Lake Champlain Basin Program

TECHNICAL REPORT NO. 84

Development of Advanced Flood Recovery and River Management Training Modules

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Final Report

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For:

The Lake Champlain Basin Program and New England Interstate Water Pollution Control Commission

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1.0 INTRODUCTION

1.1 Background

This project consisted of the Development of Advanced Flood Recovery and River Management Training Modules. The purpose was to develop training materials and implement pilot trainings in the Lake Champlain Basin to improve flood recovery and river management practices to increase flood resiliency, reduce future risks, and reduce river impacts.

Over the past several years, large damaging floods have caused extensive damage within the Lake Champlain Basin. Most notably, Tropical Storm Irene occurred in summer 2011 destroying an abundance of infrastructure and private property. The flood, typically reported to have been the 100-year flood or larger, scoured river channels and banks, filled channels with sediment, led to sudden channel realignments (i.e., channel avulsions), and relocated channel bed features.

Data collected by the Vermont Agency of Natural Resources collectively suggest that flood recovery efforts impacted rivers as much as, if not more than, the flood itself. Stream geomorphic data and historic records indicate that the widespread dredging that took place after Irene often took place within river reaches that are geomorphically sensitive to change where dredging had previously occurred. Fish and macroinvertebrate data showed a slower recovery to preflood abundance numbers in areas where dredging occurred. Channels where postflood recovery work was limited tended to rebound more quickly, often in 3 to 5 years. Of the many lessons learned from Tropical Storm Irene, one of the most important is the need for a sound approach to flood recovery and river management in order to protect water quality and the ecological integrity of rivers.

Most of the past flood recovery work created short-term benefits, yet some of the work created long-term impacts and actually increased future flood and erosion risks. In response to excessive flood recovery work immediately following Irene and the need to perform flood recovery in a better way, resource managers began an effort to improve practices and document methods. For example, the Delaware County Soil and Water Conservation District, in conjunction with the New York City Department of Environmental Protection and New York State Department of Environmental Conservation, published the *Post-Flood Emergency Stream Intervention Training Manual* (DCSWCD, 2014). This manual was a useful quick reference guide during the Irene flood recovery and has since been updated to include methods on common river management practices.

Over the past several years, the Vermont Department of Environmental Conservation has revised its Stream Alteration Rules (2013) and established a Stream Alteration General Permit (VTANR, 2014). The rules and permit refer to the recently released Vermont Standard River Management Principles and Practices (SRMPP) (Schiff et al., 2014), which present the current best science and engineering to implement flood recovery and perform river management based on the natural function of river channels and floodplains. The training modules provide detail about many of the methods and practices introduced in the SRMPP document.

This project builds on training already taking place in both Vermont and New York with a focus on improving river management. The Vermont Department of Environmental Conservation has developed

the Vermont Rivers and Roads Training with the Vermont Agency of Transportation (VTrans). The training modules developed here are the third tier of the Vermont Rivers and Roads Training.

1.2 Goals and Objectives

The goal of this project was to develop and implement four advanced flood recovery and river management training modules in the following areas.

i. Sediment and large wood removal
   a. Conveyance restoration
   b. Channel realignment
   c. Reference to vertical stability
ii. Channel stabilization
   a. Grade control
   b. Bank stabilization
   c. Natural bed and bank stabilization
iii. Floodplain restoration
   a. Floodplain restoration
   b. Flood bench restoration
   c. Flood chute restoration
iv. Geomorphic-engineering design of bridges and culverts

The following project objectives were accomplished to meet the above goal:

- Coordinate with existing training programs in Vermont and New York.
- Prepare draft training modules.
- Finalize training modules and create pilot trainings.
- Implement four pilot trainings and revise modules as needed.
- Complete reporting.

