frcog Franklin Regional Council of Governments

July 15, 2013

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

Re: Northfield Mountain Pumped Storage Project, FERC No. 2485-063
Turners Falls Project, FERC No. 1889-081

Comments on the Updated Proposed Study Plan (PSP) submitted by FirstLight June 28, 2013.

Section 3.1 Geology and Soils
Section 3.1.1 *2013 Full River Reconnaissance Study*
Section 3.1.2 *Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability*
Section 4.0 Studies not Included in the PSP
4.1 Geology and Soils, 4.1.1 Study of Shoreline Erosion Caused by Northfield Mountain Pumped Storage Operations

Dear Secretary Bose:

The Franklin Regional Council of Governments (FRCOG) is the regional planning agency for Franklin County, Massachusetts. Two committees of the FRCOG, the Connecticut River Streambank Erosion Committee (CRSEC) and the Franklin Regional Planning Board (FRPB), have worked closely with the owner/operator of the Northfield Mountain and Turners Falls Projects for almost 20 years to develop and implement bank stabilization projects that address problems of significant streambank erosion occurring in the Turners Falls Pool on the Connecticut River (the Pool). This cooperative effort set aside differences over erosion causes and focused instead on working together to identify and achieve solutions that protect prime farmland, structures, and other natural resources. Given our long-standing concern with and close involvement with the erosion problems related to the operation of these two projects, we feel uniquely qualified to comment on the above-referenced proposed studies.

Overall, we are disappointed in the quality of the updated study plans for section 3.1 Geology and Soils submitted to FERC by FirstLight on June 28, 2013. We find the updated study plans unacceptable since the detailed comments and concerns expressed by stakeholders at the study plan meetings have been essentially disregarded. The Franklin County reach of the river deserves technically defensible and rigorous scientific investigations with clearly stated goals, objectives and deliverables. FirstLight has not provided a sound approach for these studies and has consistently used language that obfuscates and confuses in each of the three drafts provided to stakeholders. The studies proposed by FirstLight should have clearly stated goals and objectives, and methodologies that are detailed and well documented, scientifically valid and reproducible. How will the mandatory conditioning agencies and stakeholders have confidence in the collection and analysis of data that will be used to evaluate the potential impacts project operations have on the resources?

It appears that FirstLight's strategy is to diminish the importance of the erosion in the Turners Falls Pool by proposing studies that will gather little useful data to inform the relicensing process or to provide the mandatory conditioning agencies, particularly the MassDEP, with the data needed to issue a 401 Water Quality Certificate that is protective of water quality and wetland and riparian resources areas. Ongoing erosion in the Turners Falls Pool is having a significant impact on state and federal listed rare and endangered species that rely upon the river for habitat, as well as on archaeological resources that are lost to bank erosion and prime farmland that is sloughing off into the river. **Bank erosion is the overarching environmental problem and the one that impacts all the other resources listed in the Proposed Study Plan** – Water Resources; Fish and Aquatic Resources; Terrestrial Resources; Wetlands, Riparian and Littoral Habitat; Recreation and Land Use; Cultural Resources; and Developmental Resources. We urge FERC to require FirstLight to develop clear and scientifically defensible studies that will provide valid and useful data about the impacts of project operations on river bank stability and erosion in the Turners Falls Pool.

We have several specific comments on the Study Plan. Unfortunately, we are not able to adequately address all of our concerns with the Updated Proposed Study Plan (Plan) in this letter due to the short timeframe between receiving the updated Plan on June 28, 2013 and the decision by FERC not to extend the comment deadline by two weeks to July 30, 2013. To reinforce our concern regarding the inadequacy of the Plan, we have included several attachments to this letter, including excerpts from the *Fluvial Geomorphology Study of the Turners Falls Pool on the Connecticut River Between Turners Falls, MA and Vernon, VT*, prepared by Field Geology Services of Farmington, ME; we will reference this study as Field (2007). This study was commissioned by the licensee and undertaken to "understand the causes of bank erosion and identify the most appropriate methods for bank stabilization on this section of river." We believe that Dr. Field's work is a comprehensive, well researched and scientifically-based document. To date, many of the recommendations in the study have not been implemented. Even more troubling is the fact that this study, its findings, conclusions and recommendations, has been completely ignored by the licensee in the formulation of their proposed Study Plans to gather information on the geology and soils of the Turners Falls Pool.

For ease of reference, our comments are organized according to the headings in the Updated Proposed Study Plan filed by the licensee on June 28, 2013.

3.1 Geology and Soils

3.1.1 *2013 Full River Reconnaissance Study*

In January 2013, the FERC suggested that the 2013 Full River Reconnaissance (FRR) could both inform the relicensing process and satisfy the compliance requirements under the current license. The Connecticut River Streambank Erosion Committee (CRSEC) agreed but stressed that 1) the 2013 FRR methodology and the Quality Assurance Project Plan (QAPP) still needed significant improvements and the CRSEC wanted to be involved in the process to refine these documents, and 2) tasks would need to be added to the 2013 FRR to gather data to inform relicensing. It was our understanding that the 2013 FRR would be significantly improved from its 2008 predecessor, and accordingly we supported including the FRR in the relicensing process.

Despite detailed, comprehensive comments on the 2008 FRR methodology and final report and the proposed QAPP for the 2013 FRR, which were submitted to both FERC and FirstLight, none has been addressed or included in the 2013 FRR methodology. The proposed methodology for the 2013 FRR is exactly the same as that used in 2008. The QAPP, which the licensee detached from the FRR study plan, is still not adequate. The references to "CRSEC input" in the study plan text are a misrepresentation of what actually happened during the development of the 2008 FRR methodology and the QAPP. As documented in previous correspondence to FERC, input from the CRSEC was neither actively sought nor seriously considered by FirstLight.

We assert that the 2013 FRR study plan is not adequate for compliance or relicensing purposes. Further, we respectfully reserve the right to contest the QAPP and the findings of the 2013 FRR as they relate to the current license and ongoing compliance issues.

