

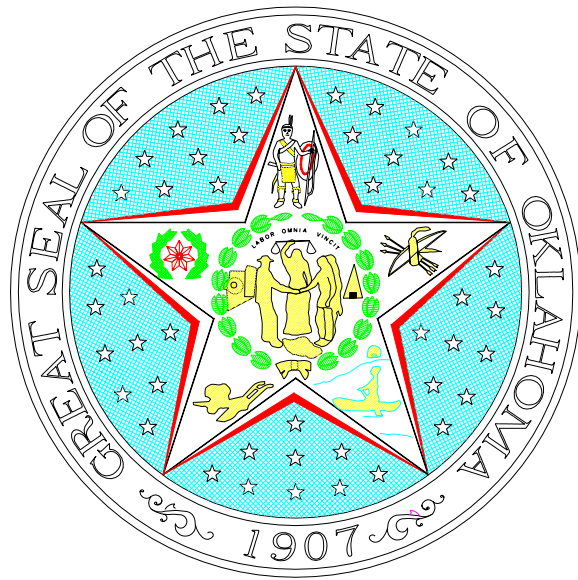
OWRB TECHNICAL REPORT 99-3

**Standard Operating Procedures
For Stream Assessments and Biological Collections
Related to Biological Criteria
in Oklahoma**



April 5, 1999

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EXECUTIVE SUMMARY OF
STANDARD OPERATING PROCEDURES FOR STREAM ASSESSMENTS
AND BIOLOGICAL COLLECTIONS RELATED TO BIOLOGICAL CRITERIA
IN OKLAHOMA

The thrust of U.S.E.P.A criteria development over the past several years has been to encourage states to develop and adopt, at a minimum, narrative biological criteria. EPA has also encouraged all states to follow the lead of a few states in developing and adopting numeric biological criteria. Biological criteria for Oklahoma have yet to be developed. The development process, however, is continuing and this protocol is another step in that process.

This protocol is the result of the cumulative efforts of numerous representatives from several state agencies and universities. Approximately four years have been invested in the development of these procedures and field tests have repeatedly validated them.

The intended application of this protocol is establishment of a uniform biological assessment through which aquatic communities of similar streams can be compared. Any section of the protocol (physical, chemical or biological) is capable of being used separately. However, a complete picture of the biological condition of any given stream necessitates that each section be applied in conjunction with the others. Agencies, universities, independent entities and individuals are not required to employ these protocols for their own projects unrelated to biological criteria. Separate, project-driven or agency-devised protocols are acceptable for other purposes. Only when results are to be used in biological criteria applications related to Oklahoma's Water Quality Standards will these protocols be required.

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INTRODUCTION

For the past several years, EPA has been moving toward and encouraging the development of biological criteria (biocriteria) in conjunction with numeric water quality criteria. The use of endemic organisms and communities as indicators of long-term water quality has been recognized by biological researchers for decades. Only recently has the concept begun moving into the regulatory arena. Several states have implemented some form of biocriteria over the past decade and Oklahoma is aggressively moving toward that same goal.

Oklahoma Water Resources Board (OWRB) staff, in conjunction with a Technical Advisory Committee, have developed the following Standard Operating Procedures (SOPs) for assessments involving or relating to biological criteria. This group was comprised of individuals representing several agencies and universities in order to gain as much insight and as many different perspectives as possible. These protocols are the culmination of years of development and testing.

These protocols are required for use during any project where the biological component of a stream is to be compared to reference conditions or other biocriteria results. For biocriteria-related projects, four major classes of parameters must be sampled. These are as follows:

1. Physico-chemical parameters of the water. These include temperature, pH, specific conductivity, dissolved oxygen, percent oxygen saturation, turbidity, instantaneous discharge, hardness, alkalinity, ammonia, phosphates, and nitrates.
2. Habitat Assessment.
3. Macroinvertebrate community structure.
4. Fish community structure.

SOP's for these parameters will be detailed in the following pages. These SOP's are designed and intended to be used outside of the mixing zone of the receiving stream. **ALL ASSESSMENTS AND BIOLOGICAL COLLECTIONS SHOULD ONLY OCCUR AFTER 13 STREAM WIDTHS DOWNSTREAM OF THE POINT OF DISCHARGE.**

STANDARD OPERATING PROCEDURES

CHEMICAL PARAMETERS

All chemical testing follows protocols from the 18th edition of Standard Methods for the Examination of Water and Wastewater (American Public Health Association et al., 1992). Any modifications to these protocols must comply with USEPA regulations and approval.

Parameters to be tested during any sampling event, and associated requirements, will include:

- temperature ($^{\circ}\text{C}$ thermometer)
- pH (standard units)
 - pH meter or standard titration
- specific conductivity (μS)
 - conductivity meter or calibrated instrument such as Hydrolab or YSI
- dissolved oxygen (mg/L)
 - modified Winkler titration or calibrated DO meter
- percent oxygen saturation (%)
 - calibrated instrument such as YSI or Hydrolab or conversion from solubility chart (such as from Benson and Krause, 1980 or Hach, 1992 as attached)
- turbidity (NTU's)
 - calibrated instrument such as YSI, turbidimeter or colorimeter
- instantaneous discharge(flow measured as CFS)
 - calibrated instrument such as Marsh-McBirney Flomate model 2000 and appropriate calculation
- total hardness (mg/L equivalent CaCO_3)
 - EDTA titration or colorimeter
- alkalinity (mg/L equivalent CaCO_3)
 - sulfuric acid titration or colorimeter
- ammonia (mg/L)
 - Nessler's titration, colorimeter or colorimetric kit
- phosphates (mg/L total orthophosphate)
 - ascorbic acid colorimetric method or colorimetric kit
- nitrate (mg/L)
 - cadmium reduction colorimetric method or colorimetric kit

All references to colorimeter or colorimetric methods should be interpreted as meaning following manufacturers instructions for each parameter being tested with the colorimeter or spectrophotometer.

All references to equipment such as Hydrolab or YSI refers to the multi-parameter recording dataloggers available from both companies. All manufacturer's instructions should be followed for calibration and maintenance of the equipment.

All references to colorimetric kits refer to those kits from reputable companies such as LaMotte. These kits have proven reliable through prolonged use by volunteer monitors.

All references to collection equipment manufacturers such as Smith-Root are for reference and comparison only. Mesh sizes in nets, seines and sieves are the only required specifications for equipment intended to be used.

SITE SELECTION

The site chosen for chemical testing should be one that is free of obvious trash and surface materials (e.g. scums, oil sheens, foams, etc.). A site which is close to the road may be preferable for convenience but may not be representative of conditions in the stream as a whole. Select a site that has sufficient depth to submerge the Hydrolab or YSI monitor, lacks excessive turbulence and appears to be similar to most of the visible stream reach to be assessed.

SAMPLE COLLECTION

When collecting a water sample for laboratory analysis, how the sample is taken can be as important to the results as the chemical composition of the water. In most cases, a simple grab sample is sufficient for chemical analyses. It is recommended that all grab samples be taken **BELOW** the surface to prevent contamination by surface materials that may be present. Submerge the sample container inverted and turn it upright once the container is fully submerged. When collecting D.O. samples for titration, **DO NOT** allow bubbles to interfere with the analysis. This can be prevented by submerging the D.O. bottle on its side allowing the water to enter the bottle gradually without causing bubbles to form. Submerge the bottle completely so that the neck of the bottle is full and water will be expelled when putting the cap on. This prevents additional oxygen from being dissolved into the sample from the space at the top of the bottle. This procedure is not necessary if the Hydrolab or YSI is equipped with a D.O. sensor.

Samples transported to the lab must be preserved. In most cases, samples can be preserved using ice and a covered ice chest if analysis is to occur within 24 hours. The dark and cold will prevent algal and chemical activity and possible alteration of chemical composition of the sample. The sample container should be covered at least to the lid by ice to ensure rapid and continuous cooling. If taking more than one sample during any particular trip, ensure that each sample container is labeled with the date, collectors names and appropriate site identification information (e.g. stream name, legal location, county name, etc.).

Some types of analysis (nitrate and ammonia) require that samples be preserved with acid if analysis cannot be performed within approximately 24 hours. In these cases, using approximately 2ml sulfuric acid per liter of sample will reduce the pH of the sample sufficiently to allow storage for up to 14 days (for nitrate) and 28 days (for ammonia) **in refrigeration** (<4° C). Samples will still need to be iced when transporting from the field after preservation and in the laboratory until analysis is completed.

Using the form in Figure 1 will help ensure consistent record-keeping. The table found in Figure 2 can be used to approximate oxygen saturation percentage by dividing the D.O. results in sample by the saturation concentration found on the table. Be sure to know the temperature and barometric pressure at the time of sampling.

STREAM _____				
COUNTY _____				
LEGAL _____				
DATE _____		ANALYZERS _____		
	SITE 1 (A)	SITE 2 (B)	SITE 3 (C)	SITE 4 (D)
water temp (°C)				
dissolved oxygen (mg/L)				
oxygen saturation (%)				
carbon dioxide (mg/L)				
pH				
turbidity (NTU)				
specific conductance (µS)				
ammonia (mg/L)				
nitrate (mg/L)				
phosphates (mg/L)				
hardness (mg/L)				
alkalinity (mg/L)				
flow (CFS)				

SITE DESCRIPTIONS

- (A)
- (B)
- (C)
- (D)

Figure 1: Water chemistry data sheet used in OWRB biocriteria assessments.

