Standard Operating Procedure

Methods for Assessing Habitat in Wadeable Waters

Commonwealth of Kentucky
Energy and Environment Cabinet
Department for Environmental Protection
Division of Water

Version 2.0

Effective Date: February 2022
Original Effective Date: March 1, 2011

Document ID: DOWSOP03024

DOCUMENT REVISION HISTORY

Version and Effective Date	Page(s) Revised	Revision Explanation	Version Author and Reviewers
1.0 January 31, 2011	All	New Document	Aric Payne (Author); Bryan Marbert, Lara Panayotoff, John Brumley (Reviewers)
2.0 February 2022	All	Updated to current SOP template format (added Summary of Method and Data & Records Management sections). Re-arranged elements to match current datasheet. Corrected error in Index Period. Added details on several datasheet elements: updated Figure 1, added descriptions and definitions for most elements of 8.2, added bedrock to substrate in 2a, add Figure 2 to element 5; updated Table 2 format; added 8.4 photo documentation. Minor updates to both datasheets.	Mary Rockey

Suggested Citation: Kentucky Division of Water (DOW). 2022. Methods for Assessing Habitat in Wadeable Waters. Kentucky Department for Environmental Protection, Division of Water, Frankfort, Kentucky.

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1.0 SCOPE & APPLICABILITY

This manual has been developed by the Kentucky Division of Water (DOW) as guidance for the uniform and accurate evaluation of habitat parameters present in the wadeable waters of Kentucky. The methods defined herein are required for all habitat assessment procedures and quality assurance (QA)/quality control (QC) activities resulting in information that could be used for water quality assessments.

2.0 SUMMARY OF METHOD

Habitat condition is critical to understanding and assessing stream health. This procedure outlines the methods used by DOW to evaluate the habitat available for aquatic life within Kentucky's wadeable streams and the riparian habitat surrounding those streams. The procedure described herein is based on the historical methods used by the Water Quality Branch (WQB) (DOW, 2008), as well as general methods recommended in the manual *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers* (Barbour et al. 1999).

3.0 DEFINITIONS & ACRONYMS

BG – Bluegrass Bioregion
DOW – Kentucky Division of Water
GNIS – Geographic Names Information System
K-WADE – Kentucky Water Assessment Data for Environmental Monitoring
MT – Mountain Bioregion
MVIR – Mississippi Valley-Interior River Bioregion
PR – Pennyroyal Bioregion
QA – Quality Assurance
QC – Quality Control
RBP – Rapid Bioassessment Protocols; an inexpensive, easily implemented screening tool for determining if a stream is in support or non-support of its designated use.
SOP – Standard Operating Procedure
Thalweg – Path of deepest thread of water
WQB – Water Quality Branch

Pool – An area of a stream characterized by deep (usually > 0.5 m), slow velocity and a variety of substrate types. Because of slower velocities, sediment deposition can occur over pool substrate. Pools may have a higher diversity of permanent microhabitat types.
Riffle – An area of a stream with an observable decrease in gradient characterized by shallow (<0.5 m), fast velocity and stable, layered rock substrate. The surfaces of some substrate could be exposed above the waterline.
Run – An area of a stream characterized by deep (usually > 0.5 m), fast velocity and a variety of substrate types. Runs are commonly found below riffles. In low gradient streams, runs (also called glides) are the dominant habitat where velocity is faster than the surrounding habitats.

4.0 HEALTH & SAFETY STATEMENT

All field staff should review *Worksite Hazard Assessment Guidance Document* (DOW, 2017). In addition, each employee will be individually trained by his/her supervisor, or designee, to perform assigned job tasks safely, prior to his/her performing the task.

Field staff working in and around potentially contaminated surface waters should receive immunization for Hepatitis A in accordance with DEP Departmental Policy Memorandum SSE-708 (revision, 2007). In addition, staff should receive immunization for Hepatitis B and tetanus to aid in the prevention of contracting those pathogens. All field staff should also be trained in CPR, First Aid, and Blood Borne Pathogens in accordance with DEP Departmental Policy Memorandum SSE-711 (2001). It is recommended to share relevant allergies, such as bee stings, with field crew members. Members of a field crew should familiarize themselves with the nearest hospital, doctor's office, or urgent medical care provider prior to leaving for site visit.

Personal protective equipment (PPE) should be used when sampling. This includes, but is not limited to, site-appropriate wading boots, personal flotation device, and cold weather clothing.

5.0 CAUTIONS & INTERFERENCES

Habitat assessment should be performed during base flow conditions and in the appropriate index period (see Section 8.1). If very low/no flow, high flow, or flooding conditions are present, data collection should be postponed. If a scouring rain event has occurred in the last 14 days, data collection may need to be postponed, depending on project objectives (scouring event is defined in Section 8.2.3). When habitat assessments are conducted in conjunction with biological sample collection (e.g. fish, macroinvertebrates, or algae) it is typical to postpone the full data collection event to allow for re-colonization of the target fauna. If habitat assessments are performed independently, postponement may still be appropriate if riparian or instream habitat has been significantly altered from its typical conditions and is no longer considered representative.

Data sheets are specific to stream gradient. The appropriate data sheet must be used to evaluate high versus low gradient streams. Stream gradient categories are defined in Section 8.2.

Failure to collect data during the appropriate season, under the appropriate conditions, and using the appropriate method can invalidate the data and make it not usable for biological assessment. If a potential monitoring reach has backwater from a lake, dam, or large river, this reach should not be used for biological assessment. The investigators are responsible for the quality and integrity of the data. Data must be accurate so that valid assessments can be made later.

6.0 PERSONNEL QUALIFICATIONS

All personnel involved in habitat assessment will meet at least the minimum qualifications for their job classification. Field biologists must have basic knowledge of aquatic organisms and their habitats. In addition, biologists must have knowledge of stream geomorphology and stream physical processes. All field biologists will receive formal training in this procedure and training will continue on-the-job through interaction with experienced field personnel.

7.0 EQUIPMENT & SUPPLIES

The following list of supplies are needed to complete this habitat assessment.

- High or Low Gradient Stream Data Sheet (Appendices 1 and 2)
- Waterproof pen, permanent marker, or pencil
- Range finder and/or measuring tape and flagging
- GPS unit

8.0 STEP-BY-STEP PROCEDURE

A habitat assessment should be conducted at every sampling reach where bioassessments are conducted. Such assessments will allow investigators to evaluate the quality of instream and riparian habitat, and the availability of quality habitat directly influences the biological integrity of the stream reach. Information obtained from the habitat assessment can be used to supplement biological and physicochemical data when determining the overall health of the stream reach and designated use attainment for 305(b) reporting.

Additionally, habitat assessments can be used to document physical changes that occur at a sampling reach over time. Habitat assessments provide continuity and consistency between all entities involved in multi-agency monitoring efforts. Habitat assessment procedures described herein follow those outlined in *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers* (Barbour et al. 1999).

8.1 Sampling Considerations

Before sampling begins, the appropriate index period and method must be determined.