Task 1: Document existing riverbank Features and Characteristics
Task 1a: Identify and Define Current Riverbank Features and Characteristics

Field (2007) noted that the erosion mapping from previous FRRs suggests that specific points on the bank can change from eroding to stable or vice versa regardless of whether the total amount of mapped erosion increases or decreases from year to year. Consequently, using changes in the overall totals of mapped erosion to understand how the patterns of erosion in the Turners Falls Pool are evolving is not adequate for relicensing data needs. Identifying where the erosion is occurring, the type of erosion and the stage or temporal sequence of erosion must be inventoried and understood before ascribing potential causal mechanisms as FirstLight is proposing to do in Study 3.1.2.

Field (2007) stated that an adequate discussion of the causes and management of erosion depends on *an understanding of the types, distribution, rates, and temporal sequence of erosion in the Turners Falls Pool*. The licensee's proposal to evaluate the causes of erosion in Study 3.1.2 and the management of project and non-project related erosion is of primary concern to the FRCOG, as well as the mandatory conditioning agencies and other stakeholders. Eroding banks degrade water quality, reduce habitat, and result in the loss of prime agricultural land.

Field (2007) stated that future efforts for monitoring erosion in the Turners Falls Pool must utilize a consistent, well documented technique for identifying erosion sites that is conducted in the early Spring or late Fall when bank exposures are least obscured by vegetation: "*such a technique should be based on the* <u>*types*</u> *of erosion observed and* <u>*stage*</u> *of erosion present not proxies for erosion or erosion susceptibility such as the amount of vegetation, percentage of exposed soil, bank height and slope, or soil type"*. [emphasis added]. Dr. Field suggested that the written and visual descriptions of erosion types presented in Tables 1 and 2 and described in Section 7.1 of his report could provide the basis for such an approach (see Field's Tables 1 and 2 which are attached to this letter). However, FirstLight chose to ignore these recommendations and instead both the 2008 and 2013 FRR methodologies (Tables 3.1-1 and 3.1-2) **use all of the "proxies for erosion or erosion susceptibility" described by Field.** Furthermore, the rationale for the grouping of these characteristics (Table 3.1-2) is not explained, nor are citations provided for its origin.

Another fatal flaw in these tables is the use of the category "mass wasting" to characterize the <u>extent of erosion</u>. First, mass wasting describes the movement of material downslope under the influence of gravity. The term lumps three types of erosion - flow, slide and fall - and the term doesn't describe what erosional stage is responsible for the mass movement of the bank material. Mass wasting is a generic term to describe a typically catastrophic event like a landslide or mudslide. It is a term that should be more accurately used (if at all) as a grouping of erosion types. To characterize the spatial extent of erosion, we should be gathering data on the linear and vertical extent of the specific types of erosion as identified by Field (2007), which can be quantified, rather than combining types of erosion into one category and using qualitative terms like "little/none", "some" or "extensive" to describe the erosion. These qualitative terms are not valid due to their extreme subjectivity and should not be used at all in the relicensing studies to describe the erosion in the Turners Falls Pool. According to Field (2007), four of the erosion types described by Lawson (1985) are widely observed in the Turners Falls Pool: falls, topples, slides, and flows (Field (2007) Tables 1 and 2), which are attached to this letter. Dr. Field noted that these four erosion types rarely occur in isolation, but rather work in concert to remove bank material from the upper and lower slope. According to Dr. Field, visual observations of bank conditions at various places in the Turners Falls Pool permit the development of an idealized model that describes a sequence of events occurring through time at a single point (Field, Figure 30), which is attached.

The spatial or temporal extent of the erosion cannot be documented by the methods proposed for the 2013 FRR. Simply put, the type and stage of erosion should be documented according to Field (2007) and then maps could be generated that show, for example, the linear extent and location of all types and stages of erosion. Knowing this information is critical to any efforts to understand the causes of erosion. **Data that are proxies for erosion should not be used as data in the study to determine the causes of erosion**. For the reasons articulated above and because the language is confusing and no citations are provided for the provenance of the 2013 FRR methodology, we disagree with the statement in the updated Proposed Study Plan on page 3-7 that refers to the use of Tables 3.1-1 and 3.1-2 to log and characterize riverbank characteristics as a reliable method. The text we refer to follows:

> Page 3-7 of the Updated Proposed Study Plan states: "*The grouping approach combines riverbank features and characteristics into key associations that can provide insight into which features and characteristics are associated with stability and which are associated with erosion. Statistical distributions of characteristics within each group can aid in further understanding erosion and stability issues such as which combination of features and characteristics trend towards stability, and which trend toward erosion. Such information and understanding can aid in the planning process in developing appropriate approaches in addressing erosion issues.*"

On page 3-8, it is stated that the 2008 and 2013 FRR methodologies include the six stages of erosion identified by Field (2007). We assert that this is a misrepresentation of what Dr. Field identified in his report. He provides definitions for each stage of erosion, along with a picture of a representative site in the Turners Falls Pool and a profile drawing. What is presented in the 2013 FRR methodology (Table 1 on page 3-8 of the Updated Proposed Study Plan) is not comparable to Field's Figure 30. Further, these are stages of erosion as identified by Field (2007) not types of erosion as identified in the 2013 FRR methodology. The 2013 methodology does not identify the stages of erosion. In Appendix C of the proposed QAPP for the 2013 FRR, the types of erosion listed include: none, notching, overhanging bank, undercut toe, and slide. A representative picture is provided. No citations, descriptions, or line drawings are given for the source of these types of erosion. This list of the types of erosion includes only one of the four types of erosion listed by Field (2007) – slide. In fact, it appears that the 2013 FRR methodology has confused the type of erosion with the stage of erosion or perhaps lumped the two categories and picked only a few categories to include as representative of the conditions in the Turners Falls Pool.

More troubling is the Mass Wasting section of Appendix C of the QAPP, which contains pictures showing "little/none", "some" and "extensive" mass wasting. We refer back to our concerns about using the term mass wasting to describe the extent of erosion because mass wasting is a term that refers to collectively to a group of different types of erosion. An examination of the pictures shows that a variety of different types and stages of erosion are occurring in these "representative" mass wasting pictures. This important information is lost when masked by a "little/none" category, for example. To illustrate this point, looking at the attached "little/none" mass wasting pictures, there is clear evidence of different types and stages of erosion as defined by Field (2007). Clearly, the 2008 and 2013 FRR methodologies have not incorporated Field's (2007) recommendations.