	Pressure in Millimeters and Inches Hg								
	775	760	750	725	700	675	650	625	mm
TEMP (oC)	30.51	29.92	29.53	28.54	27.56	26.57	25.50	24.61	inches
0	14.9	14.6	14.4	13.9	13.5	12.9	12.5	12.0	
1	14.5	14.2	14.1	13.6	13.1	12.6	12.2	11.7	
2	14.1	13.9	13.7	13.2	12.9	12.3	11.8	11.4	
3	13.8	13.5	13.3	12.9	12.4	12.0	11.5	11.1	
4	13.4	13.2	13.0	125.5	12.1	11.7	11.2	10.8	
5	13.1	12.8	12.6	12.2	11.8	11.4	10.9	10.5	
6	12.7	12.5	12.3	11.9	11.5	11.1	10.7	10.3	
7	12.4	12.2	12.0	11.6	11.2	10.8	10.4	10.0	
8	12.1	11.9	1.7	11.3	10.9	10.5	10.1	9.8	
9	11.8	11.6	11.5	11.1	10.7	10.3	9.9	9.5	
10	11.6	11.3	11.2	10.8	10.4	10.1	9.7	9.3	
11	11.3	11.1	10.9	10.6	10.2	9.8	9.5	9.1	
12	11.1	10.8	10.7	10.3	10.0	9.6	9.2	8.9	
13	10.8	10.6	10.5	10.1	9.8	9.4	9.1	8.7	
14	10.6	10.4	10.2	9.9	9.5	9.2	8.9	8.5	
15	10.4	10.2	10.0	9.7	9.3	9.0	8.7	8.3	
16	10.1	9.9	9.8	9.5	9.1	8.8	8.5	8.1	
17	9.9	9.7	9.6	9.3	9.0	8.6	8.3	8.0	
18	9.7	9.5	9.4	9.1	8.8	8.4	8.1	7.8	
19	9.5	9.3	9.2	8.9	8.6	8.3	8.0	7.6	
20	9.3	9.2	9.1	8.7	8.4	8.1	7.8	7.5	
21	9.2	9.0	8.9	8.6	8.3	8.0	7.7	7.4	
23	9.0	8.8	8.7	8.4	8.1	7.8	7.5	7.2	
22	8.8	8.7	8.5	8.2	8.0	7.7	7.4	7.1	
24	8.7	8.5	8.4	8.1	7.8	7.5	7.2	7.0	
25	8.5	8.4	8.3	8.0	7.7	7.4	7.1	6.8	
26	8.4	8.2	8.1	7.8	7.6	7.3	7.0	6.7	
27	8.2	8.1	8.0	7.7	7.4	7.1	6.9	6.6	
28	8.1	7.9	7.8	7.6	7.3	7.0	6.7	6.5	
29	7.9	7.8	7.7	7.4	7.2	6.9	6.6	6.4	
30	7.8	7.7	7.6	7.3	7.0	6.8	6.5	6.2	
31	7.7	7.5	7.4	7.2	6.9	6.7	6.4	6.1	
32	7.6	7.4	7.3	7.0	6.8	6.6	6.3	6.0	
33	7.4	7.3	7.2	6.9	6.7	6.4	6.2	5.9	
34	7.3	7.2	7.1	6.8	6.6	6.3	6.1	5.8	
35	7.2	7.1	7.0	6.7	6.5	6.2	6.0	5.7	
36	7.1	7.0	6.9	6.6	6.4	6.1	5.9	5.6	
37	7.0	6.8	6.7	6.5	6.3	6.0	5.8	5.6	

Figure 2: Oxygen saturation table from Hach (1992). All measurements are reported in mg/L.

STANDARD OPERATING PROCEDURE

Macroinvertebrate Collection

Macroinvertebrate collections made for purposes of stream assessment are made from the community which requires or prefers flowing water. Reasons why this community is sampled rather than various lentic communities include:

1. The flowing water community is routinely exposed to the average water quality of the stream.
2. The metrics designed to analyze the macroinvertebrate community of streams were designed for the flowing water community. There is no evidence that they work when applied to lentic communities.
3. The database of pollution tolerance of macroinvertebrates found in Oklahoma is much larger for lotic communities.

Lotic communities in streams require a substrate of some type to attach to. The most common substrates of this type which are encountered are rocky riffles, streamside rootmasses, and woody debris. Where possible, a rocky riffle should be sampled, but if it is not present, or is of dubious quality, or rocky riffles cannot be found in all streams of a given ecoregion, both of the other two alternate habitats should be sampled. At present, it appears that the streamside rootmasses are superior to woody debris but until that is definitely established, both should be sampled.

Collection of Benthic Macroinvertebrates from Rocky Riffles

When sampling the invertebrate communities within a lotic environment, the investigator must remember that the organisms have adapted to moving water and will not be easily dislodged. Care must be taken to thoroughly examine any and all material that is being sampled but not taken back to the lab (large rock, large woody debris, etc). Large debris and rock in the sampling zone can be scrubbed and thrown aside. After completing the sampling event, replace the debris in the riffle.

- I. **Suitable Substrates** - A riffle is defined as any sudden change in the level of the streambed such that the surface of the water becomes disrupted by small waves. For this collection method the substrate of the riffle must be composed of gravel, or cobble from 2cm-30cm in the longest dimension. Riffles with substrates of bedrock or tight clay are not suitable.
- II. **Method of collecting the sample** - Support a 1m² kicknet (number 30 mesh (650 μm)) in such a way that any organisms dislodged from the substrate will be carried into it by the current. The bottom of the net should be tight against the bottom of the stream and the current must be sufficient to insure that dense organisms such as small molluscs will be carried into the net from the sampling area. It is usually best to lean the net backward (downstream) so that currents caused by the presence of the net will not carry organisms around the sides of the net.

Beginning at the farthest downstream point of the riffle, vigorously agitate the substrate of a 1m² area of the bed of the riffle immediately upstream of the net until all rocks and sediment to a depth of at least ten centimeters have been thoroughly scraped against each other and the organisms living between and upon the rocks have been dislodged and carried into the net by

the current. Continue agitation until it can be seen that the area being sampled is producing no new detritus, organisms, or fine sediment.

At this point, rinse leaves, sticks and other large debris caught in the net in the current so that organisms on them are carried into the net. When the volume of the sample is reduced enough that three such samples will fill a 1 liter sample jar three fourths full or less, remove all of the material from the net and place it in the sample jar. If there is still too much debris to fit into the jar with 2 more samples, remove a portion of the debris and record the estimated percentage of the sample that went into the jar. Care should be exercised in removing the organisms from the net. Dislodge as much material as possible from the sides of the net by splashing stream water up the sides of the net and allowing the water to wash material down to the bottom. Continue this process until the debris and organism sample is collected into a small region. Seine samples can then be carefully picked up and transferred into the jar.

ALWAYS THOROUGHLY RINSE ALL EQUIPMENT AND HANDS BETWEEN SAMPLINGS TO AVOID CROSS-CONTAMINATION OF SAMPLES!

- III. **Where to sample the riffle** - Three 1 m^2 areas of the riffle must be sampled. They can be square, rectangular or trapezoidal so long as each area equals 1 m^2 in area. One should be in the fastest part of the riffle where the largest rocks and the smallest amount of interstitial sediment will generally be found. The second should be in the slowest part of the riffle, often near the edge of the stream where the smallest rocks and the greatest amount of interstitial sediment will be found. The third sample should be in an area intermediate between the first two.
- IV. **When to sample**- All sampling should occur when the stream has a relatively constant flow **at or near base flow**. This will usually require knowing the hydrologic history of the stream but a safe estimate of base flow will be limiting sampling events to periods between late May and mid-October. **Do not sample within a week of a substantial rain event (>0.5 inch).**
- V. **Preservation**- All sample containers should have approximately 3-5 cm of space at the top of the container. All samples should be preserved in 90% ethanol until identification can occur. Insure that ethanol covers all sample material.
- VI. **Processing of the Sample** - The sample should be processed and picked according to the USEPA Rapid Bioassessment Protocol (RBP 5).

Collection of Macroinvertebrates from streamside and emergent vegetation

- I. **Suitable substrates** - Any streamside or emergent vegetation which offers structure for invertebrates to dwell within or upon is suitable. The vegetation being sampled must include materials in the current so that it offers suitable habitat for organisms which collect drifting particles or which need flowing water for other reasons. This habitat will often be found along the undercut banks of runs and bends where the fine roots of grasses, sedges, and trees, such as willow and sycamore, hang in the water.
- II. **Method of collecting the sample** - This type of sample should be collected with a dip net made of #30 size mesh material. The net should be placed around or immediately

downstream of the vegetation being sampled. The organisms can be dislodged from the roots either by vigorously shaking the net around the roots or by shaking the roots with your hand while the roots and your hand are inside the net.

ALWAYS THOROUGHLY RINSE ALL EQUIPMENT AND HANDS BETWEEN SAMPLINGS TO AVOID CROSS-CONTAMINATION OF SAMPLES!

- III. **Where to sample** - Sampling should continue for five minutes of actual collection time. Do not count the time while you are walking between areas you sample.
- IV. **When to sample**- All sampling should occur when the stream has a relatively constant flow **at or near base flow**. This will usually require knowing the hydrologic history of the stream but a safe estimate of base flow will be limiting sampling events to periods between late May and mid-October. **Do not sample within a week of a substantial rain event (>0.5 inch)**.
- V. **Preservation**- All sample containers should have approximately 3-5cm of space at the top of the container. All samples should be preserved in 90% ethanol until identification can occur. Insure that ethanol covers all sample material.
- VI. **Processing of the samples** -The sample should be processed and picked according to the USEPA Rapid Bioassessment Protocol (RBP 5). Follow identification protocols found at the end of this section.

Collection of macroinvertebrates from woody debris

- I. **Suitable substrates** - Any dead wood with or without bark in the stream is suitable as long as it is in current fast enough to offer suitable habitat for organisms which collect drifting particles or which need flowing water for other reasons. The final sample should consist of organisms collected from an even mixture of wood of all sizes and in all stages of decay.
- II. **Method of collecting sample**- This type of sample should be collected with a dip net made of #30 mesh material. The net should be placed around or immediately downstream of the debris being sampled. The organisms can be dislodged from the debris either by vigorously shaking the net around the woody debris or by shaking the debris with your hand while the debris and your hand are inside the net. Large logs which are too big to shake should be brushed or rubbed vigorously by hand while the net is held immediately downstream.

ALWAYS THOROUGHLY RINSE ALL EQUIPMENT AND HANDS BETWEEN SAMPLINGS TO AVOID CROSS-CONTAMINATION OF SAMPLES!

