kills to four to five feet. Long-term trends show a slight increase in turbidity throughout the inner harbor (NYCDEP, 2003).

In the upper East River region of the harbor (which includes the East River north of Roosevelt Island, western Long Island Sound to Hart Island, and the Harlem River), bottom dissolved oxygen levels have risen from approximately 3.0 to 3.5 mg/l in the early 1970s to above 6 mg/l presently. Over the past two years, however, dissolved oxygen levels have been lower, with average summer 2002 levels falling to 5.7 mg/l at the surface and 4.6 mg/l at the bottom. This was the first time levels were below 5 mg/L since 1991. Fecal coliform levels in the upper East River have improved from summer geometric means in excess of 2,000/100 ml in the early 1970s to below 50/100 ml in recent years. Chlorophyll a levels throughout the upper East River region have generally been between 10 to 15 ug/l since 1992. Turbidity in the upper East River has shown variability between areas of the region, with the Harlem River secchi depths of three to four feet and the East River at four to six feet transparency. Long-term trends show a slight increase in turbidity (NYCDEP, 2003).

305(b) and 303(d) Listing

Section 305(b) of the Clean Water Act requires states to report to the U.S. Environmental Protection Agency (EPA) on whether waters of the state are supporting the designated uses and standards of the state's water laws. The state's waterbody inventory and priority waterbody list (WI/PWL) are used to inventory the data obtained by state monitoring programs (including the New York State Rotating Intensive Basin Studies [RIBS] program) and to track known or suspect water quality problems. Waterbodies where designated uses are threatened, stressed, precluded, or impaired, are identified on the PWL and in the 305(b) report.

The East River is included in the New York State 305(b) listing. A 3,520-acre section of the lower East River estuary and a 3,200-acre section of the upper East River estuary are listed as impaired for aquatic life due to high oxygen demand from combined sewer overflows. A 1,280-acre portion of the lower East River estuary is also listed as impaired for public bathing due to pathogens from combined sewer overflows. All three segments are listed for sediment contamination that precludes or impairs fish consumption (NYSDEC, 2000; 2002).

Pursuant to section 303(d) of the Clean Water Act, states must develop Total Maximum Daily Loadings (TMDLs) for waterbodies identified on the state's PWL that cannot meet standards after application of best available technology. The TMDLs apportion the allowable daily loading of pollutants amongst point, non-point, and natural sources. The East River has been identified as a priority for development of TMDLs to address the impairments discussed above.

5.3.2.6 Environmental Effects - Water Quality

The proposed Project would not be expected to effect on water quality parameters such as dissolved oxygen or oxygen demand. The Project would not affect levels of fecal coliform or pathogens.

Based on the lack of resuspendable sediment found in the RITE Project demonstration site and the RITE East Cahnnel buildout field, Verdant does not anticipate any increased turbidity. Further, Verdant does not expect any release of chemicals into the water column because limited to no sediments would be suspended or disturbed during the short deployment construction of 3 months. Since the Verdant KHPS machines have no hydraulics; there is no potential for lubricant leaching. Construction and maintenance activities could increase the potential for accidental release of gas or oil from work boats through vessel collisions. Coordinating activities with the USCG should mitigate potential for vessel collisions.

Because no impacts to water quality are expected from the operation of the East Channel pilot project, no further monitoring is proposed. For the West Channel Stage 2 pilot project, Verdant proposes to conduct similar assessments in the area of the field prior to construction. If the assessments indicate a need for water quality monitoring, Verdant will propose a Water Quality Study for the West Channel.

5.3.2.7 Unavoidable Adverse Impacts

None identified.

5.3.2.8 No Action Alternative

If the proposed buildout is not installed, there would be no increased construction or maintenance vessels that could potentially impact water quality.

5.3.2.9 Sources

CR Environmental, Inc. 2005 (March). Acoustic Remote Sensing Survey for the Roosevelt Island Tidal Energy Project.

CR Environmental. 2007. 2007 Expanded Geophysical Survey Roosevelt Island Tidal Energy Project; prepared by CR Environmental, April 2007.

Devine Tarbell & Associates, Inc. (DTA) 2005b. Sediment Sampling and Contour Mapping Results for the Roosevelt Island Tidal Energy Project. March, 2005

Environmental Protection Agency (EPA). 2003. Envirofacts database. [Online] URL: http://oaspub.epa.gov/enviro

New York State Department of Environmental Conservation (NYSDEC). 1999. Descriptive data of municipal wastewater treatment plans in New York State. NYSDEC, Albany, NY.

NYDEC. 2000. New York State Water Quality 2000. NYSDEC, Albany, NY.

NYSDEC. 2002. New York State 2002 Section 303(d) List of impaired waters requiring a TMDL. NYSDEC, Albany, NY.

New York City Department of Environmental Protection (NYCDEP). 2003. New York Harbor Water Quality Report. NYCDEP, New York, NY.

National Oceanic and Atmospheric Administration (NOAA). 2003c. Water Level Station Data for "The Battery" and "Kings Point". [Online] URL: http://co-ops.nos.noaa.gov/data_res.html.

Verdant. 2003. Initial Consultation Document (ICD) (October 2003)

Verdant and DTA. 2006. Roosevelt Island Tidal Energy Project; FERC No. 12611; Verdant Power Inc. East River Hydrodynamic Survey; developed by Devine Tarbell & Associates, Inc. (DTA) October 25, 2006. (Study Plans, 2006).

Verdant Power, Inc. 2007 (March). 60-Day Interim Monitoring Report for the Roosevelt Island Tidal Energy Project Fish Movement and Protection Study. Prepared by Devine Tarbell and Associates. (60-day report, 2007)

DTA, 2008. East River Hydrodynamic Survey; Provisional post - deployment processed data (10 pages) Devine Tarbell & Associates, Inc. May 2007

Bryden, I.G., Grinsted, T., Melville, G.T. Assessing the potential of a simple tidal channel to deliver useful energy. Applied Ocean Research. July 2004, Vol. 26, 5. (Bryden, 2004)

Bryden, I.G., Couch, S.J. ME1-marine energy extraction: tidal resource analysis. Renewable Energy. February 2006, Vol. 31, 2. (Bryden, 2006)

5.3.3 Aquatic Resources

5.3.3.1 Affected Environment

During the course of the preliminary permits Verdant has conducted a number of studies to evaluate the interaction between the fish and aquatic environment and the operating KHPS machines. These studies represent the first ever in-water monitoring of operating Verdant Power design KHPS machines and as such develop a unique body of information related to understanding this interaction, specific to Verdant Power's technology. NYSDEC, ACOE, USFWS, NOAA/NMFS, and EPA were active participants in these groundbreaking efforts and have worked with Verdant to develop, modify, and adapt these studies and protocols over the course of the RITE demonstration project.

Since 2005, Verdant has collected, analyzed and reported the following major data summaries. This history of studies and lessons learned advance the knowledge of the understanding of KHPS fish interaction and specifically support the licensing of the RITE East Channel pilot project and proposed monitoring protocols discussed in this application. Each of the following chronology of study periods and results are summarized in this section:

- Literature review as part of the Initial Consultation Document - ICD,
- Historical Fisheries data; 15 separate studies ranging from 1982 to 2007 (provided to agencies in July 2007),
- Studies and consultations resulting in the Fish Monitoring and Protection Plan (FMPP) Revision 6.0 (October 2005) and execution of studies pre and post deployment (2005 - June 2007); reported on in the 60-day report and ftp site posting July 11, 2007, and
- Working memorandum; supplemental information for discussion related to RITE FMPP June 11, 2008, (attached as Appendix B to this Exhibit);

- Study and consultations August 2007 - June 2008 resulting in the FMPP revision 7.5 (September 2008 and ongoing).

A separate discussion of East River Underwater Noise Survey follows.

The specific study objectives of this effort executed during the RITE Demonstration; as stated in the Fish Monitoring and Protection Plan was to:

1. Characterize the use of the six-pack deployment area (near-field) by fish communities.
2. Characterize the use of the east channel of the East River (far-field) by fish communities, and to the extent possible, populations on a seasonal basis with emphasis on a potential full deployment field of additional turbines.
3. Evaluate fish behavior (direction and velocity of swimming) relative to tide direction and current speed near the individual turbines.
4. Evaluate the effects of multiple turbines on fish passing through the turbine field.
5. Incorporate where practical the data gathered from the pilot study to make assertions relative to the potential effect of a larger turbine array on the fish community, and to the extent possible, the fish populations within the vicinity of East channel of the East River near Roosevelt Island.

Background on Studies Conducted

ICD

As discussed in the Verdant ICD, the Urban Core of the New York Bight Watershed offers aquatic habitats that support large numbers and diversity of marine, estuary, freshwater, and migratory fish (USFWS, 1997). Fish species common to the

Urban Core were listed in the ICD on Table 6.3-1 (page 6-25 and 6-26). The ICD documented a study of the estuary fish community from 1979 to 1989 (Woodhead, 1991), which documented 101 species of fish, including marine (70 percent), migratory (10 percent), freshwater (10 percent) and estuarine (10 percent) species. Studies conducted by ConEdison between 1974 and 1990 documented 139 total taxa (annual average of 80 taxa) in the lower Hudson region (ConEdison, 1992 in USFWS, 1997). Studies have also identified 117 fish taxa in the lower bay (Walfords, 1971, in USFWS, 1997).

The New York Bight watershed provides important habitat for numerous migratory species, including American eel, alewife, American Shad, Atlantic menhaden, Atlantic sturgeon, Atlantic tomcod, bay anchovy, blueback herring, rainbow smelt, shortnose sturgeon and striped bass. The East River is believed to be used by migratory species as a passageway and as a temporary seasonal habitat (USFWS, 1997, Henderson, 2002).

In reviewing a number of fish sampling surveys that have been done in the East River in the vicinity of the site, Henderson (2002) reports:

> …the dominant fish species found in the East River are winter flounder, Atlantic tomcod, grubby, striped bass, and bay anchovy. Their abundance changes seasonally as they move between the East River, Long Island Sound, and the Section 6 Existing Environmental Resources Hudson River. There appear to be few, if any, permanent resident species in the East River. Species such as American shad, alewife, blueback herring, Atlantic tomcod, striped bass, and white perch are seasonal in occurrence. These species are generally migrating through the East River to over-wintering areas offshore or spawning grounds further upriver in the Hudson. The only two relatively common species found in the East River over most life stages are Atlantic silverside and northern pipefish. Both of these species are abundant in the shallow, highly vegetated nearshore waters of Long Island Sound. Early life stages of some species, such as winter flounder, bay anchovy, grubby, fourbeard rockling, windowpane, and bluefish are

found in the East River. Their occurrence is probably linked to spawning in the marine waters of the Atlantic Ocean, New York Harbor or Long Island Sound region.

Recreational and Commercial Fishery

The New York/New Jersey Bight Urban Core estuary system supports significant recreational and commercial fisheries. Recreational fishing represents approximately two million anglerdays annually, with primary target species including flounder, scup, American eel, bluefish, striped bass, Atlantic mackerel, black sea bass and weakfish (USFWS, 1997). The commercial fishery includes the Hudson River fishery (American shad, striped bass, American sturgeon, herring and baitfish); the lower estuary fishery (hake, scup, flounder and tautog); and the near shore and mid-water fishery (flounder menhaden, bluefish, weakfish, and mackerel). Within the East River itself, commercial shellfishing and fishing are restricted or prohibited for most species due to contamination.

Historical Fisheries Data for the East River

As requested by the agencies, Verdant compiled a significant amount of historical fishery data in an around the RITE project site-- both East and West Channels. Figure 5.3.3.1- 1 shows the location of this historical fishery data in relationship to the RITE Project.

- March to October 1982 - River Walk 16' trawl
- November 1983 to April 1984 - River Walk 16' and 30' trawl
- December 1983 and February and April 1984 - River Walk gill and trap nets
- December 1984 to May 1985 - River Walk 16' and 30' trawl
- December 1984 to May 1985 - River Walk gill and trap nets
- March 1985 to February 1986 - East River (Hunter's Point) 16' trawl

- March to December 1985 - East River (Hunter's Point) 50' seine
- March 1985 to February 1986 - East River (Hunter's Point) gill and trap nets
- August 1986 to August 1987 - East River 30' trawl (East River Landing data)
- January to September 1992 - Ravenswood generating station impingement data
- February 1993 to January 1994 - Ravenswood impingement data
- January to December 1993 - Astoria generating station impingement data
- January to December 1993 - East River Generating Station impingement data
- March to December 2005 - Ravenswood impingement data
- June 2006 to January 2007 - Ravenswood impingement data

Figure 5.3.3.1-1. Location of historical fishery data.

This data was provided to the agencies in July 2007; Verdant continues to process this available historic data in an around the East River to gain an understanding of fish species composition and relative abundance information, particularly for young-of-year (YOY) and yearling fish. Verdant shall use this information to compliment the studies discussed below -- the fixed hydroacoustics; stationary netting and mobile Didson/SBT groundtruthing -- to develop a species composition local to the RITE project site to be presented in the Final License Application.

The Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act, directs the NMFS to develop Fisheries Management Plans (FMP) to protect Essential Fish Habitat (EFH) for federally managed species. NMFS develops FMPs and identifies the EFH for target species and life stages, and coordinates with state and federal agencies to develop habitat enhancement and conservation measures. As noted in the ICD, the Mid-Atlantic region, FMPs have been developed for Summer Flounder, Scup, Black Sea Bass, Dogfish, Bluefish, Atlantic Surfclam, Ocean Quahog, Atlantic Mackerel, Squid, Butterfish and Tilefish. The East River lies within the estuarine EFH ranges for several of these species and life stages.

Studies and Consultations under the Fish Monitoring and Protection Plan (FMPP)

During the preliminary permit process and specifically as part of the RITE demonstration project , Verdant Power, in consultation with NYSDEC and ACOE, and other cooperating agencies (NOAA, USFWS, EPA) has been operating under a joint NYSDEC and ACOE permit: DEC No. 2-6204-01510/00001 and 00002 and NAN-2003-402-EHA for the Roosevelt Island Tidal Energy Project since 2005. Both permits have been extended to May 5, 2009, with conditions that require the execution of a Fish Monitoring and Protection Plan (FMPP).

The FMPP was initially developed and approved by the agencies in October 2005 (Rev 6.0) and executed through pre and post deployments #1 and #2 ending in July 2007. Following the end of Deployment #2; Verdant, in consultation with the agencies prepared two documents; the working memorandum regarding the data collected to date at the RITE demonstration project through March 2008 (document contained in Appendix A) and a working draft Revision 7.0 of an amended Fish Monitoring and Protection Plan to reflect the lessons learned and changes in the project conditions for Deployment #3. Through the summer of 2008, the agencies working with Verdant arrived at a final version of the FMPP Rev 7.5 that develops two new protocols for observation of operating KHPS turbines in the environment. These new protocols are currently being executed by Verdant through deployment #3 and form the basis of the proposed monitoring plans for the RITE Pilot project contained in this application.

In order to understand the affected environment; the FMPP devised a series of detailed study plans with objectives and detailed methodologies to characterize existing fish communities, and to the extent possible populations, their use of the footprint area, their use of the east channel, evaluate effects of the test turbines on individual fish communities and populations, as well as potential effects based on a larger full-scale deployment.

The FMPP allowed for the deployment of study units while executing concurrent aquatic resource study plans. There were three separate deployments of KHPS study units with data collection and analysis and discussion with the resource agencies after each pre- and post- deployment. Table 5.3.3.1-1 below summarizes these study plans and periods of execution.

Table 5.3.3.1-1. Summary of RITE Aquatic Studies.

