CONNECTICUT RIVER WATERSHED COUNCIL
The River Connects Us
Upper Valley: P.O. Box 206, Saxtons River, VT 05154

September 29, 2016

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

Re: Wilder Dam Project No. 1892
Bellows Falls Project No. 1855
Vernon Dam Project No. 1904
Connecticut River Watershed Council Comments on TransCanada August 1, 2016 Study Reports; Request for Study Modification to Require Compliance with the RSP.

Dear Secretary Bose,

The Connecticut River Watershed Council, Inc. (CRWC) is a nonprofit citizen group established in 1952 to advocate for the protection, restoration, and sustainable use of the Connecticut River and its four-state watershed. We have been participating in the relicensing of the five hydropower facilities on the Connecticut River since the beginning of the process in late 2012. We have reviewed the set of Study Reports posted by TransCanada on August 1, 2016. CRWC attended the study report meeting held on August 24, 2016. Below are our comments on several of the studies. Included as part of these comments, is the *Peer-Review of ILP Study 2 and Study 3 Riverbank Transect and Riverbank Erosion Studies* prepared by Princeton Hydro (attached) ("Peer Review").

I. Study Dispute and Request for Study Modifications

These comments and the attached Peer Review demonstrate that numerous, significant aspects of Studies 2-3 were conducted: (1) in violation of the Revised Study Report (RSP) dated August 14, 2013 and approved with modifications from FERC on September 13, 2013; (2) failed to rely on generally accepted scientific methods; and/or (3) otherwise reached conclusions that the science, data or evidence do not support. Accordingly, some conclusions are invalid. CRWC requests that these studies be modified pursuant to 18 C.F.R. § 5.15(a) and (d) (1) to fully address these comments and the Peer Review. Portions of the Studies 2-3 Report, as detailed in the comments below and the attached Peer Review, should be revised or redone. Where appropriate, TransCanada should modify the study conclusions based on the revisions.

Individually or together, violations of the RSP, the failure to adhere to generally accepted science, failing to ground properly conclusions in the data and evidence, providing invalid

conclusions, all provide good cause to modify studies. The Peer Review details how each of the several faults in Studies 2-3 violates the RSP or otherwise provides good cause for modification. The following comments do the same. Indeed, these faults and failures are significant and skewed Studies 2-3's outcomes and conclusions, providing further good cause for modification. As detailed in the Peer Review and comments, study modification is required to assess properly the Projects' actual impacts on water quality, habitat, and the environment.

II. Comments

Studies 2-3: Riverbank Transect and Riverbank Erosion

CRWC hired consulting engineering firm Princeton Hydro (http://www.princetonhydro.com/) and Dr. Melinda Daneils of the Stroud Water Research Center to conduct a peer review of this study report. Based on the peer review, CRWC requests that TransCanada modify Studies 2-3 as follows:

- TransCanada should incorporate hydraulic modeling results from Study 4 into Study 2 - 3, and analyze the results to assess the relationship between shear stress and riverbank erosion, as proposed in the RSP.
- TransCanada should revise Study 2 and Study 3 to identify the effects of shoreline erosion on riparian areas and shoreline wetlands, rare plant and animal populations, water quality, and aquatic and terrestrial wildlife habitat, as stated in the RSP.
- FERC should consider the August 1, 2016 Study 2 – 3 report to be the interim report and that the Erosion Working Group's current review of the Combined Study 2 -3 be integrated into a revised study that the Erosion Working Group is then able to review as the final study, as proposed in the RSP.
- TransCanada should formally meet with the erosion working group as necessary to consider its comments and revise Study 2- 3 report to reflect those comments, as proposed in the RSP.
- TransCanada should extend the cross-section monitoring beyond the two-year monitoring period proposed in the RSP given that the Study itself suggests that this period was not long enough to analyze the *"cycle of erosion"* at all sites. This is a conclusion that is a product of the RSP so the fieldwork should continue until TransCanada collects sufficient data to measure erosion changes over time.
- TransCanada should analyze how water surface elevation (WSE) fluctuations increase the vertical range on the bank exposed to additional erosive forces such as boat waves, piping, and ice jams, that are all issues identified in the RSP.
- TransCanada should revise the report and present an analysis of the effects of the differences in the gradient of ground water and WSE changes.
- TransCanada should re-evaluate the existing data with respect to these important factors (i.e., methodology used, groundwater elevations, and surrounding land use) to "ascertain

the relative importance of water-level fluctuations associated with project operations in the erosion process relative to other contributing factors" as per the RSP (page 21, RSP Study 2).

- TransCanada should revise the report to add data supporting their claim that "normal project operations that have changed little in several decades" that appears in the last paragraph in the report.
- TransCanada should revise the report and formulate correlations between riparian buffers and erosion sites. TransCanada response dated 6/1/2016 to the comments on Study 1 (submitted March 1, 2016) stated, "Study 3 will include data on presence or absence of riparian buffer on most recent aerial photographs and relate it to erosion mapped in 2014; however, such an analysis was beyond the approved scope of Studies 1-3." Stakeholders expected this analysis to be part of the study.
- TransCanada should modify Studies 2-3 as otherwise detailed in the attached Peer Review.

These modifications are required to comply with the RSP, and to assure scientific integrity and valid conclusions. These are important departures from standards and requirements mandated by the RSP, and therefore provide good cause for these modifications.

CRWC has the following additional comments based on our review:

1. These studies were supposed to be a package of information that would show the history of erosion at all three projects AND show an analysis of causation of the erosion along the entire reach of river affected by the projects. That is not what the project owner presented to the stakeholders with these studies.

   Throughout the conversations of plan development/revision/review TransCanada knew that CRWC and other stakeholders wanted an analysis that lead to a conclusion of either none/partial/full responsibility on the part of TransCanada operations relative to flows and WSE as a cause or partial cause of erosion. The stakeholders thought the experts were supposed to design a plan that got us there and yet the Study 2 -3 report avoids providing any answer to the basic, often stated, clear, and consistent question from the stakeholders. The statement in the goals of Study 2 framed our expectations: "*whether water level fluctuations, described in terms of magnitude, periodicity and duration, and increased shear stresses resulting from project operations are correlated with erosion in project-affected areas."*

Recommendation: TransCanada should revise the Study 2-3 report to make those connections and evaluate the effects of project operations on erosion as was envisioned in the RSP despite the claim by TC at the August 25, 2016 meeting that that was not the intent of the study (pg. 11). They only referenced a 1979 study done by the USACE. This certainly is not an answer to the unfulfilled expectations of the stakeholders and TransCanada did not conduct the study as provided for in the approved study plan.

2. TransCanada declined conducting geotechnical slope analysis for this study because they considered it premature and related to mitigation.[1]. CRWC disagrees and believes that geotechnical slope analysis would be an effective tool for analysis to fulfill objectives of the study: characterize the processes of erosion, and ascertain the likely causes of erosion. If we are to have mitigation discussions later in the ILP process, we will have no geotechnical data that may guide these discussions. An added observation about this mitigation claim is that no one, neither FERC, the company, nor the stakeholders has had one word of discussion about mitigation for project effects and as near as CRWC can tell there is not time identified in the ILP schedule when those discussions might take place. We seem to be saving this discussion for a forum that has not and may never materialize.

Recommendation: See the Princeton Hydro's technical peer review memo for recommendations regarding how TransCanada can correct this shortcoming, and why TransCanada should modify Study 2-3 to address this lack of data and analysis.

3. An omission in Studies 2 and 3 is the lack of any support information at all about the statement in the last paragraph that "normal project operations have changed little in several decades." CRWC specifically asked that since 'several decades' is a pretty loose description of time and since during the last three decades the electric power industry has deregulated and operates in a manner different from the time before deregulation TransCanada should present data to support such a statement. Despite there being no mention in their meeting summary, CRWC asked this question and elicited a response from TransCanada that they would address our concern.

Recommendation: TransCanada should provide stakeholders with data showing project operations over the past 25 years that documents their claim of unchanged project operations as stated in the last paragraph of the report. This is in compliance with §5.15(b) and TransCanada assured qualification of that statement at the meeting August 25, 2016 (meeting summary pg 11).

4. There is no correlation of erosion with land cover despite specific mention at two of the stakeholder meetings that land use and the lack of riparian zones are part of the cause of erosion. TransCanada noted that, "a GIS line file was created for the presence or absence of riparian vegetation by hand-digitizing the locations of riparian vegetation as viewed on 2010 digital orthophotographs available through NH Granit (Web citation 8)," but there is no analysis and correlation between problematic land uses and erosion sites creating another

[1] TransCanada's 12/14/15 response to the Sept. 14, 2015 USR (page 3), stated, "With regard to geotechnical slope analysis, we continue to assert that it is premature as such an exercise would be for the purpose of identifying potential mitigation measures rather than license conditions under new FERC licenses, rather than to provide information on the current conditions." FERC agreed in its September 13, 2013 Study Plan Determination (pp. B-6 to B-7), and did not require TransCanada to perform such an analysis at this study stage.

blank in the analysis of erosion causation. See meeting summary October 1, 2015 meeting question on pg 14.

Recommendation: TransCanada has the needed information and therefore should revise the report and make those correlations available to the stakeholders as requested at the October 1, 2016 meeting.

5. The study claims that the "magnitude of water surface fluctuations in the study area is less than 2 ft. for 75% of the study area's length, so hydraulic gradients between groundwater levels in the bank and the adjacent river level are likely small (page 111 Executive Summary, Study 2 and Study 3 Report). However small the gradient might be, it was incumbent on TransCanada to evaluate the effect of piping as the expression of the difference in gradient in creating the first stage of erosion, water edge notches.

Recommendation: TransCanada should revise the report and analyze the effects of the differences in the gradient of ground water and WSE changes (pg ES 3 Study 2-3). Since the report is dismissive of the possible effect, CRWC requests that TransCanada document their claim that the 2 ft. difference has only a small effect. This does not square with Study 3 goal to *"ascertain the likely causes of erosion (e.g., high flows,* ***groundwater seeps,*** *eddies,* ***water level fluctuations*** *related to project operations),"* so TransCanada did not conduct the study as provided for in the approved study plan.

6. With regard to Aquatic Habitat, the Study 2-3 report references Study 8 but acknowledges that the Study 2-3 did not quantify the effect of fine-grained riverbank materials on increased embeddedness of coarse-grained spawning substrates in the project reservoirs. CRWC has twice commented on the lack of any analysis of the loss of habitat to the sediment caused by shoreland erosion and other sources of sediment. With the completion of the studies at this point, we still have no idea of the impact of erosion on loss of habitat.

Recommendation: TransCanada should continue gathering and analyzing data to determine the effects of project operations on the loss of aquatic habitat. This does not square with the Study 3 goal *"identify the effects of shoreline erosion on other resources (e.g., aquatic habitat),"* so TC did not conduct the study as provided for in the approved study plan.

7. According to the RSP: "*An interim study report will be prepared after the first year of study is complete synthesizing the above deliverables into a narrative that addresses the study goals and issues raised in various study requests. The report will be provided to stakeholders for review and comment." (Page 25 RSP Study 2),* and *"The interim study report will be prepared after the first year of study is complete. The report will be provided to stakeholders for review and comment."* (page 36 RSP Study 3) TransCanada did not provide any Interim Reports for Study 2 and Study 3 to the Erosion Working

Group for review and comment so it was not possible to have working group comments on the interim report included in the August 1 report.

Recommendation: FERC should recognize this review period ending August 1, 2016 as the interim review that was mentioned in the RSP, and that the Erosion Working Group's current review of the Combined Study 2 - 3 be integrated into a revised study that the Erosion Working Group is then able to review comment on as the final study. This is in compliance with §5.15(b) and the RSP. The Initial Study Report (ISR) dated 9/15/14 and the Updated Study Report (USR) dated 9/14/15 were short updates on study progress, and were not interim reports.

Beyond these comments, we reference and include the attached memorandum, *Peer-Review of ILP Study 2 and Study 3 Riverbank Transect and Riverbank Erosion Studies* prepared by Princeton Hydro for other specific issues CRWC feels FERC should address at this stage and in the upcoming license renewal.

Studies 14-15: Resident Fish Spawning in Impoundments and Riverine Sections

It seems ironic that the report offers Figure 4.1-4 solely as an example of the vertical orientation of perch egg masses because it is a view of dewatered eggs. It is also a picture of what fishers in the Bellows Falls area see in the setbacks north of the Bellows Falls dam every year. That sight concerns them greatly.

CRWC agrees with the VT Fish &Wildlife Department that egg laying and maturity are a function of water temperature much more than of the day on the calendar. TransCanada needs to base operations on temperature -- not the day of the month during spring and fall spawning periods. Yellow perch is a favored game fish and the high loss of eggs should prescribe a change in operations during the spawn.

Study 21: American Shad Telemetry

CRWC supports the recommendations from the US Fish and Wildlife Service and the VT Fish & Wildlife Department that TransCanada needs to do further work relative to measuring the actual success rate of the passage of fish at the project fish ladders. The report also needs to resolve how the information is present so there is less confusion about what it means that a shad or any other fish passed the dam using the ladder.

III. Conclusion

FERC should require TransCanada to modify Studies 2-3 consistently with the attached Peer Review, our requests for revisions in the study report and these comments. FERC should acknowledge the comments regarding Studies 14, 15, and 21.

CRWC would like to thank FERC for the opportunity to comment on these studies. The balance of the other studies we have already commented on or find that they provide sufficient information. It would be helpful to hear back from FERC about issues raised in these and other stakeholder comments.

David L. Deen, River Steward
Connecticut River Watershed Council

Andrea Donlon River Steward
Connecticut River Watershed Council

ATTACHMENTS
Princeton Hydro Peer Review
Princeton Hydro resumes

Scientists, Engineers & Environmental Planners Designing Innovative Solutions for Water, Wetland and Soil Resource Management

September 30, 2016

MEMORANDUM

To: Andrea Donlon, CRWC
David Deen, CRWC

From: Laura Wildman, P.E., Princeton Hydro, LLC
Paul Woodworth, Fluvial Geomorphologist, Princeton Hydro, LLC
Melinda Daniels, PhD, Fluvial Geomorphologist, Stroud Water Research Center

Re: FERC Re-Licensing Process for TransCanada Hydro Northeast Inc.
Peer-Review of ILP Study 2 and Study 3
Riverbank Transect and Riverbank Erosion Studies

The Connecticut River Watershed Council (CRWC) is a stakeholder and participant in the re-licensing process of the Federal Energy Regulatory Commission (FERC) for the three hydropower facilities owned by TransCanada Hydro Northeast Inc. on the Connecticut River, Wilder Dam, Bellows Falls Dam, and Vernon Dam. Princeton Hydro, with the Stroud Water Research Center, was retained by CRWC to complete peer-review of technical erosion studies, specifically Integrated Licensing Process (ILP) Study 2 and Study 3: Riverbank Transect and Riverbank Erosion Studies. ILP Study 1: Historical Riverbank Position and Erosion Study was reviewed for background data, as was the study plan laid out in the Revised Study Plan (RSP), dated August 14, 2013, and as revised in Appendix B: Staff's Recommendations on Proposed and Requested Study Modifications And Studies Requested, dated September 13, 2013[1]. This memorandum is a critical review of ILP Study 2 and Study 3 and aims to address the following questio*ns* as defined in 18 CFR § 5.15 Conduct of studies (d) Criteria for modification of approved study, and the RSP:

- Were the studies completed as per the Revised Study Plan?
  - Were the objectives set in the RSP met?
    a. If not, is additional data collection or analysis warranted?
  - Were the methods described in the RSP utilized?

[1] Our review was limited to the RSP, Study 1, and the Study 2 and Study 3 Report, as well as their associated Appendixes. No field work was conducted as part of our review, so we are not able to comment on if the observations stated in the studies accurately reflect field conditions within the project reach. In addition, we did not review, in any detail, the numerous other studies submitted to FERC as part of TransCanada's recent submittal.

- Was the analysis described in the RSP conducted?
- Was the Study conducted in a manner consistent with generally accepted scientific practice?
    a. Was the methodology utilized consistent with generally accepted scientific practice?
        i. If not, is additional analysis or a different type of analysis warranted to meet the RSP goals of conducting the study in a manner consistent with generally accepted scientific practice?
    b. Were the conclusions of the study consistent with the scientific evidence presented?
- Were the deliverables promised in the RSP included in the final study report submittal?

FRAMEWORK FOR THIS PEER REVIEW

For ease of review of this memorandum we have italicized, placed in quotes, and referenced page numbers for any text taken directly from the Revised Study Plan (RSP) or the combined Study 2 and Study 3 Report. Our comments have been structured as per the Integrated Licensing Process (ILP) regulations 18 CFR § 5.15(d)(1) regarding conduct of studies, and have been subcategorized to reflect the structure of the subsections taken from the Revised Study Plan, dated August 14, 2013, pages 19-36, and additionally revised September 13, 2013.

The Revised Study Plan was organized into 14 sections, including:

RELEVANT STUDY REQUESTS
STUDY GOALS AND OBJECTIVES
RELEVANT JURISDICTIONAL AGENCY RESOURCE MANAGEMENT GOALS
ASSOCIATION WITH OTHER STUDIES
EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION
PROJECT NEXUS
STUDY AREA AND STUDY SITES
METHODS
ANALYSIS
CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE
DELIVERABLES
SCHEDULE
LEVEL OF EFFORT AND COST
REFERENCES

We have organized our review to comment on only those sections of the Study 2 and Study 3 Report that we felt were not conducted as provided for in the Revised Study Plan, as per the ILP regulations 18 CFR § 5.15(d)(1) regarding conduct of studies. The sections we commented on relating to their consistency with the RSP are:

STUDY GOALS AND OBJECTIVES

METHODS
ANALYSIS
CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE
DELIVERABLES

All of our comments fall under the ILP regulations 18 CFR § 5.15(d)(1), which asks if "approved studies were not conducted as provided for in the approved study plan."

Each section of our review starts by including the exact statement from the Study 2 and Study 3 Report that we are commenting on, and then follows with our peer review comment and our recommendation.

STUDY GOALS AND OBJECTIVES

This section includes our comments on the "Study Goals and Objectives" as described in the RSP. We have specifically commented on the objectives from the RSP that we feel were not met or not conducted as provided for in the RSP.

Objective from RSP, under Study Goals and Objectives: *"Observed water-level fluctuations and shear stresses from nonproject-related factors will also be investigated."* (Page 19, RSP Study 2)

"Hydraulic modeling (Study 4) will be integrated into the study after field sampling ends to analyze the relationship between shear stress and bank erosion." (Page 25, RSP Study 2)

"Analyze hydraulic modeling data to provide information on flow velocity, stage (water surface elevation or WSE), and shear stress impacting riverbanks in the study area." (Page 5, Study 2 and Study 3 Report)

Peer Review Comment: No hydraulic modeling results, including shear stress impacting riverbanks in the study area, were analyzed or discussed in the Study Report. Without this analysis, a key part of the study as proposed in the RSP is missing and a fundamental driver in the erosion process (i.e. shear stress) has gone unassessed.

Recommendation #1: TransCanada should incorporate hydraulic modeling results from Study 4 into Study 2 and Study 3, and analyze the results to assess the relationship between shear stress and river bank erosion, as proposed in the RSP.