- III. **Where to sample** - Sample for a total of five minutes counting only the time that debris is actually being agitated. Include as many types of debris in the sample as possible. These types often include wood which is very rotten and spongy with bark, wood which is fairly solid which has loose and rotten bark, and wood that is solid with firmly attached bark. They should range in size from 1cm to about 20cm in diameter.
- IV. **When to sample**- All sampling should occur when the stream has a relatively constant flow **at or near base flow**. This will usually require knowing the hydrologic history of the stream but a

safe estimate of base flow will be limiting sampling events to periods between late May and mid-October. **Do not sample within a week of a substantial rain event (>0.5 inch).**

- V. **Preservation-** All sample containers should have approximately 3-5cm of space at the top of the container. All samples should be preserved in 90% ethanol until identification can occur. Insure that ethanol covers all sample material.
- VI. **Processing the sample** -The sample should be processed and picked according to the USEPA Rapid Bioassessment Protocol (RBP 5). Follow identification protocols found at the end of this section.
- VII. **Identification of organisms-** Once the samples have been returned to the lab, picked, and sorted, identification can proceed at the convenience of the investigator. It is recommended that only personnel appropriately trained in invertebrate taxonomy be involved in the identification phase of the assessment. Recommended taxonomic keys include Merritt and Cummins' "*Introduction to the Aquatic Insects of North America*" (no earlier than 2nd ed., 1988) and Pennack's "*Freshwater Invertebrates of North America*" (2nd ed., 1984). The second edition of Pennack's publication is preferable to the third edition for use with insects because the insects have been eliminated from the third edition. Pennack's third edition possesses updated taxonomy for use with non-insect taxa. Use of multiple editions of the same work should be approached with care as revisions and corrections to taxonomy may produce conflicting results.

All identifications should be taken to as restrictive a level as possible but all organisms should be identified to at least family level.

- VIII. **Archiving samples-** Each individual agency and/or school generally employs a method of archiving that involves saving and cataloging data and samples or individual specimens of both fish and macroinvertebrates. In some cases, arrangements can be made with local universities to store specimens. Many already have some form of museum collection and will be open to such arrangements. It is recommended that entities undertaking biocriteria sampling develop a location and a procedure whereby collections can be archived for future reference. Data archiving will involve either hardcopy or electronic version. Each individual stream that is assessed and sampled for the purposes of biocriteria must be documented and archived for future reference.

STANDARD OPERATING PROCEDURE

Fish Collection in Streams

Variations of habitat, types of fish, and water chemistry dictate the use of different collection techniques both within and among streams. For purposes of conducting a statewide assessment which allows for the comparison of one stream to another, we use a combination of seines and a backpack shocker in every stream. The width and length of the seine being used will vary according to the stream width and the depth of pools. **All seines used are to be no larger than 1/4" mesh.**

Specific techniques for, and relative advantages of seining and electrofishing vary considerably according to stream type, and conductivity and are discussed in detail in Fisheries Techniques (edited by B.R. Murphy and D.W. Willis and published by the American Fisheries Society, 1996).

The following procedure is recommended for collecting fish in streams for biocriteria-related projects.

A. Training Procedures

If you have not already done so, read the chapters in Fisheries Techniques which deal with streams, seines, and electroshockers.

B. Field Collection Methods

1. Distance of stream to be sampled. Distance should be no less than 200 meters up to 400 meters until, using the best professional judgement of the sampling team, all types of available habitat have been sufficiently sampled and the team leader feels that additional sampling will not significantly affect the results of the survey.

2. Collection Procedures

THE SEGMENT SAMPLED MUST BE INCLUDED IN THE SEGMENT ASSESSED FOR HABITAT QUALITY!

a. Seining. A stream should be seined before it is shocked since fish that utilize cover in the stream will generally not leave the area when disturbed. These fish are most efficiently collected by shocking and will still be there when electroshocking commences.

Seine sizes may range from 3 to 6 foot seines in 10, 20, and 30 foot lengths. Seine height is dictated by water depth, and length is determined by width of the water being sampled. If possible the seine should be 15-25% longer than the width of the waterbody being sampled and about 25% higher than the depth of the water. This will allow the center of the net to form a bag behind the operators where the fish are more likely to stay in the net. **REMEMBER that the longer the seine is, the more difficult it will be to control in stream currents.**

The leadline should be kept on the bottom, and in front of the float line. If there are many obstructions on the bottom, the leadline will become caught or bounce, and most fish will escape underneath the bottom of the net. If this

happens use a smaller net that allows you to avoid obstructions, roll up the ends of the existing net to make it more manageable, or go to electroshocking.

The brailles of the net should be used to disturb the area under any undercut banks or beds of macrophytes near the edge in order to scare fish hiding in cover out towards the middle of the net.

Under ideal conditions the net should be pulled through the water in the manner described above for about 10 meters and dragged out of the water on a gradually sloping preselected beach. The person pulling the seine on the side of the stream opposite the beach should swing ahead of the other person so that the seine is pulled out on the beach stretched over the same distance it was stretched in the stream.

If the stream doesn't have gradually sloping banks, the dip method should be used. This method consists of sweeping around and through the area to be sampled, keeping a wide bag and moving the lead line as much under the undercut bank as possible. Use the brailles to probe repeatedly as far as possible into the undercut area working towards each other until the brailles overlap. The seine should then be swiftly stretched and lifted vertically from the water. An alternative method of retrieving fish under these conditions is to slowly turn the brailles to wind the net up once they have overlapped to form an enclosure. This may wind up the fish with the net and allow them to be lifted out of the water with the rolled up net. **RECORD THE TIME SPENT SEINING AND SEINE MESH SIZE ON THE FIELD DATA SHEETS.**

- b. Electroshocking. A Smith-Root Backpack Electrofisher model 115-B POW with a Honda model EX-350 generator is recommended for use in collecting fish. Always use this equipment in accordance with manufacturer instructions.

BEFORE OPERATING OR ASSISTING with the shocker, **READ** and **UNDERSTAND** the manuals for the generator and the shocker. Starting procedures, safety procedures and troubleshooting are well documented in these manuals and are not detailed here. The manuals can be obtained from the manufacturer.

The shocker consists of a trailing stainless steel cable electrode and a ring electrode mounted on the end of a PVC pole.

The shocking team must consist of at least two people. One will carry and operate the shocker while the other(s) will net stunned fish. The shocker is most useful where a seine cannot be used effectively in areas such as brushpiles, rootwads and cobble substrates. The forward electrode should be gradually passed back and forth over and in these areas as the team walks upstream. As fish are stunned, they will usually roll over and become more visible, allowing the netters to see and capture them.

In very dense brush or root cover, fish often sense the presence of the team before they are close enough to be stunned and then retreat so deeply into cover that it is impossible to net them when they are stunned. It is often better in situations such as these to insert the electrode into the brush before it is

turned on, give the fish a minute or so to get used to the new situation and then turn the current on. Many fish will be much closer to the edge of brushpile when they are stunned in this manner. **RECORD THE TIME SPENT ELECTROSHOCKING ON THE FIELD DATA SHEET.**

c. Preservation and Field I.D.

Currently, there is discussion concerning the ethical treatment of the fish specimens collected for any reason. In the future, amendments to this protocol may require an anesthetizing agent be added to the formalin prior

to introduction to the fish sample. There is no current requirement for the use of or agreement on the necessity of such an agent.

In general all fish should be placed in 10% formalin immediately after capture and returned to the lab for identification. There are a few exceptions made for large (>100 g) fish which can be positively identified in the field. If all team members agree on the identification of such a fish, it can be returned to the water far enough away that recapture is unlikely. However, if the specimen is unusual or rare (e.g. eels, bowfins, obvious or gross abnormalities, etc.), it too should be preserved regardless of size.

Fish much larger than 0.3 to 0.4 Kg, which cannot be identified in the field, should be sliced open along the ribs when preserved in order to allow the formalin to penetrate the body cavity fast enough to prevent decay.

Formalin is a carcinogen and can also cause permanent damage to mucous membranes and eyes. Care must be taken when placing fish in formalin so that the fish does not flop around and splash formalin onto people near the jar. The fish should be put into the jar with the lid tilted open away from the operator so that the lid shields the face and body of the operator. Flood any skin exposed to formalin with plenty of water as soon as possible. Safety glasses should be worn by those handling formalin. If it gets in your eyes, flood the eyes with water immediately and go to the doctor immediately after that.

d. Sample Identification

Write date, stream name, type of sample (seine or electrofishing), time spent sampling, seine mesh size and legal location on the front of each jar using a wax pencil or an indelible marking pen (e.g. Sharpie). All specimens can be identified using a reputable taxonomic reference such as [Fishes of Arkansas] (Robinson and Buchanan, 1988). Attempts are currently underway to update and republish [The Fishes of Oklahoma] which has not been in print since the 1960's.

e. Field Data

At all sites where fish are collected, a stream habitat evaluation **must** be performed. It does not have to be done on the same day as the fish are collected, but should be done before major floods change the habitat.

f. Safety

1. Primary responsibility for safety while electroshocking rests with the team leader. All crew members should receive training in First Aid and CPR. Electro-fishing units have a high voltage output and may deliver dangerous electrical shock. While electrofishing, avoid contact with water unless sufficiently insulated against electric shock. Use chest waders with non-slip soles and water-tight rubber (or electrician's) gloves. **Avoid contact with anode at all times. At no time while electrofishing should a crewmember reach into the water for any reason.** The electrofishing equipment is equipped with a 45 degree tilt switch which interrupts the current. Do not make any modifications to the electrofishing unit which would make it impossible to turn off the electricity.
2. General safety guidelines should be observed. If waders or gloves develop leaks, leave the water immediately. Avoid operating electrofishing equipment near people, pets or livestock. Discontinue any activity in streams during thunderstorms or heavy rain. Rest if crew becomes fatigued.
3. Gasoline is extremely volatile and flammable. Its vapors readily ignite on contact with heat, spark or flame. Never attempt to refill the generator while it is running. **Always allow the generator to cool before refilling.** Keep gasoline out of direct sunlight to reduce volatilization and vapor release. Always wear gloves and safety glasses when handling gasoline. Keep gasoline only in approved containers.
4. Decision to use electrofishing equipment will depend on size of site, flow, conductivity and turbidity. If conductivity is below 10 or over 1200 μS , if flow is too high, site too deep or water is too turbid to assure safe footing or locate stunned fish, the team leader may consider use of seine only or determine that site is "Unsampleable". **THIS IS A SAFETY DECISION.**

STANDARD OPERATING PROCEDURE

STREAM HABITAT ASSESSMENT

THE SEGMENT SAMPLED FOR BIOTA MUST BE INCLUDED IN THE SEGMENT ASSESSED FOR HABITAT QUALITY!

