ENVIRONMENTAL
Fact Sheet

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

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Fluvial Geomorphology and Stream Crossing Assessments

Overview

Rivers are among the most beautiful features of nature but we are frequently reminded that they are dynamic systems. While every Granite State river is prone to flooding, people are often surprised when the rivers themselves change, sometimes dramatically. New Hampshire has endured multiple flood events in recent years that have washed out culverts, undermined bridges and roads, and washed away streambanks. In response, the New Hampshire Geological Survey (NHGS) continues to focus its scientific expertise to address hazards associated with flood events and the potential for significant erosion, bank failures and failed stream crossings. The impacts from Tropical Storm Irene across the North Country, and additional flood events since then in the Connecticut River valley, should remind us all of the power of running water to alter the landscape.

Floods are known for posing inundation risks to properties and infrastructure in floodplains adjacent to rivers, but there is a less-appreciated danger associated with sudden channel scouring and riverbank collapse, bridge abutment failure and culvert washouts, or even wholesale changes in the course of rivers. The risks of such situations are highest during active flood events, when rivers and streams have high velocities and the greatest ability to erode and shape the streambeds and banks. The most dramatic kind of erosion event, known as an “avulsion,” occurs when a river cuts through one of its banks and erodes an entirely new path, usually abandoning its old path in the process. Such an event occurred on the Suncook River in the town of Epsom during the Mother’s Day Flood of 2006 when Huckins Mill Dam and Bear Island were bypassed by a new channel that cut through an area of wetlands and a working gravel pit. When sudden changes of a river occur, or infrastructure such as stream crossings fail, the effects on property owners and natural ecosystems can be significant and long-lasting.

Flooding in the News

In the aftermath of Tropical Storm Irene, while national media attention was focused on the flood damage that occurred in Vermont, New Hampshire's North Country was trying to recover from its own erosion impacts and resulting property damage. In particular, the East Branch Pemigewasset River (Lincoln); Peabody River (Gorham); and Saco River (Bartlett/Conway) were hard hit. Like other floods in recent memory in the state, damage was greatest where bridges and culverts were unable to adequately convey flood flows, or where long-ago actions such as channel straightening increased the speed of river flow, increasing the force available to erode and undermine river banks and lead to collapse.

Since Irene, New Hampshire has experienced continual reminders that brooks in small watersheds can flood and cause erosion damage if the right ingredients come together. In 2012, a stationary thunderstorm produced an estimated eight inches of rain in the Westmoreland area, leading to impacts on nearby streams (photo at left). This same area experienced further issues a year later in 2013, at the same time that widely-reported damage occurred on Slayton Hill Road in Lebanon. A year later, in 2014, staff responded to concerns in the Woodstock and Lincoln areas. NHGS continue to receive phone calls and emails from communities and citizens concerned about long-term flood issues at locales throughout the state. Town officials and citizens in New Hampshire have become increasingly aware of their vulnerability to flood and river hazards and the need to plan accordingly. NHGS, in partnership with units throughout NHDES and other state and federal agencies, assesses rivers at sites of concern in the state and provides results to state agencies and towns via data made available on the web and via maps, reports and presentations. NHGS' data collection efforts have centered upon fluvial geomorphology assessments, including site visits after flood events. In addition, stream crossing assessments have become an increasingly requested service and a large part of river data collection efforts. Both efforts and capabilities are described below.

River and Site Fluvial Geomorphology Assessments

Fluvial geomorphology, a science that examines how river processes shape the landscape in the vicinity of these landscape features, is a key contributor not only to flood hazard mitigation, but also for broader rivers management. Both New Hampshire and Vermont have led efforts to incorporate fluvial geomorphology science into decision-making at the state level. The State of Vermont developed a set of comprehensive protocols for conducting river geomorphic assessments, with the goal of understanding a river's current condition, to assist in making sound management decisions. Since 2008, NHGS staff have assessed 400 miles of river using a variation of these protocols. The resulting data have been made available to regional planning commissions for inclusion in hazard mitigation plans, in addition to its availability directly from NHGS. More recently, outputs are freely accessible on the internet (link provided below).

As a result of the recent flooding in New Hampshire and resulting river channel changes, NHGS staff, with multiple state agencies, are increasingly focused on providing more site-specific assessments and

interpretations that directly address the particular flood-related concerns of towns and emergency management officials. NHGS' uses its scientific and mapping expertise to identify the potential for erosion and catastrophic streambank failures to damage property and infrastructure in order to help communities both prepare for and respond to flood events. Such assessments in towns are often conducted in partnership with state and federal agency members of the New Hampshire Silver Jackets, for which NHGS is the lead. The Silver Jackets is part of an Army Corps of Engineers initiative to bring together state and federal agencies to offer towns with technical assistance in flood risk management and reduction. In New Hampshire, with many areas of steep terrain compared to many other states, flood risk issues are often related to river channel changes.

