STREAM ASSESSMENT TO FILL DATA GAPS FOR SOUTHWESTERN OKLAHOMA: PHASE II

OCC Task 090
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1.0 INTRODUCTION

1.1 HISTORY

The Oklahoma Conservation Commission (OCC) is charged by state statute with the task of monitoring nonpoint source (NPS) impacts to state waters. Because there are no numerical criteria for many of the common NPS pollutants, reference conditions must be established to allow assessment of NPS impacts. The OCC has done this over focused portions of the state through various projects, which include assessments in the Illinois River area, eastern Oklahoma border area, and the southern Oklahoma Muddy Boggy system. Each of these studies has resulted in a database of both positive and negative reference conditions for habitat, fish, benthic macroinvertebrates, and water quality for select areas. However, these studies have left significant data gaps over a large area of the western part of the state where there has been no systematic stream assessment for NPS impacts and no determination of reference conditions. Lack of data regarding NPS impacts and conditions of streams in these areas prevents the establishment of a water quality basis for Oklahoma's NPS programming.

In light of OCC's monitoring responsibilities, reference sites are required to determine the highest water, habitat, and biological quality attainable for ecologically similar streams. Across the country, many state organizations responsible for tracking the health of their streams have made use of ecological regions to help establish water quality standards. The Environmental Protection Agency (EPA) has developed this ecoregion concept and defines ecoregions as "regions of relative homogeneity in ecological systems or in relationships between organisms and their environments" (Omernik, 1987). By carefully studying patterns of land use, potential natural vegetation, physical geography, and soils, Omernik developed a map depicting the ecoregions of the United States (Omernik, 1987). Land use maps are essential in creating ecoregions since they detail urbanization and agriculture (Gallant et al., 1989). Since there is not one type of river or stream, a single criterion will not be adequate for all. To prevent developing criteria for every site, it is useful to divide an area into ecoregions, affording a sound, spatial framework for establishment of criteria for similar areas.

The method for compiling the national ecoregion map balances a quantitative method with an overlying qualitative method. As there is much variation across areas on the degree of importance of particular parameters and the variation of quality in source materials across the nation, manual adjustment on the part of the analyst is important in formulating the final delineation of ecoregions (Gallant et al., 1989). Mapping based solely on qualitative numbers for the same set of parameters can introduce biases into the final ecoregion determination and overlooks other important possibilities. To establish ecoregions, the forces that are most important in defining the area must be used in determining the boundaries; for example, physical geography may drive vegetation and land use in one area, while annual rainfall controls the same variables in another (Gallant et al., 1989).

To define regions, a standard process is recommended. First, the scope of the project including specification of the issues and objectives is established. Reference materials including maps are then acquired and used to determine regional characteristics based on the defined objectives. Boundaries are tentatively determined and refined through comparison with the source materials and through field-checking sites. Once the boundaries are completed, the region can be characterized (Gallant et al., 1989).

A variety of uses exist for the ecoregion concept. These include an analytical, spatial framework for determining least impacted reference sites, analyzing and interpreting environmental data, and deriving sampling designs for evaluating spatially distributed resources (Gallant et al., 1989). Ecoregions are the spatial framework for a number of states' water quality standards programs.

Ohio wanted to establish a framework to protect and restore water bodies for beneficial uses. By using the ecoregions delineated by Omernik, the Ohio EPA created regional biocriteria for the state (Gallant et al., 1989). A review of indices that track the health of fish and macroinvertebrate assemblages allowed the state to establish expected index values by region. Now, the departure from the expected regional biocriteria values from the biological monitoring is used to determine attainment or non-attainment for water bodies in Ohio (Gallant et al., 1989).

To determine how well Omernik's ecoregions separated the state's streams, Arkansas performed ordination analyses on fish assemblages, water chemistry and physical habitat variables (Rohm et al., 1987). The results of this study allowed them to determine that the differences detected in the ecoregions truly addressed differences reflected in the environment and were similar for all three data types (Rohm et al., 1987). Prior to the ecoregion development, natural conditions for streams in certain locations precluded the achievement of national and state water quality standards. Channelized streams had higher dissolved oxygen levels than swamp streams with slow flow (Hughes and Larsen, 1988). Omernik's regions were used by Arkansas to establish regional quantitative criteria for temperature, turbidity, and dissolved oxygen (Gallant et al., 1989).

Wisconsin compared Omernik's ecoregions with fish assemblages across the state and found that the ecoregions correspondence improved with increasing stream size (Lyons, 1989). This is because larger streams are better able to integrate variability found in an area than smaller streams; small streams are more influenced by local distinctions not detected at the larger ecoregion level than larger streams (Lyons, 1989). Lyons (1989) determined that the ecoregions as established by Omernik would be beneficial in managing resources over the entire state but not as helpful in dealing with specific water bodies.

Many states have found that the EPA ecoregions were not refined enough to meet their needs for establishing water quality standards, biological criteria, or reference streams. By subdividing ecoregions into subregions, variability within the ecoregion can be classified (Gallant et al., 1989). The scale of a defined ecoregion is determined by the ultimate need of those defining the area. For viewing the status of an ecological aspect at a global level, the scale is much more coarse than it would be for a national level

(Omernik, 1995). In creating the ecoregions through the Rocky Mountains, minute details were minimized as the level of detail desired was to establish a general ecoregional framework; changes in the area due to climate and elevation lent themselves to a multitude of subregions that were too small to manage, and hindered the ability to extrapolate based on the level of resolution (Gallant et al., 1989). To establish reference streams and develop water quality standards and biological criteria, states need a more detailed region delineation than that developed by the EPA. The question of scale, however, is very important, as more time and resources per unit area are required for regions of a larger scale (Omernik, 1995).

Because all states do not have the same types of streams, parameters that are important in one state may not apply to another state. Wisconsin found that water temperature and stream gradient were the most important factors in determining fish assemblages but acknowledged that states lacking coldwater streams would not be able to predict local fish assemblages using Wisconsin's parameters (Lyons, 1989). Omernik's ecoregions can be used across a large area as the parameters measured impact the constitution of the aquatic ecosystem.

Wisconsin encountered spatial inconsistencies in the available regional frameworks due to the differing agendas of the groups developing the classifications. For example, those agencies dealing with forest resources developed regions focused almost exclusively on terrestrial aspects of the areas as opposed to water resources, and agencies dealing with water resources neglected terrestrial resources (Omernik et al., 2000). This was forcing the agencies to make use of a variety of maps, including those developed for specific types of resources and those of insufficient scale to manage the ecosystem as a whole (Omernik et al., 2000). To create "general purpose" regions that would allow for a more holistic management of the state's natural resources, Wisconsin divided the six EPA ecoregions located within its boundaries into twenty-four subregions (Omernik et al., 2000).

Subregions were established in Iowa to aid in the development of biological criteria and the selection of regional reference sites (Griffith et al., 1994). Of the original five ecoregions crossing Iowa, one was subdivided into six subregions, establishing a total of ten subregions in the state (Griffith et al. 1994). Iowa intends to work with neighboring states on sharing data from regions held in common with Minnesota, Wisconsin, and Missouri (Griffith et al. 1994).