1.3 Training Module General Content

Each of the four modules includes the following items:

a. Lesson plan
b. Teaching computer slides
c. Teaching notes
d. Recommended handouts
e. Review questions in each presentation section
f. Two design examples for group work at the end of the training
g. Evaluation form

Teaching slides were created in *PowerPoint* (.ppt) with speaking notes for each slide. The teacher has the option to view the teaching notes on a laptop in 'presenter view' or print the teaching notes next to

a thumbnail of the slide. Note that the slide numbers in the teaching notes refer to the slide position in the *PowerPoint* slide deck and not to the page number in the combined PDF files of all of the module materials in the appendices.

The content of each module generally includes the following items:

a. Objectives
b. Background
c. Habitat maintenance recommendations
d. Common mistakes
e. Connecting observed damages to river processes
f. Alternatives analysis overview
g. One or two recent design and implementation examples that generally provide visual representation of the problem and implemented practice
h. Assessment methods
i. Design methods
j. Permitting requirements
k. Construction recommendations

1.4 Training Module Implementation Themes

This module builds on Tiers 1 and 2 of the Vermont Rivers and Roads training. An assumption is made that attendees of the Tier 3 training have prior knowledge such as an understanding of problem identification linking damages to river form and process (Schiff et al., 2014), the ability to move through an alternatives analysis to minimize risk when required, and basic river and floodplain geomorphic principles such as the ability to identify bankfull width (VTANR, 2009). These topics are addressed as a refresher when considering design and implementation.

The Tier 3 modules emphasize permanent work yet include consideration of how emergency and temporary work during larger floods can be done in better and more permanent ways to minimize the need for repeat work and river disturbance. The modules focus on technical information and best practices and do not consider flood recovery logistics such as deployment and incident command systems that can influence assessment and design during flood recovery.

The Tier 3 modules do not address funding. The methods presented here provide the best way to reduce risks over the long term and not the best way to fund such work. Work minimization, and thus cost reduction, is addressed in the trainings.

The modules are set up for face-to-face teaching in a classroom setting. Materials may be posted on the internet in the future for easy access. Fully independent, self-guided, internet-based trainings are not anticipated with the Tier 3 materials at this time. The materials will serve as an important reference once the training has been completed. The module information and trainings are currently free. Professional certification is not part of the current modules. The duration of the trainings ranges from a half to a full day.

The target audience for the trainings is state highway personnel, state river managers, public works directors, municipal highway crews, conservation districts, private consultants, and construction contractors. The intent of the modules is to provide existing design professionals, project reviewers, and those who may be thrust into design roles during large-scale flood recoveries with the most current river management information to improve future flood resiliency while minimizing project impacts and costs. The Tier 3 trainings alone will not create new design professionals but rather will advance technical capacity amongst established professionals and create a more informed designer. Participants with different backgrounds will get different information out of the trainings. A design professional will get advanced details to improve his/her assessment and design process while an environmental specialist will get information that will facilitate better project review.

The following four chapters provide a brief overview of the modules and pilot trainings. The module teaching materials are contained in the appendices and available electronically through the Lake Champlain Basin Program and other project partners upon request.

1.5 Pilot Training Overview

Each of the four modules was presented in a pilot training as a test run and to gather feedback. The logistics of the sessions are described below. All feedback from the project team and training participants was considered, and edits were made to the module materials. The duration and timing of the trainings were refined following each pilot session, which is reflected in the lesson plans presented in the module information included in this report.

Training participants should be given a computer file (PDF) of the teaching slides so that they can view on a device or print and take notes during the teaching sessions. At least one participant in each group for the design exercises at the end of the trainings needs quick access to the slides to view charts and figures required for solving the problems.

2.0 SEDIMENT AND WOOD REMOVAL (APPENDIX A)

2.1 Content

The sediment and wood removal module provides guidance on restoring channel conveyance following excessive deposition. The objectives of the module are to minimize risk and impacts primarily through proper material removal and the minimization of the need for repeat work. The module also includes guidance on channel alignment and reference to the need for establishing vertical channel stability as presented in the channel stabilization module.