In addition to completely revising the 2013 FRR methodology, there are two tasks that could be added to Study 3.1.1 to provide data that would be informative to the relicensing process. They are:

1. The photographic log of the riverbanks compiled during the fluvial geomorphology study (Field, 2007) should be updated during the 2013 FRR to provide a method for visually identifying and confirming the condition and location of eroding banks. Re-photographing the riverbanks periodically from the same locations will provide a means of identifying new erosion sites or, conversely, areas that are stabilizing. Unfortunately, this simple, relatively low cost recommendation was not implemented in the 2008 FRR or proposed for the 2013 FRR. A wealth of information can be easily gleaned from photographs and photographic logs that are updated over time.

2. Field (2007) recommended that the initial photographic log compiled during his study be compared with continuous digital image logs taken during 2001 and 2004 (NEE, 2005). We would add the continuous digital image logs taken for the 2008 FRR and the 2013 FRR to this list.

3.1.2 Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability

We are disappointed that this study does not specifically build upon the findings and recommendations in the Field (2007) report, which was commissioned by the licensee to understand the causes of bank erosion and identify the most appropriate methods for bank stabilization on this section of river. Dr. Field reviewed and summarized the previous work that had been done by the Army Corps of Engineers and others to understand the erosion occurring in the Turners Falls Pool. According to Field (2007), conditions in the Turners Falls Pool create a situation where the riverbanks are near the threshold of erosion. Further, Field (2007) notes:

> *"Minor natural or anthropogenic changes in the Turners Falls Pool, therefore, have the potential to cause significant changes in the extent and severity of bank erosion." (page 37).*

> *"The reported increase in erosion since the opening of the Northfield Mountain Pumped Storage Project (U.S. Army Corps, 1977), at a time when flood flow velocities have decreased due to the raising of the Turners Falls Dam and implementation of flood control projects upstream, suggests other factors may also be causing erosion in the Turners Falls Pool. Other observations inconsistent with natural flood flows being the sole cause of erosion is the higher incidence of erosion on the inside bends of meanders compared to outside bends (Table 3). Typically, flow velocities and erosion on unregulated rivers are greatest on the outside bends of meanders (U.S. Army Corps,1979; Easterbrook, 1993). Furthermore, a comparison of mapped erosion sites (Appendix 5) with the hydraulic modeling (Appendix 4) reveal extensive areas of erosion where shear stresses and flood flow velocities are relatively low (Figure 18)." (page 39).*

> *"The preponderance of bank erosion of floodplain sediments, where natural groundwater seeps are uncommon, indicate natural seepage forces are not a primary cause of erosion in the Turners Falls Pool. However, human management of river levels has potentially created additional seepage forces that have enhanced erosion where natural groundwater seeps are absent." (page 40).*

An important opportunity has been missed to build upon scientifically sound and well documented work. We urge FERC to require the Study Plan be revised to provide scientifically sound and defensible data.

<u>Task 3: Install Proposed Water Level Monitors in Turners Falls Impoundment</u>

In response to stakeholders' concerns about having adequate data on the rate of change in the water surface elevation of the Turners Falls Pool during project operations and having greater coverage throughout the length of the 22-mile impoundment, FirstLight is proposing to add four gages to the four existing gages. Only one of the four proposed new gages is listed as being located to provide information on water level changes due to the operation of the Northfield Mountain Pumped Storage project. Two of the new gages are located in VT, downstream of the Vernon Dam and the remaining new gage is located 8.5 miles upstream of the tailrace. The number of proposed new gages is not adequate to capture the changes in water elevation and the rate of change, in order to provide a suitable data set for the various tasks proposed to utilize the data (Tasks 3a-3f). The cost of installation of water level monitors is relatively low compared to the potential benefits of the data collected. We urge FERC to require the installation of more water level monitors at appropriate locations, including at the fixed recoverable transects and areas where the BSTEM analysis will be conducted (see below). In addition, it is not clear why data gathering is limited to August-November 2013. It would be important to understand water elevation changes and rate of change throughout the year, particularly during the spring freshet and summer months when electricity demand for air conditioning may require more "peaking" power from the pumped storage project.

<u>Task 5: Field Study and Task 6: Causes of Erosion</u>

The results and data gathered from the 2013 FRR are identified by FirstLight as a significant source of data for Study 3.1.2, specifically Task 5: Field Study and Task 6: Causes of Erosion and their associated sub-tasks. For the reasons articulated above, the 2013 FRR, as proposed, will not provide adequate and reliable data for Task 5 or Task 6.

Assuming that all relevant data has been gathered, that the spatial and temporal resolution of the data set is adequate, and that the appropriate Quality Assurance/Quality Control procedures have been followed during data collection, the crucial task of this study is Task 6: Causes of Erosion. The approach to determining the causes of erosion is presented in a "scatter shot" manner. There is no clear and well documented integrative methodology that ties the results of the sub- tasks together or describes how the results of each of the tasks build upon each other. The clearest methodology presented is the Bank-Stability and Toe-Erosion Model (BSTEM). It appears that the BSTEM approach is appropriate and may yield useful information. However, it is not clear from the text the number and the location of the proposed data collection points and whether the data collection points correspond to the proposed fixed recoverable transects, the 22 existing transects and/or other locations to be determined. We note that TransCanada has proposed installation of 64 data-loggers to provide a thorough picture of river conditions. Task 6 should be revised to present a clear, step-by-step methodology that includes appropriate citations and references to standard practices in the disciplines of fluvial geomorphology and geotechnical and soil evaluation.

4.0 Studies not Included in the PSP

4.1 Geology and Soils

4.1.1 Study of Shoreline Erosion Caused by Northfield Mountain Pumped Storage Operations

As a point of clarification, NOAA's National Marine Fisheries (NMFS), a Federal resource agency, also requested this study (study request 6.14) in their comments filed on March 1, 2013. The goals and objectives of this study, as stated in FRCOG's and NMFS' study requests, would be to determine the environmental effects of the presence and operation of the licensed facilities on river bank stability, shoreline habitat, agricultural farmland, wetland resources, bed substrate, and water quality in the Turners Falls impoundment.