8.1.1 Index Period

Habitat assessment within the designated index periods is critical for accurate evaluation of wadeable streams. Index periods for streams, based on their drainage area, are:

- Headwater streams (<5mi^2 drainage area) – March 1st through May 31st
- Wadeable streams (>5mi^2 drainage area) – May 1st through September 30th

In some cases, assessment outside these index periods is permissible to determine immediate impacts (e.g., chemical spills, leaks, etc.). For routine assessments or baseline data collection, data collected outside of these index periods are considered unacceptable. Also, habitat should not be assessed during periods of excessively high or low flows or within two weeks of a known scouring flow event (see Section 8.2.3).

8.1.2 High vs. Low Gradient Streams

Streams in Kentucky are characterized as high gradient or low gradient streams. This stream classification is based on flow and presence or absence of particular types of habitat. An understanding of the differences in high gradient and low gradient streams is important as each gradient type has its own habitat assessment datasheet.

High gradient

High gradient streams are defined as streams that have velocities greater than 0.013m/sec (0.5ft/sec), exhibit rapid changes in stream gradient, and have a high frequency of riffle habitat. These streams are found in the Mountain, Bluegrass, and Pennyroyal Bioregions of Kentucky (Figure 1).

If a high gradient stream has minimal or completely lacks natural riffle habitat, biologist(s) are to complete a High Gradient Habitat Assessment Datasheet, and indicate the lack of riffle habitat in Parameter #7 (frequency of riffles). Additionally, provide comments as to why riffle habitat was lacking (e.g. backwater from the Ohio River). Such notes will assist the biologists in determining biological integrity at a later date.

Low gradient

Low gradient streams are defined as streams that have velocities less than 0.013m/sec (0.5ft/sec) and naturally lack riffle habitat. These streams are found primarily in the western parts of the state, particularly in the Mississippi Valley and Interior River Bioregion (Figure 1).

In addition, it is possible to encounter low gradient streams in the western part of the Pennyroyal Bioregion. Streams lying within this transitional area between the Pennyroyal and Mississippi Valley and Interior River bioregions may be difficult to classify (Figure 1). Assessors should use best professional judgment and the following guidelines to determine gradient:

- If stream gradient is not obvious, assessors should walk the sampling reach, make notes, and take photographs of shallow, fast areas of the stream and determine if these macrohabitats are composed of stable riffles with prominent cobble and/or boulder substrate (which would indicate high gradient).
- Historical sampling information may also provide assistance in making gradient determinations. If a station has been classified as high or low gradient in the past, the classification should carry forward in future assessments.

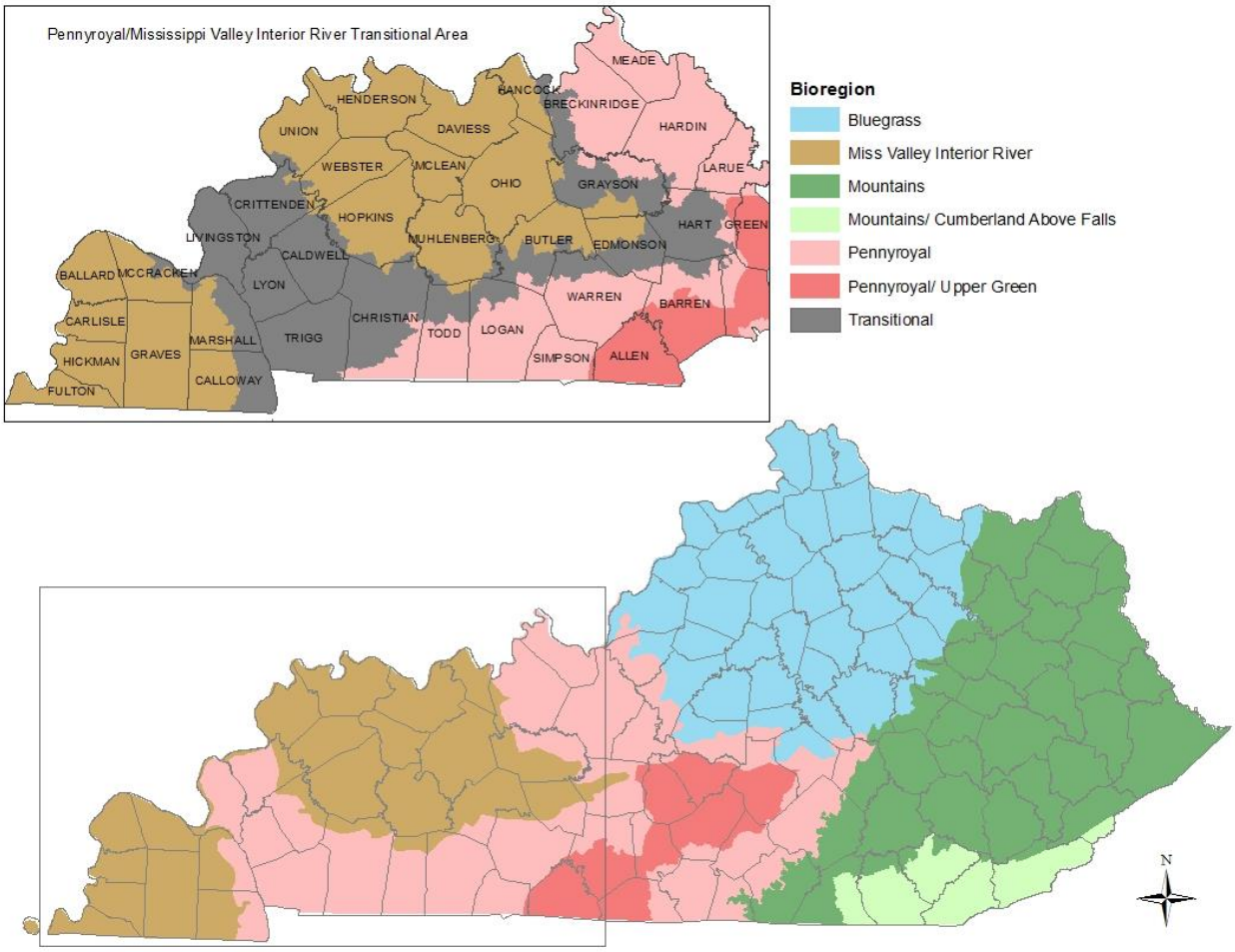

Figure 1. Bioregions of Kentucky and the transitional area between the Pennyroyal and Mississippi River Interior Valley bioregions

8.2 Filling out a Habitat Assessment Datasheet

The following sections explain how to complete each individual portion of the habitat assessment datasheet in high gradient and low gradient streams. If any of the observations on this sheet are insufficient to capture conditions at the site, provide additional descriptive notes and photos to supplement the data.