	Pre -Deployment	Deployment #1	Deployment #2	Deployment #3
Period	**May 2005 to Dec 2006**	**December 2006 to January 2007**	**April 2007 to June 2007**	**August 2008 to Current**
Authority	**FMPP rev 6.0**	**FMPP rev 6.0**	**FMPP rev 6.0**	**FMPP rev 7.5**
KHPS Operating	No	Two - December 11, 2006 through January 21, 2007	Six - April 13 2007 to June 20, 2007	Two - September 11, 2008; grid-connected until October 13, 2008; Rotating till November 3, 2008
Reporting	60-day interim Report [FERC Docket Ref 1]	60-day interim Report [Ref 1]	June 2008 memorandum [Ref 2] Appendix A	Still under development by Verdant
Fixed Hydroacoustics	3 Frames 6 transducers Nov 2006	3 Frames 6 transducers Aimed Dec 10-Ffeb 11, 2007	8 frames 24 transducers Aimed May 29, 2007	Partial array operating; Provisional data (Appendix A)
DIDSON	Dec 2006	Failed January 2007	None	Mobile Didson/SBT groundtruthing stud
Mobile Hydroacoustics	5 day and 5 night Sept.18, 2005 to Nov. 22, 2005	Jan-March 2007	April - June 2007	Suspended as not useful
Trawling and Netting	Conducted 2005 suspended too dangerous	None	None	Stationary Netting - planned Dec 2008

Studies and Consultations under the Fish Monitoring and Protection Plan (FMPP) - Rev 6.0

The overall execution of this study plan was a multi-faceted approach to achieving a scientific understanding of the objectives. It relied on several proven methods and several new applications to examine the interaction of the fishery resource to a kinetic hydropower system. A brief summary of these methods follows:

- Fixed hydroacoustics- a 24 split-beam transducer (SBT) array around the RITE six-pack demonstration project (near and far field),
- Fixed Dual Identification Sonar (DIDSON) - to cover the top portion of the

water column where the split-beam transducers could not "see",

- Mobile hydroacoustics transects -- over a seasonal and day/night (project area coverage), and
- Netting -- to groundtruth species vs. size as seen in the hydroacoustics.

The data was collected and the efficacy and cost of applying each of these techniques was assessed during the period 2006-2008. Agencies were actively involved and consulted throughout this period; with a series of progress reports commencing in December 2006 through July 2007. The data collection and results were presented to the agencies under Privileged Business Data; however two of the documents --the 60 day Interim report (March 2007) and the June 11, 2008 working memorandum have now been included with this pilot license application as public documents (Appendix B) to be used in the Commission's environmental analysis. Key results are summarized below.

Fixed Hydroacoustic Array

The fixed hydroacoustic studies utilized an array of 24 Biosonic split-beam acoustic transducers in mobile (far-field) and fixed (near-field and far-field) surveys to gather information on fish spatial distributions and abundance, as well as provide fish behavior information by tracking a fish's swimming location and direction. The split-beam technique provided estimates of individual fish target strength, a measure that roughly corresponds to the physical size of the fish. Verdant deployed both phases of first 12 and then 24 fixed hydroacoustic SBT transducers around the array of six hydrokinetic turbines in December through June 2007. A large body of information was generated about the presence, abundance and interaction of fish communities with Verdant Power's KHPS machines within the RITE demonstration array. Information about the interpretation of data, and the limitations and difficulties associated with calibrating, aiming the transducers, maintaining and managing data integrity and viability, hardware failures and in-water instrument degradation over time was shared with the agencies during the course of the preliminary permit period. More discussion on the results of this study follows.

Fixed DIDSON

The split-beam acoustic technology was supplemented with an innovative but still experimental DIDSON system which uses high definition sonar to produce a near video quality graphic display. This system has greater flexibility in analyzing data around boundary layers but has other limitations which limit its use to supplemental to the hydroacoustic technology. The stationary DIDSON was deployed in the tidal fluctuation zone above T2 during deployment #1. Verdant Power's initial experience with the DIDSON technology during deployment #1 (December 2006 - January 2007) was disappointing on several levels:

- deployment/retrieval expense,
- hardware failures and biofouling,
- software interpretation bugs, and
- extreme level of effort and volume of data post processing.

On a positive note -- the DIDSON did provide some images (of a limited field) for a short (1.5 week) duration pre-deployment. In reviewing the use of the DIDSON for future applications with both the manufacturer and the agencies it was concluded that the instrument can be used as an effective tool to observe fish interaction with the KHPS turbines; but not as a continuously deployed instrument. The harsh environment in the East River service area presents difficulties for utilizing the equipment; therefore Verdant has developed a new protocol for use of the DIDSON at RITE during deploy #3. This new protocol is discussed later in this section.

Mobile Hydroacoustic Transects

The mobile hydroacoustic survey study plan used the SBT mounted in a downward looking arrangement passing over multiple transects across the East River in a wide pattern in and around the RITE project area to observe fish presence, abundance, and size distributions (by virtue of signal strength). A total of four mobile surveys were conducted prior to KHPS turbine deployment (September 2005 to November 2005). Post-deployment mobile surveys were conducted once a month for the first six months following turbine installation (January 2007 to June 2007) to assess seasonal changes in fish occurrence, distribution, and abundance. This data was delivered in both the 60-day report and on July 11, 2007. Mobile surveys were conducted for the duration of the study for a total of 10 months of mobile surveys (four pre-deployment surveys and six monthly surveys during fall 2005 and spring 2007).

The goal of the mobile surveys was to identify distribution patterns of fish abundance across the channel and within the water column prior to and after turbine installation. In general, since the data is not species definitive, the mobile survey study plans and protocols yielded very little usable information relative to pre- and post-distributions, and by mutual agency consent no further mobile surveys were executed.

Netting

Fish collections using trawl net gear is very difficult in the East channel which has many security and navigation issues as well as hazardous sampling conditions (debris and swift currents). However, some netting data was attempted by Verdant in accordance with the FMPP but was suspended due to safety considerations. Throughout 2007, discussions and observations between Verdant and the agency fishery biologists resulted in a draft alternative stationary supplemental netting plan that is currently being executed.

In summary, following the execution by Verdant and its contractors of the above aquatic resource study plans during the RITE demonstration project deployments #1 and #2; in August 2007 it was determined that a revision of the study plan protocols was necessary to answer valid questions of the agencies on the interaction of aquatic resources with operating KHPS machines in deployment #3.

Studies and Consultations under the Fish Monitoring and Protection Plan (FMPP) - Rev 7.5

Verdant and the resource agencies reviewed the combined results and efficacy of the study plans after the conclusion of the RITE demonstration project Deployment #2 (June 2007) to answer remaining questions associated with the aquatic resource interaction with the KHPS units.

This effort was undertaken in five successive reporting and consultation periods over the period of August 2007 through September 2008.

- **August - December 2007:** Verdant reassesses KHPS technology to respond to deployment #2 technology issues and begins to design alternate aquatic resource protocols. Limited discussion with agencies, except to cease monthly mobile surveys and extend NYSDEC/USACE permit terms; with the condition that a new Fish Monitoring and Protection Plan (FMPP) be negotiated.
- **January - April 2008:** Verdant provides a draft FMPP revision; with two new study protocols for discussion with the agencies. These two protocols -- Stationary Netting and Mobile DIDSON/SBT groundtruthing are discussed below. Verdant also prepares a draft report on the analysis of data under the fixed hydroacoustic study June 2007 through March 2008.

- **May - June 2008:** Verdant meets with agencies and discusses above results, new study protocols and submits additional aquatic resource data; pursuant to agency requests through May 2008 (Verdant, 2008 Appendix B).
- **June - September 2008:** Verdant and agencies continue negotiation of terms of FMPP version 7.5; approved by NYSDEC and USACE on September 3; 2008 allowing deploy #3 to go forward. Verdant continues monthly status reporting of aquatic resource observations.
- **September - November 2008:** Verdant begins execution of the FMPP rev 7.5 and continues regular reporting of progress and execution of studies under the FMPP. These studies are ongoing and results will be submitted as part of the Final License Application. .

5.3.3.2 Environmental Effects

In accordance with the FMPP (rev 6.0) a 60-day Interim Report (Verdant, 2007) was delivered to the agencies in March 2007 that summarized data taken by Verdant and its consultants through February 2007; both pre and post deployment #1. This report had basic data and few conclusions; since only a few days of post deploy data had been gathered. During the period of April - June 2007; the RITE demonstration project deployment #2 took place and the six KHPS units were in operation. However, limited actual operating data of fish interaction with KHPS was available from deploy #2 (limited window between when the fixed hydroacoustic array became operable and the project began experiencing rotor failures). All raw data collected was posted to a proprietary website for agency review on July 11, 2007.

In January 2008, at the request of the agencies, Verdant began analysis of the automatically generated provisional Biosonics fixed hydroacoustic array daily reports. This data was summarized in a draft working memorandum to the agencies covering the period June 2007 through March 2008. The specific elements of this memorandum included:

- Abundance of fish targets for the entire period of record - June 2007 to March 2008,
- Details of KHPS operational month June 2007 and following month July (no operating KHPS),
- Zonal location of fish targets observed in the turbine zones,
- Fish behavior, direction, velocity and timing of movement,
- Fish abundance during KHPS operational and non-operational periods, and
- Preliminary conclusions about the body of data collected by the fixed hydroacoustics.

Following up on this report; Verdant Power met with the agencies on May 25, 2008 to discuss the data and interpretations. At the request of the agencies several specific new data analyzes were added and a second memorandum dated June 11, 2008 (Verdant, 2008b) was issued for review. This report extended the analysis period to June 2008 and included some additional information and conclusions. Please see Appendix B for a full understanding of the system and interpretations.

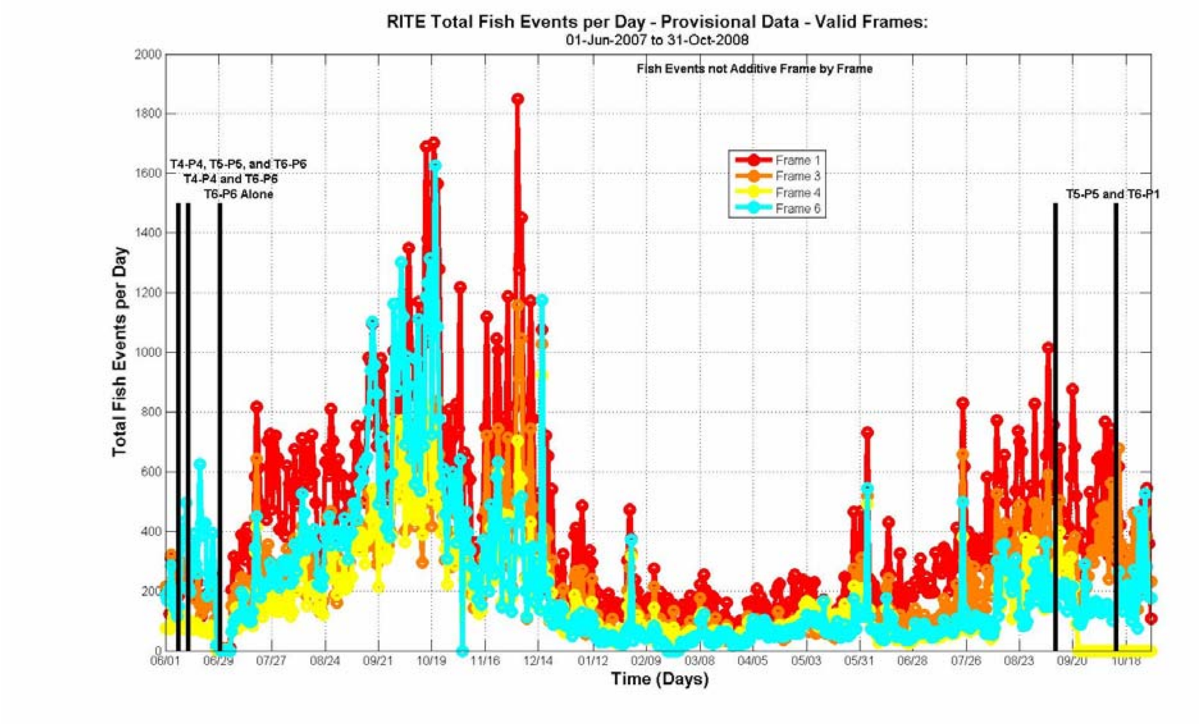
Since May 2008, Verdant has continued to collect and process data. Deploy #3 data (September 2008 - October 2008) data has not been processed yet but will be submitted in the Final License Application. All data is provisional since the full QA/QC protocol of the fixed hydroacoustics was never executed; however the abundance of data and the general trends certainly confirm the applicability. The initial conclusions addressing the five stated goals of the FMPP have been circulated to the agencies and are presented below.

1. Characterization of Fish Populations Near the Six-pack

The volume of data (24 transducers, operating 24/7 for 10 months +) that was collected with the fixed hydroacoustics -- beginning in January 2007 to May 2007 and then continuously from June 2007 through and including November 2008 -- has succeeded in characterizing the fish population near the RITE Demonstration Project. The detailed zonal and tidal data analysis can characterize the fish population around the RITE six-pack area as follows:

- daily densities are quite low (per frame ranging from 16 fish per day to >1,400, with an average around 330 (Figure 5.3.3.2-1),
- predominated by small fish (<-30 dB) (see Figure 5.3.3.2-2 below),
- most fish observed inshore (and not in zones occupied by KHPS),
- fish can (and are observed to) swim faster than tidal velocities,
- greatest abundance is seen in non-impact zones,
- greatest movement is observed in the direction of tides or during transition periods of non-operation, *i.e.* slack up to water velocities <0.8 m/sec, when KHPS are non-operational, and
- equivalent abundance is seen day and night (see Figure 5.3.3.2-3 below).

Figure 5.3.3.2-1. RITE Hydroacoustics: June 2007 - November 2008 - all targets.



2. Characterize East Channel Seasonally

The detailed information in an around the six-pack deployment field has demonstrated a seasonal variation in fish population. See 5.3.3.2-1 for the entire period of June 2007 - October 2008. The monthly observed fish targets (events) are quite low per frame, with increased events in the months of October and November/December. The fish population in zones of impact is a small percentage of the total population regardless of seasonal abundance.

Figure 5.3.3.2-2. RITE Demonstration Project - target strength; small fish vs. large fish.

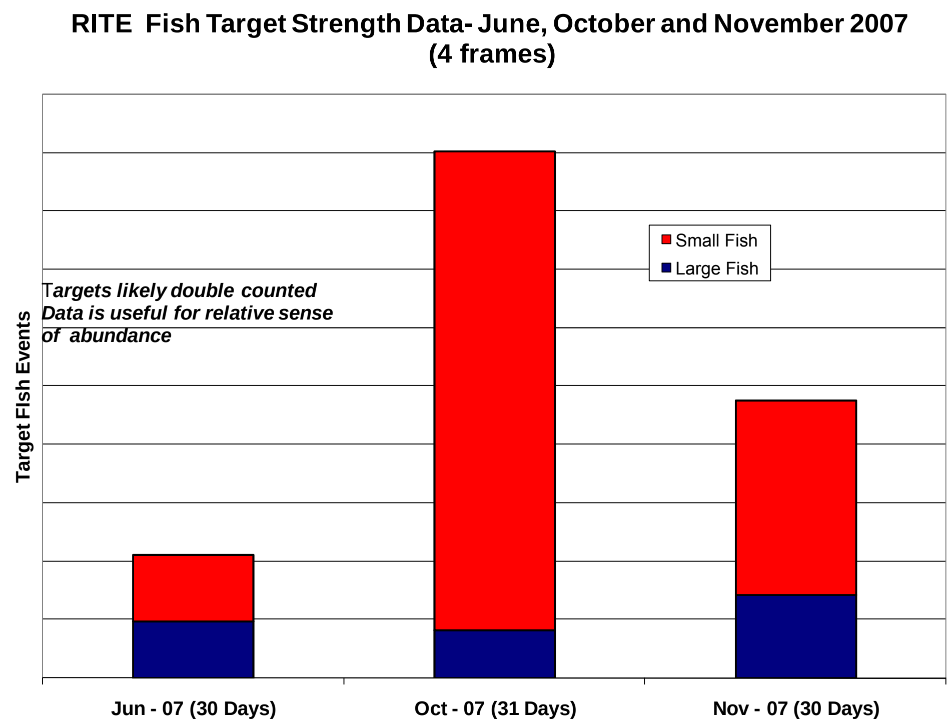
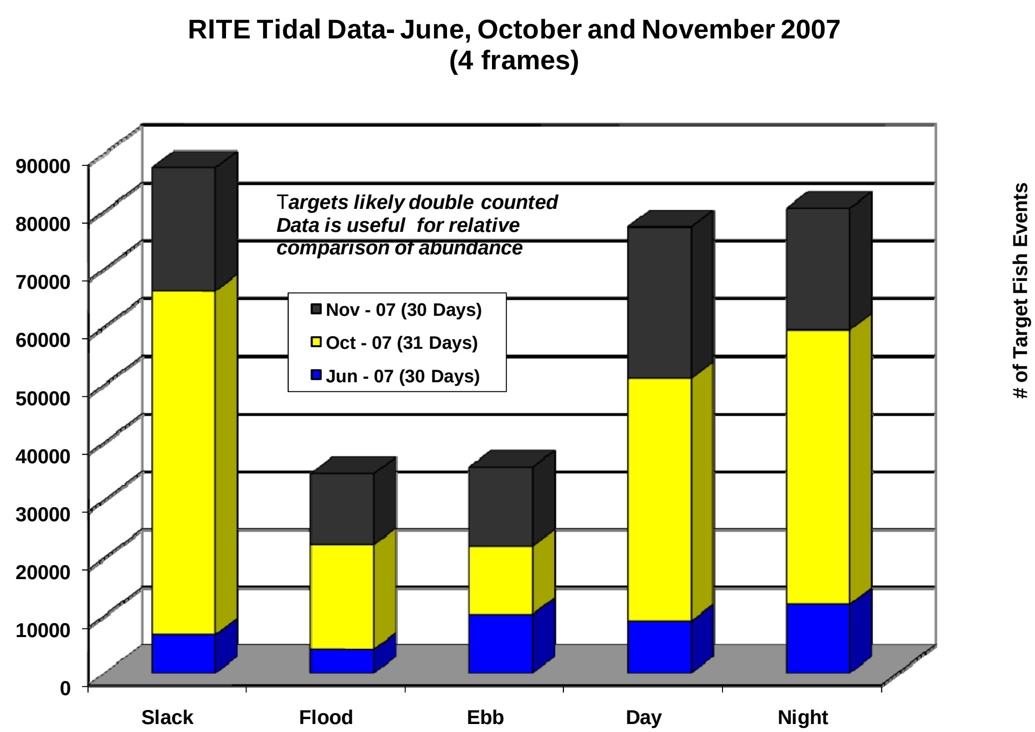


Figure 5.3.3.2-3. RITE target abundance during tidal and day/night.



