Beyond the edge of the field: planning agricultural buffers to accommodate increased frequency of flooding and planform change
Vermont stream geomorphic assessments (2004-2010) describe current physical stream conditions and the likelihood of channel adjustments. The data show that after 200 years of landscape changes that include channel, floodplain, and watershed modification, 75% of the field assessed stream miles are in an unstable condition. The increased power of larger floods, contained within these incised channels, has led to higher rates of systemic bed and bank erosion. These streams will continue to erode, deposit sediment, and adjust their slope, as they “evolve” to most probable stable forms. Anticipated channel adjustments are governed by the fundamental physics that streams will continue to do work until they come into balance with watershed inputs.

http://www.anr.state.vt.us/dec/waterq/rivers.htm
During the 1980s and 1990s, the Northeast experienced a rise in heavy precipitation events (defined as more than two inches of rain falling in less than 48 hours). To assess possible future changes in precipitation patterns, the Union of Concerned Scientists analyzed historical data.

The number of heavy precipitation events is also projected to increase by eight percent by mid-century, and 12 to 13 percent by the end of the century. This means that, in addition to having more rain when it does rain, there will also be more two-day periods with heavy downpours. Finally, increases are also projected for the wettest five-day period of each year. By mid-century, 10 percent more rain is projected to fall during these events. By the end of the century, 20 percent more rain is projected relative to the average event during the years 1961 to 1990. Overall, these changes indicate that the types of heavy rainfall events that have occurred in the Northeast in recent years will become increasingly common (Figure 7), raising the risk of flooding.

Source: Climate Change in the US Northeast, 2006
Union of Concerned Scientists
Vermont CREP

Joint State (VT Agency of Ag) and Federal Program (Farm Service Agency) that aims to improve water quality by establishing buffers along streams (grass or trees) on agricultural lands.

Landowners are compensated for the loss of productive agricultural land through upfront and annual incentive payments provided by VT Agency of Agriculture and FSA.

Contracts are for 15 or 30 years, during which the buffer must be maintained (mowing grass buffers periodically, upkeep of fencing or other structures installed through the program are intact, etc) by the landowner.

90% of the costs associated with installing the buffer, fencing, alternate watering facilities for livestock, animal crossings, etc are covered through the program. Funds from other sources (ie, USF&W Partners Program) can be used to cover the additional 10% of the costs, making the whole project 100% cost-shared!

Partners:

[Logos for USDA Farm Service Agency, Vermont Agency of Agriculture, Partners for Fish and Wildlife, and NRCS]
Available Practices Include:

- Filter Strips
- Riparian Forest Buffer
- Grassed Waterways
- Wetland Restoration
Lamoille River, Fairfax: relatively stable planform (lots of bank armoring and very good access to floodplain) but frequently flooded, often several times/year - older CREP Filter Strips good, but not addressing major water quality challenges.
In 2000, USDA FSA helped with the cost of filling in gullies and scour holes - with 1266 yards of fill (90, 14 yard truck loads of fill)

In 2002, same thing - this time “65, 14 yard truck loads of sand”
Grassed Waterway (flood chute) earning it’s keep...
Mud Creek, Newport Center: Straightened stream channel, lack of buffer, frequent soil loss/nutrient runoff, crop yield losses.
pt where stream spilled into field

potential alluv. fan corridor

actual toe of slope
Mud Creek (upper Missisquoi)

35' forested buffers

Forested Buffer/Filter strip (flood chute)

35' Forested Buffer

Forest buffer/flood chute protection

35' Forested Buffers
Missisquoi River, North Troy: straightening, increasing flood frequency/crop losses from field scouring and sediment deposition, drainage challenges.
Trout River, Montgomery: extensive history of gravel mining on high bedload stream planform changes increasingly in conflict with ag fields, landowner interest in bank armoring. Project development involved multiple partners – from MRBA, DEC River Management, consultant, VTAAFM, VRC, USFWS PFW.
Geomorphic Assessment

Nearly every stream and river in the state of Vermont is undergoing change. Sometimes these changes are natural or imperceptible. Other times, and more often, streams and rivers are adjusting to channel, flood plain, or watershed changes imposed in years past by human activity. Understanding the natural tendencies of a stream, its current condition, and what changes may be anticipated in the future is invaluable to making sound protection, management, and restoration decisions.

