Relicensing Study 3.2.2

HYDRAULIC STUDY OF TURNERS FALLS IMPOUNDMENT, BYPASS REACH AND BELOW CABOT

Initial Study Report Summary

Northfield Mountain Pumped Storage Project (No. 2485) and Turners Falls Hydroelectric Project (No. 1889)

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SEPTEMBER 2014

1.1 Study Summary

This study requires the development, calibration and verification of two hydraulic models in the project area including a) Turners Falls Impoundment (Impoundment) from Vernon Dam to Turners Falls Dam and b) from Turners Falls Dam to Holyoke Dam.

1.2 Study Progress Summary

Task 1: Update Turners Falls Impoundment HEC-RAS model

FirstLight has updated the Impoundment hydraulic model to include major tributary inflows, specifically the Ashuelot and Millers Rivers, which are both equipped with United States Geological Survey (USGS) gages.

FirstLight collected updated bathymetry in the Impoundment at the following reaches:

- From Vernon Dam downstream to about a half mile below the New Hampshire/Vermont and Massachusetts border bathymetric data was collected between June 5 and 11, 2014. Although data had been collected originally in 2006, due to the overlapping project boundaries in this area, FirstLight opted to re-do the bathymetry again on a much denser and detailed scale. In this approximately 6-mile long reach, the bathymetry was collected by the use of about 45 cross sections and normally 7 longitudinal lines within the Impoundment.

- As part of Study No. 3.3.9 (*Two-Dimensional Modeling of the Northfield Mountain Pumped Storage Project Intake/Tailrace Channel and Connecticut River Upstream and Downstream of the Intake/Tailrace)*, FirstLight collected bathymetric data approximately 5 km upstream and downstream of the Northfield tailrace between May 27 and June 4, 2014. Similar to the new bathymetry data collected in the upper Impoundment, this data was collected on a dense spacing consisting of about 15 cross sections and between 7 and 11 longitudinal lines within the impoundment.

The 2014 bathymetric data was combined with the bathymetric data collected elsewhere in the Impoundment in 2006 and a revised and more detailed bathymetry map was created for the Turners Falls Impoundment. Shoreline and overbank topography was obtained from LIDAR (Light Detection and Ranging) data from TransCanada as a result of a data sharing agreement with TransCanada. This data was combined with the bathymetry data to create a topographical map of the Impoundment area, including the bathymetry and up to about 15 feet above the normal water surface elevations (WSELs). Based on this information, revised cross sections were developed and are being used in the HEC-RAS hydraulic model of the Impoundment.

Task 2: Installation of Water Level Recorders in Turners Falls Impoundment for Model Verification

During 2013, five temporary water level recorders set to collect data on 15-minute intervals were installed on August 1st, 2013 and were removed on November 11th, 2013. These loggers were located at: Downstream of Vernon Dam, Downstream of the confluence with the Ashuelot River, Near W. Northfield Road, at the Route 10 Bridge, and upstream of the Northfield tailrace. In addition, FirstLight maintained its permanent loggers at the Vernon Tailrace, the Northfield Tailrace, the Turners Falls Boat Barrier[1], and at the Turners Falls Dam.

[1] There have been some issues with the WSELs at the boat barrier line.

Per FERC's September 13, 2013 Study Plan Determination Letter (SPDL), it required additional water level data loggers be installed at transect 14000 (French King Gorge) and 70000 and that all loggers be deployed during the period April through November 2014. Data logger locations are shown in Figure 1 at the end of this Initial Study Report (ISR). FirstLight installed most of the loggers on March 24th and 25th, 2014, but could not deploy the FERC-requested logger at transect 14000 in the same time frame due to safety concerns related to ice, and later, very high flows. The logger at transect 14000 is located in the French King Gorge area and since flows were high, velocities through the gorge area created safety issues. FirstLight's Health and Safety Plan curtails normal boating access to the Impoundment when flows exceed 18,000 cfs. The logger was installed on April 29, 2014, from a land based access point when flows receded (but were still above 18,000 cfs) and it was safer to install the equipment.

