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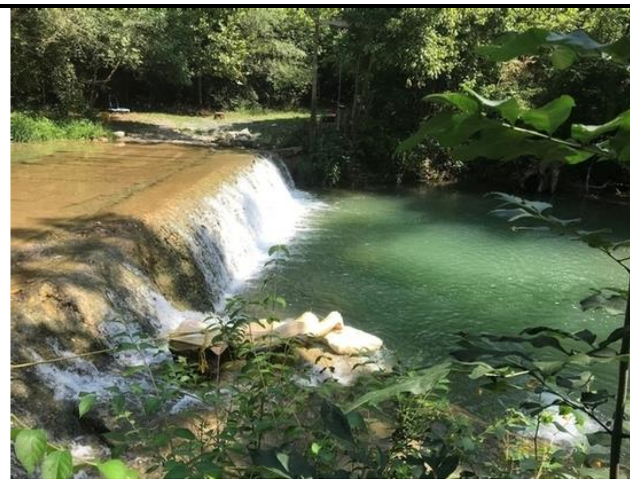
Chesapeake Bay Program: Goal Implementation Team

Tuscarora & Mill Creeks Watershed

Aquatic Connectivity Study

"Bridge Adequate" (No Barrier)



Ford (Severe Barrier)

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Participating Agencies and Organizations

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Definitions

Passability is a measure of the extent that a crossing allows the movement of aquatic animals. A Higher score indicates more ability for crossings

Crossing Site (or stream crossing) are locations where automotive or railroad traffic crossed over or fords a stream.

Structures are the man-made devices that allow for the stream crossing. Structures include rock and concrete fords, bridges, culverts, or a combination thereof.

Culverts are pipe-like structures that pass water through the crossing site. Culverts are constructed of corrugated steel and/or concrete and can be round, oval, arched, and open bottom.

Examples: Every stream crossing must have a structure. A stream crossing can include multiple structures (a culvert and a bridge side by side or more than one culvert (i.e., pipe).

CHESAPEAKE BAY PROGRAM CROSS GOAL IMPLEMENTATION TEAM (2019-2020)

Scope of Work 6: Culvert Assessments for Fish Passage and Sediment in the Opequon Watershed of West Virginia.

Introduction

This report provides the results of work conducted by Cacapon Institute (CI) and subcontractor Downstream Strategies for the Chesapeake Bay Program Goal Implementation Team (GIT) 2019 project.

CI conducted assessments of culverts and other stream crossing structures for fish passage and sediment transport in Tuscarora Creek and Mill Creek, sub watersheds of Opequon Creek (WV), using the protocols developed by the North Atlantic Aquatic Connectivity Collaborative (NAACC).

The Goal Implementation Team's goals are to:

- support the Chesapeake Bay Program's Fish Passage, Brook Trout, and Stream Health Outcomes by identifying high priority fish passage projects and reconnect high-quality river segments
- support local water quality goals the Chesapeake Bay Program's Water Quality and Stream Health outcomes through the focus on sediment reduction;
- increase ability of environmental agency staff to identify fish passage projects in other watersheds through North Atlantic Aquatic Connectivity Collaborative (NAACC) culvert assessment training and;
- increase understanding of fish-friendly culvert design by state highway agencies through a "lessons learned" section below the discussion of results.

Study Areas

This study looked at Tuscarora and Mill Creek subwatersheds of Opequon Creek, Berkeley County, WV. Both of these watersheds are on the 303(d) list as impaired for biological criteria and fecal coliform bacteria, and have Total Maximum Daily Load studies and Watershed Based Plans in place to address these impairments (Hartman et al, 2008; Hartman et al, 2013).

Tuscarora Creek is located in Berkeley County, West Virginia. It drains approximately 26 square miles and the mainstem is 11.7 miles long. It is characterized by karst[1] terrain, thus springs,

[1] **Karst:** landscape underlain by limestone which has been eroded by dissolution, producing ridges, towers, fissures, sinkholes and other characteristic landforms and is important to note because of its impact on ephemeral streams.

sinkholes[2], and discontinuous drainage patterns are common. Its major tributary, Dry Run, is ephemeral and disappears in headwaters for miles under typical flow conditions, including at least a mile directly above the confluence with Tuscarora Creek. This natural dry disconnect makes assessment of Dry Run for fish passage purposes moot. Likewise, while much of Tuscarora Creek flows above ground, in its headwaters it disappears into a sinkhole for a considerable distance. In addition to the dry sections, two small dams in Tuscarora Creek bar passage of aquatic organisms. One of these dams is in Poor House Farm Park, and is really more of a weir than a typical dam.

Mill Creek is a spring-fed stream that begins in Virginia, just south of the Berkeley County, West Virginia border. It drains approximately 29.8 square miles and the mainstem is 14.5 miles long. It flows north through orchards, new developments, older residential areas, and the town of Bunker Hill. Mill Creek's two major tributaries are Torytown Run (3.5 miles) and Sylvan Run (7.7 miles, 2.7 of which are in Virginia). Karst terrain is not a major feature in the Mill Creek watershed. There are two dams in the watershed that create severe barriers to passage of aquatic organisms.

Methods

CBP GIT directed Cacapon Institute to conduct assessments of culverts and other stream crossings for fish passage and sediment transport in Tuscarora Creek and Mill Creek, subwatersheds of Opequon Creek (WV), using the protocols developed by the North Atlantic Aquatic Connectivity Collaborative (NAACC).

The published NAACC protocols and methods used by CI to conduct the work are included in this report (see Citations for link).

Principle tasks and timeline:

- CI's Quality Assurance Project Plan (QAPP) based on the standardized NAACC Protocols was approved before the surveys began. The QAPP included a description of in-house QA/QC procedures to assure quality of field data collection, transcription, and reporting through the NAACC on-line reporting system.
- CI field verified the information on the NAACC subwatershed prioritization map. CI identified which crossings are on private property and, by way of letters and in-person contacts, attempted to gain access approval to those locations.
- U.S. Fish & Wildlife Services Field Coordinator Callie McMunigal trained CI staff and GIT-Technical Project Lead (GIT-TPL), Alana Hartman, in NAACC protocols on July 8-9, 2019.
- Following the training, fieldwork began. An in-person meeting with the GIT-TPL occurred approximately two weeks into the data collection phase to review preliminary results for preliminary analysis and input on the survey phase.

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[2] A sinkhole is a depression in the ground that has no natural external surface drainage. Basically, this means that when it rains, all of the water stays inside the sinkhole and typically drains into the subsurface. (USGS)

- Culvert assessments were entered into the regional database at https://naacc.org/naacc_data_center_home.cfm.
- Downstream Strategies (DS) conducted an analysis of CI's field data to identify best sites for future fish passage projects with recommendations for Best Management Practice (BMP) implementation involving culverts that reduce sediment and benefit aquatic habitat in the two study watersheds. The DS report is included as Attachment 5.
- CI reviewed the literature to summarize lessons-learned for culvert design.

Process

Prior to starting fieldwork, three CI staffers and Alana Hartman (WVDEP) completed the online Non-Tidal Stream Protocol training through the NAACC. Following the online training, our group traveled to White Sulphur Springs (WV), to complete NAACC's Non-Tidal Stream Shadowing Training administered by US Fish & Wildlife Service staff and NAACC Coordinators (Figure 1). During this two-day training, our team conducted 20 field surveys while being shadowed. Throughout this process, our team gained field experience surveying all structure types within the NAACC system (Attachment 1).