Another project was developed by a multi-state consortium in further defining the Blue Ridge Mountains, the Central Appalachian Ridges and Valleys, and the Central Appalachian ecoregions. These ecoregions cover parts of Virginia, West Virginia, Maryland, and Pennsylvania. By working with other states, uniformity can be established in methods of sample collection and data can be exchanged that will allow an ecoregion to be managed more effectively as a whole unit (Omernik, 1995). An added bonus to cooperation with neighboring states in this case was the ability for Maryland and West Virginia to gain data from the other states concerning sites in the newly formed subregions of the Central Appalachian Ridges and Valleys ecoregion as neither state had many reference sites available within their boundaries; pooling information allowed better management of their subregional areas of the Central Appalachian Ridges and Valleys ecoregion (Omernik, 1995).

The map created by Omernik for the EPA has eleven ecoregions crossing the state of Oklahoma. Three of these are included in this study. The Central Great Plains ecoregion is typified by grasslands transitioning from a tallgrass to a shortgrass prairie community forming a mixed grass prairie across much of its area (Hoagland and Stoodley, 1998). Riparian areas and ravines of this region support woodlands consisting of cottonwoods, willows, hackberries, and elms (Hoagland and Stoodley, 1998). This ecoregion contains salt flats and springs and supports flora and fauna adapted to living in soils and waters with high salt concentrations (e.g., Red River pupfish). The Wichita Mountains with areas reflecting that found in eastern Oklahoma, gypsum hills containing large caves, redbud plains with high iron content, and western sand dunes conducive to forming wetlands represent the geographical diversity found in the Central Great Plains ecoregion (Hoagland and Stoodley, 1998).

The Southwestern Tablelands represent an area consisting of mixed grasslands and shinnery oak scrub communities (Hoagland and Stoodley, 1998). Riparian areas in this ecoregion are characterized by cottonwoods and willows; all major rivers excluding the Washita River are bordered by sand dunes (Hoagland and Stoodley, 1998). Included in this ecoregion is Black Mesa, which can be found in the northwestern portion of the panhandle. Shortgrass prairie forming dense sods interspersed with cacti covers this portion of the ecoregion (Hoagland and Stoodley, 1998). Mesa slopes are covered by shrubs and juniper woodland communities (Hoagland and Stoodley, 1998).

The transition between eastern forests and western grasslands forms the Central Oklahoma/Texas Plains ecoregion (Hoagland and Stoodley, 1998). Prairie areas cover the northern and southern locales of this ecoregion with dry upland forests consisting of short post oaks and blackjacks located in the central range (Hoagland and Stoodley, 1998). The majority of this ecoregion is covered by grasslands, though some portions offer moist soils that support black hickories; other portions are drier, sporting shorter and fewer trees (Hoagland and Stoodley, 1998). Bottomland forests in this ecoregion are represented by fewer species than those found in the eastern portion of the state due to less rainfall (Hoagland and Stoodley, 1998). The Arbuckle Mountains are located in this ecoregion. This area contains flora and fauna similar to that found in eastern Oklahoma (Hoagland and Stoodley, 1998).

1.2 PROJECT BACKGROUND

Following changes in the national and regional 319 guidance, the project *Stream Assessment to Fill Data Gaps for Eastern Oklahoma* was incorporated in the FY 96 work program. That project began a formal strategy to achieve a more complete monitoring coverage, which eventually resulted in receipt of funding for the tasks at hand. The “Data Gaps” projects for southwestern (1997 Task 500) and northwestern (1998 Task 400) Oklahoma were designed to be executed in two phases. The Phase I component of each project provides a preliminary screening of a large number of stream sites in terms of habitat (abbreviated assessment) and water quality (dissolved oxygen, pH, temperature, turbidity, conductivity, and qualitative site characteristics). Phase II activities involve use of the preliminary assessment to select sites for more intensive monitoring, which will fill remaining data gaps for water quality, habitat, and biological data. This report focuses on and is a fulfillment of workplan directives for Phase II of the Southwest Oklahoma, Task 500 project. Because the data was collected concurrently for both the northwestern and southwestern sectors of the state, a more complete analysis will be made at a later point. This data will then be combined with data collected for the Eastern Oklahoma Data Gaps and other projects and reanalyzed to gain a more complete reference stream coverage for ecoregions in their entirety.

Results of these projects serve two purposes: (1) development of the OCC reference stream database for the western half of the state and (2) provision of a current assessment of water quality and biological conditions for the study area. Additionally, the completion of the reference stream database makes future assessments more time and cost efficient and adds more certainty to the conclusions. The information will also be included as "assessed" data in the state's 319 Assessment Report and the Integrated Report (305(b) report and 303(d) list) and will be made available for use by other federal, state, local, and tribal agencies.

A preliminary assessment of over 500 western Oklahoma stream sites (Figure 1) was conducted to facilitate selection of a list for intensive monitoring for the areas southwest of I35 and northwest of I35 as a whole. Although the preliminary sites were not divided up by task; the final, intensive sites were broken down into Task 500 (OCC Task 90) and Task 400 (OCC Task 104). All preliminary sites are located in the region west of I35 extending to all applicable state boundaries. A total of 39 counties comprising four ecoregions were covered during the survey. The ecoregions include the following: 1) Central Oklahoma/Texas Plains, 2) Central Great Plains, 3) Southwestern Tablelands, and 4) Western High Plains. Preliminary sites were chosen to facilitate full coverage of the area. For the southwest project specifically, app. 280 stream sites covering 20 counties in three ecoregions were chosen for preliminary assessment.

All preliminary stream sites were rated in terms of habitat and water quality parameters. Habitat evaluations comprised an abbreviated version of the OCC intensive habitat assessment (a modified RBP). Water quality assessment was limited to field parameters (dissolved oxygen, pH, temperature, turbidity and conductivity). Qualitative observations of stream health were also made including excessive periphyton growth, salts on the stream bank, oil sheens, scum or foam, unpleasant appearance, and odor. Human disturbance was factored into the assessments in determining the level of cultivation and urbanization within 15 stream miles of the site. Point sources were located and considered if present. Additionally, the abundance of livestock fecal material within bankfull elevation of the site was determined and considered.