Objective from RSP, under Study Goals and Objectives: *"The objectives of this study are to: Ascertain the likely causes of erosion (e.g., high flows, groundwater seeps, eddies, and water-level fluctuations related to project operations)."* (Page 27, RSP Study 3)

"This study will ascertain the relative importance of water-level fluctuations associated with project operations in the erosion process relative to other contributing factors and how the importance of water-level fluctuations in the erosion process varies with soil type and geomorphic setting." (Page 21, RSP Study 2)

Peer Review Comment: The third objective of Study 3, to "*ascertain the likely causes of erosion" (page 27, RSP Study 3)*, has not been completed, nor has the study ascertained *"the relative importance of water-level fluctuations associated with project operations in the erosion process relative to other contributing factors"* (page 21, RSP Study 2). The Study 2 and Study 3 Report characterizes the cyclical processes of bank erosion but concludes that, *"Trying to distinguish specific effects of normal project operations among the panoply of potential controls on bank erosion in any given location is not possible"* (page 108, Study 2 and Study 3), and states, *"Attempting to identify a single cause for erosion fails to recognize that multiple processes operate collectively to effect change on the riverbanks through space and time"* (ES-3, Study 2 and Study 3 Report). The fact that there are multiple causes of bank erosion is a generally accepted assertion; the intent of the study was not to determine if project operation were the single cause for erosion but to ascertain the likely causes of erosion, in other words to ascertain which causes are more dominant than others and thus, to *"facilitate conclusions as to the association and effect of project operations on active erosion"* (page 13, RSP Study 1). The RSP's Project Nexus for Study 2, page 21, states that, *"This study will ascertain the relative importance of water-level fluctuations associated with project operations in the erosion process relative to other contributing factors*". The study fails to *"ascertain the relative importance"* of the project operations (i.e., WSE fluctuation) in relation to other contributing factors (e.g. high flows, groundwater seeps, eddies), because it uses a methodology that cannot accomplish this study objective, referred to in the study as *"the erosion ratio" (first described on page* 82, Study 2 and Study 3 Report), and which was not proposed in the RSP. Please see our comment under the section on "CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE" in this peer review.

In addition, no data was collected to ascertain groundwater seeps associated with water fluctuation as a likely cause of erosion. An investigation of groundwater seeps would have required identifying the elevation of groundwater adjacent to the banks with respect to the varying water surface elevation in the channel. The report states, *"the magnitude of water surface fluctuations in the study area is less than 2.0 ft for 75% of the study area's length so hydraulic gradients between groundwater levels in the bank and the adjacent river level are likely small"* (page 111, Executive Summary, Study 2 and Study 3 Report); however, no groundwater data was collected to affirm that statement, nor to assess the remaining 25% of the study area.

The Revised Study Plan provides a simple list of causes of erosion, *"e.g., high flows, groundwater seeps, eddies, and water-level fluctuations related to project operations,"* (page 27, RSP Study 3) that were considered at the outset of the project. However, the Study does not consider adjacent land use as a factor (other than the presence or absence of riparian vegetation at the top of bank), and yet numerous peer-reviewed research studies have investigated and confirmed that adjacent land use has a strong role in bank stability and erosion. In addition, the study does not consider the impact that daily WSE fluctuations may have on limiting vegetative growth at the toe of the river banks, although the study itself acknowledges the important role that vegetation can have on increasing bank resistance to erosion.

Recommendation #2: TransCanada should re-evaluate the existing data, or if necessary gather additional data, with respect to these important factors (i.e., methodology used, groundwater elevations, and surrounding land use) to "*ascertain the relative importance of water-level fluctuations associated with project operations in the erosion process relative to other contributing factors*" as per the RSP (page 21, RSP Study 2).

Objective from RSP, under Study Goals and Objectives: *"Identify the effects of shoreline erosion on other resources (e.g., riparian areas and shoreline wetlands, rare plant and animal populations, water quality, and aquatic and terrestrial wildlife habitat)."* (Page 27, RSP Study 3)

Peer Review Comment: The fourth objective of Study 3, *"to identify the effects of shoreline erosion on other resources"* (page 27, RSP Study 3) has not been completed. In the final section of the Study 2 and Study 3 Report, the Assessment of Project Effects makes brief references to other studies (page 112, Study 2 and Study 3 Report); however, these studies do not assess shoreline erosion project effects and in most cases these additional studies were not intended to do so. Specifically:

A. With regard to Water Quality, reference is made to Study 6 - Water Quality Monitoring Study (Louis Berger Group and Normandeau, 2016a), which *"found that the Wilder, Bellows Falls, and Vernon projects had negligible to no effect on turbidity"* (page 112, Study 2 and Study 3); however, the following statement, *"the few recorded spikes in turbidity were found to occur in response to high flows resulting from heavy rain events,"* (page 112, Study 2 and Study 3) fails to distinguish if bank erosion is a contributing factor in the turbidity peaks. Thus, the project effects on water quality remain unassessed and its conclusion that project operations had negligible effect on turbidity are unfounded.

B. With regard to Aquatic Habitat, reference is made to Study 8 – Channel Morphology and Benthic Habitat Study (Stantec and Normandeau, 2016), but acknowledges that the study did not quantify the effect of fine-grained riverbank materials on increased embeddedness of coarse-grained spawning substrates. Another reference is made to Studies 14/15 – Resident Fish Spawning in Impoundments and Riverine Sections Studies

(Normandeau, 2016a), Study 16 – Sea Lamprey Spawning (Normandeau, 2016b), and Study 21 – American Shad Telemetry Study – Vernon (Normandeau, 2016c) (page 112, Study 2 and Study 3); however, none of these studies had the objective of assessing the impacts of bank erosion on aquatic habitats. Thus, the project effects on aquatic habitat remain unassessed.

C. With regard to Rare Animal Populations, reference is made to Study 24 – Dwarf Wedgemussel and Co-Occurring Mussel Study (Biodrawversity et al., 2014; 2015, Study 25 – Dragonfly and Damsel Fly Inventory and Assessment (Normandeau, 2016d), Study 26 – Cobblestone and Puritan Tiger Beetle Survey (Normandeau, 2016e), Study 28 – Fowler's Toad Survey (Normandeau, 2016f), and Study 29 – Northeastern Bulrush Survey (Normandeau, 2016g) and they *"did not identify erosion resulting from normal project operations water level fluctuations as a potential factor"* (page 113, Study 2 and Study 3). However, none of these studies had the objective of assessing the impacts of bank erosion on rare animal populations, both direct (i.e. WSE fluctuation) and indirect (i.e. bank collapse impacts). Thus, the project effects on these rare animal populations remain unassessed.

Recommendation #3: TransCanada should revise the Study 2 and Study 3 Report to identify the effects of shoreline erosion on riparian areas and shoreline wetlands, rare plant and animal populations, water quality, and aquatic and terrestrial wildlife habitat, as stated in the RSP.

Objective from RSP revision of Sept. 13, 2013: "*The study's analysis will include a correlation of visible indicators of erosion with project-caused water-level fluctuations at the 21 transect locations established in the Riverbank Transect Study (Study 2)."* (Page 1 Study 2 and Study 3)

Peer Review Comment: This objective is not accomplished because the *"erosion ratio"* metric (page 82, Study 2 and Study 3) employed to attempt to identify correlation is not a generally accepted scientific practice. It lacks the rigor of other accepted statistical analysis techniques. For additional discussion on this topic please see our comments relating to "CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE" later in this memorandum.

The RSP notes on page 32 the importance stratigraphy can play in bank erosion: *"the layering of sediments within the banks can play an instrumental role in bank stability with contacts between permeable sand above impermeable clay providing a zone along which water can preferentially seep out of the bank. Consequently, identification of the various sedimentary layers within a bank is critical to understanding the distribution and causes of erosion."* In addition, the RSP states on page 29 that, *"Detailed information to be collected as part of this study on bank stratigraphy, depth to sand-clay interfaces, and their relationship to past water-level fluctuations is needed to confirm whether project operations are causing reductions in bank instability."*

While stratigraphic data were collected and provided in the appendices, these data were only referenced in general statements in the study and not analyzed or discussed, such that the relationship between WSE fluctuations and bank instability were unassessed. The Study 2 and Study 3 Report states:

- "*Banks composed of non-cohesive sediments and interlayered cohesive and non-cohesive sediments are the most susceptible to erosion.*" (page 10, Study 2 and Study 3 Report)
- *"Normal project operations result in daily or sub-daily fluctuating water levels. At many sites, the position of those daily fluctuations on the bank aligns with the location of notching at the base of the bank"(page 53, Study 2 and Study 3 Report)*. Figure 5.4.2-6, below, from the Study 2 and Study 3 Report illustrates this observation, with the location where the WSE fluctuation based on normal operating range intersects with the notch in the river bank, circled in red.

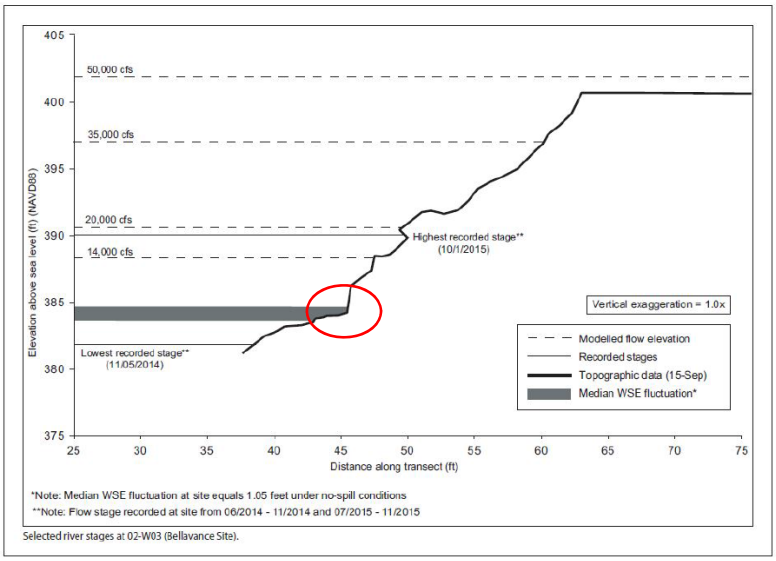

Figure 5.4.2-6. Position on bank of normal operating range aligns with location of notching at 02-W03 (Bellevance Site).

- *"Fluctuations in WSE related to normal project operations under no-spill conditions are consistent with notching and overhangs observed at the base of 8 of the 21 monitored banks at some point during the two-year monitoring period (Appendix A). Erosion can result from seepage forces generated by WSE fluctuations (Budhu and Gobin, 1995) with overhangs developing when seepage is focused along a single layer (Fox and Wilson, 2010)."* (page 111, Study 2 and Study 3)
- *"The character of sediments in the study area creates banks with limited resistance to erosion. The bank sediments at the monitoring sites, representative of the study area as a whole, are nearly ubiquitously comprised of fine-grained and unconsolidated floodplain or glaciogenic sediments particularly prone to erosion (see Appendix A stratigraphic columns). Frequently observed inter-beds of permeable sand and less*

> *permeable silt can further reduce the resisting force of floodplain sediments by creating horizontal surfaces along which groundwater can preferentially move, potentially increasing seepage forces acting on the bank."* (page 109, Study 2 and Study 3)

A more detailed discussion and analysis of these site conditions is warranted in order to determine "*their relationship to past water-level fluctuations" and "confirm whether project operations are causing reductions in bank instability"* as per the plan set forth in the RSP.

The study concludes that, "Trying to distinguish specific effects of normal project operations among the panoply of potential controls on bank erosion in any given location is not possible," (page 108). We suggest that a statistical method such as an Analysis of Variance (ANOVA), Multivariate Analysis of Variance (MANOVA), or Principal Component Analysis (PCA) would be consistent with generally accepted scientific practice and would yield more conclusive results. This is further discussed in our comments under "CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE" that follow in this memorandum. In addition to a statistical method, a modeling method, such as Bank Toe Erosion Model (BSTEM), coupled with a sensitivity analysis of the input variables, would assist in distinguishing the degree to which WSE fluctuation impacts bank stability versus other erosive mechanisms. The input variables in a bank stability model such as BSTEM typically include geotechnical and vegetation data, such as surface erodibility, critical shear stress, geotechnical strength, bulk unit weight, riverbank sediment particle-size distribution, maximum rooting depth of vegetation, and riparian species distribution. This type of bank stability model has the ability to run with various parameters either included or not included, in order to better assess the likely causation of erosion.

Recommendation #4: TransCanada should utilize the existing data to further assess the potentially "instrumental role" that WSE fluctuation may have on initiating the erosion cycle, by directly comparing the elevations where notching is observed and where the normal operational WSE fluctuations occur, and incorporate their data, relating to the "layering of sediments within the banks" and the stratification of permeable and less permeable zones, into this assessment. In addition, TransCanada should utilize a more rigorous statistical method to analyze the significant amount of data collected.

METHODS

This section includes our comments on the "Methods" as described in the RSP. We have only included comments on the sections of the "Methods" from the RSP that we feel were not conducted as provided for in the RSP.

Repeat Surveys

Statement from RSP: *"TransCanada will consult with the erosion working group during the 2-year monitoring period to discuss the need for, and locations of, increased sampling frequency based on the initial monitoring results and any information gleaned from the historical data research in Study 1 (Historical Riverbank Position and Erosion) that supports the need for more periodic monitoring based on significant erosion rates. The need for, and extent of, additional monitoring approaches (e.g., groundwater-level monitoring) could also be discussed in consultation."* (Page 23 RSP Study 2)

Peer Review Comment: TransCanada did not consult with the Erosion Working Group[2] during the 2-year monitoring period as described on page 23 of the RSP. The Erosion Working Group participated in choosing the transect locations, but was allowed only to review the study after the 2-years of monitoring were completed and the Study 2 and Study 3 Report were submitted.

This interim consultation appears to have been added to the RSP to justify the reduction in the number of monitoring sites from 30, requested by FERC (10 for each project), to 20 (page 21 RSP Study 2, an additional cross section was added later) and from a biweekly monitoring frequency, requested by NHDES, NHFG, and VANR, to "*at least four times per year for 2 years" (page 23 RSP Study 2),* and yet this consultation and interim reporting did not take place.

Recommendation #5: TransCanada should formally meet with the erosion working group as necessary to consider its comments and revise the Study 2 and Study 3 Report to reflect those comments, as proposed in the RSP.

Hydraulic Modeling

Statement from RSP: *"For this study, two-dimensional (2-D) modeling at up to six sites using River2D may be necessary to understand complex sites where HEC-RAS modeling does not adequately describe eddy flows that might develop, for example, upstream of valley constrictions or flow deflection that might occur, for example, around a mid-channel bar or island."* (Page 33 RSP Study 3)

[2] **TransCanada organized stakeholders into working groups to discuss study plans and study details. CRWC is or was a member of the Erosion Working Group.**

Peer Review Comment: The RSP stated that 2D modeling "may be necessary to understand the complex sites". No 2D modeling was prepared, nor was its use or reasons for not using it discussed in the Study.

Recommendation #6: TransCanada should add a discussion to the Study 2 and Study 3 Report that explains why 2D modeling was not completed and that the 1D modeling provided in Study 4 was adequate to analyze the more complex sites.

ANALYSIS

This section includes our comments on the "Analysis" as described in the RSP. We have only included comments where we felt that the Study Report was not conducted as provided for in the RSP.

Statement from RSP: *"TransCanada will consult with the erosion working group periodically to solicit comments to strengthen data collection procedures, analysis of erosion causes, and continuing studies during the 2-year study period."* (Page 35 RSP Study 3)

Peer Review Comment: TransCanada did not consult with the Erosion Working Group periodically to solicit comments to strengthen data collection procedures, analysis of erosion causes, and continuing studies during the 2-year study period for Study 3, as stated in the RSP.

Recommendation #7: FERC should consider the August 1, 2016 Study 2 and Study 3 Report to be the interim report and that the Erosion Working Group's current review of Study 2 and Study 3 Report be integrated into a revised study that the Erosion Working Group is then able to review as the final study as proposed in the RSP.

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

This section includes our comments on the Study 2 and Study 3 Report in relation to its "Consistency with Generally Accepted Scientific Practice" as described in the RSP. We have only included comments on the methods used and conclusions drawn that we feel were not conducted as provided for in the RSP. We have broken our comments down into two sections, to respond to the Study's consistency with generally accepted scientific practice, as stated below:

"The various methods to be used for this study conform to generally accept scientific practice" (Page 24 RSP Study 2), and *"The various methods to be used in the Riverbank Erosion Study conform to generally accepted scientific practice as detailed in the Methods section above"* (Page 35 RSP Study 3).

The first section relates to comments on how the methodology used in Study 2 and Study 3 is consistent with generally accepted scientific practice (i.e., cross section selection and the erosion ratio method utilized), the second relates to comments on whether the Study's conclusions are supported by the evidence given.

1. Consistency of Methodology with Generally Accepted Scientific Practice

Cross Section Selection for Monitoring

While we believe that the study selected the cross section monitoring sites in accordance with the RSP, the study extrapolates observations regarding bank erosion, on a project-wide basis, from monitoring sites that were "*selected so a range of"* conditions *"are incorporated into the analysis"* (page 22 RSP Study 2). Because the sites were not selected to reflect statistical occurrence along the project-wide reach, any extrapolation on a project-wide basis may not be well supported.

> **Recommendation #8:** TransCanada should revise the report to omit extrapolations to the entire study area based on the monitored cross sections unless a statistically based method is used to link cross-section observations with their likely occurrence frequency over the entire study reach.

Erosion Ratio

The primary metric relied upon for *"identifying the propensity of erosion to occur in association with certain conditions"* (Page 34 RSP Study 3) is the *"erosion ratio"* (Page 82, Study 2 and Study 3). This approach is not a generally accepted scientific practice and is not included in the RSP. It was presumably used to accomplish the objective of including a *"correlation of visible indicators of erosion with project-caused water-level fluctuations at the 21 transect locations"* (Page 1, Study 2 and Study 3). No citation or reference is provided for this metric, and the metric is not used, to our knowledge, in the extant fluvial geomorphic scientific literature. The Study does not demonstrate that the method *"conforms to generally accepted scientific practice"* (page 24, RSP Study 2 and Page 35 RSP Study 3).

The erosion ratio is too simplistic for attempting to ascertain the likely causes of erosion, when there are multiple known causes. It is defined as the ratio of two percentages: *"the percentage of bank erosion in the study site that is present within a specified feature divided by the percentage of bank length occupied by that feature"* (page 82, Study 2 and Study 3). According to the report, a value greater than 1.0 represents a propensity (or *"more likely to occur"*), and a value less than 1.0 indicates no propensity (i.e. *"less likely to occur"*).

Generally accepted scientific practices for analyzing processes with multiple causative variables rely on statistical analyses more sophisticated and robust than simple ratios. Such statistical methods that may be applied in these Studies, depending on the type and structure of the collected data, include Analysis of Variance (ANOVA), Multivariate Analysis of Variance (MANOVA), or Principal Component Analysis (PCA).

As much of the data is geographic in nature (e.g. the location of bank instability) and managed within a GIS, more rigorous spatial statistical methods should be employed to ascertain spatial autocorrelation or spatial regression, particularly to analyze *"correlation of visible indicators of erosion with the project-caused water-level fluctuations"* (page 1, Study 2 and Study 3).

