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John S. Howard
Plant Manager

February 15, 2012

Honorable Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
88 First Street, NE
Washington, DC 20426

Re: Northfield Mountain Pumped Storage Project (FERC No. 2485)
Sediment Management Plan – Proposed Technical Changes to Sampling Methodology

Dear Secretary Bose:

FirstLight Power Resources Services, LLC on behalf of FirstLight Hydro Generating Company (collectively “FirstLight”) owns and operates the Northfield Mountain Pumped Storage Project (Project No. 2485), located along the Connecticut River near Northfield, MA. On July 15, 2011, FirstLight filed with FERC a Sediment Management Plan (Plan) for the Project which was developed in consultation with the US Environmental Protection Agency (USEPA) and the Massachusetts Department of Environmental Protection (MADEP). The Plan contained proposed methods to assess sediment dynamics in the Project’s upper reservoir and Turners Falls Pool (Connecticut River) from 2011 through 2014.

The main components of the Plan included conducting annual bathymetric surveys in the upper reservoir, collecting turbidity and total suspended solids (TSS) data routinely from the Project area, and reporting requirements. FirstLight began implementing the Plan in 2011 and, on December 1, 2011, filed a report with FERC which summarized the bathymetric survey and sediment monitoring data collected during 2011 at the Project. In the 2011 report, FirstLight also stated that it is in the process of making technical improvements and revisions to their sediment sampling methodology. Specifically, FirstLight is proposing to continuously measure suspended sediment concentrations in lieu of using turbidity measurements as a surrogate for TSS.

On December 6, 2011, FERC acknowledged receipt of the 2011 report and specified that FirstLight should file the revised Sediment Management Plan by February 15, 2012 after consultation with the MADEP and USEPA. A draft of the revised Plan was provided to the MADEP and USEPA by letter dated December 22, 2011. The MADEP submitted comments on the Plan to FirstLight on January 17, 2012. The comments received by MADEP were addressed in the revised plan; a responsiveness summary is provided in Appendix A. A copy of the comment letter is attached in Appendix B. As of the date of this letter, the USEPA has not provided any comments on the revised Plan.

The enclosure contains the proposed revisions to the Sediment Management Plan to modify and improve suspended sediment sampling methodology.

If you have any questions or concerns, please contact me at 413-659-4489.

Sincerely,

John Howard

cc: Robert J. McCollum, MADEP Western Regional Office
Michael Fedak, USEPA Region 1
Adam Kahn, Foley Hoag
Mike Swiger, Van Ness Feldman
Mark Wamser, Gomez and Sullivan Engineers

Enclosure

NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT

FERC NO. 2485-058

SEDIMENT MANAGEMENT PLAN

Prepared for:

FirstLight Power Resources
GDF SUEZ

Prepared by:

Gomez and Sullivan Engineers, P.C.

REVISED

FEBRUARY 15, 2012

1 BACKGROUND

FirstLight Power Resources Services, LLC on behalf of FirstLight Hydro Generating Company (collectively "FirstLight") owns and operates the Northfield Mountain Pumped Storage Project (Project), a 1,080-MW pumped storage project constructed in 1972 along the Connecticut River near Northfield, MA. The project consists of an underground powerhouse, four reversible pump-turbine generators, an underground pressure shaft, four unit penstocks and draft tubes, and a mile-long tailrace tunnel connecting the powerhouse to a 22-mile-long reach of the Connecticut River known as the Turners Falls Pool, which serves as the lower reservoir. The manmade upper reservoir was formed with four earth-core rockfill embankment structures and a concrete gravity dam.

The Northfield Mountain station planned a dewatering outage for May 2010 as part of routine operations and maintenance to maintain protection against powerhouse flooding, and perform preventative long term maintenance programs. The dewatering plan consisted of draining the water from the upper reservoir through the pressure shaft and penstocks, powerhouse, and tailrace tunnel, enabling inspection and maintenance of the project.

On May 1, 2010 FirstLight began the planned three-week dewatering outage with the intent of undertaking various capital projects, including spherical valve seal water control and various piping replacements, dewatering pump/equipment replacements, upper/lower reservoir trash rack repair/replacement, concrete tailrace tunnel roof repairs, and draft tube gate guide rail repairs.

On May 3, 2010, FirstLight became concerned that the ongoing dewatering operation had a higher level of silt than previously expected and notified the USEPA Region 1 office accordingly. Upon further investigation, it became evident that the upper reservoir intake channel silt had dislodged and migrated into the water conveyance tunnels. It was deposited at multiple locations, including a large quantity in the mile-long tailrace tunnel. Dewatering through normal means ceased on May 5, 2010 when all equipment and machinery was shut down and an assessment of the extent of the problem commenced.

FirstLight's response to the incident involved silt removal from three primary areas:

- upper reservoir intake channel;
- tailrace tunnel; and
- lower pressure shaft elbow and four unit penstocks.

Silt clearing in the intake channel was a mechanical excavation operation. Once the upper reservoir had been dewatered, the work began to remove the accumulated river silt from the intake channel of the upper reservoir to reduce the quantity of river silt, which had the potential to be subsequently discharged from the reservoir to the Connecticut River during normal plant operations. Approximately 4,000 cubic yards of dry silt were trucked from the upper reservoir to the storage yard area off of Route 63 where previous sediment stockpiles, logs, and other debris were stored. Approximately 122,000 cubic yards of wet river silt were moved from the intake channel to an adjacent upland peninsula within the upper reservoir. This material required final grading and hydro-seeding to maintain its stability and to reduce reintroduction of river silt into the upper reservoir.

Silt clearing in the tailrace tunnel was more difficult. The initial method of removal from the tailrace involved mechanically excavating the silt and mixing it with river water to obtain a solution of approximately 6 % or fewer solids by volume, then pumping the mixture out to the lower reservoir using temporary pumps. Discharges to the lower reservoir were contained close to shore using a series of turbidity curtains with a floating boom and weighted bottom, which were modified and adjusted based on rainfall and upstream and downstream dam operations. This method was halted in response to the USEPA Administrative Order issued August 4, 2010.

Subsequent methods to clear silt from the tailrace involved lowering a high-capacity solids pump and mixer into the tunnel and pumping the mixture up to a truck loading station near the pumphouse, from whence it was transferred to an upper reservoir silt storage area. A system of frac tanks were set up near the tailrace to return clear water to the Connecticut River. Tailrace tunnel silt removal was completed by August 26, 2010. A large dewatering basin and several smaller polishing basins were constructed above the pumphouse to settle out solids and discharge treated water back to the river. The dewatering basin was completed and began use on September 4, 2010.