Each stream segment was surveyed for 400 meters upstream or downstream of the starting point (usually a road crossing). Observations were recorded every 50 meters for the eleven different habitat/stream characteristics (instream cover, pool bottom

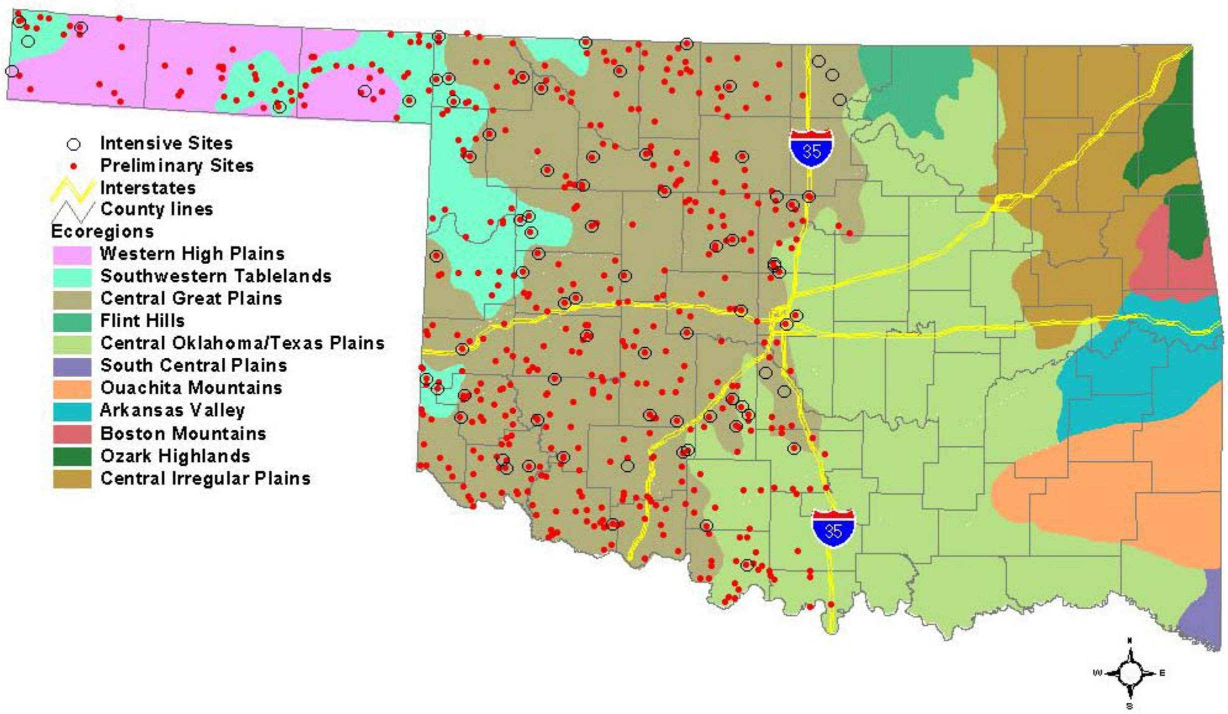

Figure 1. Preliminary and Intensive Monitoring Sites for West of I35 Project.

substrate, pool variability, canopy cover, percent rocky runs and rocky riffles, flow at base elevation, channel alteration, channel sinuosity, bank stability, vegetative stability, and dominant streamside vegetation). Sinuosity was calculated from digital ortho quad maps using Geographic Information System technology (GIS). Points acquired from these eleven categories based on a standardized scoring matrix comprised the total habitat score. Field water quality parameters were measured at one location according to OCC SOPs. The water quality score was obtained through points established in a manner similar to that of the habitat score. The categories covered in the water quality score were dissolved oxygen, turbidity, pH, livestock droppings, periphyton, land use, and point sources. Appendix B contains the field sheets and final scoring regime for both the water quality and habitat assessments.

To begin Phase II of the projects, sites were selected based upon the specific habitat and water quality score results from the preliminary assessment. Selection was designed to cover a breadth of conditions, thus providing potential for determining the habitat-biota and water quality-biota relationships. Sites were chosen in proportion to ecoregion coverage of the study area and were selected to fulfill the following composition of stream conditions: (1) fifty percent good habitat and good water quality, (2) twenty-five percent good habitat and poor water quality, (3) and twenty-five percent bad habitat and poor water quality (Table 1).

Table 1. Percent ecoregion and relative number of stream sites targeted for intensive monitoring.

Ecoregion	Percent Ecoregion Occurrence	Number Selected per Ecoregion (based on 80 total)	Good Water Quality/Good Habitat (50%)	Good Water Quality/Poor Habitat (25%)	Poor Water Quality/Good Habitat (25%)
Central Oklahoma/Texas Plains	9.8	8	4	2	2
Central Great Plains	64.5	52	26	13	13
Southwestern Tablelands	14.1	11	5	3	3
Western High Plains	11.6	9	5	2	2
TOTALS	*100.0*	*80*	*40*	*20*	*20*

Seventy-nine streams were selected for intensive investigation (Appendix A). Thirty-two of these represent the southwestern Oklahoma project (Table 2). This number was reduced from fifty as stated in the workplan due to issues of accessibility, site inviability for project duration, etc. The number of streams for each ecoregion was based on the total eighty streams to be monitored. Scores for each individual assessment were grouped by ecoregion and sorted best to worst for habitat and water quality. Upper and lower quartiles were then calculated for each ecoregion, and the final list was selected to fulfill the following criteria: (1) fifty percent from the upper quartiles of habitat and water quality scores, (2) twenty-five percent from the upper quartile of habitat scores and lower quartile of water quality scores, and (3) twenty-five percent from the lower quartile of habitat scores and the upper quartile water quality scores. Sites were field reviewed and final selections refined based on geographic location, stream order, and accessibility.

2.0 MATERIALS AND METHODS

2.1 WATER QUALITY MONITORING

Water sampling efforts for intensive sites began in May 2000 and continued on five-week intervals until April 2002 (20 total events/site). All sampling and measurement activities followed procedures outlined in the appropriate OCC SOP (nos. 1, 8, 9, 10, 12, 14, 15, 18, 24, and 32). In-situ measurements included the following parameters: temperature (YSI Model 55), dissolved oxygen (YSI Model 55), pH (YSI Model 60), specific conductance (YSI Model 30), alkalinity (Hach Digital Titrator Model 16900-01), turbidity (Hach Portable Turbidimeter Model 2100P), and instantaneous discharge (Marsh-McBirney Flo-Mate Model 2000).

One water sample was collected per site per 35 day interval in two, new, sample rinsed HDPE bottles; one was preserved to a pH <2 with H_2SO_4 and both were stored and delivered on ice or at 4^o C. Quality assurance/control samples were collected in accordance with the project QAPP. Samples were submitted to the Department of Environmental Quality (DEQ) Laboratory and to the Department of Agriculture Laboratory for analysis of the following parameters: nitrate, nitrite, ammonia, total Kjeldahl nitrogen, total phosphorus, ortho-phosphate as phosphorus, sulfate, chloride, hardness, and total suspended solids.

Table 2. Intensive Site List for the Southwest of I-35 Project.