Figure 1, Non-Tidal Stream Shadowing Training

To start, CI downloaded the stream crossing locations from the NAACC website. Then, using ArcPro[3] CI parsed the locations within the two target subwatersheds and, in Mill Creek, we eliminated the locations in Virginia. This left 155 NAACC identified stream crossing to survey. To expedite our investigation and maximized the efficiency of our NAACC-trained staff we determined to conduct a pre-survey using the 2019 WV Bay Intern Team.[4]

The pre-survey provided photos of all the crossing and identified:

- "ghost locations," i.e., NAACC identified stream crossing that do not exist (because they never did or the crossing was removed);
- stream crossing over ephemeral streams (because a complete NAACC survey would not be required);
- public versus private stream crossings (so we know where surveys could be conducted immediately without landowner consent); and
- type and number of structures in the stream crossing (so we could estimate the time a full NAACC survey might take).

[3] ArcPro is ESRI Geographic Information System mapping software with many applications to visualize, explore, parsing, and understand geographic data.

[4] In the summer of 2019, Cacapon Institute coordinated seven interns to work on watershed issues including four interns in The City of Martinsburg and one in Charlestown conducting street tree investigation, one with WV Division of Forestry and one with CI conducting tree inventories and maintenance, and one with the WVDEP conducting stream studies.

At the same time, we began the pre-survey, we mailed letters of introduction to all property owners proximate to the stream crossings we were surveying. Using ArcPro and employing West Virginia University property parcel information, we identified all the property owners with stream crossings or property adjacent to public stream crossings. CI's years of experience with street tree planting informs us that public-private property lines are often confused. We know it is common for a private landowner to believe, incorrectly, that their property runs right up to the pavement of a public road when, in fact, their property line may stop twenty or more feet from the pavement. In order to alleviate potentially upsetting private landowners, we determined to mail a letter to all the property owners near public crossings to introduce CI and the NAACC survey. Informing property owners would, we believed, reduce the likelihood of upsetting a home or farm owner who observed us near "their property" when we were in the public right-of-way, on the side of the road, conducting surveys. In Tuscarora there were 56 property parcels near crossings and in Mill Creek 52. After removing duplicates (where two or more parcels were owned by the same entity), we mailed 94 letters of introduction (Attachment 3).

Over the course of two days, our team of eight interns, four CI staffers, and Alana Hartman (WVDEP) completed the pre-survey in ArcGIS Collector (an ESRI application for smart phones). Our pre-survey teams identified and added eleven stream crossings, including one new bridge and several fords, that were not in the NAACC databases list of 155. Of the 166 sites covered in the pre-survey we found[5]:

- 19 "ghost locations" NAACC locations where there was no crossing to survey
- 67 ephemeral stream crossings that did not require complete surveys
- 64 locations where the stream might be ephemeral but NAACC certified inspectors would need to investigate and make a determination
- 66 crossings on private land (including CSX)
- 35 crossings close enough to private land that permission would be required from the proximate resident before a NAACC survey could be completed.

Regarding the private stream crossings, after eliminating stream crossings at ephemeral sites (where a cursory inspection by a NAACC trained surveyor would suffice) we identified eleven (11) stream crossing on private property that we desired to survey. We mailed those owners requesting permission to conduct a survey and included a self-addressed, stamped, postcard for their reply. We also included an Opequon Creek Canoe Guide by way of appreciation. By post card, email, or phone response, seven (7) property owners invited us to conduct a survey on their land.

Figure 2, Gillies & Hartman, surveying on Mill Creek

On August 2nd, 2019 our four certified NAACC surveyors began field surveys in our study areas. At least two trained surveyors were on location for each survey completed, it took twelve days to complete 109 surveys. On average, it took twenty minutes per survey once on site. We recorded data on field sheets developed by NAACC (Attachment 2). We found that talking with landowners was vital to gaining access on private property.

[5] Note. The numbers do not total because they are not cumulative, e.g., a crossing can be private and ephemeral.

Natural Ford on Mill Creek

Sylvan Run under I-81, structure length 250’

CSX bridge on Dry Run

CSX bridge on Mill Creek

Tuscarora Creek Headwaters: ephemeral channel on private driveway

Mill Creek Headwaters: culvert constructed from tires, plywood, and concrete

Results

CI utilized standard NAACC stream crossing protocols to assess stream crossings in the Mill Creek and Tuscarora Creek subwatersheds of Opequon Creek in West Virginia. For the purposes of this study, stream crossings included every instance where automotive or railroad traffic crossed over or through a river or stream. Such crossings included fords, bridges, box culverts, and culverts of various designs (round, oval, arched, open bottom). A culvert is a structure that is buried. We found that stream crossings might have a single structure or multiple structures.

The NAACC protocols collect a variety of data that result in a numeric Aquatic Passibility Score for a crossing structure, a measure of the extent to which a crossing restricts the movement of aquatic animals. The scores range from 0.0 to 1.0, with 0.0 being most severe restriction and 1.0 representing no barrier to the passage of either aquatic or terrestrial life. These numeric scores are divided into the following narrative Aquatic Passability Barrier categories: severe, significant, moderate, minor, insignificant, and no barrier.

The NAACC protocol data collected includes information on:

- the total width of the crossing relative to the width of the stream,
- the alignment of the structure(s) relative to the stream,
- the base elevation of the crossing structure(s) relative to the stream bed at both the inlet and outlet,
- the presence and type of sediment in the crossing structure,
- the presence and size of scour pools below the outlet.

Since the NAACC assessment does not address sedimentation directly, we use the scour pool information as a proxy for sites with likely erosion issues. The larger the scour pool, we believe, the more sediment the site produces.

Through a mailing (with a return-addressed stamped postcard), we sought permission to visit all of the NAACC sites on private lands and received favorable replies. Unfortunately, some owners, including CSX railroad, did not respond. Fortunately, most of the NAACC sites CI could *not* assess were on very small, ephemeral or intermittent stream segments—segments that could not provide significant passage or habitat for aquatic life. Furthermore, we managed to get “eyes on” all but one railroad crossing to determined that CSX structures were all passable and “bridge adequate” so they required no additional on-site data collection.

166	NAACC stream crossings		
	142	CI found stream crossings	
		109	CI surveyed stream crossings
		151 structures were found in the 109 stream crossings	
			81 single structure crossings
			19 double-structures crossings
			4 triple-structures crossings
			5 quadruple-structures crossings

Aquatic Passability Scores for each assessed stream crossing location.

	No Barrier	Insignificant	Minor	Moderate	Significant	Severe	No Score
Stream Crossings	32	42	15	6	4	8	2
Percentage	29%	39%	14%	6%	4%	8%	2%

APS (Aquatic Passability Score). The higher the score, the higher the "passability."