In the past we have used two separate assessments for streams and riparian areas. Because of the importance of intact riparian areas to stream habitat and water quality there is really no reason to separate these two assessments. We are now merging them, and this SOP describes the correct method of filling out the new assessment form.

Record all measurement data in meters. This includes height of eroded bank, width of riparian zone, depth of pools, size of cobbles or boulders, width of stream and anything else you measure except flow. All measurements used to calculate instantaneous discharge are in feet.

If you use feet or inches in any measurement except flow, you will be responsible for converting it to meters before can be compared to other sites or historic data.

- 1. Name of stream on USGS 7-1/2 minute map.** If the county map, soil map, or other map has a different name, the USGS 7-1/2' map takes precedence. If a stream is unnamed on the USGS map, but named on another map, use that name, but write the name of the map in parentheses beside the stream name.
- 2. Names of people doing assessment.** [Don't use initials.]
- 3. Direction--circle the appropriate word.** If you go upstream from the start point, circle upstream.
- 4. Date the assessment is done.**
- 5. Water Body number.** If the stream has site letters assigned to it, use the site designation of the start point also.
- 6. Flow--enter the flow in CFS.** Flow should be taken during base flow conditions or as close as possible. **Never measure within a week of a significant rain event (>0.5 in)**
- 7. Start Point.** A description, legal or otherwise, of where the assessment is started. Someone else should be able to locate this point from your description.
- 8. Legal description of the portion of stream assessed** to the nearest 1/4 section.
- 9. Latitude/Longitude of the start point in the format 00°00'00"/00°00'00".**
- 10. Channel sinuosity.** This measurement must be completed in the office using a planimeter. When the assessment is completed, you will know exactly how far up or downstream you have walked. In the office, using the planimeter, measure that distance on a USGS 7-1/2 minute map along the portion of the stream you walked, starting at the point you started at in the stream. For example, if you started the assessment at a bridge on the east boundary of section 9 T9N R8W and walked upstream for 200 meters, you get out the 7-1/2 minute map containing section 9 T9N R8W and set your

planimeter wheel on the bridge from which you started. Being very careful to keep the planimeter wheel on the stream, follow the stream upstream from the bridge until you reach the point on the map where the planimeter reads 200 meters. **Mark this point.**

Next, draw a straight line (using a ruler) from the point where you ended the survey to the point from which you started the survey, and measure this distance using the planimeter.

Channel Sinuosity is the ratio of in-stream channel length divided by the straight line distance. It will always be ≥ 1 .

11. **Distance.** The distance from the start point as measured by the hip chain. A stream must be assessed a minimum of 200 meters. Parameters 12 through 37 should all be measured at the start point and recorded to the right of the start (0) point. Generally we assess streams in conjunction with a bioassessment. For this purpose, **parameters 12-37 will be measured and recorded every 10 meters along the stream.** Instruction for their measurement follow.
12. **Depth.** Depth of water is measured in meters to the nearest 0.1 meter. **The left bank of the stream is that on your left as you face downstream.** The left \square (L \square) is the depth of water midway between the center of the stream and the left bank. Center (C) is the depth of water in the center of the streambed. Right \square (R \square) is the depth of water midway between the center of the stream and the right bank.
13. **Width WTR & Width BNK** are the width of the water in meters to the nearest 1 m, and the width of the lower bank in meters to the nearest 1 m. The lower bank extends from the water's edge at summer low flow to the top of the normal high water line. The normal high water line is usually marked by the beginning of well-established perennial vegetation. Below this line will be gravel and bare soil. There may be a sparse covering of annual vegetation below this line. The lower bank width is the distance between the tops of the left and right lower banks.
14. **Substrate.** This is an estimate of the substrate of the stream at the point where measurements are taken from the edge of the water on one side to the edge on the other side. The total of all substrate components should add up to 100 percent. The categories include the following:
 - a. **S. & C** Loose silt and clay.
 - b. **SND** Sand or rock particles; 0.1 to 2mm.
 - c. **GVL** Gravel; rocks from 2 mm to 50 mm.
 - d. **CBL** Cobble; rocks from 50 mm to 250 mm.
 - e. **BLD** Boulder; rocks > 250mm.
 - f. **BRK** Bedrock or hardpan clay.
 - g. **POM** Particulate organic matter--rotten leaves and fragments of stick and logs.
 - h. **HPC** Hardpan clay
15. **Habitat Type.** 0 Check the box that is most applicable to the habitat type present at the station. A **riffle** has surface which is definitely broken and usually makes a sound. A **pool** has a smooth surface, no or very little current and can be deep or shallow. A **run** has an obvious current, may be deep or shallow and often has a surface which may be

slightly broken, but doesn't make any noise. Check **dry** if the stream has no water in it at the point being measured.

If there are two obvious habitat types at the cross section you are measuring, check both boxes. An example is when a backwater pool is encountered beside a run or riffle.

- 16. Instream Cover Area.** This category attempts to quantify the amount of cover present for fish in the section of stream from the previous station to the present one. For example, if the section was 20 meters long and averaged 6 meters wide, its area would be 120m². A submerged log about 3 meters long by 0.5 meters wide would offer 1.5m² cover, and you would note that the LWD (large woody debris) category offered 1.5/120 or 1.3 percent cover. Waterwillow, an emergent aquatic macrophyte, might be growing in shallow water along the edge of the stream. If both edges had a zone about 1 meter wide where it grows, there would be (1 meter) (20 meters) (2 sides)=40m² of EAV (emergent aquatic vegetation in the 120m² section of stream and you would check 40/120 or 33 percent in the EAV column. **Note that the totals of the [percent cover] columns for each row will rarely add up to 100 percent and may often be 0 percent.**

The categories are:

- a. **UCB** Undercut banks
- b. **LWD** Large woody debris--woody debris in the water > 10 cm. in diameter.
- c. **SWD** Small woody debris-- woody debris in the water <= 10 cm. in diameter.
- d. **RTS** Roots--these are submerged root wads of trees. If single or occasional roots are encountered, count them in one of the woody debris categories.
- e. **BRL** Bedrock ledges--underwater bedrock ledges not forming part of an undercut bank.
- f. **SAV** Submerged aquatic vegetation.
- g. **EAV** Emergent aquatic vegetation.
- h. **TV** Terrestrial vegetation which is currently underwater. An example would be tree branches or grass leaves that are actually hanging down into the stream.
- i. **CBG** Cobble, Boulder and Growth. This is an estimate of the percent coverage of cobble and boulder in the 20 meter section. It may not be the same number as the percent composition of cobble and boulder in the cross section where you estimated substrate since they represent different areas.

- 17. EMB - Embeddedness.** This quantifies the amount of silt, clay and sand which has been **DEPOSITED**. If there is no fine material surrounding the cobble and gravel, and there is at least some free space under the rocks, that is 0 percent embedded. If the free space under the rocks is filled but the sides are untouched, count that as 5 percent embedded. As the level of fines rises up the cobble sides, estimate the percentage of the total height of the cobbles that is covered. This is your embeddedness estimate. You can often see this line quite distinctly if you lift the rocks out of the water.

18. **CAN - Percent Canopy Cover.** At each measuring station, estimate the percent canopy cover in the previous segment. It can range from 0 to 100 percent, but if you can see any sky directly overhead, that part is not covered and your estimates should be less than 100 percent.
19. **PTB - Point Bar.** If a recently formed point bar is present, that is, it has no or little vegetation, put a check in this box.
20. **D&S - Deposition and Scouring.** If there is evidence of scouring (smooth, clean bedrock or hardpan clay) or deposition (loose, shifting bottoms of fine sand or silt or filled in pools) in the previous segment surveyed, check this box.
21. **BVC - Bank Vegetative Cover.** Record an estimate of the total area on both banks that is protected from erosion by well established **perennial** vegetation. Soil doesn't have to be covered as long as it's stable. If banks are covered with rip-rap or large gravel, they can still be stable. Remember to note this in the "Comments" section.
22. **DV - Dominant Vegetation.** Place an S (shrub), T (tree), or G (grasses and forbs) in the box indicating which type of vegetation is most dominant **ON THE BANKS** in terms of percent of ground protected. For our purposes, shrubs are any woody plant whose trunk and branches are ≤ 10 cm in diameter. If the vegetation is mixed but each of the three groups contribute at least 20% of the total put an M in the box.
23. At each measurement point **record the average % of streambank that is actively eroding** for both the left bank and the right bank of the stream segment you just walked. Measure from the edge of the lower bank to the edge of the upper bank. [The upper bank is usually the edge of the flood plain.]

REMEMBER THAT THE LEFT BANK IS THE BANK TOWARDS THE LEFT AS YOU FACE DOWNSTREAM so if you are walking upstream the left bank will be the one on your right side.

24. Record the **average height of the eroding banks** on either side of the stream segment you just walked. Measure from the lower edge of the bank to the upper edge of the bank.
25. Record the average % slope of the banks in degrees. Measure from the lower edge of the bank to the upper edge of the bank.
26. Record the **typical substrate of each bank**, use the same substrate abbreviations that are used in the stream assessment form.
27. Record the **average width of the riparian vegetation** for each side of the segment you just walked. The riparian zone for our purposes extends from the top of the upper bank outwards from the stream. (Remember that you have already described the size and vegetative state of the banks in columns 21, 22, 24, & 25.) For our purposes, the riparian zone ends where the unmanaged (i.e. not plowed or mowed) portion of land ends. Riparian vegetation is typically bottomland hardwood forest when in a natural state, but mixtures of trees and herbaceous plants are frequently encountered. These

will grade from a fairly dense forest with sparse grasses to land that is mostly pasture with a few scattered trees.

IF WOODY SHRUB AND SAPLING GROWTH CAN BE CONTROLLED USING A 6' BRUSHHOG AND A MEDIUM SIZE TRACTOR IN BETWEEN THE LARGER TREES, THE LAND WILL BE LABELED PASTURE AND MAY OR MAY NOT BE INCLUDED IN THE RIPARIAN ZONE. IF THE LARGE TREES ARE SO DENSE THAT A TRACTOR AND MOWER OF THIS SIZE CAN'T BE USED FOR BRUSH CONTROL, THE LAND SHOULD BE LABELED AS FOREST AND INCLUDED IN THE RIPARIAN ZONE. Remember that the riparian zone stops where pasture or crop management begins.