Site Name	WBID	Legal	County	LAT	LONG	E-region
Roaring Creek	OK310810-02-0170G	Sections 35/36 5N 6W	Grady	34.86168	-97.794	CGP
Bitter Creek	OK310820-01-0030G	NW¼ Section 9 6N 6W	Grady	35.01324	-97.84362	CGP
Little Washita River, Grady Co.	OK310820-02-0010B	Section 25/26 6N 7W	Grady	34.9638	-97.89957	CGP
Little Washita River, Caddo Co.	OK310820-02-0010F	Section 23/26 5N 10W	Caddo	34.88416667	-98.21986667	CGP
Washita River # 466	OK310830-03-0010G	Sections 11/14 10N 16W	Washita	35.34938333	-99.85788333	CGP
Willow Creek	OK310830-06-0030H	Sections 10/14 9N 12W	Caddo	35.2622	-98.45123333	CGP
Whiskey Creek	OK311210-00-0140D	Sections 20/29 3N 9W	Comanche	34.71016667	-98.16845	CGP
Cottonwood Creek, Comanche Co.	OK311210-00-0150G	Sections 21/22 3N 9W	Comanche	34.72423333	-98.14073333	CGP
Tahoe Creek	OK311300-03-0070G	NW¼ NW¼ Section 13 5N 12W	Caddo	34.90818333	-98.4283	CGP
Blue Beaver Creek	OK311310-02-0060G	N.C. Section 22 2N 13W	Comanche	35.46438333	-98.55258333	CGP
Brush Creek	OK311310-03-0050G	Sections 14/15 3S 14W	Tillman	34.30137	-98.64433	CGP
Stinking Creek	OK311500-01-0050G	Sections 30/31 2N 19W	Jackson	34.60881667	-99.23335	CGP
Tepee Creek	OK311500-01-0110G	Section 22/27 5N 19W	Kiowa	34.88506667	-99.199	CGP
West Otter Creek	OK311500-02-0040G	Sections 4/9 2N 17W	Kiowa	34.66706667	-98.99493333	CGP
Little Elk Creek	OK311500-03-0040G	Sections 2/11 7N 18W	Kiowa	35.10228333	-99.0746	CGP
Turkey Creek	OK311510-02-0060G	NE¼ Section 15 9N 24W	Beckham	35.25917	-99.7232	CGP
Salt Fork of the Red River	OK311600-02-0010G	Sections 16/21 2N 21W	Jackson	34.63758333	-99.40888333	CGP
Bitter Creek	OK311600-02-0110G	NE¼ NE¼ Section 3 1N 21W	Jackson	34.59435	-99.38813333	CGP
Cave Creek	OK311600-02-0140G	NW¼ Section 34 5N 24W	Greer	34.8681	-99.71606667	CGP
Deer Creek, Greer Co.	OK311800-00-0070C	Sections 13/14 6N 24W	Greer	34.98893	-99.69555	CGP
Crooked Oak Creek	OK520520-00-0150G	Sections 12/13 11N 3W	Oklahoma	35.43537	-97.47437	CGP
Buggy Creek	OK520610-02-0120G	Sections 4/5 10N 9W	Caddo	35.3756	-98.1665	CGP
North Walnut Creek	OK520610-03-0010G	SE¼ Section 23 7N 3W	McClain	35.06011	-97.4769	CGP
North Fork Walnut Creek	OK520610-03-0080G	SW¼ Section 15 8N 4W	McClain	35.16423	-97.61451	CGP
Laflin Creek	OK310810-02-0200G	Section 4/9 5N 5W	Grady	34.92786	-97.72758	COTP
Winter Creek	OK310810-02-0220G	Sections 19/30 6N 5W	Grady	34.97157	-97.77389	COTP
Rush Creek	OK310810-05-0010H	Sections 9/10 3N 2W	Garvin	34.7441	-97.4054	COTP
West Mud Creek	OK311100-04-0080G	Sections 27/28 5S 5W	Jefferson	34.08903	-97.72041	COTP
Dry Creek	OK311200-00-0080G	Sections 12/13 3S 8W	Stephens	34.30405	-97.99986667	COTP
Crutcho Creek	OK520520-00-0070B	Sections 27/28 12N 2W	Oklahoma	35.48617	-97.40618	COTP
Fish Creek	OK311800-00-0130G	SE¼ Section 6 6N 25W	Greer	35.01885	-99.88026	SWT
North Elm Creek	OK311800-00-0170G	Sections 17/21 7N 26W	Beckham	35.07495	-99.95988333	SWT

Separate samples were collected and submitted concurrently for analysis of fecal coliform, *E. coli*, and *Enterococcus* bacteria.

All data were compiled and entered into an Access database for later analysis. Upon retrieval, data were proofed, quality assured, and the descriptive statistics were generated for each parameter using the statistical software package *Mintab, V. 11.2*. All statistics were determined for each parameter according to ecoregion. Parameters for which strongest biological responses have been demonstrated were chosen and criteria developed (Table 3) to allow opportunity for ranking of sites within their respective ecoregion. Fecal coliform bacterial density was chosen as a surrogate metric to attempt determination of the relative magnitude of NPS disturbance for sites.

The ranking process was founded upon the determination of the frequency of exceedance (FOE) of the criterion (Table 3) for each parameter by site; the higher a site's FOE for a given parameter the lower the rank (for this and similar methods following, the lower rank translates to a higher rank number [i.e., rank number 2 is better than rank number 5]). Thus, a site with an FOE of 25 percent for parameter of interest would rank higher (i.e., closer to 1) than a site exhibiting an FOE of 75 for the same parameter. To limit the number of possible ranks, ranks were assigned to each unit of ten percent exceedance (e.g., 0-9 received rank 1, 10-19 received Rank 2, and so on).

Upon determination of FOEs and their associated ranks for each parameter, a final matrix was compiled allowing the average of all ranks for a site to be determined. This value was used as the site's "Water Quality" score in the final ranking table. Again, the lower the total score the better the site in terms of water quality.

Table 3. Water quality parameters and associated criteria for quality assessment.

Water Quality Parameter	Criterion*
DO-percent saturation	<lower quartile or >upper quartile
PH	<lower quartile or >upper quartile
Turbidity (NTU)	>upper quartile
Available-N; Ammonia+NitrateNitrite (mg/l)	>upper quartile
Total-N; TKN+NitrateNitrite (mg/l)	>upper quartile
o-P (mg/l)	>upper quartile
Total P (mg/l)	>upper quartile
TSS	>upper quartile
Fecal Coliform, ln transformed FCUs	>upper quartile

*respective to ecoregion

2.2 BIOLOGICAL MONITORING

2.2.1 Habitat Assessment

In the summers of 2000 and 2001, OCC staff conducted instream and riparian habitat assessments at intensive sites concurrent with fish collections. Investigators recorded data for 20 stations at 20 meter intervals, which included the following primary parameters: stream depth, width, substrate composition, habitat type, fish cover, canopy cover, percent bank erosion and riparian width/condition. All assessments were conducted in accordance with procedures outlined in the OCC Habitat Assessment SOP, no. 39, revision 7.