For example, the data set that categorizes all banks within the study area into one of six classes: eroding, vegetated eroding, failing armor, stable, healed erosion, and armored (page 79, Section 5.6.4 Mapping Results, Study 2 and Study 3) should be re-analyzed through one of these multi-variate methods with respect to the various contributing factors such as bank height, WSE fluctuation, riparian vegetation, bend geometry, etc. It also should be noted that the classes *"healed erosion"* and *"armored"* are essentially banks that were eroding in the past but are not anymore, and those previously eroding banks may also have been due to project operations. Including those two classes in the larger *"stable"* category may lead to overlooking past impacts associated with project operations and could significantly change the findings in Section 5.3 Analysis of Historical Aerial Photography (page 23). For example, in Figures 5.3-1a, b, c, (Pages 25, 27, and 29, Study 2 and Study 3, respectively) it is unclear whether the decrease in bank erosion through time was influenced by bank armoring which may have arrested the process in some areas, while the source of the problem continued to exist.

In addition, the data set derived from the review of aerial photographs at 0.5-mile increments (Page 23, Section 5.3 Analysis of Historical Aerial Photography, Study 2 and Study 3) should also be re-analyzed with multi-variate methods with respect to the bank classification data mentioned above or with respect to the various contributing factors such as bank height, WSE fluctuation, riparian vegetation, bend geometry, etc. Further, the data set related to the 21 transects (Page 30, Section 5.4 Erosion Monitoring, Study 2 and Study 3) should be re-analyzed through a multi-variate method with respect to the erosion at the top, upper, mid, lower and toe of bank (Table 5.4.2-1, page 44) and to the median WSE fluctuation.

The erosion ratio appears to have limitations and be subject to biases. In discussing the erosion ratio associated with WSE fluctuations in the Vernon impoundment in Section 5.6.5 of Study 2 and 3, page 97, an abnormally high value is dismissed because the WSE range in question exists for such short lengths, which indicates that the erosion value can be easily skewed. To avoid 'interpreting results potentially skewed by short lengths', the analysis deliberately disregards any bank lengths that are less than 10% of the study area. This is problematic for two reasons. First, it overlooks banks that, albeit short, may be severely impacted by project operations. Second, multiple classes of 0.5-foot increment WSE fluctuations, which may fall below the arbitrary 10% threshold individually, collectively add up to a significant proportion, likely over 25%. Thus, in attempting to circumvent allegedly skewed results, the analysis dispenses with data that could otherwise be informative.

Recommendation #9: TransCanada should re-analyze the data in Study 2 and Study 3 Report according to generally accepted scientific practice, as specified in the RSP. The data set that categorizes all banks within the study area into one of six classes (i.e. eroding, vegetated

eroding, failing armor, stable, healed erosion, and armored (Page 79, Section 5.6.4 Mapping Results, Study 2 and Study 3)), should be re-analyzed through a multi-variate statistical method with respect to the various contributing factors such as bank height, WSE fluctuation, riparian vegetation, bend geometry, etc. In addition, the data set derived from the review of aerial photographs at 0.5-mile increments (Page 23, Section 5.3 Analysis of Historical Aerial Photography, Study 2 and Study 3) should also be re-analyzed with multi-variate methods with respect to the bank classification data mentioned above or with respect to the various contributing factors such as bank height, WSE fluctuation, riparian vegetation, bend geometry, etc. The data set related to the 21 transects should be re-analyzed through a multi-variate method with respect to the erosion on the bank (at the top, upper, mid, lower, and toe) and the median WSE fluctuation.

2. Consistency of Conclusions with Scientific Evidence Presented

Included below are our peer review comments relating to the consistency of the conclusions stated in the Study 2 and Study 3 Report. We believe that many of the Studies' conclusions were accurate and reflected a sound review of the significant amount of data, both historic and current, that was collected. Our comments below therefore only focus on Study conclusions that are not properly supported by the data presented in the Studies, or were not stated in conjunction with other related findings.

Study Conclusion #1: *"Taken together, natural conditions in the study area, by both reducing the resisting forces and enhancing the driving forces, create a situation where the riverbanks are likely near the threshold of erosion. As a result, minor natural or anthropogenic changes in the study area have the potential to initiate erosion already primed by the river valley's natural history and character."* (Page 109 Study 2 and Study 3)

"Given the significant changes in the rate and amounts of erosion documented through historical aerial photography and multiple mapping efforts, respectively, normal project operations that have changed little in several decades cannot adequately explain the observed patterns of erosion. Attempting to identify a single cause for erosion fails to recognize that multiple processes operate collectively to effect change on the riverbanks through space and time." (Page 115 Study 2 and Study 3)

Peer Review Comment: The study points out the significance of river banks that are at the "threshold of failure" by stating on page 11 "*When a bank is at the threshold of failure, a slight increase in shear stress or a small decrease in shear strength can lead to bank erosion"*. The study then concludes, on page 109, that the riverbanks in the study area *"are likely near the threshold of erosion"* and that *"As a result, minor natural or anthropogenic changes in the study area have the potential to initiate erosion already primed by the river valley's natural history and character."* These statements further support the need to confirm whether project operations are playing any role in the

reductions in bank instability. Because the study area has been classified as being near the threshold of failure, analysis of the data does not support a conclusion that dismisses the significance of the potential role of WES fluctuation in the cycle of erosion based on the fact that it is not the *"single cause for erosion" (page 115 Study 2 and Study 3)*.

Recommendation #10: TransCanada should revise the Study 2 and Study 3 Report to assess how the "threshold" conditions of the study reach may be impacted by even the slightest change in erosive force, whether acting alone, or in conjunction with other erosive forces.

Study Conclusion #2: *"The apparently increasing rate of erosion in the upper Wilder impoundment (Figure 5.3-1a) is more likely related to upstream inflows than Wilder project operations. The upper Wilder impoundment is closer to the McIndoes project than to Wilder dam. Therefore, McIndoes inflows along with significant natural discharges likely have a greater impact on erosion rates in upper Wilder impoundment than Wilder project operations."* (Page 111, Study 2 and Study 3, Assessment of Project Effects)

Peer Review Comment: This statement is not supported by any data included and described in Study 2 and Study 3.

Recommendation #11: TransCanada should provide their data on the upstream inflows in the Wilder impoundment and analysis to support their conclusion regarding the impact of these inflows.

Study Conclusion #3: ***"****The fact that these three sites experienced recession only once during two years of monitoring and that 12 additional monitoring sites mapped as unstable did not experience any bank recession at all may seem incongruous but actually indicates that bank recession, even in the most unstable areas monitored, does not occur annually but rather occurs episodically at time scales extending more than two years."* (Page 52, Study 2 and Study 3)

"Fluctuations in WSE related to normal project operations … are consistent with notching and overhangs observed at the base of 8 of 21 monitored banks at some point during the monitoring period." (Page 111, Study 2 and Study 3)

Peer Review Comment: Section 5.4.2 Repeat Monitoring indicates that only three of the 21 monitored transects experienced measurable recession at the top of the bank, and that erosion does not occur annually but rather episodically at time scales beyond the 2-year monitoring period. The study also acknowledges: *"At many sites, the position of those daily fluctuations on the bank aligns with the location of notching at the base of the bank: (page 53 Study 2 and Study 3), "Fluctuations in WSE related to normal project operations … are consistent with notching and overhangs observed at the base of 8 of 21*

monitored banks at some point during the monitoring period" (page 111 Study 2 and Study 3). These observations seem to indicate that as many as 38% (8/21) of monitored banks may experience notching as a result of project-caused WSE fluctuations. According to the final study the notching at the base of the bank likely drives the *"idealized cycle of erosion"* depicted in Figure 5.6.2-1 and results in eventual top of bank recession. It is noted therefore that this episodic erosion could be related to WSE fluctuation and may not be able to be adequately assessed within a 2-year monitoring period.

Recommendation #12: TransCanada should extend the cross section monitoring beyond the two-year monitoring period proposed in the RSP, for the above reasons and because the Study itself indicates that this period was not long enough to analyze the *"cycle of erosion"* at all sites.

Study Conclusion #4: *"The magnitude of water surface fluctuations in the study area is less than 2.0 ft for 75% of the study area's length so hydraulic gradients between groundwater levels in the bank and the adjacent river level are likely small, whereas waves breaking against the bank at the same elevation as water level fluctuations may generate stronger erosive forces."* (Page 111 Study 2 and Study 3, Executive Summary and Assessment of Project Effects)

Peer Review Comment: Hydraulic gradients depend on the elevation of surface water and groundwater, which were not measured. As there was no assessment of hydraulic gradients, wave actions, or erosive forces, no valid comparison can be made between the two bank erosion factors. This statement also raises the question of whether daily WSE fluctuations increases the vertical range on the bank that becomes exposed to wave action and ice jams and their associated erosive forces.

Recommendation #13: TransCanada should retract this conclusion, unless additional data is supplied that supports this statement. TransCanada should analyze how the WSE fluctuation may increase the vertical range on the bank that is exposed to additional erosive forces such as boat waves, piping and ice jams, which are all issues identified in the RSP.

Study Conclusion #5: "*The approximately 40% of bank instability mapped through the study area is similar to more free-flowing portions of the Connecticut River (Field, 2005), so normal project operations cannot be considered to be a cause of excessive erosion."* (Page 114, Study 2 and Study 3)

Peer Review Comment: Throughout Section 5.3 Analysis of Historical Aerial Photography (page 23 Study 2 and Study 3) and in subsequent sections, comparisons are made between impounded sections and riverine sections with the assumption that conditions

in the riverine sections are natural, normal or unaffected by project operations. However, riverine sections are also subject to the downstream effects of dams, which includes exacerbated / accelerated bank erosion due to sediment trapping by the dam and sediment deprivation in the downstream reaches. While these Studies are not focused on the downstream effects of the dams, this "hungry water" effect (Kondolf, 1997) renders any conclusions from such comparisons invalid.

Recommendation #14: TransCanada should provide additional data in Study 2 and Study 3 Report regarding the previous assessment of free-flowing portions of the Connecticut River, if it is to be used as a scientifically supported comparison to the impounded reaches. Specifically, TransCanada should show how these "free-flowing" reaches are not impacted by other factors such as limited upstream sediment inputs due to the presence of upstream dams.

Study Conclusion #6: "*Tractive forces generated by flood flows are the only mechanism capable of removing the sediment from the base of the bank that otherwise would lead to bank stabilization if not removed."* (Page 114, Study 2 and Study 3, Conclusions)

Peer Review Comment: This statement is not supported by any data included and described in Study 2 and Study 3. This statement speaks to the importance of flood flows and tractive forces in the *"cycle of erosion"* described in the study; however, it appears that no attempt was made to quantify the shear stress created by flood flows or to utilize relevant data from Study 4 – Hydraulic Modeling Study.

Recommendation #15: TransCanada should complete additional analysis of the hydraulic conditions.

Study Conclusion #7: *"While other processes such as waves or seepage forces created by project-related WSE fluctuations may exert some control on the cycle of erosion, they cannot be considered as resulting in excessive erosion that negatively impacts other resources since ultimately the continuation of erosion depends on flood flows that sustain the cycle of erosion*." (Page 114, Study 2 and Study 3, Conclusions)

Peer Review Comment: This study conclusion does not follow a logical thought process since although it is stated that *"seepage forces created by project-related WSE fluctuations may exert some control on the cycle of erosion"* the role of their impact cannot be negated based solely on the fact that these initial erosive forces are taking place in a riverine environment where high flows are ultimately transporting eroded material downstream and continuing the cycle indefinitely.

This statement discounts the role of fluctuating WSE on bank erosion because it is likely acting on only a portion of the *"cycle of erosion"*; however, the study describes a *"cycle of erosion"* that is initiated with the creation of a notch or overhang at the toe of the bank (see Figure 5.6.2-1). Further, the description from the Executive Summary states that *"Bank erosion in the study area is a cyclic process that begins with the formation of notches and overhangs at the base of the bank. The resulting over-steepening at the bank's base destabilizes the upper bank generating planar slips, rotational slumps, topples, and flows that transfer bank material downslope. Material supplied from the erosion of the upper bank accumulates at the base of the bank and can ultimately lead to the stabilization of the bank unless the sediment and fallen trees are removed by river currents, wave action, groundwater seepage, or other forces. If the material is removed, the notching at the base of the bank can begin afresh and the cycle of erosion repeated."* (Page ES-1, Study 2 and Study 3)

The study also reports that *"Erosion can result from seepage forces generated by WSE fluctuations (Budhu and Gobin, 1995) with overhangs developing when seepage is focused along a single layer (Fox and Wilson, 2010)"* (page 111 Study 2 and Study 3).

Recommendation #16: Based on the data presented, TransCanada should revise the statement as follows:

> "Processes such as waves or seepage forces created by project-related WSE fluctuations may exert some control on the initiation of the cycle of erosion; however, they cannot be considered as resulting in excessive erosion that negatively impacts other resources on their own, since ultimately the continuation of erosion depends on flood flows that sustain the cycle of erosion."

This revised conclusion is based on the observed results and acknowledges that bank erosion is caused by multiple contributors at different stages of the cycle of erosion. Importantly, it does not eliminate WSE fluctuation as one of the potential contributing factors. It is also important to note that the report does not include a discussion of the potential loss of resistive forces such as vegetation growth at the toe of the bank due to daily WSE fluctuation, which could also contribute to the ongoing cycle of bank erosion. Thus, the implication is that project-caused WSE fluctuations may not be the sole cause of bank erosion but that it could be exacerbating and accelerating bank erosion.

Study Conclusion #8: The study concludes in the last paragraph that *"normal project operations that have changed little in several decades"* (page 115 Study 2 and Study 3)

Peer Review Comment: There is no data or descriptions in the study on how operations have changed, or not changed, over time.

Recommendation #17: TransCanada should provide additional data supporting their claim that "normal project operations that have changed little in several decades".

DELIVERABLES

This section includes our comments on the "Deliverables" as described in the RSP. We have only commented on the deliverables from the RSP that we feel were not conducted as provided for in the RSP.

Statements from RSP: *"An interim study report will be prepared after the first year of study is complete synthesizing the above deliverables into a narrative that addresses the study goals and issues raised in various study requests. The report will be provided to stakeholders for review and comment."* (Page 25 RSP Study 2)*, and "The interim study report will be prepared after the first year of study is complete. The report will be provided to stakeholders for review and comment."* (Page 36 RSP Study 3)

Peer Review Comment: Interim Reports for Study 2 or Study 3 were never provided to the Erosion Working Group to review and comment.

Recommendation #18: FERC should consider the August 1, 2016 Study 2 and Study 3 Report to be the interim report and that the Erosion Working Group's current review of Study 2 and Study 3 Report be integrated into a revised study that the Erosion Working Group is then able to review as the final study as proposed in the RSP.

SUMMARY CONCLUSIONS

Based on our review of the Study 2 and 3 Report, our review team has made 18 recommendations as discussed earlier in this memorandum. Most critically, we find that the Study 2 and Study 3 Report did not "*ascertain the relative importance of water-level fluctuations associated with project operations in the erosion process relative to other contributing factors"* as stated in the RSP and has instead stated that *"trying to distinguish specific effects of normal project operations among the panoply of potential controls on bank erosion in any given location is not possible"*. A better understanding of causation should be ascertained with a different methodology such as a statistical analysis of the data collected or a bank stability model that utilizes a wider variety of geotechnical and vegetative parameters, such as geotechnical strength, maximum rooting depth, and hydraulic gradient between ground water and river water levels.

The Study Report does not consider adjacent land use as a factor (other than the presence or absence of riparian vegetation at the top of bank), and yet numerous peer-reviewed research studies have investigated and confirmed that adjacent land use has a strong role in bank stability and erosion. Nor does the study consider the impact that daily WSE fluctuations may have on limiting vegetative growth at the toe of the river banks, although the study itself acknowledges the important role that vegetation can have on increasing bank resistance to erosion.

The Study Report does not adequately "i*dentify the effects of shoreline erosion on other resources (e.g., riparian areas and shoreline wetlands, rare plant and animal populations, water quality, and aquatic and terrestrial wildlife habitat)"* as stated in the RSP, and instead bases its conclusions on other studies that were not tasked with assessing the effects of shoreline erosion on these critical resources.

In addition, the coordination with the Erosion Working Group promised in the RSP was not conducted, and the interim reports were not delivered for review, such that the study could have been adjusted as needed to successfully complete the objectives stated in the RSP.

TransCanada should revise the Study Report or issue an Addendum to the report that includes the revisions as per the recommendations set forth in this peer review.

Laura A.S Wildman, PE

Director, New England Regional Office, Princeton Hydro, LLC
Fisheries Engineering and Aquatic Resource Management

Education:

- PhD Candidate, current, Engineering and the Environment, University of Southampton, United Kingdom (part time enrolment) – Focus Dam Removal
- Masters of Environmental Management, 2004. Yale University, New Haven, CT. Relevant course work in Biology of Fishes, Fish Biomechanics, Organic Pollutants, and River Processes (TA in River Processes & Restoration)
- B.S. Civil Engineering, 1989, University of Vermont, Burlington.

