PART III:
STREAM BIOLOGICAL MONITORING PROGRAM
QUALITY ASSURANCE MANAGEMENT PLAN

Revision 5
01/31/2020
SIGNATURES AND APPROVALS

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Section 1

INTRODUCTION

1.1 Purpose of Document

This document presents the quality assurance (QA) management plan for the Kansas Stream Biological Monitoring Program. Quality assurance goals, expectations, responsibilities, and program evaluation and reporting requirements are specifically addressed. Standard operating procedures (SOPs) for the collection, preservation, examination and archival of biological specimens and the gathering of ancillary field data are provided in the appendices of the plan.

1.2 Basic Principles

Freshwater macroinvertebrate communities, consisting of insects, crustaceans, mollusks, annelids and other organisms that lack a true backbone and are observable with the unaided eye, have long been recognized as excellent indicators of water quality (Gaufin 1973; Weber 1973; Patrick 1977; Dance and Hynes 1980; Reger and Kevern 1981; Wynes and Wissing 1981; Whiting and Clifford 1983; Pederson and Perkins 1986; Taylor and Roff 1986; Plafkin et al. 1989; Rosenberg and Resh 1993; Davis and Simon 1994; Loeb and Spacie 1994; Merrit and Cummins 1996; Karr and Chu 1999). Utilization of macroinvertebrate communities in water quality assessments offers several advantages over the use of other aquatic organisms or reliance on physicochemical measurements alone:

1. Collection of macroinvertebrate specimens requires little specialized equipment and entails a relatively small commitment of staff and other resources.

2. Macroinvertebrate species differ in their physiological tolerances to contaminant exposure. A knowledge of the taxa comprising a macroinvertebrate community, coupled with an understanding of the tolerances of individual taxa, provides a highly discriminatory assessment tool.

3. Many aquatic macroinvertebrates live for several months or years and almost all spend the majority of their lives in the water. Hence, macroinvertebrate communities provide an integrated measure of water quality over a relatively long period of time.

4. Although movement of certain types of macroinvertebrates does occur, primarily in the form of drift, long-term import and export rates are generally similar and the continuity of the community is normally maintained (Bird and Hynes 1981; O'Hop and Wallace 1983). Relative to the more mobile organisms, such as fish, macroinvertebrates tend to provide a clearer indication of prevailing water quality conditions within a given stream reach (Rosenberg and Resh 1993).
(5) Most macroinvertebrate communities contain herbivorous, carnivorous and detritivorous species (Merritt and Cummins 1996). Changes in the relative abundance of these feeding groups may be used as an indicator of the effect of water pollution on trophic relationships (food web interactions) among species.

Ongoing pollution problems, whether continuous or intermittent in nature, tend to reduce in abundance the more pollution intolerant species. Conversely, tolerant forms often achieve unusually high densities due to reduced interspecific competition for food, elimination of predators, and other factors. The predictable community-level response to environmental pollution is, therefore, an increase in the abundance of tolerant taxa and, at higher pollutant loadings, a measurable decrease in species richness (Hynes 1960). Where macroinvertebrate sampling is used in conjunction with physicochemical monitoring activities (see Kansas stream chemistry monitoring program QA management plan), the ability to detect ongoing water quality problems is greatly enhanced, even at low biological sampling frequencies.

1.3 Historical Overview of Program

1.3.1 Development of Monitoring Network and Sampling Protocols

The Stream Biological Monitoring Program (SBMP) was initiated by the Kansas Department of Health (later reorganized into the Department of Health and Environment or KDHE) in April 1972. Approximately 33 stream stations, located at widely scattered locations across the state, were included in the original monitoring network. The initial goals of the program were to document long-term trends in surface water quality and to supplement site-specific information then being gathered through other departmental monitoring efforts (e.g., intensive river basin surveys).

During the first six years of the program, field protocols entailed a combination of qualitative and quantitative sampling techniques at all stream monitoring stations. Qualitative methods included the collection of macroinvertebrate specimens from all accessible microhabitats using D-frame nets and other simple apparatus. Quantitative methods, focusing on the density of macroinvertebrate populations, varied depending on the predominate substrate type. A Surber sampler generally was used on coarse sediments such as cobble and gravel, whereas a petite Ponar dredge was used on finer sediments such as sand and silt. These tools were not well suited to the sampling of woody debris, tree roots, emergent aquatic vegetation, or other nonhomogeneous surfaces, even though such habitats accounted for much of the macroinvertebrate abundance and diversity in many Kansas streams. Hence, early quantitative measures of macroinvertebrate abundance and diversity employed by the agency tended to underestimate the actual size and complexity of stream biological communities.

In 1978, the monitoring program adopted a revised protocol for the collection of macroinvertebrate samples (Appendix B). This new protocol was a time-based "equal effort" quantitative technique. It measured the number of specimens collected in a prescribed (one person-hour) time frame using D-frame nets and other tools previously associated with strictly qualitative sampling activities.
Emphasis on the number and kinds of specimens collected per unit time (rather than on aerial or volumetric estimates of macroinvertebrate density predicated on the use of Surber samplers and Ponar dredges) permitted the examination of essentially all types of stream habitat. The revised protocol proved to be less resource intensive and produced a more consistent measure of macroinvertebrate abundance and diversity. Similar protocols were eventually endorsed by the United States Environmental Protection Agency (EPA) and applied within the water quality assessment programs of several other states (see Rapid Bioassessment Protocol III in Plafkin et al. 1989). In 1990, field staff also began to routinely record observations of any living unionid mussels encountered at stream biological monitoring sites, whether or not these organisms were actually included in the quantitative samples. Staff also began to make representative collections of any encountered (freshly dead, weathered or relict) shell materials to provide an indication of any recent or historical changes in the composition of the unionid mussel community (Appendix B).

During the period 1994-1996, samples were obtained from six relatively unpolluted locations or "reference sites" on a quarterly schedule and from one potential reference site on a monthly basis. During the period 1999-2004, additional reference sites were added to the monitoring network. Data from reference sites are utilized to calibrate diagnostic macroinvertebrate metrics. Diagnostic metrics are usually based on the types (diversity), numbers (abundance), and tolerance of organisms to pollution and habitat degradation. Diagnostic metrics form the basis of indices of biological condition or biotic integrity which are used to express the ecological condition or health of a sampled stream reach.

From 1984 to 2006, as climatic conditions permitted, most monitoring activities at long-term stations adhered to a seasonal rotational schedule to reduce statistical bias and provide a more comprehensive picture of the resident macroinvertebrate communities; i.e., samples from a given site were collected during the spring of one year, the summer of the next, and the fall of the next, a cycle that was repeated every three years. By 2006 adherence to the seasonal rotation of sites had become impractical due to increased workloads related to special studies and an expanding Fish Tissue Contaminant Monitoring Program (FTCMP) activities. For the FTCMP shares the same two program staff as the SBMP. Since 2006 sampling efforts have been conducted primarily as climatic and stream flow conditions allow, with the objective to collect most samples during summer base flow conditions to minimize seasonal effects on the data.

Although macroinvertebrate sampling activities at many of the original SBMP monitoring stations were eventually discontinued, new sites were continually added to the network (see Figures 1.3.1-1 and 1.3.1-2). As of 2018 the program has collected 2,263 macroinvertebrate samples and visited 222 monitoring sites. The resulting macroinvertebrate database that contains 80,097 predominantly genus/species level records (545,974 individual organisms). A reference collection containing representative specimens of 835 macroinvertebrate taxa has also been assembled. Program data are currently primarily utilized by the Bureau of Water for the development of TMDL’s (Total Maximum Daily Loads), NPDES (National Pollutant Discharge Elimination System) permitting, and Clean Water Act sections 303(d) and 305(b) reporting requirements.
1.3.2 Development of Taxonomic Capabilities

The past four decades witnessed a dramatic improvement in science's understanding of the North American and regional macroinvertebrate faunas. Several comprehensive taxonomic works, new and revised, were published during this period (Appendix D). In Kansas, the basic composition of the state's macroinvertebrate fauna was elucidated by the Kansas Biological Survey (KBS), and a number of taxonomic keys were developed for the more common families, genera and species of aquatic insects (Appendix D). These developments allowed personnel of the Stream Biological Monitoring Program to more accurately monitor the composition of macroinvertebrate communities within the state and, therefore, to apply more sophisticated statistical techniques in the evaluation of surface water quality (see section 1.3.3, below). Although the program's taxonomic capabilities developed in a generally continuous and cumulative manner, the chronology of this developmental process involved at least three discernable phases:

(1) 1972-1978 - Most macroinvertebrate specimens collected from 1972 to 1976 were identifiable only to the taxonomic level of order or family. From 1977 to 1978, an increasing number of taxonomic assignments were made at the generic level. Collection methodologies during this period did not yield samples of high diversity, and only the most abundant taxa were consistently collected. The systematics of certain major groups (e.g., annelids and midges) was poorly developed at this time. In general, the available taxonomic literature and limited knowledge of the regional fauna did not permit greater resolution of macroinvertebrate assemblages. The principal taxonomic keys in use during this period were: "Freshwater Invertebrates of the United States" (Pennak 1953); "Aquatic Insects of California" (Usinger 1956); and "Freshwater Biology" (Edmondson 1959).

(2) 1979-1982 - A reference collection of macroinvertebrate specimens was started by the department in 1979 and grew rapidly over the next several years. Many of these reference specimens were identified or independently verified by experts at KBS. Several important taxonomic keys were published during this period, and many additional faunal groups were identifiable at the generic or species level (Table 1.3.2-1). Indeed, virtually all members of the dragonfly suborder Anisoptera, the caddisfly family Hydropsychidae, the beetle family Elmidae, and the mayfly genus Stenonema were identifiable to species. Only a few difficult or obscure faunal groups (e.g., annelids) continued to receive taxonomic assignments at the order or familial level.
Figure 1.3.1-1. Historical distribution of inactive stream biological monitoring stations.

Figure 1.3.1-2. Current distribution of routine and reference stream biological monitoring stations.
### TABLE 1.3.2-1
PRINCIPAL TAXONOMIC REFERENCES USED FROM 1979 TO 1982

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<th>Literature for Specific Taxonomic Groups</th>
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<tr>
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<td>Turbellaria (Kenk 1972)</td>
</tr>
<tr>
<td>“Aquatic Insects of Wisconsin”</td>
<td>Hirudinea (Klemm 1972, Klemm 1982)</td>
</tr>
<tr>
<td>“Aquatic Insects of North America”</td>
<td>Oligochaeta (Hiltunen and Klemm 1980)</td>
</tr>
<tr>
<td>“Freshwater Invertebrates of the United States”</td>
<td>Tubificidae (Stimpson et al. 1982)</td>
</tr>
<tr>
<td></td>
<td>Bivalvia (Murray and Leonard 1962; Burch 1972, 1973)</td>
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<tr>
<td></td>
<td>Gastropoda (Leonard 1959; Burch 1982)</td>
</tr>
<tr>
<td></td>
<td>Crustacea (Hobbs 1972; Holsinger 1972)</td>
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<td></td>
<td>Isopoda (Williams 1972)</td>
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<tr>
<td></td>
<td>Coleoptera (Brown 1977)</td>
</tr>
<tr>
<td></td>
<td>Diptera (Mason 1973; Beck 1976)</td>
</tr>
<tr>
<td></td>
<td>Ephemeroptera (Burks 1953; Lewis 1974; Bednarik and McCafferty 1979)</td>
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<tr>
<td></td>
<td>Hemiptera (Hungerford 1954)</td>
</tr>
<tr>
<td></td>
<td>Odonata (Needham and Westfall 1954; Cannings 1981)</td>
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<tr>
<td></td>
<td>Plecoptera (Stark and Gaufin 1976)</td>
</tr>
<tr>
<td></td>
<td>Trichoptera (Schuster and Etnier 1978)</td>
</tr>
</tbody>
</table>

(3) 1983-present - The accuracy of taxonomic determinations continued to improve during this period due to the increasing experience of program personnel and the availability of many additional reference specimens. The growth in the reference collection reflected, in part, a desire to document intraspecific variations in anatomical form, such as occur among life stages or disjunct populations. Significant advances were made in the identification of members of the family Chironomidae, a large group of great diagnostic importance; these advances reflected the availability of improved taxonomic keys and the participation of program staff in identification workshops hosted by KBS or other institutions. Most remaining insect groups were identifiable to the species level during all or part of this period owing to the publication of several major works on the taxonomy
of the larval life stages (Table 1.3.2-2). The distribution of many aquatic macroinvertebrate species in Kansas was also well documented through the efforts of KBS and other researchers. This knowledge proved extremely useful in discriminating between polluted and relatively unpolluted streams.