Most loggers, other than the logger in the French King Gorge area as described above, were installed before the spring runoff. When servicing/downloading the loggers (normally done on a bi-weekly basis other than when very high flows curtailed access) it was discovered that three loggers had been affected by sediment during the high flows in April 2014 that exceeded 60,000 cfs released from Vernon Dam. Table 1 highlights the logger location/name, the installation date, and any issues with the logger through August 1, 2014.

Table 1: 2014 Status of Water Level Loggers in Turners Falls Impoundment.

Logger Location	Installation Date	Issues
Turners Falls Dam (existing gage maintained by FirstLight year round)	NA	None
Transect No. 486.259: Turners Falls Boat Barrier Line (existing gage maintained by FirstLight year round)	NA	Data from this gage has been unreliable since the fall of 2012. Data may need to be adjusted based on a vertical datum correction.
Transect No. 14000: French King Gorge (New Transect added by FERC in its SPDL	April 29	None
Transect No. 33486.3: Located upstream of Northfield tailrace	March 25	None
Transect No. 56926: Located at Route 10 Bridge	March 24	None
Transect No. 70000: New Location added by FERC in its SPDL located below Pauchaug	March 25	None
Transect No. 71986.3: Located approximately 8.5 miles upstream of Northfield tailrace near the Stateline	March 25	During April, this logger had issues recording the water elevation. Preliminary QA/QC indicates that the data is not usable and the logger was reinstalled on May 9, 2014. Since the reinstall, the data has been reliable.
Transect No. 92986.3: Located	March 24	During April, this logger was impacted by high flows. Preliminary QA/QC indicates that the data

Logger Location	Installation Date	Issues
below Stebbins Island		is usable and the logger was reinstalled on June 24, 2014.
Transect No. 102986: Located approximately 2,500 feet above upper most section of Stebbins Island	March 24	During April, this logger was washed out and buried, but was reinstalled on June 10, 2014. Preliminary QA/QC indicates the water level data is not usable due to the combination of burial and movement.
Vernon Tailrace (existing gage maintained by TransCanada)	NA	Minor erratic behavior of the gage has been occurring since late May, 2014 and is being investigated by FirstLight, but the data seems mostly reliable.

In addition to the water level logger data, FirstLight has been recording other data during the same period the loggers have been deployed including:

- Vernon Dam discharge (cfs)
- Northfield flows used for generation (cfs)
- Northfield generation (kW) and pumping (kW)
- Station No. 1 generation (kW), which will be converted to flow through a ratio of design flow to design capacity be converted to flow
- Cabot Station generation (kW), again this will be converted to flow
- Flow recorded at the USGS gages on the Ashuelot and Millers Rivers.

All flow, water elevation and generation data is recorded on a 15 minute time increment.

Task 3: Model Verification and Calibration (Turners Falls Impoundment)

With the WSEL data obtained in Task 2, FirstLight is currently in the process of calibrating the hydraulic model to measured WSELs and select flows. The HEC-RAS model is being operated as steady state with no pumping or generating occurring at Northfield Mountain Project such that flow conditions through the length of the Impoundment are relatively steady for several hours. FirstLight has developed a relationship between flow and travel time (in hours) through the Impoundment. As a guide, at flows less than 20,000 cfs, the travel time is approximately 10 hours, and at flows near 80,000 cfs, the travel time is approximately 4 hours. The HEC-RAS model is being operated for a given flow and the WSELs measured at FirstLight monitoring locations will be compared to the model results. Calibration has consisted of adjusting Manning n values (roughness) or adjusting contraction/expansion coefficients within reasonable measures such that the measured and modeled WSELs are reasonably close.

Task 4: Unsteady Flow Model (Turners Falls Impoundment)

After calibration is complete, the model will be updated to simulate unsteady flow conditions. In this case, time varying flows will be simulated to determine changes in the WSEL at select locations in the

Impoundment. Several production runs/sensitivity analyses will be conducted to evaluate various sources relative to WSELs. For example, a time varying discharge hydrograph from Vernon Station will be simulated while the Northfield Mountain Project remains idle to determine the contribution of WSEL fluctuations caused by the Vernon Station. Similarly, a constant discharge hydrograph from Vernon Station will be simulated while the Northfield Mountain Project is operated as a pump or generator. A matrix of proposed model runs was included in Table 3.2.2-3 of the Revised Study Plan (RSP). Output from the model will include WSEL and mean channel velocities for the flows simulated.

