



NONPOINT SOURCE SUCCESS STORY

Michigan

Replacing Culverts on Osborn Creek Improves Stream Channel Stability

Waterbody Improved

Undersized and perched road culverts caused flow alterations in Osborn Creek, which led to stream channel erosion and sedimentation that degraded aquatic habitat. Restoration efforts, which included replacing culverts with bridges, decreased sedimentation and improved habitat in the creek. As a result of these efforts, migratory fish can move through Osborn Creek and access upstream tributaries.

Problem

Osborn Creek (Assessment Unit ID number 040601010803-02) is a tributary to the North Branch White River in west-central Michigan's Oceana County.

An undersized and perched culvert at Pierce Road on Osborn Creek 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 (Figure 1). Significant quantities of soil also eroded from the Pierce Road roadbed onto the Osborn Creek floodplain near the stream crossing.

Project Highlights

Since 2011, nine culverts on Osborn Creek were 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 (see 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, next page). The road approaches to the stream crossing were paved as well, reducing soil erosion from the Pierce Road roadbed.



Figure 1. Osborn Creek, looking upstream toward Pierce Road, before (top) and after (bottom) an undersized culvert was replaced with a bridge. Before being replaced, the perched culvert had prevented upstream fish migration. Erosion on either side of the culvert had contributed excess sediment to the creek.



Figure 2. Osborn Creek, looking downstream away from Pierce Road, before (left) and after (right) the culvert was replaced. Downstream sedimentation has declined, allowing the stream to become deeper and narrower.

Results

Channel stability in the plunge pool downstream of the culvert on Pierce Road was assessed using the U.S. Environmental Protection Agency’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”); after construction of the bridge, the BHR was 1.0 (“functioning;” Table 1).

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

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

Before culvert replacement, the streambed immediately upstream of the road crossing consisted entirely of fine sand. Although some sand still remains 3 years after replacement, much has been transported downstream, lowering the streambed about 0.5 feet (Figure 3) and exposing coarse gravel. The median particle size (D50) and the particle diameter in the 84th percentile (D84) in this reach, which were visually characterized as 100 percent fine sand (less than 2 millimeters [mm] in diameter) before culvert replacement, were substantially coarser after culvert replacement (D50 = 0.46 mm [medium sand] and D84 = 28 mm [coarse gravel]). Further riffle development is expected in this reach in the coming years.

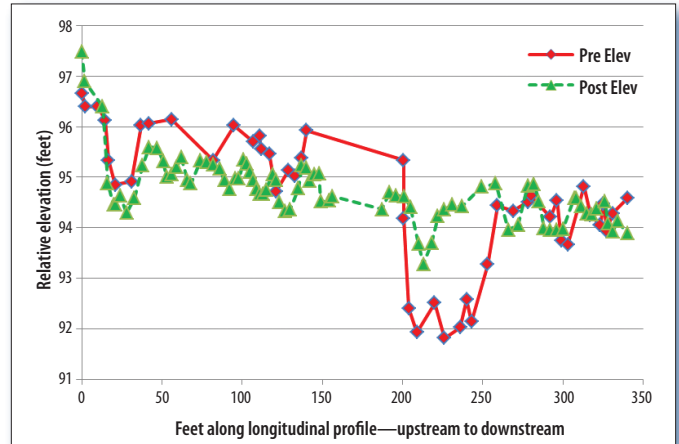


Figure 3. Overlay graph of longitudinal profile data of Osborn Creek, before and after culvert replacement. The red line, which reflects the elevation of the streambed before restoration, shows a deep plunge pool at the culvert and an accumulation of sediments on either side. The green line, which reflects the stream elevation after the culvert was replaced by the bridge, shows the plunge pool has almost disappeared, and the accumulated sediment has been transported downstream.

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

Partners and Funding

The partners involved in replacing the multiple culverts were the White River Watershed Partnership, White River Watershed Task Force, Oceana County Road Commission, KPM Engineering, Land Conservancy of West Michigan, U.S. Fish and Wildlife Service, and U.S. Forest Service–Huron-Manistee National Forest.

Replacing the Pierce Road culvert cost \$127,319 in Clean Water Act section 319 grant and match funds and \$93,618 in additional funds from the road commission, for a total of \$220,937. Replacing all nine culverts totaled \$1,173,770 in grant funds and \$945,327 in matching funds, for a total of \$2,119,097. The Michigan Department of Environmental Quality’s Nonpoint Source Unit staff conducted the pre and post geomorphology monitoring; staff time was funded with the fiscal year 2012 and 2015 Clean Water Act section 319 grants.



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