Appendix A contains the module lesson plan, slides, teaching notes, recommended handouts, review questions for each section, design examples for group work at the end of the training, and the evaluation form.

2.2 Pilot Training

The pilot training for the sediment and wood removal module was held on January 29, 2016 at the Vermont Agency of Transportation (VTrans) Training Center in Berlin, Vermont. Nearly 30 attendees from VTrans and the Vermont Department of Environmental Conservation attended the training. Many of the attendees played a role in temporary or permanent flood recovery following Tropical Storm Irene.

The duration of the training was 8 hours. The actual teaching and exercises lasted for 6.5 hours, lunch break was 1 hour, and follow-up questions and evaluations took 0.5 hours.

The module includes 14 review questions that are embedded in the presentation slides. The two design exercises covered a low- and high-risk problem site to allow attendees to learn about the decision-making and design process around work and impact minimization.

The evaluations from the training indicated that participants generally enjoyed and benefited from the training (Figure 2-1). One main point of feedback was that nondesign professionals who take the Tier 3 modules should not be expected to readily design and implement sediment and wood removal projects. Even with this advanced training, assistance will be needed from those who have education and design experience in river management. Participants also want access to slides while working on the design exercises at the end of the day for quick reference.

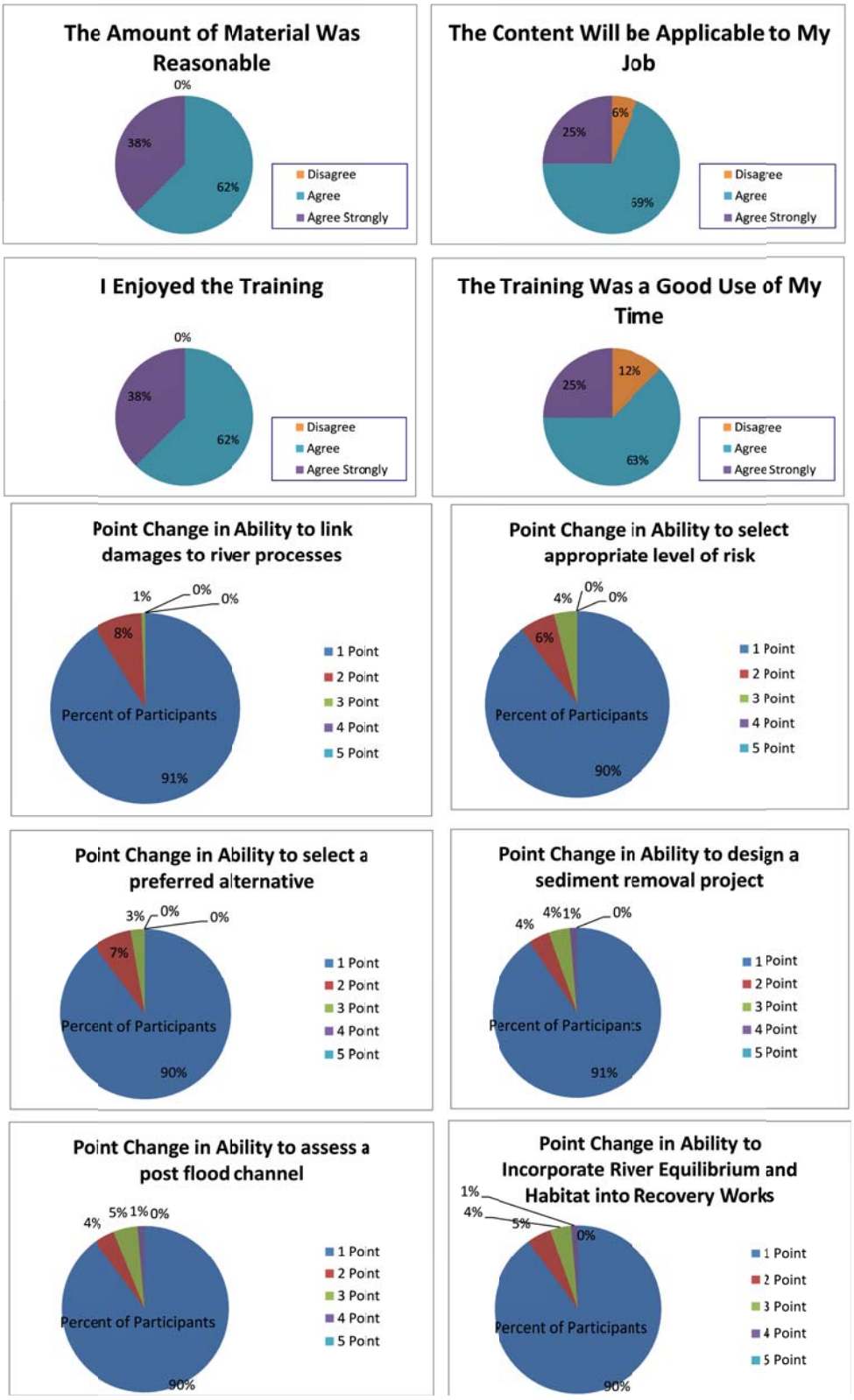

Figure 2-1: Sediment and wood removal pilot training evaluations showing feedback and skill improvement

3.0 CHANNEL STABILIZATION (APPENDIX B)

3.1 Content

The channel stabilization module provides guidance on improving channel stability following erosion events. The objectives of the module are to minimize risk and impacts primarily through proper stabilization only when life or unmovable infrastructure exists. The module includes guidance on vertical stabilization (i.e., grade control), lateral or bank stabilization, and natural bed and bank stabilization through the installation of excessively dredged riverbed material.