Professional Certifications and Awards:

- Registered Professional Engineer in the State of Connecticut
- NOAA Restoration Center Award for Leadership in Restoration for Service in Fish Passage Engineering; Coastal Am. Spirit Award for Anadromous Fish Restoration

Professional Training/Courses Instructed:

- Succeeding with a Dam Removal Project – Univ. of WI Madison, 2000 - 2014
- River Processes & Restoration – Assist with instruction of Yale University FES graduate course, New Haven, Connecticut, 2000-2009.
- Dam Removal Demystified – American Rivers' Workshop, NC 2011
- Dam Removal Short Course – Fish Passage 2015 Conference in Groningen, Netherlands; and ASDSO National Conference, DC, 2011
- Removing Small Dams & Stream Barriers Short Course – ASCE/EWRI, 2010
- Sustainable Floodplain Management Through Stream Restoration Short Course - ASCE/EWRI Conference, Providence, RI, 2010
- EWRI Short Course on Dam Removal and Sustainable Flood Management, 2010
- Sustainable Flood Management – Organized course and instructed, NJ, 2008
- Engineering Innovative Fish Passage: Dam Removal and Nature-like Fishways – Univ. of Wisconsin/ Madison, NH 2002 & CA 2003
- Applied Hydrology - Assist w/ instruction of Yale FES Masters course, New Haven, Connecticut 2003.
- Dam Removal: The Restoration of a River – USFWS training course, MA, 1999 and WV, 2000.
- Hydrology and Hydraulics for Restoration Projects –ACOE HEC in-house training course, CA, 2000.
- Advanced Training for River Geeks Series – Organized/Instructed courses on Sediment Mobility & HEC-RAS, 2008
- Academic Guest Lecturer: Tufts University; Bucknell University; Connecticut College; Wesleyan; UCONN, Yale, Mt. Holyoke, UMASS, University of WI-Madison, Western NE College School of Law, SUNY, Univ. of Montana's River Center, Cornell

Areas of Expertise:

- Involved in hundreds of fish passage, barrier removal, and river restoration projects
- Extensive experience in fish passage, fish behavior, fish biology, and fish biomechanics relating to migratory fish passage in the NE
- Design, implementation and management of fish passage, fish habitat, ecological restoration, sustainable flood & watershed management, and dam repair projects
- National and international expert in barrier removal and alternative fish passage technologies
- Governmental grant, policy and advocacy experience relating to fish passage and river science/restoration
- Instructor/lecturer for courses on fish passage, barrier removal, river processes/ restoration, sustainable flood management, risk communication & hydraulic modeling
- Expertise in fluvial geomorphology, water resource management, and instream flow management
- Construction oversight & administration on numerous river restoration projects
- Has provided guidance and input for multiple fish passage prioritization/optimization approaches

Professional Affiliations:

- President of the American Fisheries Society's Bioengineering Section – 2012 – 2015; current Past President
- Board of Governors for the American Fisheries Society 2012- 2015; and Management Committee 2014-2015
- Board of Governors for the Environmental and Water Resources Institute of ASCE (EWRI) 2010 - 2013
- University of CA-Berkley's Dam Removal Clearinghouse Steering Committee – established in 2002 - 2013
- Established and Manages the Dam Removal & Fish Passage LinkedIn Network, 2010 – Current; Co-manager of World Fish Migration Platform, 2012-Current
- Federal Interagency Advisory Subcommittee on Sedimentation - Dam Removal, 2008 - Current
- Aspen Institute's National Policy Dialogue on Rivers & Dams, 2000-2002;
- Chairman EWRI/ASCE Task Committee on Sediment Dynamics Post Dam Removal 2004 - 2011
- Co-chairman EWRI/ASCE River Restoration Manual of Practice Task Committee 2007-2008
- Established & Chairman of the Northeast Stream Barrier Task Force, 2001-2008
- AFS, Bioengineering Section, Fluvial Ecological Engineering Curriculum Working Group 2002-2003
- Member: ASCE, EWRI, ASDSO, ASFPM, AFS, Diadromous Species Restoration Research Network

Laura A.S. Wildman, PE
Director, New England Regional Office

Summary of Qualifications:

Ms. Wildman is a practicing fisheries engineer and aquatic resource manager that established and runs the New England Regional Office for Princeton Hydro focusing on ecological restoration consulting for aquatic systems. Her expertise and passion, centers on the restoration of rivers through the reestablishment of natural functions and aquatic connectivity. She is considered one of the foremost experts on barrier removal and alternative fish passage techniques, regularly lecturing, instructing, and publishing on these topics; including assisting with the instruction of courses for the University of Wisconsin and Yale University, and a recent publication for a special edition of the Journal of Engineering Geology regarding the history and human dimensions of barrier removal projects. Her work has also focused on reconnecting communities to rivers, and the socio-economic complexities relating to the balance between natural resource management and healthy river systems. She has been involved in hundreds of river restoration, barrier removal, and fish passage projects throughout the U.S.; working on all aspects of the projects from inception, project identification, cooperative agreement development, and funding, through design, project tracking/scheduling, identification of cost effective solutions, and construction, both as a licensed professional engineer designing and managing the projects and as a non-profit project partner during her 8 years with American Rivers (AR) managing their fish passage and barrier removal efforts and NOAA grants in the NE. Ms. Wildman received her bachelor's in Civil Engineering from University of Vermont and her Master of Environmental Management from Yale University, and integrates both engineering and a deep understanding of fisheries biology and river science into her restoration work. In 2009 she received a Leadership in Restoration award from NOAA's Restoration Center for her many years of dedicated service in fish passage engineering and a Coastal America Spirit Award for anadromous fish restoration in 2001.

Prior to returning to consulting, Ms. Wildman worked on fish passage and dam removal as American Rivers' Director of River Science and Chief Engineer, where she established and managed AR's Northeast Filed office, and served as their fish passage coordinator throughout the northeast and oversaw, managed and implemented multiple large scale fish passage, barrier removal and watershed restoration/management efforts. She initiated and led the Northeast Stream Barrier Task Force for 8 years, which established a network for NGO's state, and federal agencies working on aquatic connectivity issues (fish passage and barrier removal) throughout the greater northeast. She developed numerous guidance documents and standardized procedures for the removal of barriers to promote fish passage. In addition during her AR tenure, Ms. Wildman lead the AR-NOAA Open River Initiative Grant Program in the northeast, worked on policy and advocacy issues relating to rivers, and was an active member in the VT Dams Task Force, the NH River Restoration Task Force, Hudson River Stream Barrier Task Force, the CT Migratory Corridor Group, and the Gulf of ME Barrier Removal Monitoring Coordinating Committee. In 2010 she developed and now leads the Dam Removal and Fish Passage Network on LinkedIn with almost 2,000 members internationally, as well as co-manages the World Fish Migration Network.

Ms. Wildman was an invited participant in the Aspen Institute's two year National Policy Group regarding dam removal and played a key role in establishing the online University of CA-Berkley's Clearinghouse for Dam Removal Information. Ms. Wildman was also a member of the American Fisheries Society Bioengineering Section (AFS-BES) Working Group that developed curriculum guidance for a master's level program in Fluvial Ecological Engineering, which was recently incorporated into the UMASS Fish Passage Engineering Program. Ms. Wildman has developed and lead multiple successful symposia, one of which lead to the creation of a recently published American Society of Civil Engineers Environmental and Water Resource Institute's (ASCE-EWRI) manual on Sediment Dynamics Post Dam Removal, for which Ms. Wildman chaired the Task Committee. She is currently a member of the Federal Interagency Advisory Subcommittee on Sedimentation developing guidelines for sediment management and dam removal. In 2008 she headed the Environmental Impacts subgroup for Association of State Floodplain Managers' (ASFPM) Working Group on Dams.

Ms. Wildman the current Past-President for the Bioengineering Section (BES) of the American Fisheries Society (AFS) and served on the AFS Governing Board. She is a former member of the Governing Board of American Society of Civil Engineers' (ASCE) Environmental and Water Resource Institute (EWRI), where she continues to lead and participates in multiple committees relating to fish passage, barrier removal and river restoration. In 2011, Ms. Wildman initiated an Ad Hoc Committee under both AFS-BES and ASCE-EWRI leadership to further the strategic goals of both organizations with the objective of developing a partnering relationship between the two organizations on the topic of fish passage, by establishing the joint reoccurring national fish passage conference and developing a large scale online database/repository for fish passage information.

In addition to her work in river restoration, fish passage and barrier removal, Ms. Wildman also has significant experience in fluvial geomorphology, fisheries habitat, instream flow analysis, dam modification/repair, open channel hydraulics, grant coordination, public outreach and communication, and advanced hydraulic and sediment transport modeling.

Laura A.S. Wildman, PE
Director, New England Regional Office

Employment History:

- 2009-Current, Director of the New England Regional Office for Princeton Hydro; Fisheries Engineer; S. Glastonbury, CT
- 2001-2009, Chief Engineer and Director of River Science at American Rivers, Glastonbury, CT
- 1991-2001, Project Manager and Water Resource Engineer at Milone & MacBroom, Cheshire, CT
- 1989-1991, Water Resource Engineer at Urban Design, Inc. Kirkland, WA

Select Project Experience

Farmington River Restoration, Farmington/Bloomfield, CT (2009-2012) – Dam Removal & Nature-like Fishway

Ms. Wildman was the Project Manager for the engineering assessment, final design, and construction management/oversight for this fast paced fish passage improvement project on the famed Wild & Scenic Farmington River in Connecticut. The restoration project included both the removal of the Spoonville Dam and the design of a nature-like fishway (inverted partial rock ramp fishway) at the Winchell-Smith Dam. The design for both sites was completed in less than one year and the construction was accelerated years ahead of schedule for the Spoonville Dam Removal through the Project Manager's suggestion and leadership regarding the implementation of a design-build approach, which saved the client approximately $700,000.00 on the final project construction cost. The project included multiple public meetings to gain the support of the local whitewater community who actively use the site and the renowned whitewater run directly upstream for recreational kayaking.

Mitchell Brook Restoration, Whatley, MA (2009-2013) – Replaced Perched Culvert with Arch Culvert

Ms. Wildman was the Project Manager for the replacement of the existing perched, undersized 36" CMP culvert at Conway Road on Mitchell Brook, just upstream of the confluence with West Brook, in Whately, MA. Specifically, the services for the project included engineering design, geotechnical investigation, geomorphic assessment, permitting, bid preparation, construction management, and construction oversight. The project goals and objectives included: the design of a crossing meeting the MA River and Stream Crossing Standards; restoration of a stable, natural channel upstream and downstream, for a range of flow events; restoration of open aquatic and terrestrial passage for a variety of species; the creation of a successful project that could be used as a "model" demonstration site. The site already had extensive data collected relating to the distribution of native brook trout populations and this monitoring will be continued post-project to verify the success of the effort.

Guilford Lakes Nature-Like Fishway, Guilford, CT (2002) – Nature-like & Alaskan Steeppass Fishway

While Chief Engineer at American Rivers, Ms. Wildman was asked to investigate alternative fish passage options for the Guilford Lakes Dam that would reduce the cost of fish passage, previously estimated at $70-100K. Ms. Wildman enrolled the help of Yale graduate students and completed a design for a nature-like fishway that modified an existing bypass route along with two sections of Alaskan Steeppass fishway, and reduced the project cost down to $31K, for which she helped obtain two grants through the American Rivers-NOAA Community-Based Restoration Program Partnership and USFWS. Ms. Wildman later conducted an in-field hydraulic analysis of the completed fishway to assess velocities and potential passage routes. Additionally a more detailed telemetry study, completed by others, demonstrated passage through the fishway while identifying areas where the fishway would need adaptive management to further increase efficiency. The project had been designed with adaptive management in mind and additional stones had been stockpiled on-site to accommodate future modification.

Naugatuck River Restoration, Naugatuck Valley, CT (1998-2001) – Four Dam Removals & One Bypass Channel

The Naugatuck River Restoration Project was part of a large scale multi-million dollar watershed management and restoration effort that included the investigation of dam removal and fish passage around eight obsolete industrial dams on the Naugatuck and Mad Rivers. The project sought to improve water quality, increase public access to the river and restore the historic diadromous fish runs. The project dams included the Anaconda Dam, Union City Dam, Platts Mill Dam, Freight Street Dam, Tingue Dam, Chase Brass Dam, Plume & Atwood Dam, and Bray's Buckle Dam, ranging in size from 100-300 ft long and 4-20 ft high. Five of the eight dams investigated were removed and an innovative bypass channel was designed to circumvent another. Ms. Wildman was the engineering Project Manager for the project and led the fish passage feasibility assessments, the hydrologic/hydraulic analyses, the dam removal designs, and the preliminary bypass design, as well as providing full-time construction oversight for four of the dams removed. This multimillion dollar restoration effort was one of the first of its kind in the country and targeted the restoration of American shad, blueback herring, alewife, American eel, and sea-run brown trout to the watershed.

Barrier Removal & Fish Passage/Habitat Project Experience While at Princeton Hydro (2009-Current):

- Clarks Brothers Dam Removal (CT) – Project Manager
- Carpenter Dam Removal (CT) – Project Manager
- Papermill Dam Removal (CT) – Project Manger
- Hyde Dam Removal (CT) – Project Manager
- Spoonville Dam Removal & Winchell-Smith Dam Fishway – 2 dams (CT) - Project Manager
- Middle Street Dam Removal (CT) - Project Manager
- Heminway Pond Dam Removal (CT) - Project Manager
- West Branch Saugatuck Ford Removal (CT) - Project Manager
- Noroton Fish Passage (CT) - Project Manager
- Furnace Brook Fish Passage (CT) - Project Manager
- Pond Lily Dam Removal Sediment Assessment (CT) - Project Manager
- Mill Street Dam Assessment & Wiley-Russell Dam Removal – 2 dams (MA) - Project Manager
- Tannery Dam Removal (NH) – Project Manager
- Tel-Electric Dam Removal (MA) – Project Manager
- Mitchell Brook Culvert Replacement (MA) - Project Manager
- Century Brook Bog Restoration and Barrier Removal (MA)
- Hunters Mill Pond Dam Removal (MA) - Project Manager
- Horseshoe Pond Dam Fish Passage Alternatives Assessment (MA) – Project Manger
- Cumberland Fish Passage Assessment Technical Review Team (ME)
- Saccarappa Fish Passage Assessment (ME) - Project Manager
- Marshfield-8 Dam Removal (VT) - Project Manager
- Dunkard Creek Dam Removals – 2 dams (PA)
- Little Lehigh Dam Removals – 4 dams (PA)
- Home Depot Dam Removals – 3 dams (PA)
- Jordon Creek Dam removals – 5 dams(PA)
- Rakes Pond & Marshell's Pond Dam Removals – 2 dams (PA)
- Plymouth Crossing Dam Removal (PA)
- Finesville Dam Removal Feasibility Study (NJ)
- Lawrence Brook Fish Passage – 2 dams (NJ) - Project Manager
- Cumberland Dam Removal Assessment (MD) - Project Manager
- Klamath Dam Removal Report Peer Review – 4 dams (CA)
- SanClemente Dam Removal Technical Advisory Team – 2 dams (CA)
- Otsego Dam Removal Expert Assistance – 2 dams (MI)
- Goldsboro Dam Removal Assessment (NC) - Project Manager
- Lassiter Dam Removal (NC) - Project Manager
- Neuss River Restoration & Fish Passage Assessment (NC) - Project Manager

Selected Barrier Removal & Fish Passage/Habitat Project Experience Prior to Joining Princeton Hydro (1998-2009)**:**

- Pizzini Dam Removal (CT) – Design & Construction Oversight
- Raymond Brook Dam Removal (CT) – Design & Construction Oversight
- Penobscot Dam Removals – Great Works & Veazie (ME) – Technical Oversight
- Cumberland Dam Removal on the Presumpscot (ME) – Technical Oversight
- Zemko Dam Removal (CT) – Technical & Construction Oversight
- Springborn Dam Removal (CT) – Technical Oversight
- Willimantic Dam Removals (CT) – Technical Oversight
- Milbury Dam Removal Assessment (MA) – Technical Assistance
- Cobbesecontee Dam Removal (ME) – Technical Assistance
- Winnicut Dam Removal (NH) – Technical Assistance
- Merrimack Village Dam (NH) – Technical Assistance
- Cuddebackville Dam Removal (NY) -– Technical Assistance
- Pawtuxet Dam Removal Assessment (RI) – Technical Assistance

- East Burke Dam Removal (VT) – Technical Assistance
- Matilija Dam Removal (CA) – Technical Review
- Klamath Dam Removals (CA) – Technical Review of Reports
- Presumpscot Dam Removals (ME) – Technical Assistance
- Naugatuck River Dam Removals: Anaconda, Freight St., Union City, Platts Mill Dams (CT) - Project Manager
- Naugatuck River Dam Removal Assessments: Brays Buckle, Chase Brass, Tingue, & Plume & Attwood Dams (CT)
- Coginchaug River – Dam Removal Assessments for Starr Mill Pond and Savage Mill Dams (CT) – Project Manager
- Billington Street Dam Removal (MA) – Project Manager for Preliminary Design
- Edwards Dam Removal (ME) – Technical Oversight

Publications

- **Dam Removal: A History of Decision Points** – Sole author, **Reviews in Engineering Geology**, 2013
- **From Sea to Source** – Section of Dam Removal Monitoring in the USA, coauthor Peter Philipsen, edited by Peter Gough, 2012
- **ASCE/EWRI Manual on Sediment Dynamics Post Dam Removal** – Chairman of task committee, heading publication, & co-author on and supervisor of summary paper. 2011
- Avoiding Dam Breach Through Preemptive Dam Removal & Public Awareness - ASDSO Conference Proceedings, September 2006
- Community Guide to Dam Removal – Contributor. Written by Connecticut River Watershed Council. 2006.
- **Gravel Streambed Dynamics Post Dam Removal: Case Study of the Anaconda and Union City Dam Removals** -Primary author. **Journal of Geomorphology** October 2005. Presented at the 2002 Binghamton International Geomorphology Symposium.
- 10 Dam Removals, 10 Years Later – Primary author. ASDSO National Conference Proceedings 2008
- An Illustrative Handbook on Nature-like Fishways - Primary author. Summary version presented at the American Fisheries Society's Annual Conference, Baltimore, 2002. Final publication scheduled for completion 2008.
- Dam Removal: A New Option For a New Century - Contributor and dialogue participant. The Aspen Institute Program on Energy, The Environment, and the Economy, Dialogue on Dams and Rivers, 2002.
- Stream Barrier Removal Monitoring Guidelines – Coordinating Committee & Workshop Participant
- A Cross-section of Swimming Performance and Biomechanics of Five Fish Species in a New England Stream – Author. Prepared for Yale Biology of Fishes Master's course. 2003
- Hydraulics of Nature-Like Fishways: Velocity Cross-Section Analyses of Sennebec and Guilford Lakes Nature-Like Fishways - Author. Prepared for Yale Independent Study on River Processes & Restoration for Masters degree program. 2004
- Sediment Transport & Management Relating to Dam Removal - Author. Prepared for Yale Independent Study on River Processes & Restoration for Masters degree program. 2003
- Dam Removal – A Tool for River Restoration on the Naugatuck River – Primary author. American Society of Engineers' Joint Conference on Water Resources Engineering and Water Resource Planning and Management Proceedings, Minneapolis, Minnesota, 2000
- Dam Removal: One Size Does Not Fit All! - Primary author, 2003. ASCE-EWRI Conference in Philadelphia, 2003
- Why Are The River Rocks Round – Author. Children's book on fluvial geomorphology and aquatic ecology. Written for Master's course at Yale University. Completed 2004, currently looking into publication.
- Fluvial Ecological (River) Engineering Curriculum - Co-author. AFS Bioengineering Section Working Group, to be presented at the Annual American Fisheries Society Conference in Canada, 2003.
- Cursed on Both Ends and Dammed in the Middle – Author. Editorial article on the controversy surrounding the removal of the Billerica Dam in MA, prepared for Yale Environmental Writing masters course. 2003
- Exploring the Human Dimensions in the Efforts to Remove Dams and Restore Rivers- The Billerica Dam Case Study – Author. Prepared for Yale Human Dimensions masters course. 2003
- Dam Removal Success Stories – Contributor. Trout Unlimited and American Rivers' publication, 1999.
- Sediment Transport Relating to Dam Removal - A Literature Search of Current Methods Used for Analyzing Sediment Transport - Sole author. University of Connecticut graduate studies paper, Storrs, Connecticut, 1997
- Engineering: Exploring the Human Dimension - Sole author. University of Vermont undergraduate studies paper. First Place Northeast American Society of Civil Engineers Paper Competition, 1989

Invited Lecturer & Presentations (2000 – Current)