The OCC's habitat assessment adheres to a modified version of the EPA Rapid Bioassessment Protocols (RBP) (Plafkin et al., 1989) and is designed to assess habitat quality in relation to its ability to support biological communities in the stream. The assessment is based on particular parameters grouped into three categories for a total of eleven components (Plafkin et al., 1989). The three primary categories assessed include micro scale habitat, macro scale habitat, and riparian/bank structure. Micro scale habitat includes substrate makeup, stable cover, canopy, and flow. Macro scale assesses the channel morphology, sediment depositions, and other parameters. The third category looks at the riparian zone quality, width, and general makeup (trees, shrubs, vines, and grasses) as well as bank features. Bank erosion, and streamside vegetative cover are incorporated into this section. Quantitative weighting is given to each of these sections in relation to their biological significance. Scores are computed for each of the eleven categories, summed, and assigned as an evaluation of that stream section and riparian zone. Scores can reach a maximum of 180 points (OCC SOP #39, revision 7).

Upon determination of total habitat scores for all sites, the data were submitted to *Mintab* for calculation of descriptive statistics. Total scores greater than the median or less than the lower quartile for each ecoregion were ranked from best (i.e., rank 1) to worst resulting in two possible categories ("Good" and "Poor"). Sites not meeting the criterion for one or both categories were assigned a default rank logical for the category of interest. For example, sites not meeting the "good habitat" criterion (i.e., > median) were assigned a default rank of plus one of the lowest rank of sites meeting the criterion; sites not meeting the criterion for "worst habitat" (i.e., < lower quartile) were assigned a default of rank "1". Rankings were averaged per site for both categories to achieve a "Habitat" score for use in the final rankings table.

2.2.2 Fish

In the summers of 2000 and 2001, fish were collected from a 400-meter reach at all intensive sites using a combination of seining and electroshocking according to procedures outlined in OCC SOP, nos. 35 and 39. The collection of fish follows a modified version of the EPA Rapid Bioassessment Protocol V (EPA, 1989) supplemented by other documents. Specific techniques and relative advantages of seining and electrofishing vary considerably according to stream type and conductivity. Specifics of the gear and their application are discussed in detail in Fisheries Techniques (edited by L.A. Nielsen and D.L. Johnson and published by the American Fisheries Society 1983).

Except for those individuals readily identifiable in the field, fish were placed in 10% formalin immediately after capture and identified to species by a professional taxonomist. Any fish species released were photographed on print film for reference. All samples were eventually preserved in ethanol and retained for future reference.

Fish data were compiled and analyzed by site following a modified version of Karr's Index of Biotic Integrity (IBI) (adapted from Plafkin et al., 1989). Although a variety of metrics were calculated, seven were chosen which seemed to exhibit best "signal" strength and were most often demonstrated in the literature. Descriptive statistics were determined by ecoregion for each metric, and criteria were imposed to allow ranking of sites within ecoregions.

The ranking process followed a similar course to that used for habitat with some differences. For each site, metric scores were subjected to the criteria below, (Table 4) and the number of metrics meeting the criteria for each category was determined. Sites were ranked for each category according to number of metrics meeting their respective criteria; e.g., for "good" sites, the greater the number of metrics meeting the criteria, the higher the rank (i.e., rank closer to 1). As with the habitat rankings, sites not meeting the criterion for one or both categories were assigned a default rank logical for the category of interest. Rankings of both categories were averaged per site to achieve a "Fish" score for use in the final rankings table.

Table 4. Fish metrics and associated criteria used for site evaluation.

Metric	"Good" Criteria*	"Poor" Criteria*
Total Species	>=median	<=lower quartile
Shanon Diversity	>=median	<=lower quartile
Number of Centrarchid species	>=median	<=lower quartile
Number of Intol Species	>=median	<=lower quartile
Percent of Individuals as Tolerant	<=median	>=upper quartile
Number of Sensitive Benthic Species	>=median	<=lower quartile
Number of Insectivorous Cyprinid Species	>=median	<=lower quartile

*respective to ecoregion

2.2.3 Macroinvertebrates

Macroinvertebrates were collected at intensive sites for both the winter and summer index periods of 2000 and 2001 according to procedures outlined in OCC SOP, nos. 29, 30, 31, and 36. Sampling efforts included attempts to procure animals from all available habitats at a site; thus, total effort at a site may entail up to three total samples with one from each of the following habitats: rocky riffles, streamside vegetation, and woody debris.

Briefly, collection methods entailed an assessment of each of the habitats similar to methods outlined in the EPA RBP (1989). Riffle sampling effort consisted of three separate 1 m^2 kicknet samples in areas of rocky substrate reflecting the breadth of the hydraulic regime at a site. Riffles with substrates of bedrock or tight clay were not sampled. Any streamside vegetation in the current that appeared to offer fine structure was sampled by agitation within a #30 mesh dip net (3 minutes total agitation time). Any dead wood with or without bark which was in current fast enough to offer suitable habitat for organisms was sampled by agitation by scraping/brushing upstream of a #30 mesh dip net (5 minutes total agitation time). Woody debris sampled generally ranged in size from 1/4" to about 8" in diameter. Each sample type was preserved independently in quart mason jars with ethanol, labeled, and sent to a contractor for picking.

Preserved samples were picked in the laboratory, and the picked subsamples sent to a professional taxonomist for identification. Data were compiled, collated by year, season, and sample type and entered into a spreadsheet for metric calculations and subsequent ranking. Of the total of 16 metrics calculated, seven were chosen which appeared to render strongest signals and have been commonly employed throughout the literature. Descriptive statistics of the metrics for each season specific sample type (e.g., summer riffle, winter vegetation, summer woody) were determined by *Minitab* for each ecoregion, and criteria (Table 5) were imposed to allow ranking of sites within ecoregions.

The site ranking process used for this data was identical to that employed for fish and resulted in six categories for each of the index periods: "good" and "poor" summer riffle, vegetation, and woody; and "good" and "poor" winter riffle, vegetation, and woody. Rankings of all categories were averaged respective of season resulting in a single value for their representation. To better represent a site at its potentially harshest condition (i.e., summer low flow), only the average rankings for the summer macroinvertebrate data were incorporated as the "Bug" score for use in the final rankings table.

Table 5. Benthic macroinvertebrate metrics and associated criteria used for site evaluation.

Metric	"Good" Criteria*	"Poor" Criteria*
Number of taxa	>=median	<=lower quartile
Modified HBI	<=median	>=upper quartile
EPT/EPT+Chironominae	>=median	<=lower quartile
EPT/Total	>=median	<=lower quartile
EPT taxa	>=median	<=lower quartile
Dominants/total	<=median	>=upper quartile
S-W Diversity	>=median	<=lower quartile

*respective to ecoregion for each season specific sample type

2.3 BENEFICIAL USE SUPPORT ASSESSMENT

All pertinent data were subjected to a beneficial use support evaluation as per Oklahoma Water Resources Board WQS 785:45 and 46 and the state's Continuing Planning Process, *Integrated Water Quality Report Listing Methodology* (Department of Environmental Quality website).