Appendix B contains the module lesson plan, slides, teaching notes, recommended handouts, review questions for each section, design examples for group work at the end of the training, and the evaluation form.

3.2 Pilot Training

The pilot training for the channel stabilization module was held on April 28, 2016 at the Cornell Cooperative Extension Building at the Essex County Fairgrounds in Westport, New York. Twenty-seven attendees from the New York State Department of Transportation, the New York State Department of Environmental Conservation, the Vermont Department of Environmental Conservation, the Ausable River Association, Soil and Water Conservation Districts, and other groups attended the training. Many of the attendees play a role in designing, reviewing, or permitting channel stabilization practices.

The duration of the training was 7 hours. The actual teaching and exercises lasted for 5.5 hours, lunch break was 1 hour, and follow-up questions and evaluations took 0.5 hours.

The module includes seven review questions that are embedded in the presentation slides. The two design exercises covered a channel bed and bank stabilization problem.

The evaluations from the training indicated that participants generally enjoyed and benefited from the training (Figure 3-1). One main point of feedback was that it would take several days and more examples to raise skill level to help with implementation. Some participants also felt that one of the design exercises was too challenging; therefore, we revised one of the group exercises to make it simpler and more relevant to the practice. Participants also wanted slides on computer or paper for design exercise work.

In addition to the April pilot training, a short overview of some of the primary design principles in the channel stabilization module was presented at the Northeastern Transportation and Wildlife Conference in Lake Placid, New York, on September 12, 2016. Approximately 30 people attended this presentation.