3. Fish Behavior

The fixed hydroacoustic system has been able to detect the direction and velocity of fish swimming near the individual turbines, by zones. Processing this data automatically through an event type system was proven to be not a viable or cost-effective method to determine behavior through the field. However several major initial findings on behavior are presented below:

During KHPS operation and in other months as well, significantly lower numbers of targets were observed in the zones of turbine impact, possibly indicating turbine avoidance behavior (5.3.3.2-4).

The direction of swimming is strongly influenced by tidal velocity and fish were observed to swim faster than the tidal velocity.

The movement of fish occurs during both the operational (18 hrs) and non-operational (6 hrs) period of the KHPS turbines. Fish movement is seen during the transition period from flood to ebb and ebb to flood, at slower swimming velocities. Fish are seen during operational periods, at faster velocities, but as shown on Figures 5.3.3.2-4 and 5.3.3.2-5, fish movement during operation is noted to occur predominantly in non-impact zones, possibly indicating turbine avoidance behavior. Please note that Figure 5.3.3.2-4 depicts the same monthly distribution of fish targets observed in the turbine operating (impact) zones and non-impact zones for Frame 1 as 5.3.3.2-5; however it is shown on a logarithmic scale as requested by the agencies to more clearly see the interaction at lower observation density levels. The reader is cautioned that visually this depiction can be misleading since the y-axis scale is an order of magnitude different and therefore is not comparative at observational scale.

Fish zonal location data confirms observations that fish tend to the inshore (slower velocity, non-turbine) zones of the KHPS turbine array area; minimizing opportunity for harm (Figure 5.3.3.2-5).

Figure 5.3.3.2-4. Summary of fish targets in impact and non-impact zones with operational vs. non-operational periods: Frame 1 – 4 months.

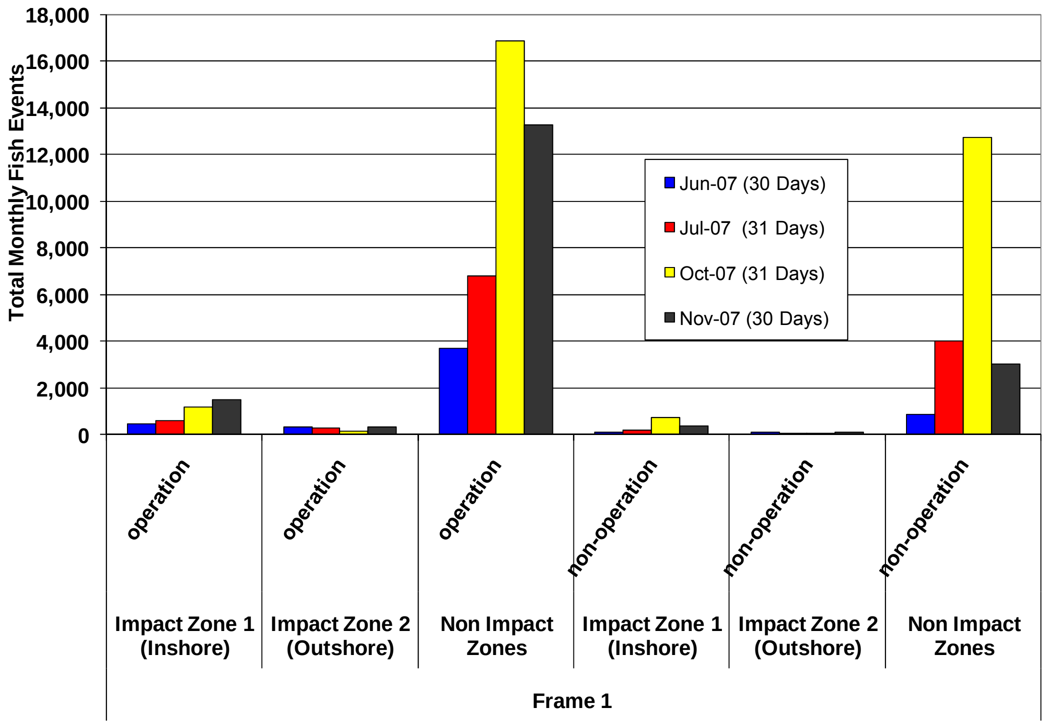
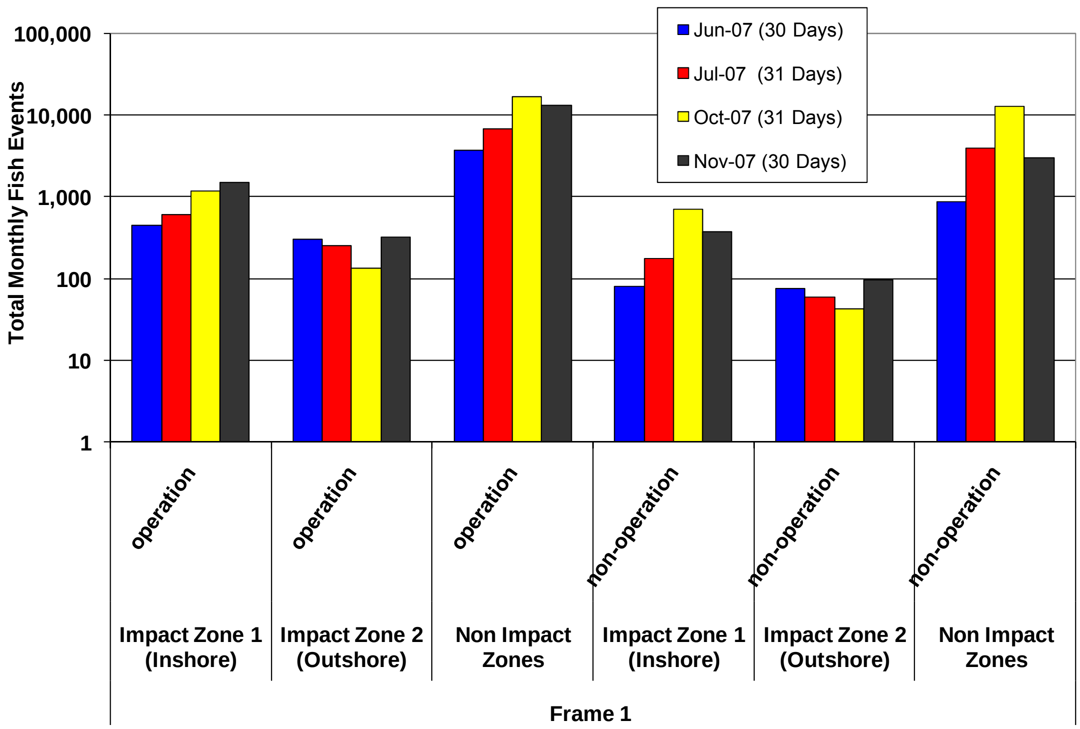


Figure 5.3.3.2-5. Summary of fish targets in impact and non-impact zones with operational vs. non-operational periods: Frame 1 – 4 months.



4. Evaluation of Effects of Multiple Turbines

Given the large body of detailed data generated to date -- even with limited observation with operating turbines in June 2007 -- the data collected about zonal and tidal behavior suggests that fish behavior is influenced in this channel predominately by the natural tidal currents and only secondarily by the presence of rotating KHPS units. Overall the data June 07 to March 08 indicates a preference to inshore and non-operational zones.

Some possible avoidance behavior was noted in the June 2007 data, with three KHPS turbines of the six-pack in operation; and so the Mobile DIDSON Groundtruthing protocol was developed to attempt to observe fish behavior near operating KHPS turbines.

Deployment #3 hydroacoustic data with two KHPS turbines operating for one month has not been processed yet and will be provided as a Supplement to this Draft License Application. Likewise, stationary netting will be completed in December and data provided as well as part of this proceeding. Verdant did complete one field attempt in October 2008 at groundtruthing. This report is still under preparation and consultation with the agencies and will be filed as Supplemental information; after agency review.

5. Assess Potential Effect of Commercial Array

The volume of data collected by the fixed hydroacoustic system under the RITE demonstration has provided a number of insights as to the “appropriate” level of commercial project monitoring of an array of up to 100 KHPS turbines. In general, Verdant’s overall observations regarding large commercial arrays that can be made from this body of collected data on operating KHPS units and arrays include:

- Prudent siting of KHPS turbines can avoid predominant fish movement pathways. Given the strong evidence that the fish population travels inshore, avoids the strong currents and travels in zones where KHPS are not rotating, the location of a field of KHPS should be in the fast portion of the channel, which is consistent with energy production. With this in mind the prudent siting of a field of KHPS turbines will not affect the vast majority of fish population or movement.

- Allowance of sufficient KHPS turbine spacing will enhance fish avoidance. Given the data presented in the zonal analysis of the RITE demonstration project, the KHPS longitudinal spacing (6D; 30 m) allowed for movement of fish to non-operational zones; thus avoiding turbine areas. However the tight spacing was proven not to be effective from an energy production standpoint, hence the Deploy #3 design of a 12D spacing. This increase in spacing (longitudinally between KHPS) should only enhance the fish population’s ability to negotiate a larger array.

- A commercial KHPS field will have a minimal influence on fish abundance and movement. Based on the observations and collected data to date, it is Verdant's initial opinion that a field of 30 KHPS turbines in the location proposed is not likely to significantly influence abundance and movement of fish in the East Channel of the East River.

- Limited likelihood for fish harm or mortality. Appropriate siting, spacing and KHPS design has shown no obvious indications of fish harm. The data collected to date has demonstrated that fish avoid zones of impact and populate inshore zones. In addition, the slow tip speed of KHPS turbines (35 rpm), lack of ducted pinch points; and ample opportunity for fish movement indicates minimal opportunity for harm. During Deployment #1, #2, and #3 there was no observed evidence of increased fish mortality or injury, nor was any irregular bird activity observed.

- Limited proportional monitoring based on seasonal abundance may be appropriate for short periods. The extreme level of study protocol used for the RITE six-pack demonstration was proven to be excessive and non-sustainable for the long-term. A reduced level of monitoring during peak periods may be appropriate to continue to build and support the current observations of the limited influence and effects of operating KHPS. Based on this observation, no fixed hydroacoustics are proposed for the RITE East Channel Pilot project, and instead a combination of seasonal mobile DIDSON monitoring and seasonal netting is the proposed RITE post license monitoring plan presented in this Draft License Application.

In summary, Verdant, through the demonstration project, established a wealth of data regarding the fish movement and apparent minimal impact to the fish community in and near operating Verdant Power KHPS machines. Still ongoing are the results of the new study protocols developed for deployment #3; however it is expected that this enhanced data analysis, presentation and interpretation of the data from the groundtruthing studies will support the initial conclusions and validate the appropriate parameters for future operational monitoring studies, consistent with the apparent minimal impact.

RITE Monitoring of Environmental Effects (RMEE)

Verdant has performed extensive pre- and post-operation data collection and monitoring on and around the proposed RITE site in the East River in New York. This work was done under a groundbreaking demonstration project that is still ongoing. This body of information on the potentially effected environment, and the interaction of Verdant Power's KHPS design within that environment, form the basis for this ongoing environmental effects monitoring program.

Specifically our environmental monitoring plans for the RITE East Channel Phase 1 field call for:

- RMEE - 1 Seasonal Mobile DIDSON Monitoring
- RMEE - 2 Seasonal Stationary Netting
- RMEE - 3 Bird Monitoring

The details of the proposed plans are included in the section on proposed monitoring plans in this volume of the draft License Application.

5.3.3.3 Underwater Noise

Affected Environment

As part of the preliminary permit consultation, the agencies expressed concerns regarding the potential impacts of noise from the KHPS units on the aquatic life in and around the project site. As a result, Verdant performed an underwater noise (acoustic) evaluation in conjunction with the deployment of the RITE Gen 4 demonstration project (Study Plans, 2006). Specifically, Verdant and its contractor attempted to obtain both pre- and post-deployment environmental sound measurements from near-field around the study units through an agency approved methodology. The objective of this study was to determine the biological significance of detectable noise generated by the turbines based on known acoustic sensitivities of aquatic life in the East River.

In summary, the ambient underwater noise levels within the demonstration project area and far-field were expected to be rather high, due to the presence of a variety of urban characteristics (subway train, generating stations), a high level of navigation traffic, and the shallow water environment (<15 meters). This was generally confirmed by the measurements taken in the pre-deployment period (July 13-15, 2006) and described in the 60-day report (March 2007). However, due to technical difficulties during the execution of the pre-deployment survey (discovered later in 2007), accurate readings for the pre-deployment period for comparison are not available.

Post deployment #2 measurements were taken during the period of May 13-16, 2007. At this time four KHPS machines were operating; one KHPS – the dynamometer with a variable brake – had broken blades and was rotating at 2-3 times normal speed, when not being braked and one KHPS had stopped rotating during the survey. Despite difficulties with the data collection protocols, issues regarding timing of the sound samples with the operating KHPS units, and the lack of pre-deployment comparison data; some useful data is available. Measurements were taken and some analysis is provided below. In general, Verdant observes:

- There are areas within the East Channel and not near the turbines that are noisier than near the operating KHPS turbines (specifically the subway and Ravenswood generating station).

- The measured noise levels -- even with the technical difficulties -- compared to the aquatic resource audiograms demonstrate that there is an unlikely case for effect.

A discussion of these observations follows:

Acoustic Environment

The area containing the six RITE demonstration KHPS turbines is located in the East Channel of the East River just north of the Roosevelt Island Bridge (see Figure AN-1). The nominal depth is approximately 30 feet or 10 meters; or a shallow water noise environment. The shore is covered with riprap extending to below the low water line. The bottom is bare solid rock with some scattered boulders. By specific examinations of bathymetry and substrate conducted by Verdant contractors in 2005, there is no sediment, sand, or gravel covering the rock due to the fast currents in the area. Diver videos indicate that marine vegetation is minimal or non-existent as described in other sections of this Exhibit E.

The existing underwater environment has many existing sources of potential noise. In addition to the location of the noise source (above water or below water), how that sound couples is important. Anything that is in the water will couple vibration directly to the water much more efficiently than if it has to couple through the air or through rock.

Noise Sources Located Above the Water in the East Channel:

- Automotive and Truck Traffic on Roosevelt Island Bridge (RIB) and Queensboro Bridge (QB)- the RIB is the only means for automotive traffic to access RI and can be fairly busy during rush hours. The bridge abutments couple the traffic noise to the underwater environment.

- RIB Bridge Lowering and Raising Operations - the RIB is a lift-bridge which is raised when large vessels pass in the river. The bridge abutments couple the bridge operation noise to the underwater environment.
- RIB and QB Maintenance Work- the large QB usually has some part of it being maintained at anytime. The RIB does not normally have constant maintenance work but presently has a multi-year top-to-bottom renovation. The maintenance work involves trucks, jack-hammers, sand-blasting and other loud tools. The bridge abutments couple the bridge work noise to the underwater environment.
- Gas and Steam Turbine Operations at Ravenswood Power Plant - this powerplant just across the channel and south of RIB has many turbines which might be acoustically coupled to the underwater environment through cooling water pipes when in operation.