8.2.1 Station Visit Information

The header information is identical on all sheets and requires sufficient information to identify the timing and location of data collection. These details include:

- Station Identification (K-WADE (Kentucky Water Assessment Data for Environmental Monitoring) station ID)
- Locale (GNIS stream name)
- Location Description (as described in K-WADE)
- County

- Date and time (start and finish) of assessment (time in 24 hour format)
- Name(s) of the investigator(s) (include designated Activity Lead and all Field Technicians)
- Project and Trip for which the data was collected (as listed in K-WADE)

Additional details such as primary and secondary bioregion (if applicable; see Figure 1), stream permanence (ephemeral, intermittent, and perennial; see below), and stream type (headwater or wadeable; see section 8.1) are also found in this section.

Stream Permanence

Note if the stream is perennial, ephemeral, or intermittent. Biological communities inhabiting ephemeral or intermittent streams are markedly different from communities in perennial streams due to unstable water flows. Those communities present in ephemeral and intermittent streams may consist of more tolerant organisms. The following definitions apply to these terms:

- **Ephemeral Stream** – has flowing water only during, and for a short duration after, precipitation events in a typical year.
- **Intermittent Stream** – has flowing water during certain times of the year, when groundwater provides water for stream flow. During dry periods, intermittent streams may not have flowing water.
- **Perennial Stream** – has flowing water year-round during a typical year.

Bioregion

Kentucky is divided into 4 bioregions based on the geomorphology of the region (Figure 1). The biological communities found in these bioregions are distinct and varied. The primary bioregion is the bioregion within which the station is located. When a station is located near the border of two or more bioregions, this second, neighboring bioregion is considered the secondary bioregion. This information is included in the station details from K-WADE, and can also be determined using GIS.

8.2.2 Station Point Verification

For first-time station visits where station locations are determined using GPS coordinates and mapping software such as ArcMap or Google Earth, verification of the site coordinates is required. This is achieved utilizing a series of datasheet elements.

1) **K-WADE Target Point**: The target latitude and longitude of the station are listed on the datasheet in advance; these coordinates are from the GPS coordinates derived from mapping software.
2) **Field GPS Location**: Field staff navigate to site with the assistance of a hand held GPS unit. Once on site the latitude and longitude on the handheld unit are recorded as the Field GPS Location, along with details on the satellite accuracy.

- If the listed coordinates do not get staff to the stream or area of interest (or, in rare cases, a sampling location is shifted based on criteria outlined in applicable PMPs or PSPs) staff will continue to navigate until they reach the intended area for sampling before recording the Field GPS Location.
- **Nav. to Target Point Within GPS Error?** Check the GPS satellite error and mark if the field station location is within that error when compared to the K-WADE Target Point (expected location in the stream channel).
- **Target on Correct Stream?** If, after navigating to the K-WADE Target Point, the wrong stream is identified and the station must be moved or not sampled, mark 'N', otherwise, mark 'Y'. If 'N' add notes to the datasheet describing the error.
- **Field GPS Error**: Record the GPS satellite error for the Field GPS location.

3) **GPS Final:** Finally, the field staff determines which set of coordinates is most accurate and annotates it in the appropriate section on the datasheet (circle 'K-WADE' if coordinates from '1)' are used, and circle 'Field' if coordinates from '2)' are used).
    - **K-WADE Station Update**: If the field GPS coordinates are used to identify a sampling location, the project lead will update the K-WADE station accordingly to reflect the correct coordinates.

8.2.3 Weather

Note the present weather conditions on the day of the survey and those immediately preceding the day of the survey. This information is important when interpreting the effects of hydrologic events on sampling efforts. Weather abbreviations are as follows:

HR = heavy rain	CS = clear, sunny
SR = steady rain	CO = cloudy, overcast
IS = intermittent showers	SSH = snow, sleet, hail

Additionally, note if there has been a scouring rain event within the last 14 days. Determination of scouring event is based upon biologist's best professional judgment, but is typically considered if 2 inches of rain or more falls within a watershed in a 24 hour period. In addition, observations of recent high water such as signs that the stream has recently exceeded its banks, obvious removal of filamentous algae, signs of recently shifted substrate, new bank scarring, turbid waters, or a lack of macroinvertebrates on large instream rocks should be used in making this decision (see Section 5.0 for more information on the implications of this observation).

8.2.4 Stream Shading

An exposed stream often exhibits increased water temperatures that may be directly or indirectly limiting to some organisms and may be favorable for nuisance algal blooms and decreased dissolved oxygen. Light intensity may be limiting to some organisms and favorable to others. A partially shaded stream generally contains the highest species diversity. In wadeable streams, sufficient shade to maintain temperatures and habitats that will support indigenous organisms is generally created by a 50% to 75% tree canopy. Natural headwater streams should generally have 75% to 100% tree canopy.

Visually assess the overhead canopy cover throughout the stream reach and estimate the canopy shading as full (canopy provides fully effective shading of stream reach), partial (canopy is present and provides some shading to stream reach), or none (there is no canopy to provide effective shading of the stream reach).

Note if tree canopy is 'leafed out' by circling 'Y' for yes, or 'N' for no. The emergence of leaves over a period of days and weeks and varies by species and location. Use best professional judgement to determine if the canopy is 'leafed out' by considering its functionality as a shade for the underlying stream and riparian habitat.

While not used for assessing stream shading, if shading is provided by a non-vegetative source such as a building or natural feature, and therefore the above observations do not accurately represent conditions at the site, make note of this on the datasheet.

8.2.5 Stream Flow

Indicating the level of stream flow (dry, pooled, low, high, normal) is important because it can influence biological communities and water quality (i.e. low or pooled flow can increase chemical parameters in water chemistry samples). Additionally, this information can be used to verify if the data can be used in assessment (i.e. macroinvertebrate samples collected during a high flow event would not be used for assessment purposes because sampling efficiency is lowered).

8.2.6 Instream Features

Instream features are measured or estimated within the sampling reach.

Stream Width

Stream width is measured as the average wetted width, estimated visually or using a measuring device. Wetted width is the distance from the edge of the water on one side of the main channel to the edge of the water on the opposite side of the main channel. Visually estimate or measure the wetted width of a representative sample of pool, riffle, and run habitat, and average the results.

Maximum Stream Depth

Maximum stream depth is measured as the vertical distance from water surface to stream bottom at its maximum or deepest spot within the sampling reach. Maximum stream depth should be measured with some type of measuring device (i.e. carpenters rule or marked net handle) when possible. If a measuring device is not available, maximum stream depth can be estimated.

Sampling Reach Length

When conducting habitat assessments in conjunction with biological sampling, establish the reach length according to biological methods and project objectives before sample collection begins. The habitat assessment reach should coincide with the established biological reach length. When assessing habitat without collecting biological samples, visual observations must be conducted along 100 meters of stream to adequately assess habitat integrity at a site. Unique habitat features may warrant extending the habitat assessment reach beyond 100 meters, but it should not be extended beyond 300 meters in length. If for some reason a sampling reach is not between 100 and 300 meters in length, the reasons for this excursion should be documented on the field assessment form. Reach length may be visually estimated or measured using a range finder or other measurement device.

8.2.7 Riffle/Run/Pool or Run/Pool Sequence

The riffle/run/pool sequence measured as the number of each macrohabitat type present within the reach.