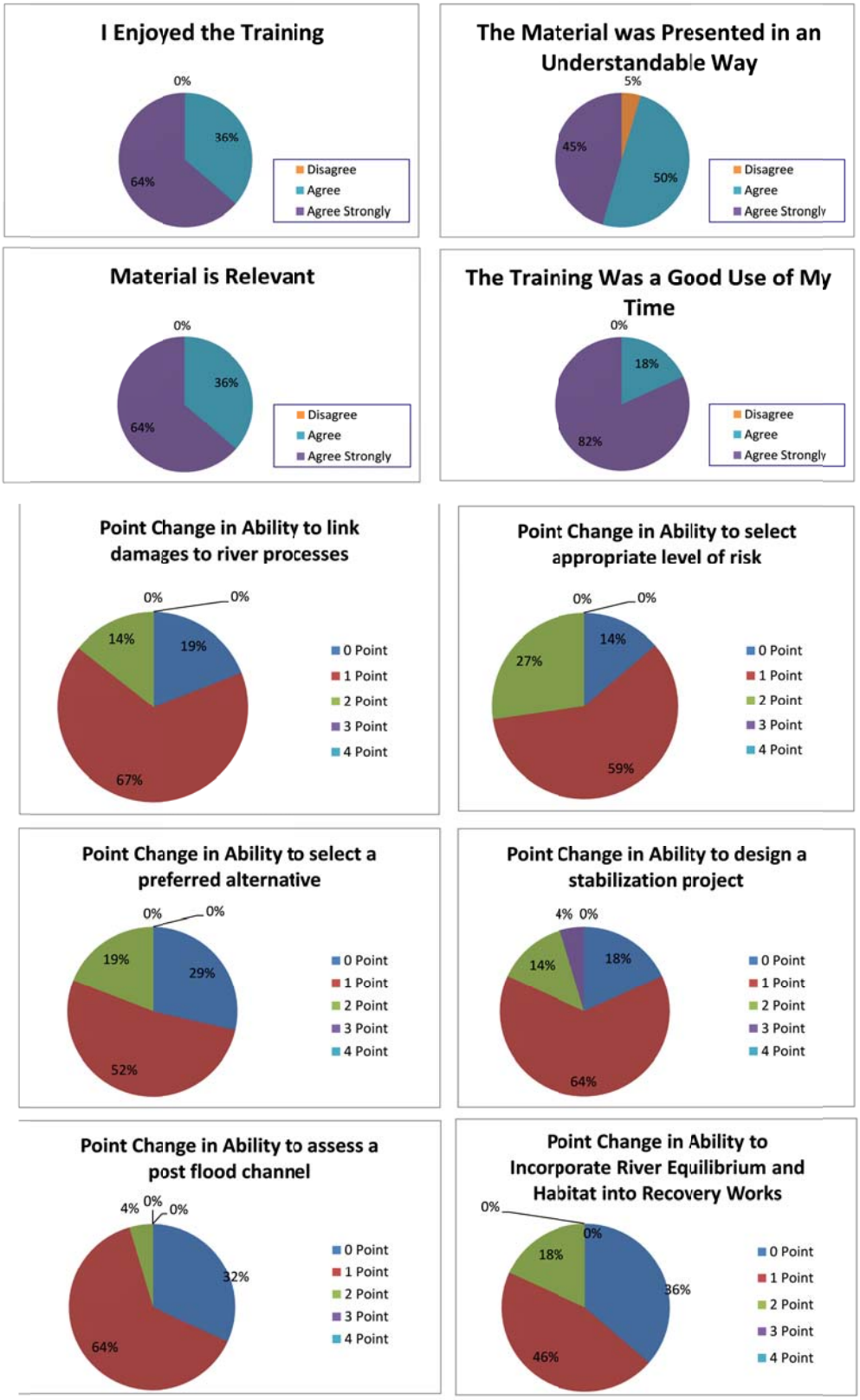

Figure 3-1: Channel stabilization pilot training evaluations showing feedback and skill improvement

4.0 FLOODPLAIN RESTORATION (APPENDIX C)

4.1 Content

The floodplain restoration module provides guidance on reestablishing floodplains and the channel-floodplain connection to reduce future risks and minimize the potential for excessive erosion or deposition events. The objectives of the module are to minimize risk and impacts primarily through floodplain restoration so that floodwaters, sediment, large wood, and ice can spread out and be deposited away from infrastructure and private property. Floodplain restoration has become a common risk reduction practice used in river management, and this module provides important design information to improve project implementation. The module includes guidance on restoring floodplains, smaller flood benches, and flood chutes.