Dam Removal

- *The Evolution of the Pro-Active Dam Removal Movement in the US over the Last Quarter Century* – Plenary, International Fish Passage Conference, June 2015, Groningen, Netherlands
- *The Dam Removal Movement In The US - Key Elements Of The Evolution and What We Can Learn For The Situation In Europe* – Atlantic Salmon Summit, Huningue, France, September 2015
- *Dam Removal Key Lessons Learned* – Instructor, World Fish Migration Foundation Webinar, 2015
- *Dam Removal Short Course* – Instructor, International Fish Passage Conference, June 2015, Groningen, Netherlands
- *Effects of Dams on Floodplain* Function – Annual AFS Conference, 2014
- *Biggest Barriers to Barrier Removal* – International Fish Passage Conference, June 2014, Madison, Wisconsin
- *Dam Removal Case Studies* – Plenary, Poland, 2014
- Highlights *of Historic Battles over Dams & Fish* – Plenary, National Conference on Engineering & Ecohydrology for Fish Passage, MA, 2011; Farmington River Watershed Assoc., plenary, 2011; & Wesleyan University, 2012; EWRI, NM, 2012
- *Dam Removal Techniques & Sediment Management* – ASDSO, 2011 & Dam Removal Workshop, NC, 2011
- *Dam Removal Classification System* – National Conference on Engineering & Ecohydrology for Fish Passage, Amherst, MA, 2011; Joint Federal Interagency Conference on Hydrologic and Sediment Transport Modeling Las Vegas, NV, 2010; & ASCE/EWRI National Conference, Providence, RI, 2010
- *Dam Removal Lessons Learned*– ASCE/EWRI National Conference, Providence, RI, 2010
- *Willimantic River Dam Removal* – UCONN Environmental Journalism Course, 2009
- *Categorization of Dam Removals* – Diadromous Species Restoration Research Network, Bangor, ME 2009
- *Restoring the Naugatuck River* – Ansonia Nature & Recreation Center, CT 2009
- *Dam Removal Case Studies* – Invited presenter for Yale's Water Resources case Study Masters Course, 2008-2011
- *Dam Removal: A History of Decision Points* – Chauncey Loomis Lecture Series by HVA, CT, 2010 & Mount Holyoke's Environmental Leadership Series, 2007
- *Avoiding Dam Breaches Through Preemptive Dam Removal and Public Awareness –Association of State Dam Safety Officials Annual Conference, Boston, MA, September 2006*
- *Do It Yourself Dam Removal Investigation* – Session talk. National River Rally, NH, 2006
- *Dam Removal Overview: Issues to Consider, Regulatory Approaches and Lessons Learned* – Massachusetts Permit Streamlining Committee Meeting, 2006
- *Sediment Dynamics Post Dam Removal: State of the Science & Practice* - Joint Federal Interagency Sedimentation & Hydrologic Modeling Conference, 2006
- *Restoring Rivers Through Selective Dam Removal* – CT Department of Environmental Protection In-house Training, June 2006
- *Dam Removal: A History of Decision Points* – ASWM & UMASS Integrated River Restoration Workshop, 2005
- *Dam Removal: One Size Does Not Fit All* - ASCE/EWRI Watersheds 2005 Conference – Organized and Lead seven sessions (25 papers) on sediment dynamics post dam removal and presented individual paper
- *How Do You Remove a Dam? Technical Challenges* - Univ. of Montana Dam Removal Workshop, 2005
- *Dam Removal: One Size Does Not Fit All* - Association of State Dam Safety Officials annual meeting, AZ, 2004
- *Dam Removal Lessons Learned* – UMASS Workshop 2004
- *A History of Decision Points* - Boston Environmental Exposition, 2004
- *Dam Removal A New Option for a New Century* - Association of State Dam Safety Officials annual meeting, PA, 2003
- *Un-Designing Dams* - Bucknell University, 2003
- *Dam Removal A New Option for a New Century* - Vermont Dam Task Force, 2003
- *Restoring Our River Through Selective Dam Removal* - Plenary talk. *Anadromous Fish Restoration in the Naugatuck River Basin* - Session talk. New York Regional American Fisheries Society annual meeting, 2003.
- *An Overview to Dam Removal, Dam Removal: Sediment and Site Restoration* - Dam Removal and Alternatives Workshop, Mid-Atlantic/Northeast Training Workshop, Stream, Floodplain And Wetland Restoration: Improving Effectiveness through Watershed and Source Water Programs, Bear Mountain, NY, 2002.

- *Gravel Streambed Dynamics Post Dam Removal: Case Study of the Anaconda and Union City Dam Removals* - Binghamton International Geomorphology Symposium , 2002
- *Dam Removal Project Overview, and Hydrology and Sediment Management for Small Dams* - New Jersey Dam Safety, one-day course put on by Princeton Hydro, 2002.
- *Dam Removal: River Sediment Processes* - NOAA National Marine Fisheries Retreat, Plymouth, 2002
- *Restoring Rivers Through Dam Removal and Fish Passage* - CT Association of Wetland Scientists, 2001
- *Creating A Northeast Action Agenda: Dam Removal and The Restoration of Biological Integrity* - Organizer and presenter, Plymouth, Massachusetts, May 2001.
- *Restoring Rivers through Dam Removal and Non-Traditional Passage Alternatives* – California-Nevada Chapter of American Fisheries Society's 34th Annual Symposium and Conference, Ventura, California, 2000
- *Dam Removal - Anadromous Fish Restoration the Naugatuck River Basin* – Norwalk River Watershed Association, Inc., Connecticut, 2000.

Fish Passage – Fishways

- *Opening Rivers to Fish Migration in the US* – Plenary, Poland, 2014
- *Applied Fish Passage Strategies: Getting Fish Up Rivers* - NY Regional Herring Workshop, NYC, 2012
- *Categorization of Nature-like Fishways Worldwide* – AFS National Conference, Seattle, WA, 2011
- *Removing Barriers at Road Crossings using Stream Simulation Techniques in the Northeast US* **-** ASCE/EWRI National Conference, Providence, RI, 2010
- *Fish Passage Options For Connecticut's Rivers: Thinking Outside of the Box* -Connecticut Watershed Conservation Network, 2005
- *Thinking Outside The Box: An Introduction to Nature-Like Fishways* - River Management Interagency Workshop, WV, 2003
- *Thinking Outside of the Box - An Introduction to Nature-Like Fishways* - Dam Removal and Alternatives Workshop, Mid-Atlantic/Northeast Training Workshop, Stream, Floodplain and Wetland Restoration: Improving Effectiveness through Watershed and Source Water Programs, Bear Mountain, NY, 2002.
- *Restoring New England's Historic Herring Runs* - North and South River Watershed Association and Massachusetts's Audubon, 2003.
- *An Engineers Perspective on Research Needs In Dam Removal and Fish Passage* - Academy of Natural Sciences, 2002
- *Illustrated Handbook on Nature-Like Fishways* – National American Fisheries Conference 2002
- *Natural Approach to Dam Removal and Fish Passage* - Association of State Dam Safety Officials annual meeting in Florida, 2002.
- *Thinking Outside of The Box - An Introduction to Nature-Like Fishways* - New Jersey Dam Safety, one-day course put on by Princeton Hydro, 2002.
- *Restoring Rivers through Dam Removal and Non-Traditional Passage Alternatives* – Western District American Fisheries Society's Annual Conference, Telluride, Colorado, 2000.

Monitoring

- *10 Dam Removals, 10 Years Later* – ASDSO National Conference, CA, 2008
- *Stream Barrier Removal Monitoring Guide* – EWRI/ASCE National Conference, HI, 2008

Dams and Risk Communication

- *Manmade Flood Zones* – Wesleyan University lecture series, Middletown, CT, 2012
- *Dam Safety Experience from Neighboring States* – New York Federation of Lake Associations, NY, 2009
- *Risk Communications* – invited presenter to the National Dam safety review Board, 2008; NJASFM, 2009
- *Inundation Zones* - ASDSO National Conference , TX, 2007
- *An Introduction to Dam Impacts & Dam Removal Efforts*- Thames River Watershed Partners, CT, 2007
- *Easily Accessible Inundation Zone Mapping: Linking GIS Databases to Google Maps* - NE ASDSO, NH 2007
- *Dam Nation: Legal Aspects* – Western NE College, School of Law, 2007

- *Dam Nation* – Plenary presentation for Yale's Conference on Large Dams. Keynote speaker: Bruce Babbitt, 2006
- *Dam Ownership By Default: Buyer Beware* - Convocation of Connecticut Land Trusts, 2006
- *Our Dam: Should It Stay or Should it Go!* - Stanford Land Trust, 2002.

River Restoration & Fish Habitat

- MC, Overview, and Panel Discussion - Naugatuck River Forum, 2011
- *Restoring Rivers for a Living* – presentation to East Hartford 7th Graders, 2007
- *Restoring Our Rivers* - Plenary speaker and *River Morphology - The Shaping Processes of a River* - Co-presenter, New Hampshire River and Wetlands Conference, 2001.
- *River Restoration through Fish Habitat Enhan*cements - New England Association of Environmental Biologists Annual Conference, Connecticut, 2001.

Hydraulic & Sediment Transport Modeling

- *HEC-RAS for Non-Modelers* – Initiated the Advanced Training for River Geeks Series and am currently developing this course under series to be offered in 2008.
- *One Size Does Not Fit All* - EWRI/ASCE Conference for the Sediment Dynamics Task Committee, 2003
- *Applied Hydrodynamic Modeling: Case Studies* – Coastal America Modeling Workshop for Salt marsh Restoration, Massachusetts, 1999.
- *Applied Hydrodynamic Modeling* – 7th Annual Long Island Sound Research Fund Symposium at Connecticut College, Connecticut, 1999.

Management/Outreach

- *Lessons Learned & Next Steps: Creating National & Regional Support for Clean Water Infrastructure* – Panelist, Long Island Sound Citizens Summit, CT 2009
- *It Takes A Village To Pass A Fish*: Linking Fish Passage Efforts & Experts - AFS Nat. Conference, CA, 2007
- *Community Resilience & Sustainability within Riverine Systems* – to FEMA Management in DC, July 2008
- *Model State Dam Removal Programs* – lead panel discussion for the ASDSO National Conference, CA, 2008
- *American Rivers & The USFWS Sustainable Ecosystem Restoration in New England* – presented to USFWS Management, MA, 2007
- American Rivers Board Meeting Presentations - 2003 & 2005

Flood Management

- *Dam & Levee Impacts on Community Resilience & Sustainability* – Wesleyan University lecture series, Middletown, CT, 2012
- *Implementation of Sustainable Flood Management Practices: Examples & Methods* - ASFPM, FL 2009
- *Community Resilience & Sustainability within Riverine Systems* – FEMA Mitigation Seminar, DC, January 2008
- *Healthy Rivers Promoting Healthy Communities* – FEMA Community rating System Task Force, MA, 2008
- *Economic Benefits of Sustainable Flood Management*- Organized & presented at the NJ Sustainable Flood Management Course, NJ, 2008

MELINDA D. DANIELS

Associate Research Scientist
Stroud Water Research Center
Avondale, PA 19311
610-268-2153 x268, mdaniels@stroudcenter.org

EDUCATION:

2003: Ph.D. in Physical Geography, University of Illinois, Urbana-Champaign, Illinois.

1997: Master of Research in Environmental Science, University College London, London, United Kingdom.

1996: B.S. (Honors) in Natural Resources and Environmental Science, Cornell University, Ithaca, New York.

PROFESSIONAL EXPERIENCE:

2013 –	Associate Research Scientist, Director of Fluvial Geomorphology Section, Stroud Water Research Center, Avondale, PA.
2013 –	Adjunct Associate Professor, Graduate Faculty Member, Kansas State University, Department of Geography,
2014 –	Ancillary Associate Professor, University of Delaware, Department of Geography
2015 –	Ancillary Associate Professor, University of Delaware, Department of Geology
2010-2013	Associate Professor and Graduate Program Director, Kansas State University, Department of Geography, Physical and Environmental Geography
2008-2010:	Assistant Professor, Kansas State University, Department of Geography, Physical and Environmental Geography (Accepted position in 2007, deferred start date to 2008 to have my first child in 9/2007 in Connecticut. First tenure application 2009, approved effective 2010)
2002-2008:	Assistant Professor, University of Connecticut, Department of Geography, Physical and Environmental Geography (no tenure application)
2001-2002:	Instructor, University of Illinois, Introduction to Physical Geography
1998-2001:	Research Assistant and Fellow, University of Illinois, Stream Confluence Dynamics, River Restoration Science

PUBLICATIONS: *(*denotes students)*

Albertson, L. K., and **M. D. Daniels**. *In press.* Invasive crayfish influence fine sediment accumulation, gravel movement, and macroinvertebrate communities in streams. *Freshwater Science.*

Rüegg, J., W. K. Dodds, **M. D. Daniels**, K. R. Sheehan, C. L. Baker, W. B. Bowden, K. J. Farrell, M. B. Flinn, T. K. Harms, J. B. Jones, L. E. Koenig, J. S. Kominoski, W. H. McDowell, S. P. Parker, A. D. Rosemond, M. T. Trentman, M. Whiles, W. M. Wollheim. 2016. Baseflow physical characteristics differ at multiple spatial scales in stream networks across diverse biomes. *Landscape Ecology* 31(1)1: 119-136. doi:10.1007/s10980-015-0289-y

Caldas M.M., M.R. Sanderson, M. Mather, **M. D. Daniels,** J. S. Bergtold, J. Aistrup, J. L. Heier Stamm, D. Haukos, K. Douglas-Mankinh, A. Y. Sheshukov, and D. Lopez-Carr. 2015. Opinion: Endogenizing culture in sustainability science research and policy. *Proceedings of the National Academy of Science of the United States of America* 112(27): 8157–8159.

Fencl J. S., M.E. Mather, K. H. Costigan, **M. D. Daniels.** 2015. How Big of an Effect Do Small Dams Have? Using Geomorphological Footprints to Quantify Spatial Impact of Low-Head Dams and Identify Patterns of Across-Dam Variation. *PLoS ONE* 10(11): e0141210.

Ruffing, C. M., K. A. Dwire, and **M. D. Daniels**. 2015. Carbon pools in stream-riparian corridors: legacy of disturbance along mountain streams of southeastern Wyoming. *Earth Surface Processes and Landforms*. DOI: 10.1002/esp.3830

Grudzinski, B. P., Daniels, M. D., Anibas, K., & Spencer, D. (2015). Bison and cattle grazing management, bare ground coverage, and links to suspended sediment concentrations in grassland streams. *JAWRA Journal of the American Water Resources Association*, n/a-n/a. doi: 10.1111/1752-1688.12364

Dodds, W.K., Gido, K., While, M.R., **Daniels, M.D.**, Grudzinski*, B.P. 2015. The stream biome gradient concept: controlling factors of streams across broad biogeographic scales. *Freshwater Science,* 34(1):1–19.

Ruffing*, C., **M. Daniels,** and K. A. Dwire. 2015. Disturbance legacies of historic tie-drives persistently alter geomorphology and large wood characteristics in headwater streams, southeast Wyoming. *Geomorphology,* 231:1-14.

Costigan, K.H., **M.D. Daniels,** W.K. Dodds. 2015. Fundamental spatial and temporal disconnections in the hydrology of an intermittent prairie headwater network. *Journal of Hydrology*, 522: 305-316.

Costigan* K. H., Ruffing* C. M., **Daniels M. D.** and Perkin* J. S. 2014. Rapid response of a sand-dominated river to installation and removal of a temporary run-of-the-river dam. *River Research and Applications*, DOI: 10.1002/rra.2843

Burchsted*, D., & **Daniels, M. D.** 2014. Classification of the alterations of beaver dams to headwater streams in northeastern Connecticut, USA. *Geomorphology, 205*, 36-50. doi: 10.1016/j.geomorph.2012.12.029

Costigan*, K. H., **Daniels, M.D.**, Perkin, J. S., & Gido, K. B. 2014. Longitudinal variability in hydraulic geometry and substrate characteristics of a Great Plains sand-bed river. *Geomorphology, 210*, 48-58. doi: 10.1016/j.geomorph.2013.12.017

Perkin*, J. S., Gido, K. B., Costigan*, K. H., **Daniels, M.D.**, & Johnson, E. R. 2014. Fragmentation and drying ratchet down Great Plains stream fish diversity. *Aquatic Conservation: Marine and Freshwater Ecosystems*, n/a-n/a. doi: 10.1002/aqc.2501

Fischer*, J., Paukert, C., & **Daniels, M.D.** 2014. Influence of riparian and watershed alterations on sandbars in a Great Plains river. *River Research and Applications*, doi: 10.1002/rra.2811

Larson* DM, Grudzinski* BP, Dodds WK, **Daniels M**, Skibbe A, Joern A. 2013. Blazing and grazing: influences of fire and bison on tallgrass prairie stream water quality. *Freshwater Science* 32(3):779–791.

Plater, A.J., **Daniels, M.D.** and Oguchi, T. 2012 Present Research Frontiers in Geomorphology, Chapter in Treatise in Geomorphology, Elsevier.

Chin, A., Laurencio, L., Wohl, E., **Daniels, M.D.**, Urban, M., Boyer, K., Butt, A., Piegay, H., and Greory, K. 2012. The significance of perceptions and feedbacks for effectively managing wood in rivers, *River Research and Applications*, DOI: 10.1002/rra.2617

Fischer*, J., Paukert, C. and **Daniels, M.D.** 2012. Fish community response to habitat alteration: impacts of sand dredging in the Kansas River, *Transactions of the American Fisheries Society*, 141:6, 1532-1544

Costigan*, K.H. and **Daniels, M.D.**, 2012. Damming the prairie: Human alteration of Great Plains river regimes. *Journal of Hydrology*, 444-445, 90-99.

Costigan*, K.H. and **Daniels, M.D.**, 2012. Spatial pattern, density, and characteristics of large wood in Connecticut streams: Implications for stream restoration priorities in southern New England. *River Research and Applications*, In Press, available online, DOI: 10.1002/rra.158.

Daniels, M.D. and McCusker*, M.H. 2011. Reply to Bunte et al. (2011) "Discussion of Daniels and McCusker (2010): Operator bias characterizing stream substrates using Wolman pebble counts with a standard measurement template." Geomorphology 115, 194–198. *Geomorphology*, 134, 501-502.3

Burchsted*, D., **Daniels, M.D.**, Thorson, R.M., and Vokoun, J.C. 2010. The river discontinuum: beavers (*castor canadensis*) and baseline conditions for restoration of forested headwaters. *Bioscience*, 60(11): 908-921.

Daniels, M.D. and McCusker*, M.H. 2010. Operator bias characterizing stream substrates using Wolman pebble counts with a standard measurement template. *Geomorphology,* 115: 194–198**.**

Daniels, M.D., D. Burchsted*, J. MacBroom, L. Wildman, S. Harold, M. Carabetta, P. Woodworth, and G. Boardman **2010**. Redefining the Dam Removal Paradigm in Formerly Glaciated Forested Headwater Systems, *Proceedings of the EWRI/ASCE Congress, 2010*

Burchsted*, D., **Daniels**, **M. D.**, and R. M. Thorson. 2010. Restoring the River Discontinuum: Looking at the Example of Beaver Dams, *Proceedings of the EWRI/ASCE Congress, 2010*

McCusker*, M.H., and **Daniels, M.D.** 2009. The potential influence of small dams on basin sediment dynamics and coastal erosion in Connecticut. *Middle States Geographer*, 41:82-90.

Daniels, M.D., Boardman*, G.C., and Woodworth*, P.M. 2008. Assessing dam removal impacts on downstream geomorphic stability using hydrodynamic modeling. *Papers of the Applied Geography Conference*, 31: 133-141.