To remove silt from the unit penstocks and lower pressure shaft elbow, FirstLight deployed a high-pressure water cannon mounted on a remotely controlled vehicle (ROV) into each unit penstock through the scroll case mandoor and activated the water cannon to sluice material through the pump turbine. Unit penstock silt removal was initiated on August 27, 2010 and completed in September.

The extended outage at the Northfield Mountain Project lasted from May 1, 2010 through November 18, 2010. Rewatering of the upper reservoir began on November 19, 2010 and the project was returned to service on November 21, 2010.

Article 20 of the existing FERC license for this project requires FirstLight to take reasonable measures to prevent soil erosion and stream siltation resulting from construction, operation, or maintenance of the Project. In response to the recent sedimentation event, FERC had requested a plan and/or procedures designed to avoid or minimize the entrainment of silt into the project's works during similar drawdowns needed in the future. Similarly, the USEPA Administrative Order requested a report identifying measures FirstLight would adopt to prevent discharges of sediments to the Connecticut River associated with draining the upper reservoir.

After consultation with the USEPA and MADEP, on July 15, 2011, FirstLight filed with FERC a Sediment Management Plan for the Project which contained proposed methods to assess sediment dynamics in the Project's upper reservoir and Turners Falls Pool (Connecticut River) from 2011 through 2014 ("July 15, 2011 Plan"). FirstLight began collecting data in accordance with this plan in 2011 and submitted a summary report to FERC on December 1, 2011. Through this initial data collection effort it became apparent that, although useful to understand baseline river conditions, the turbidity data collection methods proposed in this plan would be of limited value to achieve the objective of evaluating strategies to avoid the entrainment of accumulated silt into project works during drawdown or dewatering activities. Therefore, the July 15, 2011 Plan has been updated to describe FirstLight's revised suspended sediment data collection methods.

A draft of the revised Plan was provided to the MADEP and USEPA by letter dated December 22, 2011. The MADEP submitted comments on the Plan to FirstLight on January 17, 2012. The comments received by MADEP were addressed in this final version of the revised Plan; a responsiveness summary is provided in Appendix A.

A copy of the MADEP comment letter is attached in Appendix B. The USEPA has not provided any comments on the revised Plan.

2 GOALS & OBJECTIVES

The sediment that accumulates in the upper reservoir at the Northfield Mountain station has its origins in the Connecticut River and is entrained in suspension through the powerhouse during normal project operations. Once in the upper reservoir, silt tends to settle out of the water and accumulate in deposits, which generally lie undisturbed until larger drawdown or dewatering activities.

The goals of this plan are to assess sediment dynamics in the upper reservoir and Turners Falls Pool and to evaluate management strategies to address the entrainment of accumulated silt into Project works during upper reservoir drawdown or dewatering activities. To achieve these goals, FirstLight has initiated a data collection effort in the Project area with the following objectives:

1. Monitor suspended sediment concentrations and particle size distribution (PSD) in the Northfield Mountain Project intake and discharge under a range of operating and ambient river conditions.

2. Monitor suspended sediment concentrations and PSD in the Turners Falls Pool (at the Route 10 Bridge) under a range of flow and water level elevation conditions.

3. Conduct bathymetric mapping of the upper reservoir to estimate annual sediment accumulation rates and locations.

4. Propose management measures to address entrainment of sediment into the Project works during upper reservoir drawdown or dewatering activities.

The tasks described herein will be completed to further these objectives.

3 SEDIMENT ASSESSMENT METHODS

3.1 Bathymetric Surveying

No changes are proposed to the bathymetric surveys of the upper reservoir in this updated plan.

Frequency and Timing

Bathymetric mapping of the upper reservoir will be conducted once a year from 2011 through 2014 to better understand the rate, volume, and location of sediment accumulation in the upper reservoir. The first bathymetric survey was completed in early November, 2011 and the results were included in the December 1, 2011 report to FERC. The 2011 survey established baseline conditions. All bathymetric mapping is proposed to occur when the upper reservoir is near its normal maximum elevation so that the maximum extent of bathymetric mapping can be obtained. Subsequent surveys in 2012-2014 will be conducted at approximately the same time of year as the initial survey to predict annual sediment dynamics.

After 2014, the frequency of future bathymetric mapping will be determined based on the previous four-year assessment. It is envisioned that FirstLight will describe potential future bathymetric mapping efforts associated with major drawdown/dewatering activities in its sediment assessment report and management plan prepared at the conclusion of the monitoring effort, as described below.

Methods
FirstLight retained Ocean and Coastal Consultants (OCC) to perform the bathymetric survey work. The hydrographic survey was performed by SeaVision as a subconsultant to OCC. SeaVision's methods included performing a single-beam bathymetric survey of the upper reservoir at a spacing of 100 feet in the north-south direction, and with cross lines at a spacing of 100 feet in the east-west direction. A single beam echosounder was paired with an RTK-GPS receiver to collect bathymetric soundings continuously on survey lines with horizontal and vertical positioning accuracy better than 0.2 feet. After collection, all data was processed using the Hypack hydrographic survey software suite to generate deliverable products.

Data Analysis
Data obtained from the bathymetric surveys is translated into a GIS compatible format for reporting purposes. For all bathymetric mapping conducted after the 2011 survey, the mapping will be compared to previous and baseline data to estimate rates of sediment accumulation and volume of accumulated silt.

Data Reporting
A report of the bathymetric survey will be provided to MADEP, USEPA Region 1, and FERC along with the results of the suspended sediment monitoring, described below.

Each bathymetric survey report will include the following:

- Results of the current bathymetric survey, including a contour and sounding plan map,
- Comparisons of survey data to previous and baseline survey results, and
- Volumetric estimates and location of sediment accretion and erosion from year to year.

3.2 Suspended Sediment Monitoring

In the July 15, 2011 Plan, FirstLight proposed a four-year sediment monitoring study (2011 - 2014) in which turbidity and total suspended solids (TSS) data were to be collected routinely as well as during targeted periods of high flow in various locations within the Turners Falls Pool and the Northfield Mountain upper reservoir. TSS and turbidity grab samples were collected on two occasions during 2011 in accordance with the July 15, 2011 Plan.