Examples

No Barrier. APS >0.99 (Site #73784)

Insignificant. APS 0.80 – 0.99 (Site #73786)

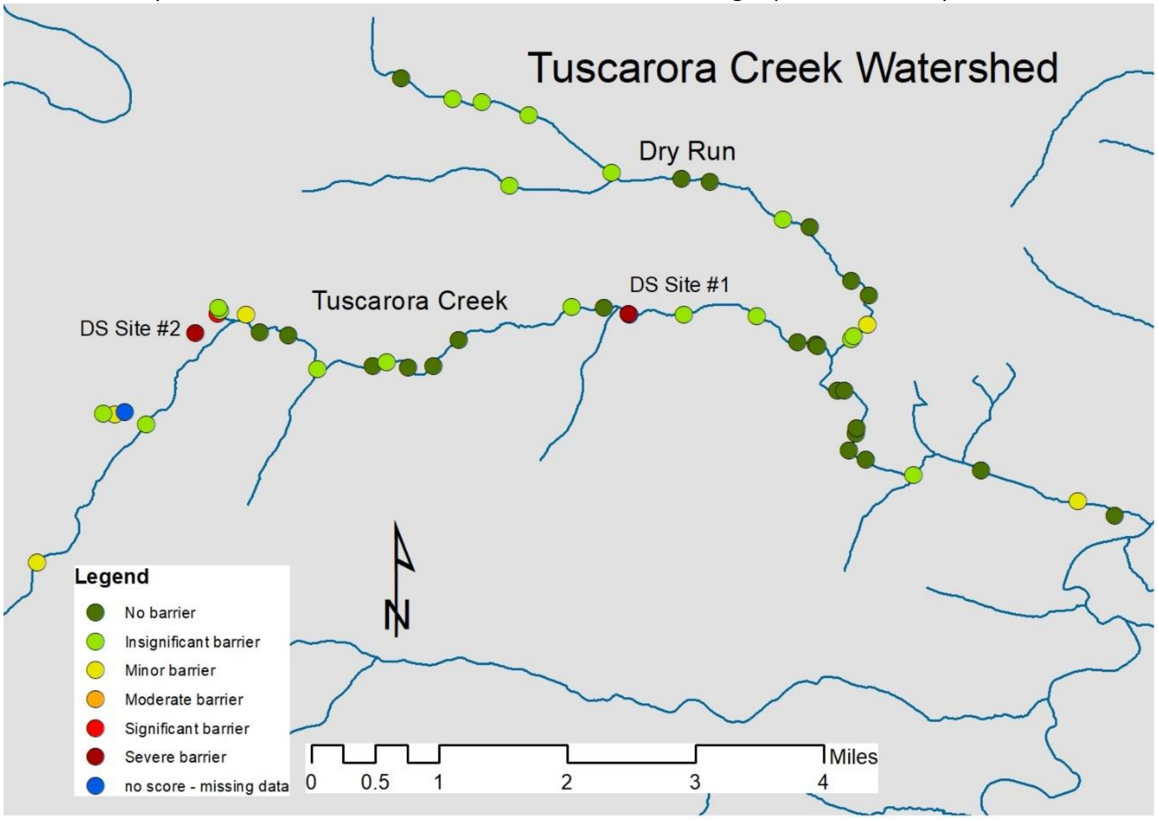
Minor. APS 0.60 – 0.79 (Site #73413)

Moderate. APS 0.40 – 0.59 (Site #73127)

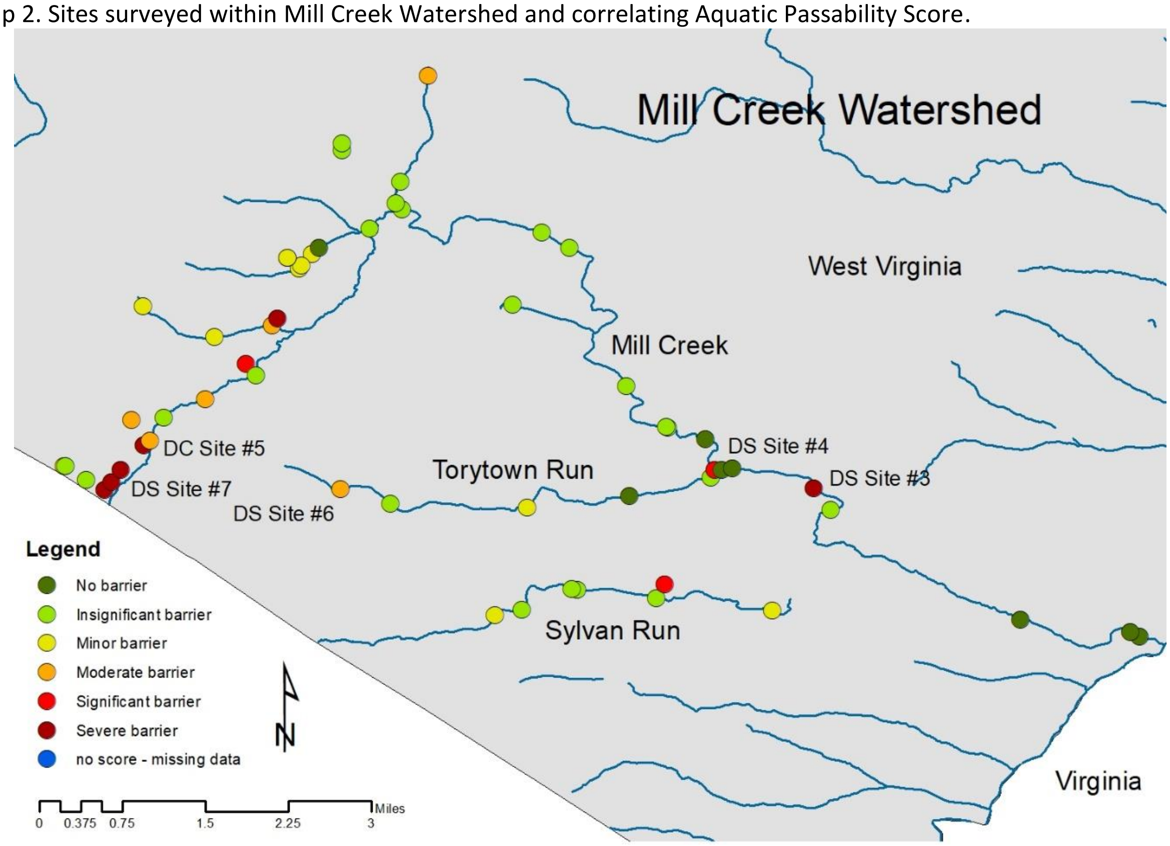
Significant. APS 0.20 – 0.39 (Site #74050)

Severe. APS <0.19 (Site #73407)

Map 1. Sites surveyed within Tuscarora Creek Watershed and correlating Aquatic Passability Score.



Map 2. Sites surveyed within Mill Creek Watershed and correlating Aquatic Passability Score.



Downstream Strategies (DS) reviewed the field data collected by CI and made recommendations on barriers to replace or modify to have the greatest benefit for aquatic organism movement. DS weighed the severity of the barrier, flow during low-water periods, and cumulative forest cover upstream. Based on CI's 109 site surveys and Downstream's analysis, we identified six high priority stream crossings for remediation. A seventh site with significant erosion issues was also included in their recommendations. Their recommendations are Attachment 5, "Opequon Creek Culvert Replacement Prioritization".

The NAACC APS system is not intended to assess sedimentation but CI considers sediment an important indicator of stream stability and health. CI used the presence of scour pools at the outlet of crossings as an indicator of likely erosion issues associated with crossing structures. CI assessed 109 stream crossing sites. Of these 83 (76%) had no scour pool, 18 (16.5%) had small scour pools, and eight (7.3%) had large scour pools. It would appear from this information that stream crossings in the study watersheds were not generally a source of significant sedimentation in the study streams. The report by DS makes recommendations for addressing the erosion issues around a site where the inlet side creates an erosion problem.

Discussion

APS (Aquatic Passability Score)	
No Barrier	1.0
Insignificant barrier	0.80 – 0.99
Minor barrier	0.60 – 0.79
Moderate barrier	0.40 – 0.59
Significant barrier	0.20 – 0.39
Severe barrier	0.00 – 0.19

Only two structure types can fit the ideal "No Barrier": bridges and bottomless culverts. Other structures lose points because they have less ideal characteristics (round culverts, pipe arch/elliptical culverts, box culverts, or fords). The APS is a representation of passability. Understanding the actual impact of these stream crossing will require more study.