FirstLight dismissed the Relevant Resource Management Goals (18 CFR Section 5.9(b)(2)) listed by FRCOG by stating that we, along with other stakeholders that requested the study, were not resource agencies. NMFS is a federal resource agency. The resource management goals listed by NMFS in their study request include:

> "Our management goal is to ensure high quality habitat for migratory diadromous fish. Shortnose sturgeon, American shad and American eel all require suitable spawning, rearing, migratory and foraging habitat. Eroding banks and subsequent increases in turbidity and deposition of fine
> grained material onto bed substrates in the Turner's Falls headpond, the bypass reach and downstream of the Turner's Falls project reduces the quality of habitat for these species. Elevated levels of suspended sediment are associated with a diminution in water quality which also affects the quality of habitat encountered by ***trust resource species***. [emphasis added]
>
> In addition to habitat effects, soil erosion contributes to nutrient loading. In 2001, the U.S. EPA approved New York and Connecticut's Long Island Sound (LIS) dissolved oxygen Total Maximum Daily Load. As a result, the New England Interstate Water Pollution Control Commission (NEIWPCC) established the Connecticut River Workgroup and the Connecticut River Nitrogen Project. This project is a cooperative effort involving staff from NEIWPCC, the states of Connecticut, Massachusetts, New Hampshire, and Vermont, and EPA's Region 1 and Long Island Sound (LIS) offices. All are working together to develop scientifically-defensible nitrogen load allocations, as well as an implementation strategy, for the Connecticut River Basin in Massachusetts, New Hampshire, and Vermont, which are consistent with Total Maximum Daily Load allocations established for LIS. Since its inception, the Connecticut River Workgroup has participated in a number of projects to better understand nitrogen loading, transport, and reductions in erosion."

We are very concerned that FirstLight omitted the study requested by NMFS, FRCOG and other stakeholders. FERC should direct FirstLight to incorporate the tasks suggested by NMFS, FRCOG and other stakeholders into Proposed Study Plan 3.1.2. The argument that certain requested tasks should not be done because FERC uses current conditions as its baseline for evaluating project effects and alternatives is not valid from a scientific basis. The baseline conditions should bracket the timeframe for data analysis to the year Northfield Mountain pumped storage project came on-line to the present day. Current conditions, meaning what we see today, and future conditions under which the project will operate cannot be evaluated in any meaningful way without an appropriate context. We understand that TransCanada is assembling and reviewing historical data as part of their study plans related to understanding erosion in the upper reach of the river. We assert that a similar level of effort is required for the Turners Falls Pool. We are asking for a reasonable time period, a reasonable context within which collected data will be evaluated to assess the impacts of project operations in the Turners Falls Pool and cumulative impacts of all five projects on the river.

We are surprised that FirstLight would assert that it "is unclear how the requested data would inform potential PME measures." (page 4-3). Understanding how project operations affect the river, its banks and other resources is critical to designing appropriate PME measures. Giving the erosion issue "short shrift" in the Study Plan process will ensure that inadequate and suspect data informs potential PME measures.

We request that FERC direct FirstLight to add the following tasks from NMFS', FRCOG's and other stakeholder's study request – Study of Shoreline Erosion Caused by Northfield Mountain Pumped Storage Operations to FirstLight's proposed study 3.1.2.

1. This study should determine the net soil loss in cubic yards between when Northfield Mountain project operations began and the present; a density estimate of the eroded material should also be provided. Provide an analysis of where the greatest loss has occurred, location of proximity to the tailrace, soil type, riparian land use, and vegetative cover in that area. Calculate nutrient loadings (nitrogen and phosphorus compounds) to the river system based on soil loss.

2. Obtain copies of the original survey plans for the project (Exhibit K), and complete a new survey using the same landmarks used previously. The Field (2007) report states on page 11 that the original survey plans of the river are still retained by Ainsworth and Associates, Inc. of Greenfield MA. Use pre-operation aerial photos and current aerial photos to complete a 10-foot topographic map of the section of river between Turners Falls Dam and Vernon Dam and the 200-foot buffer regulated under the Massachusetts Rivers Protection Act. The Field (2007) report on page 11 states that Eastern Topographics, Inc. determined that sufficient information is known about the 1961 aerial photos (e.g., height of airplane) to create a 10-foot topographic map of that time period, and that 1961 aerial photos could be accurately overlaid with recent aerial photos. Field (2007) states that this analysis would enable a more reliable determination of small-scale shifts in channel position and changes in bank height that may have resulted from the erosion of a low bench that previously existed along portions of the river and help identify areas of the most significant bank recession during the past 45 years. Among other things, create a single map showing areas of erosion and deposition, and also overlay the Field report's hydraulic modeling analysis of the river channel.

3. Complete detailed surficial mapping (topographic map or LIDAR) to identify the various geomorphic surfaces, height of benches/terraces above the river level, and types of sediments underlying the surfaces. This will allow one to determine how erosion varies with geomorphic conditions. One could then normalize the amount of erosion to a specific type of bank material/geomorphic surface/terrace.

FirstLight's reason for not conducting LIDAR, which they said was too expensive and other topographic data was available, is not valid for two key reasons. First, the data FirstLight proposes to use, the USGS 10 meter digital elevation model, does not have sufficient resolution to determine how erosion varies with geomorphic conditions. Second, TransCanada is using LIDAR for the northern reach of the river and consistent data is needed to enable FERC to evaluate both individual project impacts and cumulative impacts.

In closing, we would like to stress our disappointment that a feasibility study of a closed-loop system is not being required at this stage in the relicensing process since we believe a closed-loop system would eliminate many of the environmental problems associated with using the river as the lower reservoir.

Thank you for the opportunity to submit comments on FirstLight's Updated Proposed Study Plan. We regret that the short timeframe between receiving the Updated Proposed Study Plan (June 28, 2013) and the date the comments are due (July 15, 2013) does not provide us an opportunity to submit more detailed comments.