The River Management Program provides the technical assistance to conduct geomorphic assessments of streams and their watersheds. Contact River Management Program geomorphic assessment technical assistance staff for data forms, assessment protocols, and geomorphic reference tools used by the State to assess stream condition and responses.

Resources

New to the SGA DMS Bridge and Culvert database:

- Improved data entry forms and search tools to find local roads inventory data in the VOBCIT database;
- Geomorphic Compatibility Screen: ranks individual structures on the extent to which they impede sediment and debris transport, affect instablity;
- Aquatic Organism Passage Screen (culverts only):
  - Ranks individual culverts according to the extent to which they impede migration of aquatic organisms throughout the stream
  - Ranks individual structures according to their potential for being retrofitted to reduce the degree to which they impede organism migration
  - Determines the potential extent of habitat that would be made accessible by removing or retrofitting culverts that act as barriers to aquatic organisms

Detailed information on these new additions can be found in the following documents:

- 2009 Bridge and Culvert Assessment Protocol (pdf, 1.9 MB)
- The Stream Geomorphic Assessment Bridge and Culvert Data Management Manual (pdf, 338 KB)
- The Vermont Geomorphic Compatibility Screen Report (pdf, 1.8 MB), and
- The Vermont Aquatic Organism Passage Report (pdf, 2.96 MB)

Assessment Reference Tools and Links

- Geomorphic Assessment Viewer (MapServe)
- Vermont Regional Hydraulic Geometry Curves: 2006 (pdf, 461 KB)
- Stream Geomorphic Assessment Data Management System (SGA DMS)
- Stream Geomorphic Assessment Tool (SGAT) User Guide (pdf, 4825 KB)

Why do Geomorphic Assessments?
### Step 4. Flow & Flow Modifiers

<table>
<thead>
<tr>
<th>4.1 Springs / Seeps</th>
<th>Minimal</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.2 Adjacent Wetlands</td>
<td>None</td>
</tr>
<tr>
<td>4.3 Flow Status</td>
<td>Moderate</td>
</tr>
<tr>
<td>4.4 # of Debris Jams</td>
<td>0</td>
</tr>
<tr>
<td>4.5 Flow Regulation Type</td>
<td>None</td>
</tr>
<tr>
<td>Impoundments</td>
<td>None</td>
</tr>
<tr>
<td>Impoundment Loc.</td>
<td></td>
</tr>
<tr>
<td>4.6 Up/Down Strm flow reg.</td>
<td>(old) Upstrm Flow Reg: None</td>
</tr>
<tr>
<td>4.7 Stormwater Inputs</td>
<td>None</td>
</tr>
<tr>
<td>Field Ditch</td>
<td>Road Ditch</td>
</tr>
<tr>
<td>Other</td>
<td>Tile Ditch</td>
</tr>
<tr>
<td>Overland Flow</td>
<td>Urb Strm Wtr Pipe</td>
</tr>
<tr>
<td>4.9 # of Beaver Dams</td>
<td>0</td>
</tr>
<tr>
<td>Affected Length (ft.)</td>
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</table>

