Tropical Storm Irene: Lessons Learned on the White Mountain National Forest

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3 to over 10 inches of Rain fell across the White Mountain National Forest

Source: National Weather Service Advance Hydrologic Prediction Service
http://water.weather.gov/precip/
The greatest damage came from the massive amount of water and how quickly it came.
$4.4 million ERFO funding available for repairs

About $10 million of damage to trails, roads, bridges, campgrounds, and recreation sites
HOW CAN THIS EVENT HELP US PREPARE FOR THE NEXT BIG STORM?
1. Stream crossing upgrades are moving us in the right direction
Statistics from stream crossing surveys

<table>
<thead>
<tr>
<th>Stream crossing statistics</th>
<th>All crossings surveyed on WMNF</th>
<th>Damaged/failed road crossings with survey info</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>334</td>
<td>15 surveyed (&gt; 47 total)</td>
</tr>
<tr>
<td>Mean inlet span (feet)</td>
<td>4.0</td>
<td>3.4</td>
</tr>
<tr>
<td>Mean bankfull width (feet)</td>
<td>7.0</td>
<td>8.0</td>
</tr>
<tr>
<td>Mean pipe span/bankfull width ratio</td>
<td>0.64</td>
<td>0.53</td>
</tr>
<tr>
<td>% with outlet perch or cascade</td>
<td>69%</td>
<td>86%</td>
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- Continue surveying roads (and trails) across the Forest.
- Current protocol is oriented toward fish passage. Collecting additional information on intermittent streams and bridge sites would help address hydrologic issues.
Recent culvert replacements

Crossings did not overtop

Movement of bed/bank material in some cases

Watch for scour at “pinch points”
Stream crossings need to pass more than just water

- Crossing failure due to low span, anchor cables, etc.
- Lateral stream movement leading to abutment and bank scour

Wild River at Hastings Bridge
The hidden cost of undersized culverts in the wrong location

Sawyer River Road

Culvert span: 4 feet
Bankfull width: 12 feet
2. Know your stream morphology—meanders

Figure 2. Stream types: gradient, cross-section, plan view (adapted from Rosgen 1994). Original drawings by Lee Silvey. Courtesy of Catena Vedag.
Considerations for meander bends

- Is meander geometry appropriate for slope, valley type and bed material?
- Is sediment or wood deposition likely to cause lateral adjustment?
- Can bank protection withstand erosive force on the outer bend?
- Has the channel been altered?

Hancock Brook along Kancamagus Highway
Channel modification makes matters worse

Source: Stream Restoration Design Handbook, 210-VI-NEH, p. 3-20
3. Know your stream morphology— alluvial fans

Figure 2. Stream types: gradient, cross-section, plan view (adapted from Rosgen 1994). Original drawings by Lee Silvey. Courtesy of Catena Vedag.
Alluvial fans

Gently sloping, cone- to fan-shaped landforms created by deposition of eroded sediment at the base of mountain ranges
Deposition leads to shifting stream courses

Where will the water go next?

Photo: NPS, Death Valley National Park

Unnamed tributary to Tunnel Brook, WMNF
4. Handle floodplains with care
Roads in floodplains

Warning signs:

• Stream bed elevation similar to road elevation
• Valley changes from narrow to wider
• Steep tributaries transport a lot of material
• Observable changes in gravel bars and side channels
• Stream energy directed toward road

The streambed formerly known as Tunnel Brook Road
Floodplain crossings

1. Find an alternate crossing location when possible
2. Span or provide floodplain relief where floodplain crossings are unavoidable
5. Don’t underestimate the importance of vegetation
### Road damage by type

<table>
<thead>
<tr>
<th>Type</th>
<th>% damaged</th>
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<tbody>
<tr>
<td>Class 1 (closed until needed)</td>
<td>0.02%</td>
</tr>
<tr>
<td>Class 2 (native/gravel)</td>
<td>3.98%</td>
</tr>
<tr>
<td>All other (gravel/paved)</td>
<td>9.94%</td>
</tr>
</tbody>
</table>
Summary

• Sizing culverts according to stream simulation principles appears to be effective for hydraulics, based on limited data.

• Road location is critical—channel slope changes, meanders, floodplains, and unbroken road grades increase risk.

• Locating travel corridors in valley bottoms has a long term cost in terms of dollars and natural resources.

• Maximizing vegetative cover limits the extent of damage.
Greeley Ponds Trail Stabilization

THE PERFECT STORM IN THE MAD RIVER HEADWATERS
An alluvial fan in action
Changes in the Mad River during Irene

Woody debris accumulated in floodplains and side channels

Gravel and cobble from upstream deposited in the streambed, directing flow toward the trail

The river bed was now higher than the Greeley Ponds trail!
Once the river got onto the trail, it couldn’t get off...

New headcut
Until it found a small tributary with a small culvert not far downstream.

Culvert with plugged "beaver box" on tributary to Depot Camp Brook.
Why move the river?

- High risk of Mad River relocating into the trail.
- Straight trail bed and small tributary channel would lead to years of erosion.
- Loss of Greeley Pond Trail as a recreation resource.
- High risk to Livermore Road and a culvert with historic value.
- Wide, low elevation drainage existed on other side of channel.
Short-term actions
Remove the wood jam and standing trees along a side channel to allow the Mad River to relocate at a lower elevation
Short-term actions
Place a log jam in the Mad River just downstream of the western channel to force water down the eastern channel.
Short-term actions
Place downed trees between the trail and the Mad River to slow water velocities and prevent another potential channel relocation down the trail.
Monitoring Results

Downstream view of channel after project

Upstream view of confluence of abandoned and new channels

Channel has degraded through loose surface deposits and remained in the eastern side channel. A cross-section was established to monitor channel response after the project.
Long term solutions

• Relocate a portion of the Greeley Pond Trail to higher ground.
• Trail segments in the alluvial fan have a winding, rolling design to prevent channelized flow.
• Consider resizing the tributary culvert in case the river jumps again.
The Big Picture for Irene Recovery

• Funding through USFS, Federal Highways, and local groups
• Public volunteer projects
• National Forest Foundation *Treasured Landscapes* program to raise additional funds

See [http://www.fs.fed.us/r9/forests/white_mountain/](http://www.fs.fed.us/r9/forests/white_mountain/)
Acknowledgements

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