Sincerely,

Ann Banash, Chair
FRCOG Executive Committee

Jerry Lund, Chair
FRPB Executive Committee

Tom Miner, Chair
CRSEC

cc: Congressman James McGovern
Franklin County Legislative Delegation
Michael Gorski, Regional Administrator, MassDEP
Robert McCollum, MassDEP
Robert Kubit, MassDEP
Town of Erving
Town of Gill
Town of Montague
Town of Northfield

Attachments

Table 1: Typical types of slope movements on eroding banks. (Field, 2007)

Table 2: Types of erosion occurring in the Turners Falls Pool and their characteristics. (Field, 2007)

Figure 30: Model illustrating idealized sequence of erosion. (Field, 2007)

Table 1. Comparison of Field's Stage of erosion with matrix of riverbank features and characteristics (Updated Proposed Study Plan document submitted by FirstLight, June 28, 2013)

Excerpts from Draft Appendix C of Quality Assurance Project Plan for 2013 FRR (Appendix D of the Proposed Study Plan document submitted by FirstLight, April 15, 2013)

Erosion Type	**Description**
Falls	- Material mass detached from a steep slope and descends through the air to the base of slope - For the purposes of this study, also includes erosion resulting from transport of individual particles by water
Topples	- Large blocks of the slope undergo a forward rotation about a pivot point due to the force of gravity - Large trees undermined at the base enhance formation
Slides	- Sediments move downslope under the force of gravity along one or several discrete surfaces - Two forms occur: planar slips and rotational slumps - Slumps rotate down and out along a surface that is concave upward - Slips move along shallow planar surface without rotary motion
Lateral spreads	- Transitional form between slides and flows
Flows	- Sediment/water mixtures that are continuously deforming without distinct slip surfaces - Two forms occur depending on rate of movement: slow creep and rapid grain flows

Table 1: Typical types of slope movements on eroding banks.

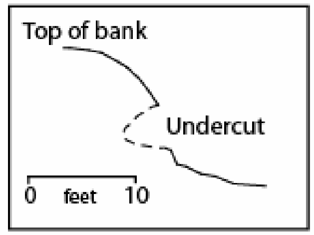
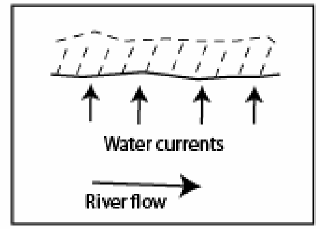
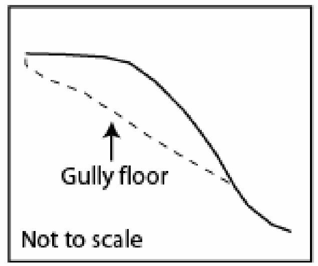
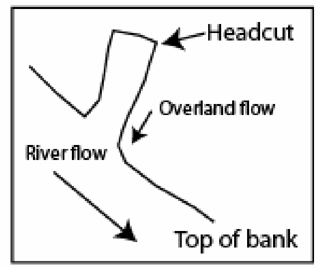
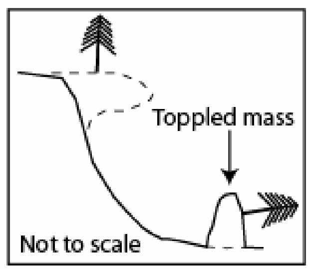
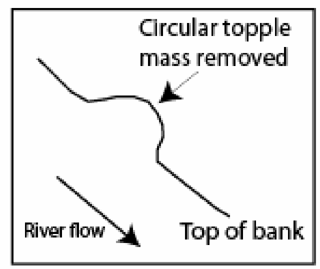
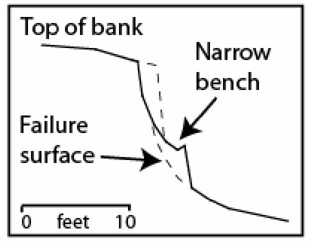
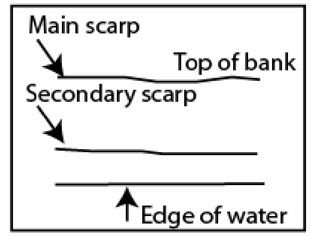
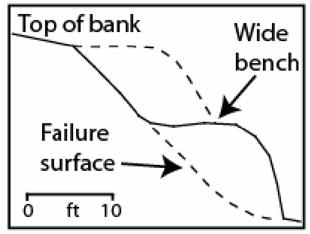
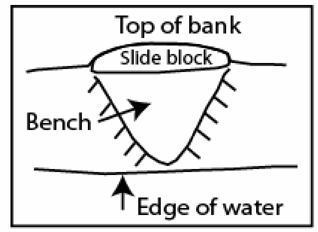
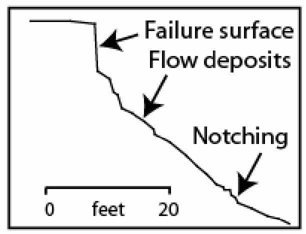
Erosion type	Photo	Profile	Planview	Description
Falls - Undercuts				- Undercutting - Notching and oversteepening at the toe of the slope
- Gullies				- Gullies formed by overland flow and groundwater seeps
Topples				- Vertical tension cracks at the top of slope - Trees lean away from bank - Toppled mass creates mound of soil at base of bank

Table 2: Types of erosion occurring in the Turners Falls Pool and their characteristics.

<table>
<tr><th>Erosion type</th><th>Photo</th><th>Profile</th><th>Planview</th><th>Description</th></tr>
<tr><td>Slides
- Planar slip</td><td></td><td>

Across from tailrace (Split River)</td><td>
</td><td>- Vertical tension cracks at top of slope
- Top surface of slide mass has flatter slope than rest of bank (narrow bench)
- Trees lean in towards bank
- Trees can remain in growth position despite sliding</td></tr>
<tr><td>- Rotational slump</td><td></td><td>

Munns Ferry</td><td>
</td><td>- Vertical tension cracks at top of slope
- Deeper seated than slips
- Trees lean in towards bank
- Arcuate failure surfaces</td></tr>
<tr><td>Flows
- Grain flows</td><td></td><td>

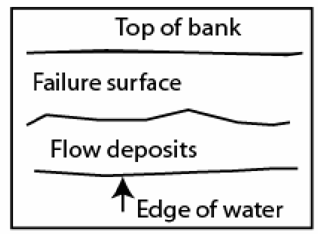
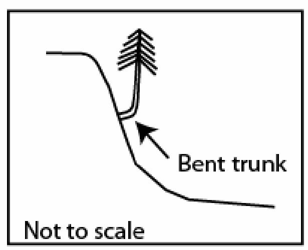
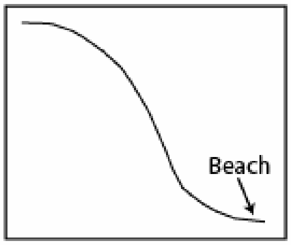
Downstream RR Bridge in VT (Kendall)</td><td>
</td><td>- Colluvial deposits created by flows accumulate at base of slope to form concave up surfaces</td></tr>
<tr><td>Creep</td><td></td><td>
</td><td>Not applicable</td><td>- Tree trunks bent downslope at base</td></tr>
</table>

Table 2 (continued).