Based on the data collected in 2011, as summarized in the December 1, 2011 report to FERC, FirstLight is proposing changes to the data collection methods as described herein. To accomplish the study goals, this plan deviates from the methods initially proposed in the July 15, 2011 Plan. Rather than quarterly monitoring at various locations over the four years of study, a more focused and iterative sampling approach is proposed.

In summary, FirstLight is proposing the following:

- Collect continuous suspended sediment concentration and PSD data from the Turners Falls Pool at the Route 10 Bridge during 2012.
- Collect continuous suspended sediment concentration and PSD data from the Northfield Project intakes during 2012 (this will provide information on the concentration and PSD of sediment in water being used during pumping and generating cycles).

<u>2012 Sampling Program</u>

The purpose of the continuous monitoring is to understand suspended sediment levels in the Connecticut River and in the water used for Northfield Mountain Project operations over a range of river flow conditions and pumping/generating cycles. Continuous monitoring of suspended sediment concentration and PSD will occur on an hourly time step; this will provide a larger data set more representative of conditions experienced over varying rivers and a range of Project operational cycles (as opposed to four quarterly data points from each station, which provides only a snapshot in time).

Ideally, installation of the monitoring equipment will occur to allow data collection during the spring freshet; although the sample timing may be modified if there is any ice cover on the Turners Falls Pool. The continuous monitoring for 2012 is proposed to begin on approximately March 1 (pending approval of this plan). A data report will be prepared for agency submittal at the end of the 2012 sampling effort.

<u>Instrumentation and Sampling Locations</u>

Sampling equipment will collect the data required to evaluate the characteristics of suspended sediment in the Connecticut River as well as dynamics of suspended sediment moving through the hydro system during pumping and generation. These instruments would provide continuous monitoring of sediment data that could significantly improve the understanding of sediment as it relates to the river/reservoir sediment dynamics as well as direct knowledge of suspected sediment levels flowing through the reversible turbines.

Continuous measurement of suspended sediment concentration and PSD is proposed for 2012 from the following two locations (shown in Figure 1):

- Connecticut River - Route 10 Bridge
- Northfield Mountain Station – installed into a tap in the service water line to collect data during pumping and generating cycles.

Connecticut River Sampling Location - Route 10 Bridge

Sampling at the Route 10 Bridge will provide data on sediment transport in the Turners Falls Pool. A continuously recording sampler will be installed to measure suspended sediment concentration and PSD on an hourly basis. The sampler will pump in river water from a single fixed location in the Connecticut River at the Route 10 Bridge. This location was selected to allow access laterally across the river during all flow conditions without having to use a boat.

Since sediment concentration is known to vary laterally across the river and vertically with depth above the river bed, point sample data will also be collected (described in more detail below) so a correlation can be developed over a range of flow conditions between the overall suspended sediment transport through the entire cross-section compared to the continuous sampling at the single, fixed location. The combination of a single fixed location to provide hourly sediment concentrations coupled with sampling of the entire cross-section through a range of flow conditions over a relatively short period of time provides the best combination of data to develop a good understanding of both the temporal variations in sediment transport from the fixed sampling location, along with the lateral and vertical distribution of sediment transport through the cross-section so a coefficient can be applied to the temporal data. This is an acceptable method described by the USGS (Edwards and Glysson, 1999).

The point sampling will also serve as an independent comparison of the continuous data collected.

Sampling equipment proposed for the fixed location sampler at the Route 10 Bridge is the LISST-StreamSide sediment sensor. Information on this sampler is provided in Appendix C.

Northfield Mountain

To monitor suspended sediment concentrations moving into and out of the upper reservoir, a continuous sampler will be installed in-line with water and any suspended sediment that is flowing through the reversible turbines at the Northfield Mountain Project. After investigating this option, an appropriate location for in-line monitoring is a service water line that ties directly into the tailrace tunnel which contains the same water that is flowing through the reversible turbines. During pumping, the water is transporting sediment that is being taken into the system from the Connecticut River through the tailrace intake. During generation, the water is transporting sediment that is being discharged from the upper reservoir back to the river.

Sampling equipment proposed for the in-line sampler at Northfield Mountain is the LISST-HYDRO sediment sensor. Information on this sampler is provided in Appendix D. Point sampling described below will serve as an independent comparison of the continuous data collected.

Point Measurements

To account for the variation of suspended sediment concentration and PSD both vertically in the water column and laterally across the river, FirstLight is proposing to collect point samples to develop a relationship between the LISST-StreamSide continuous sampling from a single fixed location at the Route 10 Bridge and the overall sediment transport through the reach. To determine the relationship between the data collected by the automatic pumping-type sampler and the overall suspended sediment concentration through the cross-section, concentrations determined from the pumping sampler will be compared with the corresponding concentrations determined from a complete depth integrated cross-section sample over a wide range of flows. This relation will then be used to adjust the pumped sample data. In addition, adjustments to the continuous sampling location in the water column may occur to more accurately reflect the concentration across the cross-section.

In order to collect the necessary samples, a LISST-SL sensor would be utilized along with a crane and reel for cable suspension from the Route 10 Bridge. At least 10 point samples using the Equal Width Increment method (Edwards and Glysson, 1999) over a range of flow conditions (from low to high flow) will be collected. Information on this sampler and equipment is provided in Appendix E.

Periodic point sampling with the LISST-SL will also occur at the Northfield Mountain Station concurrently with the continuous LISST-HYDRO sampling for comparison purposes.

2013-2014 Sampling

An adaptive approach is proposed relative to sampling after 2012. FirstLight may continue sampling in 2013 and 2014 consistent with 2012, but based on 2012 results may propose modifications to the sampling program. It may also propose discontinuing sampling and instead propose management measures to address entrainment of sediment into the Project works during upper reservoir drawdown or dewatering activities. In either event, FirstLight would consult with the MADEP and USEPA Region 1 prior to consulting with FERC.

3.3 Data Analysis and Reporting

Suspended sediment concentration and PSD data collected at key locations in the Connecticut River (at the Route 10 Bridge) and within Northfield Mountain will provide a basis for determining the quantity and sizes of suspended sediment that are being transported through the Turners Falls Pool as well as the quantity and sizes of sediment being pumped from the river up to the upper reservoir through Northfield Mountain and similar information for sediment being discharged from the upper reservoir through Northfield Mountain back to the river.

