



United States Department of the Interior

NATIONAL PARK SERVICE

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To: Rick Slade, Superintendent, CATO

Through: Alan C. Ellsworth, Chief, Aquatic Systems Branch (ASB)

From: Michael Martin, Hydrologist (WRD)

Subject: Evaluation of Erosion Issues along Ike Smith Stream.

Executive Summary

In response to Technical Assistance Request #2279, WRD staff conducted a geomorphic assessment of Ike Smith Stream in the vicinity of the Ike Smith Pump House, part of the parks water distribution system and a valuable cultural resource. The overall goal of this assessment was to evaluate the hydrologic and hydraulic conditions associated with accelerated erosion in Ike Smith Stream and develop strategies for mitigating the erosional impacts and protecting infrastructure and cultural features. The purpose of this report is to describe the conditions that led to the current state of the channel and outline the steps necessary to restore the creek to a functional fluvial system. Restoring the functionality of Ike Smith Stream appears to be a practicable alternative and is necessary to protect the cultural landscape associated with the pump house.

Problem Statement

Ike Smith Stream drains a relatively small, upper elevation watershed on the west side of Catoctin Mountain Park. Ike Smith Stream is tributary to Owens Creek, a high quality waterway that carries a “natural trout waters” designation by the State of Maryland. A long-established fire road that crosses the stream channel just west of Manahan Road has caused incision of the channel bottom and subsequent bank failure immediately downstream of the crossing (Figure 1). The affected reach of the stream is about 300 ft. (91 m) long, with the incision depth in excess of 3 ft. (0.9 m) in some sections. This constitutes a substantial alteration to the natural stream system and further degradation, both deepening of the channel and retreat of the banks, may be expected. The continual loss of terrace and floodplain material not only generates sediment, it is threatening the Ike Smith pump house, a historic structure that also serves as part of the parks water distribution system.

A vehicle access bridge to the pump house has already been compromised by bank erosion at this location (Figure 2), and much of the terrace material, some of it possibly cultural, has been destabilized. The remaining pieces of this bridge, especially the deck and the right bank abutment, are contributing to bank scour and accelerating erosion at this location. The gravel service road that parallels the creek not only affects floodplain hydraulics and adds to the stream related impacts, but with the road base in its current state of disrepair, out-of-

channel flows periodically result in erosion and release of limestone gravel and other exotic material into the riparian system.

Further channel incision, bank loss and other erosion related impacts may occur with each high flow and continue into the future. However, elimination of the cause of the erosion and restoration of the stream system to a functional state appears to be a practicable alternative.

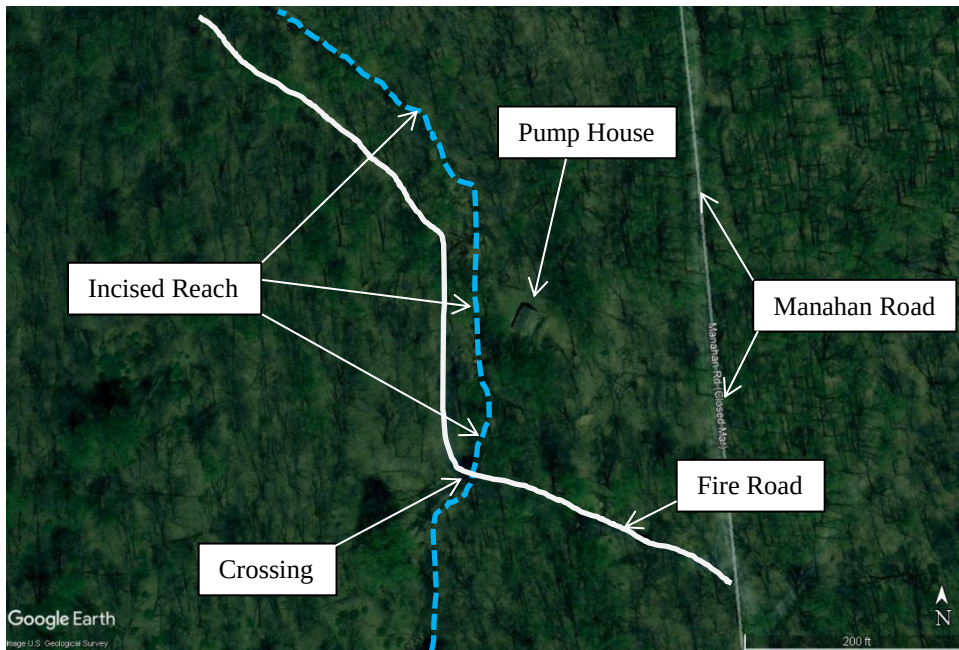


Figure 1 - Google Earth image (February, 2007) showing area around Ike Smith Pump House. Ike Smith Stream alignment is depicted as a dashed blue line with flow from south to north. The fire road is depicted as a solid grey line crossing the creek.