### Step 5. Channel Bed and Planform Changes

<table>
<thead>
<tr>
<th>5.1 Bar Types</th>
<th>Diagonal: 2</th>
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<tbody>
<tr>
<td>Mid</td>
<td>0</td>
</tr>
<tr>
<td>Delta</td>
<td>1</td>
</tr>
<tr>
<td>Flood chutes</td>
<td>0</td>
</tr>
<tr>
<td>Neck Cutoff</td>
<td>0</td>
</tr>
<tr>
<td>Avulsion</td>
<td>0</td>
</tr>
<tr>
<td>5.2 Other Features</td>
<td></td>
</tr>
<tr>
<td>5.3 Steep Riffles and Head Cuts</td>
<td>Head Cuts: 0</td>
</tr>
<tr>
<td>Straightening</td>
<td>0</td>
</tr>
<tr>
<td>5.4 Stream Ford or Animal Crossing</td>
<td>Yes</td>
</tr>
<tr>
<td>5.5 Straightening Length (ft.)</td>
<td>0</td>
</tr>
<tr>
<td>5.5 Dredging</td>
<td><strong>Dredging</strong></td>
</tr>
</tbody>
</table>

### Step 6. Rapid Habitat Assessment Data

| 6.1 Epifaunal Substrate - Avl. | 8 |
| 6.2 Pool Substrate             | 10 |
| 6.3 Pool Variability           | 14 |
| Sediment Deposition            | 12 |
| Channel Flow Status            | 10 |
| Channel Alteration             | 10 |
| Stream Gradient Type           | Left: 7, Right: 7 |
| Channel Sinuosity              | 16 |
| Bank Stability                 | 10 |
| Bank Vegetation Protection     | 8, 5 |
| 6.10 Riparian Veg. Zone Width  | 5, 3 |

### Step 7. Rapid Geomorphic Assessment Data

| 7.1 Channel Degradation        | 14 |
| 7.2 Channel Aggradation        | 12 |
| 7.3 Widening Channel           | 12 |
| 7.4 Change in Planform         | 13 |
| Geomorphic Rating              | 0.64 |
| Channel Evolution Model        | F |
| Channel Evolution Stage        | III |
| Geomorphic Condition           | Fair |
| Stream Sensitivity             | Very High |

**Note:** The highlighted text indicates significant features or changes in the assessment data.
Stage III - Channel is still entrenched, widening and migrating laterally through bank erosion caused by the increased stream power (B or G or F Stream Type). The system regains balance between the power produced and the boundary materials as sinuosity increases and slope decreases. There are profound physical adjustments that occur upstream and downstream from the site of alteration as bed degradation (head cuts) migrates up through the system and aggradation in the form of sedimentation occurs downstream. Stream bed largely becomes a featureless plane bed.
Phase 2 Stream Geomorphic Assessment

Trout River Watershed
Towns of Berkshire, Enosburg, Richford, and Montgomery
Franklin County, Vermont

Reach T4-03 – Given the observed planform adjustments which have been documented in T4-03, and the expected future adjustments, a corridor protection plan should be established for reach T4-03. The plan would limit channel management and encroachments to allow for the expected widening, aggradation, and planform adjustments to occur as the channel evolves toward geomorphic equilibrium. A key part of any corridor protection plan should include re-establishment of adequate woody buffers to filter out excess nutrients, stabilize streambanks, and improve wildlife habitat.

found to be in evolution stage III. Historic degradation has increased the incision ratio to 1.3, though the channel still has access to most of its historic floodplain during high flow events. Significant planform adjustments were observed between the Phase 1 river center line and the current meander centerline. Bar scalping was observed on a few of the large point bars in the middle of the reach. The riparian corridor was dominated by hay and corn fields with relatively narrow buffers ranging from 0 to 25 feet.

Figure 14: T4-03

Given the current adjustment processes observed, and the very high sensitivity rating, the most appropriate restoration/conservation projects for this reach are corridor protection and buffer enhancement. These techniques would allow the expected channel adjustments to occur...
River Corridor Easements: A Vermont River Management Alternative

This Guide introduces one of the Program’s new avoidance strategies, the river corridor easement, which includes deeded land use and channel management restrictions for protecting certain reaches of river. The transfer of channel management rights is a notable aspect of this easement, offering a unique tool for restoring watersheds and reducing hazards by protecting natural river processes at key locations (from “A Guide to River Corridor Easements “VTDEC
Buffers on unstable streams channels – are eligible to enroll in CREP, but take careful planning. Try to involve as many partners as possible....