Quality Assurance and Representativeness

Data collected in the Northfield Mountain plant will be tied into a computer for data monitoring and storage. Continuous data collected at the Route 10 Bridge will be stored in the instrument memory and will be periodically downloaded and reviewed.

Based on the methods proposed above, two continuous data sets will be obtained. As the data are obtained, a quality assurance/quality control review of the measurements will occur and any erroneous data will be identified. Any data censored or not used will be well documented in the data set. Raw data files from the LISST sensors will be retained in original format for long-term storage.

In order to determine representativeness of the continuous data, the pumped sample results will be compared to the sediment concentration of the point samples collected laterally across and vertically with depth. A coefficient will be developed to “correct” the pumped sample so it will be representative of sediment transport in the overall cross-section.

Data Analysis

Data files downloaded from the LISST Streamside at the Route 10 Bridge will be coupled with the hourly data recorded at the Project that includes the computed flow through the Turners Falls Pool. The hourly suspended sediment concentration and PSD data will be combined in a spreadsheet with the hourly flow data. The spreadsheet will allow computation of the tonnage of suspended sediment being transported in the Turners Falls Pool. Graphs will be prepared showing the variation in suspended sediment transport over time (tonnage and concentration), along with the variation in flow. Total tonnage transported on a monthly and annual basis will be summarized along with the range and average suspended sediment concentration.

Suspended sediment and PSD data collected from Northfield station will be combined with data from the standard hourly hydraulic computation data sheets in a spreadsheet. From this spreadsheet, graphs of concentration over time during pumping and generation cycles will be prepared showing hourly variations of this variable. Based on volumes of flow during pumping and generation combined with the suspended sediment data, tonnages of sediment being pumped up into the upper reservoir from the river and the tonnage of sediment being discharged from the upper reservoir back to the river during generation will be computed. The difference between the tonnage pumped up to the upper reservoir and the tonnage being discharged during generation will provide a quantification of sediment being trapped in the upper reservoir (which can be compared with changes in bathymetry over time). The key descriptors of PSD such as D16, D50, D84, during pumping and generation will be compared to show how the PSD varies over time and how the PSD compares during pumping and generation cycles. It is anticipated that the PSD during pumping is somewhat larger than during generation since the larger-sized particles tend to settle out more rapidly and completely than the smaller-sized particles. Monthly and annual summaries of PSD data will be prepared to show trends and comparisons in PSD between pumping and generation cycles. The relationship between flow and PSD will also be developed to see how the magnitude of flow might affect the sizes of sediment being sent through the hydropower system.

The above analysis will provide a basis for the sediment budget and dynamic interaction between the river and upper reservoir. The quantity of sediment being transported in suspension in the Turners Falls Pool will be known as represented by the suspended sediment data collected at the Route 10 Bridge (computed as a mass quantity – tons per day, month, and year). The quantity of sediment being pumped from the river through Northfield to the upper reservoir during the pumping cycle will also be quantified, again as a mass quantity. Similarly, the tonnage of suspended sediment that moves back to the river from the upper reservoir through Northfield during the generation cycle will be quantified. These three basic quantities of sediment form the basis of the sediment budget (sediment transported in the Turners Falls Pool, sediment pumped up to the upper reservoir and sediment discharged back to the river during generation). The difference in the tonnage of sediment between the pumping and generation cycles represents a quantification of the amount of sediment deposited in the upper reservoir. This will be compared to the difference in bathymetric surveys.

The dynamic interaction between the river and upper reservoir will be demonstrated by showing the trends in the quantities and sizes of sediment transported in the river and the quantities and sizes of sediment being pumped up to the upper reservoir and discharged back to the river as a function of flow in the river. The percentage of sediment trapped in the upper reservoir as it varies over time and with flow will be computed.

The quantification of sediment transport in the river and by the pumping/generation cycles and trends in the data will be used in understanding the sediment budget and dynamic interaction between the river, the hydropower system and the upper reservoir. This information will be utilized to develop criteria relating loss of upper reservoir storage to drawdowns and potential sediment management measures. Development of criteria will also consider the minimum storage needed to effectively operate the hydropower system so as to reduce potential loss in generation capacity. Specific details of these criteria will become apparent as the data are collected and as analysis documents the sediment budget and dynamic interaction between the river, the hydropower system and the upper reservoir. The objective of developing these criteria will focus on how best to manage the sediment issues during drawdowns.

Annual Reporting

A report summarizing the monitoring data and bathymetric mapping effort will be developed after the close of each study year. An annual report of the monitoring and bathymetric data will be provided to MADEP, USEPA Region 1, and FERC.

3.4 Development of Sediment Management Alternatives

Collecting the above data will provide FirstLight with a better understanding of sediment dynamics in the Connecticut River in the Project area and the upper reservoir, and the relationship between suspended sediment concentrations and the magnitude of flow on the Connecticut River.

In addition to the annual reports, at the conclusion of the data collection and assessment effort, FirstLight will develop a comprehensive report that evaluates the results of the bathymetric mapping and suspended sediment monitoring assessments, identifies the potential build-up of sediment in the upper reservoir and upper reservoir intake channel, and proposes management measures to avoid the entrainment of accumulated silt into the Project works and the Connecticut River at harmful levels during drawdown or dewatering activities. The options to be considered as a result of the assessment may include, but are not necessarily limited to: continued periodic sediment dynamic assessments, periodic dredging of the upper reservoir, changes to the frequency, rate, or magnitude of upper reservoir drawdowns, and combinations thereof. The final report will include standard operating procedures and protocols to be used to determine when the specific measures recommended by the Plan will be implemented. The standard operating procedures and protocols will be developed in consultation with the MADEP and USEPA and will comply with all applicable laws.

The assessment report/management plan will be provided to MADEP and USEPA Region 1 to allow for at least a 30-day review and comment period. Comments will be addressed and the final report is anticipated to be filed with FERC no later than December 1, 2015.

In conclusion, FirstLight believes that this revised program of data collection and analysis will provide an important understanding of the interaction between suspended sediment transport in the river, sediment deposition in the upper reservoir and potential operational or design options or criteria to appropriately deal with this sediment issue.

References

Edwards T.E., and Glysson G.D., 1999. Field methods for measurement of fluvial sediment: U.S. Geological Survey Techniques of Water-Resources Investigations Book 3, Chapter C2, 89 p. (http://pubs.usgs.gov/twri/twri3-c2/pdf/TWRI_3-C2.pdf).