Chin, A., **Daniels, M.D.,** Urban, M., Piegay, H., Gregory, K.J., Gregory, S.V., Wohl, E., Laurencio, L., Bigler, W., Boyer, K., Grable, J., LaFrenz, M. 2008. Perceptions of Wood in Rivers and Challenges for Stream Restoration in the United States. *Environmental Management*, 41(6): 893-903.

Rhoads, B.L., Garcia, M.H., Rodriguez, J., Bombardelli, F., Abad, J., and **Daniels, M.** 2008. Methods for evaluating the geomorphological performance of naturalized rivers: examples from the Chicago metropolitan area. *Uncertainty in River Restoration*, Sears, D. and Darby, S. (editors). Wiley, Chichester, pp. 209-228.

Daniels, M.D. and Rhoads, B.L. 2007. Influence of experimental removal of large woody debris on spatial patterns of three-dimensional flow in a low-energy meander bend: A LWD removal experiment. *Earth Surface Processes and Landforms*, 32: 460-474.

Daniels, M.D. 2006. Grain size sorting in meander bends containing large woody debris. *Physical Geography*, 24(7): 348-362.

Daniels, M.D. 2006. Distribution and dynamics of large woody debris and organic matter in a low-energy meandering stream. *Geomorphology*, 77(3-4): 286-298.

Urban, M.A. and **Daniels, M.D.**, 2006. Exploring the links between geomorphology and ecology. *Geomorphology*, 77(3-4): 203-206.

Daniels, M.D. and Rhoads, B.L. 2004. Effect of LWD Configuration on Spatial Patterns of Three-Dimensional Flow in Two Low-Energy Meander Bends at Varying Stages. *Water Resources Research*, 40 (11) W11302 10.1029/2004WR003181 25 November 2004

Daniels, M.D. and Rhoads, B.L. 2004. Spatial patterns of turbulence kinetic energy and shear stress in a meander bend with large woody debris. Chapter in the American Geophysical Union Monograph volume entitled "Riparian Vegetation and Fluvial Geomorphology: Hydraulic, Hydrologic and Geotechnical Interactions", S. Bennett and A. Simon (eds.).

Daniels, M.D. and Rhoads, B.L. 2003. Influence of a large woody debris obstruction on three-dimensional flow structure in a meander bend. *Geomorphology*, 51, 159-173.

Wade, R.J., Rhoads, B.L., Rodriguez, J., **Daniels, M.D.**, Wilson, D., Herricks, E.E., Bombardelli, F., Garcia, M., and Schwartz, J. 2002. Integrating Science and Technology to Support Stream Naturalization near Chicago, Illinois. *Journal of the American Water Resources Association*, 38, 931-944.

GRANTS AND CONTRACTS AWARDED

C. Staudt, S. Christy, T. Ganesh, **M. Daniels (Co-PI)**, N. Dietrich. Strategies: Water SCIENCE: Supporting Collaborative Inquiry, Engineering, and Career Exploration with Water. NSF ITEST, $1,199,608

L. Kaplan, J. Khan, B. Sweeney, A. Aufdenkampe, **M. Daniels (Co-PI)**. Long-Term Research in Environmental Biology (LTREB): Trajectory for the Recovery of Stream Ecosystem Structure and Function during Reforestation, NSF DEB, 2/1/16 – 1/31/21, $450,000

Melinda Daniels (PI), with L. Kaplan, M. Erhart, and A. Aufdenkampe. Transforming Water Quality in the Sharitz Run Headwaters of Brandywine Creek, PA DEP Growing Greener, 2015-2020, $1,789,571

Melinda Daniels (PI), with B. Sweeney, D. Arscott, M. Erhart, W. Eldridge, J. Jackson, S. Gill, Restoring Flood Attenuation and Ecological Resiliency in the Mid-Atlantic Piedmont, 2014-2016, National Fish and Wildlife Foundation, $3,030,000

Melinda Daniels (PI), with A. Aufdenkampe, N. Dietrich, C. Staudt. Collaborative Research: Teaching Environmental Sustainability - Model My Watershed, 2014-2016, NSF DRK-12, $1,588,886

J. Blair, J. Nippert, S. Baer, W. Dodds and T. Joern (**M. Daniels: Senior Personnel**). KNZ LTER VII: Long-Term Research on Grassland Dynamics – Assessing Mechanisms of Sensitivity and Resilience to Global Change, 2014-2019, NSF, $6,100,000

Melinda Daniels (PI), with J. Aistrup, J. Bergtold, M. Caldas, K. Douglas-Mankin, D. Haukos, J. Hierr-Stamm, M. Mather, and A. Sheshukov, CNH: Coupled Climate, Cultivation, and Culture in the Great Plains: Understanding Water Supply and Water Quality in a Fragile Landscape, 2013-2016, NSF CNH, $1,450,000

Melinda Daniels (PI) and Bartosz Grudzinski*, Doctoral Dissertation Research: Influence of Grazing Differences on Stream Geomorphology in Tallgrass Prairie Headwater Streams, 2013, National Science Foundation GSS $15,759

Melinda Daniels (PI) and Claire Ruffing*, Doctoral Dissertation Research: The Impact of Historical Logging Activities on the Ecology and Geomorphology of Mountain Streams, 2013, National Science Foundation GSS $15,972

Melinda Daniels (PI), Impacts of In-Channel Sand Mining on the Geomorphology of the Kansas River, 2012-2014, Kansas Water Resources Institute (USGS), $53,390.

Melinda Daniels (PI) and Katie H. Costigan*, Doctoral Dissertation Research: Thermal, Hydraulic and Geomorphological Dynamics at Stream Confluences, 2012, National Science Foundation GSS $11,695

Melinda Daniels (PI), Watershed Assessment of the Wakarusa River, KS, Blue Earth LLC/Kansas Department of Health and the Environment, 9/19/2011-12/15/2012, $14,000.

Melinda Daniels (PI), Impacts of Large-Scale Forest Loss on Stream Channel Form, Process and Sedimentation, US Forest Service (USDA), 8/19/11-8/20/15, $49,667

Keith B. Gido, Joshuah S. Perkin, **Melinda Daniels (co-PI)** and Katie H. Costigan*, Reproductive Life History Of Great Plains Pelagic-Spawning Fishes In The Ninnescah River, Kansas, FY 2011 State Wildlife Subgrant Program, Kansas Department of Wildlife and Parks, 5/1/2011 to 4/30/2013, $192,675

Melinda Daniels (PI) Assessing the Impact of Channel and Riparian Zone Modifications on Aquatic Biodiversity in the Kansas River Basin, Kingsbury Family Foundation, 12/25/2011-12/25/2012, $24,951

Melinda Daniels (PI) American Rivers Patapsco River Restoration Project, McCormick Taylor, INC, 12/18/2010-12/18/2012, $11,299

Melinda Daniels (PI) KSU ORSP Faculty Development Award for travel to the 12th International Symposium on the Interactions between Sediments and Water, UK, (June, 2011) $1,200

Melinda Daniels (PI) Wildcat Creek Watershed Assessment, US Department of Agriculture/Blue Earth, LLC, 10/10-1/11, $7,400

Melinda Daniels (PI) Subcontract to Konza NSF LTER for geomorphology research support, 8/2010-8/2011, $26,000

Craig Paukert and **Melinda Daniels (co-PI)** Sand Dredging Effects on Fishes and Fish Habitat in the Kansas River, FY 2009 State Wildlife Subgrant Program, Kansas Department of Wildlife and Parks, 1/2010-1/2012, $181,983

Keith Gido, **Melinda Daniels (co-PI)** and Joe Gerken Seasonal Fish Assemblages and Habitat Effects near Bowersock Dam: Implications for Fish Passage, FY 2009 State Wildlife Subgrant Program, Kansas Department of Wildlife and Parks,1/2010-1/2012, $195,249

Melinda Daniels (PI) Hydraulic, Geomorphologic and Thermal Dynamics at Small Tributary Confluences, University Small Research Grant, Kansas State University, 2009, $1,500

Eric Schultz, Jason Vokoun and **Melinda Daniels** (Co-PI) Integrating Fluvial Geomorphology and Stream Ecology: Processes Shaping the Distribution of Freshwater Mussels in Connecticut, Connecticut Department of Environmental Protection, 2007-2009, $16,185

Melinda Daniels (PI) Post-Ice Control Structure Geomorphological Assessment of the Salmon River, NOAA/The Nature Conservancy, 2007 $3,500

Melinda Daniels (PI) Fluvial Dynamics of Large River Secondary Channels: Channel Morphology, Hydraulic Habitat, and Potential for Restoration, National Science Foundation Geography and Spatial Sciences, 7/11/2006-3/11/2009, $56,793

Melinda Daniels (PI) The Nature Conservancy: Dam Removal Alternatives Assessment for Umpawaug Pond Brook, 6/2006-12/2007, $19,800

Melinda Daniels (PI) National Park Service/Farmington River Alliance: Habitat and Flushing Flow Evaluation of the Farmington River Wild and Scenic Reach, CT, 1/2007-8/2007, $12,000

Melinda Daniels (PI) UCONN Research Foundation Large Faculty Grant: Thermal Dynamics At Tributary Confluences: Geomorphological And Hydraulic Research To Support Restoration Design And Management, 2006, $10,573

Melinda Daniels (PI) Monitoring the Effects of Dam Removal, NOAA/The Nature Conservancy, 1/2006-12/2006, $9,300

Jason Vokoun and **Melinda Daniels (co-PI)** CT Institute for Water Resources: Development and evaluation of a multi-dimensional spatially and temporally dynamic mesohabitat classification model for stream management and water flow allocation planning in southern New England streams, 2005-2007, $24,996

Melinda Daniels (PI) Pre-Ice Control Structure Geomorphological Assessment of the Salmon River, The Nature Conservancy, 6/2005-6/2006, $7,500

Melinda Daniels (PI) A preliminary study of the sediment dynamics of the Pomperaug River, Connecticut, Pomperaug River Watershed Coalition, 6/1/2004-9/1/2004 $2,000

Melinda Daniels (PI) Fluvial Dynamics of Large River Secondary Channels: Process, Form and Potential for Restoration, UCONN Research Foundation Faculty Grant Program, 6/2003-5/2004, $20,000

Bruce Rhoads and **Melinda Daniels (Co-PI)** Doctoral Dissertation Research: The Role of Large Woody Debris in the dynamics of a Low-Energy Meandering Stream in The Midwest, National Science Foundation Geography and Spatial Sciences, August 2000-August 2001, $9,274

AWARDS AND FELLOWSHIPS

Provosts Award: Development of new undergraduate curriculum: Global Change and Natural Hazards, University of Connecticut, 2006

Environmental Leadership Certificate of Appreciation (Finalist for Faculty Environmental Leadership Award) University of Connecticut Environmental Policy Advisory Council, 2005

University of Illinois Graduate Fellowship August 2001 - May 2002, $10,000

University of Illinois Joseph Russell Graduate Fellowship August 2000 - May 2001, $10,000

University of Illinois Charles S. Alexander Graduate Fellowship August 1999 - May 2000, $10,000

University of Illinois Graduate Program Enhancement Fellowship, August 1997 - May 1998, $10,000

GRANTS, FELLOWSHIPS AND SCHOLARSHIPS AWARDED TO STUDENTS UNDER MY SUPERVISION ($520,760)

Melinda Daniels (PI) and **Bartosz Grudzinski**, Doctoral Dissertation Research: Influence of Grazing Differences on Stream Geomorphology in Tallgrass Prairie Headwater Streams, 2013, National Science Foundation $15,759

Melinda Daniels (PI) and **Claire Ruffing**, Doctoral Dissertation Research: The Impact of Historical Logging Activities on the Ecology and Geomorphology of Mountain Streams, 2013, National Science Foundation $15,972

Melinda Daniels (PI) and **Katie H. Costigan**, Doctoral Dissertation Research: Thermal, Hydraulic and Geomorphological Dynamics at Stream Confluences, Submitted to Geography and Spatial Sciences, 2012, National Science Foundation $11,695

Katie H. Costigan, 2011 Yellow Springs Instruments (YSI) Graduate student grant and equipment loan (M9, CastAway CTD, IQ), $10,000 grant; $1,000 travel grant; estimated equipment value of $80,000

Katie H. Costigan, Reds Wolman Graduate Student Research Award, Association of American Geographers Geomorphology Specialty Group, "Critical Corridors in the Fluvial Ecosystem Landscape; Hydraulic, Geomorphologic and Thermal Habitat Dynamics at Confluences", 2011, $600

Heidi Mehl and Melinda Daniels (Faculty Sponsor) EPA-F2011-STAR-B1. Tribes and American Indian/Alaska Native/Pacific Islander Communities (B1). A cultural ecology of riparian systems on the Prairie Band Potawatomi Nation: understanding stream incision, riparian function, and Indigenous Knowledge to increase best management plan adoption, 9/2011-9/2014, $97,920

Keith B. Gido, Joshuah S. Perkin, Melinda Daniels, and **Katie H. Costigan* (co-PI)**, Reproductive Life History Of Great Plains Pelagic-Spawning Fishes In The Ninnescah River, Kansas, FY 2011 State Wildlife Subgrant Program, Kansas Department of Wildlife and Parks, 5/1/2011 to 4/30/2013, $192,675

Denise Burchsted, Beaver Meadow Hydrology, Sigma Xi Grant in Aid of Research, 2010, $1000

Denise Burchsted, Pre-Colonial River Conditions in Connecticut: Baseline Hydrology and Morphology for River Restoration, Geological Society of America Graduate Student Research Grant, $2,600

Denise Burchsted, Turner Designs Instrument Donation Program. June 2010. Aquafluor Handheld Fluorometer. Instrument and materials resale value $2,500.

Denise Burchsted, UConn Center for Environmental Science and Engineering, Multidisciplinary Environmental Research Award, 2007 and 2010 (two awards). $11,400

Denise Burchsted and **Melinda Daniels (Faculty Sponsor)** EPA-F2007-STAR-E1. Aquatic Systems Ecology - freshwater systems only) Pre-Colonial River Conditions in Connecticut: Baseline Hydrology and Morphology for River Restoration, 9/2007-9/2011, $110,000

PROFESSIONAL PRESENTATIONS AND WORKSHOPS

*(last 6 years) *denotes student*

Geological Society of America Annual Meeting, Baltimore, MD, 1-4 November 2015: *Longitudinal variation in thickness and composition of legacy sediments and buried organic soils in headwaters of the Christina river basin, USA*, Daniels, M.D., Marshall, A. and Chatterjee, S.

American Association of Geographers Annual Meeting, Chicago, IL April 21-25 2015: *Reconstructing River and Watershed Restoration: Physical Geography and a New Restoration Design Science*, INVITED as part of the Symposium on Physical Geography: Environmental Reconstruction I, Daniels, M., Ruffing, C. and Marston, B.

American Association of Geographers Annual Meeting, Chicago, IL April 21-25 2015: *Climatic influences and temporal variability in suspended sediment dynamics in actively grazed grassland streams,* Grudzinski, B., Ruffing, C., Barnes, P. and Daniels, M.D.

American Association of Geographers Annual Meeting, Chicago, IL April 21-25 2015: *Barriers to Fluvial Connectivity and Aquatic Biodiversity in the Central Great Plains: Fragmentation of Stream Networks in Semi-Arid Kansas,* Chatterjee, S. and Daniels, M.D.

National Science Teachers Association Area Conference in Philadelphia: November 12–14, 2015: *Sim City in the Real World: Modeling YOUR Neighborhood Environment*, Marcum-Dietrich, N., Daniels, M.D. and Staudt, C.

National Science Teachers Association Area Conference in Philadelphia: November 12–14, 2015: *NARST Session: Teaching Environmental Sustainability Using a Place-Based Watershed Modeling Application*, Marcum-Dietrich, N., Daniels, M.D. and Staudt, C.

National Science Teachers Association Area Conference in Philadelphia: November 12–14, 2015: *Teaching Environmental Sustainability Using Model My Watershed*, Marcum-Dietrich, N., Daniels, M.D. and Staudt, C.

Society for Freshwater Science Annual Meeting: Milwaukee, WI, May 17-21, 2015: *Are engineering effects of crayfish on gravel bed morphology mediated by species identity, behavior, and body size?* Albertson, L.K. and Daniels, M.D.

Society for Ecological Restoration, Newark, DE, March 28, 2015: *What's wrong with our streams and how can we fix them?* Daniels, M.D. (presentation to field trip group at SWRC)

River & Regolith Erosion and Deposition Summit, Newark, DE, May 2015: *Legacy Impacts of Tie Driving on Rocky Mountain Streams*, Daniels, M.D., Ruffing, C., Marston, B. and Dwire, K.

BP Grudzinski, **MD Daniels**, K Anibas, D, Spencer, *"Influence of watershed grazing management on bare ground production and sediment dynamics in grassland headwater streams"* Association of American Geographers, 2014 (Tampa, FL)

MD Daniels, L Kaplan*,"Riverscape Forcing Of Hot Spots, Hot Moments And Carbon Sequestration In A Topographically Complex Watershed"* Association of American Geographers, 2014 (Tampa, FL)

S. Chatterjee and **MD Daniels,** "Stream Network Fragmentation and Drought Combine to Drive Native Fishes from the Great Plains" Association of American Geographers, 2014 (Tampa, FL)

H Mehl and **MD Daniels**, "Land Tenure and Watershed Restoration on a Fractionated Indian Reservation" Association of American Geographers, 2014 (Tampa, FL)

S Chatterjee and **MD Daniels**, *"Coupled mechanism of unsystematic Damming and Climate Change effect on the rivers of the Great Plains of Kansas"* American Geophysical Union Fall Meeting, 2014 (San Francisco, CA)

J Schoenstein, **MD Daniels**, S Chatterjee, J Matkov, "Thermal Dynamics and Transient Storage in a Spring-fed Forested Headwater Stream, Southeastern PA, USA" CUAHSI 2014 Biennial Colloquium, 2014 (Sheperdstown, WV)

Ruffing, C.M., **M. D. Daniels**, W. K. Dodds, K. A. Dwire. 2013. "Fluvial Geomorphic Legacies of Tie Driving Regulate Carbon Cycling in Rocky Mountain Headwater Streams, WY" American Geophysical Union Fall Meeting, San Francisco, CA, December 9-13.

Ruffing, C.M., **M. D. Daniels**, W. K. Dodds, K. A. Dwire. 2013. "Carbon Cycle Legacies of Tie Driving in Rocky Mountain Headwater Streams, WY." Geological Society of America Annual Meeting, Denver, CO, Oct. 27-30.

Ruffing, C.M., **M.D. Daniels**, K. A. Dwire. 2013. "Influence of disturbance legacies on geomorphic and riparian dynamics in mountain streams" Association of American Geographers Annual Meeting, Los Angeles, CA, April 9-13.

