Flooding in the Deerfield River after Tropical Storm Irene. Photo courtesy of the City of Greenfield

PROJECT PARTNERS

Franklin Regional Council of Governments

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Project Description

The Franklin Regional Council of Governments’ project, **Using the Science of Fluvial Geomorphology to Develop River Corridor Management Tools to Protect the Health and Improve the Resiliency of the Deerfield River Watershed** (17-06/319), developed and piloted innovative practices for delineating and managing river corridors. This Toolkit provides a background on the science of fluvial geomorphology, which was used to develop this river management approach.

The Toolkit includes a cost-effective, scientifically defensible river corridor mapping protocol and two management tools to accompany the mapping: a River Corridor Protection Overlay Zoning District Bylaw and a River Corridor Easement Restriction.

The materials in this Toolkit were developed for use by state agency staff, communities and landowners who are interested in river restoration and protection, climate resilient land use, and the reduction of harm to land, water, habitat, people, and infrastructure caused by increasingly severe and frequent flood events. We envision that the Toolkit resources can be used by municipalities in the Deerfield River Watershed and across the Commonwealth to manage river corridors and improve the climate resiliency of their communities and their watersheds.

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Fluvial geomorphic-based river restoration, land conservation, and river corridor management is a new paradigm for river management in Massachusetts.

Fluvial geomorphic assessments and river corridor mapping are a watershed-scale framework for identifying projects and management strategies that cross town boundaries and build climate resiliency at the local and watershed scale.
Background

Over the last 10 years,

FRCOG has been using the science of Fluvial Geomorphology and the work of the VT Rivers Program to develop and pilot cost-effective, sustainable and scientifically grounded river and watershed assessment, restoration and management techniques in the Franklin County portion of the Deerfield River Watershed.1 These techniques increase climate resiliency, protect and restore the river system and reduce or avoid conflicts between the river and the built environment.

Historic land clearance and the legacy of channel modification are two of the main stressors still affecting the rivers and streams of the Deerfield River watershed today. Continued development and encroachments in the river corridor, along with the more frequent and intense rain events due to climate change, also stress these unstable river systems.

Rivers are dynamic systems that “work” to carry water and sediment. Changes in the amount of water in the river channel and the sediment load can alter the width, depth, and other physical dimensions of the river. These changes can occur rapidly due to a large flood event like Tropical Storm Irene, or more slowly over many decades.

River health and climate resiliency are directly related to the amount of sediment the river is trying to transport along its length. In the assessed streams of the Deerfield River Watershed, excess sediment is a significant impairment that results in increased fluvial erosion hazards to bridges, roads and other infrastructure and degradation of riverine habitat and water quality.


Fluvial Geomorphology:
the study of
the form and function of rivers
and the interaction between rivers
and the landscape around them.

Fluvial Erosion Hazards:

Erosion and deposition are natural river processes. Fluvial (river-related) Erosion Hazards (FEH) occur when these natural processes of erosion and deposition impact property, infrastructure, and other features on the landscape. FEH are often associated with flood events. Fluvial erosion can be catastrophic, resulting in changes to river channel dimensions and location. Sediment deposition or scour can damage and destroy adjacent infrastructure such as roads and bridges. FEH differ from inundation hazards, which are when floodwaters rise out of the river channel and cover adjacent lands. Both FEH and inundation hazards often occur during the same storm event.
What are Our Options to Reduce Fluvial Erosion Hazards?

- **Manage the river channel with traditional engineering fixes** for bank stabilization, such as rock riprap, concrete retaining walls, or gabion baskets. This approach may be necessary to protect existing infrastructure when other fluvial geomorphic-based techniques aren’t feasible. Hard, engineered structures increase the bank’s resistance to erosive scour, but also increase the erosive forces acting on adjacent upstream and downstream river segments. In other words, the problem might be solved at the site, at least for a while, but will eventually crop up elsewhere in the river system. Habitat degradation caused by excess sediment loading from bank erosion is typically not addressed by traditional engineering fixes either.