28. As stated earlier, natural riparian vegetation is typically bottomland hardwood forest, but when disturbances have been or are present there will be varying amounts of herbaceous plants and bare soil also. In these two columns you are asked to decide whether the majority of the land in the riparian zone on either side of the stream is grassland or forest. USE THE CRITERIA FROM CATEGORY 27 FOR THIS DETERMINATION. You are also called upon to decide how much bare soil is exposed. In grassy areas, this is a straight forward determination and is done by estimating the average % of bare soil you see as you walk the 10 meter riparian zone in question. Forest, while not expected to have grasses & forbs covering the ground, is expected to have a layer of spongy duff composed of organic matter in various states of decay covering the soil. This layer is usually covered by a layer of recently fallen leaves or annual herbaceous vegetation that haven't yet started to decay, so you will have to move these leaves or vegetation out of the way to determine if the duff layer is present. Soil not covered by duff should be counted as bare. Estimate the % bare soil exposed in forest as you walk the area in question.

THE RIPARIAN ZONE ON BOTH SIDES OF THE STREAM SHOULD BE PLACED IN ONE OF THE FOLLOWING CATEGORIES. Write "W" after the condition class if at least 5 meters of riparian area depth appear to be wetland based on the presence of standing water or saturated soil after at least a week of dry conditions, or dominance by sedges, rushes, button bush or willow.

1A	STABLE FOREST	<1% bare soil exposed
1B	MODERATELY USED FOREST	1-10% of surface is bare soil
1C	HEAVILY USED FOREST	>10% of surface is bare soil
2A	GOOD CONDITION GRASSLAND	<1% bare soil exposed
2B	FAIR CONDITION GRASSLAND	1-5% bare soil exposed
2C	POOR CONDITION GRASSLAND	>5 <20% bare soil exposed
2D	BAD CONDITION GRASSLAND	>20% bare soil exposed

29. **Cattle excluded from the stream.** Put a check mark in the box if this statement is true for the last 10 meters.
30. **% of land trampled.** This is an estimate of land where livestock trampling is evident within one meter either way of the transect. In other words, you are looking at a 2 meter wide strip that runs from the top of the right upper bank across the stream to the top of the left upper bank.
31. **# cow pies.** This is the number of cow pies in the 2 meters wide transect of column 30.

- 32. # trails.** This is the number of livestock trails on both banks that reach the stream over the entire 10 meter transect. A single trail that crosses the stream and goes up the other side counts as two trails.
- 33. Class of cow trails.** Each cow trail should be placed in one of the following classes and the class of each trail recorded in this column.
1. < 0.75m wide
 2. $\geq 0.75 < 1.5$ m wide
 3. $\geq 1.5 < 2.5$ m wide
 4. ≥ 2.5 m wide
- There should be as many numbers listed here as there were cow trails in column 38. Separate each number by a comma.
- 34.** If a road is contributing excess sediment to the stream, or a pipe is discharging to the stream or there is a dump present or any other thing which you deem significant is present, record it in the comment block at the end of the page.

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HABITAT ASSESSMENT PART 1

1. STREAM NAME:	5. INVESTIGATORS:	7. DIRECTION:
2. FACILITY/COUNTY:		8. SITE LOCATION:
3. DATE:	6. FLOW:	
4. SITE NUMBER:	SINUOSITY:	9. START POINT:

10. DIST. 11. DEPTH 12. WIDTH 13. SUBSTRATE % 14. HABITAT TYPE 15. INSTREAM COVER % AREA 17 18 19 20 21 22

DIST (M)	LS	1/4	T, 1/2	3/4	RS	WTR	BNK	CLY	SIL	SND	GVL	CBL	BLD	POM	HPC	BRK	RIF	PL	RUN	DRY	UCB	LWD	SWD	RTS	BRL	SAV	EAV	TV	CBG	EMB	CAN	PtBr	D+S	BVC	DV
0																																			
10																																			
20																																			
30																																			
40																																			
50																																			
60																																			
70																																			
80																																			
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110																																			
120																																			
130																																			
140																																			
150																																			
160																																			
170																																			
180																																			
190																																			
200																																			

HABITAT ASSESSMENT PART 2

1. STREAM NAME:	2. FACILITY/COUNTY:	3. DATE:
4. SITE NUMBER:	5. WB NUMBER/HUC	

	23. % ERODED BK		24. HT. ERODED BK		25. SLOPE BK		26. SUBSTRATE BK		27. RIP. WIDTH		28. RIP. COND.		CATTLE						
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	29. EXCL	30. %TRAM	31. # CP	32. TRAILS	33. CLASS TRAILS	COMMENTS	
0																			
10																			
20																			
30																			
40																			
50																			
60																			
70																			
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HABITAT ASSESSMENT PART 2

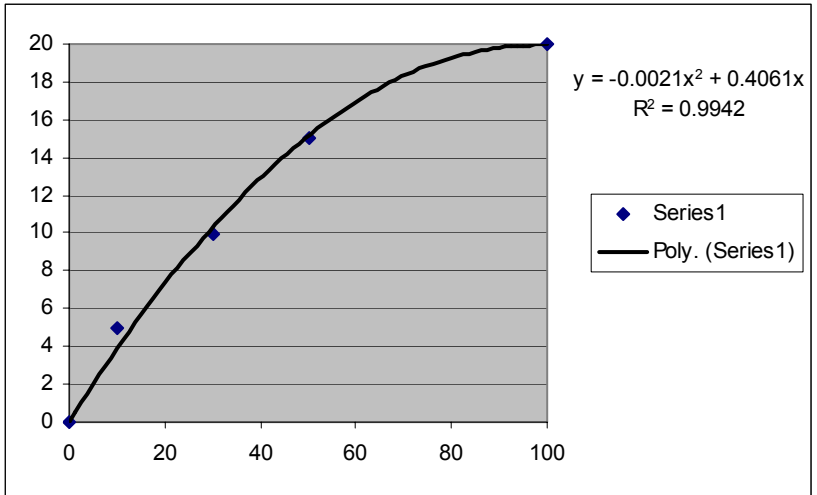
STREAM NAME:	DATE:	STREAM ORDER:
FACILITY/COUNTY:		
SITE #:		LINK MAGNITUDE:

HABITAT PARAMETERS:	SCORE	DATA SUMMARY:																								
1. Instream cover <i>(Part 1 No. 15)</i>		Instream Structures and Occurrence																								
		% Areal Coverage																								
		<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <td style="width:25%;">undercut banks</td> <td style="width:25%;">lg. woody debris</td> <td style="width:25%;">sm. woody debris</td> <td style="width:25%;">roots</td> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> </tr> <tr> <td>bedrock ledges</td> <td>submer. aqua. veg.</td> <td>emer. aqua. veg.</td> <td>ter. veg.</td> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> </tr> </table>	undercut banks	lg. woody debris	sm. woody debris	roots					bedrock ledges	submer. aqua. veg.	emer. aqua. veg.	ter. veg.												
		undercut banks	lg. woody debris	sm. woody debris	roots																					
bedrock ledges	submer. aqua. veg.	emer. aqua. veg.	ter. veg.																							
2) Streambed/substrate Composition <i>(Part 1 No. 13)</i>		<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <td style="width:25%;">bedrock</td> <td style="width:25%;">boulder</td> <td style="width:25%;">cobble</td> <td style="width:25%;">gravel</td> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> </tr> <tr> <td>sand</td> <td>silt</td> <td>clay</td> <td>POM</td> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> </tr> <tr> <td>Packed clay</td> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> </tr> </table>	bedrock	boulder	cobble	gravel					sand	silt	clay	POM					Packed clay							
		bedrock	boulder	cobble	gravel																					
		sand	silt	clay	POM																					
Packed clay																										
3. Pool Variability <i>(For Glide/Pool prevalence)</i>		AVG % Embeddedness:																								
		<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <td style="width:33%;">Pool variability</td> <td style="width:33%;">% deep pools</td> <td style="width:33%;">% shallow pools</td> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> </table>	Pool variability	% deep pools	% shallow pools																					
Pool variability	% deep pools	% shallow pools																								
4. Canopy cover (shading)		Overhead Canopy																								
		<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <td style="width:25%;">open</td> <td style="width:25%;">partly open</td> <td style="width:25%;">shaded</td> <td style="width:25%;">average</td> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> </tr> </table>	open	partly open	shaded	average																				
open	partly open	shaded	average																							
5. Riffle/ROCKY run prevalence		Channel Morphology and Structure																								
		<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <td style="width:25%;"> </td> <td style="width:25%;">riffle</td> <td style="width:25%;">pool</td> <td style="width:25%;">run</td> <td style="width:25%;">dry</td> </tr> <tr> <td>% of sample site</td> <td> </td> <td> </td> <td> </td> <td> </td> </tr> </table>		riffle	pool	run	dry	% of sample site																		
	riffle	pool	run	dry																						
% of sample site																										
6. Flow at representative level		CFS																								
7. Channel alteration		POINT BARS																								
		ISLANDS																								
8. Channel sinuosity		SINOUSITY																								
9. Bank stability		Bank Slope																								
		<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <td style="width:25%;">flat (<15)</td> <td style="width:25%;">mod(15-30)</td> <td style="width:25%;">steep(30-60)</td> <td style="width:25%;">vertical(>60)</td> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> </tr> </table>	flat (<15)	mod(15-30)	steep(30-60)	vertical(>60)																				
flat (<15)	mod(15-30)	steep(30-60)	vertical(>60)																							
10. Bank vegetative stability		Bank Erosion																								
		<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <td style="width:33%;">evident</td> <td style="width:33%;">potential</td> <td style="width:33%;">unlikely</td> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> </table>	evident	potential	unlikely																					
evident	potential	unlikely																								
11. Streamside cover		Banks and Riparian Cover																								
		<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <td style="width:25%;">devoid of cover</td> <td style="width:25%;">grasses and forbs</td> <td style="width:25%;">shrubs</td> <td style="width:25%;">trees</td> <td style="width:25%;">mixed</td> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> <td> </td> </tr> <tr> <td>value</td> <td>value</td> <td>value</td> <td>value</td> <td>value</td> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> <td> </td> </tr> </table>	devoid of cover	grasses and forbs	shrubs	trees	mixed						value	value	value	value	value									
		devoid of cover	grasses and forbs	shrubs	trees	mixed																				
value	value	value	value	value																						

