Title: Culvert Replacement on Osborn Creek Improves Stream Channel Stability

Waterbody Improved: Osborn Creek (AUID number 040601010803-02) in the White River watershed, in Oceana County, Michigan. Osborn Creek is not on the Clean Water Act section 303(d) list of impaired waters.

GRTS Numbers: 98502312-01 and 98502315-01 (pre and post monitoring support, respectively)

Problem: An undersized and perched culvert at Pierce Road caused upstream sediment deposition and downstream channel erosion, and prevented upstream migration of native fishes including brook trout and sculpin, as well as stocked salmonids. The plunge pool immediately downstream of the culvert eroded and destabilized the adjacent stream bank, causing sediment deposition in a riffle immediately downstream. Significant quantities of soil also eroded from the Pierce Road roadbed onto the Osborn Creek floodplain near the stream crossing.

Project Highlights: Nine culverts on Osborn Creek have been replaced using a variety of funding sources. At Pierce Road, an undersized and perched culvert was replaced by a wider timber bridge, and the road approaches to the stream crossing were paved.

Results: Since 2011, nine culverts on Osborn Creek have been replaced using a variety of funding sources. On Pierce Road, a 6 foot culvert was replaced with a 20 foot by 7 foot timber bridge (Figure 1). Prior to replacement the plunge pool immediately downstream of the culvert was 40 feet wide and 5.6 feet deep, compared to a normal channel width of 26 feet and depth of 2.7 feet at a nearby riffle. After replacement, sandy floodplain benches had formed in this reach, reducing channel dimensions to 32 feet wide and 1.8 feet deep (Figure 2).

Channel stability in the plunge pool was assessed using EPA's stream function metric of bank height ratio (BHR), which is a measure of channel down-cutting, floodplain access, and bank erosion potential. Before the culvert was replaced the BHR of the deep plunge pool was 3.0 ("Not functioning"), and after construction of the bridge the BHR was 1.0 ("Functioning"; Table 1).

Prior to culvert replacement the streambed immediately upstream of the road crossing consisted entirely of fine sand. Although some sand still remains three years after replacement, much has been transported downstream, lowering the streambed about 0.5 feet (Figure 3) and exposing coarse gravel (Table 2). The median particle size (D_{50}) and D_{84} (the particle diameter in the 84^{th} percentile) in this reach are both substantially coarser after culvert replacement. Further riffle development is expected in this reach in the coming years.

Erosion control measures conducted in conjunction with the culvert replacement also reduced soil erosion from the Pierce Road roadbed (Figure 4).

Finally, migratory salmon and steelhead were unable to pass through the culvert, but have been sighted by local residents and U.S. Forest Service personnel upstream of the Pierce Road crossing since the bridge was built (Figure 5).

Partners, Funding, and Congressional District: Partners in replacing the multiple culverts were the U.S. Forest Service – Huron-Manistee National Forest, Oceana County Road Commission, U.S. Fish & Wildlife Service, Land Conservancy of West Michigan, Michigan Department of Environmental Quality, White River Watershed Partnership, and West Michigan Steelheaders. The total project cost of the Pierce Road crossing replacement was $139,670, of which $103,592 was secured through grants. Project costs to restore all seven crossings was $861,596 (grants totaling $634,458, match/in-kind of $227,138). The MDEQ Nonpoint Source Unit funded the pre-and-post geomorphology monitoring. This project is in Michigan's 100th Congressional District.

Photographs:

Figure 1. Before and after photographs of the Pierce Road crossing.

Figure 2. Before and after photographs of Osborn Creek downstream of the Pierce Road culvert, showing the plunge pool and destabilized stream channel (before) and the narrower, shallower channel and floodplain benches (after).

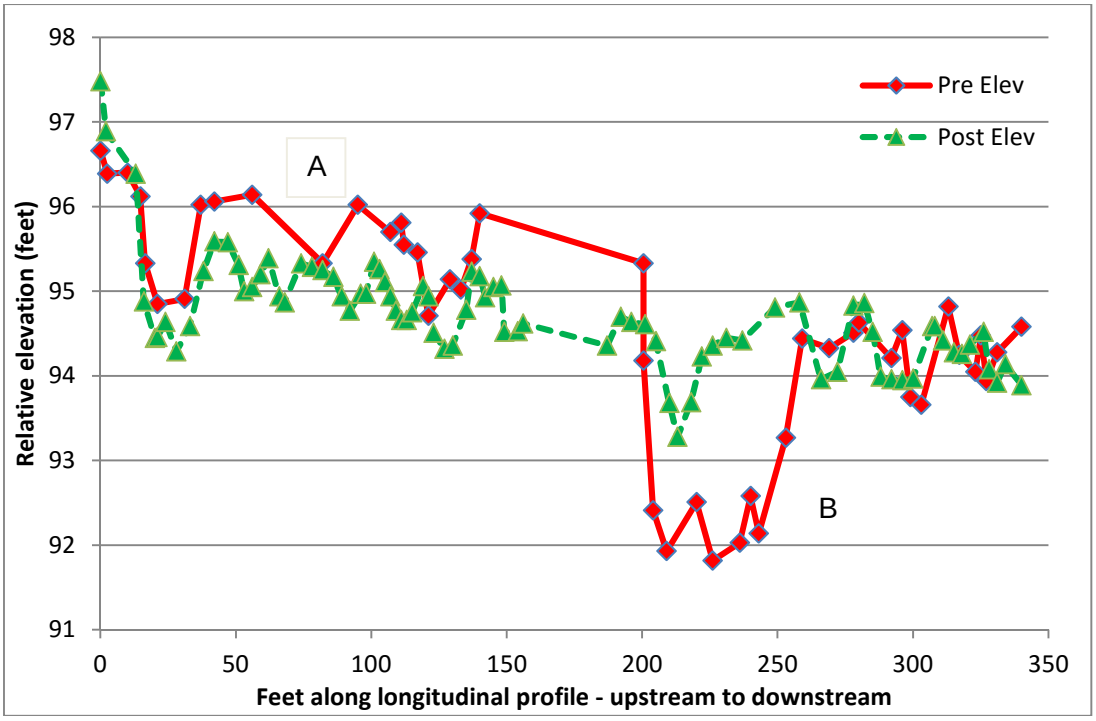

Figure 3. Overlay graph of longitudinal profile data, before and after culvert replacement. A = lowered streambed elevation after sand transport; B = plunge pool mostly filled in.

Before	After
	

Figure 4. Before and after pictures of Pierce Road near the stream crossing, formerly a source of sediment to Osborn Creek.

Figure 5. Steelhead in Osborn Creek at Buchanan Road, 0.5 miles upstream of Pierce Road; May 2013. (Photo courtesy of Chris Riley, U.S. Forest Service)

Data table/graph/chart:

Table 1. Stream function categories based on bank height ratio.

	Before	After
Near-bank depth (ft)	5.6	1.8
Mean riffle depth (ft)	1.9	1.8
Bank height ratio	3.0	1.0
Stream function category	Not functioning	Functioning

Table 2. Pebble count data from the reach immediately upstream of the road crossing.

	Before	After
D_{50}	Visually characterized as 100% fine sand (≤ 2 mm)	0.46 mm (medium sand)
D_{84}		28 mm (coarse gravel)

Contact Information: Joe Rathbun, Michigan Department of Environmental Quality; 517-284-5517; rathbunj@michigan.gov