Acceptable Buffer Widths - Unstable Channel

Whenever a determination by field staff is made that an unstable channel exists on a project area, the VT Agency of Natural Resources Stream Geomorphic Assessment Data should be reviewed and the River Management Program should be contacted to verify the form and extent of channel instability. If Phase II data and the meander belt component of a river corridor map exist for the reach in question, use the meander belt as a base layer in the CREP project mapping process. The river management scientist and field staff should conduct a site visit to GPS and, if necessary, refine the meander belt lines. The meander belt is intended to accommodate a stable equilibrium channel in the long term, and depending on the rate and type of river adjustment over the length of the contract, a buffer that meets the goals of CREP may not need to extend to the full meander belt boundary. A buffer width of at least 50 feet must be contracted in all areas and should extend to the full extent of the meander belt boundary for very highly to extremely sensitive channels as determined through the ANR Stream Geomorphic Assessment (Appendix C may be helpful). The
Consult old aerial photos...

1943
Using Meander Beltwidth Corridor to plan a sustainable buffer on an unstable stream
Belt Width = 6 x Channel Width.

Legend

- **Surface Water VHD**
- present stream edge
- 50foot_Buffer_Resource Inventory (Line)
- Buffer_present stream edge
- 40_Buffer_south_trib (1.5 ac)
- CREP buffer (8.5 ac)
- RM corridor (19.8 ac)
- meander_beltwidth (120' each side)
- Straight stream/ditch CREP option
- meander_centerline
- land_unit

For up to three river miles south of the village of Bristol, the New Haven River is highly dynamic with a tendency toward multiple threads, or a braided system. Within this section (geomorphic reaches M13, M12, M11), the river is transitioning from a steep-gradient channel confined closely by its valley walls to a very broad, unconfined, low-gradient valley setting. The reduced gradient and valley confinement lead to a reduction in sediment transport capacity. Sediment and debris carried in the river tend to drop out, and flows are directed laterally - resulting in a braided system.
River behind trees

Active flood chute – looking south
Flowed 8 times in 2011 so far
Flowing at half bankfull
Flood chute further down field. Road on right. All 3-6” cobble stones. Topsoil completely gone.
Instantaneous Flow (Provisional) - New Haven River at Brooksville, Nr Middlebury, VT (USGS Stn# 04282525)

Approximate Flow (recorded at the USGS station) at which avulsion channel on the Bristol Flats is active: 1,400 cfs (at least 13 events since 1 Oct 2010)

- TS Irene: 16,400 cfs 8/28/11, 22:00
- 11,000 cfs 10/1/10, 14:15
- Q100 = 15,700 cfs
- Q25 = 11,500 cfs
- Q2 = 4,410 cfs

1998 Flood:
- Q500 = 21,200 cfs

Measurement Date:
- 08/31/10
- 11/30/10
- 03/01/11
- 05/31/11
- 08/30/11
- 11/29/11
- 02/28/12
Once again, multiple partners worked together to pull together a CREP and VT DEC River Corridor Easement combo to provide enormous short and long–term water quality benefits to New Haven River: VT DEC Clean and Clear (ERP, now) funds to allow consultant to develop projects based on Phase II Geomorphic assessment data, VTAAFM, VT DEC River Management, VRC, NRCD, etc.
Neshobe River, Brandon: major planform adjustments resulting from heavy bedload/change in slope, berming/straightening in conflict with use of adjacent agricultural field

Channel transitions from steep reach to broad flat reach. FP development in left corridor. Historic straightening. Active aggradation coupled with major planform leading to very active channel adjustments and recent flood scouring of field. (from phase 2 geomorphic assessment)
Some of the multiple project partners involved in the field!
CP22, 17.6 ac

15 ft of zone three grasses between planted trees and cropfield
Thanks!