Task 5: Contact FEMA and Obtain FIS Hydraulic Model (Turners Falls Dam to Holyoke Dam)

In the RSP, FirstLight proposed to develop a hydraulic model of the Connecticut River from Turners Falls Dam to Holyoke Dam. Transect data for the hydraulic model was to be based on past Federal Emergency Management Agency (FEMA) flood insurance studies (FIS) developed for the various towns along the river. FirstLight contacted FEMA, MA Department of Transportation and other state/local agencies to secure the original HEC-2 hydraulic models developed for each town and data for the bridges crossing the Connecticut River. FirstLight was provided with microfiche for most of the towns along the Connecticut River between Turners Falls Dam and Holyoke Dam and the bridge data; however, data for the town of Hatfield could not be located. Extensive efforts were made to locate this information, but to no avail.

Given this, FirstLight opted to collect eight (8) transects in the Hatfield area such that the upper and lower portion of the hydraulic model could be connected. Transect data was collected on May 29, 2014.

Task 6: Development of HEC-RAS model and Model Calibration (Turners Falls Dam to Holyoke Dam)

The data on the printed input files were entered into the HEC-RAS model and combined with the new transects collected by FirstLight from the Hatfield area. The FIS hydraulic model was re-constructed and validated by simulating the 100-year flood flow to ensure that the HEC-RAS model output—specifically, the water surface profile—reasonably matched the output shown in the FIS. Then the model was used to simulate various steady state flows similar to the methodology described above. For example, one of the flows simulated was a relatively constant flow throughout the 35-mile long reach experienced during the period for which FirstLight has WSEL data at the Route 116 Bridge and Rainbow Beach (4/30 to 10/24/2012). The measured WSEL at these two locations and at the Montague USGS gage was compared to that predicted by the model. The model was calibrated by adjusting Manning n values, within the reasonable range of n values.

After the FIS model was recreated and calibrated, it was updated by inserting the HEC-RAS transects included in the Corps/TNC hydraulic model of the Northampton area. The model was rerun again to ensure that the measured WSELs reasonably match modeled WSELs.

Task 7: Unsteady Flow Model (Turners Falls Dam to Holyoke Dam)

The model is being used to simulate unsteady flow conditions. Time varying flows are being used to determine WSEL changes at select locations in the 35-mile long reach. Sensitivity analyses are being conducted to evaluate the effect of various sources on WSEL fluctuations. WSEL fluctuations can be a function of, or influenced by, the Turners Falls Project, the Deerfield River Project, the WSEL maintained at Holyoke Dam and to a lesser extent, tributary inflow. For example, a time varying discharge hydrograph from the Turners Falls Project is being simulated while flows from the Deerfield River remain stable to determine the effect of the Turners Falls Project operations on water level fluctuations. Similarly, a constant discharge hydrograph from the Turners Falls Project is being simulated while the Deerfield River Project discharges vary. Finally, other combinations of flows, operating conditions at the Turners Falls and Deerfield River Project, and starting downstream boundary conditions (Holyoke Dam

elevation) are being evaluated. A matrix of proposed model runs is included in Table 3.2.2-4 of the RSP. Output from the model will include WSEL and average channel velocities for various flows.