Appendix C contains the module lesson plan, slides, teaching notes, recommended handouts, review questions for each section, design examples for group work at the end of the training, and the evaluation form.

4.2 Pilot Training

The pilot training for the floodplain restoration module was held on May 17, 2016 as a workshop during the 15th Annual Meeting of the New York State Floodplain and Stormwater Managers Association in Saratoga Springs, New York. The workshop was approved for professional development credits as part of the Association of State Floodplain Managers Certified Floodplain Manager Program. Forty-seven attendees from state agencies, municipalities, nonprofits, and private companies attended the training. Many of the attendees regulate floodplains in New York State, seek floodplain protection projects such as floodplain restoration, and review projects that take place in the floodplain.

The duration of the workshop was 3 hours. The full module is longer, yet the training was reduced to fit the structure of the conference workshop. The actual teaching lasted for 2.5 hours, and the session included a 15-minute break and 15 minutes for evaluations.

The module includes seven review problems that are embedded in the slides. The two design exercises covered a low- and high-risk problem site to allow attendees to learn about the decision-making around work and impact minimization.

The evaluations from the training indicated that participants generally enjoyed and benefited from the training (Figure 4-1). Several of the Certified Floodplain Managers indicated that they would not be able to design anything from the course but are now in a better position to review floodplain management activities.