Gray, J.R., G.D. Glysson, L.M. Turcios, and G.E. Schwarz, 2000. Comparability of Suspended-Sediment Concentration and Total Suspended Solids Data. U.S. Geological Survey Water-Resources Investigations Report 00-4191 (http://water.usgs.gov/osw/pubs/WRIR00-4191.pdf).

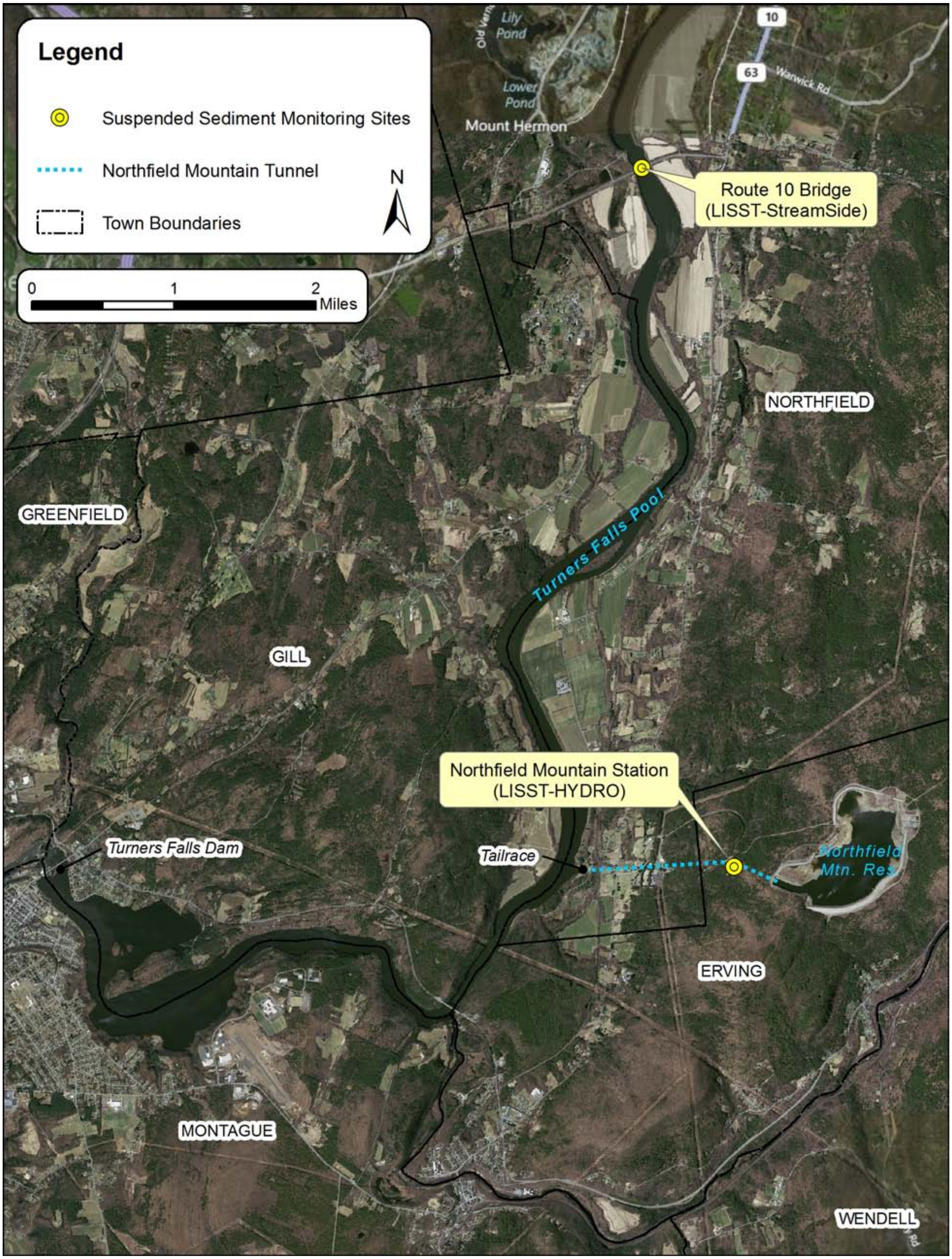


Figure 1 – Sampling Locations.

APPENDICES

Appendix A: Responsiveness Summary

Appendix B: MADEP Comment Letter

Appendix C: LISST-StreamSide Equipment Specifications

Appendix D: LISST-HYDRO Equipment Specifications

Appendix E: LISST-SL Equipment Specifications

APPENDIX A – RESPONSE TO AGENCY COMMENTS ON REVISED PLAN

The following provides a summary of comments received in a letter dated January 17, 2011 from the MADEP (provided in Appendix B) regarding the updated sediment management plan, and a description of how these comments were addressed in the final updated plan filed with FERC on February 15, 2012.

1. **The proposal to measure total suspended solids (TSS) directly rather than measuring turbidity as a surrogate is encouraged as more useful data should result.**

   FirstLight concurs.

2. **The final Sediment Management Plan should include one or more diagrams/figures of the site layout and proposed monitoring locations. The current document does not have any such graphics.**

   The proposed continuous monitoring locations include one site in the Connecticut River at the Route 10 Bridge in Northfield, and another site within the Northfield Mountain Station. Figure 1 has been added to depict these locations. In terms of the layout of each sampling location, the continuous meters within the station will be installed in-line with water and suspended sediment that is flowing through the reversible turbines. At the Route 10 Bridge, FirstLight is still evaluating options for power and clean water at the site, so the exact layout is not known yet. At this site water from the river will be pumped up to the instrument for analysis and then returned to the river.

3. **Use of LISST technology to estimate TSS sounds like a viable alternative for this project, but water samples (and lab analyses) should also be collected periodically for comparison to the LISST-derived TSS values from each type of unit employed. A MA-certified (in TSS) lab should be used and relevant analytical Standard Operating Procedure provided. The Sediment Management Plan should clearly define how, when and where the manual sampling would occur.**

   According to the manufacturer of the sampling equipment, a concentration calibration is performed in the lab prior to shipping which is good for the life of the instrument as long as the optical surfaces are clean and the instrument has not been subject to mechanical shock during transport and installation that has caused the optics to go out of adjustment (misalignment). The instruments also perform automatic background measurements with clean water and these can then be compared to the factory background measured prior to shipping as a check.