The NAACC writes (2015):

> *"People often ask about the relationship between these categories and actual passability for fish and other aquatic organisms. At this point the relationship is unknown and we regard it as a fruitful area for future research. The concept of aquatic passability is complicated and includes: variations in the swimming and leaping abilities of individuals within a species …, variability in passage requirements for a broad diversity of species…, and the timing of passability (for what proportion of the year is the structure passable). For now, the best way to consider these aquatic passability scores is that they represent the degrees to which crossings deviate from an ideal. We assume that those crossings that are very close to the ideal (scores> 0.6) will represent only a minor or insignificant barrier …."*

Thankfully, we found that the large majority (85%) of the stream crossings on Mill Creek and Tuscarora Creek scored minor, insignificant, or no barrier. Unfortunately, some crossings (15%) do present significant and severe barriers to the passage of aquatic organisms.

Lessons Learned

An informal pre-survey of the existence and condition of stream crossings from downloaded NAACC data will rapidly eliminate dubious data (we could not find 19 out of 155 crossings (12%) and allow for updated information (new crossings not on the NAACC databased). A pre-survey also allows for participation by untrained participants, e.g., volunteers or local watershed managers.

The NAACC Aquatic Passability Scoring system (NAACC, 2015) describes the following features as core elements for a stream crossing structure to have no impact on movement of aquatic life:

- inlet and outlet of structure are at stream grade;
- no drop to stream surface at the outlet;
- water depth at inlet and outlet at least 0.3 feet at typical low flow;
- substrate on bottom of structure is present for the full length of the structure; and,
- the structure contains no physical barriers.

Thirty-two (29.4%) of the crossing sites we assessed were rated as "no barrier"; all of these crossing sites were bridges. Forty-two (38.5%) of the crossing sites we assessed rated as "insignificant barrier" and the type and number of crossing structures at these sites varied. We found different kinds of crossing structures can be installed in a manner that allows ready passage of aquatic life.

The NAACC website contains a page titled "Implementing Codes and Standards" that provides a clearinghouse for suggested stream crossing guidelines/standards for some states, including WV. The introduction to the page provides a useful introduction to the value of adopting State Stream Crossing Standards, excerpted below:

> *"The adoption of state level stream crossing standards is a great starting point for influencing crossing designs at a broad scale. The process of developing a set of standards can provide an important forum for discussion among environmental and transportation agency staff as well as conservation groups and others. Several states have adopted standards or guidelines for stream crossing design.*
>
> *…*
>
> *"Stream crossing standards may be referenced in general permits or legislation, such that projects for new or replacement stream crossings that meet the standards can proceed more quickly.*
>
> *…*
>
> *"Formal reference to a set of standards has proven to be an important requisite for accessing post-disaster recovery funding. If the state or municipality has adopted a set of standards for crossings, then post-disaster recovery funding may be used to improve rather than simply replace stream crossings that sustain major damage. Regulations for Public Assistance funding from the Federal*

Emergency Management Agency (FEMA) specify that standards be formally adopted, implemented, and consistently applied prior to the disaster. If these conditions are not met, then recovery funding may only support repair or replacement of a damaged structure to its pre-disaster condition, even if the pre-design condition is problematic for aquatic organism passage and flooding. (If a structure has a documented history of repeated damage, another FEMA funding stream, the Hazard Mitigation Grant Program, may be used to pay for culvert improvement.)"

The NAACC crossing standards support the state stream crossing guideline and have elements in common. CI found these concepts common:

- Clear span bridges and bottomless arch culverts are least likely to cause passage issues as they do not typically create barriers and best preserve physical habitats.
- Inlet and outlet bottom elevations should match stream bed elevation
- Structure design should minimize potential for collection of debris.

The Connecticut guidelines set the standards for other types of crossings. In brief:

- Bridges are best
- Single culverts are second best with low inverts[6] at least one foot below the thalweg[7]
- Multiple culverts are discouraged, but, when they must be used, one or more of the culverts should have invert(s) buried one foot below the thalweg
- Culvert gradients[8] should match the stream gradient and should not exceed 3%.
- Alignment should be similar to the stream.
- Culverts should be as short as possible.
- Culvert(s) should have a width that spans 1.2 times the bankfull width.

Following these guidelines will make structures more resilient to the increased frequency of high flow conditions expected due to climate change. This should reduce maintenance costs for both structures and nearby infrastructure.

[6] Invert: the lowest point in the structure or the thalweg of the lowest culvert
[7] Thalweg: the lowest point in the stream bottom
[8] Gradient: the slope of the stream (i.e., the change in elevation between the upper and lower ends of the stream crossing).

Literature and Internet Citations

The published NAACC protocols and methods (http://streamcontinuity.org/resources/naacc_documents.htm) are included in this proposal, by inference, as the methods CI used to conduct the work.

NAACC has created a subwatershed prioritization map to help focus survey efforts in the project area (tnc.maps.arcgis.com/apps/webappviewer/index.html?id=f64c9c61e01d4befafdb63afa638511f).

NAACC Steering Committee (2015). Scoring Road Stream Crossings as Part of the North Atlantic Aquatic Connectivity Collaborative.

Hartman and Mielcarek (2013). Tuscarora Creek Watershed Based Plan West Virginia Stream Code: WVP-4-C In the Potomac River Watershed Berkeley County, WV

Hartman, Bennett and others (2008). Watershed Based Plan for Mill Creek, A Tributary of Opequon Creek, in the Potomac Direct Drains Watershed, Berkeley County, WV.

Implementing Codes and Standards. (2019, August 30). Retrieved from https://streamcontinuity.org/naacc/toolkit/implementing-codes-and-standards

Department of Energy and Environmental Protection. (n.d.). Retrieved from https://portal.ct.gov/deep

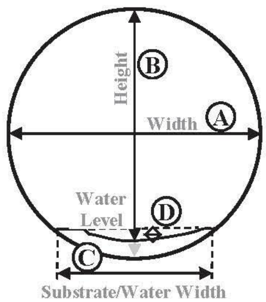
Attachment 1

Structure Shape & Dimensions

1) Select the Structure Shape number from the diagrams below and record it on the form for Inlet and Outlet Shape.
2) Record on the form in the approriate blanks dimensions **A**, **B**, **C** and **D** as shown in the diagrams;
   C captures the width of water or substrate, whichever is wider; for dry culverts without substrate, C = 0.
   D is the depth of water -- be sure to measure inside the structure; for dry culverts, D = 0.
3) Record Structure Length (**L**). (Record abutment height (**E**) only for Type 7 Structures.)
4) For multiple culverts, also record the Inlet and Outlet shape and dimensions for each additional culvert.

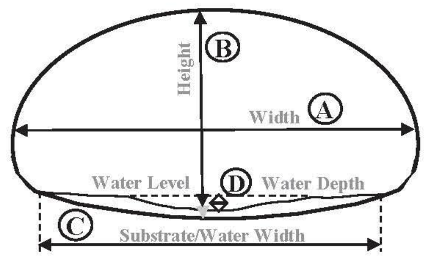
NOTE: Culverts 1, 2 & 4 may or may not have substrate in them, so height measurements (B) are taken from the level of the "stream bed", whether that bed is composed of substrate or just the inside bottom surface of a culvert (grey arrows below show measuring to bottom, black arrows show measuring to substrate).