2.4 FINAL SCORING AND STREAM SELECTION

Rank scores for each of the categories (water quality, habitat, fish, and bugs) were assembled in a scoring matrix by site to allow determination of a final ranking score. Category scores were summed for each site and final scores sorted in ascending order by ecoregion (again, the smaller the number, the better a site's rank). Candidates for "good" reference conditions constituted those sites exhibiting the lowest total rank scores for each ecoregion, which appear to be supporting for the Fish and Wildlife beneficial use. "Poor" reference site candidates were those exhibiting highest rank scores for a given ecoregion and appear not to support the Fish and Wildlife Propagation beneficial use. For all analyses, depauparate "n" for Southwest Tablelands precluded useful results; thus, no reference candidates were chosen. When these two streams are added to additional streams from the same ecoregion in the NW Oklahoma study, due out next year, reference streams from this ecoregion will be chosen.

3.0 RESULTS AND DISCUSSION

3.1 WATER QUALITY MONITORING

Overall water quality data for the project can be found in Appendix C (see file "Appendix C WQ data.doc" on disc included). Descriptive statistics used for site evaluation may be found below (Table 6). Results of water quality parameters assessed indicate relative

Table 6. Descriptive Statistics for Water Quality Evaluation Parameters.
CGP=Central Great Plains, COTP=Central Oklahoma/Texas Plains, SWT=Southwestern Tablelands.

Variable	Ecoregion	N	Mean	Median	StDev	SE Mean	Min	Max	Q1	Q3
% Sat.	CGP	458	98.04	97.69	29.82	1.39	4.12	241.67	81.28	109.19
	COTP	116	88.3	96.68	39.15	3.63	3.57	204.56	70.18	109.95
	SWT	38	87.47	92.87	34.28	5.56	10.99	174.02	66.71	104.42
PH	CGP	429	7.9057	8	0.4709	0.0227	5.01	8.97	7.79	8.19
	COTP	110	7.8614	7.975	0.5821	0.0555	5.04	8.58	7.735	8.2325
	SWT	39	7.8033	7.88	0.4326	0.0693	6.88	8.93	7.54	8.13
Turb (NTU)	CGP	453	48.63	12	124.44	5.85	0.66	1000	6.16	34.85
	COTP	116	89.5	15.4	199.5	18.5	0.7	1000	5.4	57
	SWT	39	31.86	20.1	37.32	5.98	2.12	172	8.07	44.8
oP (mg/l)	CGP	458	0.1207	0.0385	0.3204	0.015	0.002	3.242	0.012	0.0902
	COTP	116	0.0975	0.0375	0.2303	0.0214	0.005	2.32	0.011	0.101
	SWT	39	0.01754	0.009	0.01944	0.00311	0.003	0.093	0.005	0.021
Total-P (mg/l)	CGP	458	0.2024	0.094	0.3785	0.0177	0.005	3.536	0.048	0.1717
	COTP	116	0.2326	0.0915	0.541	0.0502	0.005	4.62	0.0355	0.2188
	SWT	39	0.0649	0.035	0.1096	0.0176	0.005	0.659	0.014	0.075
Available-N, Ammonia+NitrateNitrite (mg/l)	CGP	460	1.2185	0.76	1.5421	0.0719	0	10.858	0.34	1.3978
	COTP	116	0.972	0.444	3.782	0.351	0.035	40.882	0.231	0.949
	SWT	39	0.5304	0.23	0.6022	0.0964	0.024	2.27	0.1	0.9
Total-N, TKN+NitrateNitrite (mg/l)	CGP	386	1.7829	1.301	1.721	0.0876	0.09	11.499	0.774	2.094
	COTP	98	1.89	1.05	4.672	0.472	0.162	45.882	0.739	1.747
	SWT	33	1.044	0.74	0.808	0.141	0.23	3.928	0.452	1.359
TSS (mg/l)	CGP	458	63.33	17	175.5	8.2	1	2240	10	46
	COTP	116	64.1	13	221.8	20.6	1	2305	9.2	46.2
	SWT	39	44.38	24	54.5	8.73	2	261	10	54
ln F. coliform (c.u.)	CGP	347	5.5005	5.6348	1.6567	0.0889	0	10.7934	4.6052	6.4615
	COTP	81	4.886	5.075	2.241	0.249	0	10.736	3.8	6.397
	SWT	38	4.402	3.689	1.953	0.317	1.609	10.404	2.924	5.776

similarity between ecoregions. Inadequate representation of the Southwestern Tablelands (SWT) and to some extent the Central Oklahoma Plains (COTP) preclude determination of differences between ecoregions at this point and will be addressed during a forthcoming statewide evaluation. The reader is cautioned against drawing conclusions from this table since it was partly derived from streams with point sources. To obtain an adequate number of streams with bad water quality, these point source containing streams were sampled disproportionately to their frequency of occurrence in the region. This process results in descriptive statistics being skewed upwards.

3.2 BIOLOGICAL MONITORING

3.2.1 Habitat Assessment

Total habitat score ranges for each ecoregion and selected descriptive stats are listed below (Table 7). The complete habitat data for the project can be found in Appendix D (see file "Appendix D Habitat data" on disc included). No significant differences between ecoregions were apparent with this data. Again, the reader is cautioned against drawing conclusions from this table since it was derived from streams selected for either good or bad habitat. To obtain an adequate number of streams with bad or good habitat, streams were sampled disproportionately to their frequency of occurrence in the region. This process results in descriptive statistics being skewed in an unknown amount and direction.

Table 7. Total Habitat Score Ranges and Selected Descriptive Statistics for each Ecoregion.

Ecoregion	Total Habitat Score, range	Median	Lower Quartile
Central Great Plains	31.7 – 104.3	70.45	52.5
Central Oklahoma Texas Plains	28.6 – 87.6	63.9	48.93
Southwest Tablelands	80.1 – 103.6	Insufficient data	Insufficient data

3.2.2 Fish Collections

Descriptive statistics for fish metrics used to evaluate sites are listed below (Table 8). For a complete listing of fish data including species and numbers caught, consult Appendix E (see file "Appendix E Fish data" on disc included). The complete fish metric analysis is located in Appendix F (see file "Appendix F Fish metrics" on disc included) No significant differences between ecoregions were apparent with this data. Again, the reader is cautioned against drawing conclusions from this table since it was derived from streams selected for either good or bad fish communities and does not represent a randomly collected sample To obtain an adequate number of streams with bad or good fish communities, streams were sampled disproportionately to their frequency of occurrence in the region. This process results in descriptive statistics being skewed in an unknown amount and direction.

Table 8. Descriptive Statistics for Fish Metrics Used for Evaluation.