Continual efforts are made by program staff performing taxonomic determinations to research the latest literature related to taxonomy and/or distribution of the organisms encountered during program sampling events. Taxonomic nomenclature and hierarchal classification of the organisms included in the program’s macroinvertebrate, fish, and mussel databases are standardized to the Integrated Taxonomic Information System (ITIS). ITIS was constructed as a result of a 1996 partnership between various federal agencies to ensure scientifically credible (valid) taxonomic information on species names and hierarchal classification. Most government and non-government entities performing taxonomic determinations utilize ITIS in order to standardize the use of scientific names. SBMP staff often utilize the ITIS web site (http://www.itis.gov/info.html) to check the validity and/or hierarchal status of a scientific name, particularly when revisions have been proposed for a taxon or group of taxa.
### TABLE 1.3.2-2
PRINCIPAL TAXONOMIC REFERENCES USED FROM 1983 TO PRESENT

| Comprehensive Taxonomic Literature |  |
|------------------------------------|  |
| “Freshwater Invertebrates of the United States” | (Pennak 1978, 1989; Smith 2001) |
| “Guide to the Freshwater Invertebrates of the Midwest” | (Huggins et al. 1981) |
| “Aquatic Insects and Oligochaetes of North and South Carolina” | (Brigham et al. 1982) |
| “Aquatic Insects of Wisconsin” | (Hilsenhoff 1982) |
| “Aquatic Insects of North America” | (Merrit, Cummins, Berg 2008) |
| “Aquatic Entomology” | (McCafferty 1998) |
| “Thorp and Covich’s Freshwater Invertebrates” | (Thorp and Rogers 2016) |

| Literature for Specific Taxonomic Groups |  |
|-----------------------------------------|  |
| Turbellaria (Kenk 1972) |  |
| Hirudinea (Klemm 1982) |  |
| Clitellata (Kathman and Brinkhurst 1998; Wetzel et al. 2009) |  |
| Gastropoda (Leonard 1959; Burch 1982; Wu et al. 1997) |  |
| Isopoda (Williams 1972) |  |
| Diptera (Ferrington 1983; Fittkau and Roback 1983; Epler 2001; Boesel 1985; Roback 1985; Gelhaus 1986; Grodhaus 1987; Andersen, Cranston, & Epler 2013) |  |
| Ephemeroptera (Burks 1953; Lewis 1974; Edmund et al. 1976; Bednarik and McCafferty 1979) |  |
| Hemiptera (Hungerford 1954; Bennett and Cook 1981) |  |
| Plecoptera (Stark and Gaufin 1976; Stewart and Stark 1984; Zwick 1984; Huggins 1987) |  |
1.3.3 Development of Statistical Indicators

Prior to 1983, departmental efforts to evaluate water quality through the statistical examination of aquatic macroinvertebrate data were hampered by an inability to identify most specimens to the level of genus or species. Although Shannon-Wiener diversity, species evenness, and other indices were sometimes used in an attempt to measure the impacts of water pollution on stream biological communities, taxonomic constraints generally confounded such efforts. Most biological assessments of water quality during this period were instead based on the presence or absence of insect orders and families historically associated with unpolluted aquatic habitats (e.g., Ephemeroptera, Plecoptera, Trichoptera, Elmidae).

In 1984, the department began to analyze stream biological data using the macroinvertebrate biotic index or "MBI" (Davenport and Kelly 1983). This statistical measure evaluated the effects of nutrients and oxygen demanding pollutants on macroinvertebrate communities based on the relative abundance of certain indicator taxa (orders and families). Additional measures or "metrics" that were routinely utilized by this time included the Ephemeroptera-Plecoptera-Trichoptera (EPT) index and total taxa (for discussion, see Plafkin et al. 1989). Like the MBI, these metrics facilitated quantitative comparisons of water quality over time and between monitoring stations.

In 1985, under a contractual agreement with the Kansas Department of Health and Environment, KBS initiated a detailed evaluation of many of the biotic indices published up to that time in an effort to identify the index best suited to aquatic macroinvertebrate communities and stream conditions in Kansas. The results of this evaluation were published three years later (Huggins and Moffett 1988) and pointed to the Chutter index (and the mathematically equivalent Hilsenhoff index) as the most desirable metric for use in Kansas (see Chutter 1972; Hilsenhoff 1977, 1982, 1987). The published report also presented preliminary pollution tolerance scores for all genera and species of aquatic insects then known to occur in the state. Individual scores, ranging from zero (least tolerant) to five (most tolerant) were proposed for six different pollution categories, including nutrients and oxygen demanding substances, agricultural pesticides, heavy metals, persistent organic compounds, salinity, and suspended solids and sediments. The KBS report also proposed a new metric for measuring the capacity of streams to support diverse macroinvertebrate communities in the absence of water pollution problems. Designated the habitat development index or "HDI", this new metric provided a potential means of accounting for the possible effects of habitat differences on biotic index values and other metrics.

In 2001, a "percent mussel taxa loss" metric was developed by KDHE and subsequently applied in the 2002 and later Kansas water quality assessments (i.e., 305 (b) reports). Application of this metric was limited to sites where (a) at least three mussel surveys had been conducted over the past decade and (b) cumulative mussel species richness was five or greater. Sites were rated by this metric as fully supporting of aquatic life support if fewer than three mussel taxa or less than
ten percent of the historically occurring species had been lost. The latter determination involved comparisons between the contemporary mussel communities and historical assemblages reconstructed from published reports, museum collections and/or weathered and relict shell materials recovered by monitoring program personnel (see SOP SBMP-003b). Metrics that were routinely employed for diagnostic purposes included MBI, KBI-N (nutrients and oxygen demanding pollutants), EPT index, EPT taxa as a percentage of total taxa, EPT expressed as a percentage of total abundance, total taxa, percent mussel taxa loss and HDI.

In 2011 an effort was initiated by the program to develop a new habitat index that could better correlate instream habitat with macroinvertebrate data than with the HDI. The effort culminated in the “Stream Macroinvertebrate Assessment Sampled Habitat Index” (SMASH Index, Form APP. C-1) using a similar conceptual and scoring framework as the HDI, i.e. only the habitat features sampled for macroinvertebrates are recorded and scored. The new index was field tested and refined during the 2011 and 2012 field seasons. The index was formally adopted during the 2013 season. Incorporated into the index form (backside of Form APP. C-1), were sections for recording site information, field notes, site sketches, and the results of freshwater mussel surveys, which eliminated the need for separate forms.

Between 1990 to year 2012 routine biological site assessments were made using various biotic condition indicator metrics. The analytic process involved calculating the five-year 75th percentile for metrics whose values increase with decreasing environmental quality (e.g. MBI and KBI), and 25th percentile for metrics whose values decrease with decreasing environmental quality (e.g. EPT Index). The percentiles were compared to a reference table containing value ranges representing three levels of aquatic life use support (ALUS) classified as “non”, “partial”, and “full.” Final determinations of monitoring station ALUS status were made using best professional judgment, which involved considerations of metric-determined support levels (especially when metrics disagreed or were near break point thresholds), data trends, adequacy of data, and historical use support levels. However, as the program evolved and became increasingly employed in special studies or investigations of limited duration, often at locations where little or no historical data were available, it became evident that the development of an additive multi-metric index was needed from which ALUS status could be determined on a sample-by-sample basis. In 2013 program staff initiated an effort to construct such an index following guidance contained within U.S. EPA’s Rapid Bioassessment Protocols (EPA 1999).

The process of constructing the program’s additive multi-metric index (ALUS index) began with the selection of five diagnostic metrics (Table 1.3.2-3). The metrics were intended to provide measures of community richness, composition, dominance, and water quality impairment tolerance. Two of the metrics (MBI and KBI-N) vary directly with water quality impairment, i.e. larger values = greater impairment, and the others (EPT, EPT% Count, and Shannon’s Evenness) vary indirectly with impairment. Values for each of the five metrics were calculated for all SBMP network samples (including candidate reference sites) collected between 1990 - 2012 (n = 1291). Next, the ≤ 5th and ≥ 95th percentile data associated with each metric were trimmed from the dataset to eliminate outliers, then the 20th, 40th, 60th, and 80th percentile groups of the remainder of the
metric distributions were assigned ordinal scores of 0 to 4 to represent biological condition levels (Table 1.3.2-3). Thus, an “ALUS Index” score for a given sample would be the integer sum of the five metrics (range of 0 to 20). Next, “ALUS index” scores were generated for the samples and the distribution was divided into 10th, 25th, 75th, and 90th percentile groups, which were also assigned biological condition categories (Table 1.3.2-3). “Fair” was framed the broadest category (spanning the 25th to 75th percentiles) to allow flexibility in the application of professional judgment, especially near the break-points of “good” and “poor” conditions. To facilitate interpretation of the index within the framework of CWA 303(d) and 305(b) reporting requirements, the 25th, 50th, and 75th percentiles of the ALUS index distribution were assigned three aquatic life “use” support categories (Table 1.3.2-4), with “full support” corresponding to the “good” biological condition break point. Finally, the distribution of ALUS index scores among all monitoring stations were compared to the distribution of candidate reference site scores (N = 95) to determine if further calibration (i.e. scale sliding) would be required. However, because the 25th percentile value (13) of the ALUS index score distribution of the reference sites corresponded to the break point between “good” or “full support” among the full population of monitoring stations, no scaling adjustments appeared necessary (see EPA’s Rapid Bioassessment Protocols 1999).

TABLE 1.3.2-3. Stream Biological Monitoring Program Aquatic Life Use Support (ALUS) multi-metric index scoring criteria. MBI = Macroinvertebrate Biotic Index (Davenport and Kelly 1983); KBI-N = Kansas Biotic Index for nutrients and oxygen demanding substances (Huggins and Moffett 1988); EPT = number of Ephemeroptera, Plecoptera, Trichoptera taxa; EPT % CNT = percent sample relative abundance of EPT; SHAN EVN = Shannon’s Evenness Index.

<table>
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<th>MBI</th>
<th>KBI-N</th>
<th>EPT</th>
<th>EPT% CNT</th>
<th>SHAN EVN</th>
<th>METRIC SCORE</th>
<th>BIOLOGICAL CONDITION</th>
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<td>≤ 4.18</td>
<td>2.52</td>
<td>≥ 16</td>
<td>≥ 65</td>
<td>≥ 0.849</td>
<td>4</td>
<td>Very Good</td>
</tr>
<tr>
<td>4.19 - 4.38</td>
<td>2.53 - 2.64</td>
<td>14 - 15</td>
<td>56 - 64</td>
<td>0.826 - 0.848</td>
<td>3</td>
<td>Good</td>
</tr>
<tr>
<td>4.39 - 4.57</td>
<td>2.65 - 2.75</td>
<td>12 - 13</td>
<td>48 - 55</td>
<td>0.802 - 0.825</td>
<td>2</td>
<td>Fair</td>
</tr>
<tr>
<td>4.58 - 4.88</td>
<td>2.76 - 2.87</td>
<td>10 - 11</td>
<td>38 - 47</td>
<td>0.767 - 0.801</td>
<td>1</td>
<td>Poor</td>
</tr>
<tr>
<td>≥ 4.89</td>
<td>2.88</td>
<td>≤ 9</td>
<td>≤ 37</td>
<td>≤ 0.766</td>
<td>0</td>
<td>Very Poor</td>
</tr>
</tbody>
</table>

1Based on SBMP candidate reference stream and network site data (1990 to 2012).