8.2.8 Local Watershed Features

Document the prevalent land-use type in the watershed of the sampling station (noting any other land uses in the area, which although not predominant, may potentially affect water quality). These land uses could potentially impact biological communities and water chemistry results. Use GIS, if needed, to accurately document land use within the entire catchment area.

8.2.9 Current Channel Alterations

Note if any current or recent dredging or channel alterations are present (i.e. straightening of stream channel, bridge construction, artificial bank stabilization). These types of alterations often decrease instream habitat and directly influence the presence or absence of biological communities. If current or recent activities are present, include notes and photos.

8.2.10 Riparian Vegetation

Due to its stabilizing effects as well as its ability to influence water temperatures, a riparian zone of 18 meters or more is preferred. Indicate the dominant vegetation type (trees, shrubs, herbaceous plants, and grasses) in the riparian zone. In addition, the number of canopy strata present in the riparian zone should be counted as it is an indication of riparian age and quality (e.g. overstory, understory, shrub, herbaceous layer). Dominant riparian species are noted in the provided space.

8.2.11 Hydraulic Structures

Note the presence of hydraulic structures such as dams, bridge abutments, fords, islands, waterfalls, and berms within or nearby the sampling reach (for dams consider any known structures in the watershed). These structures often form barriers that restrict movement of organisms, which could result in the lowering of assessment scores.

- **Dams** – a barrier constructed to hold back water and raise its level. Note the presence of dams anywhere upstream or downstream of the sampling reach that may impact the water quality of the sampling reach or the movement of aquatic organisms.
- **Abutments** – a structure built to support the end of a bridge or dam.
- **Fords** – a shallow place in a river or stream used for vehicle crossings.
- **Islands** – an area within the stream channel where dry land (including exposed substrate) is bounded on all sides by water.
- **Waterfalls** – a cascade of water falling from a height, formed with a river or stream flows over a precipice or steep incline.
- **Berms** – an artificial ridge or raised bank bordering a river.

8.2.12 Field Meter Data

Measure and record values for each of the water quality parameters indicated (temperature, dissolved oxygen (mg/L and % saturation), pH, and specific conductance) using the appropriate calibrated water quality instrument(s) and following standard operating procedures (SOP) (DOW, 2018). Note the instrument ID and calibration information in the "Field Activities, Multi-Probe" section.

If collecting discharge data, measure and record stream discharge and percent uncertainty using the *Measuring Stream Discharge SOP* (DOW, 2020). Note the instrument ID and beam check information in the "Field Activities, Discharge" section.

8.2.13 Field Activities

Note the types of samples collected during the station visit. Each biological community has a corresponding sampling protocol indicating how and what types of samples were collected. Where applicable, indicate the numbers of samples collected and if duplicate samples were collected. Indicate the lead collector(s) for each sample collection.

8.2.14 Substrate Characterization

In general, variations in particle size and type are reflected in flowing bodies of water by gradation of habitat types from stream headwaters to mouth. Each longitudinal gradation in substrate type harbors a characteristic biotic community. The absence of characteristic community members in the presence of a favorable substrate type can be a useful indication of stream disturbance.

For estimates of substrate size, the pool, riffle, and run habitats are visually surveyed by each field crew member to estimate the substrate by percent particle size. Results are expressed as percent of total and determined by consensus within the field crew. Sample particles sizes are listed in Table 1 to provide a fixed concept of category size. Sizes are applicable to the intermediate dimension of the particle (i.e. a rock that is flat (e.g. 0.5 inches) but wide and long (e.g. 7 inches by 11 inches), should be classified as "cobble" based on its intermediate dimension of 7 inches). Results are recorded on the habitat assessment datasheet. In addition, the estimated percent of riffle, run, and pool habitat within the sampling reach are recorded.

Table 1. Substrate particle size chart

Categories	Size (mm)	Size (inches)
Silt/Clay	< 0.06 mm	< 0.002 in
Sand	0.06 - 2 mm	0.002 – 0.08 in
Gravel	2 - 64 mm	0.08 - 2.5 in
Cobble	64 - 256 mm	2.5 - 10 in
Boulders	> 256 mm	> 10 in

8.2.15 Reach Location Description

A description of the reach of stream that was sampled during this site visit. Use permanent features where possible to identify the upper and lower limits of the sampling reach. If available, map tools such as GPS topographic maps or aerial view map applications can be used to better identify and describe sampling reach boundaries.

8.2.16 Assessment Procedures

The habitat assessment is conducted following biological and water chemistry sampling so that the entire stream reach is observed during the collection of biological samples. The habitat assessment should be conducted in collaboration by all biologists present – who deliberate and reach a consensus on how each parameter is scored.

The visual based habitat evaluation consists of ten parameters that rank instream habitat, channel morphology, bank stability, and riparian vegetation for each sampling reach. A numeric scale of 0 (lowest) to 20 (highest) is used to rank each parameter (Barbour et al. 1999). For each parameter, the investigators will determine which of the following conditions exist at the sampling reach: Optimal, Suboptimal, Marginal, or Poor. A parameter score will then be given within the condition category chosen above: Optimal (20-16), Suboptimal (15-11), Marginal (10-6) or Poor (5-0). The investigators will total all of the parameter ratings to obtain a final habitat ranking (Barbour et al. 1999).

Habitat Assessment Parameters

These parameters should be evaluated within the sampling reach. All of the areas within the reach should be evaluated together as a composite.

1 Epifaunal Substrate/Available Cover (High and Low Gradient Sheets)

This metric describes the relative quantity and variety of natural structures in the stream, such as cobble, boulders, fallen trees, logs, branches, root mats, undercut banks, aquatic vegetation, etc., that provide refugia, feeding opportunities, and sites for spawning and nursery functions for aquatic macrofauna. Riffles and runs are critical for maintaining a variety and abundance of insects by offering a diversity of habitat through variety of particle size, and, in many small high gradient streams, will provide the most stable habitat. Snags and submerged logs are among the most productive habitat structure for macroinvertebrate colonization and fish refugia in low gradient streams. However, "new fall" will not yet be suitable for colonization. Assessment is a composite of the entire biological sampling reach. Areas with bedrock or sand/fines alone will not be considered stable habitat.

High Gradient:

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
1.Epifaunal Substrate/ Available Cover Score	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.

Low Gradient:

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
1. Epifaunal Substrate/ Available Cover Score	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new and transient).	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.

2a Embeddedness - (High Gradient Sheet)

The extent to which base substrate (gravel, cobble, boulders, and bedrock/hardpan clay) and snags are covered or sunken into the silt, sand, or mud of the stream bottom. Generally, as rocks become embedded, the surface area available to macroinvertebrates and fish (for shelter, spawning, and egg incubation) is decreased. Embeddedness is a result of large-scale sediment movement and deposition, and is a parameter evaluated in the riffles and runs of high gradient streams. The rating of this parameter may be variable depending on where the observations are taken. To avoid confusion with sediment deposition (another habitat parameter), observations of embeddedness should be taken in the upstream and central portions of riffles and cobble substrate areas. At a minimum, a total of 10 riffle rocks from 2 separate riffles will be examined to determine embeddedness.