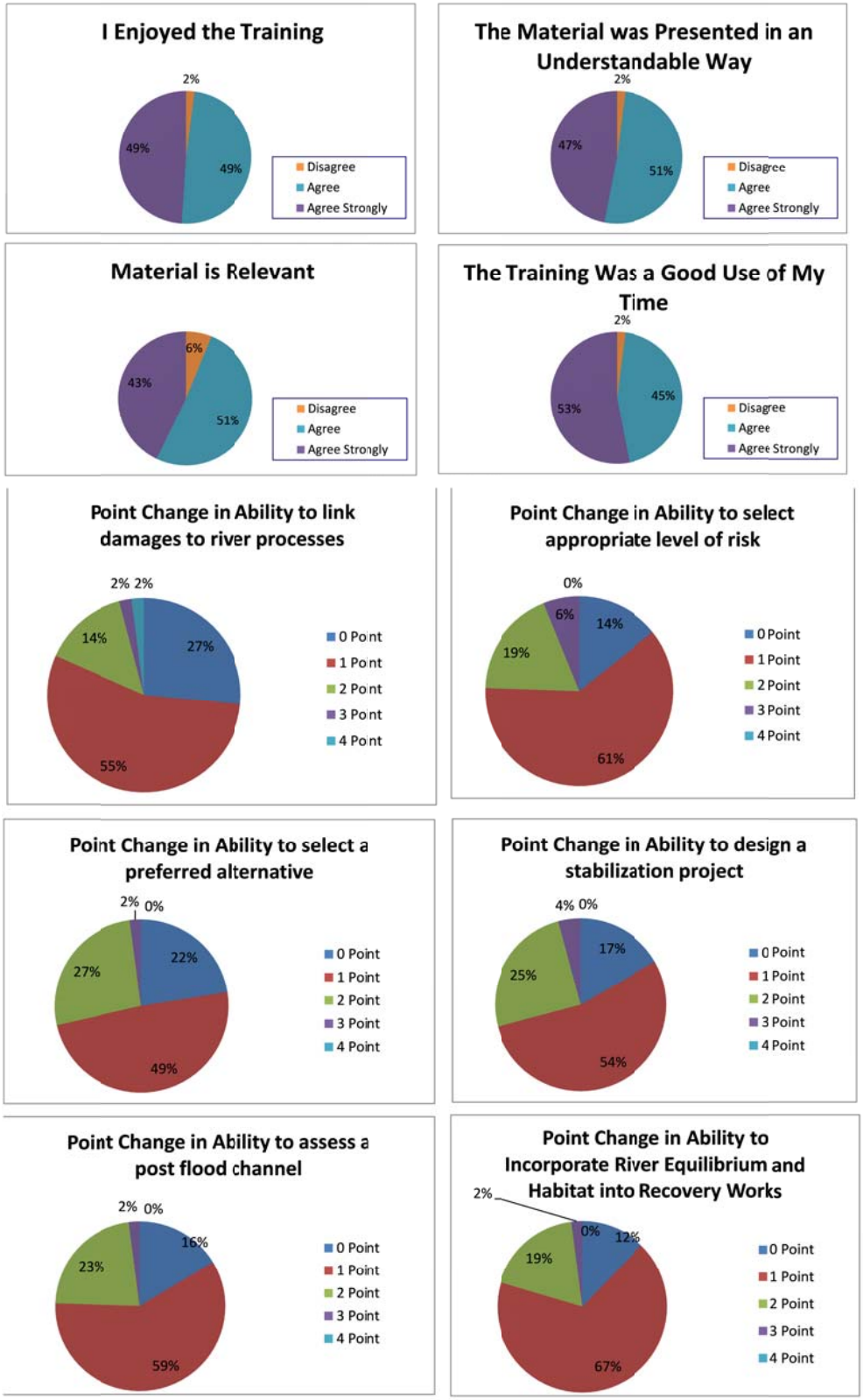

Figure 4-1: Floodplain restoration pilot training evaluations showing feedback and skill improvement

5.0 GEOMORPHIC-ENGINEERING DESIGN OF BRIDGES AND CULVERTS (APPENDIX D)

5.1 Content

The geomorphic-engineering design of bridges and culverts module provides guidance on matching new structures to channel type. The objectives of the module are to maximize the life span of bridges and culverts by building on typical design guidance to include explicit consideration of channel type, sediment load, and wood load. The module described the details of bankfull width structure sizing and emerging design requirements in our region.

Appendix D contains the module lesson plan, slides, teaching notes, recommended handouts, review questions for each section, design examples for group work at the end of the training, and the evaluation form.

5.2 Pilot Training

The pilot training for the geomorphic-engineering design of bridges and culverts module was held on September 16, 2016 at the Vermont Agency of Natural Resources Annex in Berlin, Vermont. Thirteen attendees from VTrans, VTDEC, and Vermont Fish & Wildlife joined the training in person while nearly the same number of attendees participated from New York State, Rhode Island, and Vermont via webinar. A short overview of some of the primary design principles in the bridge and culvert module was presented at the Northeastern Transportation and Wildlife Conference in Lake Placid, New York, on September 14, 2016. In all, about 25 people attended the pilot training, and about 30 people attended the short talk. Many of the attendees design and permit crossing structures, consider environmental aspects of bridges and culverts, and plan for structure replacement at state transportation agencies.

The duration of the module was 7 hours. The actual teaching lasted for 5.5 hours. Lunch break was 1 hour long, one session break lasted for 15 minutes, and evaluations and wrap-up took about 15 minutes.

The module includes six review problems that are embedded in the slides. One design example is a bridge problem while the other design example is a culvert problem.

The evaluations from the training indicated that participants generally enjoyed and benefited from the training (Figure 5-1). One main point of feedback was again the concern that attendees would be expected to design structures after receiving this training. This is not the case. More education and project experience are needed to become competent in structure design. This module is intended to build on the knowledge base of existing design professionals and also allow project reviewers and planners to ask the correct questions and seek good structures that minimize risks.