TABLE 1.3.2-4. Stream Biological Monitoring Program ALUS Index interpretative categories.

<table>
<thead>
<tr>
<th>ALUS Index Score</th>
<th>Biological Condition</th>
<th>Aquatic Life Use Support Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>17 – 20</td>
<td>Very Good</td>
<td>Full Support</td>
</tr>
<tr>
<td>14 – 16</td>
<td>Good</td>
<td>Partial Support</td>
</tr>
<tr>
<td>7 – 13</td>
<td>Fair</td>
<td>Non-support</td>
</tr>
<tr>
<td>4 – 6</td>
<td>Poor</td>
<td></td>
</tr>
<tr>
<td>0 – 3</td>
<td>Very Poor</td>
<td></td>
</tr>
</tbody>
</table>
1.4 Contemporary Program Objectives

The Stream Biological Monitoring Program endeavors to provide scientifically defensible information on the quality of flowing waters in Kansas through the analysis of aquatic macroinvertebrate communities. This information is intended for use in:

1. complying with the water quality monitoring and reporting requirements of 40 CFR 130.4 and sections 106(e)(1), 303(d), 305(b), and 319(h) of the federal Clean Water Act;

2. evaluating waterbody compliance with the Kansas surface water quality standards (K.A.R. 28-16-28b et seq.);

3. identifying point and nonpoint sources of pollution contributing most significantly to water use impairments in streams;

4. documenting spatial and temporal trends in surface water quality resulting from changes in prevailing climatological conditions, land use/landcover, natural resource management practices, wastewater treatment plant operations, and other factors;

5. developing scientifically defensible environmental standards, wastewater treatment plant permits, and waterbody/watershed pollution control plans; and

6. evaluating the efficacy of pollution control efforts and waterbody remediation/restoration initiatives implemented by the department and other agencies and organizations.
Section 2

QUALITY ASSURANCE GOALS

The foremost goal of this QA management plan is to ensure that the Kansas Stream Biological Monitoring Program produces data of known and acceptable quality. "Known quality" means that data precision, accuracy, completeness, comparability and representativeness are documented to the fullest practicable extent. "Acceptable" means that the data support, in a scientifically defensible manner, the informational needs and regulatory functions of the Bureau of Water, the Division of Environment, and the agency. The success of the program in meeting this general goal is judged on the basis of the following quality control (QC) performance criteria and requirements:

1. Where practicable, the reliability of the program data shall be documented in a quantitative fashion. Relative percent difference (RPD) is used to assess replicate comparability. For routine metrics, such as species richness, the MBI, or the EPT index and variants, the precision of the data shall be evaluated via replicate sampling activities conducted by field staff. Such metrics are expected to exhibit an RPD of less than fifteen percent among replicate samples. Accuracy, as the term is used in this QA management plan, refers to the correct identification of biological specimens to the lowest practicable taxonomic level. Accuracy is evaluated through the use of reference specimens and through internal and external audits of taxonomic performance (see section 4.6.3). As a general goal, fewer than one percent of the specimens collected in the course of sampling activities shall be misidentified by program personnel.

2. Loss of biological data due to specimen collection, transport or storage problems, or to the subsequent mishandling of data, shall be limited to less than two percent of the data originally scheduled for generation. If problems occur and a substantial quantity of data is lost, an effort shall be made to resample the stream or streams in question to maximize data completeness.

3. Changes in the methods used to obtain and analyze biological samples shall be carefully documented through formal revisions to the SOPs appended to this QA management plan. This requirement is intended to help maintain a reasonably consistent database over time, enhance knowledge of the effects of any procedural changes on reported metric or index values, and facilitate the identification and evaluation of long-term trends in surface water quality.

4. Data generated through this program shall be compared and contrasted with other available monitoring information to examine the representativeness of program findings relative to other reported results. Staff shall attempt to ascertain the probable causes of any discrepancies observed between the various existing databases QMP/III/BOW and describe, in end-of-year program reports, the magnitude and practical significance of such discrepancies.
Section 3
QUALITY ASSURANCE ORGANIZATION

3.1 Administrative Organization

The Stream Biological Monitoring Program is one of several environmental monitoring programs administered by the Monitoring and Analysis Unit of the Watershed Planning, Monitoring and Assessment Section, Bureau of Water (see BOW QA Management Plan, QMP, Part II). Program offices are located at the Curtis State Office Building, 1000 SW Jackson, Topeka, Kansas.

The general administrative structure of the Stream Biological Monitoring Program is depicted in Figure 3.1-1, below.

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Figure 3.1-1. Administrative hierarchy of Stream Biological Monitoring Program.
3.2 Staff Responsibilities

Program staff include two environmental specialists. One environmental specialist serves as the program manager and is accountable for most program planning, data interpretation, taxonomic accuracy, and report writing functions. This employee also participates in field work, performs taxonomic determinations, monitors and evaluates program QC, designs, implements, and interprets supporting special scientific studies, apprises the unit leader of any equipment or staff training needs, and participates in the annual review and revision of the program QA management plan (see section 5). The other environmental specialist participates in field activities, performs taxonomic determinations, maintains the biological reference collection and taxonomic library, and assists with data interpretation and report writing functions.

Personnel from other WPMAS programs occasionally assist with stream biological sampling activities, especially in the event of staff absences or when additional people are needed to conduct the work in a timely, safe and efficient fashion. Staff of the Stream Biological Monitoring Program provide reciprocal assistance to other WPMAS programs.

3.3 Staff Qualifications and Training

Minimum technical qualifications for program staff vary by position. However, each environmental specialist must hold at least a four-year college degree in aquatic invertebrate biology or a closely related scientific field and have substantial experience in the performance of water quality studies and associated data analysis and statistical procedures. The program manager must possess an expert level of familiarity with the taxonomy and distribution of aquatic macroinvertebrates in Kansas, understand the basic principles of project and program management and quality control, and possess advanced computer skills and written and oral communication skills. Also, pursuant to Part I of the divisional quality management plan (QMP), the program manager must complete quality assurance training offered by EPA. The program's environmental specialists must possess a strong taxonomic familiarity with the invertebrate organisms occurring in Kansas streams. He/she must also command a thorough understanding of the procedures used in the sampling, preservation, identification, enumeration, labeling and archival of invertebrate specimens and in the processing of associated paperwork and other documentation.

All individuals routinely participating in this program must possess a valid Kansas driver's license and current certifications in first aid and cardiopulmonary resuscitation (CPR). They must review the program’s QA management plan and SOPs prior to assuming field/laboratory duties and repeat this review at least annually (QMP, Part I). All program staff receive in-house training in applicable work procedures and related safety requirements. As funding and other agency resources allow, the program manager and the environmental specialist are encouraged to participate in technical workshops and seminars dealing with environmental monitoring operations and related field, analytical, data management and statistical procedures.
Section 4

QUALITY ASSURANCE PROCEDURES

4.1 Monitoring Site Selection

The monitoring network is designed around the objectives set forth in section 1.4 of this document. Specifically, an effort is made to evaluate macroinvertebrate communities and water quality conditions in each of the state's major river basins and ecoregions (objectives 1, 2 and 4) while providing data on individual waterbodies needed to identify major sources of contaminants (objective 3), develop scientifically defensible permits and/or pollution control plans (objective 5), and assess the effectiveness of implemented pollution control or remediation efforts (objective 6). In selecting individual stations for inclusion (or retention) in the monitoring network, the following questions are posed:

(1) Would the candidate station materially enhance the spatial coverage of the monitoring network? That is, would the location coincide with an ecoregion or a major river basin currently under represented in the network?

(2) Would the candidate station reflect habitat and water quality conditions occurring throughout most of the watershed or stream segment, or would local phenomena (e.g., stream obstructions, sand and gravel removal operations, channelization projects, point sources, area cropping practices, livestock access, riparian deforestation) create conditions unrepresentative of the watershed or stream segment as a whole?

(3) Would the candidate station afford long-term access to the stream for monitoring purposes? Could access be curtailed at the discretion of a private landowner?

(4) Do historical macroinvertebrate data or water quality data exist for the candidate site? If so, does the historical database provide a reliable indication of historical water quality conditions?

(5) Do other, ancillary data exist for the candidate site? Does the site coincide with any other water quality or hydrological data collection efforts (e.g., departmental stream chemistry monitoring station; United States Geological Survey (USGS) stream flow gaging station)?

(6) Would the candidate station provide water quality data of unique interest? For example, does the site represent an unusually pristine location, suitable for use as a long-term ecoregional reference location? Does the waterbody constitute an outstanding national resource water, exceptional state water, or a critical habitat for any state or federally listed threatened or endangered species? Is the candidate site
located on an interstate stream in the vicinity of the state boundary, thereby constituting a potential interstate stream monitoring station?

As mentioned previously, the current monitoring network includes several reference sites which have been sampled more frequently than other network sites. Reference sites serve to identify the variation in community structure and species abundance associated with relatively unperturbed streams in a given land use setting, geological or geographical area, or ecoregion (Gallant et al. 1989). Biological data obtained from reference sites may be compared to data from other sampling locations of similar habitat and hydrology, thus improving the likelihood of identifying streams with aberrant macroinvertebrate community characteristics and associated water quality problems.

4.2 Determination of Site Location

The longitude and latitude of all new sites may be determined in the field using a handheld global positioning system (GPS) unit (Appendix B), or determined using mapping software such as Google Earth. Coordinates are determined near the center line of the stream within the sampled reach. The use of GPS technology facilitates the interpretation of biological data in a geographical context and expedites the development of species distribution maps and similar work products (sections 1.4 and 4.12). Digital photographs also are taken of all monitoring locations, and periodically updated, to track changes in the physical character of sites over time and to assist monitoring personnel in site identification and verification.

4.3 Sample Collection

Appendix B provides a detailed description of the sampling protocols used in this program. In the collection of quantitative macroinvertebrate samples, a time-based "equal effort" method is employed which is essentially equivalent to EPA's Rapid Bioassessment Protocol III (see Plafkin et al. 1989). During each sampling event, macroinvertebrate specimens are collected by two individuals using D-frame nets and forceps. Sampling activities continue for thirty minutes or a combined duration of one person-hour. An effort is made to sample all accessible macrohabitats (riffles, pools, runs) and microhabitats present at the stream station within the allotted time period. Specific methods of collection include, but are not necessarily limited to:

1. Kicking riffles and leaf packets and allowing the current to carry dislodged organisms into the D-frame nets;
2. Sweeping the D-frame nets through submersed or floating aquatic vegetation, submersed terrestrial vegetation and tree roots, accumulations of woody debris, and growths of filamentous algae;
3. Sieving fine sediments (silt and fine sand) through the D-frame nets; and
4. Using forceps to pick organisms directly from logs, large rocks, or other surfaces not easily dislodged by kicking.
Field staff endeavor to collect a combined total of at least 200 organisms. The minimum acceptable sample size is a total count of 100 organisms. Where multiple habitats are present, no more than 50 organisms may be collected from a single microhabitat. Specimens of a given taxon are collected in numbers roughly proportional to their relative abundance in the stream community. Specimens are placed in 120-mL glass jars containing 70 to 80 percent ethyl alcohol. The station number and date of collection are written with indelible marker on label tape affixed to the outside of the jars. Upon completion of sampling, a field collection form is filled out by one of the workers (Appendix C). Information recorded on the form includes station number and location, time and date of sample collection, names of field workers, and flow conditions at the time of sampling. Prior to leaving the monitoring station, stream temperature is measured, and a SMASH Index form is completed (Appendices B and C).