1



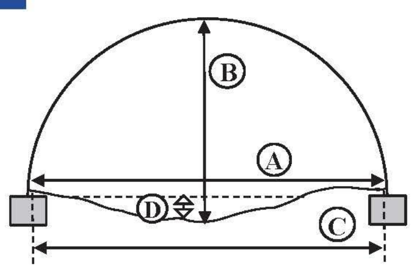
Round Culvert

2



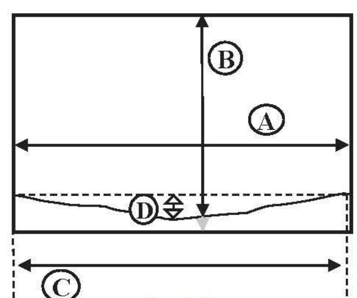
Pipe Arch/Elliptical Culvert

3



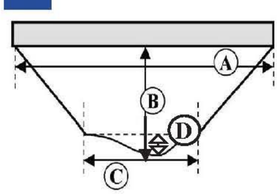
Open Bottom Arch Bridge/Culvert

4



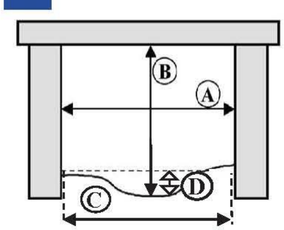
Box Culvert

5



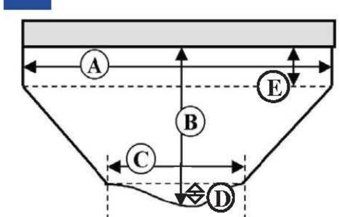
Bridge with Side Slopes

6



Box/Bridge with Abutments

7



Bridge with Abutments and Side Slopes

Attachment 2

NAACC

AQUATIC CONNECTIVITY
Stream Crossing Survey
DATA FORM

DATABASE ENTRY BY ____ ENTRY DATE ____
DATA ENTRY REVIEWED BY ____ REVIEW DATE ____

CROSSING DATA

Crossing Code ____ Local ID (Optional) ____

Date Observed (00/00/0000) ____ Lead Observer ____

Town/County ____ Stream ____

Road ____ Type ☐ MULTILANE ☐ PAVED ☐ UNPAVED ☐ DRIVEWAY ☐ TRAIL ☐ RAILROAD

GPS Coordinates (Decimal degrees) ☐☐.☐☐☐☐☐ °N Latitude — ☐☐.☐☐☐☐☐ °W Longitude

Location Description

Crossing Type ☐ BRIDGE ☐ CULVERT ☐ MULTIPLE CULVERT ☐ FORD ☐ NO CROSSING ☐ REMOVED CROSSING ☐ BURIED STREAM ☐ INACCESSIBLE ☐ PARTIALLY INACCESSIBLE ☐ NO UPSTREAM CHANNEL ☐ BRIDGE ADEQUATE

Number of Culverts/ Bridge Cells ____

Photo IDs INLET ____ OUTLET ____ UPSTREAM ____ DOWNSTREAM ____ OTHER ____

Flow Condition ☐ NO FLOW ☐ TYPICAL-LOW ☐ MODERATE ☐ HIGH

Crossing Condition ☐ OK ☐ POOR ☐ NEW ☐ UNKNOWN

Tidal Site ☐ YES ☐ NO ☐ UNKNOWN

Alignment ☐ FLOW-ALIGNED ☐ SKEWED (>45°)

Road Fill Height (Top of culvert to road surface; bridge = 0) ____

Bankfull Width (Optional) ____ Confidence ☐ HIGH ☐ LOW/ESTIMATED

Constriction ☐ SEVERE ☐ MODERATE ☐ SPANS ONLY BANKFULL/ ACTIVE CHANNEL ☐ SPANS FULL CHANNEL & BANKS

Tailwater Scour Pool ☐ NONE ☐ SMALL ☐ LARGE

Crossing Comments

STRUCTURE 1

Structure Material ☐ METAL ☐ CONCRETE ☐ PLASTIC ☐ WOOD ☐ ROCK/STONE ☐ FIBERGLASS ☐ COMBINATION

OUTLET

Outlet Shape ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ FORD ☐ UNKNOWN ☐ REMOVED

Outlet Armoring ☐ NONE ☐ NOT EXTENSIVE ☐ EXTENSIVE

Outlet Grade (Pick one) ☐ AT STREAM GRADE ☐ FREE FALL ☐ CASCADE ☐ FREE FALL ONTO CASCADE ☐ CLOGGED/COLLAPSED/SUBMERGED ☐ UNKNOWN

Outlet Dimensions A. Width ____.__ B. Height ____.__ C. Substrate/Water Width ____.__ D. Water Depth ____.__

Outlet Drop to Water Surface ____.__ Outlet Drop to Stream Bottom ____.__ E. Abutment Height (Type 7 bridges only) ____.__

L. Structure Length (Overall length from inlet to outlet) ____.__

INLET

Inlet Shape ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ FORD ☐ UNKNOWN ☐ REMOVED

Inlet Type ☐ PROJECTING ☐ HEADWALL ☐ WINGWALLS ☐ HEADWALL & WINGWALLS ☐ MITERED TO SLOPE ☐ OTHER ☐ NONE

Inlet Grade (Pick one) ☐ AT STREAM GRADE ☐ INLET DROP ☐ PERCHED ☐ CLOGGED/COLLAPSED/SUBMERGED ☐ UNKNOWN

Inlet Dimensions A. Width ____.__ B. Height ____.__ C. Substrate/Water Width ____.__ D. Water Depth ____.__

ADDITIONAL CONDITIONS

Slope % (Optional) ____ Slope Confidence ☐ HIGH ☐ LOW

Internal Structures ☐ NONE ☐ BAFFLES/WEIRS ☐ SUPPORTS ☐ OTHER ____

Structure Substrate Matches Stream ☐ NONE ☐ COMPARABLE ☐ CONTRASTING ☐ NOT APPROPRIATE ☐ UNKNOWN

Structure Substrate Type (Pick one) ☐ NONE ☐ SILT ☐ SAND ☐ GRAVEL ☐ COBBLE ☐ BOULDER ☐ BEDROCK ☐ UNKNOWN

Structure Substrate Coverage ☐ NONE ☐ 25% ☐ 50% ☐ 75% ☐ 100% ☐ UNKNOWN

Physical Barriers (Pick all that apply) ☐ NONE ☐ DEBRIS/SEDIMENT/ROCK ☐ DEFORMATION ☐ FREE FALL ☐ FENCING ☐ DRY ☐ OTHER

Severity (Choose carefully based on barrier type(s) above) ☐ NONE ☐ MINOR ☐ MODERATE ☐ SEVERE

Water Depth Matches Stream ☐ YES ☐ NO-SHALLOWER ☐ NO-DEEPER ☐ UNKNOWN ☐ DRY

Water Velocity Matches Stream ☐ YES ☐ NO-FASTER ☐ NO-SLOWER ☐ UNKNOWN ☐ DRY

Dry Passage through Structure? ☐ YES ☐ NO ☐ UNKNOWN Height above Dry Passage ____

Comments

5/26/16

1 AQUATIC CONNECTIVITY STREAM CROSSING SURVEY DATA FORM

Attachment 3

Stream Survey

#10 Rockford Road
Great Cacapon, West Virginia 25422

Cacapon Institute
304-258-8013
ci@cacaponinstitute.org
www.cacaponinstitute.org
August 9, 2019

NAME
STREET
CITY, STATE ZIP

Dear Property Owner,

Please be informed that Cacapon Institute, a West Virginia non-profit dedicated to protecting rivers and streams, is doing research on stream crossings and culverts that are on or near your property. You may see Cacapon Institute staff parking along driveways, dirt & gravel roads, lanes, and roads. We will be looking at, and measuring, culverts (pipes and bridges) and the streams that flow through them.

The purpose of this research is to estimate "aquatic connectivity," the likelihood that fish, salamanders, turtles, and other amphibious and aquatic creatures can pass. Passage up and downstream is essential for feeding, finding shelter, and breeding. This research is part of the North American Aquatic Connectivity Council's national inventory. Water from your property flows to the Opequon that flows to the Potomac that, in turn, flows to the Chesapeake Bay.