In preparation for any fluvial geomorphologic assessment, technical staff consult topographic and geologic maps, and current and historical aerial photographs to identify the past history of a site. Information collected during a typical assessment includes height and length of bank erosion, lengths of channel straightening, and field identification of the main direction of flow forces, all features and processes known to enhance channel change, flood risks, and subsequent property and infrastructure damages. With the right flow and geological conditions, a river could also carve a new path for itself – an avulsion – as occurred on the Suncook River.

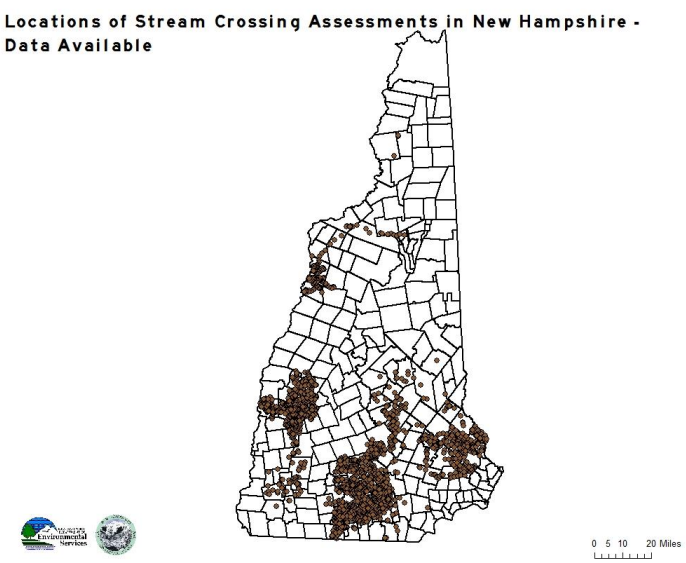
Stream Crossing Assessments

In October 2005, a blocked culvert catastrophically failed in Alstead, resulting in extensive damage and the loss of 7 lives. After this event, New Hampshire began to focus efforts on conducting stream crossing assessments, in order to identify crossings that pose future public safety risks and to prioritize crossings most in need of replacement. Culverts not sized properly for the streams that flow through them can cause erosion immediately downstream of the crossing and prevent fish from migrating to points upstream, impacting watershed-based aquatic habitat. To address these concerns, four state agencies, including NHDES, NHDOT, Fish & Game, and the Department of Safety, Division of Homeland Security and Emergency Management have partnered to collaboratively manage the New Hampshire bridge and culvert assessment initiative to collect data about stream crossings. Stream crossing assessments have been conducted across New Hampshire since 2009. NHGS staff provide assessment training on the bridge and culvert assessment protocol to entities, including regional planning commissions, and funded private contractors who collect the data during the summer months. Collected data then undergo a quality control and review process, coordinated by NHGS. Once finalized, the collected data are placed into a scoring tool that ranks crossings (especially culverts) for their compatibility with river form and process (see figure above) Towns can use this information as a guide to prioritize those crossings most in need of retrofit or replacement and to support requests for funding to address these issues. Fluvial geomorphology data are also helpful in identifying river constrictions, in addition to culverts, that have the potential to cause debris and ice jams. Towns can then develop actions that will help prevent or reduce the same kinds of flood damage experienced in previous years.

Table 1
Fowler Brook Crossings

Crossing	Structure Type	Percent Bankfull Width[1]	Geomorphic Compatibility[2]	Aquatic Organism Passage (AOP)[3]
Maple Street	Culvert	77%	Fully Compatible	Reduced AOP
Buck Street Extension	Culvert	39%	Mostly Incompatible	Full AOP
28	Culvert	69%	Mostly Incompatible	Reduced AOP
Drolet Road	Culvert	94%	Mostly Compatible	Full AOP
Jug City Road[4]	Culvert	-	-	-

[1]Shaded for bankfull width percentage less than 50%; [2]Scores and ratings developed with the Culvert Geomorphic Screening Tool; [3]Scores and ratings developed with the Culvert Aquatic Organism Passage Screening Tool; [4]Jug City Road culvert assessed but scores and ratings not calculated given the wetland features existing just upstream.



The map at left represents approximately 2,400 crossings for which data have been quality control reviewed and are publicly available. Additional crossings have been assessed during the summer of 2016, through the combined efforts of NHGS' summer interns, Fish & Game, NHDOT, the regional planning commissions, and agency-funded private contractors. These crossings are undergoing quality control review as of September, 2016. Data will be made available upon completion of that process. A total of almost 6,000 crossings, representing approximately 35% of the known crossings statewide, have been assessed since the initiative began.

Additional stream crossing assessments will be conducted in the future. Final data and products, both for stream crossings, and fluvial geomorphology investigations are available by contacting NHGS, or by accessing the New Hampshire Coastal Viewer, located at http://nhcoastalviewer.unh.edu (Coastal Viewer shows publicly-available fluvial geomorphology/stream crossing data for entire state).

More information

For more information about the fluvial geomorphology and stream crossing assessments in New Hampshire, contact Shane Csiki, Ph.D., CFM, Flood Hazards Program Administrator at the New Hampshire Geological Survey, NHDES at (603) 271-2876, or by email: Shane.Csiki@des.nh.gov.