4.4 Sample Chain-of-Custody

All samples and associated paperwork are transferred to the BOW central office in Topeka. In the unlikely event a sample is delivered by someone other than the staff involved in its collection, the courier’s signature and the date and time of sample transfer are recorded on the field collection form. Samples and paperwork are retained in the possession of, or delivered to, the program's environmental specialist. This employee stores the biological samples in a secured location pending taxonomic determinations. Similarly, all field collection forms (SMASH Index forms) are filed by this employee for future reference (Appendix B).

4.5 Taxonomic Determinations

Appendix B provides a detailed description of the taxonomic procedures used in this program. Macroinvertebrate samples are identified to the lowest practicable taxon utilizing literature specific to the Kansas fauna or the most appropriate, up-to-date taxonomic literature available. Voucher specimens of newly discovered or rarely encountered taxa are added to the reference collection on an ongoing basis. Opinions of outside taxonomic experts are solicited as needed. Samples are retained for a minimum of five years following specimen identification. Historical data may be adjusted to accommodate ongoing changes in the scientific nomenclature, as reflected in the Kansas Biological System Database (KBSD) reference file table of the taxonomic database (see section 4.9).

4.6 Internal Procedures for Assessing Data Precision, Accuracy, Representativeness and Comparability

4.6.1 In-house Audits

The section chief or designee generally conducts annual audits of field, analytical and taxonomic procedures on an annual basis. This effort may involve a system audit, consisting of a qualitative, onsite review of QA systems and physical apparatus and facilities for monitoring, measurement and specimen identification, or a performance audit, in which a quantitative assessment is made of
the efficiency and reliability of invertebrate sample collection and taxonomic procedures. During system audits, staff responsible for field operations are required to demonstrate a proper understanding of the requirements imposed by the QA management plan and accompanying SOPs. During performance audits, staff are required to conduct field and laboratory measurements and taxonomic determinations in the presence of the section chief or designee, report measured values for stream temperature that fall within five percent of those established by the section chief or designee, and report measured values for the SMASH Index and selected community metrics that fall within twenty percent of those established by the section chief. Should these values fall outside the stipulated control limits, the section chief and program personnel initiate corrective actions as described in section 4.8.

4.6.2 Replicate Samples

The protocol for macroinvertebrate sample collection involves two field staff working simultaneously within the same general stream reach (section 4.3; Appendix B). The subsample obtained by one of the workers is pooled with that of the other to form a single sample. Duplicate (or replicate) pooled samples are collected successively (i.e., during the same site visit). Collectively, these samples comprise about ten percent of the total number of samples collected on an annual basis. Overall precision (i.e., combined sample collection and taxonomic precision) is estimated for various metrics based on data obtained from these duplicate (replicate) samples. Field staff must take great care not to resample any substrate that has been physically disturbed by prior sampling or impacted by drift (movement of dislodged organisms) from upstream invertebrate sampling activities. In the event precision levels indicated by the successive sampling method fail to meet the QC requirements of section 2, paragraph (1), the program manager and section chief invoke the corrective action measures described in section 4.8.2.

4.6.3 Taxonomic Accuracy

Taxonomic determinations are validated by comparing the list of taxa from a particular sample to the historical list of taxa for the station or stream of interest. Determinations also may be checked against the KBS inventory of aquatic macroinvertebrates previously documented in Kansas. Rare or unusual specimens are compared to specimens in the agency reference collection (section 4.5) and, if necessary, submitted to outside experts for further examination. Each year, at a rate of approximately five percent of the annual taxonomic work load, the program manager randomly selects invertebrate samples of moderate to high diversity for reidentification and re-enumeration of specimens. The results of this exercise are compared with information recorded on the original identification bench sheet (Form APP.C-2). Exact reproducibility is not expected as some specimens have already been subjected to dissection and removal of key anatomical features. Annual program audits conducted or overseen by the section chief may evaluate, among other things, the taxonomic proficiency of program staff. If the accuracy of specimen identification fails to meet the requirements of section 2, paragraph (1), corrective action measures are initiated (section 4.8.2).
4.6.4 Preventative Maintenance

Periodic inspection and routine maintenance of field and laboratory equipment is necessary to minimize malfunctions which could result in the loss of data or disruption of program activities. Sampling equipment, such as D-frame nets and hip and chest waders, and microscopes and illuminators used in specimen identification, must be inspected periodically and repaired or replaced if necessary. Vehicles used during field activities also must be maintained in a reliable condition. Entries must be made in the vehicle log upon completion of each field trip. All vehicle malfunctions must be reported to appropriate personnel (i.e., program manager, unit chief, section chief) as soon as possible to expedite necessary repairs or the acquisition of a replacement vehicle (see section 4.8.1).

4.6.5 Safety Considerations

Attention to job safety protects the health and well-being of program staff and helps maintain a work atmosphere which ultimately enhances data quality and consistency. Program staff must be familiar with proper precautionary measures and the use of available safety equipment prior to assuming field duties. All field staff must be certified in adult cardiopulmonary resuscitation and basic first aid by the American Red Cross or an equivalent institution. All vehicles routinely used in the Stream Biological Monitoring Program must be maintained in proper condition and equipped with first aid kits, emergency eye wash bottles, fire extinguishers, spare tires and tire changing equipment, rain gear, road reflectors and/or flares, and operable flashlights. A cellular phone is assigned to each monitoring vehicle and staff are directed to turn these on when in the vehicle so that communication can be maintained with the central office in the event of vehicle mishaps, medical problems, or other emergencies. The use of a cellular phone is especially important when conducting overnight sampling runs or when traveling alone or during periods of potentially severe weather. As an added safety feature when traveling in remote areas of the state, an automated external defibrillator (AED) was procured to provide aid in the event of cardiac emergencies; this lifesaving device guides the rescuer step by step through the entire rescue pending the arrival of trained medical personnel. Additional safety considerations are presented in the SOPs accompanying this QA management plan.

4.7 External Procedures for Assessing Data Precision, Accuracy, Representativeness and Comparability

At the discretion of the section chief, bureau QA representative, bureau director, or divisional QA officer, the Stream Biological Monitoring Program may, from time to time, participate in independent performance/system audits or in interagency exchanges or comparisons of macroinvertebrate reference samples. Participation in such activities promotes scientific peer review and enhances the technical integrity and overall credibility of the program.
4.8 Corrective Action Procedures for Out-of-Control Situations

4.8.1 Equipment Malfunction

Any equipment malfunction discovered during routine sampling or taxonomic activities, or during an internal or external performance audit, must be reported immediately to the program manager. This employee is responsible for appraising the scope and seriousness of the problem and, if necessary, for determining whether the equipment item should be repaired or replaced. The program manager also is responsible for ensuring that backup equipment is available for all critical field and taxonomic activities. Arrangements for a backup vehicle must be made in advance of any mechanical problems or mishaps that might render the program's regular vehicle inoperable for an extended period.

4.8.2 Data Precision/Accuracy Problems

If sampling activities or taxonomic determinations fail to meet the requirements of section 2, paragraph (1), the program manager must plan and implement an investigation to determine the cause of the problem. The program manager is expected to work closely with staff in this endeavor and in the selection and implementation of appropriate corrective measures. Persistent problems may trigger a program audit by the section chief or bureau QA representative, result in the disqualification of a substantial amount of stream biological data, or invoke other remedial responses (e.g., an independent audit).

4.8.3 Staff Performance Problems

If an employee has difficulty with a given work procedure, as determined by an internal or independent performance audit, an effort must be made by the program manager to identify the scope and seriousness of the problem, to identify any data affected by the problem, and to recommend to the section chief an appropriate course of corrective action. All questionable data are either flagged within the computer database or, at the discretion of the section chief, deleted from the database. Possible corrective actions include further in-house or external training for the employee, a reassignment of work duties, or modification of the work procedure.

4.9 Data Management

4.9.1 General Data Management

All field- and laboratory-generated data are handled in an orderly and consistent manner. Time and date of sample collection, stream monitoring station identification number, and other basic field information, including habitat evaluations, are recorded on standardized field forms; similarly, taxonomic determinations and metric scores are recorded on standardized biological data forms (Appendix C). The original forms are carefully reviewed for obvious errors or omissions and are subsequently filed in a secured location for future reference.
Information on biological data forms is transferred manually to the Kansas Biological System Database (KBSD) currently maintained on an ORACLE database supported by the agency's Office of Information Technology (OIT). This database also contains station identification headers; sample collection date/time files; KBSD codes for individual macroinvertebrate species and other taxonomic designations; pollution tolerance values and other rating systems for calculation of biotic indices; and other supporting information. Staff can generate custom views using an Open Database Connection (ODBC) viewer to facilitate database access and the viewing, validation and editing of program data.

Transfers of raw data may be accomplished by downloading selected portions of the database in .dbf file format. Raw data may be sorted or restricted based on station number, date of sample collection, or KBS code, with or without associated station header information, metric values, and other supporting information. Metric retrievals may be printed, viewed, or downloaded as .dbf files. Calculated values for various biological metrics also are maintained on a personal computer spreadsheet (EXCEL). These values are downloaded directly from the ORACLE database. Calculated values may be retrieved and reported in various formats or subjected to basic statistical analyses. The KBSD is supported and backed-up daily to an external hard drive (for rolling back data within the last 30 days) by the KDHE Office of Information Technology (OIT).

4.9.2 Data Entry Requirements

Environmental data (and metadata) manually entered into an electronic database by program staff are examined by visually comparing database retrievals with the original bench identification sheets (Form APP.C-2) and verified at least annually by the program manager. This process entails the selection of a representative, randomly selected sample of data and the documentation and correction of any data entry errors. This sample generally comprises 5-10 percent of the data collected during the preceding year. Staff transferring or receiving data electronically perform random spot checks of the data and report any problems for further investigation and resolution. Persistent problems are reported to the section chief and bureau QA representative for consideration of necessary corrective actions.

4.9.3 Verification of Calculations

Computer-based mathematical, statistical, graphical and geographical programs and models involving environmental data are tested before application by comparison to other computer programs, through hand calculations involving randomly selected data, or through other appropriate means. The reliability of these models and programs is reexamined on at least an annual basis or whenever a problem is reported within a computational system. Excel, ArcView, SigmaPlot, Minitab, R, and PRIMER are among the forms of software used for generating spreadsheets, graphs and models or for performing statistical characterizations, comparisons and trend analyses.
4.9.4 Data Transformation and Outliers

Many forms of environmental data do not conform to a normal distribution and may necessitate the use of nonparametric statistical methods. Alternatively, the data may be transformed statistically to induce a normal, log normal, or some other preferred data distribution. The data distribution is often depicted graphically to help identify the most appropriate transformation procedure. Commercially available computer programs also may be applied in more detailed assessments of data distribution. Minitab software maintained on selected BOW desk top computers offers several algorithms for characterizing departure from normality (e.g., Shapiro-Wilk and Kolmogorov tests).

All environmental databases may contain a few anomalous values or statistical outliers. Obvious outliers (those that are orders of magnitude beyond any reasonable value) often constitute data transcription errors or other simple errors. Program data are automatically questioned by staff if a calculated metric is outside the historical range for the waterbody in question. Such an occurrence may prompt another comparison of the information stored on the program database with the information recorded on the bench identification sheet. The program manager also may elect to reexamine the computer algorithms used to generate the metric. If necessary, the original sample may be retrieved from storage and reexamined. In other instances, outliers may reflect actual (though rarely occurring) fluctuations in biological community composition. Nonparametric procedures based on rank-order or percentile tend to be less influenced by these kinds of data and are often favored by staff for statistical characterizations, comparisons and trend analyses.