   In addition to the continuous monitoring, FirstLight proposes to use the LISST-SL to collect in independent point measurements across a range of flows to compare against and verify the continuous data. Water samples for TSS laboratory analysis are not proposed. The USGS advises that suspended sediment concentration and TSS data collected from natural waters are not comparable and should not be used interchangeably (Gray, et al., 2000).

4. **There is no mention of the use particle size distribution (PSD) in the analysis. Why not? One of the major advantages of the LISST equipment is PSD output. The proposed assessment of "sediment dynamics" might benefit from also looking at PSD.**

   The sampling equipment is capable of collecting particle size distribution (PSD) data. The Plan has been revised to include documentation of PSD on an hourly basis.

5. **Do the LISST devices provide TSS in mg/l (using known or assumed mean particle density, i.e., conversion factor) or in ul/l? If the latter, how will LISST TSS values be converted from ul/l to mg/l (standard units) for this project?**

   According to the equipment manufacturer, the LISST-StreamSide measures suspended sediment concentrations in µl/l which can be converted to mg/l by assuming a density of the particles. 2.65 g/cm^3 is the density of single-size mineral grains. The USGS will be contacted to determine the applicability of this value and how it might vary from region to region depending on the geology of the watershed.

6. **The lower range of the LISST units appears to be approximately 10 mg/l TSS (grain-size dependent). Undisturbed ambient surface waters are often typically below this value. How will this affect the data analysis, given that this technology may be less accurate as TSS concentrations decrease (Gray et. al., 2002)?**

   According to the equipment manufacturer, the minimum detection limit is extremely dependent on the particle size; the detection limit decreases as particle size decreases. Based on qualitative observations during the recent flood event in 2011, the sediment deposited in the floodplain was very fine-grained, which would cause the minimum detection limit to be lower than 10 mg/l. For laser diffraction equipment, the detection limit is dependent of the grain size of the sediment because the laser light scattering is proportional to the surface area of the particles that are in the beam at the time of the measurement. Since the total surface area relative to total mass or volume of particles is larger for small particles than for large particles, it means that the signal-to-noise ratio for a given concentration of small particles is better than for the same concentration of large particles.

7. **It is unclear how the TSS data (and PSD data if included) will be analyzed. More specific information in this planning document regarding how the TSS, etc. data will be used in meeting objectives of developing a sediment budget and minimizing sediment entrainment during drawdowns would be helpful.**

   Section 3.3 has been revised to clarify data analysis procedures relating to understanding the sediment budget and dynamic interaction between the river, the hydropower system and the upper reservoir which will inform FirstLight as sediment management measures during drawdowns are evaluated.

8. **Will biofouling of the continuous LISST devices be minimized or addressed through sampling design and/or maintenance? Also, "streamside" LISST device should be purged a minimum amount of time (5 min.?) prior to sample collection, per manufacturer's recommendations.**

According to the equipment manufacturer, the biofouling of the LISST-HYDRO is a non-issue as the device is equipped with ultrasonic cleaning rods. For the LISST-StreamSide, fouling is minimized by keeping clean water in the optical cell between sampling so that no sediment dries up and no water leaves spots on the optical surfaces. The purging mentioned is not a clean water purge; it is a purge with sample water in order to make sure that the instrument optics and the water is at the same temperature.

9. **More specific information in the plan regarding sampling locations, durations and frequencies as they relate to operational cycles (including exact locations for each type of TSS monitoring) would be useful.**

As described in Section 3.2 of the Plan, sampling equipment proposed for the fixed location sampler at the Route 10 Bridge is the LISST-StreamSide sediment sensor. Sampling equipment proposed for the in-line sampler at Northfield Mountain is the LISST-HYDRO sediment sensor. The sampling frequency for these two locations is on an hourly time step. This will allow data collection under a full range of operational cycles.

In addition to the continuous monitoring, FirstLight proposes to use the LISST-SL to collect independent point measurements across a range of flows to verify the continuous data at both sampling locations.

10. **With respect to data analysis and reporting, any/all data censored or not used should be well documented. Raw data files from the LISST sensors should be retained as raw records.**

FirstLight concurs. The suggested measures were added to the Quality Assurance section of the Plan.

APPENDIX B – MADEP COMMENT LETTER

MassDEP

Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection

Western Regional Office • 436 Dwight Street, Springfield MA 01103 • 413-784-1100

DEVAL L. PATRICK
Governor

TIMOTHY P. MURRAY
Lieutenant Governor

RICHARD K. SULLIVAN JR.
Secretary

KENNETH L. KIMMELL
Commissioner

January 17, 2012

John S. Howard, Plant Manager
FirstLight Power Resources Services, LLC
Northfield Mountain Station
99 Millers Falls Road
Northfield, MA 01360

RE: Comments to Revised Sediment Management Plan
Northfield Mountain Pumped Storage Project
FERC Project No. 2485

Dear Mr. Howard,

The Department of Environmental Protection has reviewed the revised Sediment Management Plan for the Northfield Mountain Pumped Storage Project submitted to us for comment on December 22, 2011. The following are our comments:

1. The proposal to measure total suspended solids (TSS) directly rather than measuring turbidity as a surrogate is encouraged as more useful data should result.
2. The final Sediment Management Plan should include one or more diagrams/figures of the site layout and proposed monitoring locations. The current document does not have any such graphics.
3. Use of LISST technology to estimate TSS sounds like a viable alternative for this project, but water samples (and lab analyses) should also be collected periodically for comparison to the LISST-derived TSS values from each type of unit employed. A MA-certified (in TSS) lab should be used and relevant analytical Standard Operating Procedure provided. The Sediment Management Plan should clearly define how, when and where the manual sampling would occur.
4. There is no mention of the use particle size distribution (PSD) in the analysis. Why not? One of the major advantages of the LISST equipment is PSD output. The proposed assessment of "sediment dynamics" might benefit from also looking at PSD.
5. Do the LISST devices provide TSS in mg/l (using known or assumed mean particle density, i.e., conversion factor) or in ul/l? If the latter, how will LISST TSS values be converted from ul/l to mg/l (standard units) for this project?

6. The lower range of the LISST units appears to be approximately 10 mg/l TSS (grain-size dependent). Undisturbed ambient surface waters are often typically below this value. How will this affect the data analysis, given that this technology may be less accurate as TSS concentrations decrease (Gray et. al., 2002)?