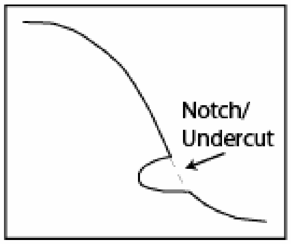
Stage | **Profile** | **Photo** | **Description**

a) Stable bank



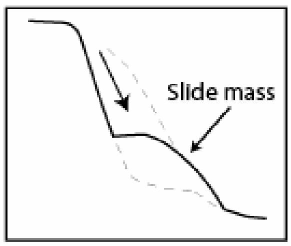
- Rounded slope, concave up at base
- Beach face protects slope from attack by currents

b) Notching or undercutting



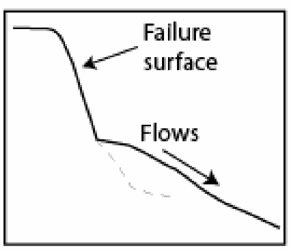
- Bank toe oversteepened by notching or undercutting
- Upper slope remains stable

c) Slide or topple



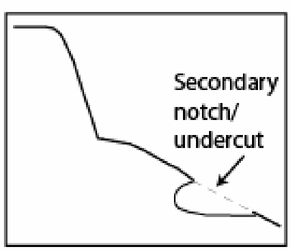
- Upper slope eventually destabilized by oversteppening at toe
- Slide or topple mass remains intact with narrow bench at top

d) Flows



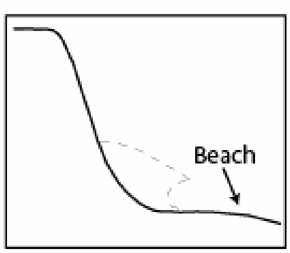
- Slide or topple mass becomes disaggregated at base and material flows to toe of slope

e) Secondary notching or undercutting



- Currents notch or undercut flow material to cause further collapse and flow of material

e) Bare bank



- Steep bare bank develops if flow material completely removed from base of bank
- Beach development can protect the toe of slope from further current attack
- If beach does not develop or persist, then erosion sequence can begin afresh

Figure 30: Model illustrating idealized sequence of erosion. Different stages of erosion can be occurring adjacent to each other along a long continuously eroding bank.

Field Geology Services Fluvial Geomorphology

Group	Mass Wasting	Erosion Type	Degree Upper Riverbank Vegetation	Upper Riverbank Slope	Upper Riverbank Sediment	Lower Riverbank Slope	Lower Riverbank Sediment	Upper Riverbank Height	Lower Riverbank Vegetation
			to Heavy				to Rock	High	Heavy
7	None	None	Moderate to Heavy	Flat	non-Rock	Flat to Vertical	Silt/Sand to Rock	Low to High	None to Heavy
8	None	None	None to Heavy	Flat to Overhanging	Rock	Flat to Vertical	Silt/Sand to Rock	Low to High	None to Heavy

Comparison of Field's stage of erosion to Table 3.1-1 Matrix of Riverbank Features and Characteristics

Field's Figure 30 presents 6 stages of erosion as presented above. These 6 combinations of riverbanks provide useful information on possible combinations of riverbank features and characteristics. The matrix of riverbank features and characteristics utilized in the 2008 FRR and proposed for the 2013 FRR provide a comprehensive set of key features and characteristics, including those outlined by Field, 2007. The use of the matrix allows for a detailed and comprehensive approach in classifying riverbanks and allows development of a detailed and comprehensive understanding of riverbanks. Each of the stages described in Field's Figure 30 is included in the matrix as shown in Table 1. Inclusion of the six descriptions of riverbanks developed by Field and the numerous other possible sets of riverbank features and characteristics in the matrix provides a comprehensive set of riverbank features and characteristics that both describe the riverbank conditions as observed in the field, as well as the stages of erosion as described by Field.

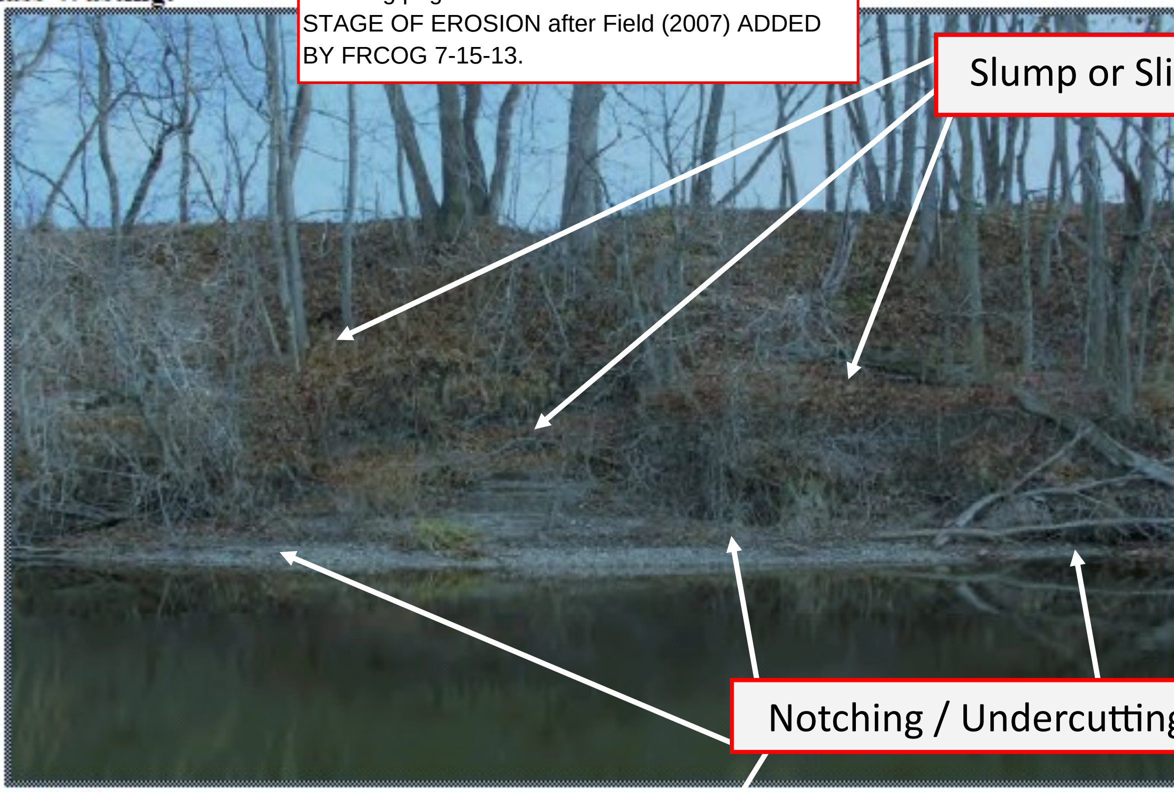
Table 1. Comparison of Field's stage of erosion with matrix of riverbank features and characteristics