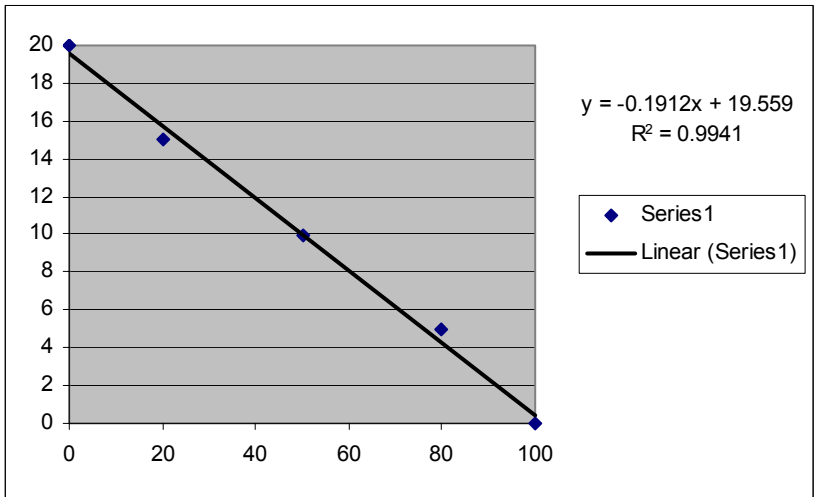
TOTAL SCORE **0.0**

WATER QUALITY EVALUATION			
D.O. (mg/L)	Temp. (deg. C)	Alkalinity (mg/L)	Hardness (mg/L)
pH	Cond. (umhos)	Ammonia (mg/L)	FLOW

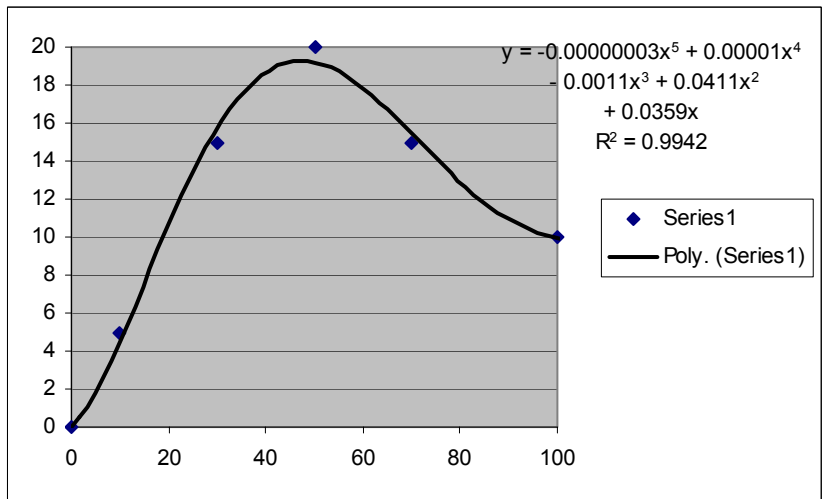
Metric 1	Value	Score
Instream Cover	100	20
	50	15
	30	10
	10	5
	0	0