7. It is unclear how the TSS data (and PSD data if included) will be analyzed. More specific information in this planning document regarding how the TSS, etc. data will be used in meeting objectives of developing a sediment budget and minimizing sediment entrainment during drawdowns would be helpful.

8. Will biofouling of the continuous LISST devices be minimized or addressed through sampling design and/or maintenance? Also, "streamside" LISST device should be purged a minimum amount of time (5 min.?) prior to sample collection, per manufacturer's recommendations.

9. More specific information in the plan regarding sampling locations, durations and frequencies as they relate to operational cycles (including exact locations for each type of TSS monitoring) would be useful.

10. With respect to data analysis and reporting, any/all data censored or not used should be well-documented. Raw data files from the LISST sensors should be retained as raw records.

If you have any questions, please contact Robert Kubit at 508-767-2854, Robert.kubit@state.ma.us or myself at 413-755-2138, Robert.mccollum@state.ma.us.

Sincerely,

Robert J. McCollum
Program Chief
Wetlands & Waterways
DEP Western Region

Cc: Michael Fedak/USEPA
Robert Kubit/DWM/MassDEP

APPENDIX C – SUSPENDED SEDIMENT SAMPLING EQUIPMENT ROUTE 10 BRIDGE

LISST-StreamSide

A pumped in-line Sediment Sensor designed for continuous monitoring of shallow streams and rivers

• Particle Size Distribution • Sediment Concentration

Sequoia Scientific, Inc. announces the availability of a new laser particle size analyzer designed for monitoring shallow rivers, streams, or ponds. The LISST-StreamSide is a flow-through instrument designed for use in field environments. Water is pumped through the instrument and the detailed size distribution and volume concentration is measured. After flowing through the instrument the water is then returned to the source. A water sample is not retained. Therefore no sample handling or lab processing is required. Sampling protocols are easily programmed through software or graphics touch panel display. Built-in clean water background system allows for automatic "zeroing" of the instrument before each measurement or on a fixed schedule. This automatic re-calibration of the instrument allows the instrument to compensate for fouling of the optics due to biological growth or other means. Communication with the instrument is through a standard serial link that is compatible with many wired and wireless remote data transfer devices. Detailed specification and list of features are provided on the back.

LISST-StreamSide

Pumped In-line Sediment Sensor

FEATURES

- Laboratory grade laser particle size analyzer compliant with ISO-13320-1 standard
- Records detailed size distribution and concentration in 32 size classes
- Standard 5mm optical path for high concentrations
- Built-in Clean water delivery system for automatic clean water background collection
- 5-inch Graphics Touch panel for system configuration and size distribution display
- Built-in Compact Flash memory (128Mb standard, expandable to 4Gb)
- Size Distribution is computed on board and saved as ASCII file compatible with Excel
- Nominal 12VDC power (110VAC or 220VAC optional)
- Sealed NEMA-4X housing with clear cover.
- Optional Extended Interface Module to provide additional inputs, outputs and controls. Inputs include external analog inputs such as water level sensors, rain gage or temperature sensors. Digital inputs can be used to trigger sample collection. Outputs include switch closure triggers for traditional water samplers and 4-20ma output for Mean Size and Total Volume Concentration.
- Specially designed 12V sealed pump is available and recommended for use with the LISST-StreamSide

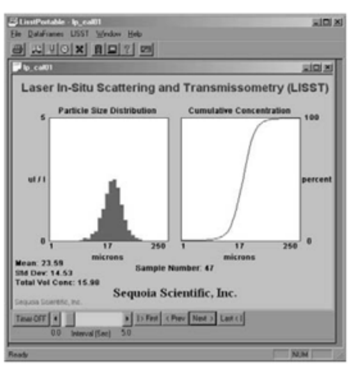
SPECIFICATIONS (PRELIMINARY, SUBJECT TO CHANGE)

Sediment Concentration
Range: 10 mg-3,000 mg/L (approx. range; depends on grain size)
Resolution: <1mg/l

Sediment Size Distribution
Number of size classes: 32 (log-spaced)
Size Range: 2.5-500 microns

Sample Acquisition Time
1 sec for 30 measurement average. Typical maximum sample rate is 1 size distribution per minute.
Number of measurements per average and sample rate is programmable.

Mechanical and Electrical
Dimensions: 30cm tall x 25cm wide x 18cm deep
Power: 6-15VDC 500ma max during sampling (not including pump)
Communications: RS-232 9600 baud



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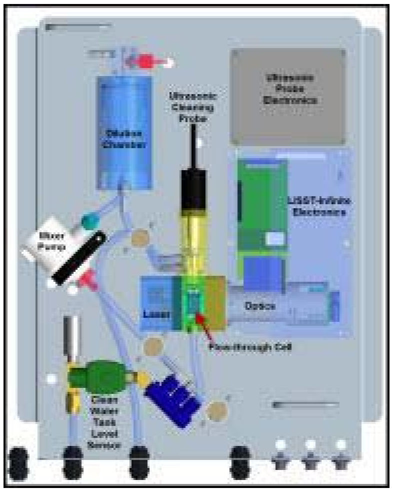
Bellevue, WA 98005 USA
Phone 1-425-641-0944
Fax. 1-425-643-0595
info@SequoiaSci.com
www.SequoiaSci.com

APPENDIX D – SUSPENDED SEDIMENT SAMPLING EQUIPMENT NORTHFIELD MOUNTAIN

Sediment (Silt) Monitoring for Turbine Erosion Prevention in Run of River Hydro Power Plants Using LISST-Infinite and LISST-Hydro.

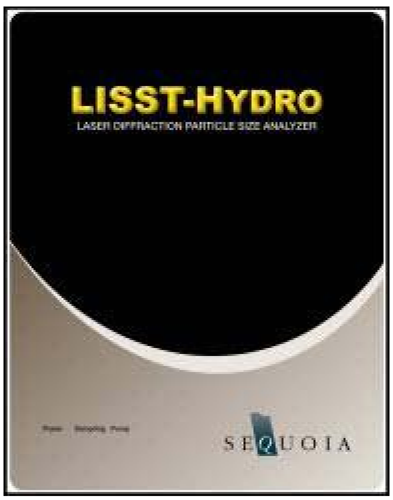


LISST-Infinite assembly

In run of river power plants, severe erosion of turbine parts can occur due to sediments carried by rivers, despite the presence of desiltation chambers. The problem is severe in power plants that are sited in the steep terrains, e.g. the Himalayan topography, or in regions with rivers carrying large amounts of sediment, e.g. South America.