No action from you is required. The survey measurements, and data collection, is non-invasive and will not cause any damage. A typical survey lasts 20 minutes to an hour and includes, primarily, measuring the size of the culvert(s), width & depth of streams, and collecting photos.

We will respect all private property signs and fence lines. If we cannot access the culvert on your property, we will contact you for permission.

The survey project began August 1 and will last through October 2019.

Please contact me by phone or email if you have any questions.

Thank you.

Frank F. Rodgers
Executive Director
frodgers@cacaponinstitute.org
304-240-2721 (c)

We do not discriminate on the basis of race, color, national origin, gender, faith, or sexual orientation.
We strive to be inclusive, regardless of age or disability, and seek a diverse workforce and audience.

From the Cacapon River to the Potomac to the Chesapeake Bay,
we protect rivers and watersheds using science and education.

Attachment 4

Cacapon Institute

Protecting rivers since 1985

#10 Rockford Road
Great Cacapon, West Virginia 25422
www.cacaponinstitute.org
304-258-8013

August 10, 2019

NAME
STREET
CITY, ST ZIP

Dear Property Owner,

We request your permission to access your property to conduct a survey for the North American Aquatic Connectivity Council.

Cacapon Institute, a West Virginia non-profit dedicated to protecting rivers and streams, is doing research on stream crossings and culverts that feed water into Opequon Creek. We are looking at, and measuring, culverts (pipes and bridges) and the streams that flow through them. Connectivity is the ability of fish and aquatic creatures such as trout, salamanders, and turtles to pass a road crossing. It is essential to survival because it affects finding shelter and food, and raising young.

We cannot complete this important work without your help. The survey measurements, and data collection, is non-invasive and will not cause any damage. A typical survey lasts less than 20 minutes and includes measuring the size of the culvert(s), width & depth of streams, and collecting photos. In many cases, where the crossing is small or over a dry stream, a quick photo is all we need to record the site.

We respect your privacy and your property so we are contacting you to ask your permission. Permission to access your property does not imply any further consent or cooperation. Cacapon Institute is fully insured and we hold you harmless. You are not liable to Cacapon Institute in any way.

Please use the self-addressed, return, postcard to reply. We hope to complete this work by September 23rd so, please take a moment and reply today.

Frank F. Rodgers
Executive Director
frodgers@cacaponinstitute.org
304-240-2721 (c)

P.S. The enclosed "Opequon Creek Water Trail" map is yours to keep. We hope you love and enjoy the Opequon as much as we do. Please help by returning the postcard today.

*We do not discriminate on the basis of race, color, national origin, gender, faith, or sexual orientation.
We strive to be inclusive, regardless of age or disability, and seek a diverse workforce and audience.*

*From the Cacapon River to the Potomac to the Chesapeake Bay,
we protect rivers and watersheds using science and education.*

Landowner access request response postcard.

WV GIT-NAACC survey of Tuscarora and Mill Creek, Opequon Creek watershed, Berkeley County, WV, summer-fall, 2019. (front / back).

Self-addressed & stamped by CI.

Note the card does not offer a "no" response. We accepted a lack of response as a negative.

Cacapon Institute

Protecting Rivers & Watersheds Since 1985

☐ Yes you may survey the culvert on my property anytime.

☐ Yes. You may survey the culvert on my property. Please call to schedule an appointment. Call

(304)____________________

Comments

____

____

____

Cacapon Institute
10 ROCKFORD RD
GREAT CACAPON, WV
25422

Attachment 5

Opequon Creek Culvert Replacement Prioritization

Jenny Newland

Evan Fedorko

Will Postlethwait

Downstream Strategies

Ideas that sustain.

December 2, 2019

911 Greenbag Road
Morgantown, WV 26508
downstreamstrategies.com

ACKNOWLEDGEMENTS

Cacapon Institute received a grant to perform "Scope of Work 6: Culvert Assessments for Fish Passage and Sediment in the Opequon Watershed of West Virginia" by the Chesapeake Bay Program Goal Implementation Team in 2019. Downstream Strategies received a subcontract from Cacapon Institute to conduct the following analysis. The Downstream Strategies project team wishes to thank the Cacapon Institute, North American Aquatic Connectivity Council, Callie McMunigal from the U.S. Fish and Wildlife Service for their input to this analysis.

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ABBREVIATIONS

BMP	Best management practice
CI	Cacapon Institute
DS	Downstream Strategies
GIT	Goal Implementation Team
NAACC	North American Aquatic Connectivity Collaborative

1. INTRODUCTION

Cacapon Institute (CI) engaged Downstream Strategies (DS) to conduct an analysis of North American Aquatic Connectivity Collaborative (NAACC) field data collected by CI to identify potential, future, fish passage projects and recommend best management practices (BMP) for implementation. DS developed recommendations to reduce sediment and benefit aquatic habitat in the two study watersheds.

1.1 Study Location

Two study watersheds in the western half of the Opequon Creek drainage, Tuscarora Creek and Mill Creek, were selected by the Chesapeake Bay Program Goal Implementation Team (GIT) for this project. CI then completed assessments of culverts and other stream crossing structures using NAACC protocols in the two watersheds. CI field staff assessed all public road crossings and private crossings where permission to access the sites could be attained. In total, 109 crossings were assessed and added to the NAACC database. The data was reviewed and approved by the West Virginia NAACC coordinator. The locations of all assessed crossings along with known dams in the study watersheds are shown in Figure 1.

1.2 Prioritization Goals

Initial focus for the study as defined by GIT was to identify stream crossings (culverts, box culverts, and bridges) that had the most negative impact on brook trout habitat in the study watersheds. In reviewing population information and determining that available modeled habitat for brook trout was very limited, DS and CI agreed that including locally important migratory fish would provide more ecological value to the project to simply focusing on brook trout.

Prioritization was based on the severity of the impediment as defined by NAACC criteria posed by the existing structure and distance to sizable springs that could maintain more even water temperatures and flow. Those structures contributing to instability and streambank erosion were then ranked highest from the narrowed pool of structures.

2. HIGH PRIORITY PASSAGE BARRIERS

Opequon Creek is a direct tributary of the Potomac River and drains most of Berkley County and roughly half of Jefferson County in the Eastern Panhandle of West Virginia. Community watershed groups, local leaders, and landowners have been working with agency partners to address nutrient and sediment sources in the watershed for more than 10 years. Projects implemented in the watershed include riparian buffers, agricultural nutrient removal plans, streambank stabilization and restoration, dam removals, and repair and replacement of inadequate wastewater infrastructure.

The GIT is interested in promoting fish habitat improvement projects by identifying passage barriers in the watershed and providing BMP recommendations for how to provide uninhibited access for trout and other aquatic organisms. DS based our prioritization on the above goals.

2.1 Prioritization Criteria

Initial focus for the assessment in the Opequon Creek Watershed was on likely brook trout habitat. However, local observations combined with modeled results indicated limited suitable brook trout habitat in the Opequon.

DS first reviewed the barrier locations against a brook trout stress and habitat likelihood model for brook trout developed for the Chesapeake Bay by DS, West Virginia University, and the U.S. Fish and Wildlife Service. This model, formerly accessible via FishHabitatTool.org, utilized a variety of data to predict existing suitable brook trout habitat, reported as a likelihood of occurrence (ie, for a particular stream segment, the model reports “there is a 74% chance that brook trout reside here.”) The model also predicts changes to predicted likelihood if existing stressors are addressed. Our review of these data found that these subwatersheds are very unlikely to contain populations of brook trout. Only one subwatershed currently has a greater than 50% chance of having adequate brook trout habitat. Even when stressors are removed from the model, only this one subwatershed scores over 50%.