Noise Sources Located Below the Water in the East Channel:

- Boat Propeller and Engine Noises - most of the larger vessels in the East River use the West Channel for transit. However the east channel is used by recreational vessels, NYC police, USCG, water taxis and smaller commercial traffic. Fishing charter boats use the east channel when the striped bass are present. Large tugboats maneuver large oil barges at the Ravenswood plant. Several times a year when the United Nations is in session, for security reasons all west channel boat traffic is routed through the East Channel. Boat propellers spin at a much higher frequency than KHPS turbine rotors.
- Subway Traffic in Riverbed Tunnel between RIB And QB - a major subway tunnel passes under the riverbed between Roosevelt Island and

Queens between the RIB and QB. During rush hours subway trains pass through as often as every 5 minutes.

- Water Intake and Output Noises at Ravenswood Power Plant - the Ravenswood Power Plant uses water taken from the East River in its operations. The noise from electric water pumps and potentially other industrial machines such as steam turbines inside the plant will pass through these pipes into the River.

Underwater Noise Survey Methods and Analysis

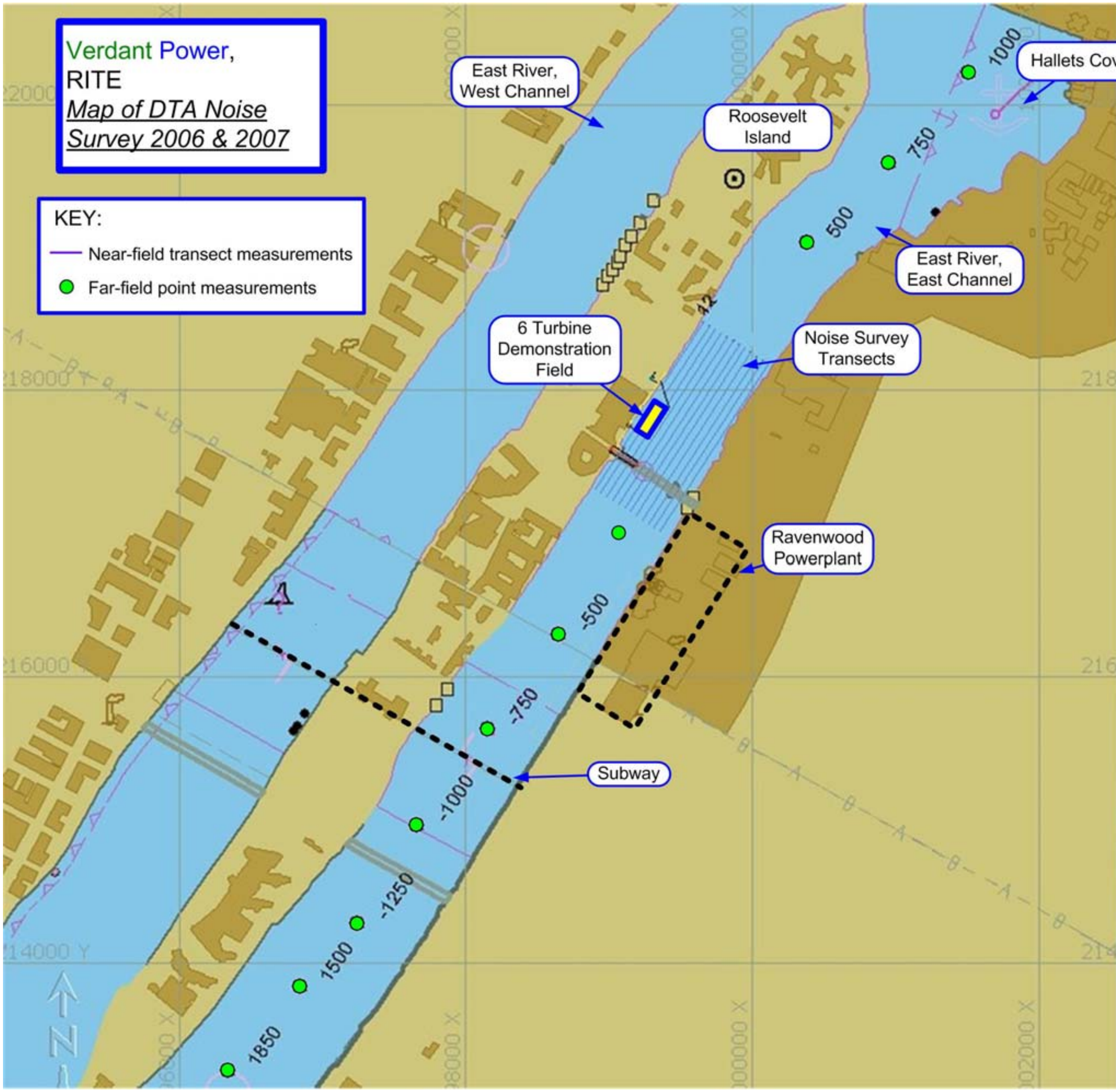
Through a desktop survey, Verdant and its contractor had identified a substantial amount of scientific literature on aquatic sound and fish (DTA 2004, DTA 2005), particularly the estuarine species likely found in the East River such as American shad and river herrings. However, little was known about underwater noise generated by operating KHPS turbines. The East River Underwater Noise Survey (Study Plans, 2006) were designed for both the pre and post-deployment to establish an initial understanding of the sound signature of the operating KHPS units and the baseline of the East River in general.

The area for the pre and post-deployment underwater noise survey consisted of the area of the demonstration project --an area of approximately 180 wide by 365 m long, with additional long distance measurements points up to 1850 m away. See Figure 5.3.3.3-1 for the far field locations; including noise sources such as the F-train subway and Ravenswood generating plant; and Figure 5.3.3.3-2 for the near-field transects showing the RITE demonstration project and the Roosevelt Island Bridge. The study layout was designed to measure noise from the turbine array in relation to fish habitat. Therefore, transects were defined in the horizontal plane, and in the vertical plane. Measurements were made along predetermined transects parallel to the shore and surrounded the turbine array.

Verdant's Contractor deployed acoustic equipment from a shallow draft inflatable catamaran able to navigate near the turbines. The contractor utilized a Cetacean Research™ C54XRS cylindrical omni-directional hydrophone, calibrated for measuring a frequency range of 0.5 Hz – 250 kHz; with an appropriate data acquisition system to provide data spectral analysis software for onboard data quality verification. On a separate laptop computer, navigation software displayed drawings and nautical charts with geo-referenced data for accurate transect, turbine, buoy and shoreline locations.

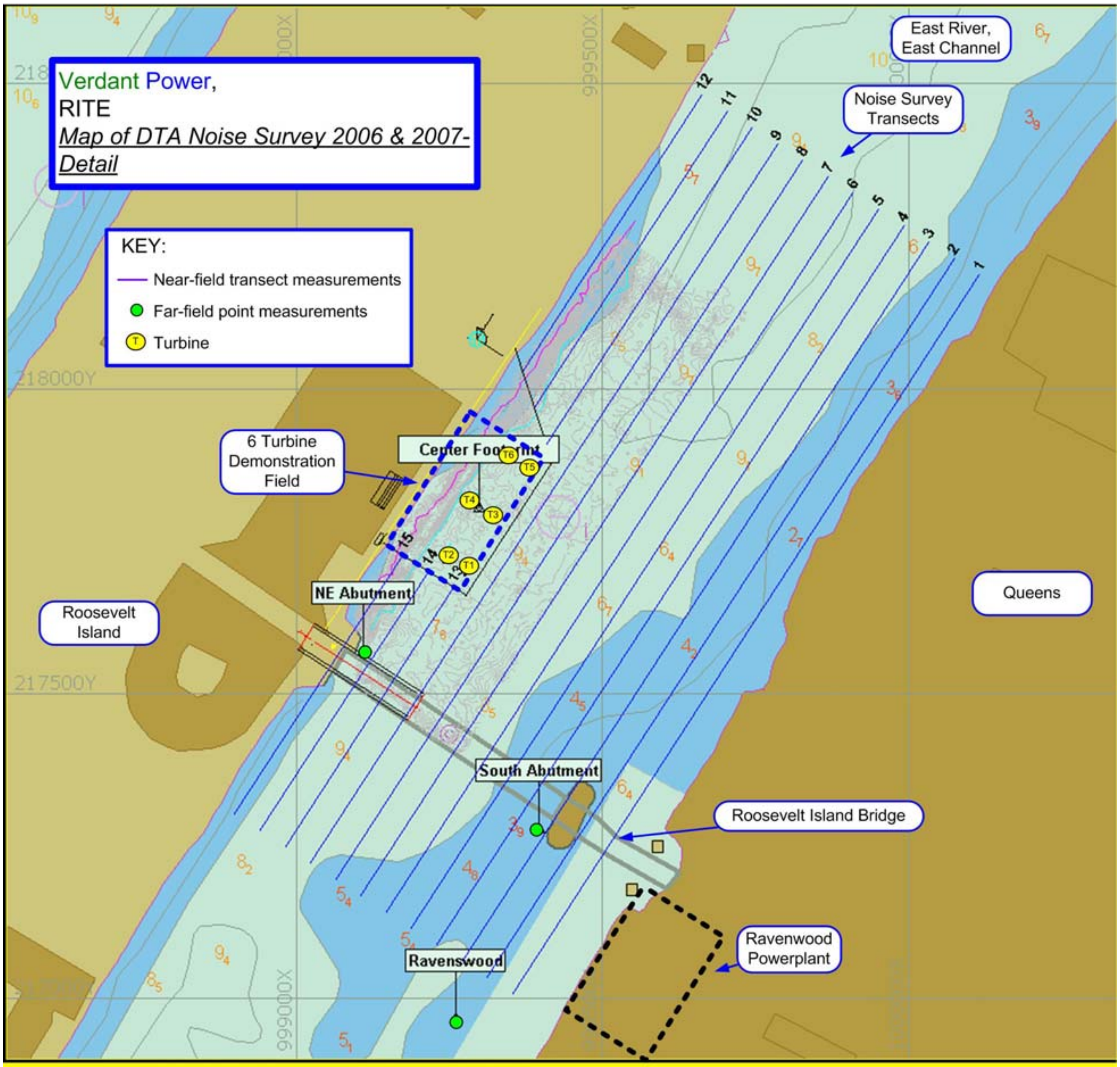
The data analysis concentrated on the identification of turbine operation frequencies. Results will be presented as Sound Pressure Levels (SPL) (x dB re 1μPa) and as Root Mean Squares (RMS) values. In order to understand environmental affects on aquatic species, the spectral data, including frequency and amplitudes of periods of KHPS turbine operation were compared with representative fish hearing threshold curves (audiograms). Surrogate audiograms were used if audiograms do not exist for all expected species. Noise levels of 145 SPL x dB re 1μPa RMS measured approximately 20 m from the 6 KHPS turbine array center were used as the environmental noise level for comparison to aquatic species audiograms.

Figure 5.3.3.3-1. Near-field transect layout and far-field measurement locations.



Reference: (DTA, Draft July 2007) as annotated by Verdant.

Figure 5.3.3.3-2. Near-field transect layout.



Reference: (DTA, Draft July 2007) as annotated by Verdant.

Post Deployment Data Assessment

The post-deployment survey data was taken during deploy #2 from May 13-16, 2007. At this time four KHPS machines were operating and the dynamometry KHPS which has a variable brake had broken blades and was rotating at 2-3 times normal speed and one KHPS was in failure mode, which may contribute to a noisier signature.

Figure 5.3.3.3-3 is a graphical timeline of the KHPS turbine status, survey times, and water velocities showing tidal cycles. While the protocol called for sampling noise when KHPS machines were operating at peak tidal point, there is a significant discrepancy in the time stamped data files that makes this body of data suspect. The water velocities shown are a Turbine Average Weighted (TAW) measurements that averages ADCP Bin velocities to represent the seep at the hub of the KHPS turbine. The ADCP was turned off for two of the six underwater noise acoustic periods; to avoid interfering with the noise survey.

Sound Level and Transmission through Water

Table 5.3.3.3-1 shows received post deploy levels for sound recording samples by distance and direction from the RITE demonstration turbine array, taken at the middle depth level and at transect 9. All measurements were made at mean column depth. The right two columns compare measurements during periods of subway activity and in-activity.

Table 5.3.3.3-1. RITE Project post deployment sound levels.

Location	Distance from Mid Array	Post deploy with Inactive Subway (SPLdB re 1µPa@1m)	Post deploy with Active Subway (SPLdB re 1µPa@1m)
north (near Hallets Cove)	+1060 m	123.6	
north (RI North)	+700 m	122.9	
north	+415 m	123.8	
north	+168 m	130.5 trans 9	
north	+84 m	136.3 trans 9	
T5-T6	+30m	N/A	
T3-T4- mid array	0	144.7 trans 9	
T1-T2	-30m	N/A	
south	-84 m	138.5 trans 9	
south	-168 m	131.9 trans 9	
Ravenswood Power plant	-450 m	125.8	134.5
south	-700 m	125.6	134.9
south (Subway)	-735 m		148.6
south	-1200 m	124.3	133.6
south (RI south)	-1550 m	127.8	132.4

N/A = Not Available (data could not be taken directly over the KHPS array)

For post deployment, the above table demonstrates that the noise concentration around the subway is equal or greater than that measured at RITE demonstration array. The subway noise appears somewhat comparable to the turbine array noise although the subway noise covers a larger area since it stretches across the entire river. In the area of the RITE demonstration project; sound levels directly at the KHPS turbines could not be taken because of limited clearance of the hydrophones to the active turbine rotors.

Environmental Effects

Interpreting the Effect of Measured Noises on Local Fish

With regard to biological behavioral impact analysis; there are very few audio sensitivity analyses for the fish species found in the East Channel. Comparable proxy fish species were used to relate the sensory information to the east channel fish. These species comparisons are shown in Table 5.3.3.3-2. Results of the impact analysis on East River fish species indicate that the noise generated by the turbine array though audible to most species, would not cause injury.

For all but one species analyzed (tautog), SPL rise above hearing thresholds did not reach over 30dB in any one frequency range, well below levels reported found to cause injury to fish hearing organs. Popper and Carlson 1998 cite numerous studies on the effect of noise levels on fish and offer a potential index of damage between 60dB for the most sensitive, and 100dB for least sensitive species above threshold levels. For those species that are able to detect the turbine noise in the East River, many are migratory not resident, thus further limiting their exposure potential to the period of time when they are passing the site.

Based on the observed results and the limited hearing abilities of this group, it is doubtful that any of the generalist species studied in this report would exhibit strong behavioral reactions to the KHPS turbine noise, even in a 30 turbine array situation.

Of the hearing specialist fish, none of the species studied show significant SPL levels above hearing thresholds (see Figure 5.3.3.3-5 and 5.3.3.3-6). Behavioral studies are limited for the species studied. However, studies aimed to evaluate the effectiveness of noise deterrents on the impingement of fish at water uptake structures have reported significant results for clupeid species, such as Alewife (Ross *et al*. 1993), blueback herring (Nestler *et al.* 1992), and American shad (NEPCO). Source levels used to elicit a deterrence (or avoidance) behavior whereby fish moved away from the underwater speaker, ranged from 180 to 190 SPL x dB re 1μPa. These values are well above the source level of 145 160.75 SPL x dB re 1μPa @ 1m measured at the RITE project demonstration project array. Therefore, it is unlikely that even at very close range clupeid species will react strongly to the KHPS turbine noise.