- **Remove or relocate structures** threatened by fluvial erosion hazards. This is typically the least feasible approach, due to cost and the fact that people do not want to leave their homes and businesses. However, it is most effective at eliminating the conflict between rivers and human infrastructure.

- **Implement fluvial geomorphic-based river restoration projects** that address identified problems and restore key river functions (reconnect the river to its floodplain, add roughness and structure to the channel, stabilize eroding banks, etc.).

- **Protect and manage the river corridor.** A river corridor includes the active river channel and a portion of floodplain or riparian area where the river is expected to move over time through bank erosion and channel migration. Accommodating river meander and floodplain processes by protecting and managing the land in the river corridor is a cost-effective, climate resilient and environmentally sustainable river management approach.

While this River Corridor Management Toolkit primarily focuses on the last option – **Protect and manage the river corridor** – it also includes information on fluvial geomorphic-based river restoration projects developed under FRCOG’s previous 604b- and 319-funded projects.
The River Corridor Management Toolkit has 5 sections:

1. Mapping River Corridors
2. Climate Resilient Watersheds: River Restoration Projects and River Corridor Management Tools
   - River Restoration Projects
   - River Corridor Management Tools
   - Example River Restoration Projects
     - Sediment Storage
     - Floodplain Reconnection, Removal of Encroachments and Flood Water Attenuation
     - Conservation of Landscape-scale Green Infrastructure, including Attenuation Assets and River Corridors
   - Model River Corridor Protection Overlay Zoning District
   - Model River Corridor Easement Restriction

3. Integrating River Corridor Maps Into Other Local and Watershed-Scale Planning Efforts
4. River Corridors and Climate Resilient Watersheds Field Trip Materials
5. Other Outreach Materials Developed for the Project
   - River Corridor Easement Brochure
   - Powerpoint presentations from the River Corridor Workshop, 9/13/19

Before and after photos of the North River in Colrain, MA where flooding and fluvial erosion destroyed a dam and altered the river channel.
Insert TAB 1
**What is a River Corridor and Why is it Important?**

A river corridor is the area the river requires to achieve equilibrium conditions. A river corridor includes the active river channel, associated bars and wetlands, and a portion of riparian area, floodplain, terrace or adjacent slope. The river is expected to migrate within the river corridor over time. River corridor access allows for the dissipation of high flows and sediment deposition, reducing conflicts with existing infrastructure and improving water quality.

A river corridor varies in width throughout the stream system, depending on stream size, valley conditions (slope and confinement), sediment load and other factors. It is different from the Riverfront Area, which is a regulated resource area bordering perennial streams in the Commonwealth of Massachusetts that was established in 1996 with the Rivers Protection Act. The Riverfront Area is defined as a 200-foot setback from Mean Annual High Water (aka Ordinary High Water or Bankfull) along both sides of the stream channel. It should be noted however, that in some specified urban areas, the Riverfront Area setback is only 25-feet.
Several options are available to map a river corridor. These various mapping approaches differ depending on the intended use of the maps. For example, FEMA Flood Insurance Rate Maps (FIRMs) delimit areas that are subject to flood inundation hazards. Inundation hazards occur when the river rises above its banks and spills onto the adjacent land. The boundaries of the FEMA delineated 100-year flood hazard area, which is a flood with a 1 percent chance of occurrence in any given year, is a common river corridor familiar to most people. In the figure below, the shaded area on the FIRM for the Town of Conway shows the limits of the 100-year floodplain in a portion of Conway Center. Towns reference the FIRMs in their Floodplain Zoning regulations and the owners of structures within the 100-year flood zone are required to have flood insurance from the National Flood Insurance Program (NFIP). However, FIRMs do not show areas along rivers that are subject to fluvial erosion hazards (FEH), which can pose a significant threat to infrastructure and degrade water quality and aquatic habitat with excessive sediment loading.
Mapping River Corridors

The Massachusetts Wetlands Protection Act (WPA) identifies resource areas and eight interests (or services) that the resource areas provide and are protected under the WPA regulations: private or public water supply, protection of groundwater, flood control, prevention of storm damage, prevention of pollution, protection of land containing shellfish, protection of wildlife habitat, and protection of fisheries. In 1996, the Rivers Protection Act amended the WPA to include a new resource area, the Riverfront Area to protect the “natural integrity of the Commonwealth’s rivers and to establish open space along rivers.”