Additionally, a local fisheries biologist noted that hatchery raised trout are released to create a stocked trout fishery in parts of the watershed but there is little to no evidence of native brook trout reproduction anywhere in the Opequon (Raines, personal communication). He notes that although extensive springs provide good flow, the water hardness appears to limit trout reproduction. Raines did note that American eel and white sucker are two historically important migratory fish species likely to be found in the study watersheds.

> **Discussing Dams**
>
> **Dams should be included in future discussions for improving fish passage in the Opequon Creek watershed. These blockages not only create a passage issue but increase water temperature and create thermal impacts to waters immediately at and below the impoundments. Two dams on Tuscarora and two on Mill Creek have been identified by Canaan Valley Institute, WVDEP, and DS but were not included in this report. Figure 1 includes the location of known dams.**

Based on local knowledge and model predictions, DS discussed adjusting the prioritization criteria with CI. Together the project team decided to look more broadly at existing fish passage barriers to identify those that would have the greatest potential to improve habitat connective for multiple native fish species, including migratory species like American eel and white suckers. To identify which barriers to remove to have the greatest impact, we weighed the severity of the barrier, flow during low-water periods, and cumulative forest cover upstream. As a result of this analysis, six high priority barriers were identified. An additional site with significant erosion issues is also included as a replacement in case implementation stalls at the other high priority sites.

2.2 Barrier Removal Recommendations

DS identified six high priority sites to improve fish passage in the study watersheds, two in the Tuscarora Creek watershed and four in the Mill Creek watershed Figure 1 shows the locations of these sites along with one site selected due to evident erosion issues (labeled replacement implementation site below). These sites have been selected based on information from the NAACC assessment. DS staff have not visited these sites and much more assessment and outreach work will need to be done to confirm these are feasible sites and to verify recommended BMPs.

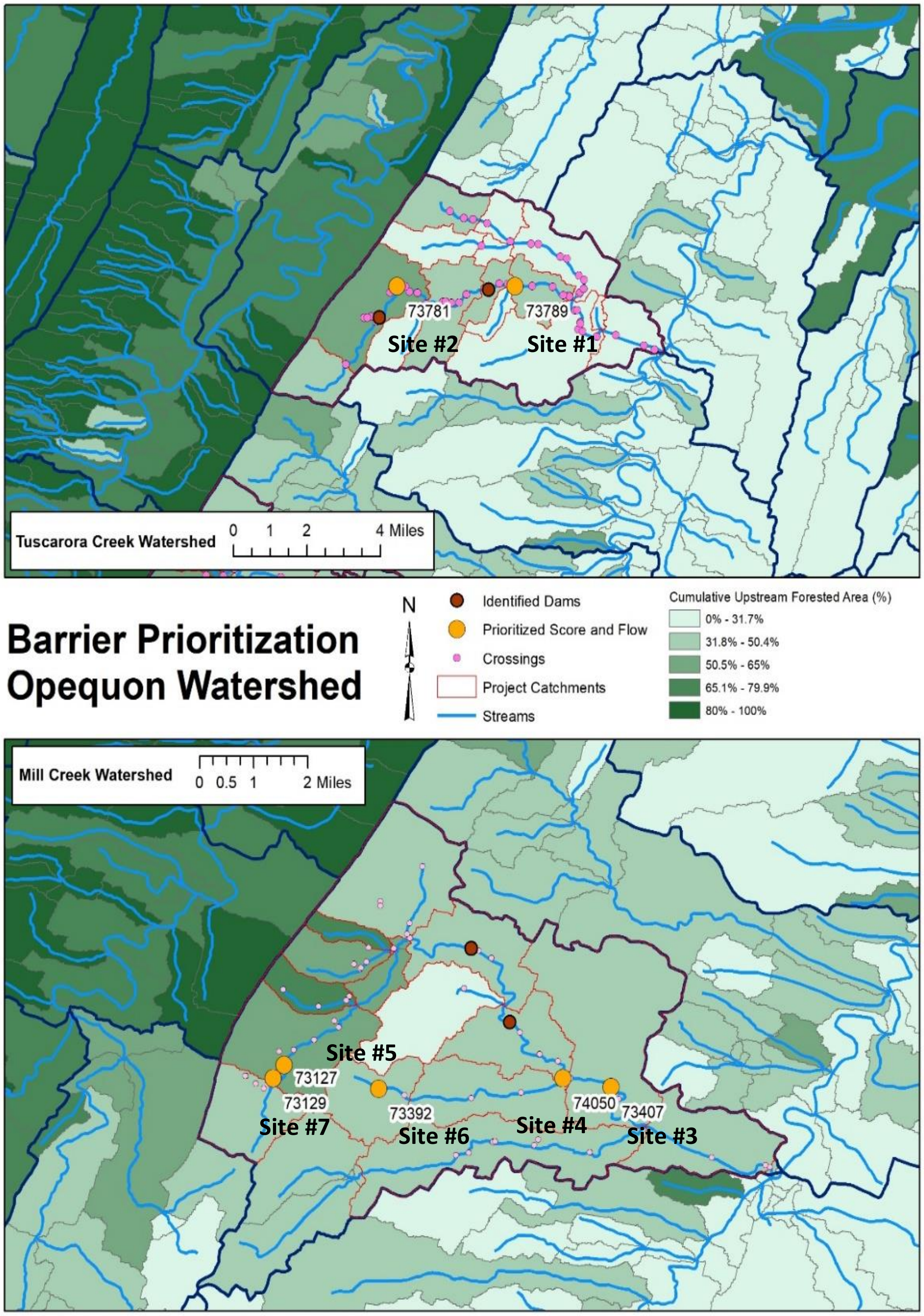

Figure 1. Location of all assessed crossings including high priority recommendations and dam locations

2.2.1 Tuscarora Creek

Figure 2. Outfall at Old Mill dam

Site 1: Old Mill Dam, Old Mill Road, Martinsburg
Survey Id: 73789
NAACC Aquatic Passability Score: 0.06
GPS: Lat: 39.46982, Long: -77.98595

This barrier is on private property and is part of a historic mill just west of downtown Martinsburg on Mill Creek. Based on the NAACC report a 1.7-foot drop at the outlet of the mill dam creates a perched culvert and will provide for a passage barrier for most aquatic species. The study site scores as severe based on a range of parameters collected using scoring criteria from NAACC Non-tidal Aquatic Connectivity Data.

Because the site is part of a historic structure and the current landowners hope to preserve the property, one option for improving fish passage would be to install steps constructed of rock and/or wood step pools at the outlet to reduce the drop. Field assessment personnel were not able to look at this structure closely and it is possible that the stream passes through some additional structures before reaching the outfall. If landowners are willing and property boundaries allow, it may be necessary to relocate Tuscarora Creek around the mill. This would require significant permitting discussions and negotiations with current landowners and their neighbors.

Figure 3. Outfall drop and scour pool at Site 2

Site 2: Poorhouse Road Spring House
Survey Id: 73781
NAACC Aquatic Passability Score: 0.33
GPS: Lat: 39.46989 , Long: -78.03247

This barrier is a hanging culvert located in the upper part of the Tuscarora Creek watershed, blocking passage on an unnamed, spring-fed tributary of Tuscarora Creek. Based on the NAACC report a 0.7-foot drop at the outlet creates a perched culvert and will provide for a passage barrier for some aquatic species. The study site scores as severe based on a range of parameters collected using scoring criteria from NAACC Non-tidal Aquatic Connectivity Data.