Figure 5.3.3.3-3. RITE Underwater Noise Survey; May 2007 - Timeline showing relationship between turbine status, underwater noise surveys and tidal velocities

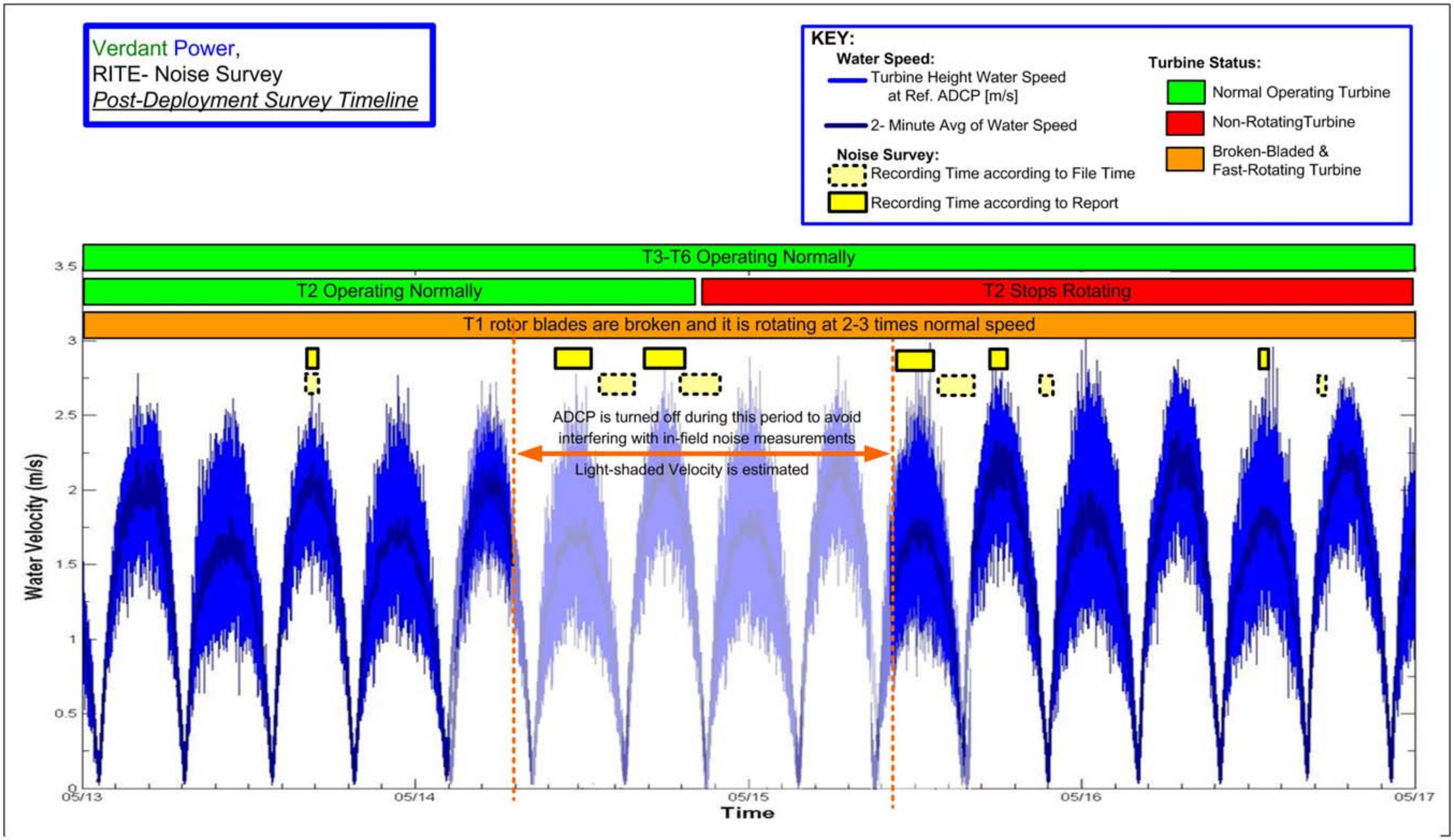


Table 5.3.3.3-2. Species used in RITE turbine noise evaluation, East River, New York.

Specialist				
Species		**Order**	**Surrogate**	
American Shad	Alosa sapidissima	Clupeiformes	(use itself)	
Alewife	Alosa pseudoharengus	Clupeiformes	American Shad	Alosa sapidissima
Atlantic Menhaden	Brevoortia tyrannus	Clupeiformes	Gulf Menhaden	Brevoortia patronus
Blueback Herring	Alosa aestivalis	Clupeiformes	American Shad	Alosa sapidissima
Generalist				
Species		**Order**	**Surrogate**	
Bay Anchovy	Anchoa mitchilli	Clupeiformes	(use itself)	
Winter Flounder	Pseudopleuronectes americanus	Pleuronectiformes	Common Dab	Limanda limanda L
Summer Flounder	Paralichthys dentatus	Pleuronectiformes	Plaice	Pleruonectes platessa
Striped Bass	Morone saxatillis	Perciformes	Euro. Sea Bass	Dicentrarchus labrax
Tautog	Tautoga onitis	Perciformes	(use itself)	
Atlantic Silverside	Menidia menidia	Atheriniformes	(use itself)	
American Eel	Anguilla rostrata	Anguilliformes	European Eel	Anguilla anguilla
Atlantic Tomcod	Microgadus tomcod	Gadiformes	(use itself)	
Shortnose Sturgeon	Acipenser brevirostrum	Acipenseriformes	Lake Sturgeon	Acipenser fulvescens
Atlantic Sturgeon	Acipenser oxirhynchus	Acipenseriformes	Lake Sturgeon	Acipenser fulvescens

[Devine Tarbell & Associates, 2007]

Figure 5.3.3.3-4. Audiograms for 4 species and 5 surrogate fish species (denoted by *) found in the East River, New York. Data sources are listed in Table 5.3.3.3-3 above.

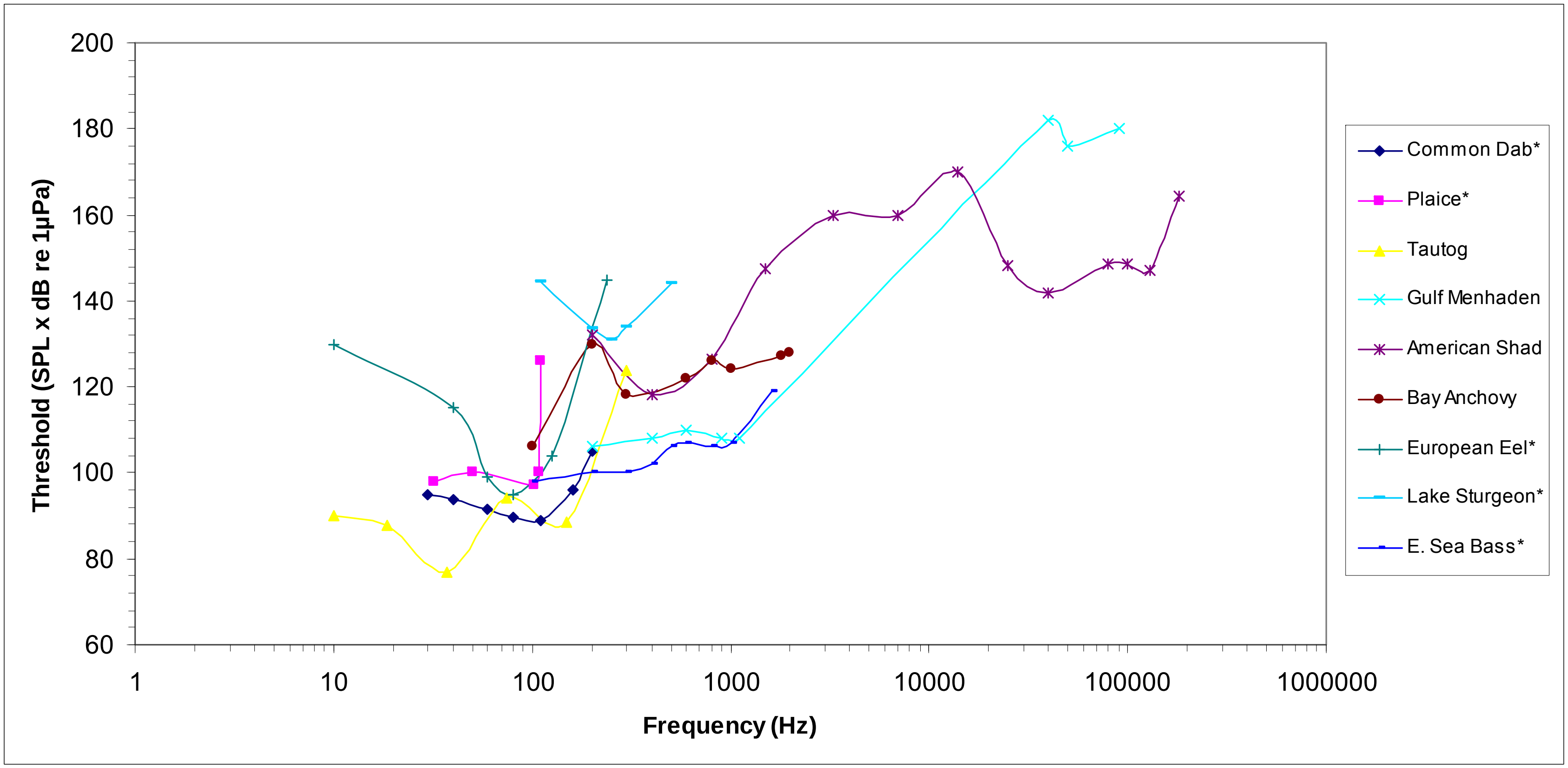


Figure 5.3.3.3-5. Species observed noise levels above hearing thresholds for five hearing generalists.

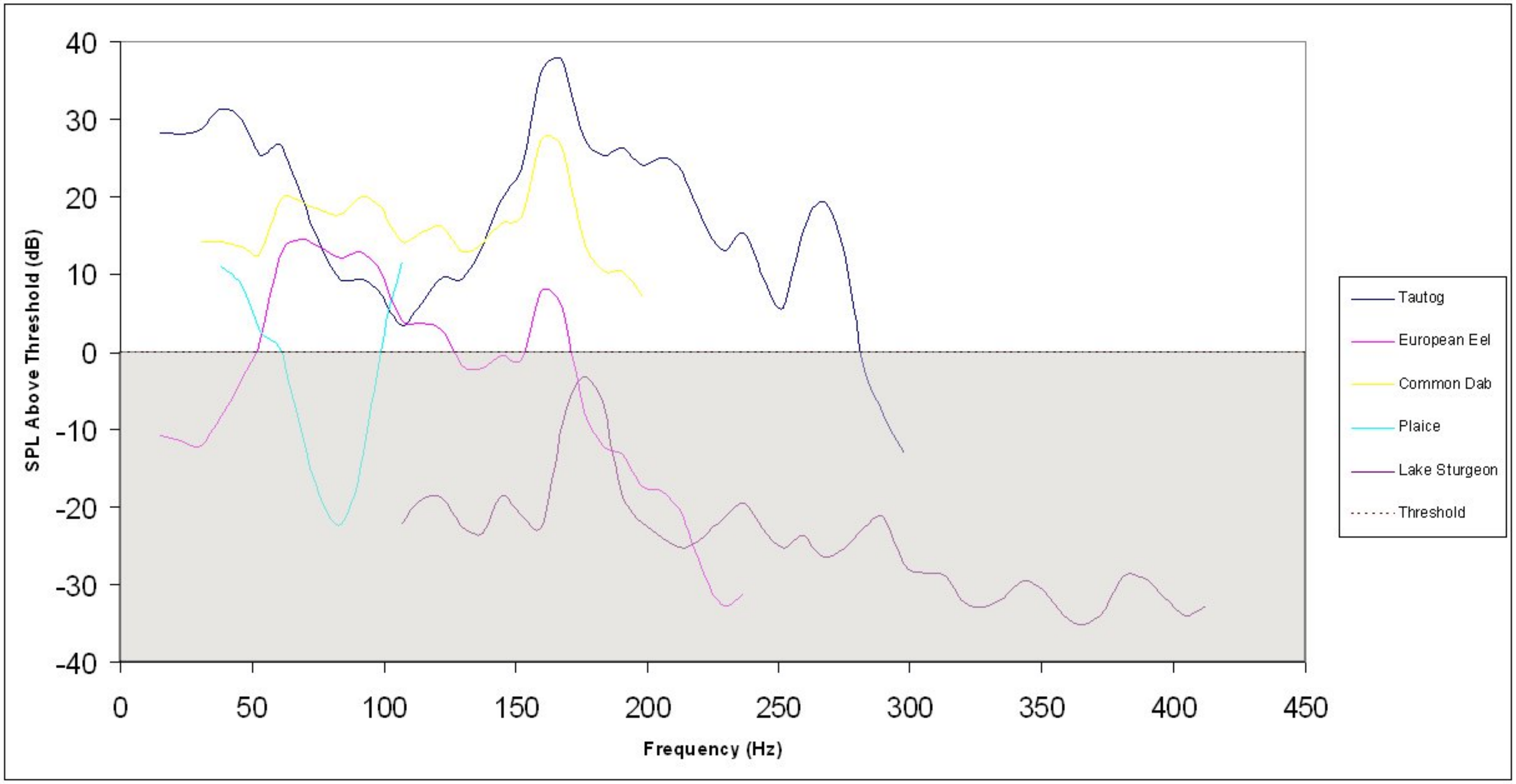


Figure represents the potential sensitivity of hearing specialist fish at a distance of 20m from the RITE turbine array from a received RMS level of 145 SPL x dB re 1µPa.

Figure 5.3.3.3-6. Species observed noise levels above hearing thresholds for two hearing specialists and two hearing generalists.

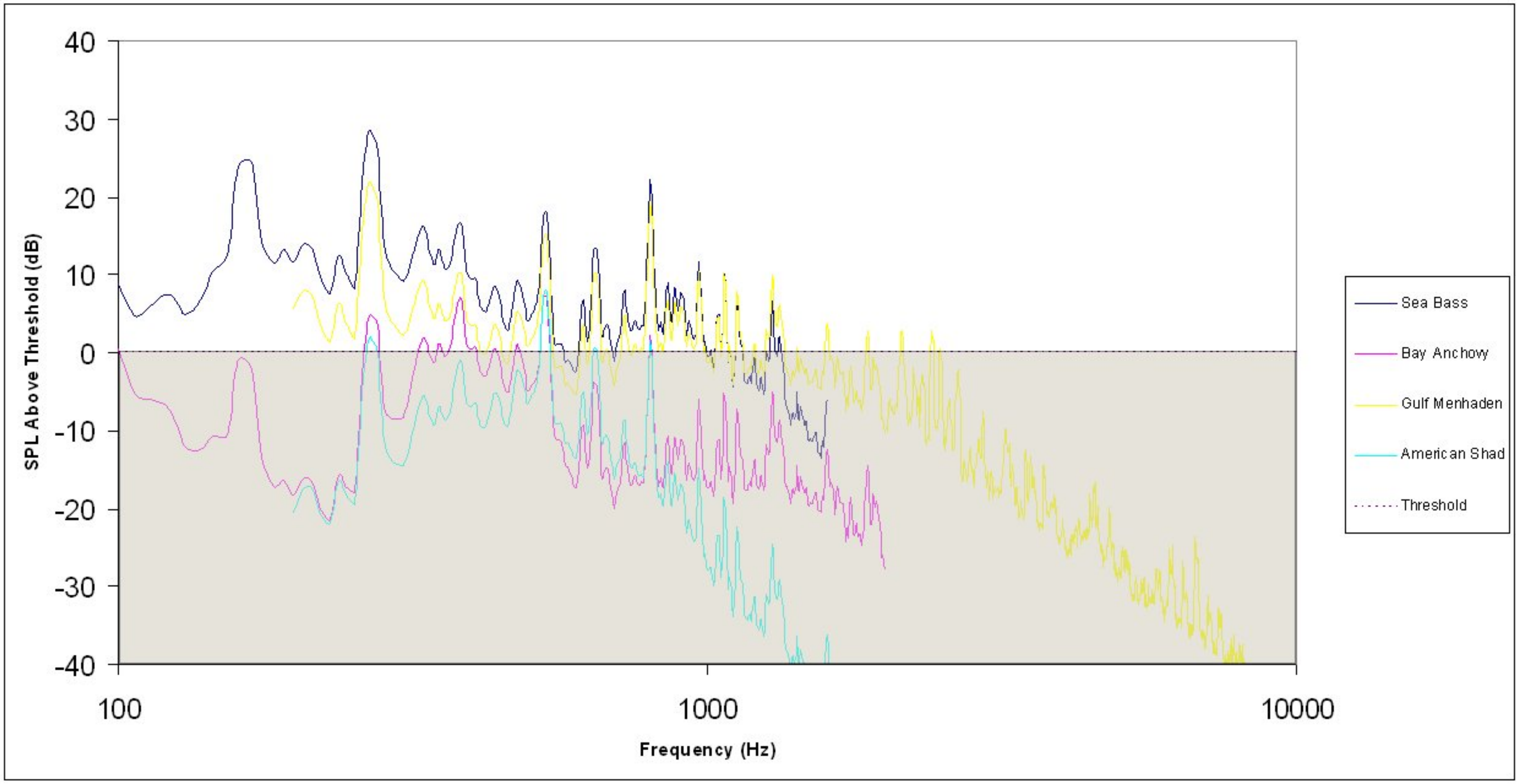


Figure represents the potential impacts from a received RMS level of 145 SPL x dB re 1µPa

Conclusions- RITE East Channel Underwater Noise Survey

Verdant has reached the following conclusions from the noise studies to date:

- During the RITE Underwater Noise Survey (May 2007); for the four operating KHPS machines, the survey and subsequent analysis indicates that is unlikely that the 4 KHPS turbines are creating noise that is harmful to fish or marine mammals in the East River. Due to difficulties with the data collection and protocols as well as the cascading failure of the KHPS machines this is likely to be true, but not well supported.
- Aquatic species are presently living with noise levels generated by the subway tunnel traffic on par with the noise levels generated by the KHPS turbines.
- Results of the impact analysis on East River fish species indicate that the noise generated by the turbine array though audible to most species, would not cause injury.
- Verdant is confident that the incremental installation of 30 operating KHPS machines at the RITE pilot project will not increase the background noise to levels that effect the aquatic community. To verify this prediction, Verdant proposes, as part of the RITE Proposed Plans, a noise evaluation study of the full pilot field levels -- accomplished after the buildout is completed. The key points for this study follow.