BP Grudzinski*, **MD Daniels** "*Influence of grazing treatments and riparian protection on stream geomorphology and sediment concentrations in the Flint Hills and Osage Plains"* American Geophysical Union, 2013 (San Francisco, CA)

BP Grudzinski*, **MD Daniels** (University of Wisconsin, Eau Claire, WI) "*Influence of grazing treatments and riparian protection on stream geomorphology and sediment concentrations in the Flint Hills and Osage Plains"* West Lakes Association of American Geographers, 2013

BP Grudzinski*, **MD Daniels** "*Influence of grazing treatments and riparian protection on stream geomorphology and sediment concentrations in the Flint Hills and Osage Plains"* Geological Society of America, 2013 (Denver, CO)

BP Grudzinski*, **MD Daniels** "*Influence of grazing treatments and riparian protection on stream geomorphology and sediment concentrations in the Flint Hills and Osage Plains"* Grasslands Symposium, 2013 (Manhattan, KS)

BP Grudzinski*, **MD Daniels** *"Influence of grazing treatments and riparian protection on stream geomorphology and sediment concentrations in the Flint Hills and Osage Plains"* Association of American Geographers Annual Meeting, 2013 (Los Angeles, CA)

Marston*, B., **MD Daniels**, SE Ryan, "*Influence of The Mountain Pine Beetle Infestation on Wood Loads in Headwater Streams of The Medicine Bow National Forest, Rocky Mountains USA",* Geological Society of America Annual Meeting, Denver, CO, Oct. 27-30.

Mehl*, H.E., **M. Daniels**, B. Swenson*, and L. Calwell. 2012. Commercial sand dredging in the Kansas River. Presented at the Governor's Conference on Water and the Future of Kansas; Manhattan, KS, Oct. 31, 2012.

Daniels, M.D. Workshop: Integrating Hydro-geomorphology into LTER Research Programs, NSF LTER All Scientists Meeting, Estes Park, Sept. 10-13, 2012.

Grudzinski*, B. Larson, D., **Daniels, M.D.** Influence of Grazing Treatments on Nutrient, Bacteria, and Suspended Sediment Concentrations and Channel Geometry in the Flint Hills, Kansas, NSF LTER All Scientists Meeting, Estes Park, Sept. 10-13, 2012.

Perkin, J.S., K.B. Gido, K.H. Costigan*, **M.D. Daniels**, and E. Johnson. 2012. Distribution of Cyprinid Fish Reproductive Guilds in a Fragmented Great Plains Riverscape. American Fisheries Society, St. Paul, MN, August 2012.

Perkin, J.S., K.B. Gido, K.H. Costigan*, **M.D. Daniels**, and E. Johnson. 2012. Distribution of Cyprinid Fish Reproductive Guilds in a Fragmented Great Plains Riverscape. American Fisheries Society, St. Paul, MN, August 2012.

Dodds, W. K.**,** Gido, K.; Whiles, M. R., **Daniels, M. D**., Grimm, N. B., The unique qualities and global significance of grassland streams, Society of Freshwater Sciences Annual Meeting, Louisville, KY, May 20-24, 2012

Russell, D. M., Grudzinski*, B. P., **Daniels, M**.**D.**, Dodds, W. K., Joern, A., Skibbe, A., Blazing and grazing: fire and bison in tallgrass prairie streams, Society of Freshwater Sciences Annual Meeting, Louisville, KY, May 20-24, 2012

Russell, D. M., Grudzinski*, B. P., **Daniels, M**. **D.**, Dodds, W. K., Joern, A., Skibbe, A., Blazing and grazing: Influences of fire and bison (*Bos bison*) on the suspended sediment and nutrient dynamics of tallgrass prairie streams, The 22nd Konza Prairie LTER Annual Workshop, KPBS, June 7, 2012.

Grudzinski*, B., D. Russell, W.K. Dodds, and **M.D. Daniels**. Influence of Grazing Treatments on Nutrient and Bacteria Concentrations in the Flint Hills, Kansas, The 22nd Konza Prairie LTER Annual Workshop, KPBS, June 7, 2012.

Daniels, M.D. and Costigan*, K.H. Human Alteration of Great Plains River Regimes and Implications for Aquatic Species Management, Annual Meeting of the Association of American Geographers, New York, NY, Feb 24-28, 2012

Daniels, M.D., The local hydraulic and geomorphic effects of natural large wood structures, Technical Workshop on Large Wood Applications and Research Needs in River Restoration, sponsored by the US Bureau of Reclamation and the US Army Corps of Engineers, Seattle, WA, Feb 14-15, 2012 (INVITED)

Daniels, M.D. and Costigan*, K.H. Human Alteration of Great Plains River Regimes and Implications for Aquatic Species Management, Kansas Natural Resources Conference, Wichita, KS, Jan 26-27, 2012

Fischer*, J., Paukert, C. and **Daniels, M.D.** Human Alteration of Great Plains River Regimes and Implications for Aquatic Species Management, Kansas Natural Resources Conference, Wichita, KS, Jan 26-27, 2012

Mehl*, H.E., Pockrandt*, B., **Daniels, M.D.**, Annett, C.A., Calwell, L. and Daniels, R. Developing a public database of geospatial information for the Kansas River Watershed, Kansas Natural Resources Conference, Wichita, KS, Jan 26-27, 2012

Daniels, M.D. and Grudzinski*, B. *Hydrology and Geomorphology of Tallgrass Prairie Intermittent Headwater Streams*, American Geophysical Union Fall Meeting, San Francisco, CA, December 4-9, 2011

Costigan*, K.H. and **Daniels, M.D.** *Hydrologic Alteration of Great Plains Rivers*, American Geophysical Union Fall Meeting, San Francisco, CA, December 4-9, 2011

Grudzinski*, B. and **Daniels, M.D.** *Impact of Cattle and Bison Grazing on Stream Morphology in a Tallgrass Prairie*, GPRM AAG Regional Division Meeting, Denver, CO, October 6-8, 2011

Ruffing*, C. and **Daniels, M.D.** *Using Lidar to Assess Local Water Resource Concerns at a Watershed Scale,* GPRM AAG Regional Division Meeting, Denver, CO, October 6-8, 2011

Mehl*, H. and **Daniels, M.D.** *Water Quality and Channel Stability on the Prairie Band Potawatomi Reservation,* GPRM AAG Regional Division Meeting, Denver, CO, October 6-8, 2011

Costigan*, K.H. and **Daniels, M.D.** *Damming the Prairie: Human Alteration of Great Plains River Regimes*, GPRM AAG Regional Division Meeting, Denver, CO, October 6-8, 2011

Terry*, E. Bartlett*, S., Ruffing*, C. **Daniels, M.D.**, and Marston*, B. *Effects of Water Diversions on Drainage Basins in the Medicine Bow National Forest.* GPRM AAG Regional Division Meeting, Denver, CO, October 6-8, 2011

Mehl*, H.E., Pockrandt*, B., Calwell, L., Annett, C. and **Daniels, M.D.** *An Inventory of the Kansas River.* Water and the Future of Kansas Conference, Topeka, KS, September 30, 2011

Dodds, W.K., Gido, K., Whiles, M.R., and **Daniels, M.D.** *Grassland Streams.* Grasslands in a Global Context, Manhattan, KS, September 12-14, 2011

Grudzinski*, B. and **Daniels, M.D.** *Influence of Grazing Treatments on Stream Substrate and Channel Geometry in the Flint Hills, Kansas.* Grasslands in a Global Context, Manhattan, KS, September 12-14, 2011

Fischer*, J., Gerken*, J., Paukert, C. and **Daniels, M.D.** *Habitat and Fish Community Response to Sand Dredging In a Large Great Plains River.* The American Fisheries Society 141st Annual Meeting, Seattle, WA Sept. 4-8, 2011

Daniels, M.D. and Grudzinski*, B. *Impacts of Grazing and Riparian Management on Geomorphology of Prairie Streams.* The 21st Annual Konza Prairie LTER Workshop, Manhattan, KS, April 16th, 2011.

Daniels, M.D. *The Great Failures Of River Conservation And Restoration – Can Redemption Be Found In An Emerging Fluvial Landscape Ecology?* Invited Seminar, University of Missouri Department of Geography, Columbia, MO, March 11, 2011

Daniels, M.D., Fischer*, J., Gerken*, J., Costigan*, K.H. and Paukert, C. *Using Hydroacoustic Technology to Assess the Impacts of In-Channel Dredging on Hydraulic Habitat Conditions in the Kansas river.* 2011 USGS National Surface Water Conference, Tampa, FL, March 28-April 1, 2011

Grudzinski* B.,and **Daniels, M.D.** *Influence of Grazing Treatments on Stream Geomorphology in the Flint Hills*, Kansas Natural Resources Conference, January 20-21, 2011, Wichita, KS.

Fischer*, J., Gerken*, J., Paukert, C., and **Daniels, M.D.** *Fish Community Response to Habitat Alteration: Impacts of Sand Dredging in the Kansas River*, 71st Midwest Fisheries and Wildlife Conference, Minneapolis, MN, December 12-15, 2010

Fischer*, J., Gerken*, J., Paukert, C., and **Daniels, M.D.** *Influence of Sand Dredging on Fish Communities in the Kansas River*, Kansas Natural Resources Conference, Wichita, KS, January 20-21, 2011

Russell*, D.M., Dodds, W.K., Grudzinski*, B. and **Daniels, M.D.** *Effects of Bison and Prescribed Fire on Prairie Stream Sediments*, Kansas Natural Resources Conference, January 20-21, 2011, Wichita, KS.

Fischer*, J., Gerken*, J., Paukert, C. and **Daniels, M.D.** *Fish community response to habitat alteration: Impacts of sand dredging in the Kansas River*, Midwest Fish and Wildlife Conference, Minneapolis, MN, December 2010

Daniels, M.D. Hook*, L.M., Sheeley, J. Brown, T. *Spatial and temporal lateral discontinuity on the pre-engineered Missouri River*, GSA Annual Meeting, , Denver, CO, November 2010

Burchsted*, D. **Daniels, M. D.** *Beaver dam impacts on sediment and water regime*, GSA Annual Meeting, Denver, CO, November 2010

Daniels, M. D., Burchsted*, D. *Incorporating pre-disturbance discontinuity into dam removal and river restoration paradigms*, GPRM Regional AAG, Lawrence, KS, October 2010

Costigan*, K.M., **Daniels, M.D.**, Gritzmacher*, G.G. *Evaluating local bed shear stress estimates in meander bends using acoustic Doppler velocimeter data*, GPRM Regional AAG, Lawrence, KS, October 2010

Daniels, M.D., Burchsted*, D. , MacBroom, J., Wildman, L., Harold, S., Carabetta, M., Woodworth, P., and Boardman, G. *Redefining the Dam Removal Paradigm in Formerly Glaciated Forested Headwater Systems*, EWRI/ASCE World Environmental and Water Resources Congress, 2010, Providence, Rhode Island, May 16-20, 2010

Burchsted*, D., **Daniels, M.D.**, and Thorson R.M. *Restoring the River Discontinuum: Looking at the Example of Beaver Dams*, EWRI/ASCE World Environmental and Water Resources Congress, 2010, Providence, Rhode Island, May 16-20, 2010

Banner, E. and **M. D. Daniels** *Documenting the historical spatial extent and character of riparian forests in Kansas using General Land Office Survey Records*, Kansas Natural Resources Conference, Wichita, KS, February 4-5, 2010

BOOK REVIEWS, REPORTS AND OTHER PUBLICATIONS

Flat Creek Restoration Assessment, National Elk Refuge, Jackson, Wyoming. 2013. Report to the Wyoming Department of Fish and Game.

Sand Dredging Effects on Fishes and Fish Habitat in the Kansas River. 2012. Report to the Kansas Department of Wildlife, Parks, Recreation and Tourism.

Seasonal Fish Assemblages and Habitat Effects near Bowersock Dam: Implications for Fish Passage. 2012. Report to the Kansas Department of Wildlife, Parks, Recreation and Tourism.

Assessing the Impact of Channel and Riparian Zone Modifications on Aquatic Biodiversity in the Kansas River Basin. Report to the Kingsbury Family Foundation.

Book Review: Urban Watersheds: Geology, Contamination and Sustainable Development**.** Martin M. Kaufman, Daniels T. Rogers and Kent. S. Murray. Boca Raton: CRC Press, 2011. 547 pp., *The Professional Geographer*, in press.

Watershed Assessment of the Wakarusa River, KS. 2012. Report to the Kansas Department of Health and the Environment.

Wildcat Creek (KS) Watershed Assessment. 2011. Report to the USDA Natural Resources Conservation Service and US Army (Fort Riley).

Processes Shaping the Distribution of Freshwater Mussels in Connecticut. 2010. Report to the Connecticut Department of Environmental Protection.

Habitat and Flushing Flow Evaluation of the Farmington River Wild and Scenic Reach, CT. 2009. Report to The National Park Service.

Post-Ice Control Structure Geomorphological Assessment of the Salmon River. 2008. Report to The Nature Conservancy (CT office).

Book Review: Hydrological Applications of GIS. A.M. Gurnell and D.R. Montgomery (Editors). John Wiley and Sons, 2000. 173 pages. *Geomorphology*, 54, 347-351.

SERVICE

Board Memberships

United States Army Corps of Engineers Environmental Advisory Board, Appointed by the Secretary of Defense, reporting directly to the Chief Engineer

Journal Editing

Editorial Board, *Geomorphology*

Special issue co-editor: "Linking Geomorphology and Ecology" *Geomorphology* Volume 77, Issues 3-4, Pages A1-A2, 203-334 (30 July 2006), edited by M.A. Urban, M.D. Daniels and M. Doyle

Special issue co-editor: "Discontinuity in Fluvial Systems" *Geomorphology*, in progress, edited by M.D. Daniels, D. Burchsted, and E. Wohl

Peer Reviews: Agencies

USGS: external publication reviews, personnel performance and promotion reviews
NSF Panelist, Water Sustainability and Climate; Hydrological Sciences; Geography and Spatial Sciences
NSF External Reviewer: Geography and Spatial Sciences, Hydrologic Science, CAREER, Water Sustainability and Climate

Peer Reviews: Journal and Monograph Manuscripts

PLOS ONE, Water Resources Research, *Freshwater Science, Ecosystems, Environmental Management, Middle States Geographer, Geomorphology, The Professional Geographer, GeoForum, Earth Surface Processes and Landforms, The Northeastern Geographer, River Research and Applications, JGR Earth Surface, Journal of the North American Benthological Society,* American Geophysical Union Monograph: "*Riparian Vegetation and Fluvial Geomorphology: Hydraulic, Hydrologic and Geotechnical Interactions*", *Journal of Women and Minorities in Science and Engineering, Area*

Leadership in Scholarly Organizations

Organizer and Chair: Science, Policy, and Politics for Restoration of the Florida Everglades: The Taylor-Francis/Rutledge Distinguished Lecture in Geomorphology, AAG Geomorphology Specialty Group, 2014 Annual Meeting
President, AAG Geomorphology Specialty Group, 2013-2014; Secretary, 2012-2013 (elected positions)
Chair, AAG Geomorphology Specialty Group Awards Committee, 2011-2012
Interim Chair, AAG Geomorphology Specialty Group Awards Committee, 2010-2011
Session co-organizer, "Migration and Economic Restructuring in Rural America: Papers in Memory of Alex Vias", Association of American Geographers Annual Meeting, February 2012, New York, NY.
Session co-organizer, "Linking Geomorphology and Ecology", Association of American Geographers Annual Meeting, April 2005, Denver, CO.
Session co-organizer, "Linking Geomorphology and Ecology I", Association of American Geographers Annual Meeting, March 2004, Philadelphia, PA.
Session co-organizer, "Linking Geomorphology and Ecology II", Association of American Geographers Annual Meeting, March 2004, Philadelphia, PA.
Session co-organizer, "New Perspectives on River Processes: Fluid Dynamics, Wood Dynamics, and Morphologic Change", American Geophysical Union meeting, December 2001, San Francisco, CA.

Graduate Students Supervised

Sarmistha Chatterjee (Univ. Delaware, PhD, active)
Heidi Mehl (KSU, PhD, Geography, active)
Bryce Marston (KSU, PhD, Geography, active)
Barrett Swenson(KSU, MA, Geography, active)
Bartosz Grudzinski (KSU, PhD, Geography, 2014)
Claire Ruffing (KSU, PhD, Geography, 2014)
David Spencer (KSU, MA, Geography, 2014)
Brianna Roberts (KSU, MA, Geography, 2014)
Katie Costigan (KSU, PhD, Geography, 2013)
Denise Burchsted (UCONN, PhD, Geological Science, 2013)
Lisa Hook (KSU, MA, Geography, 2010)
Piyumi Obesekara (UCONN, MS, Geosciences, 2009)
Natalie Vibert (UCONN, MA, Geography, 2008)
Paul M. Woodworth (UCONN, MA, Geography, 2008)
Graham Boardman (UCONN, MA, Geography, 2008)
Megan MCusker (UCONN, MS, Geosciences, 2008)
Jason Miller (UCONN, MA, Geography, 2007)
Heather Pierce (UCONN, MA, Geography, 2006)
Elizabeth Spender (UCONN, MA, Geography, 2006)
Grant Gritzmacher (UCONN, MA, Geography, 2006)

Megan McCusker (UCONN, MA, Geography, 2005)

Center, Departmental, College and University Service
Strategic Planning Committee Member, SWRC, 2013-2014
Graduate Program Director, 2010-2013, Kansas State University Department of Geography
Faculty Steering Committee, Urban Water Institute, KSU-Olathe campus, 2011-2013
University Graduate Council Member, 2010-present, Kansas State University
Sub-committee for Academic Affairs Member, University Graduate Council, 2010-2013, Kansas State University,
Geography Interim Head of Department Search Committee Member, Kansas State University, 2010-2011
Graduate Committee Member, 2009-2010, Kansas State University Department of Geography
Gamma Theta Upsilon Faculty Advisor, 2008-2009, Kansas State University
Graduate Program Committee, 2005-2008, University of Connecticut Department of Geography
Center for Integrative Geosciences Advisory Committee, 2005-2008, University of Connecticut College of Liberal Arts and Sciences
Undergraduate Program Committee Member, 2005-2008, University of Connecticut Department of Geography
Visiting Assistant Professor in Residence Search Committee Member, 2005, University of Connecticut Department of Geography
Department Head Search Committee Member, 2004-2006, University of Connecticut Department of Geography
Visiting Assistant Professor in Residence Search Committee Member, 2004-2005, University of Connecticut Department of Geography
Geosciences Advisory Review Board, 2004-2005, University of Connecticut College of Liberal Arts and Sciences,
UCONN Environmental Policy Advisory Council, 2004-2007
UCONN Environmental Policy Advisory Council Subcommittee on Land Use and Sustainable Development, Office of the Chancellor, University of Connecticut, 2003-2007
UCONN Undergraduate Coordinator, Department of Geography, University of Connecticut, 2003-2004
UCONN Environmental Science Major Program Advisory Committee, University of Connecticut, 2003 - 2007
UCONN College of Liberal Arts and Sciences Undergraduate Education Council, University of Connecticut, 2002 – 2004
UCONN Teale Nature and the Environment Lecture Series Organizing Committee, University of Connecticut, 2002 - 2007
Faculty Search Committee, Department of Geography, University of Illinois, 2000-2001

Outreach/Community Service
I have actively collaborated/consulted with several environmental non-profit and government agencies on a pro-bono basis, including the Northeast Salmon Commission, the Gulf of Maine Council on Stream Barrier Removal Monitoring, the Southbury Land Trust, the Pomperaug River Watershed Coalition, the Houston Valley Association, The Nature Conservancy, The Trustees of Reservations, The KS office of the Natural Resource Conservation Service, The Connecticut Department of Environmental Protection, the Kansas Water Office, the USACE Kansas City office, the Kansas Department of Wildlife, Parks and Recreation, Friends of the KAW, and the Kansas River Keeper.