High Gradient:

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2.Embeddedness Score	Gravel, cobble, boulder, and bedrock are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, boulder, and bedrock are 25-50% surrounded by fine sediment.	Gravel, cobble, boulder, and bedrock are 50-75% surrounded by fine sediment.	Gravel, cobble, boulder, and bedrock are more than 75% surrounded by fine sediment.

2b Pool Substrate Characterization - (Low Gradient Sheet)

This metric evaluates the type and condition of bottom substrates found in pools of low gradient streams. Firmer sediment types (e.g., gravel and sand) and rooted aquatic plants support a wider variety of organisms than a pool substrate dominated by mud or bedrock and no plants. In addition, a stream that has a uniform substrate in its pools will support far fewer types of organisms than a stream that has a variety of substrate types.

Low Gradient:

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Pool Substrate Characterization Score	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.

3a Velocity/Depth Regime - (High Gradient Sheet)

The highest scoring streams in most high gradient regions will have all of the following patterns of velocity and depth: 1) slow-deep, 2) slow-shallow, 3) fast-deep, and 4) fast-shallow. The occurrence of these 4 patterns relates to the stream's ability to provide and maintain a stable aquatic environment. Investigators may have to scale deep and shallow depending upon the stream size; a general guideline is:

*Headwater streams (<5 mi2): Deep = > 0.5 m

*Wadeable streams (>5 mi2): Deep = >1 m

*Fast = surface of the water broken with turbulence (>0.3 m/sec)

*Shallow areas adjacent to the thalweg in headwater streams will be considered as slow-shallow.

High Gradient:

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3.Velocity/ Depth Regime Score	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).

3b Pool Variability - (Low Gradient Sheet)

This metric rates the overall mixture of pool types found in low gradient streams according to size and depth. The four basic types of pools are large-shallow, large-deep, small-shallow, and small-deep. A stream with many pool types will support a wide variety of aquatic species. Rivers with low sinuosity (few bends) and monotonous pool characteristics do not have sufficient quantities and types of habitat to support a diverse aquatic community. General guidelines are any pool dimension (i.e. length, width, oblique) greater than half the cross-section of the stream for separating large from small and 1 meter depth separating shallow and deep.

Low Gradient:

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Pool Variability Score	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.

4 Sediment Deposition (High and Low Gradient Sheets)

This metric estimates the amount of sediment that has accumulated in pools and changes that have occurred to the stream bottom as a result of deposition. Deposition occurs from large-scale movement of sediment. This may cause formation of islands, point bars (areas of increased deposition usually at the beginning of a meander that increase in size as the channel is diverted toward the outer bank), shoals, or result in the filling of runs and pools. Sediment is often found in areas that are obstructed and areas where the stream flow decreases, such as bends. Deposition is a symptom of an unstable and continually changing environment that becomes unsuitable for many organisms.

For this parameter, determine the percent of bottom that is being affected by sediment deposition for the entire sampling reach (examine bars/shoals and pool substrates). Use this percentage to categorize the site as optimal, suboptimal, marginal, or poor.

High Gradient:

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition Score	Little or no enlargement of islands or point bars and less than 5% (<20% for low gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.

Low Gradient:

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition Score	Little or no enlargement of islands or point bars and less than 20% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 20-50% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 50-80% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.

5 Channel Flow Status (High and Low Gradient Sheets)

This metric estimates the degree to which the channel is filled with water. The score will change with the seasons. Estimate the percentage of the channel that is wet using the low water mark of both lower banks (Figure 2). The low water mark is the line on the stream bank that represents the height of the water during normal, or base, flow conditions. The low water mark is often identifiable as a natural line impressed on the bank, an obvious shelf in the bank, and/or as a disruption of terrestrial vegetation.

When water does not cover much of the streambed, the amount of suitable substrate for aquatic organisms is limited. In high gradient streams, riffles and cobble substrate are exposed; in low gradient streams, the decrease in water level exposes logs and snags, thereby reducing the areas of good habitat. Channel flow is especially useful for interpreting biological condition under abnormal or lowered flow conditions.

High and Low Gradient:

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5.Channel Flow Status Score	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.

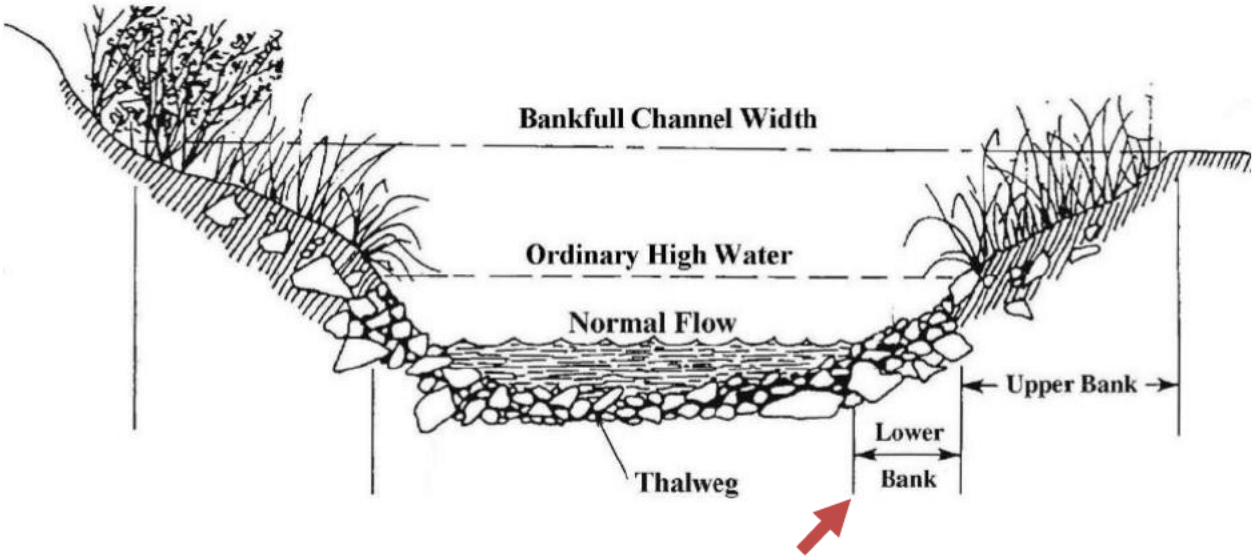

Figure 2. Typical stream cross-section indicating the low water mark of the lower bank.[1]

The next 5 parameters should evaluate an area from approx. 100-m upstream of the sampling reach through the sampling reach. This whole area should be evaluated as a composite. When determining left and right bank, face downstream.

[1] https://gaswcc.georgia.gov/sites/gaswcc.georgia.gov/files/imported/SWCC/Files/Adam_White.pdf

6 Channel Alteration (High and Low Gradient Sheets)

This metric characterizes the large-scale, direct changes in the shape of the stream channel. Channel alteration is present when 1) artificial embankments, rip-rap, and other forms of bank stabilization or structures are present, 2) the stream is very straight for significant distances because of channelization, 3) dams and bridges are present that obstruct flow, and/or 4) dredging or other substrate mining activities are occurring or have occurred.