Stream Conditions

Catoctin Mountain Park encompasses nine square miles (2330 ha) of mostly undeveloped, eastern deciduous forest. Ike Smith Stream drains an upper watershed with little human alteration that probably maintains a near natural flow regime unaltered by extensive urbanization. The reach of Ike Smith Stream from Manahan Road to the fire road crossing, which is about 650 ft. (198 m) long, has a stable channel morphology that is mostly on-grade with no signs of marked incision. The channel has a relatively high width-to-depth ratio and is well connected to its floodplain, supporting fringe wetlands through much of its length. However, at the point where the fire road crosses Ike Smith Stream, the channel morphology changes dramatically to an incised drainage with a low width-to-depth ratio and very limited connection to its floodplain. The crossing was built with a substantial amount of fill blocking the channel and the entire right-bank floodplain. A single concrete culvert provides conveyance. The combination of the channel and floodplain blockage and the concentrated flow leaving the culvert has resulted in non-natural hydraulics and dramatic channel incision downstream.

Immediately below the crossing, the channel has incised up to 2 ft. (0.6 m) and noticeably undermined the masonry structure that supports the culvert. Farther downstream, the

depth of incision increases to 3 ft. (0.9 m) or more, and has destabilized the bank material causing undercutting of mature riparian trees and failure of the vehicle bridge (Figure 2). Loss of such trees removes large sections of the bank, and reduces the natural cohesion of the remaining bank material (Figure 3).

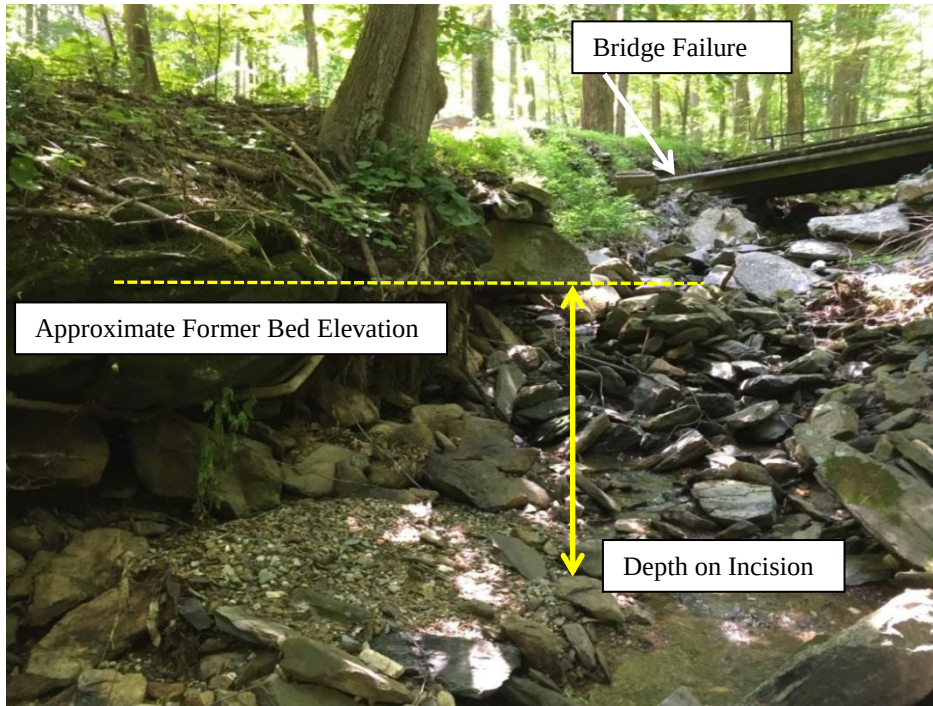


Figure 2 – Reach of Ike Smith Stream adjacent to the pump house (looking upstream) where the channel has incised about 3 ft. (0.9 m). Note the undercut tree and the failed vehicle access bridge. The dashed yellow line marks level of the former channel bottom. The solid yellow line illustrates the degree of incision. (NPS-2017)

There are still a number of mature riparian trees present on the tops of the banks, but these will undoubtedly fail at some time in the future under current conditions. Of special concern are the dozen or so large trees on the right bank terrace adjacent to the pump house. This thin layer of trees is the last line of riparian protection for this section of bank and when they are lost, bank retreat may be expected to accelerate (Figure 4).



