Protocols for Monitoring Stream Health
By Caroline Kelemen and Nadia Swit

West Creek is a living laboratory designed to develop stormwater and pollution control measures for Northeast Ohio’s urban streams. Over the past four years Qualitative Habitat Evaluation Index (QHEI), Bank Erosion Hazard Index (BEHI), Near Bank Stress (NBS) and Cross-Section Survey of stream profiles have been used to track the health of West Creek. Below compares results from 2015-2018 at an upstream point and a downstream point.

**Qualitative Habitat Evaluation Index (QHEI)**
QHEI is designed to give a “fish eye view” of stream habitats. Considering the diversity and quality of substrate, instream cover, channel morphology, bank erosion, riparian zone, depth, ratio of riffle to pool width and current velocity, a numerical value is generated to rank the QHEI range from very poor to excellent. The higher the number the healthier the stream habitat. This data is used by the Ohio EPA to track the success of an upstream project for the Cleveland Metroparks.

**Bank Erosion Hazard Index (BEHI)**
BEHI is a fluvial geomorphic assessment used to evaluate current erosion or susceptibility of erosion of a section of stream. The BEHI assessment is composed of several metrics that account for physical attributes of a stream that can contribute to erosion potential. These variables include: riparian root depth, root density, bank angle, surface protection, bank material, and stratification of the stream bank. Each metric is assigned a numerical value, which then relates to a final rating ranging from very low to extreme for a particular stream bank.

**Example BEHI Data sheet and scoring method**

2016 Above: West Creek at River Mile 6.90. The primary substrate was shale bedrock, with sparse instream cover and vegetation, which provided poor habitat for fish. Channel morphology was also ranked low, contributing to fewer opportunities for stable macrohabitat. Likewise, the development of riffle/pool complexes was poor due to fewer opportunities for stable macrohabitat. Channel morphology was also ranked low, contributing to fewer opportunities for stable macrohabitat. Likewise, the development of riffle/pool complexes was poor due to fewer opportunities for stable macrohabitat.

2018 Above: West Creek at River Mile 5.35. From 2016-2018, the drawings show an increasing depositional area along the left bank. This site of the creek had fair riffle/pool development and boulders for instream cover, however it is fairly urbanized, which contributed to the overall score. Cross Section 10091304 passes through this section.

In addition to the one-time rankings, BEHI is also carried out every year alongside cross-section surveys. The BEHI protocol was developed based on western streams, which have very different properties. The Park District uses a modified protocol to account for Northeast Ohio’s urban shale bed streams. The annual BEHI can be used in conjunction with cross-section data to build a sediment rating curve for this area.

**Near Bank Stress (NBS)**
NBS describes how much stress the flow of the river is exerting on the streambank based on stream morphology. The figure below shows the ranking given for different geomorphic areas on a stream.

Generally, if the stream is moving quickly and parallel to the bank, NBS is low. Pools cause more stress than riffles and runs because slow moving water exerts higher pressure on the bank. Meadows increase NBS, because flow is directed into the streambank - the tighter the meander, the higher the stress.

**Mid channel bars direct the flow into both banks, causing streambanks to erode and the channel to widen.**

NBS is performed alongside BEHI to show how much erosion is due to the stream’s morphology and how much is due to the bank composition. Banks with high NBS and High BEHI are especially vulnerable. Often high NBS scores should correlate to high BEHI scores, but this is not always the case. If BEHI scores are higher than NBS scores that indicates bank composition and protection are not protecting the bank from erosion and may respond well to remediation efforts. High NBS scores with low BEHI scores mean that the bank is well protected by its composition and/or surface protection.

**Streambank Cross Section Profiles**
In 2015, Cleveland Metroparks began surveying cross sections of streams to get a quantitative measurement of erosion and to develop a sediment rating curve for the region. Rebar was installed on both banks of a selected site to determine a transect of the stream, or cross-section point, where data would be taken. A tape measure is run between the two rebar to mark stations where measurements would be recorded every one to three feet, or at changes in slope of the streambank. A laser level and sensor were used to take elevation measurements, which would give a detailed profile of the Streambank and can be compared from year to year.

The profile of site 11011358 illustrates little change between 2015-2017. However, the 2018 data (depicted in blue) may indicate there was human error when taking station measurements.

The graph above illustrates the depositional area of this cross section grew between 2016 and 2017 and continued to grow in 2018. This is mirrored in the QHEI data from the same time period. Likewise the BEHI rankings corroborate this changing, assigning a High rank in 2017 and a Very High rank in 2018.

**References**
Cleveland Metroparks Natural Resources. Modified Bank Erosion Hazard Index (BEHI) Protocol
Cleveland Metroparks Natural Resources. Standard Operating Procedures for Cross Section Monitoring Project