Many streams in urban and agricultural areas have been straightened, deepened, or diverted into concrete channels, often for flood control or irrigation purposes. Such streams have far fewer natural habitats for fish, macroinvertebrates, and plants than do naturally meandering streams. Scouring is often associated with channel alteration.

High and Low Gradient:

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
6. Channel Alteration Score	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (>20 yr.) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. In stream habitat greatly altered or removed entirely.

7a Frequency of Riffles (or Bends) - (High Gradient Sheet)

This metric estimates the sequence of riffles and thus the heterogeneity occurring in a stream. Estimate riffle frequency by determining the ratio of distance between riffles divided by the width of the stream. An average of the riffle ratios is determined for biological monitoring reach and the upstream segment. The field crew will estimate this ratio for a minimum of 3 riffle distances. These 3 ratios will be averaged to get the final riffle frequency ratio.

For high gradient streams where distinct riffles are uncommon, a run/bend ratio can be used as a measure of meandering or sinuosity (see 7b).

High Gradient:

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7.Frequency of Riffles (or bends) Score	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.

7b Channel Sinuosity - (Low Gradient Sheet)

This metric characterizes the meandering or sinuosity of the low gradient stream. A high degree of sinuosity provides for diverse habitat and fauna, and the stream is better able to handle surges when water levels in the stream fluctuate as a result of storms. The absorption of this energy by bends protects the stream from excessive erosion and flooding, and provides refugia for benthic invertebrates and fish during storm events.

To gain an appreciation of this parameter in low gradient streams, a longer reach than that designated for sampling may be incorporated into the evaluation (can use accurate aerial imagery if needed). The "sequencing" pattern of the stream morphology is important in rating this parameter. In "oxbow" streams of coastal areas and deltas, meanders are highly exaggerated and transient. Natural conditions in these streams are shifting channels and bends, and alteration is usually in the form of flow regulation and diversion. A stable channel is one that does not exhibit progressive changes in slope, shape or dimensions, although short-term variations may occur during floods (Gordon et al. 1992).

Low Gradient:

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Channel Sinuosity Score	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.	The bends in the stream increase the stream length 2 to 3 times longer than if it was in a straight line.	The bends in the stream increase the stream length 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.

8 Bank Stability (High and Low Gradient Sheets)

This metric estimates whether the stream banks are eroded or have the potential to erode. Steep banks are more likely to collapse and suffer from erosion than are gently sloping banks, and are therefore considered to be unstable. Signs of erosion include crumbling, un-vegetated banks, exposed tree roots, and exposed soil. Eroded banks indicate a problem of sediment movement and deposition, and suggest a scarcity of cover and organic input to streams.

Each bank is scored independently from 10-0. Use the % of bank affected to place the bank stability into one of the four categories. The severity of erosion then can be used to give the bank a score within the determined category.

High and Low Gradient:

Habitat Parameter	Condition Category										
	Optimal		Suboptimal			Marginal			Poor		
Left/Right Bank	10	9	8	7	6	5	4	3	2	1	0
8.Bank Stability LB	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.		Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.			Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.			Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.		
RB											

9 Bank Vegetative Protection (High and Low Gradient Sheets)

This metric estimates the amount of vegetative protection afforded to the stream and the near stream portion of the riparian zone.

Each bank is scored independently from 10-0. Determine what vegetative types (trees, understory shrubs, herbs, and non-woody macrophytes) are present on each bank. This parameter supplies information on the ability of the bank to resist erosion as well as some additional information on the uptake of nutrients by the plants, the control of instream scouring, and stream shading. Those stream banks with diverse vegetation types provide better erosion protection and provide more of a variety of allochthonous food material. Native vegetation scores higher than invasive or non-native vegetation.

High and Low Gradient:

Habitat Parameter	Condition Category										
	Optimal		Suboptimal			Marginal			Poor		
Left/Right Bank	10	9	8	7	6	5	4	3	2	1	0
9. Vegetative Protection LB	More than 90% of the stream bank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.		70-90% of the stream bank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.			50-70% of the stream bank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.			Less than 50% of the stream bank surfaces covered by vegetation; disruption of stream bank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.		
RB											

10 Riparian Vegetative Zone Width (High and Low Gradient Sheets)

This metric estimates the width of the natural vegetation from the edge of the stream bank through the riparian zone. A relatively undisturbed riparian zone supports a robust stream system; narrow riparian zones occur when roads, parking lots, fields, lawns, bare soil, rocks, or buildings are near the stream bank. Conversely, the presence of "old field" (i.e. a previously developed field not currently in use), paths, and walkways in an otherwise undisturbed riparian zone may be judged to be inconsequential to altering the riparian zone and may be given relatively high scores (however, the presence of these elements should be noted on the datasheet). When determining final scores, the age and density of the riparian vegetation should be evaluated. Each bank is scored independently from 10-0.

High and Low Gradient:

Habitat Parameter	Condition Category										
	Optimal		Suboptimal			Marginal			Poor		
Left/Right Bank	10	9	8	7	6	5	4	3	2	1	0
10. Riparian Vegetative Zone Width LB RB	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.		Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.			Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.			Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.		

8.2.17 General and Sediment Notes

If any element of the data collection needs further description, or is insufficient in describing onsite conditions, use this space to provide further details. Also, observations of elements not captured in standard data collection and general impressions of the conditions of the site can be added.

Sediment notes should consider observations of sediment loading and substrate characteristics within the stream channel. Note extensive deposits of sediment or substrate within the stream, areas of obvious erosion or sources of sediment pollution in the area, or obvious scouring and substrate loss. Also note if there are extensive areas of exposed bedrock.

8.3 Habitat Rating Development

Historical reference reach habitat data were used to produce habitat criteria for the bioregions of Kentucky. The scores for all reference reach stations were ranked and divided into percentiles. The lower 10th percentile was considered the dividing line between those habitats fully supporting and those partially supporting biotic integrity. Habitats scoring in the last 10th percentile were identified as partially supporting biotic integrity. Habitats were identified as poor if their habitat score was below the lowest reference condition score for that area. For assessment purposes, habitat scoring criteria were grouped in the same manner as Bioregions (Figure 1).

For the Bluegrass (BG) Bioregion, reference sites were divided into wadeable and headwater based upon drainage area. Those above five square miles were considered wadeable and below five square miles headwater. Headwater streams in this large Ecoregion have a tendency to score higher on certain metrics (i.e. frequency of riffles, bank stability, riparian zone width) than wadeable streams as a result of intensive land use activities (e.g. residential areas, horse farms, etc.). This bias was reflected in final habitat scores. Therefore, separate habitat criteria were developed for wadeable and headwater streams.