Figure 3 – Incised reach of Ike Smith Stream looking downstream from near the culvert crossing. Note the undercut and fallen trees on the left bank. The vehicle access bridge to the pump house is visible on right side of the image. (NPS-2017)

Hydraulic Conditions

In many cases, stream incision is part of the natural channel evolution processes. However, in this reach of this stream, it is obvious that the current incised state has been caused by the road fill and the undersized culvert at the fire road crossing.



Figure 4 - The historic Ike Smith Pump House (1936) that serves as water distribution for Park facilities. The yellow ellipse marks several riparian trees that will probably be lost relatively soon without treatment. Note the vehicle access bridge that has failed on the right bank side. (NPS-2017)

Under natural conditions the incised reach would have had a cascade and

step-pool morphology and during high flows would be subjected to relatively high channel velocities because of its steep gradient. However, a non-incised channel is able to transfer energy to the floodplain as flood flows exceed channel capacity. The currently incised condition of the channel below the road crossing constrains high flows that would otherwise access the floodplain, resulting in a substantial increase in stream power, leading to further incision and subsequent loss of bank material.

In addition to the incision, the road fill that crosses the creek acts as a small dam when the culvert capacity is exceeded, creating a backwater pool that may overtop the road grade and cause substantial erosion of the remaining road fill on the left-bank terrace. Much of the road base that runs adjacent to the creek, a distance of about 250 ft. (76 m), has been destabilized exposing limestone fill and “geocell” material. The remaining road base not only serves as a source of exotic sediment and construction debris, but also affects flood hydraulics during out of channel events.

Future Conditions with “No Action”

If allowed to continue in its present state, Ike Smith Stream will experience continued downcutting and loss of bank material. Additionally, higher flows that are able to overtop the road crossing will further destabilize the remaining road-bed material mobilizing more limestone gravel and other non-native materials. The rate at which this continued erosion will progress is completely dependent on the frequency and magnitude of runoff events, and this is not predictable to any degree of accuracy. The large size of the bedload material will help the channel to resist dramatic and rapid changes, and the presence of a number of mature trees, will add some degree of bank stability as long as they are in place. However, channel evolution, which is essentially a one-way process,

will continue indefinitely. Unless restorative actions are taken, the stream channel will continue to evolve through a combination of channel downcutting and widening. The cultural landscape associated with the Ike Smith Pump House, as well as much of the remaining road-bed material, will continue to be compromised.

The pump house itself is not immediately threatened because there is about 25 feet (7.6m) of setback from the top of the right bank, and channel widening in this type of system is relatively slow. However, it is not clear how much of the historic structure, the cultural landscape and the water distribution system will ultimately be compromised through continued channel evolution. The failed access bridge (Figures 2 and 4) will continue to create bank scour and accelerate bank retreat, especially on the right bank terrace. To forestall this loss of resources, the remaining pieces of the bridge should be removed under an emergency action.

Treatments

Restoring the functionality of Ike Smith Stream would be a reasonably straight forward operation and could be completed with two broad procedures:

- 1) Removal of the road crossing, the culvert, and the remaining fire road fill. This is essentially a de-construction operation that will necessitate establishing a new service road alignment to the pump house. A reconnaissance level assessment of the area suggests there is a usable vehicle route that does not cross the creek. A more detailed analysis of the area by a road construction engineer, or other qualified professional, should be completed to confirm this observation.
- 2) Re-establish the natural cross-section of Ike Smith Stream by rebuilding the channel grade over the length of the incised reach, using appropriate natural-channel restoration techniques. The affected reach is about 300 ft. (91 m) long. The depth of incision varies from about 2 ft. (0.6 m) at the culvert to around 3 ft. (0.9 m) near the pump house. With an average bottom width of about 10 ft. (3 m), the volume of material required to rebuild the grade is in the range of about 350 cubic yds. (265 cubic m) of fill. This is not an excessive amount of fill, but given the steepness of this reach, the hydraulics associated with high flows will necessitate large material, robust design, and careful implementation to successfully restore a functional channel.

Each of these broad operations require detailed assessments, analyses, design and implementation; however, given the relatively small size of the impacted area and the fact that the watershed is in a near natural state, success should be reasonably achievable.

No precise cost estimates are available at this time because many project details including local material, transportation, and construction costs are unknown. General costs provided by experienced consultants are in the range of \$30-\$50/ft. for design and \$100-\$150/ft. for construction. These values would put the general cost for this size project (design and implementation only) in the range of about \$40,000 to \$60,000.

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