4.9.5 Ancillary Data

Ancillary data used in this program may include physicochemical topographic, edaphic, hydrological, meteorological or biological data derived from other BOW programs, governmental agencies or universities. All routine environmental monitoring programs administered by BOW are subject to the provisions of parts I and II of the divisional QMP. An effort is made to ensure that data from outside agencies are generated in accordance with QA management plans similar to those developed by BOW. In some instances, outside agencies collect data under a contractual agreement with the division, or under the auspices of an EPA grant, both of which require development and approval of a QA project plan prior to data collection (see QMP, Part I, section 2.3).

Biological metrics and species tolerance values applied in the Stream Biological Monitoring Program are taken largely from documents produced by other governmental agencies or from literature sources incorporating peer review before publication. Staff are to carefully examine underlying technical assumptions, appropriateness, and relevance to the program’s monitoring goals before applying new metrics and values.
4.10 Quality Assurance Reporting Procedures

End-of-year program evaluations shall be conducted by the program manager and a written report submitted to the unit chief, section chief, bureau QA representative, bureau director, and divisional QA officer by March 15 of the following year. The program manager shall cooperate fully in the evaluation of QA/QC performance and shall make available all records pertaining to the precision, accuracy, representativeness and comparability of the monitoring data gathered during the evaluation period. Program evaluations submitted by the section chief must indicate when, how, and by whom the evaluation was conducted, the specific aspects of the program subjected to review, a summary of significant findings, and technical recommendations for necessary corrective actions. The section chief shall discuss the reported findings with the program manager and other program staff.

4.11 Purchasing of Equipment and Supplies

When newly ordered or repaired sampling, diagnostic or computational equipment is delivered to the program office, program personnel shall compare the item to that requested on the original order, then inspect the item to ensure that no breakage has occurred in transit and that all components are included and function properly. The shipment is either accepted or rejected once this inspection is completed.

Office and laboratory supplies receive a comparable level of scrutiny. Any reference standards or reference apparatus must be accompanied by a certificate from the vendor or manufacturer verifying the quality of these products.

4.12 Program Deliverables

Program deliverables include electronic databases, illustrative materials, statistical water quality summaries, and detailed written reports used in a variety of agency applications. Staff of the stream biological monitoring program play a major role in the development of the Kansas biennial water quality assessment (305(b) report) and the Kansas list of water quality limited surface waters (303(d) list). As resources and circumstances allow, customized data retrievals are prepared by the program manager on behalf of administrative staff, legislative officials, other state and federal agencies, regulated entities, special interest groups, consultants, academicians, students, and members of the general public.
Section 5

REVIEW AND REVISION OF PLAN

To ensure that the Stream Biological Monitoring Program continues to meet the evolving informational needs of the bureau and the agency, all portions of this QA management plan and its appended SOPs must be comprehensively reviewed by participating staff on at least an annual basis. Revisions to the plan and SOPs require the approval of the program manager, unit chief, section chief, bureau director, and bureau QA representative prior to implementation. Although review activities normally follow the annual program evaluation in February, revisions to the plan and SOPs may be implemented at any time based on urgency of need or staff workload considerations.

Original approved versions of the QA management plan and SOPs, and all historical versions of these documents, are maintained by the bureau QA representative or his/her designee. The bureau QA representative also maintains an updated electronic version of the plan and SOPs on the KDHE internet server in a "read only" .pdf format.
APPENDIX A

FIELD AND LABORATORY EQUIPMENT
AND SUPPLY CHECKLIST
FIELD AND LABORATORY EQUIPMENT AND SUPPLY CHECKLIST

I. VEHICLE

A. Minivan (or other vehicle, as available)

B. Vehicle registration and proof of insurance

C. Vehicle log book (Wright Express card, list of cooperating service stations, copy of tire, battery and emergency service contracts, emergency phone number list)

D. State highway and 1/4” scale county maps

E. Vehicle key and spare key(s), KTAG pass, CSOB parking garage opener

F. Mobile cellular phone

G. Fire extinguisher, first aid kit, CPR mouthpieces, latex rubber gloves, paper and cloth towels, hand sanitizing solution in plastic squeeze bottle

H. Spare tire (fully inflated), tire changing equipment, road reflectors and/or flares

I. Tool kit, jumper cables, tow rope, windshield ice scrapers, flashlights (fully operable), fluorescent orange safety vests with reflective strips

II. FIELD EQUIPMENT AND SUPPLIES

A. Garmin GPSIII+, Garmin V, or other acceptable hand-held GPS unit (with Garmin MapSource software or other acceptable software)

B. Digital camera, memory cards, carrying case, extra batteries and instructions

C. Hip and chest waders (two pairs for each field worker) and a repair kit

D. D-frame, 0.5-mm mesh nylon nets (two in use; one spare) with 1.5-meter wooden handles calibrated in decimeters for measuring stream depth

E. Forceps (fine point, on lanyard)

F. Glass sample jars (120 mL) with screw-on plastic lids

G. Label tape (white) for sample jars
H. Ethanol solution (70-80%) for preserving invertebrate specimens. Stop watches or wrist watches with stopwatch function for timing sampling events.

J. Live Mussel Recording form

K. Field Collection Data Sheet and Habitat Development Index form

L. Metal clipboard (with maps, field forms, etc.), pens, pencils, and indelible markers

M. Fisher model #15-0778 stainless-steel dial scale thermometer (-10 to +110°C)

N. Plastic three-gallon for transporting samples and smaller equipment/supply items from stream monitoring location to vehicle; additional buckets or pails for carrying unionid mussel samples; plastic bags for securing and labeling mussel samples upon return to vehicle.

O. Rain gear, caps or visors, sunglasses, sun screen, insect repellant, hand disinfectant solution, drinking water, extra socks in the event of wader leakage.

III. TAXONOMIC EQUIPMENT AND SUPPLIES

A. Zeiss 100X-630X and Fisher Scientific 100X-400X variable magnification compound microscopes

B. Olympus 9X-110X Wild M5A 6X-50X variable zoom dissecting microscope

C. Dolan-Jenner bifurcate fiber optic, variable intensity light source

D. Glass Petri dishes

E. Steel forceps and probes (coarse and fine point)

F. Microscope slides and slide cover slips

G. Slide mounting medium

H. Lab-Line hot plate

I. Identification bench sheets (Appendix C)

J. Ethanol (70-80% with 5% glycerine) for preserving invertebrate specimens.
K. Taxonomic keys and supporting scientific literature

L. Boxes for storage of invertebrate samples (in original glass sample jars) following identification and enumeration of specimens

N. Specimen vials and trays for reference collection

M. Locking cabinet for non-unionid reference specimen collection and retrofitted map flat file cabinet for unionid reference collection
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MAINTENANCE PROCEDURES FOR FIELD SAMPLING EQUIPMENT (SBMP-001)

I. INTRODUCTION

A. Purpose

Sampling equipment must be maintained in a reliable working condition to maximize the efficiency of invertebrate collection activities and minimize the loss of data.

B. Minimum Staff Qualifications

Staff implementing this position must meet the minimum classification requirements for environmental specialist published by the Kansas Department of Administration. They will perform preventive maintenance, cleaning, and inspection of equipment to ensure a serviceable condition.

C. Equipment/Accessories

1. Hip and chest waders
2. D-frame aquatic nets

II. PROCEDURES

A. Hip and chest waders

1. When rubber waders are not in use, they should be stored in an inverted position in a cool, dark location to reduce cracking. Gore-Tex waders should be dried and rolled and stored in a cool, dark location.

2. Rips and tears are repaired with silicone seal or adhesive patches, depending on the extent of damage and wader construction.

3. Mud is removed prior to storage.

4. Insides of waders must be kept dry to reduce deterioration of lining material.

B. D-frame aquatic nets

1. Nets are checked for damage after each sampling event.
2. Rips and tears are repaired with silicone seal or sewn closed.

3. Depth graduations on the handles eventually fade and must be retraced from time to time with indelible marker.
PROCEDURES FOR FIELD
ANALYTICAL MEASUREMENTS (SBMP-002)

I. INTRODUCTION

A. Purpose

The following paragraphs describe the procedures used by program staff to measure stream temperature.

B. Minimum Staff Qualifications

Staff implementing this SOP should meet the minimum classification requirements for environmental specialist published by the Kansas Department of Administration. They also should be experienced in the measurement of the chemical and physical properties of surface water and have a basic technical understanding of the associated measurement apparatus.

C. Equipment and Accessories

1. Fisher model #15-0778 stainless-steel dial scale thermometer

II. PROCEDURES

A. Stream Temperature Measurement

Immerse lower half of thermometer probe into flowing reach of stream, preferably above “thalweg” or line connecting deepest points along stream channel. On sunny days, take temperature reading in shaded reach of stream or in own shadow. After indicator on thermometer dial has stabilized, read temperature to nearest full degree Celsius and record measured value on field sheet.
PROCEDURES FOR COLLECTION OF MACROINVERTEBRATE SAMPLES (SBMP-003a)

I. INTRODUCTION

A. Purpose

Staff involved in the collection of macroinvertebrate samples must adhere to a standardized sampling procedure to maximize the comparability of the data generated by different workers over a potentially long period of time. Consistent procedures reduce the statistical "noise" that could otherwise detract from the utility of the data.

B. Minimum Staff Qualifications

Staff implementing this position must meet the minimum classification requirements for environmental specialist published by the Kansas Department of Administration. They also must possess a strong familiarity with the range of macroinvertebrate organisms occurring in Kansas streams and command a thorough understanding of the procedures used in obtaining representative macroinvertebrate samples.

C. Field Equipment and Supplies

For complete list of equipment and supplies, see Appendix A.I - A.II. Primary sampling gear is listed below:

1. Hip or chest type waders depending on the depth and flow conditions of the stream being sampled

2. D-frame, 0.5-mm mesh aquatic net with decimeter graduations on handle for depth determination

3. Forceps (fine point with lanyard)

4. Glass sample jars (120 mL) containing 70-80% ethanol (approximately 50 mL per jar); white tape for labeling jars; indelible markers

5. Stopwatch (or wrist watch with stopwatch function)

6. SMASH Index Form (Form App.C-1); pencils; indelible pens
II. PROCEDURES

A. During each sampling event, macroinvertebrates are collected by two workers over a period of thirty consecutive minutes (a combined duration of one person-hour).

B. All available macrohabitats (riffles, pools, runs) and their microhabitats (various water depths, velocities or substrata within a macrohabitat) are sampled, as permitted by size and depth of water body and time allotted (see SOP No. SBMP-005).

C. Macroinvertebrate specimens are collected by:
   1. kicking riffles and leaf packets and allowing current to carry dislodged organisms (and debris on which organisms may occur) into D-frame nets for removal with forceps;
   2. sweeping the D-frame nets through submerged or floating aquatic vegetation, submersed terrestrial vegetation and tree roots, accumulations of woody debris, and growths of filamentous algae;
   3. sieving fine sediments (silt and fine sand) through the D-frame nets; and
   4. using forceps to directly pick organisms from logs, large rocks, or other surfaces not easily dislodged by kicking.

D. Each worker endeavors to collect a minimum of 100 organisms, for a total of 200 or more organisms per pooled sample. Samples with total counts less than 100 are not included in any assessment or analysis.

E. Different macroinvertebrate taxa present at a site are collected in numbers roughly proportional to their relative abundance in the stream community. Neither worker should collect more than 50 organisms from any single microhabitat or individual D-frame net collection.

F. As specimens are separated from debris, they are placed directly into glass sample jars containing 70-80% ethanol. Using an indelible marker and white label marking tape, jars are identified with regard to station number and collection date.