Turbines, wicket gates, valves etc. can suffer severe erosion if the size of suspended sediment grains is large. Convention has it that grains >200 microns cause the most severe damage. As a result, often desiltation efficiency is described in terms of the removal of such large grains. In fact, there is no sharp cut-off in size below which grains may cause no turbine erosion. Thus, a measurement of the full size distribution of suspended sediments is needed at all times.

The erosion of turbines in Hydro Power plants is known to be a severe problem in rivers that drain the Himalayas - covering India, China, Nepal, Bhutan and other countries of East Asia. In Europe, power plants in Switzerland and Norway also are subject to such erosion and wear. In South America, power plants in Colombia, Brazil, Ecuador, Chile and Bolivia suffer from the same damages.



LISST-HYDRO front panel

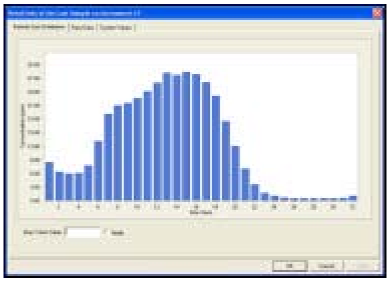
Sequoia Scientific, Inc. has developed the world's first instrument system geared to the automated at-site MONITORING of the suspended sediment size distribution and concentration. Two different systems have been developed; one with and one without an auto-dilution system. These two systems are called **LISST-Infinite** and **LISST-HYDRO**, respectively. Using our basic laser diffraction technology the concentration and size distribution can be routinely and continuously monitored.

The LISST-HYDRO is quite similar to Sequoia's LISST-StreamSide instrument, but with the capability to talk to our LISST-Infinite Monitor software for displaying real-time size and concentration in a control room environment.

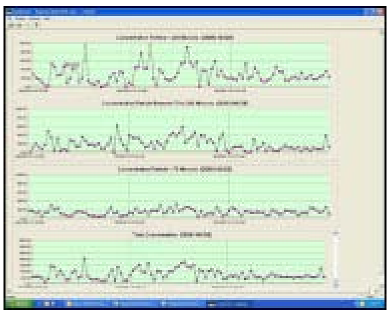
Both systems consists of a laser optical flow through cell. The user must provide power and clean filtered water. The instruments monitors the sediment properties on a user selected schedule. When the concentration exceeds a factory pre-set threshold, the LISST-Infinite will perform a dilution step before making a measurement of the concentration and size distribution. Typically, below about 2,000 mg/l (precise number depends on sediment size) no dilution is required. Thus, the upper range of concentration that the LISST-HYDRO can work in is around 2,000 mg/l. For the LISST-Infinite, the upper concentration limit is around 30,000 mg/l. See the article 'LISST Concentration Limits' for more information on what influences these limits.

Some capabilities are shared between the LISST-Infinite and the LISST-HYDRO.

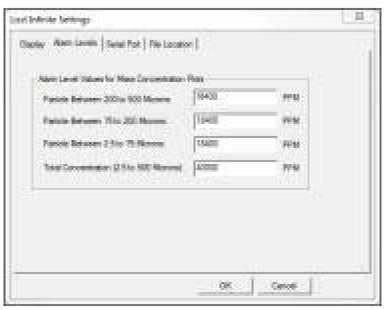
The list below details these shared capabilities.



- Measurement of size distribution and concentration; the size distribution reports concentration in 32 log-spaced size classes covering the size range from 2.5 to 500 microns



- Control Room strip chart display of history and current data on a dedicated computer;



- Systems can be programmed to set off alarms at user-selected thresholds in user-selected size classes

- Data can be archived, archived and hard-wired, or archived and telemetered to a remote site via RF or satellite links.

APPENDIX E – SUSPENDED SEDIMENT SAMPLING EQUIPMENT POINT SAMPLING

LISST-SL

A StreamLined Isokinetic Sediment Sensor

• Particle Size Distribution • Sediment Concentration

Sequoia Scientific, Inc. announces the first advanced technology laser diffraction system for measuring sediment properties in rivers and streams. The streamlined body minimizes drag. Twin fins below the body orient the LISST-SL facing upstream before insertion into the river. A novel non-moving sensor measures river velocity. The system employs active control of the intake pump that matches river velocity to intake velocity making the sample acquisition isokinetic. Diffracted light is measured in an enclosed electro-optics test section. Data are transmitted up the USGS B-reel to a Topside Control Box. The data is downloaded to a PC for processing, yielding the size distribution and volume concentration. Depth, velocity, and temperature are stored with each sample. With the included depth data, the system is capable of delivering sediment flux in the river. The system was first successfully field tested in June 2004.

For features, details, and preliminary specifications, please see reverse.

LISST-SL Being lowered into Puyallup River, Puyallup, Washington USA. June 25, 2004

LISST-SL

A StreamLined Isokinetic Sediment Sensor

SEQUOIA

SEQUOIA SCIENTIFIC, INC.
2700 Richards Road, Suite 107
Bellevue, WA 98005 USA
Phone (425) 641-0944
Fax (425) 643-0595
www.sequoiasci.com

FEATURES

- Isokinetic, self-contained operation
- 2-wire special communication protocol consistent with USGS B-reel use
- Multi-parameter measurement
- Real-time display of velocity, temperature, concentration, depth, and mean sediment grain size
- Streamlined shape for low drag (C_D <0.2) in fast streams
- Rapid re-orientation into flow on insertion
- Twin stabilizer fins to maintain accurate orientation into flow
- Programmable data averaging and storage

SPECIFICATIONS (PRELIMINARY, SUBJECT TO CHANGE)

Sediment Concentration
Range: 10 mg-3,000 mg/L (approx. range; depends on grain size)
Resolution: <1mg/l

Sediment Size Distribution
Number of size classes: 32 (log-spaced)
Size Range: 2.5-500 microns (nominal, other range may be available)

Depth of measurement
Minimum: 15 cm
Maximum: 100 meters

Water velocity
Range: 0 – 8 m/sec
Resolution: 3 cm/sec

Water temperature
Range: 0-25 Deg. C
Resolution: 0.1 degree

Sample Acquisition Time
6 sec for 64 sample average.

Mechanical and Electrical
Dimensions: 13 cm max. dia. x 75 cm long
Weight in air: 16Kg
Submerged weight: 7Kg
Rechargeable Battery life: 6 Hours (nominal; longer available)