TEACHING EXPERIENCE

UNIVERSITY OF PENNSYLVANIA: 2013-
Freshwater Biology
KANSAS STATE UNIVERSITY: 2008-2013
Environmental Geography
World Regional Geography
Fluvial Geomorphology
Methods Theories and Models in Geography

Geographic Information Systems I
River Regimes

UNIVERSITY OF CONNECTICUT: 2002-2008
Introduction to Physical Geography
Fluvial Geomorphology
Advanced Seminar in Fluvial Geomorphology
Advanced Seminar in Coastal Geomorphology
Environmental Evaluation and Assessment
Environmental Planning and Management
Environmental Restoration
Advanced Seminar in Environmental Restoration

UNIVERSITY OF ILLINOIS: 2002
Introduction to Physical Geography

MEMBERSHIP IN PROFESSIONAL ORGANIZATIONS

Society for Freshwater Science
Association of American Geographers
American Geophysical Union
Geological Society of America

Paul M. Woodworth

Fluvial Geomorphologist

Princeton Hydro

Education

- Master of Arts, Geography (Fluvial Geomorphology), University of Connecticut, 2008
- Bachelor of Arts, Biology and Environmental Studies, Middlebury College, 1999

Technical Training

- United States Forest Service, Designing Road-Stream Crossings for Aquatic Organism Passage (Stream Simulation), 2015
- Connecticut Dam Safety Program Update, Environmental Business Council of New England, 2014
- Ecological Risk Assessment: Practice and Protocols Rutgers, Office of Continuing Professional Education, 2014
- River 2D Workshop, Amherst, Massachusetts, 2012
- River & Stream Restoration: Geomorphic & Ecological Processes, NJ-AWRA, 2009
- Certificate in Geographic Information Systems, University of Connecticut, 2008
- Master Wildlife Conservationist, Connecticut Department of Environmental Protection, 2005

Areas of Expertise:

Fluvial Geomorphology

- Geomorphic Assessment
- Channel Forming Processes
- Hydrodynamic 2-D Modeling

Stream Restoration

- Process-Based Restoration
- Sediment Stability / Mobility
- Habitat Creation / Enhancement
- Aquatic Organism Passage
- Stream Simulation / Continuity

Dam Removal

- Feasibility Assessment
- Sediment Sampling, Analysis and Management
- Ecological Risk Assessment
- Geomorphic / Engineering Design & Restoration

Project Support

- Total Station Survey
- CAD / GIS
- Regulatory Compliance
- Construction Oversight

Summary of Qualifications

Focused on removing obsolete dams and restoring rivers, Mr. Woodworth has advanced over 50 barrier removal projects, which have resulted in over 25 barriers removed, in his 6 years at Princeton Hydro. He is the primary staff member responsible for integrating fluvial geomorphology into the assessment and restoration of stream channels, wetlands, and floodplains.

Mr. Woodworth supports all phases of project development, from initial project conceptualization through data collection, design, permitting and construction. During planning phases, Mr. Woodworth routinely conducts geomorphic assessments, sediment sampling, topographic surveys of channels, bathymetric surveys of impoundments, and the collection of flow data.

For project design, Mr. Woodworth analyzes and interprets sediment analysis results, geomorphic metrics, flow data, and sediment stability and mobility. His dam removal designs incorporate responsible management of sediments, restoration of channel-forming processes, enhancement of in-stream habitat, and restoration of riparian plant communities. He analyzes laboratory data and ecological screening criteria to assess ecological risk associated with sediment exposure, disturbance and release. He designs stream channels to restore lateral connectivity, fluvial processes, dynamically stable channel morphology, pool-riffle sequences, and woody material habitat features.

In addition, Mr. Woodworth has experience with complex modifications of active dams, designing creative solutions that balance aquatic organism passage with existing dam services including the design of fish by-pass channels, fish-passable rock ramps, and fish ladders. Mr. Woodworth is experienced in the interpretation of applicable regulations, completion of permit applications for county, state, and federal regulatory agencies, as well as coordination and negotiation with regulators. He has developed unique stream assessment protocols by synthesizing existing diverse approaches that incorporate geomorphology with aquatic ecology and riparian floristic quality. He has conducted long-term, repeat geomorphic surveys to monitor project success and coordinated a watershed-scale study to assess 100 culvert crossings and identify priority sites for fish-passage restoration projects. He synthesizes his work into high-quality, detailed deliverables including feasibility studies, alternative analyses, engineering design plans, and technical engineering reports. Finally, Mr. Woodworth has worked first-hand with contractors to guide the removal of approximately 10 individual dams; work that involved adapting

designs to dynamic river conditions while still satisfying project goals.

Selected Project Experience:

Cross Fork Creek AOP Culvert Replacement, Potter County, PA (2014) – Completed site assessment, USFS Stream Simulation Design, engineering design plans, and permitting for the replacement of culverts with open-bottom spans on two tributaries of Cross Fork Creek: Gravel Lick Run and Little Lyman Run.

Tannery Brook Dam Removal, Boscawen, NH (2014) – Completed due diligence assessment, site survey, geomorphic design, engineering design plans, and permitting for the removal of a large dam in central New Hampshire.

Pleasant Grove Dam Removal and Wetland Restoration, Jackson, NJ (2012) – Completed permitting and restoration design for the removal of an earthen dam on unnamed tributary to Toms River. Project included the creation and restoration of wetland habitat within the former impoundment, marking the first use of dam removal for direct wetland mitigation in the State of New Jersey.

Pomperaug Large Woody Debris Design, Southbury, CT (2012) – Completed site assessment and survey of a reach of the Pomperaug River at the Audubon Center at Bent-of-the-River for habitat restoration through the installation of large-woody debris. Developed cost-effective design, for minimal regulatory involvement, and swift progression to construction.

Little Lehigh Creek Dam Removals, Allentown, PA (2012) – Completed geomorphic assessments, topographic survey, sediment sampling, permitting and restoration design for three low-head dams for Allentown-based environmental nonprofit, Wildlands Conservancy.

Cooks Creek Culvert Assessment, Bucks County, PA (2012) – Developed culvert assessment protocol, trained volunteers, analyzed and prioritized 100 stream-road crossings for retrofits, developed conceptual designs for Bucks County Chapter of Trout Unlimited.

Nevius Street Dam Fish Passage Feasibility and Design, Raritan River, Raritan, NJ (2012) – Completed survey and site assessment; supported hydrologic and hydraulic modeling, and design of a dam notch that restores upstream migration of American shad while still supplying an existing water supply intake.

Mitchell Brook Culvert Replacement, Whately, MA (2012) – Completed a geomorphic assessment, topographic survey, and applied USFS Stream Simulation guidelines and Massachusetts Stream Crossing Standards to complete final design of an open-bottom culvert crossing that enables passage of resident cold-water fish.

Quakertown Preserve Dam Removal and Wetland Restoration, Franklin Township, Hunterdon County, NJ (2011) – Secured funding on behalf of Hunterdon Land Trust; led site assessment, design, permitting and construction oversight. Project set an important precedent, demonstrating that dam removal, which results in floodplain and wetland restoration is suitable for wetland mitigation. Project marks first dam removal financed by the NJ Wetland Mitigation Council.

Publications / Presentations:

Michael Jastremski, CFM and Ryan Williams, Housatonic Valley Association; Paul Woodworth, Princeton Hydro LLC; Xinyi Shen, Ph.D., Lanxin Hu, and Emmanouil N. Anagnostou, Ph.D., Department of Civil & Environmental Engineering, University of Connecticut. *Integrating Stream Habitat Connectivity Restoration into Local Flood Hazard Mitigation Planning in Connecticut's Northwest Hills.* April 4, 2016. Northeast Annual Fish and Wildlife Agency Conference, Annapolis, MD.

Woodworth, P.M. *River and Streams*; *Human Impacts on Rivers, Part 1: Dams*; and *Human Impacts on Rivers, Part 2: Road Crossings*. November 20, 2014. Connecticut Audubon Society, Master Naturalist Course.

Woodworth, P.M. 2011. *Redesigning Road Crossings with Stream Simulation Techniques and MA Stream Crossing Standards.* Presentation at Fish Passage 2011 – National Conference on Engineering & Ecohydrology for Fish Passage.

Woodworth, P.M., Helminiak, J.E. *Connectivity and Clutter: Ecological Uplift in Watson Creek*. February 19, 2010. Poster presentation at the Society for Ecological Restoration 2010 Mid-Atlantic Conference, New Brunswick, New Jersey.

Geoffrey M. Goll, P.E.

Vice President

Princeton Hydro

Education:

- M. Eng. Engineering Management, University of Wisconsin, Madison
- B.S. Civil Engineering, Rutgers University

Professional Certifications:

- Professional Engineer: Maryland, Massachusetts, New Jersey, New York, Pennsylvania, Vermont, Virginia
- Nuclear Regulatory Commission, Certified Radiation Safety Officer and Soil Density and Moisture Content Gauge Operator

Professional Training:

- Rosgen Level I

Professional Affiliations:

- Continuing Education Instructor Rutgers Office of Continuing Education
- American Society of Civil Engineers
- Association of State Dam Safety Officials

Areas of Experience:

- Geotechnical engineering and subsurface investigation
- Stream and river restoration
- Stormwater management
- Dredging
- Flood hazard area and floodplain modeling
- Dam restoration and removal
- Wetland mitigation design and implementation
- Regulatory permitting
- Construction administration
- Expert witness/forensic investigation for water resource-related litigation
- Assembling project partners for water resource restoration projects

Summary of Qualifications:

Mr. Goll is a founding Partner of Princeton Hydro and has extensive experience in geotechnical engineering, stormwater management, hydrology, floodplain hydraulics, environmental assessments, and environmental permitting; his professional background is specific to water resource and geotechnical engineering. The breadth of his experience ranges from stream restoration and modeling to the design of large retaining structures and building foundations; he has provided expert consultation, engineering design and support on a variety of projects including residential developments, solid waste transfer stations, correctional facilities, and wastewater treatment plants.

Mr. Goll has extensive experience in subsurface investigations, geotechnical design, and soils classification and engineering. He has designed and implemented over 100 subsurface investigation programs ranging from foundation investigations to septic system design, includes test borings in soil, bedrock and in-lake and harbor sediment. He has designed engineered steep slopes (greater than 2:1) and retaining walls, performed slope stability analysis and has provided on-site earthwork and compaction monitoring services. With regard to subsurface sewage disposal, Mr. Goll has progressed subsurface investigations for residential developments of up to 100 units. Mr. Goll has provided extensive subsurface investigations within the New Jersey coastline, the Coastal Plain, Piedmont, Highlands and Ridge and Valley geologic provinces. Mr. Goll has also provided forensic subsurface investigations to determine the origins of historic fills and determine original ground surface elevations to determine appropriate bearing locations for structure footings.

Mr. Goll has provided engineering design services, testimony, and review of stormwater management facilities for public and private clients, and has provided guidance in the development of watershed management plans and stormwater ordinance development in both New Jersey and Pennsylvania. He is well versed in stormwater runoff theory and modeling, as well as extensive knowledge of soil infiltration testing and design methods, as is required by the Phase II Stormwater Management Regulations.

Mr. Goll has extensive experience in the quantification and analysis of accumulated sediment within freshwater lakes and rivers. He is also well versed in the processes of sediment transport and accumulation and has been in responsible charge for the design of over 500,000 cubic yards of dredging projects and over 1,000,000 cubic yards of sediment quantification in lakes and rivers throughout the Mid-Atlantic region. His experience also extends to harbor dredged materials where he was in responsible charge of the stabilization of dioxin-, PCB- and heavy metal-contaminated dredged materials for a Brownfield

redevelopment. Mr. Goll's most important value to dredging projects is through his understanding of the spatial distribution of sediment types throughout a waterbody's environment and his ability to create technical and bidding specifications that ensures cost control of projects and eliminates the open interpretation of vertical and horizontal project excavation limits via strict survey control.

Mr. Goll has pioneered dam removals for the purposes of fish passage in the State of New Jersey. He was in responsible charge of the first dam removal in New Jersey funded by American Rivers, NOAA, NRCS and the US Fish and Wildlife Service. Mr. Goll regularly coordinates multiple grant sources to fund such removals as well brings different parties together to create momentum for projects. Mr. Goll has prepared public presentations to educate local communities regarding the benefits of dam removal and providing conceptual photographic images of post-removals. His understanding of sedimentation mechanisms and management of sediment behind impoundments has been instrumental in managing the mitigation of environmental impacts during and after demolition of river and streams obstructions.

Mr. Goll has also been in responsible charge of the restoration of Low to High Hazard Potential dams. He has provided design and construction management services for a number of clients in the States of New Jersey and Pennsylvania. He has run hydrologic and hydraulic modeling, and inundation mapping; prepared Emergency Action Plans and Operation and Maintenance Manuals; progressed geotechnical investigations and stability analysis; and prepared technical and bidding specifications.

During the construction phase of projects, Mr. Goll has the practical knowledge of implementation of designs through his past experience as a field inspector for civil works projects, such as residential developments and dam construction. His past field experience, combined with his design knowledge and current oversight of many construction projects, allows him to make informed and practical decisions in the field when confronted with physical site challenges.

Mr. Goll has been accepted as an expert witness by the Superior Court of New Jersey (Morris and Gloucester Counties) in the areas of stormwater management and soils. Mr. Goll provided live testimony on stormwater impacts to high elevation headwaters to the Vermont State Legislature. Mr. Goll has also provided expert testimony on behalf of applicants in front of Planning Board and Zoning Board of Adjustments and governing committees and council; projects included mining applications, residential developments, and golf courses.

Selected Project Experience:

Westtown Dam Analysis and Emergency Action Plan, Westtown Township, Chester County, PA (2012) – Mr. Goll was in responsible charge of the assessment, stability analysis, and hydrologic and hydraulic modeling of the Westtown Lake Dam, a Significant Hazard dam owned and operated by the Westtown School. Princeton Hydro completed a hydrologic and hydraulic analysis of the watershed to Westtown Lake, including developing spillway design storm flows, dam breach analysis, and the preparation of inundation mapping. Following the completion of the inundation analysis, an Emergency Action Plan (EAP) was prepared to allow for a coordinated emergency response effort to notify the public and to address varying breach scenarios during an overtopping or breach event.

NJM Regional Operations Facility Stormwater Management System, Hammonton, NJ (2010) **–** Mr. Goll was the engineer-of-record for the stormwater management design and geotechnical investigations for a 250,000 square foot corporate campus on a 55-acre site. Due to a number of site physical constraints, the site was designed to contain nearly all stormwater runoff on site, up to and including the 100-year frequency, 24-hour duration storm event. Site geotechnical investigations included investigations for building foundations, parking lot and drive subgrades and stormwater infiltration with all laboratory testing completed in-house.

Medford Lakes and Birchwood Lakes Dredging, Burlington County, NJ (2007) – Mr. Goll was in direct charge of the investigation, design, permitting and construction management of these projects Princeton Hydro progressed sediment surveys, analyzed the sediment for geotechnical properties and contamination, designed the dredging, prepared permit application and managed the construction phase of the dredging. The quantity of sediment removed from both dredging projects totaled 143,000 cubic yards. Both projects were completed on time and on budget. The Medford Lakes Colony

dredging was completed for a construction cost of $2.2 million and the Birchwood Lakes dredging was completed for a construction cost of $1.3 million.

Earthwork Monitoring and Materials Testing for Multi-family Residential Development, Lambertville, NJ (2008) – Princeton Hydro was contracted to provide earthwork monitoring and materials testing for a 129-unit, multi-family residential development. The site required fills in excess of 20 feet and cuts through bedrock of 10 feet. Princeton Hydro's role was to complete laboratory testing of soils, in-field compaction rate testing, and observation of placement and excavation of fills.

Subsurface Investigation – 37 Foot High Stream Crossing, West Amwell, NJ (2003) – Provided subsurface investigation for a 9-foot high by 35-foot span concrete arch culvert with associated 20-foot high retaining walls and reinforced earth slopes. The span was to be overlain with 26 feet of controlled compacted fill. The investigation focused on the determination of bearing capacities of the underlying bedrock and to prepare specifications for the placement of controlled compacted fill.

Select Presentations and Publications:

Goll, Geoffrey M. (Presenter), *Green Infrastructure Stormwater Management Techniques (September 18, 2015)*, Montclair State University Continuing Education Program for Environmental Professionals, Montclair, NJ

Goll, Geoffrey M. (Presenter), *Advanced Stormwater Management (2014 to present)*. Rutgers University, Office of Continuing Education, New Brunswick, NJ

Goll, Geoffrey M. (Presenter), *Lake Management Course; Dredging and Dam Safety Compliance sessions (1996 to present)*. Rutgers University, Office of Continuing Education, New Brunswick, NJ.

Goll, Geoffrey M. (Presenter), *Pond Management, Construction and Restoration; Dredging and Dam Safety Compliance sessions (2000 to present)*. Rutgers University, Office of Continuing Education, New Brunswick, NJ.

Goll, Geoffrey M. (Presenter and Panel Discussion), March 9, 2012, *NJ Future Redevelopment Forum 2012, Treating Flooding as the "New Normal",* New Brunswick, NJ.

Goll, Geoffrey M. (Instructor and Course Coordinator), September 29, 2011, *Dam Removal Technical Track Half Day Program*, Association of State Dam Safety Officials, National Conference, Washington, DC.

Goll, Geoffrey M. (Instructor), September 20-22, 2010, *Dam Removal Case Studies*, The University of Wisconsin, Madison, Succeeding with a Dam Removal Project*,* Philadelphia, PA.

Woodworth, Paul, Galster, Josh, Wyrick, Josh (Presenter), Goll, Geoffrey M. (Presenter), May 18, 2010. *Dam Removal: Adaptive Management & Bed Sediment Monitoring Before and After,* ASCE, Environment and Water Resource World Congress 2010, Providence, RI.

Goll, Geoffrey M. (Presenter), Paist-Goldman, Mary, May 18, 2010*. Case Study: Preparing for Dam and Barrier Removals along the Darby Creek,* ASCE, Environment and Water Resource World Congress 2010, Providence, RI.

Goll, Geoffrey M. (Author and Presenter), May 18, 2010*. Sediment Management and Dredging for Dam Removal,* ASCE, Environment and Water Resource World Congress 2010, Providence, RI.

Helminiak, Jacob, Wildman, Laura, Goll, Geoffrey M. (Presenter), May 18, 2010*. Removing Barriers at Road Crossings Using Stream Simulation Techniques in the Northeast United States,* ASCE, Environment and Water Resource World Congress 2010, Providence, RI.

Goll, Geoffrey M., *Sustainable Approach to Stormwater Management Design: NJM Hammonton Regional Operations Facility*, April 8, 2010. Presentation at the University of New Hampshire Stormwater Center Workshop, Jacque Cousteau National Estuarine Research Reserve, Tuckerton, NJ.