Variable	Ecoregion	N	Mean	Median	Tr Mean	St Dev	SE Mean	Min	Max	Q1	Q3
Total Species	CGP	24	11.375	11.5	11.364	4.116	0.84	2	21	9	13.75
	COTP	6	9.67	10	9.67	4.08	1.67	3	15	6.75	12.75
	SWT	2	12	12	12	0	0	12	12	*	*
Shannon-Weaver Diversity	CGP	24	1.287	1.324	1.3	0.491	0.1	0.094	2.187	0.912	1.639
	COTP	6	1.414	1.498	1.414	0.731	0.298	0.512	2.22	0.588	2.162
	SWT	2	1.489	1.489	1.489	0.38	0.269	1.22	1.758	*	*
No. Species Centrarchidae	CGP	24	3.542	4	3.5	1.474	0.301	1	7	2.25	4
	COTP	6	3.333	4	3.333	1.751	0.715	0	5	2.25	4.25
	SWT	2	4	4	4	0	0	4	4	*	*
No. Species Intolerant	CGP	24	0.75	1	0.727	0.676	0.138	0	2	0	1
	COTP	6	0.833	1	0.833	0.753	0.307	0	2	0	1.25
	SWT	2	1	1	1	0	0	1	1	*	*
% Individuals Tolerant	CGP	24	87.62	96.5	90.09	20.02	4.09	21	100	86	99.75
	COTP	6	92.17	94	92.17	7.39	3.02	81	100	84.75	98.5
	SWT	2	90	90	90	12.73	9	81	99	*	*

No. Species Sensitive Benthics	CGP	24	1.083	1	1.045	1.018	0.208	0	3	0	2
	COTP	6	1	1	1	0.894	0.365	0	2	0	2
	SWT	2	1	1	1	0	0	1	1	*	*
No. Species Insectivorous Cyprinidae	CGP	24	1.292	1.5	1.273	0.908	0.185	0	3	0.25	2
	COTP	6	1.333	1.5	1.333	0.816	0.333	0	2	0.75	2
	SWT	2	1	1	1	0	0	1	1	*	*

3.2.3 Macroinvertebrate Collections

The complete macroinvertebrate database including species and numbers captured per site can be found in Appendix G (see file "Appendix G Macro data" on disc included). Appendix H (see file "Appendix H Macro metrics" on disc included) contains all macroinvertebrate metrics calculated for project data. Again, for purposes of this evaluation, only summer macroinvertebrate data were used for final scoring purposes in an attempt to best characterize sites during their harshest conditions (summer low flow). Descriptive statistics of summer riffle (Table 9), vegetation (Table 10), and woody habitat (Table 11) samples are listed below. The reader is cautioned against drawing conclusions from this table since it was derived from streams selected for either good or bad invertebrate communities and does not represent a randomly collected sample. To obtain an adequate number of streams with bad or good invertebrate communities, streams were sampled disproportionately to their frequency of occurrence in the region. This process results in descriptive statistics being skewed in an unknown amount and direction.

Table 9. Descriptive Statistics for Macroinvertebrate Metrics (Summer Riffle) Used for Evaluation.

Variable	Ecoregion	N	Mean	Median	Tr Mean	StDev	SE Mean	Min	Max	Q1	Q3
Number of taxa	CGP	23	15.78	16.00	16.14	4.00	0.83	3.00	21.00	14.00	19.00
	COTP	4	16.00	16.00	16.00	3.27	1.63	12.00	20.00	13.00	19.00
	SWT	1	9.00	9.00	9.00	*	*	9.00	9.00	*	*
Modified HBI	CGP	23	5.59	5.62	5.62	0.97	0.20	3.60	6.92	4.68	6.49
	COTP	4	5.38	5.25	5.38	0.79	0.39	4.58	6.45	4.71	6.19
	SWT	1	4.06	4.06	4.06	*	*	4.06	4.06	*	*
EPT/ EPT+Chironomini	CGP	23	0.41	0.34	0.40	0.33	0.07	0.00	1.00	0.14	0.63
	COTP	4	0.54	0.52	0.54	0.25	0.13	0.26	0.86	0.31	0.79
	SWT	1	0.00	0.00	0.00	*	*	0.00	0.00	*	*
EPT/total	CGP	23	0.18	0.12	0.17	0.16	0.03	0.00	0.55	0.07	0.23
	COTP	4	0.30	0.24	0.30	0.25	0.13	0.08	0.65	0.10	0.56
	SWT	1	0.00	0.00	0.00	*	*	0.00	0.00	*	*
EPT taxa	CGP	23	3.74	4.00	3.76	1.66	0.35	0.00	7.00	3.00	5.00
	COTP	4	4.25	4.50	4.25	0.96	0.48	3.00	5.00	3.25	5.00
	SWT	1	0.00	0.00	0.00	*	*	0.00	0.00	*	*
Dominants/total	CGP	23	0.42	0.39	0.41	0.15	0.03	0.20	0.83	0.28	0.53
	COTP	4	0.34	0.28	0.34	0.17	0.09	0.21	0.58	0.21	0.52
	SWT	1	0.63	0.63	0.63	*	*	0.63	0.63	*	*
Shannon-Weaver diversity	CGP	23	2.71	2.80	2.76	0.66	0.14	0.70	3.70	2.35	3.15
	COTP	4	2.89	2.99	2.89	0.58	0.29	2.13	3.47	2.30	3.40
	SWT	1	1.78	1.78	1.78	*	*	1.78	1.78	*	*

Table 10. Descriptive Statistics for Macroinvertebrate Metrics (Summer Vegetation) Used for Evaluation .

Variable	Ecoregion	N	Mean	Median	Tr Mean	StDev	SE Mean	Min	Max	Q1	Q3
Number of taxa	CGP	24	14.42	15.00	14.41	5.07	1.04	5.00	24.00	10.00	17.75
	COTP	6	16.00	15.00	16.00	5.22	2.13	9.00	23.00	12.00	21.50
	SWT	3	13.33	11.00	13.33	4.04	2.33	11.00	18.00	11.00	18.00
Modified HBI	CGP	24	6.67	6.65	6.70	0.74	0.15	4.91	7.75	6.10	7.39
	COTP	6	6.15	6.39	6.15	0.96	0.39	4.95	7.22	5.02	7.00
	SWT	3	5.96	6.82	5.96	1.68	0.97	4.02	7.03	4.02	7.03
EPT/ EPT+Chironomini	CGP	24	0.36	0.29	0.35	0.28	0.06	0.01	0.89	0.11	0.58
	COTP	6	0.49	0.38	0.49	0.34	0.14	0.15	0.93	0.20	0.92
	SWT	3	0.64	0.92	0.64	0.56	0.32	0.00	1.00	0.00	1.00
EPT/total	CGP	24	0.16	0.11	0.16	0.15	0.03	0.01	0.46	0.04	0.32
	COTP	6	0.29	0.23	0.29	0.20	0.08	0.09	0.56	0.12	0.52
	SWT	3	0.11	0.01	0.11	0.18	0.11	0.00	0.32	0.00	0.32
EPT taxa	CGP	24	3.63	4.00	3.55	1.77	0.36	1.00	8.00	2.00	5.00
	COTP	6	5.50	5.50	5.50	1.52	0.62	4.00	8.00	4.00	6.50
	SWT	3	2.00	1.00	2.00	2.65	1.53	0.00	5.00	0.00	5.00
Dominants/total	CGP	24	0.41	0.30	0.40	0.23	0.05	0.17	0.88	0.24	0.63
	COTP	6	0.45	0.45	0.45	0.15	0.06	0.20	0.66	0.36	0.57
	SWT	3	0.42	0.33	0.42	0.22	0.13	0.26	0.67	0.26	0.67
Shannon-Weaver diversity	CGP	24	2.67	3.09	2.70	0.91	0.19	0.70	3.78	2.09	3.37
	COTP	6	2.81	2.70	2.81	0.73	0.30	1.82	3.92	2.28	3.44
	SWT	3	2.57	2.59	2.57	0.76	0.44	1.81	3.32	1.81	3.32

Table 11. Descriptive Statistics for Macroinvertebrate Metrics (Summer Woody) Used for Evaluation.