Metric 2	Value	Score
Pool Bottom Substrate	0	20
	20	15
	50	10
	80	5
	100	0

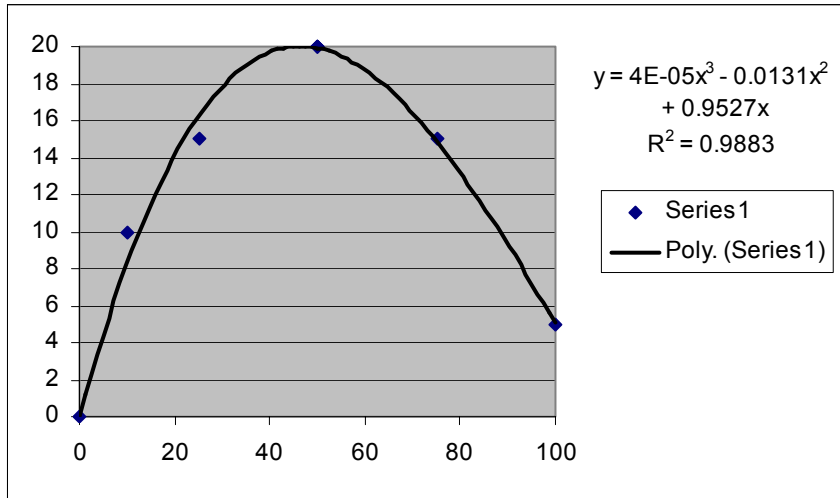


Metric 3	Value	Score
Pool Variability	0	0
	10	5
	30	15
	50	20
	70	15
	100	10



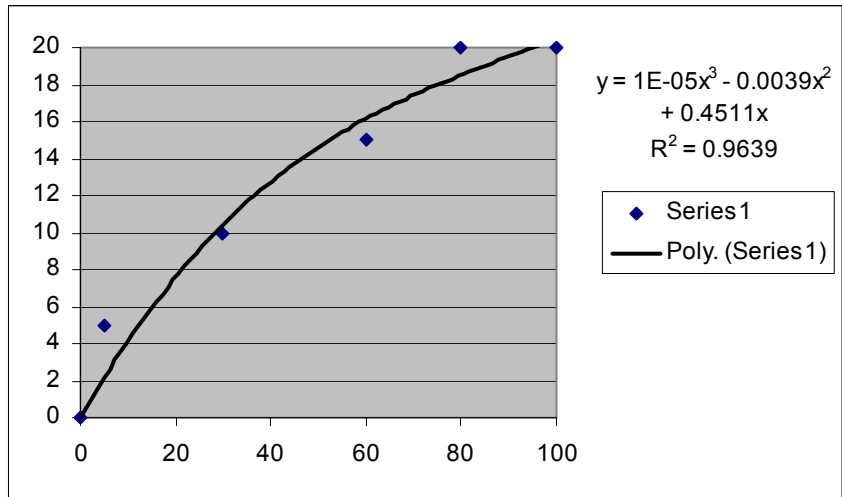
Metric 4
Canopy Cover /
Shading

Value	Score
0	0
10	10
25	15
50	20
50	20
50	20
75	15
100	5



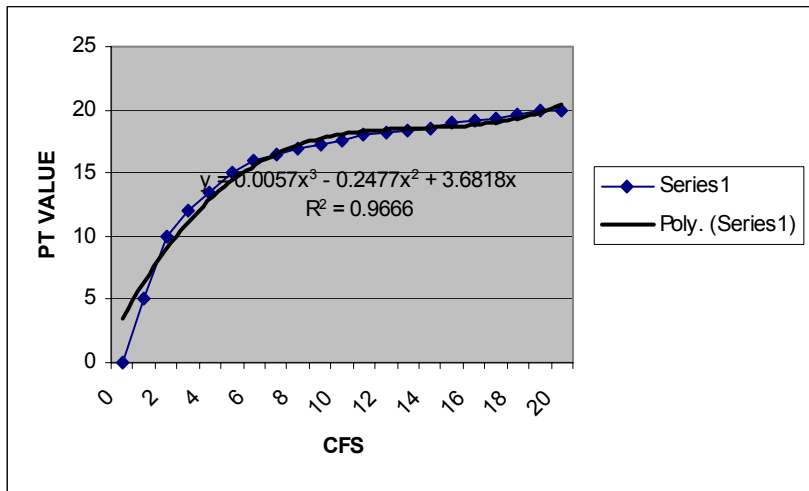
Metric 5
Rocky Runs
/Riffles

Value	Score
0	0
5	5
30	10
60	15
80	20
100	20



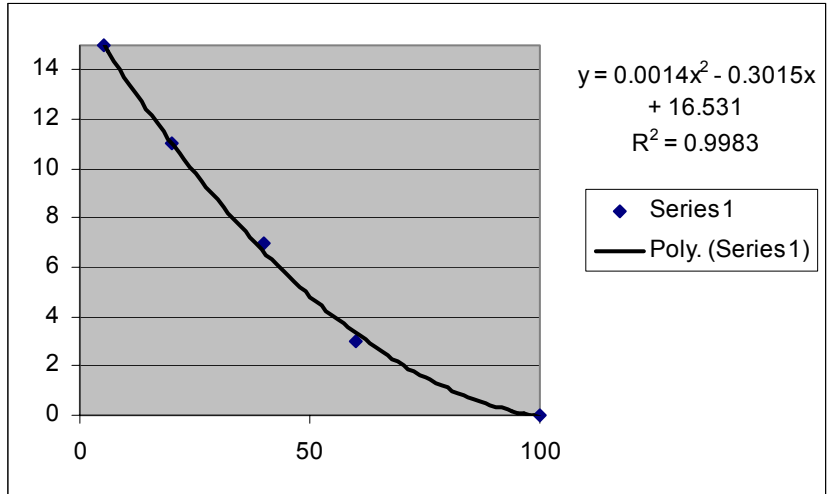
Metric 6
Flow

Value (CFS)	score
0	0
1	5
2	10
5	15
20	20



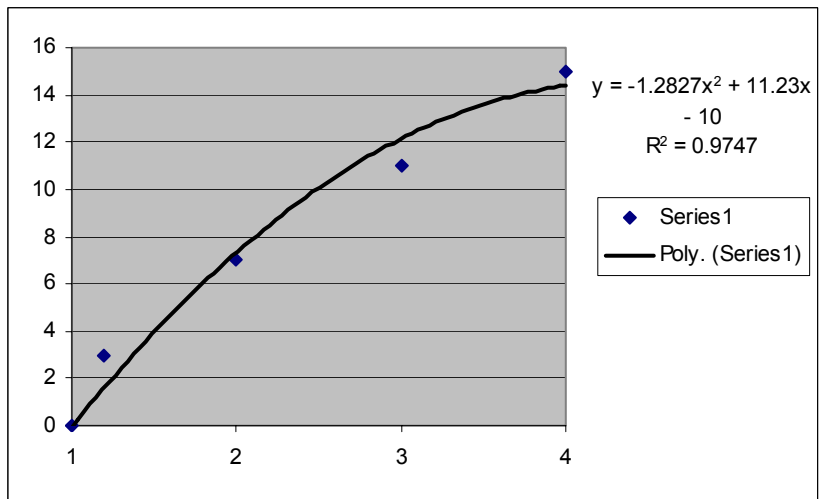
**Metric 7
Channel
Alteration**

Value	Score
100	0
60	3
40	7
20	11
5	15



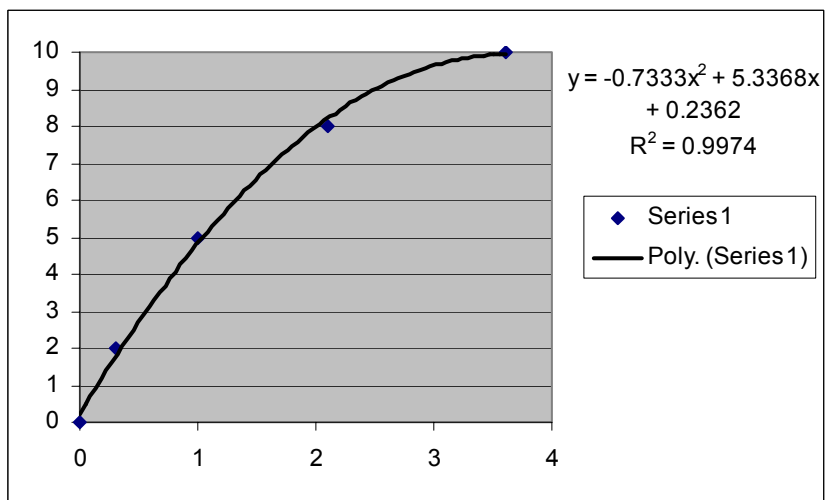
**Metric 8
Sinuosity**

Value	Score
1	0
1.2	3
2	7
3	11
4	15
> 4	15



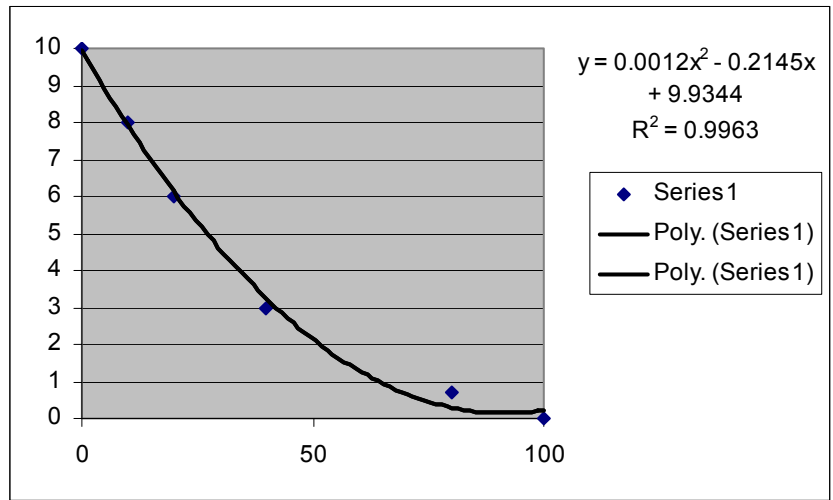
**Metric 9
Bank Stability**

Value	Score	Log of value
1	0	0
2	2	0.301
10	5	1
125	8	2.096
4000	10	3.602



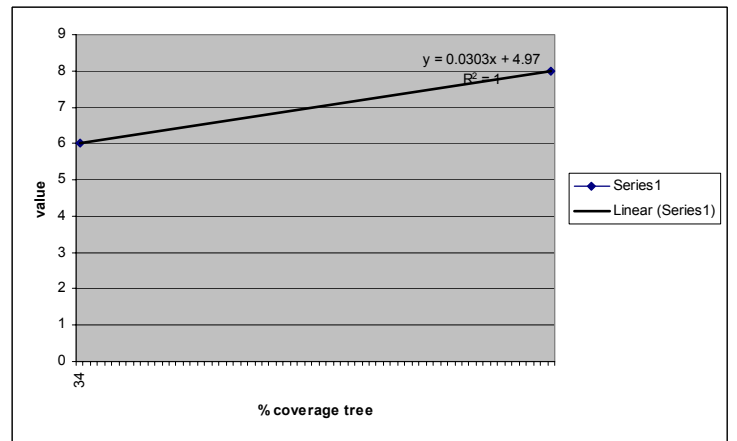
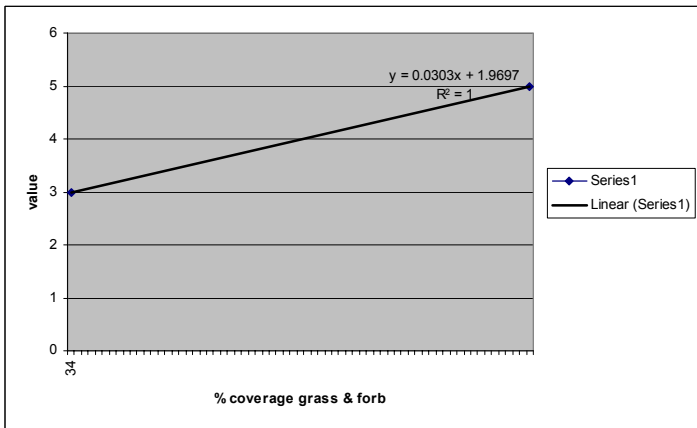
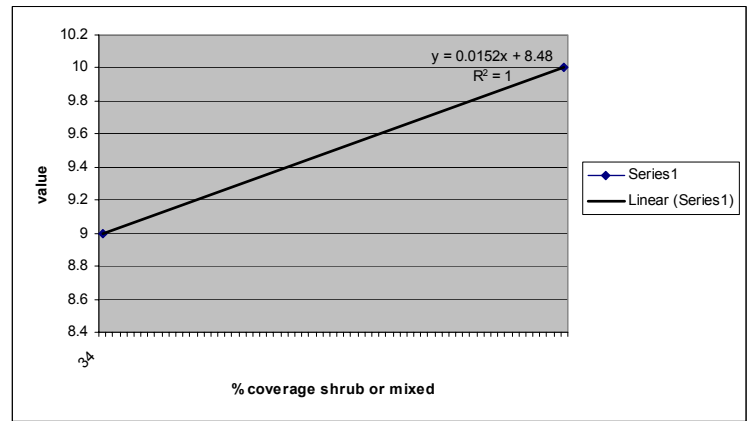
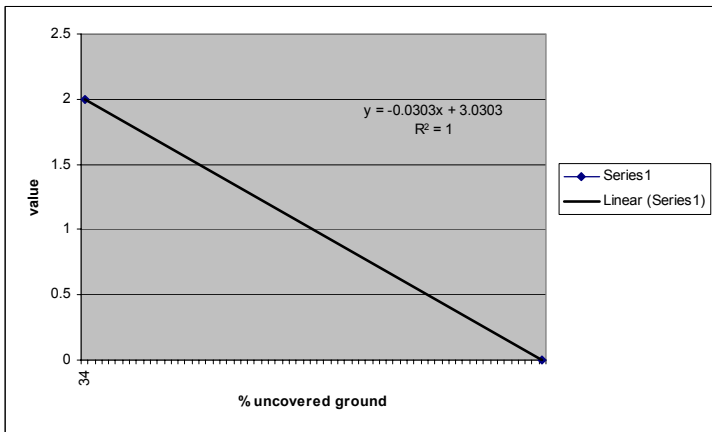
Metric 10
Bank
Vegetation

Value	Score
100	0
40	3
20	6
10	8
0	10



Metric 11
Streamside Cover

Linear
Interpolation



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#		OPTIMAL	ADEQUATE	FAIR	POOR
1	Instream Cover	Greater than 50% mix of stable habitat. Includes rubble, gravel, boulder and cobble, submerged logs, undercut banks, submerged appliance and autos, etc., etc. 100% 20 points 50% 16 pts	30% to 50% mix of stable habitat. 49% 15 points 30% 11 pts	10% to 30% mix of stable habitat. 29% 10 points 10% 6 pts	Less than 10% stable habitat. 9% 5 points 0% 0 pts
2	Pool Bottom Substrate Score by % Si&C and presence of, but not percent of desirable substrate	Mixture of desirable substrates with gravel and firm sand prevalent; root mats, CPOM and submerged aquatic vegetation common, cobble, gravel, firm sand, submerged aquatic vegetation, root mat, and CPOM all present and 80% of pool bottom. Mud and loose sand and bedrock may make up to 19% of bottom. 0% silt, clay & bedrock 20 points 19% 16 pts	Firm sand, gravel, CPOM root mat and aquatic vegetation present. Mud, bedrock and loose sand, make up 20% TO 50% of bottom 20% silt, clay & bedrock 15 points 49% 11 pts	Any three types of stable substrate present. Mud, loose, sand and bedrock make up 51% to 80% of pool bottom. 50% silt, clay & bedrock 10 points 79% 6 pts	1 or 0 types of stable habitat present. Mud, loose sand and bedrock make up 81 to 100% of pool bottom. 80% silt, clay & bedrock 5 points 100% 0 pts
3	Pool Variability deep= > 0.5m shallow=<0.5m	Even mix of deep and shallow pool present. > 40% deep pools >30% deep pools and >40% shallow pools >30% shallow pools 20 points 16 pts	Majority of pools large and deep very few shallow. deep pools > 71% 15 points deep pools = 100% 11 pts	Shallow pools much more prevalent than deep pools. deep pools < 29% 10 points deep pools < 10 % 6 pts	Majority of pools shallow or pools absent. deep pools < 10% 5 points deep pools = 0% 0 pts
4	Canopy Cover Shading	Mixture of conditions where some areas of water surface fully shaded, some fully exposed and others receiving various degrees of filtered light. Avg % canopy cover 45-55 40-45 35-40 30-35 25-30 or or or or 55-60 60-65 65-70 70-75 20 pts 19 pts 18 pts 17 pts 16 pts	Covered by sparse canopy Avg canopy < 25% 15 points > 10% 11 pts	Covered by dense canopy Average Canopy Cover > 75% 10 points = 100% 6 pts	Lack of canopy. Average Canopy Cover < 10% 5 points =0 % 0 pts