G. Upon completion of the sampling effort both workers collaborate to complete the Field Collection Form and SMASH Index (Appendix C). Information recorded on the form includes station number and location, time and date of sample collection, names of sample collectors, flow conditions, and other pertinent information at the time of sampling.
III. SAFETY

A. Standard operating procedure SCMP-002, addressing vehicle safety and maintenance, is adopted by reference.

B. Field crews in the Stream Biological Monitoring Program shall consist of two or more individuals. Crew members shall remain within hearing distance of one another during sampling activities, in the event of an accident or some other situation requiring prompt assistance. Crew members shall be certified in adult cardiopulmonary resuscitation and basic first aid by the American Red Cross or equivalent institution. Any lapse in certification shall render an employee ineligible for macroinvertebrate sampling activities, pending renewal of certification.

C. If stream current velocity exceeds 10 cm/sec, crew members shall not attempt to wade through water greater than one meter in depth (or above crotch level in chest waders). Wading in stronger currents shall be limited to water less than knee deep. Workers must remain cognizant of the inherent risk of wading in stronger currents, even in relatively shallow water. Added caution is required when walking on algal-coated rocks or other slippery surfaces.

D. Workers shall not attempt to enter or remain in streams if lightning is observed or if heavy rainfall, rising water level and/or current velocity, strong wind, or any other factor precludes the collection of samples in a safe manner or in accordance with established protocols.

E. Workers shall avoid wading in excessively deep water, where even slight, unexpected increases in depth may result in overtopping of waders. Sampling in highly turbid water must be performed with caution, owing to possible sudden increases in depth, changes in substrate stability, or unexpected encounters with entangling woody debris or other submerged obstacles.
PROCEDURES FOR QUALITATIVE OBSERVATION AND DOCUMENTATION OF UNIONID MUSSEL COMMUNITIES (SBMP-003b)

I. INTRODUCTION

A. Purpose

Freshwater mussels occur in many Kansas streams but are seldom collected in quantitative macroinvertebrate samples owing to their comparatively large size as adults, burrowing habits, and sparse or scattered distribution in stream channels. Most mussel taxa are long-lived but slow to mature and reproduce. The larvae of all but a few species are parasitic on the fins and gills of fish, whereas juvenile and adult mussels live as sedentary filter-feeders. Mussel communities are unusually vulnerable to declines in environmental condition and serve a useful diagnostic function in biological assessments of water quality. The following paragraphs describe qualitative procedures employed by staff for documenting the species of mussels inhabiting a particular stream reach and for ascertaining changes in the composition of mussel communities over time.

B. Minimum Staff Qualifications

Staff implementing this SOP must meet the minimum classification requirements for environmental specialist published by the Kansas Department of Administration. Staff must demonstrate an ability to accurately and rapidly identify each of the state’s more than forty species of mussels under field conditions. This ability is usually gained by careful study of archived specimens, review of pertinent literature (e.g. Angelo et al. 2009 and Couch 1997), and by accumulation of field experience under the supervision of a biologist knowledgeable in mussel taxonomy.

Staff must be thoroughly familiar with the current and historical distributions of unionid mussels in Kansas. For each of Kansas’ mussel species staff shall have current knowledge of their state and federal conservation status. Staff must be able to recognize live, recent, or relic shells of previously undocumented species and/or species thought to be extirpated or extinct for any given stream location. Staff must also be able to recognize a notable absence of live or recent shell material for species expected to be extant at a given site.

C. Field Equipment and Supplies

1. Hip or chest waders, depending on depth and velocity of stream being sampled
2. Digital camera for documenting any rare (e.g., threatened or endangered) mussel species represented by live individuals

3. Calipers or metric ruler for measuring length and height of any encountered rare species

4. Bucket for transporting collected (recent, weathered, relict) shell material to field vehicle

5. Plastic bags and indelible markers for segregating and labeling shell material from different sites and transporting to BOW laboratory in Topeka

6. Clipboard containing field forms (see below), pens and pencils

II. PROCEDURES

A. All safety procedures presented in SOP No. SCMP-002 and SBMP-003a are adopted by reference.

B. At the conclusion of macroinvertebrate sampling activities, program staff shall survey the unionid mussel community. At each sample site the amount of effort to be expended on a survey is contingent upon (1) the abundance and diversity of mussel species and (2) the level to which the site has been previously surveyed. Minimally each worker should survey the sample site for 15 minutes (one-half person-hour). Photographic and/or physical documentation shall be made when appropriate.

C. Routine observations shall be recorded on Form APP.C-1 (Appendix C), and should include for each species:

1. A tally of the total number of live individuals and an estimate of the number of distinct age (size) classes. Live mussels may be located by:
   a. walking along the stream margin, inspecting stream bottom near shoreline;
   b. observing tracks left by mussels in softer sediment and manually withdrawing buried mussels from terminus of tracks;
   c. inspecting bottom sediments while wading upstream in shallower, clearer reaches;
   d. digging by hand into gravel- or cobble-bottom riffles, locating mussels by sense of touch.
2. A tally of the total number of recent shells (i.e. freshly dead individuals) and an estimate of the number of distinct age (size) classes. Where very large numbers of recently dead shell materials are present, reasonable estimates may be recorded. Recent shell materials (i.e., freshly dead mussels) generally are characterized by unweathered periostracum or by periostracum weathered only in umbonal region; by unweathered nacre displaying original color and iridescence; by two valves joined by a tough but flexible proteinaceous ligament; and, in some instances, by attached soft-body tissue. Recent shell material provides important information on the composition of existing mussel communities and may be located by:

a. walking along stream margins and inspecting stream bottom near shoreline;

b. inspecting bottom sediments while wading upstream in shallower, clearer reaches, allowing current to sweep away suspended material and maintain visibility;

c. walking along sand and gravel bars during periods of low stream flow, looking for remains of mussels left by predatory animals or by stranding of live mussels following rapid reductions in water level; and

d. looking for remains of mussels within any stands of vegetation at head of sand and gravel bars and amid accumulations of driftwood and other debris, especially following periods of high flow.

3. At stations with previously undocumented or weakly documented mussel communities, weathered and relict shell material shall be identified and recorded. Weathered shell material is characterized by more significant loss or peeling of periostracum, loss of nacre color and/or development of chalky nacre, brittleness of ligament, and some loss of finer structural features, especially with respect to lateral and pseudocardinal teeth. Relict shell material consists of severely weathered single valves generally lacking any periostracum or nacre coloration and often devoid of any finer sculptural detail. Weathered and relict shell material may be located by:

a. walking along sand and gravel bars during periods of low stream flow, withdrawing partially buried valves from deposited sediment; and

b. walking or wading along steeper, erosional shorelines, extracting buried or partially buried valves from stream bank (note: such
material requires careful interpretation, in that it may range from a few years to several hundred years or more in age).

D. Significant findings of live mussels shall be documented photographically. Photographic documentation shall include digital photographs of single or multiple individuals. A metric ruler should be included in the frame for dimensional reference. Measurements of individual organisms, if made, shall include measurements of shell height and length recorded on Form APP.C-1 (Appendix C). Significant findings of live mussels include:

1. Live specimens of a previously undocumented species.
2. Live specimens outside of known distribution ranges.
3. Live specimens representing a possible recolonization of a formerly occupied range.
4. Live specimens of uncommonly encountered species and/or species listed as threatened or endangered.

E. Significant findings of shell material shall be documented physically. Physical documentation includes retaining the shell material for archiving and storage at the BOW laboratory. Significant findings of shell material include:

1. Recent material of a previously undocumented species.
2. Recent material outside of known distribution ranges.
3. Recent material representing a possible recolonization of a formerly occupied range.
4. Recent material of special interest.
5. Weathered or relict material of a previously undocumented species.
6. Weathered or relict material outside of known distribution ranges.
7. Weathered or relict material of special interest.

F. Retained shell material should be placed in plastic bags labeled in indelible ink with the following information: name of stream, biological monitoring station number, collection date, and names of collectors. Bags are tied shut or sealed with wire closures to prevent spillage and mixing of shell material from different sampling locations.
G. Shell materials to be vouchered are carefully cleaned with warm tap water and a soft-bristled brush, then air dried. All materials are labeled in indelible ink with a unique code (e.g., NE90023) identifying the river basin of origin, year of collection, and order of assignment to archive collection. For each assigned archive code, the following information is recorded on the Mussel Shell Archival Form APP.C-3 (Appendix C): stream basin, stream name, monitoring program station number, latitude and longitude or legal description, narrative site description, names of collectors, collection date, scientific name of specimen, relative abundance of taxon at site (uncommon, common, abundant), shell length and height (mm), and shell condition (recent, weathered, relict). Any other information of interest is recorded on the form under comments section. If a specimen comprises two (paired) valves, each is labeled with the same alphanumeric identifier. Specimens are transferred to plastic zipper storage bags and stored in labeled heavy duty cardboard boxes for archival purposes.

H. Collected shell material is archived in a secure location at the BOW central office storage facility in Topeka. Mussel specimens may be temporarily removed from the BOW reference collection for use in taxonomic identifications and training. At the program manager’s discretion, archived specimens may be donated to museum or university reference collections following entry and verification of associated data and metadata in the Kansas (KDHE) mussel distribution database.
PROCEDURES FOR PREPARATION, IDENTIFICATION, ENUMERATION AND PRESERVATION OF BIOLOGICAL SPECIMENS (SBMP-004)

I. INTRODUCTION

A. Purpose

Procedures employed in the identification and enumeration of quantitative macroinvertebrate samples and preservation of voucher specimens are described in this SOP.

B. Minimum Staff Qualifications

Staff implementing this position must meet the minimum classification requirements for environmental specialist published by the Kansas Department of Administration. They also must be well versed in aquatic invertebrate taxonomy and possess a strong familiarity with the macroinvertebrate taxa known from the streams of Kansas. The required level of knowledge normally is gained through a combination of college course work and several years of active research in this field.

C. Equipment/Accessories

1. Variable zoom dissecting microscope (minimally capable of at minimum 10X-70X magnification zoom range) with a variable intensity light source

2. Variable magnification compound microscope (minimally capable of at minimum 40X, 100X, and 400X magnification) with integral variable intensity light source

3. Glass or plastic Petri dishes, coarse and fine point dissection probes, fine and extra fine forceps

4. Specimen vials, specimen vial trays, solution of 70-80% ethanol and 5% glycerine, reference collection housed in locking storage cabinet

5. Microscope slide storage boxes, microscope slides, microscope slide cover slips, slide mounting and clearing medium, glycerine, hot plate for drying and curing slide mounts

6. Taxonomic keys and supporting references
II. PROCEDURES

A. Identification and enumeration of macroinvertebrate samples in the laboratory begins with completion of the header information on the Identification Bench Sheet Form APP.C-2 (Appendix C). Station number and location, collection date, and collectors' names are transcribed from the sample jar and field collection form. The examination date and name of examiner are likewise recorded on the biological data form.

B. Contents of the two jars that make up a sample are pooled into one or two Petri dishes. Extraneous debris is removed, and the organisms are presorted with the unaided eye into various phylogenetic groups (e.g., order, family, genus).

C. After preliminary sorting, the organisms are examined individually with a dissecting microscope, further sorted and identified, and enumerated on the biological data form.

D. Certain taxonomic groups, small specimens, and certain anatomical features of some groups may need to be mounted on a microscope slide and examined under higher magnification (early instars, midge head capsules, mayfly gills and legs, riffle beetle male genitalia, etc.). Ten percent KOH solution is used as a clearing agent for dissected insects or whole mounted chironomids. Euparal mounting medium is used to permanently mount dissected or whole insects and oligochaetes.

E. An attempt is made to identify all specimens to the lowest practicable taxonomic level, generally genus or species. Taxonomic works written specifically for the fauna of the state or region are preferentially utilized. Unusual or unprecedented determinations are compared to comprehensive lists of macroinvertebrate species previously documented in Kansas.