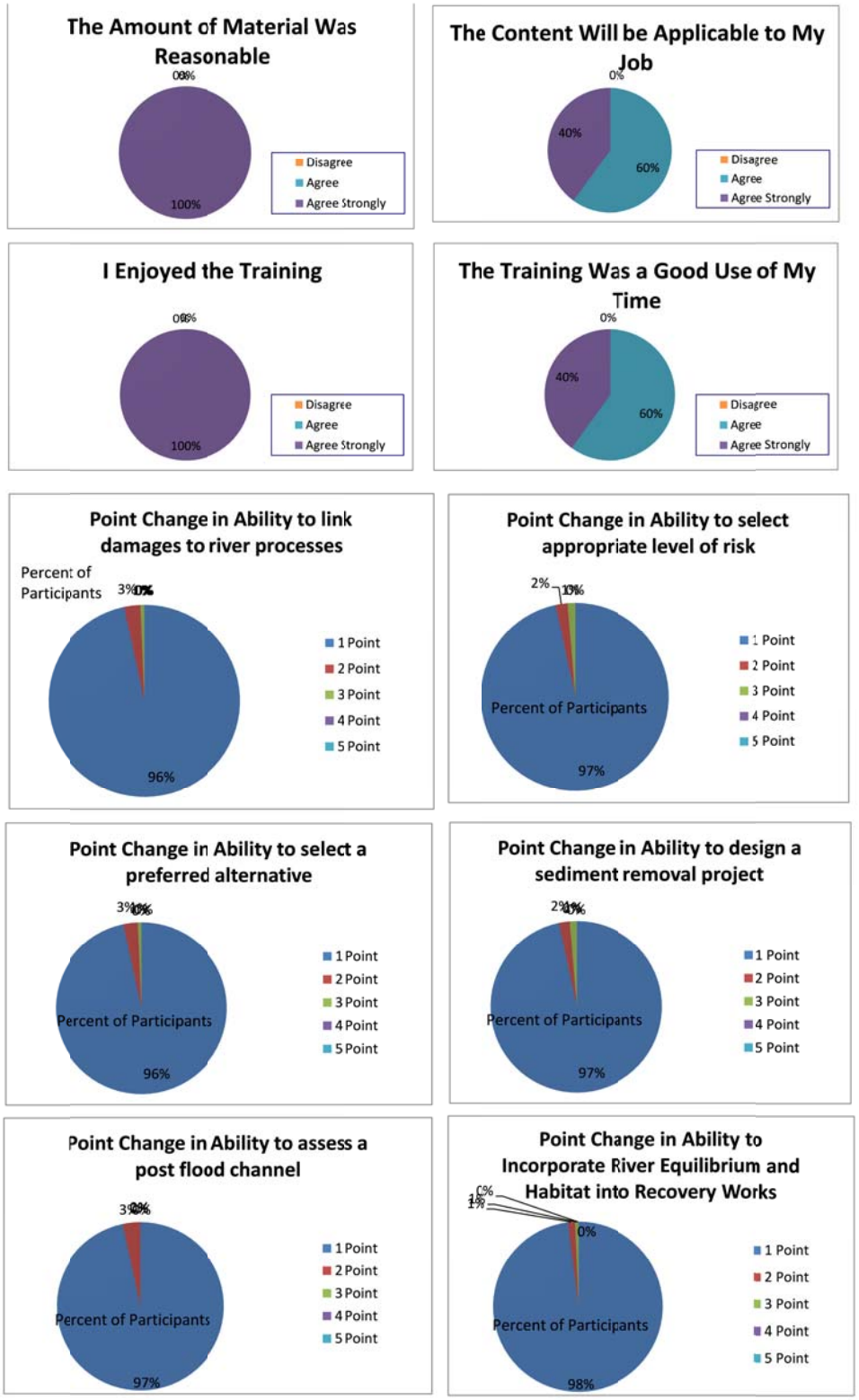

Figure 5-1: Geomorphic-engineering design of bridges and culverts pilot training evaluations showing feedback and skill improvement

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APPENDIX A

SEDIMENT AND LARGE WOOD REMOVAL TRAINING MODULE

APPENDIX B

CHANNEL STABILIZATION TRAINING MODULE

APPENDIX C

FLOODPLAIN RESTORATION TRAINING MODULE

APPENDIX D

BRIDGE AND CULVERT GEOMORPHIC-ENGINEERING DESIGN TRAINING MODULE