The Riverfront Area is a corridor that is measured from the mean annual high water line on each river bank outward 200 feet horizontally and parallel to the river. Floodplains are protected under the WPA because they provide storage for floodwaters. The WPA defines a floodplain as a type of wetland resource area that is shown on the FEMA Flood Insurance Rate Maps as the 100-year floodplain. Most work proposed to be done in these two resource areas, the Riverfront Area and the 100-year floodplain, will require a permit from the local Conservation Commission (Order of Conditions).

The Vermont Agency of Natural Resources’ River Management Program has a three part Stream Geomorphic Assessment (SGA) methodology to assess the causes of river channel instabilities and fluvial erosion hazards.1

Unlike the WPA, river corridors delineated using the SGA protocols will vary in width along a river and different segments of the river will be assigned one of 6 fluvial erosion hazard sensitivity ratings: extreme, very high, high, moderate, low and very low.

Restoration projects and management strategies identified during the SGA have the goal of reducing erosion hazards and improving aquatic habitat.

The SGA has been successfully used in Vermont with a similar approach adopted by New Hampshire. Both of these states fund and staff agencies that work with communities to delineate river corridors and implement projects that reduce flooding and fluvial erosion hazards and restore aquatic habitat.

With funding provided to the FRCOG by MEMA/FEMA (Project #LPDM 08-04), the Vermont SGA protocols were used to map the river corridor for the South River Watershed, which includes portions of the towns of Ashfield and Conway. The application of Vermont’s SGA methodology over larger areas is often prohibitively expensive and, since the regulatory structure and river management approach in Massachusetts is different from Vermont’s, a need exists to develop and pilot a cost-effective river corridor mapping protocol that is more applicable in the Commonwealth.

 Protocol and Pilot

The goal of this project was to develop and pilot a cost-effective and scientifically defensible protocol for mapping the river corridor, the area adjacent to the river within which fluvial erosion and channel migration are most likely to be contained during future floods. Field Geology Services developed the REAL (Rivers Extent Assessing Landforms) Corridor Mapping Protocol, which was used to map the river corridor in the North River (2018) and Green River Watersheds (2019). This mapping protocol can help communities identify areas that are vulnerable to flood and erosion hazards, as well as areas where riparian and aquatic habitat may be impaired by excessive bank erosion and sediment loading.

For example, zones of special concern where bank erosion and channel migration are more likely to occur can be highlighted along portions of the corridor.

**These areas typically include:**
- locations adjacent to artificially straightened channels that are prone to reforming meanders;
- upstream of valley constrictions where impounded flood flows can cause rapid deposition and consequent channel migration; and
- downstream of large tributary confluences where sudden influxes of sediment can result in severe bank erosion and channel migration.
It is interesting to note that the boundaries of the FEMA 100-year floodplain and the boundaries of the river corridors developed for the Green, North and South River watersheds can, in some places, be similar regardless of the methodology used to delineate the corridor (VT SGA or the REAL Corridor approach developed for this project). However, while effective for inundation hazards, the FEMA 100-year floodplain does not address areas vulnerable to fluvial erosion hazards (FEHs) that are within the delineated river corridor and sometimes fall outside of FEMA floodplain. Similarly, flood inundation as depicted on FEMA flood maps can extend beyond the limits of the river corridor where the floodplain is very wide. Communities may not realize this distinction or the variable risks of FEHs and may be caught by surprise. The striking difference between the boundaries of these two areas can be seen in the map of Conway Center, below.

Map of Critical Infrastructure in Conway Center located in the 100 Year Floodplain and River Corridor of the South River, Conway, MA.