F. A reference collection is maintained of all aquatic macroinvertebrate taxa encountered historically in the monitoring program. This collection is helpful when working with difficult groups or less frequently encountered species, and it provides a valuable training and educational tool. Many specimens included in the collection have been identified or confirmed by outside experts.

G. After specimens have been identified, enumerated and recorded, pooled samples are transferred to storage and maintained for a minimum of five years.

H. Microscopes must have dust covers in place at all times when not in use. Cleaning of optics is performed with lens tissue and, if necessary, cleaning solvent. The condenser on the compound microscope is periodically adjusted to maintain maximum performance and resolution.
I. INTRODUCTION

A. Purpose

This SOP provides instructions for the completion of the Field Collection Form and SMASH index (Form App.C-1). This form was developed as a multipurpose form to reduce program paperwork volume. Formerly, a separate Field Collection Form, Habitat Development Index (HDI) Form, and Live Mussel Recording Form were utilized. The form is completed upon conclusion of biological (macroinvertebrate) sample collection activities before exiting the sample site.

B. Minimum Staff Qualifications

Personnel implementing this SOP should meet the minimum classification requirements for environmental specialist published by the Kansas Department of Administration. They also should be experienced in the measurement of the chemical and physical properties of surface water and have a basic technical understanding of the associated measurement apparatus.

C. Equipment/Accessories

1. Measuring pole or D-frame aquatic net with handle graduated in decimeters
2. Hip or chest waders, depending on water depth and prevailing flow conditions
3. Plastic bucket and metric ruler
4. Digital Camera
5. Metal field folder containing, field collection forms, freshwater mussel distribution maps (e.g. Angelo 2009 and/or KDWPT 2008), and pencils

II. FIELD COLLECTION FORM – Front Side

A. Instructions for completing sample site visit information

1. Station – record the “SB” three-digit SBMP station identifier code, the
stream name, and brief description of location (e.g. SB003 Republican River 1 mile north of Concordia). If the site does not have an established code, the program manager will assign a unique identification code for future reference.

2. Date – Record the date in mm/dd/yyyy format

3. Latitude and longitude – record in decimal degrees (see SOP SBMP-006) at new stations lacking established GPS coordinates. May be left blank at established stations with existing SB numbers and GPS coordinates.

B. Instructions for completing the Stream Macroinvertebrate Assessment Sampled Habitat (SMASH) Index. The SMASH Index score is a numerical expression of the habitat sampled during a macroinvertebrate collection event. Only the habitat features where efforts were made to collect macroinvertebrates are scored. A comparison of SMASH Index scores is useful in accounting for the possible effects of habitat differences on biotic index values.

1. Flow: – For each macrohabitat type sampled, record a score for only the highest quality flow category sampled.
   a. Laminar flow occurs when water flows smoothly in parallel layers with no disruption or turbulence. The surface of the water appears smooth.
   b. Slightly turbulent flow occurs when water is pushed up and over or around submerged objects causing variations in velocity and direction. The surface of water appears broken or roughly rippled but air bubbles are not being formed and mixed into the water column.
   c. Splashing flow occurs when water becomes highly turbulent and the surface is completely broken causing air bubbles to be mixed into the water column (i.e. white water).

2. Depth – Record only the deepest depth sampled in run and pool macrohabitats.

3. Substrate – Record a score for all types of substrate sampled in each macrohabitat.

4. Edge – Record a score for all types of edge habitats sampled in each macrohabitat.
a. Macrophytes – rooted living aquatic submergent or emergent vegetation and partially submerged grasses or herbaceous riparian vegetation rooted in the channel after a prolonged period of extreme low flow.

b. Bank Roots – flexible fine (small-diameter) roots of riparian vegetation which are exposed below the water line. Large diameter inflexible woody roots are not scored. Score only the highest quality bank root type sampled if both types are sampled. Fine roots which are thinly dispersed and inadequate for sheltering large numbers of aquatic macroinvertebrates are scored as sparse. Large densely tangled masses of fine roots capable of sheltering large numbers of aquatic organisms are scored as dense.

c. Undercut – a bank that overhangs the stream bottom and is resistant to erosion, usually stabilized by the roots of riparian vegetation. Provides shelter to aquatic macroinvertebrates and fish.

5. **Algae** – record a score for all types of algae sampled in each macrohabitat.

a. Filamentous algae – consists of long threads of algae cells that sometimes intertwine into rope-like strands which may entangle and form mats. Record only the highest scoring type of filamentous algae sampled. Sparse filamentous algae are thinly dispersed upon the substrate to which they are attached providing both shelter and food for aquatic organisms. Heavy filamentous algae mostly cover the substrates to which they are attached limiting the colonization by larger macroinvertebrates (e.g. EPTs). Dominating filamentous algae completely covers the substrates to which they are attached and occupy most or all of the stream bed interstitial spaces, thus precluding colonization by larger macroinvertebrates.

b. Habitat providing periphyton – is a layer of non-filamentous algae and/or bryophytes attached to various stream substrates having a sufficient thickness to provide shelter for small macroinvertebrates (e.g. chironomidae, elmidae, baetidae, etc.).

6. **Embeddedness** – record only the highest scoring embeddedness condition sampled in each macrohabitat. Embeddedness is the proportion (percentage) of large rock substrates (gravel, cobble and boulders) which are surrounded by fine substrates (sand and silt) in the stream bottom. Estimates of substrate embeddedness are usually made using best
professional judgement. Large substrate particles may be removed from the stream bed and examined to determine embeddedness.

7. **Debris** – record all types of organic debris sampled. Record a score of 3 for “water-logged” if any sampled logs, branches, or sticks have been submerged for a sufficient length of time for water to have saturated and softened at least the outer bark and vascular cambium. For material to qualify as a branch/stick it must be too large and/or long to be swept into a D-frame net, and large enough to potentially harbor at least 50 macroinvertebrates. The material shall be recorded and scored whether colonized or not.
I. INTRODUCTION

A. Purpose

This SOP outlines vehicle safety and maintenance procedures used during the collection and transport of stream biological samples. Safety procedures are established to prevent or minimize property damage, personal injuries, and/or loss of life. Maintenance procedures are established to prevent or minimize vehicle breakdowns and to extend the usable life of the vehicle.

B. Minimum Staff Qualifications

Staff implementing this SOP should meet the minimum classification requirements for environmental specialist published by the Kansas Department of Administration. They also must possess a valid Kansas driver's license and current certifications in both standard first aid and cardiopulmonary resuscitation (CPR). Although not required, these employees are strongly encouraged to participate in defensive driving courses offered by some law enforcement agencies and other qualified organizations.

C. Equipment/Accessories

Minivan or other sampling vehicle, as available

II. PROCEDURES

Procedures described in BOW SOP No. SCMP-002 are adopted by reference.
PROCEDURES FOR DETERMINING GEOGRAPHICAL COORDINATES OF STREAM BIOLOGICAL MONITORING SITES (SBMP-006)

I. INTRODUCTION

A. Purpose

Accurate documentation of geographical position (longitude and latitude) reduces the risk of obtaining environmental samples from the wrong monitoring site and facilitates the analysis of monitoring data through geographical information system (GIS) techniques. Since 2001, the location of all stream sites visited by staff for biological sampling purposes has been precisely documented using GPS procedures.

B. Minimum Staff Qualifications

Personnel implementing this SOP should meet the minimum classification requirements for environmental specialist published by the Kansas Department of Administration. They also should be experienced in the use of GPS equipment and possess a basic understanding of the underlying technology.

C. Equipment/Accessories

1. Garmin GPSIII+, Garmin V, or other acceptable handheld GPS unit.
2. Garmin MapQuest software or other acceptable GPS software.
3. Personal Desktop or Laptop computer with Google Earth software

II. PROCEDURES – Field determination using hand held GPS unit

A. Consult the handheld GPS unit’s user manual for instructions on gathering coordinates and marking and saving waypoints.
B. At least 3 satellites must be over the horizon and free from obstruction for unit to calculate an accurate position.
C. Once waypoint has been marked in the GPS unit, record the displayed position on Field Collection Data Sheet.

III. PROCEDURES – Desktop determination using Google Earth

A. Find sampled stream on Google Earth and determine the normal upstream limit of normal sampling activities and the normal downstream limit of sampling activities.
B. Zoom view and place the cursor at the approximate location of the center of normal sampling activities in the center of the stream channel (the access point is commonly at a city, county, or state road/highway bridge).

C. Record the decimal degrees latitude and longitude displayed at the bottom of the Google Earth display.

D. Before registering the coordinates for the site, check the accuracy of the coordinates using another geographical mapping application such as ArcGIS.
APPENDIX C

STANDARDIZED FIELD AND TAXONOMIC FORMS
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### Stream Biological Monitoring Program

#### Stream Macroinvertebrate Assessment Sampled Habitat Index

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<td>Undercut (3)</td>
<td>Snagging Sand (0)</td>
<td>Snagging Sand (0)</td>
</tr>
<tr>
<td><strong>ALGAE</strong> Record All Types Sampled</td>
<td><strong>ALGAE</strong> Record All Types Sampled</td>
<td><strong>ALGAE</strong> Record All Types Sampled</td>
</tr>
<tr>
<td>Filamentous Sparse (3) Heavy (1) or Dominating (-3)</td>
<td>Silt Covered Sand or Gravel (1)</td>
<td>Silt Covered Sand or Gravel (1)</td>
</tr>
<tr>
<td>Habitat Providing Periphyton (3)</td>
<td>Large Flat Rocks/Boulders &gt; 8” Diameter (4)</td>
<td>Large Flat Rocks/Boulders &gt; 8” Diameter (4)</td>
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<tr>
<td>Cobble/Flat Rock &gt; 3-8” Diameter (3)</td>
<td>Gravel 1/2”-3” (3)</td>
<td>Gravel 1/2”-3” (3)</td>
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<tr>
<td><strong>EMBEDDEDNESS</strong> Record Best Condition Sampled</td>
<td><strong>EMBEDDEDNESS</strong> Record Best Condition Sampled</td>
<td><strong>EMBEDDEDNESS</strong> Record Best Condition Sampled</td>
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<tr>
<td>0-25% (+10)</td>
<td>0-25% (+8)</td>
<td>0-25% (+8)</td>
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<tr>
<td>26-75% (+5)</td>
<td>26-75% (+4)</td>
<td>26-75% (+4)</td>
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<tr>
<td>&gt;75% (+10)</td>
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<td>&gt;75% (+0)</td>
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<tr>
<td><strong>ORGANIC DEBRIS</strong> Record All Types Sampled</td>
<td><strong>ORGANIC DEBRIS</strong> Record All Types Sampled</td>
<td><strong>ORGANIC DEBRIS</strong> Record All Types Sampled</td>
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<tr>
<td>Logs &gt; 4” Diameter (2)</td>
<td>Branches/Sticks (1)</td>
<td>Branches/Sticks (1)</td>
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<td>Water-logged (3) or Recent Deposits (0)</td>
<td>Filamentous Sparse (3) Heavy (-1) or Dominating (-3)</td>
<td>Filamentous Sparse (3) Heavy (-1) or Dominating (-3)</td>
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<tr>
<td>Course Woody/Organic Debris or Leaf Pack Deposit (1)</td>
<td>Habitat Providing Periphyton (3)</td>
<td>Habitat Providing Periphyton (3)</td>
</tr>
</tbody>
</table>

*Only score habitat features actually sampled! Leave unscorable rows blank.
*Select one score when multiple scores are offered on a single line. Score the highest quality condition sampled.

