West Virginia Department of Environmental Protection
Division of Water and Waste Management
Watershed Branch

Establishing Reference Conditions

Reference conditions represent the characteristics of stream reaches that are least disturbed by human activities and are used to define attainable chemical, biological and habitat conditions for a region. The development of reference conditions is a key component of environmental impact evaluations. In most West Virginia streams, historic data were not collected prior to human disturbances and activities. Therefore, a logical method of determining the health of streams is to compare them to established reference conditions.

A considerable amount of time is invested each year in the process of selecting candidate reference sites, conducting field assessments on them, analyzing resultant data, and elevating them to full reference site status. This includes time spent to maintain the reference site database and improve methodologies used to identify them. The following outline provides the procedures used by WVDEP to establish reference sites.

Selecting Candidate Reference Sites

Candidate reference sites are selected by examining past assessment data (if available), consulting with regional professionals of various agencies and entities that have knowledge of their local streams, and by examining landuse data from various map sources (primarily USGS 7.5-min. topographic maps) and GIS coverages. A customized GIS program called "WCMS" (Watershed Characterization Modeling System) is utilized to determine if a particular stream assessment site has the potential to be a reference site. This includes examining land use coverages for past and present disturbances and activities such as mining, urbanization, agriculture, NPDES permits, impoundments, proportion of forested land, etc. Digital Orthophoto Quadrangles (Color Infrared aerial photo mosaics) are also examined as part of the initial step in the selection process. In general, if the drainage area above the candidate site has minimal disturbances and human activities the site may be considered a candidate. There are no stringent rules for percent forestland, agriculture, urban, etc., land uses. However, preference is given to sites with minimal agriculture and urban land cover.

Because most reference sites currently in WVDEP's database are on first and second order streams, a concerted effort should be made to select some candidates on streams with larger watershed areas. It may be necessary to relax reference criteria to accommodate these larger streams since the potential for anthropogenic disturbance generally increases as stream size increases.

Establishing reference sites throughout all regions of West Virginia can be difficult. For example, few relatively undisturbed streams exist in the Western Allegheny Plateau section of the state. Conversely, the Ridge and Valley section has many relatively undisturbed streams located mostly in the mountains of the Monongahela National Forest. Therefore, the term "least disturbed" might describe more accurately the reference conditions in the Western Allegheny Plateau. Similar to selecting candidates on streams larger than first and second order, it may be necessary to relax reference criteria to accommodate least disturbed sites in regions where it is deemed necessary.

In order to address large streams and areas where reference sites are difficult to identify, WVDEP established a second level of reference condition (Level II). While Level I reference sites meet all reference site criteria described below, Level II reference sites fail to meet one or more of them by a narrow margin. For example, Level II reference sites may be deficient in one RBP habitat parameter. Level III reference site designations are generally reserved for rivers and large streams, primarily those with watershed areas exceeding 60 square miles. Level III reference sites generally meet RBP habitat and water quality criteria at the assessment site, but because of

their size generally have point source discharges within their drainage or more land development and human disturbances than would be allowed for smaller streams designated as Level I or Level II. Level III reference sites are generally located in least disturbed segments of rivers and streams where local and upstream disturbances are minimized or distant to the site. It should be noted that best professional judgment by experienced personnel is an important part of the initial and final selection of Level I, Level II, and Level III reference sites.

Although selecting candidate reference sites a priori is the primary means of establishing reference conditions, a considerable number of sites meeting reference criteria are drawn from a pool of probabilistic sites. Additionally, reference sites can be found among targeted sites that were previously not assessed by WVDEP. Both probabilistic sites and targeted sites must meet the criteria established for candidate sites.

Elevating Candidate Sites to Reference Site Status

Following field assessments by WVDEP personnel, all chemical, habitat, biological, and reconnaissance information for each site is entered into an Access database. Each site is then evaluated to see if it meets reference site criteria. If all of the criteria are met, the site is given Level I reference site status.

1. No known significant point source discharges upstream of assessment site (i.e., NPDES)

2. Filed evaluation of anthropogenic activities and disturbances at the assessment site by trained biologists and environmental resource specialists

3. No obvious sources of NPS near assessment site

4. Primary WQ criteria:

   a.D.O. $\geq$ 5.0 mg/l

   b. pH between 6.0 and 9.0 Std.Units

6. Secondary WQ criteria: (**used as flag values - see below for description)*

   a. Conductivity < 500 µmhos/cm

   b. fecal coliform bacteria < 800 colonies/100 ml

5. No known violations of state water quality criteria (i.e., metals)**

6. U.S. EPA-RBP habitat metric scores:

   $\geq$ 11 (lowest score possible for sub-optimal rating) for following:

   (a) epifaunal substrate
   (b) channel alteration
   (c) sediment deposition

   $\geq$ 6 (lowest score possible for marginal rating) for following:

   (a) bank vegetative protection (right bank $\geq$ 6 & left bank $\geq$ 6)
   (b) riparian vegetative zone width (right bank $\geq$ 6 & left bank $\geq$ 6)

   $\geq$ 130 (mid-suboptimal score) for following:

   (a) total RBP habitat score

Explanation of Criteria

1. *Point source discharges* - Because reference sites presumably represent least disturbed conditions, significant point source discharges (NPDES) located upstream of an assessment site generally disqualify it from becoming a reference site. WCMS and other GIS coverages provide easy access to the locations of many permitted point sources. However, extra effort is taken in the field to ensure that point sources do not exist above the site. Point source discharges may be acceptable for Level II reference site designations depending on the type, volume of discharge, and proximity to the assessment site. For example, a home aeration unit located in the headwaters of a stream may not exclude an assessment site near the mouth of the stream from becoming a Level II reference site.

2. *Anthropogenic disturbances* within the stream assessment area are evaluated visually. Best professional judgement is employed to make reference site inclusions based on the number and type of disturbance(s). For example, a surface mine site would generally be considered a greater disturbance than an ATV trail and small road combined and could exclude the site from reference condition consideration. However, impacts from the ATV trail and/or road may be considered so minor that they do not exclude the site from reference consideration. This may be a case where best professional judgment dictates that the site be designated as a Level II reference site instead of a Level I site. The information gathered in the field on anthropogenic disturbance helps validate the GIS coverages used to select the candidate sites.

3. *NPS* - Obvious sources of NPS are documented within the assessment area. If sources of NPS are documented for areas above the assessment site, they are also considered. Livestock feedlots, parking lots, and road runoff are common sources of NPS. Best professional judgment is employed to make reference site inclusions (Level I or Level II) based on the type and intensity of the NPS. For example, a livestock feedlot with direct drainage to the stream would likely exclude the site from reference consideration. In contrast, a small road drain may not be significant enough to exclude a site from consideration.

4. *Primary WQ criteria*:

   a. D.O. $\geq$ 5.0 mg/l - The criterion for dissolved oxygen was taken from “WV Water Quality Standards” as developed by the State Water Resources Board (SWRB).

   b. pH between 6.0 and 9.0 Std.Units - The criterion for pH was taken from “WV Water Quality Standards” as developed by the State Water Resources Board (SWRB).

5. *Secondary WQ criteria: (used as flag values)*

   a. Conductivity < 500 µmhos/cm – Criterion for conductivity was established from analysis of WVDEP data and from best professional judgment of several experienced field employees. A value greater than 500 may indicate the presence of dissolved ions (such as sulfate, chlorides, and metals) exceeding the background levels for the area. It is important to note that a full water quality analysis that includes all possible chemical constituents is not within the resource pool of the program. Consequently, the conductivity reading of a site can be used as a means of flagging the site for further investigation before it can be considered a reference site. ** Region specific criteria for conductivity are currently being developed to address natural differences in ambient conductivity. This may result in having lower or higher conductivity thresholds based on ecoregion, watershed (8 digit HUC), etc. Currently, best

professional judgment is used when conductivity is conspicuously higher than expected for the region.

b. Fecal coliform bacteria < 800 colonies/100 ml - The fecal coliform value of 800 colonies/100ml is double the maximum set by the WV Environmental Quality Board (WV EQB) which states that fecal coliform shall not exceed 400/100ml in more than 10 percent of all samples taken during the month. This value was raised to 800/100ml for reference criteria due to the lengthy holding times of fecal samples (24 hours in many cases). Additionally, experienced field personnel have encountered fecal coliform bacteria counts exceeding the standard in streams where no human impacts were known. Thus, a value of 800/100ml would decrease the possibility of excluding some undisturbed (anthropogenically) streams from reference consideration. Similar to the criterion for conductivity, fecal coliform bacteria can be used as a means of flagging the site for further investigation before it can be considered a reference site.

7. *No known violations of state water quality standards* – If there is a violation of a water quality criterion standard as established by the (WV EQB), the site is eliminated from reference site consideration. ***This does not include fecal coliform bacteria as described above. Because of their toxicity, metals are the primary consideration when evaluating data for violations.

8. *RBP habitat metric scores*: The habitat criteria below are adapted from the US EPA-RBP habitat assessment procedures. These criteria were selected because they are considered most indicative of anthropogenic disturbance.

   ≥ 11 (lowest score possible for sub-optimal rating) for following:

   (d) epifaunal substrate
   (e) channel alteration
   (f) sediment deposition

   ≥ 6 (lowest score possible for marginal rating) for following:

   (c) bank vegetative protection (right bank & left bank scored separately)
   (d) riparian vegetative zone width (right bank & left bank scored separately)

   ≥ 130 (mid-suboptimal score) for following:

   (a) total habitat score

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