During the preliminary permit phase of the RITE project West Channel field; Verdant would propose a pre-deploy noise study; followed by a post deploy noise study in the UN field consistent with the protocols above. The previous protocols need to be modified to collect meaningful data.

Proposed Underwater Noise Monitoring and Evaluation for RITE Pilot Project

For the proposed RITE East Channel pilot field array of 30 KHPS turbines; Verdant proposes a short-term fixed monitoring mid-array because our initial data shows fairly consistent levels throughout the area. We also propose limited environmental noise collection after the field is installed at a few other locations far field to confirm the initial finding that the full pilot buildout doesn't affect aquatic resources. The details of the proposed plan are included in the section on proposed monitoring plans in this volume of the draft License Application.

5.3.3.4 Unavoidable Adverse Impacts

It is not yet clear if there are unavoidable adverse impacts to aquatic resources that would occur as a result of the proposed pilot project. The purpose of the proposed monitoring plans is to better understand potential impacts.

5.3.3.5 No Action Alternative

If the proposed buildout is not installed, no impacts to the aquatic resource would occur.

5.3.3.6 Sources

Devine Tarbell and Associates, Inc. (DTA). 2004. Attachment I – Noise Assessment in Response to Comments Public Notice No. 2003-004402-Y3 Roosevelt Island Tidal Energy Project (FERC NO. 12178). Prepared for: Verdant Power, LLC, New York, NY.

Devine Tarbell and Associates, Inc. (DTA). 2005. Fish Movement and Protection Assessment, Roosevelt Island Tidal Energy Project, FERC Project No. 12178. Revision 6.0 10-14-05. Prepared for: Verdant Power, LLC, New York, NY

Devine Tarbell and Associates, Inc. (DTA). 2007. Internal Draft Preliminary Evaluation of the Verdant Turbine Array and Noise Levels in the East River, Roosevelt Island, New York (21 pages). Prepared for: Verdant Power, LLC, New York, NY

Devine Tarbell and Associates, Inc. (DTA). March 2007. 60-Day Interim Monitoring Report for the Rite Fish Movement and Protection Study, Prepared for: Verdant Power, LLC, New York, NY.

Devine Tarbell and Associates, Inc. (DTA). October 2005. Internal Draft, Preliminary Evaluation of the Verdant Turbine Array and Noise Levels in the East River, Roosevelt Island, New York. Prepared for: Verdant Power, LLC, New York, NY

Greene, Charles R. Jr. 1995. Ambient Noise Chapter 5, in Richardson, W.J. Marine Mammals and Noise. Academic Press, London.

Hastings M. C and Popper A. N. 2005. Effects of Sound on Fish. (Subconsultants) Submitted by Jones & Stokes to California Dept. of Transportation Contract No. 43A0139. Task Order 1.

Henderson, P.A. 2002. Aquatic Ecology Issues Relating to the Roosevelt Island Tidal Energy Phase I Demonstration Project. Pisces Conservation, LTD., Lymington, England, November 2002.

NEPCO (New England Power Co.), RMC Environmental Services, and Sonalysts. 1993. Effect of ensonification on juvenile American shad movement and behavior at Vernon Hydroelectric Station, 1992. NEPCO, RMC Project 4196, Holyoke, Mass.

Nester, J. M., G.R. Ploskey, J. Pickens, J. Menezes, and C. Schilt. 1992. Responses of blueback herring to high-frequency sound and implications for reducing entrainment at hydropower dams. North American Journal of Fisheries Management 12: 667-683.

Madson P.T 2005. Marine mammals and noise: Problems with root mean square sound pressure levels for transients. J. Acoust. Soc. Am 117 (6) Pages 3952-3957.

Popper, A.N. and Carlson, T.J. 1998. Application of Sound and Other Stimuli to Control Fish Behavior. Transactions of the American Fisheries Society, 127: 673-707.

Richardson, W. J., Greene, C.R., Jr., Malme, C. I., and Thomson, D.H. 1995. Marine Mammals and Noise. Academic Press, London.

Ross, Q.E. and five coauthors. 1993. Response of alewifes to high-frequency sound at a power plant intake on Lake Ontario. North American Journal of Fisheries Management 13:291-303.

United States Fish and Wildlife Service. 1997. Significant Habitats and Habitat Complexes of the New York Bight Watershed. USFWS. Charlestown, RI.

Verdant Power, Inc. 2003 (October). Initial Consultation Document for the Roosevelt Island Tidal Energy Project (ICD), FERC Project Number 12178. Prepared by Devine Tarbell and Associates. (ICD, 2003)

Verdant Power, Inc. 2007 (March). 60-Day Interim Monitoring Report for the Roosevelt Island Tidal Energy Project Fish Movement and Protection Study. Prepared by Devine Tarbell and Associates. (60-day report, 2007)

Verdant Power RITE Project; Supplemental information for discussion; DEC Permit No. 2-6204-01510/00001 (and ACOE Permit No. NAN-2003-402-EHA); Submitted June 11, 2008. (Appendix A)

Verdant Power, Dec. 2006. Roosevelt Island Tidal Energy Project; FERC No. 12611; East River Underwater Noise Survey; Study plan. Prepared by Devine Tarbell and Associates, Inc. (DTA) (Study Plans 2006).

5.3.4 Terrestrial Resources

5.3.4.1 Affected Environment

In 2003, Verdant conducted a literature review of Terrestrial Resources around the Project area and reported the findings in the ICD (Verdant, 2003). These findings have been summarized below.

Botanical Resources

The proposed RITE Project will be located in the East River in the Manhattan Borough of New York City, New York County, New York. Manhattan Island and Roosevelt Island are developed with residential and commercial development. Due to its location and extent of urban development, the upland plant communities are predominately landscaped parks and greenways. The extent and size of natural botanical communities are significantly limited. Wetland community types include tidal wetlands and submerged aquatic macrophyte vegetation communities. Upland plant communities on Roosevelt Island and Manhattan Island are dominated by urban landscaped species and invasive species. Natural communities are limited.

Wetland Plant Communities

Wetland development in the immediate project area and around Roosevelt Island and the UN building are limited by the extensive shoreline development (including docks, piers, *etc*.) and various forms of armoring (riprap, bulkheads, *etc*.) that have been constructed.

Significant Ecological Communities

No significant ecological communities have been identified along the East River in the immediate vicinity of Roosevelt Island. The upper East River/Long Island Sound area is designated as a Special Natural Waterfront Area by the New York City Office of Planning Waterfront Revitalization Program. The USFWS has identified significant habitats in The Narrows and Lower Hudson River Estuary Complexes of the New York/New Jersey Harbor Bight Watershed; however, none are proximate to the proposed project area (Verdant, 2003; USFWS, 1997). No rare, threatened, or endangered plant species have been identified in the immediate project area through consultations with resource agencies.

Wildlife Resources

Because of the dense urban development, the availability of wildlife habitat within the Urban Core of the New York/New Jersey Bight watershed, particularly in the New York City vicinity, is relatively limited. However, there are nearby complexes that provide valuable habitats, particularly for migratory species (Verdant, 2003; USFWS, 1997).

The fragmentation of habitats that occurs in urban project areas limits the terrestrial wildlife species that may occur to primarily those opportunistic species that have adapted to living in very urbanized settings. Habitat for herptile species is also limited due to fragmentation and the lack of freshwater habitats in the project area. No threatened or endangered wildlife species have been identified in the area through consultations to date.

Avian Species

Habitats for birds are more diverse and available because the nearby New York/New Jersey Estuary, Long Island Sound Estuary, and small pockets of forests and fields that provide habitat for many species year round. The table contained in the ICD (pages 84-90) listed about 200 species of birds in the New York County region that could inhabit the project area. Agencies have commented that a number of birds may use the East River for feeding or resting. Dominant species identified so far are the double-crested cormorant (*Phalacrocorax auritus*) and a variety of gulls. The agencies were also interested in better understanding the use of the project area by other birds that may use the area during migration. Diving ducks, cormorants, and terns migrate through the area from late March through mid-May. The fall migration of species such as the brown pelican (*Pelecanus occidentalis*) or double-crested cormorant may peak in October, but species such as loons (*Gavia spp*.), northern gannets (*Morus bassanus*), scaup (*Aythya spp*.), and ring-necked ducks (*Aythya collaris*), may peak in November through mid-December, and many tern species (*Sterna hirundo*, *S. forsteri*, *S. nilotica*) migrate through the area in September. A New York state threatened species, the peregrine falcoon, is known to nest on bridges near the project area.

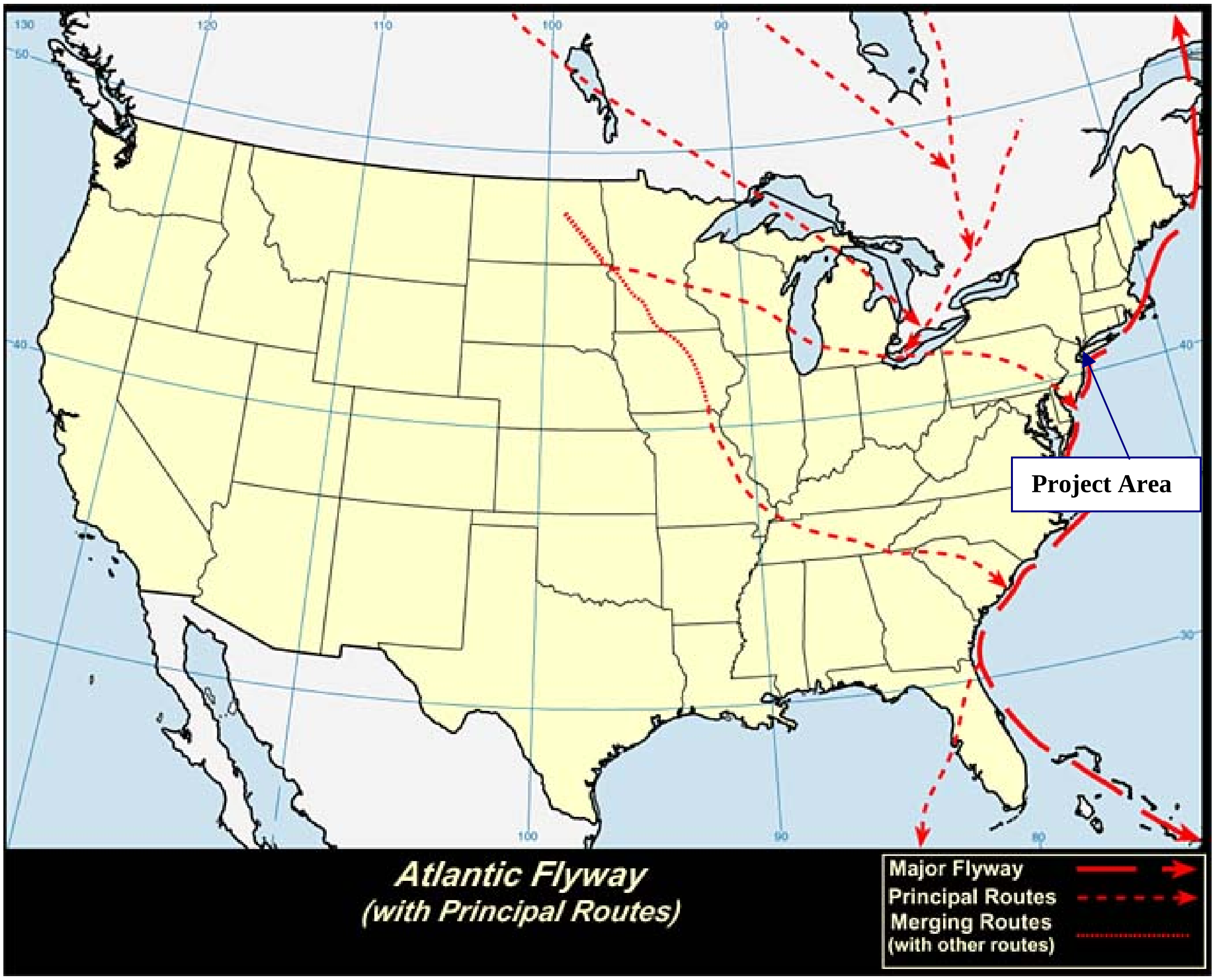
During consultation with agencies and stakeholders about the RITE Demonstration Project and this pilot license application, the main issues raised about impacts on terrestrial resources were concerns for avian species. As a result, Verdant, in consultation with the resource agencies, developed a Bird Observation Study protocol that was executed during the RITE demonstration project from 2005 to 2008 to meet these goals.

The two main objectives of the Bird observation study were:

- To observe birds around the project to determine if the KHPS turbines adversely impact diving birds associated with the East River; and
- To show whether the operation of KHPS turbines attracts diving birds to the site, an indicator of impacts to fish or a shift in fish swimming patterns.

A tertiary concern- one that was added through later consultations - considered the temporal and spatial distribution and seasonal migration patterns of migratory bird communities in relationship to the project area. Figure 5.3.4.1-1 shows migratory flyways in North America.

Figure 5.3.4.1-1. Shows migratory flyways in relationship to the RITE project area.



http://www.birdnature.com/flyways.html

Verdant Power personnel and other local birders and consultants collected the data in accordance with the study plan. Tables 5.3.4.1-1 and 5.3.4.1-2 summarize this observation period and the data collected; representing 290 hours of bird observation to date. The log includes information such as:

- Observation period time of day,
- Number and species of birds,
- Feeding, resting or diving activities,

- Proximity to the KHPS array field, and operational status of the KHPS machines,
- Tidal direction, and
- Any notes or observations that would indicate interaction with the study units.

Sparrows, gulls, and pigeons were not recorded as a part of this study, although these species are routinely present at the site.