Biosurveys conducted within the Pennyroyal (PR) Bioregion use High Gradient Habitat Assessment Datasheets. Streams within this bioregion are characterized by having well-developed macrohabitats (riffle, run, pool). Generally, the habitat assessments in this Ecoregion score higher than other bioregions found in Kentucky, except the Mountains.

Streams sampled within the Mississippi Valley Loess Plains and Interior River Valleys and Hills Ecoregions were generally low gradient streams with very few riffles. These Ecoregions were combined to form the Mississippi Valley-Interior Rivers (MVIR) Bioregion. Low Gradient Habitat Assessment Datasheets were used in these Ecoregions to evaluate the available habitat. Additionally, in low gradient sections of Interior Plateau and mountainous streams, Low Gradient Habitat Assessment Datasheets were used.

Mountainous Ecoregions of the Commonwealth provided similar habitat opportunities for aquatic community colonization and use. Habitat scores from reference sites in the Central Appalachian, Southwestern Appalachian, and Western Allegheny Ecoregions reflected these similarities. Therefore, habitat data from all of these Ecoregions were combined to develop habitat criteria for the Mountains (MT).

The narrative habitat ratings used to determine whether the sampling reach is rated as good, fair, or poor is included in Table 2.

Table 2. Scoring for narrative habitat ratings.

Bioregion	Rating	Area Scoring	
		Headwater (<5.0 mi^2)	Wadeable (>5.0 mi^2)
Bluegrass (BG)	Good	≥ 156	≥ 130
	Fair	142 - 155	114-129
	Poor	≤ 141	≤ 113
Pennyroyal (PR)		Headwater or Wadeable	
	Good	≥ 146	
	Fair	132 - 145	
	Poor	≤ 131	
Mississippi Valley Interior River (MVIR)		Headwater or Wadeable	
	Good	≥ 135	
	Fair	114 - 134	
	Poor	≤ 113	
Mountain (MT)		Headwater or Wadeable	
	Good	≥ 160	
	Fair	117-159	
	Poor	≤ 116	

8.4 Photo documentation

At each biological/habitat station, photographs need to be taken of the sampling zone, upstream of the sampling zone, downstream of the sampling zone, and typical instream habitat for the station.

Typical photos include:

- Upstream and downstream from top of reach
- Upstream and downstream from mid-reach
- Upstream and downstream from bottom of reach
- Typical left and right bank habitat
- Noted features (e.g. significant erosional areas of either bank)
- Substrate at head of riffles, in runs, in pools, and in riffles

9.0 DATA & RECORDS MANAGEMENT

All data collected shall be recorded on either a High or Low Gradient Habitat Assessment Datasheet. Datasheets shall undergo an initial data review for accuracy and completeness (see Section 11.0). Datasheets should be promptly scanned and filed in project folders. Data entry procedures should follow project guidance outlined in project QA documentation. Digital photos should be downloaded to project folders and named according to project QA guidance.

10.0 QUALITY CONTROL & QUALITY ASSURANCE

Each habitat assessment form should be filled out by at least 2 trained field biologists who discuss and come to an agreement on each element of the form in order to control for individual bias.

Upon completion, each datasheet should be reviewed for completeness and accuracy. After this initial data review, the datasheet should be signed (or initialed) and dated in the appropriate location.

In addition, each year for each DOW program conducting Rapid Bioassessment Protocol (RBP) assessments, a randomly selected five percent of samples collected may be duplicated to evaluate precision and repeatability of the technique and the sampling crew. If possible, replicates will be collected by the same biologist(s) within the same index period. Results will be considered acceptable if the same narrative habitat assessment rating is attained. If the narrative habitat assessment rating is not the same between replicate samples, all biologists will meet to assess the issue and take corrective actions, which will be documented with other QA files.

For special studies, any deviation from the procedures in this document will be noted in study documentation approved by DOW biologists prior to sampling.

11.0 REFERENCES

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J. B. Stribling. 1999. *Rapid bioassessment protocols for use in streams and wadeable rivers: periphyton, benthic macroinvertebrates, and fish, second edition*. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water, Washington, D.C.

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APPENDIX A. HIGH GRADIENT HABITAT ASSESSMENT DATASHEET

High Gradient Habitat Assessment Datasheet — Page 1

Station Visit Information

Locale Name:		Project:		Trip:	County:
Station ID:		Loc. Desc.:			Visit Date:
Field Lead:		Primary Bioregion:		Secondary Bioregion:	Visit Start Time:
Team:		Stream Perm.	Eph | Int | Per	Stream Type (HW or WA):	Visit Finish Time:

STATION POINT VERIFICATION

1) K-WADE Target Point	2) Field GPS Location	Nav. to Target Point Within GPS Error?	Target On Correct Stream?	Field GPS Error (M)	3) GPS Final	K-WADE Station Update
Lat:					K-WADE | Field	Staff:
Long:		Y | N	Y | N			Date:

WEATHER

Scouring Rain In Last 14 Days? YN — Y | N

Now:	HR	SR	IS
Circle 1	CS	CO	SSH
Past 24hr:	HR	SR	IS
	CS	CO	SSH

Stream Shading		STREAM FLOW Circle 1	INSTREAM FEATURES		RIFFLE/RUN/POOL SEQ.	
Leafed Out? Y/N	Y | N	Dry | Pooled | Low Seasonal Normal Above Normal | Flood	Avgerage Wetted Width (m):		# of riffles in reach	
General Shading Circle 1	Full | Partial | None		Maximum Depth (m):		# of runs in reach	
			Reach Length (m):		# of pools in reach	

LOCAL WATERSHED FEATURES (Major Land Use): (Check all that are present)

Surface Mining		Construction		Pasture/Grazing	
Deep Mining		Commercial		Silviculture	
Oil Wells		Industrial		Urban Runoff	
Land Disposal		Row Crops		Storm Sewers	
Residential		Forest		Permitted Outfalls	

CHANNEL ALTERATIONS- Full, Partial or Not/None

Dredging: F | P | N — Channelization: F | P | N

RIPARIAN VEGETATION

Dom. Veg. Type: Herbs | Grasses | Shrubs | Trees — # of Strata:

Dom. Taxa:

HYDRAULIC STRUCTURES (Check all that are present)

Dams:		Bridge Abutments:		Fords:		Islands:		Waterfalls:		Berms:	

FIELD METER DATA

Temp (°C):		DO (mg/l):		DO %Sat:		pH (SU):		Sp. Cond (µS/cm):		Discharge CFS | Uncert.		