#		OPTIMAL		ADEQUATE		FAIR		POOR					
5	Presence of Rocky runs or riffles. Don't count gravel > 2 cm screen. At least 50% of substrate in riffles and runs must be gravel, cobble, boulder or bedrock to count as a rock riffle or run.	Rocky riffles or runs dominant and make up at least 60% of stream	Rocky riffles and runs common.	Rocky riffles and runs infrequent.	Rocky riffles and runs rare or absent.	> 80% 20 points	>60% 16 pts	59% 15 points	30% 11 pts	29% 10 points	6% 6 pts	5% 5 points	0% 0 pts
6	Flow at representative low flow	> .6 cms (20 cfs) 20 points	> .15 cms (5 cfs) 16 pts	> .15 cms (5 cf) 15 points	> .05 cms (2 cfs) 11 pts	> .05 cms (2 cfs) 10 points	> .03 cms (1 cfs) 6 pts	> .03 cms (1 cfs) 5 points	> 0 cms (0 cfs) 0 pts				
7	Channel alteration	Little or no enlargement of islands or point bars. 5% pt bars or islands 15 points	20% pt bars or islands 12 pts	Some increase in new bar or island formation, 21% pt bars or islands 11 points	40% pt bars or islands 8 pts	Moderate deposition of new gravel and sand on old and new bars. Pools partially filled with silt. 41% pt bars or islands 7 points	60% pt bars or islands 4 pts	61% 3 points	100% 0 pts				
8	Channel sinuosity	Instream channel length 3 to 4 times straight line distance 4 15 points	3 12 pts	Instream channel length 2 to 3 times straight line distance. < 3 11 points	2 8 pts	Instream channel length 1.2 to 2 times straight line distance. < 2 7 points	1.2 4 pts	< 1.2 3 pts	= 1 0 pts				

#		OPTIMAL	ADEQUATE	FAIR	POOR
9	<p>Bank stability</p> <p>a</p> <hr/> <p>(b)(c)(d) where</p> <p>a= avg. water width b= avg. bank slope % c= avg eroded bank height d= % of stream with eroded banks up to 200% for both left and right banks</p>	<p>Bank erosion absent or infrequent 0% to 19% of bank eroded. Avg bank slope 5-20%, avg height of eroded banks 5-19% of water width.</p> <p>bank stabilization score 400 126 10 points 8 pts</p>	<p>Erosion quite evident but not the dominant feature of the banks. 20% to 49% of bank eroded with average bank slope of 20 to 39%, and avg height of eroded banks 20 to 49% of water width.</p> <p>bank stabilization score 125 10 8 points 6 pts</p>	<p>Moderate amount of bank erosion (50-100%) of stream with slope of 40-59% whose avg height is 50% to 79% water width.</p> <p>bank stabilization score 10 2.1 5 points 3 pts</p>	<p>Nearly all of stream has at least one eroded bank (100-200%) that is . 60% slope, whose avg height is . 80% of avg water width.</p> <p>bank stabil. score 2 1 2 points 0 pts</p>
10	<p>Bank vegetation stability. Don't count bedrock or concrete - soil doesn't have to be covered as long as it's stable.</p> <p>% right bnk stable + % lft bnk unstable</p>	<p>0% unstable 10% unstable 10 points 9 pts</p>	<p>11% unstable 20% unstable 8 points 6 pts</p>	<p>21% unstable 40% unstable 5 points 3 pts</p>	<p>41% unst. >100% unst. 0 2 points pts</p>
11	<p>Streamside cover: count only vegetation within 10 ft of waters edge.</p>	<p>Dominant vegetation is shrub (woody plants >10cm dbh) 100% shrub 34% shrub 10 points 9 pts</p>	<p>Dominant vegetation is tree. 100% 34% 8 points 6 pts</p>	<p>Dominant vegetation is grass and forbs. 100% 34% 5 points 3 pts</p>	<p>Dominant cover is rock, concrete, bridge material, etc. 34% 100% 2 points 0 pts</p>

STANDARD OPERATING PROCEDURE

MEASUREMENT OF STREAM FLOW WITH MARSH-MCBIRNEY MODEL 2000

I. General Information.

This SOP will provide a general discussion of flow measurement practices and detailed information concerning operation of the Model 2000 flowmeter. Before the meter is taken into the field, each operator should read the instrument manual as it contains much more information concerning such topics as error messages and those unusual situations that you might run into. Pay special attention to the correction page in the beginning as it corrects some mistakes, especially in regard to instrument calibration. Another very good source of information is the USGS manual on "Discharge Measurements at Gaging Stations". This manual will help to better explain flow calculations if you find them confusing.

Flowmeters, such as the model 2000, measure velocity through changes in the magnetic field about the sensor as caused by water flow. Although the sensor does not have moving parts, it should be protected from bumps as it does contain electronic sensors. The sensor should be kept clean, especially of oils or grease. The probe should be cleaned with soap and water.

The meter operates on two D-cell batteries and will run for about 20 hours. The meter will indicate when the batteries are low. The meter will shut off automatically when it is out of the current for five minutes.

The obtainment of accurate flow measurements is more a matter of physical technique than it is of instrument operation. Each stream will present you with a unique physical situation; therefore, it is not possible to describe to you what to do under any situation. The following instructions are presented as guidelines but you will have to exercise considerable judgement in the field to obtain good results.

II. Operation.

a. Sensor Mounting

The sensor attaches to the wading rod by means of a thumb screw. The thumb screw must be placed over the recessed portion of the sensor mount. **THE SCREW THREADS CAN BE EASILY STRIPPED - DO NOT OVER-TIGHTEN.** (The sensor does not need to be tightly attached and, since the sensor should be removed during transport, it will be put on and taken off frequently.)

b. Wading Rod

The wading rod is a top adjusting model which makes it much easier to use. To move the rod up or down, press the metal tab at the top of the rod handle and slide the smaller of the two rods up or down.

The rod is divided into feet and tenths of feet (not inches). Velocity should be measured at different depths, dependent upon the depth of the water column. The velocity should be measured at 60% of the depth from the surface.

To calculate 60% of depth from the top:

Determine depth of segment to be measured (ex. 1.4 feet)

Slide smaller rod up until the "1" on the rod lines up with the four on the rod handle moving the sensor to 0.6 feet.

c. Stream site locations

The portion of the stream where flow is to be measured should be as uniform as possible. The ideal shape is a rectangle which can be found under some cement bridges. Avoid stagnant areas or those with irregular bottoms, turbulent flow, standing waves, or strongly sloping bottoms. For small streams, the narrowest portions are generally best as velocities will be higher and fewer measurements will be required.

The stream should be divided into a number of segments. The more segments, the more accurate the results. The ideal to shoot for is to divide the stream so that each segment accounts for 5% of the flow. Using this method, if one measure is inaccurate it will not significantly affect the results. In any case, an attempt should be made to measure flow at least every foot, when the width is ≤ 20 feet with a minimum of twenty measurements. If the stream is extremely narrow, the flow should not be measured at increments less than 0.5 feet.

In many streams, the first foot or so of stream is very shallow and stagnant. There are two approaches to dealing with this problem. The first is to ignore the shallow portion while the second involves averaging the depth and velocity between the bank and the first sample point. The best approach is to take the first measurement at the closest point where depth and flow are adequate. Any stream area closer to the shore than one-half the segment width from this point is ignored.

Stretch a measuring tape from bank to bank on the stream cross section to be sampled. Measure velocity at the first point where measurement is possible and then at some regular distance from the first measurement at the prescribed depth. Point the head of the sensor directly into the current and hold steady. Stand to the side and away from the wading rod.

III. Meter operation

a. Calibration

Before each sampling trip, the meter should be checked to see if it is reading $\square 0.0$ " under zero discharge. To do this, first clean sensor with soap and water. Place sensor (attached to wading rod for stability) in a five-gallon bucket as near center as possible and at least three inches from any side or bottom. Wait ten minutes to insure that the water is absolutely still before starting measurement. Turn meter on by pressing ON/C button. Press the STO and RCL keys at the same time and a 3 will appear on the display. Reduce this figure to zero with the down arrow key (You must press the arrow key within five seconds of the time that the 3 is displayed or you will get an error message. If this occurs, press the OFF key and start over.) After you have reduced the value to zero, a 32 will be displayed which will automatically drop to zero, at which time the meter is zeroed.

b. Measurement

Turn meter on by pressing ON/C key.

In order to dampen the meter's reading tendency to fluctuate, the meter can be adjusted to either filter the reading (time constant filtering - rC) or average the reading (fixed point averaging - FPA). By filtering the reading, the meter only reads every so many seconds, as specified by the user. The other setting averages the signal over some period, as specified by the user. Either method can be used; however, for the greatest accuracy, the averaged reading method is best. The rC filter period can be set from 2-30 seconds while the averaging period (FPA) can be set from 2-120 seconds. The period can be changed using the up and down arrow keys. For the FPA setting an average of 15 seconds should be adequate.

The meter will store up to 19 data points. To store a reading, press the STO key. The meter will indicate which store reading that you are on. To recall a reading, press the RCL key and scroll through the readings with the up and down arrows. To clear the memory, press the ON/C and STO keys at the same time.

c. Instructions for completing field sheet

1. In the first row, mark EOS (Edge of Stream) in the width square.
2. Write down the corresponding depth and velocity in the rest of the line. These will often be 0, but if your stream has rock ledge banks or you're under a bridge abutment the edge of the stream will have a depth and possibly a velocity.
3. Proceed measuring flow as you have been until you have recorded your last measurement that falls on a whole distance interval.
4. The final measurement should be marked EOS in the left margin. This width may be less than all the other intervals and the depth and velocity may be 0 or >0. Record the depth and velocity of the edge of the stream no matter whether they are zero or not, and in the width column, record the distance to the edge of the stream from the last measurement point. Please use decimal increments of feet for this distance.

Field sheet is shown on the following page.

The following formula is to be used in determining flow (average discharge).

$$Q = \sum_{i=1}^n (w_{i+1} - w_i) \frac{d_i + d_{i+1}}{2} \frac{v_i + v_{i+1}}{2}$$

where w is the distance from the previous point, d is the depth measurement and v is the velocity measurement.