Field	Matrix
a) Stable bank	Upper bank slope (flat to steep), Upper bank vegetation (moderate to heavily vegetated as well as even less vegetated conditions), with little to no erosion,
b) Notching or undercutting	Erosion Type: Undercut toe, notching; Degree of erosion: (little/none, some, extensive)
c) Slide or topple	Erosion Type: Slide; Degree of erosion: (little/none, some, extensive)
d) Flows (disaggregated slide)	Erosion Type: Slide; Degree of erosion: (little/none, some, extensive)
e) Secondary notching or undercutting	Erosion Type: Undercut toe, notching; Degree of erosion: (little/none, some, extensive)
f) Bare bank with beach	Upper bank slope with none to very sparse upper bank vegetation, flat lower bank slope

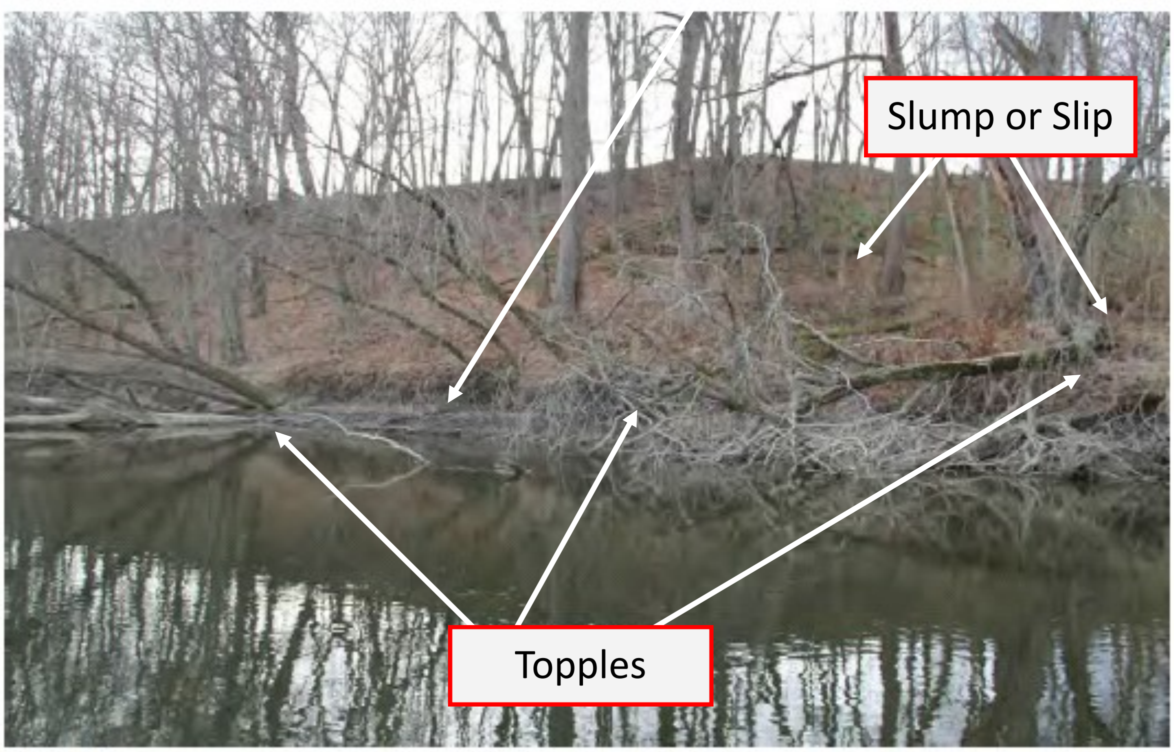
From the 3rd draft of the QAPP for the 2013 Full River Reconnaissance submitted by First Light on April 15, 2013.

TEXT, TEXT BOXES AND ARROWS on the following pages that IDENTIFY THE TYPE AND STAGE OF EROSION after Field (2007) ADDED BY FRCOG 7-15-13.

Mass Wasting:



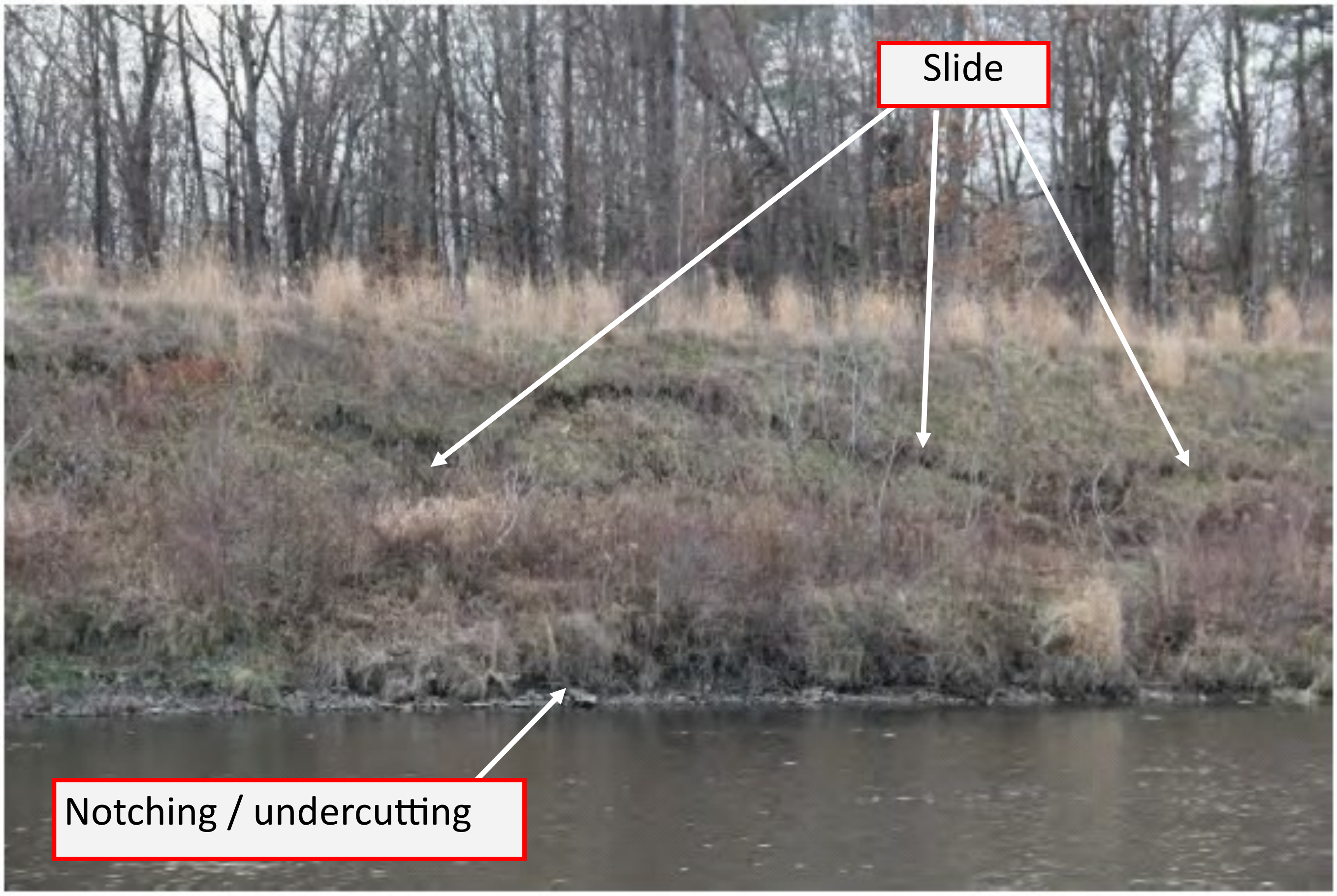
Little/None



Little/None

Stage of Erosion: b and c

Erosion Type: Falls (undercuts, gullies), Topples, Slides (slump, slip)



Little/None

Stage of Erosion: b and c

Erosion Type: Falls (notching, undercutting)
Slides (planar slip)

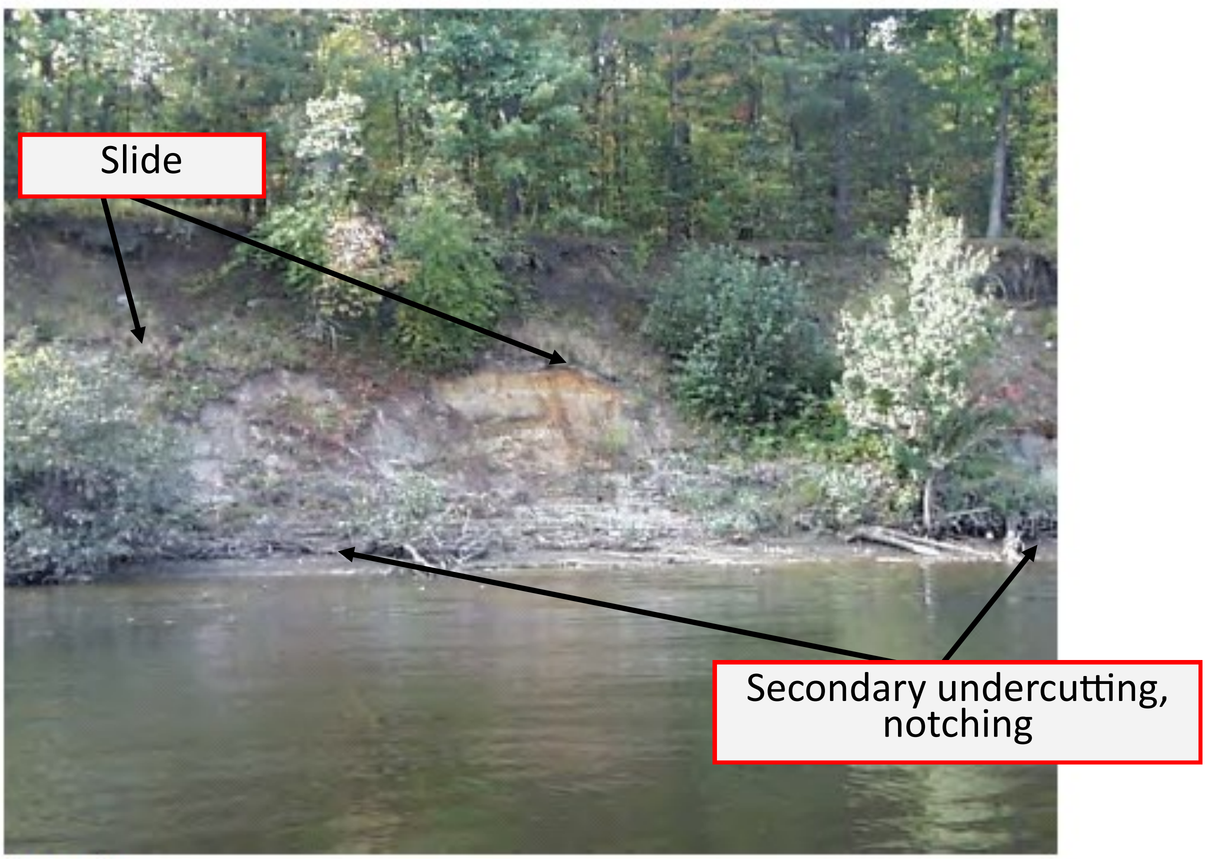
Some

Some

Stage of Erosion: b and c —Slide mass remains intact with narrow bench at top

Erosion Type: Slide

Extensive



Extensive

Stage of Erosion: b and e

Erosion Type: Slide (planar slip), Falls (undercuts)

Extensive

Stage of Erosion: e (End stage)

This is a stabilized site. It is the Flagg property.

Document Content(s)