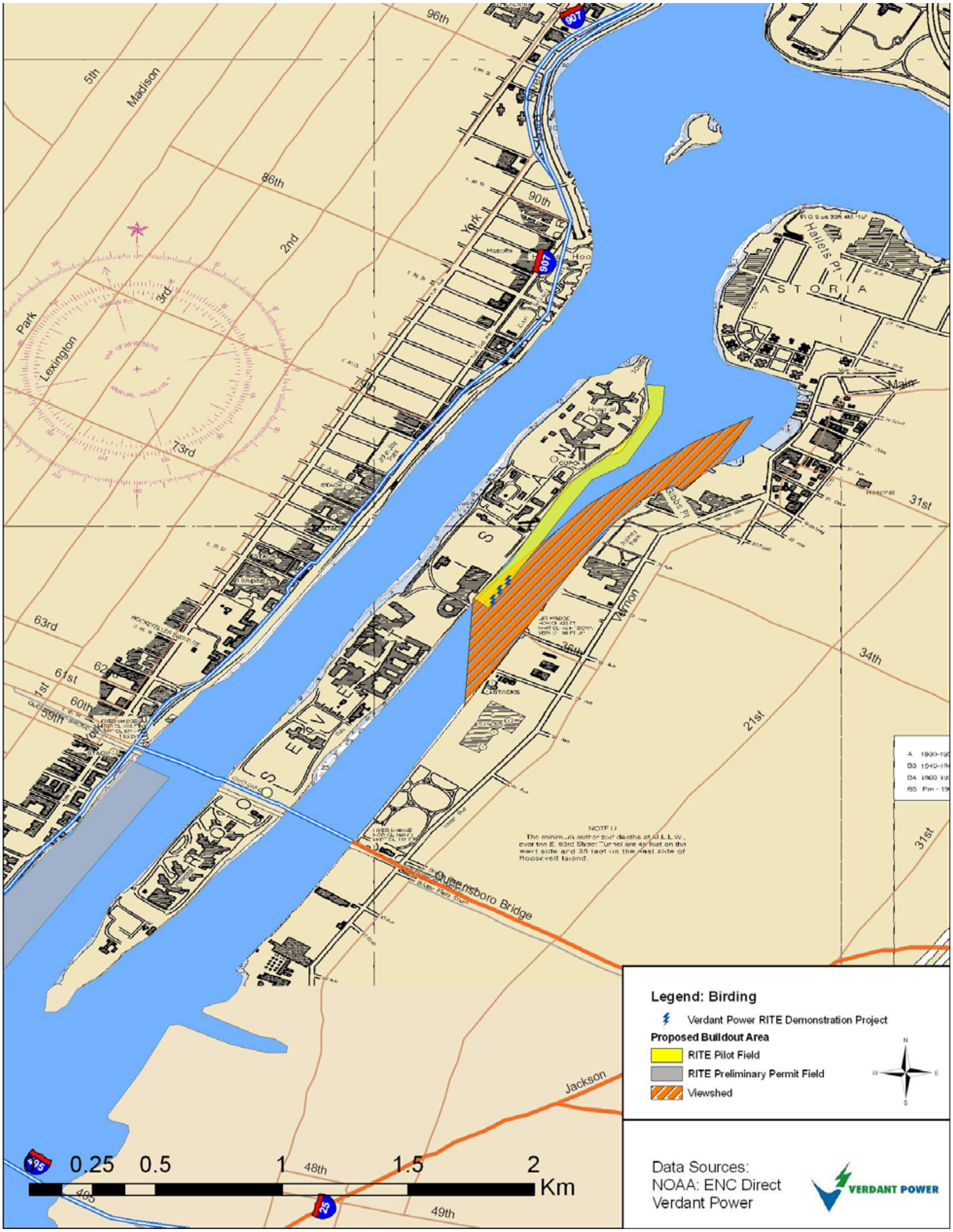
All observations were made from the shore adjacent to the deployment area (see Figure 5.3.4.1-2). The observer was equipped with binoculars, the bird book "The Sibley Field Guide to Birds in North America" (Sibley, 2003) and a camera. Photographs were taken as available; however, the photographs are intended to supplement the observations and the recorded data, the observer was not responsible for photo documenting every bird observed. Photo 5.3.4.1-1 and 5.3.4.1-2 were taken during bird-watching.

The photos and Figure 5.3.4.1-2 show the viewshed of the birder while watching birds. The photos were taken from shore at the birding spot next to the Verdant Power Demonstration Project Control Room. During observations it was noted that the Roosevelt Island Bridge and the caissons of the bridge attracted birds and specifically double-crested cormorants.

Photo 5.3.4.1-1 Photograph of bird at RITE Project.

Photo 5.3.4.1-2 Photo mosaic of viewshed for birding.

Figure 5.3.4.1-2. RITE bird observations viewshed.



A summary of all data taken is shown in Table 5.3.4.1-2 that combines reporting from previous Verdant submissions with current data taken through November 2008. Verdant Power continues to execute the bird observation survey study plan and is continuing to perform the post-deployment survey activities. Verdant will supplement this data in the Final License Application.

Table 5.3.4.1-1. RITE - Summary of Bird observation Periods (pre- and post-) during all three KHPS deployments

	Birding Hours	Birding Period	Birding Days		Significance	Published
2006						
	50 hrs	3/13/06 – 3/17/06	5		Spring Migration	60-Day Report, 2007
Deploy 1 – 12/2006: T1-P1, T2-P2						
2007						
	50 hrs	4/6/07 – 4/22/07	5		Pre-Deploy 2	July 11, 2007 Agency Filing
Deploy 2 – 4/2007: T1-P1, T2-P2, T3-P3, T4-P4, T5-P5, T6-P6						
	50 hrs	5/6/07 – 5/26/07	5		Post-Deploy 2	July 11, 2007 Agency Filing
2008						
	50 hrs	8/12/08 – 9/07/08	7		Pre-Deploy 3	New Data Pursuant to FMPP 7.5
Deploy 3 – 9/2008: T5-P5, T6-P1						
	50 hrs	9/17/08 – 9/22/08	6		Post-Deploy 3	New Data Pursuant to FMPP 7.5
	40 hrs	10/16/08 –10/30/08	4		Fall Migration	New Data Pursuant to FMPP 7.5

As noted in the Tables 5.3.4.1-1 and 5.3.4.1-2, Verdant collected data on bird activity both pre-and post- deployment of KHPS turbines in the East Channel.

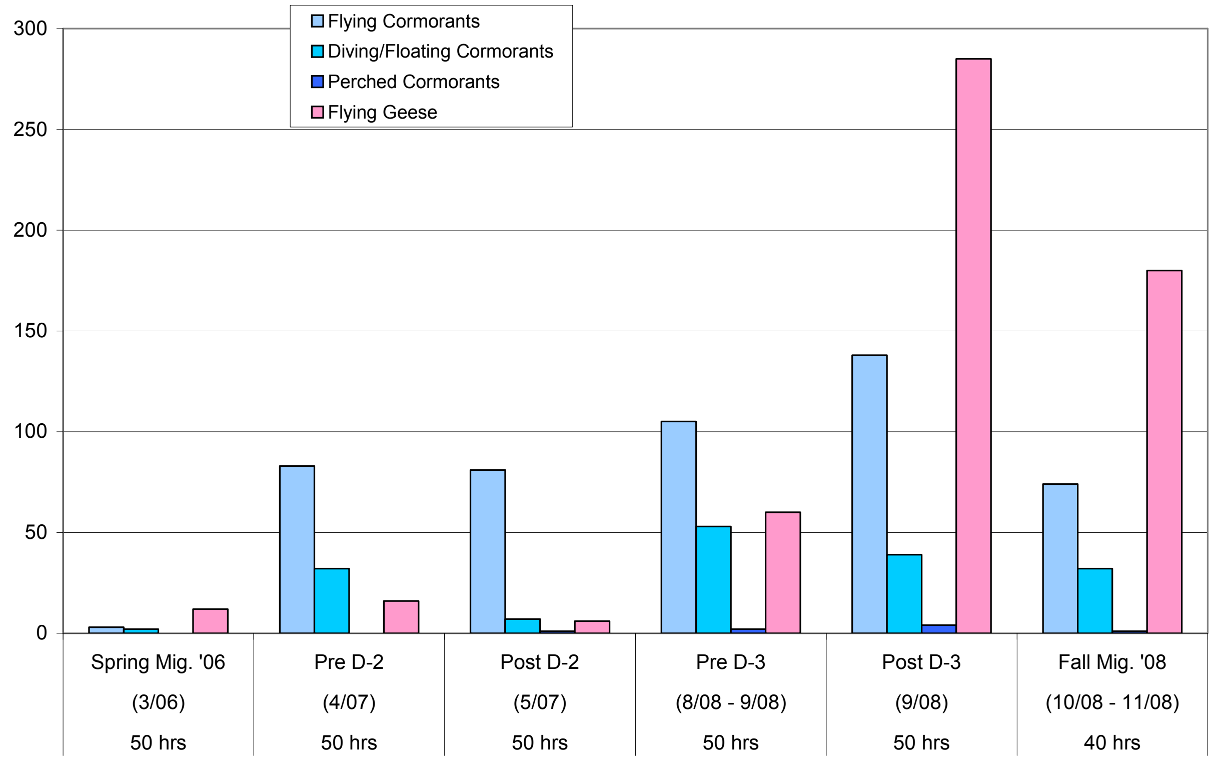
Observations were also made during deployment two and three of the RITE demonstration period. In addition, fall migration and spring migration periods were observed. Figure 5.3.4.1-3 illustrates the bird observation distribution for the entire study period.

Table 5.3.4.1-2. RITE Project - Bird Observation Study; Data 2006 - 2008

			Double Crested Cormorants			***Canada Geese***
Birding History	**Days**	**Hours**	**Flying**	**Dive/Float**	**Perched**	**Total**
Spring Migration – 2006	5	50	3	2	0	12
Post-D1 Winter – 2007	5	50	83	32	0	16
Pre-D2 – 2007– April	5	50	81	7	1	7
Post-D2 – 2007– May	7	50	105	53	2	60
Pre-D3 – 2008 – Aug	6	50	138	39	4	285
Post-D3 – 2008 – Sept	4	40	74	32	1	180
Fall Migration – 2008[6]	5	50	3	2	0	12

[6] Data presented represents data collection through November 1, 2008. Verdant is collecting fall bird observation through December 2008 and will augment this section in the Final License application.

Figure 5.3.4.1-3. Bird distribution from observations.



Almost all sightings consisted of double-crested cormorants and Canada geese *(Branta canadensis)*. Other species discussed in agency meetings were not seen around the demonstration project area (see Table 5.3.4.1-3).

Table 5.3.4.1-3. Species common to the New York region - observations near the RITE Demonstration Project.

Species	Resident	Spring Migration	Fall Migration	Observed at RITE
Double Crested Cormorant (*Phalacrocorax auritus*)	Yes	No	No	Yes
Diving Ducks	No	March to Mid May	November	2 sightings total – NOT DIVING
Tern species (*Sterna hirundo*, *S. forsteri*, *S. nilotica*)	No	Late April to Early May	September	None observed
Brown Pelican (*Pelecanus occidentalis*)	No	Not known	October	None observed
Loons (*Gavia spp.*)	No	March	November to Mid December	None observed
Gannets (*Morus bassanus*)	No	March	November to Mid December	None observed
Scaup (*Aythya spp.*), and ring-necked ducks (*Aythya collaris*)	No	March to April	November to Mid December	None observed
Canada Geese (*Branta canadensis*)	No	March to May	October	Yes- flying

In addition to the post-deployment survey observations, Verdant specifically performed five days of spring migration observations in 2006 and four days of bird observations during fall migration in 2008. The surveys were performed on March 13 to 17, 2006 without the KHPS units operating. Fall migration surveys were then performed again on October 16, 17, 29, 30 (2008) when KHPS units were rotating. Verdant also plans additional fall 2008 migratory observations that will be reported in the Final License Application.

The purpose of these additional observations was to obtain additional data during potential migration periods. Spring and fall migration also coincided with other bird observations in April 2007 (pre-deployment), May 2007 (post-deployment) and September 2008 (pre-deployment). Double-crested cormorants were the only birds observed (no specific migratory species were observed).

5.3.4.2 Environmental Effects

No potential effects to botanical or wildlife resources have been identified or are expected due to the lack of resources in the project area and the fact that the majority of the project is underwater with a minimal land footprint on already developed area.

The project has the potential to affect diving birds in and around the turbine area. Throughout 2006-2008, as discussed above, Verdant logged approximately 290 hours of bird observations before and during deployment of the RITE Demonstration Project KHPS units. Birds were observed around the demonstration project to determine if the KHPS turbines adversely impact diving birds associated with the East River; Verdant believes that the body of developed knowledge does not show any signs of impact on diving birds. This detailed effort in and around the RITE project demonstration site and the general area of the proposed RITE Pilot license did not show any material difference in pre- and post-operation bird activity. The presence of more geese flying through the area in post-deployment during the fall of 2008 can be attributed to seasonal migration patterns. Observations during the operation of the RITE Demonstration KHPS turbines also did not indicate any increased attraction of diving birds to the site which may have been expected if the turbines impacted fish in the area. Anecdotal evidence suggests double-crested cormorants, the only diving birds observed at the site, swim/float with the current and only dive during or close to slack tide when the turbines are not rotating.

Based on the observations made at the RITE demonstration project over an intermittent period from December 2006 through and including November 2008 Verdant does not believe that the Project Area is a particularly significant bird migration pathway for resting or feeding because of the urban nature of the location, the limited amount of green space, and the fast currents present.

5.3.4.3 Proposed Pilot License Monitoring Plan

Verdant believes that the data collected during the RITE Demonstration Project during a two-year period represents a baseline understanding of the relationship of operating KHPS machines with the resident and migratory bird community in the East River. However, Verdant recognizes that extending this observation to a 30 turbine field of 17 acres will require some level of ongoing monitoring to validate the demonstration results for a larger field. Therefore, Verdant has proposed an ongoing Bird Observation Monitoring Plan as part of this license application. The details of the proposed plan are included in the section on proposed monitoring plans in this volume of the draft License Application.

5.3.4.4 Unavoidable Adverse Impacts

No unavoidable adverse impacts to terrestrial or avian species have been identified.

5.3.4.5 No Action Alternative

As in the proposed alternative, the no action alternative would not affect botanical or wildlife resources, including birds.

5.3.4.6 Sources

Verdant Power, Inc. 2003 (October). Initial Consultation Document for the Roosevelt Island Tidal Energy Project (ICD), FERC Project Number 12178. Prepared by Devine Tarbell and Associates. (ICD, 2003)

Verdant Power, Inc. 2008. Birding Logs - September 2005 - October 2008 (unpublished data).

Sibley, David Allen. 2003. "The Sibley Field Guide to Birds of Eastern North America", Alfred A Knopf, Inc., New York, NY. (Sibley, 2003)

Citation for source of migratory Map – accessed November 2008. http://www.birdnature.com/flyways.html

5.3.5 Rare, Threatened, and Endangered Species

5.3.5.1 Affected Environment

Through the preliminary permit and subsequent pre-licensing studies, Verdant conducted a number of assessments and consultations to evaluate potential impacts to rare, threatened, and endangered (RTE) species associated with the deployment and operation of the RITE Project. The initial RTE Study plan was approved by the resource agencies in 2004 and subsequently included in study plans approved by the agencies in 2006. The findings from this assessment are included as part of this draft pilot license application.

The specific objectives of the RTE species assessment were to:

- Evaluate the extent of RTE species occurrence and movement in the vicinity of the Project.
- Review existing information and consult with federal and state wildlife agencies regarding the occurrence of RTE species in the vicinity of the Project.
- Conduct during the demonstration project "incidental observations" of RTE, identify potential impacts to RTE species associated with the RITE Project, and, as necessary, develop measures to minimize or mitigate such impacts.

Verdant provided information in the ICD (2003) on RTE species that had been identified in the vicinity of the project. In February 2004, FERC designated Verdant as the Commission's non-federal representative for informal endangered species consultation with USFWS, NOAA's and NMFS. Under this designation, Verdant was responsible for developing and supplying information and participating in meetings related to RTE species, consulting with FWS and NMFS, and as necessary, developing a draft biological assessment. Verdant contacted FWS, NMFS, and the NYSDEC's New York Natural Heritage Program in February 2004 to request information regarding the presence of federal and state-listed RTE species in the area of the study units. The responses Verdant received are summarized below.

NMFS**:** In a letter to the Army Corps of Engineers dated May 21, 2004, in combination with a letter to Verdant dated October 12, 2004, NMFS stated that while an occasional transient endangered sea turtle or shortnose sturgeon could occur in the East River, this would be a rare occurrence, and no other federally-listed threatened or endangered species are known to occur in the project area.

FWS**:** In a letter to Verdant dated February 17, 2004, FWS stated that no federally-listed or proposed threatened or endangered species under the Service's jurisdiction occur in the area of the experimental units and that no habitat in the project impact area is currently designated or proposed "critical habitat." FWS stated that no further Endangered Species Act coordination or consultation with the Service was required for the deployment and operation of the study units.