FIELD ACTIVITIES

Activity Completed?		Collectors	Collection Information (Check all that apply and/or enter/circle necessary information)					
Algae:			QualMHC:		Visual Form:		R4MULTI:	Other:
Fish:			Equip.:	BPEF | Seine | Barge	EF Seconds:		Seine Minutes:	
Habitat:			Habitat data other than RBP?					
Invertebrate:			1m² riffle + MH:		MACS 20-Jab:		Other:	
Multihabs Sampled Y/N or # Jabs		Undercuts/Roots: | Sticks/Wood: | Leaf Packs: | *Justicia* : | Aufwuchs: | Edge: Bedrock/Slab: | Depositional: | Rock Pick: | Em. Veg.: | Wood Pick: | Other:						
Chemistry:			H_2SO_4 Lot #:				HNO_3 Lot #:	
Multi-Probe:			Inst. ID:				Cal. Date:	
Discharge:			Inst. ID:				Beam Check:	
Other:			Other Desc:					

SUBSTRATE CHARACTERIZATION

Substrate Category	% Riffle:	% Run:	% Pool:	Reach Total
Silt/Clay (<0.06 mm)				
Sand (0.06 – 2 mm)				
Gravel (2-64 mm)				
Cobble (64 – 256 mm)				
Boulders (>256 mm)				
Bedrock/Hardpan Clay				

Site Not Sampled (Reason)- Please Add Comments

Land Owner Denial
Too Deep/Impounded
Site Not Found
Unsafe
Dry
Other (See Comments)

Reach Location Description:

Weather Choices: HR = Heavy Rain | SR = Steady Rain | IS = Intermittent Showers | CS = Clear Sunny | CO = Cloudy Overcast | SSH = Snow Sleet

Initial Data Review By:		Initial Data Review Date:		Date Entered:	

High Gradient Habitat Assessment Datasheet

Page 2

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
1.Epifaunal Substrate/ Available Cover Score	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not now fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
2.Embeddedness Score	Gravel, cobble, boulder, and bedrock are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, boulder and bedrock are 25-50% surrounded by fine sediment.	Gravel, cobble, boulder, and bedrock are 50-75% surrounded by fine sediment.	Gravel, cobble, boulder, and bedrock are more than 75% surrounded by fine sediment.
3.Velocity/ Depth Regime Score	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
4. Sediment Deposition Score	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
5.Channel Flow Status Score	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
6.Channel Alteration Score	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr.) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
7.Frequency of Riffles (or bends) Score	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
Left/Right Bank	10 9	8 7 6	5 4 3	2 1 0
8.Bank Stability LB RB	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
9. Vegetative Protection LB RB	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
10. Riparian Vegetative Zone Width LB RB	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.

Total Score

Notes/Comments:

General Notes:

Sediment Notes:

APPENDIX B. LOW GRADIENT HABITAT ASSESSMENT DATASHEET

Low Gradient Habitat Assessment DataSheet Page 1

Station Visit Information

Locale Name:		Project:		Trip:	County:
Station ID:		Loc. Desc.:			Visit Date:
Field Lead:		Primary Bioregion:		Secondary Bioregion:	Visit Start Time:
Team:		Stream Perm.	Eph | Int | Per	Stream Type (HW or WA):	Visit Finish Time:

STATION POINT VERIFICATION

1) K-WADE Target Point	2) Field GPS Location	Nav. to Target Point Within GPS Error?	Target On Correct Stream?	Field GPS Error (M)	3) GPS Final	K-WADE Station Update
Lat:					K-WADE Field	Staff:
Long:		Y | N	Y | N			Date:

WEATHER

Scouring Rain In Last 14 Days? YN Y | N

Now: Circle 1 HR | SR | IS CS | CO | SSH

Past 24hr: HR | SR | IS CS | CO | SSH

CANOPY COVER	STREAM FLOW Circle 1	INSTREAM FEATURES	RIFFLE/RUN/POOL SEQ.
Leafed Out? Y/N Y | N	Dry | Pooled | Low	Avgerage Wetted Width (m):	# of riffles in reach
General Shading Circle 1 Full | Partial | None	Seasonal Normal	Maximum Depth (m):	# of runs in reach
	Above Normal | Flood	Reach Length (m):	# of pools in reach

LOCAL WATERSHED FEATURES (Major Land Use): (Check all that are present)

Surface Mining		Construction		Pasture/Grazing			
Deep Mining		Commercial		Silviculture			
Oil Wells		Industrial		Urban Runoff			
Land Disposal		Row Crops		Storm Sewers			
Residential		Forest		Permitted Outfalls			

CHANNEL ALTERATIONS- Full, Partial or Not/None

Dredging: F | P | N Channelization: F | P | N

RIPARIAN VEGETATION

Dom. Veg. Type: Herbs | Grasses Shrubs | Trees # of Strata:

Dom. Taxa:

HYDRAULIC STRUCTURES (Check all that are present)

Dams:		Bridge Abutments:		Fords:		Islands:		Waterfalls:		Berms:	

FIELD METER DATA

Temp (°C):		DO (mg/l):		DO %Sat:		pH (SU):		Sp. Cond (µS/cm):		Discharge CFS | Uncert.		

FIELD ACTIVITIES

Activity Completed?		Collectors	Collection Information (Check all that apply and/or enter/circle necessary information)					
Algae:			QualMHC:		Visual Form:		R4MULTI:	Other:
Fish:			Equip.:	BPEF | Seine | Barge		EF Seconds:	Seine Minutes:
Habitat:			Habitat data other than RBP?					
Invertebrate:			1m² riffle + MH:		MACS 20-Jab:		Other:	
Multihabs Sampled Y/N or # Jabs		Undercuts/Roots: | Snags/Woody Debris: | Leaf Packs: | Edge Habitat: | Other: Cobble/Gravel: | Silt/Sand/Fine Gravel: | Wood Pick: | Emergent Veg.: | Other:						
Chemistry:			H_2SO_4 Lot #:				HNO_3 Lot #:	
Multi-Probe:			Inst. ID:				Cal. Date:	
Discharge:			Inst. ID:				Beam Check:	
Other:			Other Desc:					

SUBSTRATE CHARACTERIZATION

Substrate Category	% Riffle:	% Run:	% Pool:	Reach Total
Silt/Clay (<0.06 mm)				
Sand (0.06 – 2 mm)				
Gravel (2-64 mm)				
Cobble (64 – 256 mm)				
Boulders (>256 mm)				
Bedrock/Hardpan Clay				

Site Not Sampled (Reason)- Please Add Comments

Land Owner Denial
Too Deep/Impounded
Site Not Found
Unsafe
Dry
Other (See Comments)

Reach Loc. Description:

Weather Choices: HR = Heavy Rain | SR = Steady Rain | IS = Intermittent Showers | CS = Clear Sunny CO = Cloudy Overcast | SSH = Snow Sleet Hail

Initial Data Review By:		Initial Data Review Date:		Date Entered:	

Low Gradient Habitat Assessment Datasheet

Page 2

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
1. Epifaunal Substrate/ Available Cover Score	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new and transient).	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
2. Pool Substrate Characterization Score	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
4. Sediment Deposition Score	Little or no enlargement of islands or point bars and less than 20% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 20-50% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 50-80% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
5. Channel Flow Status Score	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
6. Channel Alteration Score	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (>20 yr.) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. In stream habitat greatly altered or removed entirely.
7. Channel Sinuosity Score	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.	The bends in the stream increase the stream length 2 to 3 times longer than if it was in a straight line.	The bends in the stream increase the stream length 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.
Left/Right Bank	10 9	8 7 6	5 4 3	2 1 0
8. Bank Stability LB RB	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
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