Steps constructed of rock and wood could be installed to reduce the drop at the outlet or the end of the scour pool could be armored and elevated to allow for a reduction in the drop height at the downstream end of the culvert. The culvert appears to be recently installed, but it would provide a good case study for improved installation according to established BMPs if the culvert could be removed and replaced with a bottomless box/arch culvert or small bridge.

This site was selected based on the NAACC report rating of severe and the observed flow conditions showing typical low flow with some standing pools. Standing pools will provide holding water during the driest times of the year and will increase habitat potential for desired aquatic and terrestrial species. It should be noted that this site is just downstream from the Poorhouse Farm spring and will open up only limited habitat above the culvert, less than 200 feet. However, this is a substantial spring and could provide refugia to fish during periods of low flow.

2.2.2 Mill Creek

Figure 4. Barrier created by low-water ford at Site 3

Site 3: Private Ford off Route 28
Survey Id: 73407
NAACC Aquatic Passability Score: 0.00
GPS: Lat: 39.33228, Long: -78.04275

This barrier is a low-water ford composed of concrete on the mainstem of Mill Creek. The ford is on a private road east of I-81 near Inwood. Based on the NAACC report a 5.0-foot drop from the top of the ford to the water surface creates a passage barrier for most aquatic species. The study site scores as severe based on a range of parameters collected using scoring criteria from NAACC Non-tidal Aquatic Connectivity Data.

Ford could be removed and replaced with a hardened crossing, bankfull width bridge, or bottomless box/arch culvert. The banks and channel will require stabilization because of the outlet drop of 5.0 feet. Being proactive in stabilizing these banks at this site will reduce any further channel degradation

This site was selected based on the NAACC report rating of severe and the observed flow conditions showing typical low flow with flowing water and standing pools. Standing pools will provide holding water during the driest times of the year and will increase habitat potential for native fish species.

Figure 5. Low-water ford showing evidence of erosion at Site 4

Site 4: Private Ford near BCPSD
Survey Id: 74050
NAACC Aquatic Passability Score: 0.22
GPS: Lat: 39.33442, Long: -78.05566

This barrier is another low-water ford on a private drive on the mainstem of Mill Creek. This ford presents less of a drop, but a 0.9-foot drop from the top of the ford to the water surface creates a passage barrier for some aquatic species. The study site scores as significant based on a range of parameters collected using scoring criteria from NAACC Non-tidal Aquatic Connectivity Data.

Recently placed riprap indicates that this site is susceptible to erosion and the crossing appears to have caused the stream to widen. This ford could be removed and replaced with a hardened crossing, bankfull width bridge, or bottomless box/arch culvert. It is likely that the banks and channel will require stabilization to reduce any further channel degradation and create a more stable stream with proper stream geometry.

This site was selected based on the NAACC report rating of significant and the observed flow conditions showing typical low flow with flowing water and standing pools. Standing pools along with permanent stream flow will provide holding water during the driest times of the year and will increase habitat potential for desired aquatic and terrestrial species.

Figure 6. Outfall drop at Site 5

Site 5: Guthrie Drive Double Culvert
Survey Id: 73127
NAACC Aquatic Passability Score: 0.41
GPS: Lat: 39.34372, Long: -78.12229

This barrier is a hanging double culvert on Mill Creek on Guthrie Drive upstream of Gerrardstown. Based on the NAACC report a 0.6-foot drop from the outlet to the water surface creates a passage barrier for some aquatic species; the study site scores as a moderate barrier.

The double culvert crossing is likely causing the stream to widen and inducing erosion upstream and downstream of the crossing during high water events. The double culverts also make the construction of steps to mitigate the drop more difficult. The end of the scour pool could be armored and raised to an elevation allowing for a reduction in the drop height at the downstream end of the culvert, but a bottomless culvert or bankfull-width bridge would likely be the best BMPs for this site.

Figure 7. Outfall drop at Site 6

Site 6: Morgan Cabin Culvert
Survey Id: 73392
NAACC Aquatic Passability Score: 0.50
GPS: Lat: 39.33194, Long: -78.10501

This barrier is a hanging culvert on an unnamed tributary of Mill Creek on Runneymeade Road near historic Morgan Cabin. Based on the NAACC report a 0.5-foot drop from the outlet to the water surface creates a passage barrier for some aquatic species. The study site scores as moderate based on a range of parameters collected using scoring criteria from NAACC Non-tidal Aquatic Connectivity Data.

Steps constructed of rock and wood could be installed to reduce the drop at the outlet or the end of the scour pool could be armored and raised to an elevation allowing for a reduction in the drop height at the downstream end of the culvert. The culvert is a small diameter and is likely undersized, so replacing the culvert with a bottomless box/arch culvert or small bridge would be a good option.

This site was selected based on the NAACC report rating of moderate and the observed flow conditions showing typical low flow with some standing pools. Standing pools will provide holding water during the driest times of the year and will increase habitat potential for desired aquatic and terrestrial species. In addition, this site is located in a part of the Mill Creek watershed with high cumulative forest cover.

Figure 8. Evidence of debris jam at inlet of replacement implementation site

2.2.3 Replacement Implementation Site

Site 7: Komo Lane
Survey Id: 73129
NAACC Aquatic Passability Score: 0.88
GPS: Lat: 39.34128, Long: -78.12777

This is a WVDOH double culvert in Mill Creek on Komo Lane off Dominion Road 0.83 miles north of the Virginia state line. The culverts are four-foot corrugated metal and half submerged presenting a wet passage presently blocked by woody debris.

In addition to the above high priority sites, there is one additional crossing to include in the discussion due to its apparent contribution to erosion and sedimentation. This site does not currently pose a significant passage barrier as it is a multiple culvert crossing with sediment built up inside the existing culverts. However, the crossing shows evidence of recent debris jams and the wide crossing is likely causing erosion and increasing the width of the stream above and below the crossing. Given the likelihood that this culvert is a maintenance issue and there is an opportunity to address erosion issues at the site, the project team is including this site as a possible replacement implementation site if implementation proves difficult at the high priority sites. Details on this crossing are included below along with a photo. A bottomless culvert or bankfull-width bridge would likely be the best BMPs for this site.

3. CONCLUSIONS AND RECOMMENDATIONS

A variety of structures are impeding fish passage in the two study watersheds. In order to provide the greatest benefit for fish habitat across the study watersheds, we prioritized barriers on the mainstem and barriers on smaller streams with fewer upstream stressors. This combination of sites will provide benefits to a variety of species and allow for the demonstration of a variety of best management practices. These BMPs include the creation of steps to improve access at the outfall of existing barriers. An example of this kind of BMP is included as Figure 9. This BMP is recommended for addressing the barrier at Site 1 unless the landowners are willing to discuss a more permanent solution.

Figure 9. Steps and pools created to improve fish passage on Oats Run in Pocahontas County, WV

Bankfull width bridges are another BMP that allows for natural stream function, aquatic organism passage, and reduced nuisance flooding from debris jams. An example of this kind of structure is included as Figure 10. This BMP is recommended for Sites 3 and 4 to replace the low-water crossings. This would also likely be the best option for addressing the replacement site.

Figure 10. Bankfull width bridge on Cherry Glade Run in Garrett County, MD

We have also recommended bottomless culverts as a BMP for some of the study's watershed project sites. These structures also allow for natural stream function and free movement of aquatic organisms. Bottomless culverts are generally used on smaller streams rather than bankfull width bridges and are the best solution for the Sites 2, 5, and 6. An example is included at Figure 11.

Figure 11. Bottomless culvert on Long Run in Pocahontas County, WV

REFERENCES

Raines, Clay. 2019. U.S. Geological Survey. Personal Communication.