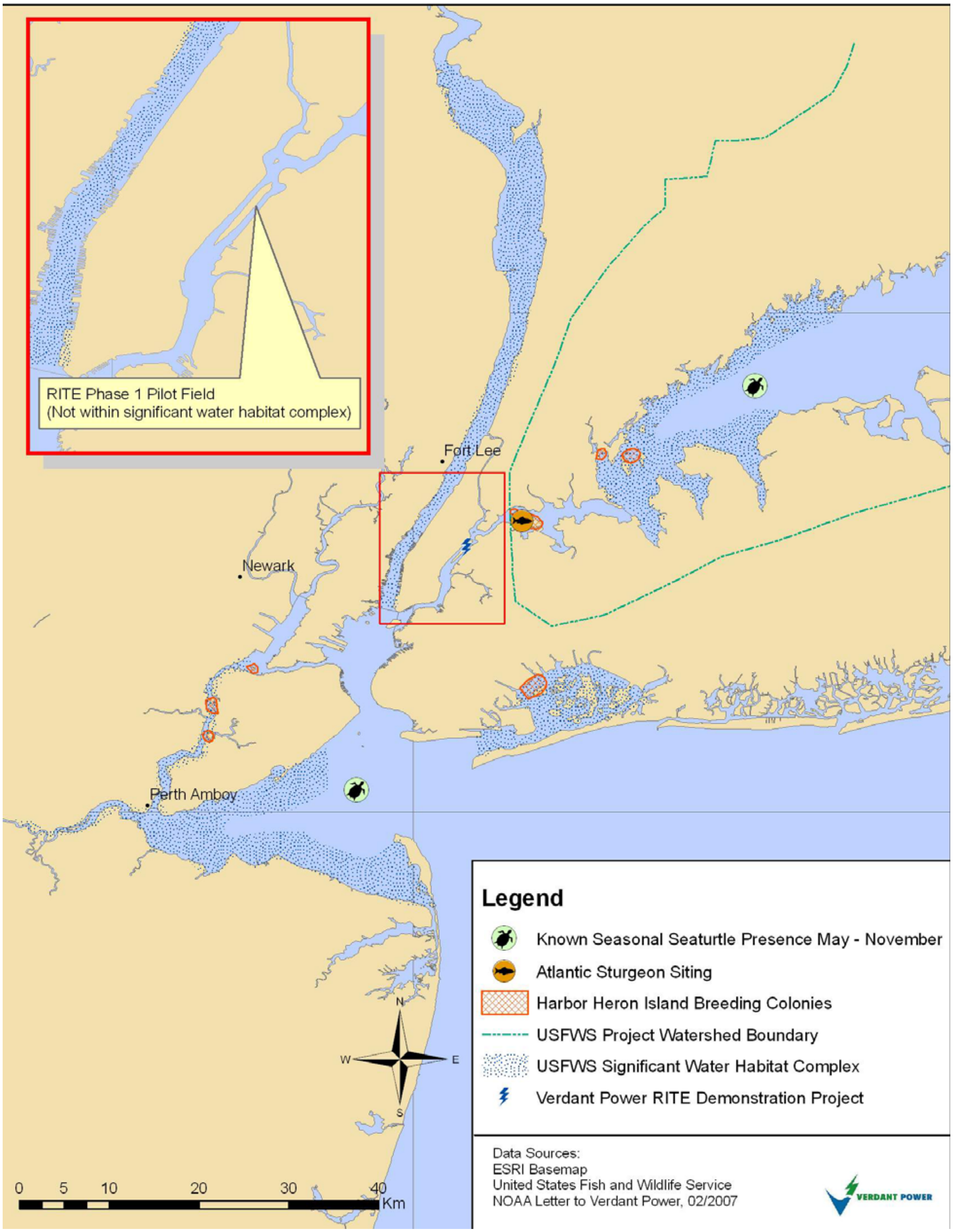
New York Natural Heritage Program**:** In a letter to Verdant dated March 4, 2004, the New York Natural Heritage Program identified the state-endangered peregrine falcon (*Falco peregrinus*) as potentially occurring in the project area.

The plan for the RTE Species Assessment for the RITE Project was reviewed at the Joint Agency/Public Meetings on December 15, 2003, at the study review meeting on June 9, 2004, and at the agency permitting meeting on September 9, 2004. The findings and concerns of the federal and state agencies summarized above were discussed at the June 9, 2004 meeting. The discussion at this meeting focused on the chance of sea turtles being present in the East River and the role of the study units in evaluating the impact of the turbines on marine species. Because the initial agency consultation occurred in 2004, Verdant developed, presented and initiated a RTE Species Assessment plan for agency review and comment beginning in December 2006, and reinitiated consultation with USFWS, NMFS, and the New York Natural Heritage Program about RTE species in the pilot project area (both RITE and UN fields).

In letters dated February 7, 2007, and July 27, 2007, NMFS indicated that they had obtained new information on the potential for shortnose sturgeon to occur in the East River as well as information on the potential effects of underwater turbines on sturgeon species. The letters also indicated that Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) are now considered by NMFS to be a candidate species and are likely to occur in the East River. The letters also discussed endangered sea turtles that may occasionally use the area, including federally threatened loggerhead (*Caretta caretta*), and endangered Kemp's ridley (*Lepidochelys kemp*) and leatherback sea turtles (*Dermochelys coriacea*). The letters recommended that consultation pursuant to Section 7 of the ESA be initiated.

Based on the consultation and information collected to date, Atlantic sturgeon (a candidate species for ESA listing), endangered shortnose sturgeon, threatened and endangered sea turtles, and peregrine falcons could be present in the area of the proposed RITE Project. Figure 5.3.5.1-1 summarizes the general locations of some of these species.

Figure 5.3.5.1-1. General location of RTE species near the Project area.



5.3.5.2 Life History Information on Identified Species of Concern

Shortnose Sturgeon (*Acipenser brevirostrum)* (from NYDEC 2008)

The shortnose sturgeon is the smallest of New York's sturgeons, rarely exceeding 3.5 feet in length and 14 pounds in weight. The shortnose sturgeon's life history is complex. Much of its spawning behavior and early life stages are still not fully understood. The shortnose sturgeon is anadromous, migrating from salt water to spawn in freshwater. In the Hudson River, it spawns from April-May. Adult sturgeon migrate upriver from their mid-Hudson overwintering areas to freshwater spawning sites north of Coxsackie. Unlike most fish species, spawning is not a yearly event for most shortnose sturgeon. Males spawn every other year and females every third year. Newly-hatched fry are poor swimmers and drift with the currents along the bottom. As they grow and mature, the fish move downriver into the most brackish parts of the lower Hudson. Shortnose sturgeon are long-lived. The oldest known female reached 67 years of age and the oldest known male was 32. Bottom feeders, shortnose sturgeon eat a variety of organisms. Using their barbels to locate food and their extendable mouths to then vacuum it up, they eat sludge worms, aquatic insect larvae, plants, snails, shrimp, and crayfish. Riverwide population estimates in the 1990s showed the spawning population had increased substantially from that observed in the 1970s.

Atlantic Sturgeon (Acipenser oxyrinchus oxyrinchus)

The Atlantic sturgeon are similar to the shortnose sturgeon as a long-lived anadromous species, however, they are much larger than shortnose sturgeon, with a usual length of 10 feet (3.05 m) (Scott and Crossman 1973). Spawning adults migrate upriver in spring, from April to May. Following spawning, males may remain in the river or lower estuary until the fall, while females typically exit within 4-6 weeks (NOAA 2008). Adults forage on benthic invertebrates while young sturgeon eat a wide variety of bottom-dwelling plant and animal material (Scott and Crossman 1973).

Sea Turtle General Overview

Most of the feeding and nesting range for the loggerhead, Kemp's ridley, and leatherback turtles is generally in the warm tropics. The annual reproductive cycle for female sea turtles includes migration to the reproductive area, the nesting period, remigration from the nesting beach to the feeding range, and a period of active foraging. Females may nest anywhere from every year to every seven years. Sea turtles are long-lived animals that depend on multiple nesting seasons to perpetuate the populations. The survival rate of hatchling sea turtles is low due to high predation. Adults and juveniles are free swimming but hatchlings often drift with mats of Sargassum in the sea currents. Adult and juvenile sea turtles are known to travel several thousand miles from nesting locations to foraging habitat (Ernst *et al.*, 1994).

It is during the foraging period that these sea turtles may wander north to find food beyond the tropical waters. This foraging period comprises the longest phase of a sea turtles life cycle. In the northern latitudes the foraging period may also include a period of hibernation. For the smaller hard-shelled sea turtles such as the loggerhead, green, and Kemp's ridley the foraging habitat can include bays, lagoons, salt marshes, creeks, and the mouth of large rivers. The diurnal activity cycle of the hard-shelled sea turtles includes foraging in the shallows during midmorning and mid-afternoon, and resting in deeper waters midday. The leatherback turtle is generally found in the open ocean (Ernst *et al.*, 1994).

Loggerhead Turtle (Caretta caretta)

The loggerhead turtle is the most abundant sea turtle in North America; however, it is listed as federally threatened in the Endangered Species Act (ESA) (NMFS, 2008). It is also the largest living hard-shelled turtle, commonly growing a shell of more than 3 feet in length. The turtle can be found in the Pacific, Atlantic, and Indian oceans. Peak loggerhead turtle nesting occurs from May to July. It is the only sea turtle that has a nesting range beyond the tropics. It has been found nesting as far north as New Jersey. Loggerheads are omnivores but invertebrates make up a dominant portion of their diet (Ernst *et al.*, 1994).

Kemp's Ridley Turtle (Lepidochelyes kempii)

The Kemp's ridley turtle is also a federally endangered species. It is the smallest sea turtle reaching a maximum shell length of about 2.5 feet. Adult Kemp's ridley turtles are rarely found beyond the boundaries of the Gulf of Mexico. Juvenile turtles have wandered along the eastern United States as far north as the Long Island Sound, NY. This species prefers shallow water typically less than 160 feet deep. Nesting occurs from April to July. The Kemp's ridley turtle is primarily carnivorous and feeds mostly on crabs (Ernst *et al.*, 1994).

Leatherback Turtle (Dermochelys coriacea)

The leatherback turtle is likely the most widely distributed reptile in the world but it is an endangered species (NMFS, 2008). The average shell size of a mature leatherback sea turtle is approximately five feet. The species is rarely observed in shallow waters of bays and estuaries. The turtles spend the majority of their lives following drifting schools of jellyfish in the open and coastal waters of the ocean. High concentrations of these turtles can be found where food is in abundance. The leatherback reaches New England in late spring in time to capitalize on concentrations of jellyfish. One of two relatively high summer abundances of these turtles occurs south of Long Island. Leatherbacks migrate to nesting habitat in tropical waters of several different continents. Only rare occurrences of nesting have been reported along the Atlantic coast and no known nests occur north of Georgia. The nesting season on the Atlantic coast lasts from April to July (Ernst *et al.*, 1994). Critical habitat for the leatherback was designated for the coastal waters adjacent to Sandy Point, St. Croix, U.S. Virgin Islands (NMFS, 2008).

Peregrine Falcon (Falco peregrinus)

The peregrine falcon is a New York state threatened species. This species was once extirpated from the state but has since made a remarkable recovery. The population decline has been attributed to the use of chemical pesticides such as DDT. Since this chemical was banned the population of this species has been increasing. These birds can be found in many different habitats including tundra, savannah, sea coasts, high mountains, forests, and cities. In urban areas the birds nest on ledges created by tall buildings or artificial nest sites on bridges (NYDEC, 2008). The peregrine feeds on a variety of birds but especially doves and pigeons (Ehrlich *et al*., 1998). The abundant source of pigeons is a likely source of forage for the peregrine in urban habitat.

5.3.5.3 Environmental Effects

Throughout the last several years, Verdant has implemented a formal procedure for observations of protected species to be recorded during the bird observation and on and near water activities associated with the operation of the RITE demonstration project and during execution of on-water studies. Verdant also attempted to evaluate the occurrence of RTE species in conjunction with performing the Fish Movement and Protection Study with the fixed hydroacoustics in January to June 2007, in conjunction with the deployment of the study units. While it was recognized that evaluating the occurrence of a rare species was difficult; Verdant attempted using the hydroacoustics to observe large, slow moving targets (representative of a rare sea turtle). This technique did not yield any observations and this protocol was abandoned by mutual agency consent in August 2007.

In addition to the fixed hydroacoustics; Verdant also made efforts to conduct incidental observations of RTE species in conjunction with other field studies -- namely monthly mobile hydroacoustic studies (pre-2005; and post-deployment for 6 months in January through June 2007) and during execution of the bird observation hours. No occurrences were logged. Verdant personnel operating during the three deployments (Dec 2006 through and including November 2008; discontinuous) were also asked to observe and record any unusual aquatic observances and the control room logs show no recorded data related to RTE. No incidental observations of rare species were made concurrent with the other >500 hours of other field studies conducted. A review of other intake data from area power plants; specifically Ravenswood and Astoria yielded no observations in the 17 years of historical record reviewed except for two shortnose sturgeon juveniles that were impinged at Astoria in 1993. Verdant has also collected operational data such as turbine blade rotational speed and water velocity measurements in and around the turbines to better understand the potential for impact.

NMFS has based some of their recently stated concerns with respect to sturgeon impacts based on reported injuries and deaths of Atlantic sturgeon at the Annapolis tidal project in Nova Scotia, Canada. However, as indicated in NMFS' letters there are substantial differences between the Annapolis River project and the RITE Project. Of particular importance is the fact that a tidal barrage system, like that used at the Annapolis Project, directs all outgoing tidal flows through an intake structure and associated turbines while the open design of Verdant's KHPS turbines affects a relatively small percentage of the cross-sectional tidal flow and has the potential to be avoidable for most fish species. The concern raised by NMFS about the potential for tidal turbines to affect sturgeon species by disrupting migration or other essential behaviors also does not appear applicable to this type of system, in which the river is not blocked.

Verdant believes that the lack of feeding habitat and macroinvertebrates in the project area, as well as the new triframe design of the turbine foundation, which provides 3 meters of clearance between the river bottom and the turbine should reduce the potential for contact with shortnose sturgeon, which are bottom feeders and outmigrate along bottom currents. Atlantic sturgeon are also bottom dwelling fish which should reduce their potential to contact the turbines, though they are known to jump out of the water at times (Scott and Crossman 1973).

Based on known information, the potential for sea turtles to be in the project area is likely to be low. The loggerhead or juvenile Kemp's ridley may occasionally be in the area, but the leatherback would not be expected to be present at any time. The lack of suitable feeding habitat in the area of the turbines would further limit the likelihood of sea turtles being in and around the proposed project.

The largest potential for the pilot project to affect any of the endangered species mentioned would be if a species moving through the area was directly struck by a turbine blade, potentially causing injury or mortality. Boat propeller strikes have been reported to cause injury or mortality to sturgeon and sea turtles. However, operational data confirms that the blades on Verdant's KHPS turbines rotate at speeds of approximately 35 rpm, orders of magnitude slower than boat propellers. Boats traveling 30-40 miles per hour have propellers capable of turning at speeds of up to approximately 2000 rpm (to approximately 600 rpm for larger commercial ships), this appears to be a very different situation than a stationary turbine rotating at 35 rpm at normal loaded operating condition; and at slightly higher speeds in a no-load operation mode.

Peregrine Falcons would not be likely to be affected by the project operation as they do not feed in the water where the turbines would be located. Peregrine Falcons do nest on bridges in the project area but construction and maintenance activities should not affect nesting behavior as it would be similar to other boat traffic on the river.

Though Verdant believes the potential for the proposed project to effect any of aforementioned endangered species appears low, Verdant is requesting FERC designation as the non-Federal representative to pursue consultation under the ESA with respect to this Pilot License Application and intends to provide more details regarding this consultation, including draft Biological Assessments, if needed, with the submittal of the

Final Pilot License Application.

Proposed Monitoring Plan - RTE- RITE Pilot

As part of the RITE Monitoring of Environmental Effects (RMEE) proposed plan, Verdant will continue to observe all species activities and migration including RTE species. In the active on-water periods of fishery seasonal mobile efforts, stationary netting, and bird observations, and during the normal course of Pilot project operation, Verdant will continue to record any incidental observational data that would support providing new information on known species occurrences during the pilot period. These studies should provide additional information on the potential for the turbines to impact any fish species as well document the occurrence of any of these endangered species in the project area.

5.3.5.4 Unavoidable Adverse Effects

No unavoidable adverse effects to any RTE species have been identified. This will be the subject of ongoing consultations with resource agencies.

5.3.5.5 No Action Alternative

While the risks of the proposed KHPS turbines on RTE species is limited, under the No Action Alternative, new turbines would not be installed and therefore no additional risk would be posed to RTE species.

5.3.5.6 Sources

Ehrlich, P.R., D.S., Dobkin, and D. Wheye. 1988. The birder's handbook: A field guide to the natural history of North American brids. Simon & Schuster Inc. New York, NY.

Ernst, C.H., J.E. Lovich, and R.W. Barbour. 1994. Turtles of the United States and Canada. Smithsonian Institution Press. Washington, D.C.