**EMBEDDEDNESS** for Runs and Pools:
- Record >75% Score = 0 for sites if no loose rock substrate was sampled.

<table>
<thead>
<tr>
<th>Site Score</th>
<th>Total:</th>
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## FIELD COLLECTION FORM – SAMPLE SITE DESCRIPTION, COMMENTS, AND MUSSEL OBSERVATIONS

**FORM APP.C-1 (Back of Form)**

<table>
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<th>COMMENTS AND OBSERVATIONS</th>
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</thead>
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<tr>
<td>FLOW CONDITIONS (CHECK)</td>
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<tr>
<td>ELEVATED</td>
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<tr>
<td>BASE</td>
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<tr>
<td>EXTREME LOW</td>
<td></td>
</tr>
<tr>
<td>WATER TEMPERATURE (CELSIUS)</td>
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<tr>
<td>MUSSEL SHELLS COLLECTED (CHECK)</td>
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<tr>
<td>MUSSEL INFORMATION RECORDED ON SITE (CONDITION)</td>
<td>SPECIES (# AGE CLASS)</td>
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<td>#</td>
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<tr>
<td>SITE SKETCH OR ADDITIONAL INFORMATION</td>
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MACROINVERTEBRATE IDENTIFICATION BENCH SHEET
FORM APP. C-2

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<th>A</th>
<th>I</th>
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<td>Trichoptera</td>
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KBS CODE=KDHE KANSAS BIOSYSTEM TAXON UNIQUE CODE A=#NUMBER OF ADULTS IN SAMPLE
N=#NUMBER OF NYMPHS IN SAMPLE L=#NUMBER OF LARVAE IN SAMPLE P=#NUMBER OF PUPAE IN SAMPLE
TOT. #_______ TOT. TAXA_______ EPT INDEX_______ MBI_______ MBI(N)_______ HDI_______ D.O._______

Sheet_______of_______
MUSSEL SHELL ARCHIVAL FORM
FORM APP. C-3

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<th>ARCHIVE #</th>
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<td>LAKE STATION #</td>
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<tr>
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</tr>
<tr>
<td>LEGAL DESC.</td>
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<tr>
<td>SCIENTIFIC NAME</td>
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</tr>
<tr>
<td>REL. ABUND.: PRESENT</td>
<td>COMMON</td>
<td>ABUNDANT</td>
</tr>
<tr>
<td>SHELL CONDITION: LIVE</td>
<td>RECENT</td>
<td>WEATHERED</td>
</tr>
<tr>
<td>SHELL HEIGHT</td>
<td>mm LENGTH</td>
<td>mm COLLECTED BY</td>
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<tr>
<td>REMARKS:</td>
<td></td>
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<table>
<thead>
<tr>
<th>ARCHIVE #</th>
<th>BASIN</th>
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</thead>
<tbody>
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<tr>
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<td></td>
</tr>
<tr>
<td>REL. ABUND.: PRESENT</td>
<td>COMMON</td>
<td>ABUNDANT</td>
</tr>
<tr>
<td>SHELL CONDITION: LIVE</td>
<td>RECENT</td>
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<td>SHELL HEIGHT</td>
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<td>mm COLLECTED BY</td>
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<tr>
<td>REMARKS:</td>
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<table>
<thead>
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<td>LAKE STATION #</td>
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<td>UAA SEG/STATION</td>
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<td>LONG.</td>
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<td>SCIENTIFIC NAME</td>
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<td>SHELL CONDITION: LIVE</td>
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<td>SHELL HEIGHT</td>
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### KANSAS NAIAD REFERENCE LIST

**FORM APP. C-4**

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<td><em>Cumberlandia monodonta</em> (Say, 1829)</td>
<td>spectaclecase</td>
<td>extirpated</td>
</tr>
<tr>
<td><em>Alasmidonta marginita</em> Say, 1818</td>
<td>elk toe</td>
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</tr>
<tr>
<td><em>Alasmidonta viridis</em> (Rafinesque, 1820)</td>
<td>slippershell mussel</td>
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</tr>
<tr>
<td><em>Anodonta suborbicularis</em> Say, 1831</td>
<td>flat floater</td>
<td>endangered</td>
</tr>
<tr>
<td><em>Anodonta occidentalis</em> (Lea, 1834)</td>
<td>cylindrical papershell</td>
<td>threatened</td>
</tr>
<tr>
<td><em>Arcida confusa</em> Say, (1829)</td>
<td>rock pocketbook</td>
<td>threatened</td>
</tr>
<tr>
<td><em>Lasmigona complanata complanata</em> (Barnes, 1823)</td>
<td>white helixshell</td>
<td>threatened</td>
</tr>
<tr>
<td><em>Lasmigona costata</em> (Rafinesque, 1820)</td>
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</tr>
<tr>
<td><em>Pyrgonula grandis</em> (Say, 1829)</td>
<td>giant floater</td>
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<tr>
<td><em>Spathula undulata</em> (Say, 1817)</td>
<td>creeper</td>
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<tr>
<td><em>Utterbackia imbecilla</em> (Say, 1829)</td>
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</tr>
<tr>
<td><em>Amblema plicata</em> (Say, 1817)</td>
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<tr>
<td><em>Cyclonaias tuberculata</em> (Rafinesque, 1820)</td>
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<td><em>Eliptio dilatata</em> (Rafinesque, 1820)</td>
<td>spike</td>
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<tr>
<td><em>Fusconaia flavus</em> (Rafinesque, 1820)</td>
<td>Wabash pigtoe</td>
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<td><em>Fusconaia aurantia</em> (Call, 1887)</td>
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<tr>
<td><em>Megalonaias nervosa</em> (Rafinesque, 1820)</td>
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<tr>
<td><em>Phlebobema sintoxa</em> (Rafinesque, 1820)</td>
<td>round pigtoe</td>
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<td><em>Quadrula cylindrica</em> (Say, 1817)</td>
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<td><em>Quadrula fragosa</em> (Conrad, 1835)</td>
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<td><em>Quadrula metanervia</em> (Rafinesque, 1820)</td>
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<td><em>Quadrula nodulata</em> (Rafinesque, 1820)</td>
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<td><em>Trigonia verrucosa</em> (Rafinesque, 1820)</td>
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<td><em>Unisona tetralasmus</em> (Say, 1831)</td>
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<tr>
<td><em>Actiononias ligamentina</em> (Lamarck, 1819)</td>
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<tr>
<td><em>Cypragena aberti</em> (Conrad, 1850)</td>
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<td><em>Eliptio lineata</em> (Rafinesque, 1820)</td>
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<td><em>Epioblasma trigonella</em> (Rafinesque, 1820)</td>
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<td><em>Ligumia subrotata</em> (Say, 1831)</td>
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<td><em>Obiquaria reflexa</em> Rafinesque, 1820</td>
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<td><em>Trancilla donatiiformis</em> (I. Lea, 1828)</td>
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<tr>
<td><em>Trancilla truncata</em> Rafinesque, 1820</td>
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<tr>
<td><em>Venustacosa elliptiformis</em> (Conrad, 1836)</td>
<td>ellipse</td>
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</table>
APPENDIX D

REFERENCES CITED


APPENDIX E

GLOSSARY OF TERMS
GLOSSARY OF TERMS

**accuracy** -- the extent to which a measured value actually represents the condition being measured. Accuracy is influenced by the degree of random error (precision) and systematic error (bias) inherent in the measurement operation (e.g., environmental sampling and analytical operations).

**activity** -- an all inclusive term describing a specific set of operations or related tasks to be performed, either serially or in parallel (e.g., research and development, field sampling, analytical operations), that in total result in a product or service.

**audit** -- a systematic and independent examination to determine whether quality activities and related results comply with planned arrangements and whether these arrangements are implemented effectively and are suitable to achieve objectives.

**bias** -- the systematic or persistent distortion of a measurement process which causes errors in one direction (i.e., the degree to which the expected sample measurement is different from the true sample value).

**chain of custody** -- an unbroken trail of accountability that ensures the physical security of samples, data and records.

**comparability** -- a measure of the confidence with which one item (e.g., data set) can be compared to another.

**completeness** -- a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions.

**computer program** -- a sequence of instructions suitable for processing by a computer. Processing may include the use of an assembler, compiler, interpreter, or translator to prepare the program for execution. A computer program may be stored on electrical, magnetic or optical media.

**corrective action** -- any measure taken to rectify a condition adverse to quality and, where possible, to preclude its recurrence.

**document** -- any written or pictorial information describing, defining, specifying, reporting, or certifying activities, requirements, procedures or results.

**duplicate samples** -- paired samples collected at essentially the same time from the same site and carried through all assessment and analytical procedures in an identical manner. Duplicate samples are used to measure natural variability as well as the precision of a method, monitoring instrument, and/or analyst. More than two such samples are referred to as replicate samples.
D-frame -- a long handled net with an opening in the shape of the capital letter D and a bag mesh size of 0.5 mm.

ecoregion -- an ecologically distinctive geographic area defined in the context of a combination of landscape characteristics such as climate, physiography, soils, vegetation (or potential vegetation), geology, and land use.

independent assessment -- a quality assessment of an environmental monitoring program, project or system performed by a qualified individual, group, or organization that is not part of the program, project or system.

internal assessment -- any quality assessment of the work performed by an individual, group, or organization, conducted by those overseeing and/or performing the work.

method -- a body of procedures for performing an activity in a systematic and repeatable manner.

organization -- a company, corporation, firm, enterprise, or institution, or part thereof, whether incorporated or not, public or private, that has its own functions and administration.

performance evaluation -- a type of audit in which quantitative data generated in a measurement system are obtained independently and compared with routinely obtained data to evaluate the proficiency of a technician, analyst or laboratory.

precision -- the level of agreement among individual measurements of the same property, conducted under identical or similar conditions.

qualified data -- data that have been modified, adjusted or flagged in a database following data validation and verification procedures.

quality -- those features of a product or service that bear on its ability to meet the stated or implied needs and expectations of the user.

quality assurance (QA) -- an integrated system of management activities involving planning, implementation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the user.

quality assurance project (program) plan (QAPP) -- a formal document that describes in detail the necessary QA, QC, and other technical activities that must be implemented to ensure that the results of the work performed for the program or project satisfy the stated performance criteria.

quality control (QC) -- the overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements of the user.
quality management plan (QMP) -- a formal document that describes a quality management system in terms of the organizational structure, functional responsibilities, and planning, implementation and assessment of work.

record -- a document or portion thereof furnishing evidence of the quality of an item or activity, verified and authenticated as technically complete and correct. Records may include reports, photographs, drawings, and data stored on electronic, magnetic, optical or other recording media.

reference site -- a stream location that is, from an ecological perspective, only minimally impacted by modern (post settlement) human activities based on comparisons to the historical baseline condition or in relation to other, more heavily impacted streams within the geographical region of interest.

relative percent difference (RPD) -- a value calculated by subtracting the lower of two duplicate analyses from the higher, then dividing this difference by the average of the two analyses and multiplying the result by 100 to convert to percent difference.

replicate sample -- see duplicate sample.

representativeness -- a measure of the degree to which data accurately and precisely represent a selected characteristic of a monitored system.

reproducibility -- a measure of the degree to which sequential or repeated measurements of the same system vary from one another, independently of any actual change in the system.

standard operating procedure (SOP) -- a written, formally approved document that comprehensively and sequentially describes the methods employed in a routine operation, analysis or action.

surveillance (quality) -- continual or frequent monitoring and verification of the status of an entity (e.g., monitoring program) and the analysis of records to ensure that specified requirements are being fulfilled.

taxon (singular of taxon) -- the lowest practicable level of identification (e.g., family, genus, species) that can be applied to a group of phylogenetically related organisms.

taxa richness -- a summation of the number of taxa determined as present in a sample.

taxonomy -- the classification of organisms according to their established phylogenetic relationships.

technical review -- a critical review of an operation by independent reviewers collectively equivalent in technical expertise to those performing the operation.
validation -- the establishment of a conclusion based on detailed evidence or by demonstration. This term often is used in conjunction with formal legal or official actions.

verification -- the establishment of a conclusion based on detailed evidence or by demonstration. This term normally implies proof by comparison.