Task 8: Report

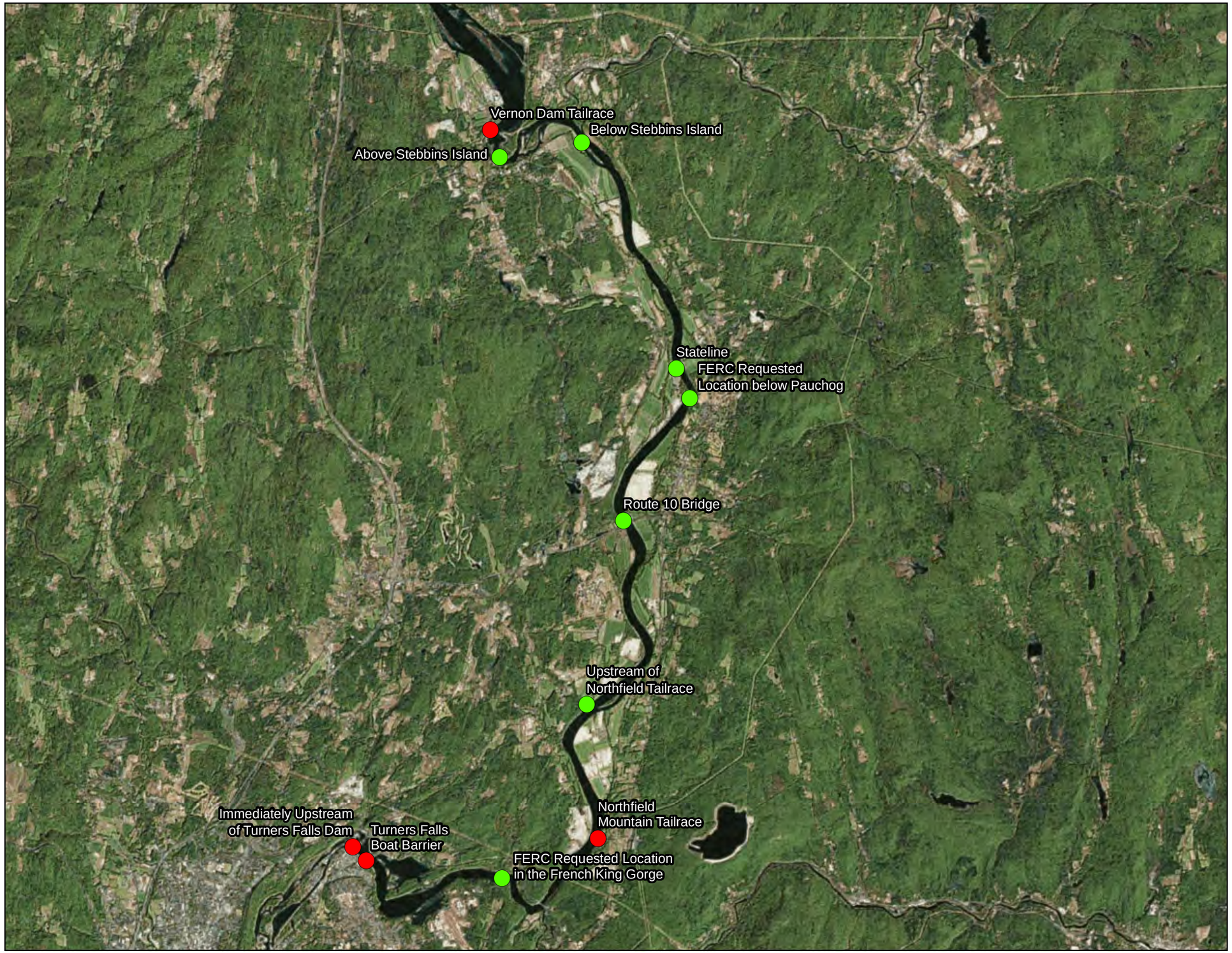
A report will be prepared for completion in the 1st quarter of 2015.

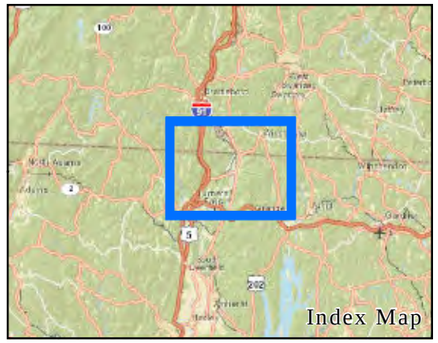
1.3 Variances from Study Plan and Schedule

To date, there are no variances from the RSP with the exception of a) having to collect transect data in the Hatfield area and b) FERC, in its SPDL, requested that water level loggers be installed in April 2013. As noted above the water level logger at the French King Gorge could not be installed until late April 2013 due to safety concerns.

1.4 Remaining Activities

Complete the hydraulic modeling and prepare the report.





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INITIAL STUDY REPORT SUMMARY
RELICENSING STUDY 3.2.2
Figure 1
Plan Map of Turners Falls Impoundment
Water Level Recorder Locations

Legend

- Existing Water Level Recorder
- Temporary Water Level Recorder

N

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1 inch = 7,920 feet

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