Variable	Ecoregion	N	Mean	Median	Tr Mean	StDev	SE Mean	Min	Max	Q1	Q3
Number of taxa	CGP	28	14.00	14.50	14.00	4.45	0.84	6.00	22.00	9.25	17.75
	SWT	1	12.00	12.00	12.00	*	*	12.00	12.00	*	*
	COTP	4	14.75	14.50	14.75	5.06	2.53	9.00	21.00	10.00	19.75
Modified HBI	CGP	28	6.43	6.51	6.45	0.86	0.16	4.80	7.60	5.95	7.15
	SWT	1	4.61	4.61	4.61	*	*	4.61	4.61	*	*
	COTP	4	6.03	6.15	6.03	1.11	0.55	4.70	7.11	4.91	7.02
EPT/ EPT+Chironomini	CGP	28	0.30	0.24	0.29	0.24	0.04	0.00	0.89	0.15	0.38
	SWT	1	0.00	0.00	0.00	*	*	0.00	0.00	*	*
	COTP	4	0.40	0.36	0.40	0.37	0.19	0.04	0.85	0.07	0.78
EPT/total	CGP	28	0.16	0.11	0.15	0.16	0.03	0.00	0.60	0.05	0.24
	SWT	1	0.00	0.00	0.00	*	*	0.00	0.00	*	*
	COTP	4	0.30	0.23	0.30	0.33	0.16	0.02	0.73	0.04	0.64
EPT taxa	CGP	28	4.04	4.50	4.04	2.37	0.45	0.00	8.00	2.00	6.00
	SWT	1	0.00	0.00	0.00	*	*	0.00	0.00	*	*
	COTP	4	4.75	4.50	4.75	3.30	1.65	1.00	9.00	1.75	8.00
Dominants/total	CGP	28	0.49	0.51	0.49	0.18	0.03	0.24	0.86	0.34	0.65
	SWT	1	0.48	0.48	0.48	*	*	0.48	0.48	*	*
	COTP	4	0.50	0.50	0.50	0.16	0.08	0.30	0.68	0.34	0.65
Shannon-Weaver diversity	CGP	28	2.42	2.58	2.44	0.72	0.14	0.90	3.35	1.72	2.99
	SWT	1	2.42	2.42	2.42	*	*	2.42	2.42	*	*
	COTP	4	2.48	2.25	2.48	0.71	0.36	1.93	3.48	1.95	3.23

3.3 BENEFICIAL USE EVALUATION

Each water body in Oklahoma is to have assigned beneficial uses. These include fish and wildlife propagation (F&WP), agricultural (AG), primary body contact recreation (REC), secondary body contact recreation, aesthetics (AES), public and private water supply, industrial and municipal process and cooling water (MI). The beneficial uses applicable for the study sites are included below (Table 12).

Table 12. Beneficial Uses Established for Each Study Site.

Site Name	WBID	County	Water Supply	F&WP	AG	MI	REC	AES	LIMIT
Roaring Creek	OK310810-02-0170G	Grady	PPWS	WWAC	*	*	PBCR	*	
Laflin Creek	OK310810-02-0200G	Grady	PPWS	WWAC	*	*	PBCR	*	
Winter Creek	OK310810-02-0220G	Grady	PPWS	WWAC	*	*	PBCR	*	
Rush Creek	OK310810-05-0010H	Garvin		WWAC	*	*	PBCR	*	
Bitter Creek	OK310820-01-0030G	Grady	PPWS	WWAC	*	*	PBCR	*	
Little Washita River, Downstream	OK310820-02-0010B	Grady	PPWS	WWAC	1	*	PBCR	*	
Little Washita River, Caddo Co.	OK310820-02-0010F	Caddo	PPWS	WWAC	1	*	PBCR	*	
Washita River # 466	OK310830-03-0010G	Washita	PPWS	WWAC	1	*	PBCR	*	
Willow Creek	OK310830-06-0030H	Caddo	PPWS	WWAC	*	*	PBCR	*	SWS
West Mud Creek	OK311100-04-0080G	Jefferson		WWAC	*	*	PBCR	*	
Dry Creek	OK311200-00-0080G	Stephens	PPWS	WWAC	*	*	PBCR	*	
Whiskey Creek	OK311210-00-0140D	Comanche		WWAC	*	*	PBCR	*	
Cottonwood Creek	OK311210-00-0150G	Comanche		WWAC	*	*	PBCR	*	
Tahoe Creek	OK311300-03-0070G	Caddo	PPWS	WWAC	*	*	PBCR	*	SWS
Blue Beaver Creek	OK311310-02-0060G	Comanche	PPWS	WWAC	*	*	PBCR	*	
Brush Creek	OK311310-03-0050G	Tillman		WWAC	*	*	PBCR	*	
Stinking Creek	OK311500-01-0050G	Jackson	PPWS	WWAC	*	*	PBCR	*	
Tepee Creek	OK311500-01-0110G	Kiowa		WWAC	*	*	PBCR	*	
West Otter Creek	OK311500-02-0040G	Kiowa	PPWS	WWAC	*	*	PBCR	*	
Little Elk Creek	OK311500-03-0040G	Kiowa	PPWS	WWAC	*	*	PBCR	*	
Turkey Creek	OK311510-02-0060G	Beckham	PPWS	WWAC	*	*	PBCR	*	
Salt Fork of the Red River	OK311600-02-0010G	Jackson	PPWS	WWAC	3	*	PBCR	*	
Bitter Creek	OK311600-02-0110G	Jackson	EWS	HLAC	1	*	SBCR	*	
Cave Creek	OK311600-02-0140G	Greer		WWAC	*	*	PBCR	*	
Deer Creek @ County Road Bridge	OK311800-00-0070C	Greer	PPWS	WWAC	*	*	PBCR	*	
Fish Creek	OK311800-00-0130G	Greer	PPWS	WWAC	*	*	PBCR	*	
North Elm Creek	OK311800-00-0170G	Beckham	PPWS	WWAC	*	*	PBCR	*	
Crutcho Creek	OK520520-00-0070B	Oklahoma		WWAC	*	*	PBCR	*	
Crooked Oak Creek	OK520520-00-0150G	Oklahoma	PPWS	WWAC	1	*	PBCR	*	
Buggy Creek	OK520610-02-0120G	Caddo	EWS	WWAC	*	*	PBCR	*	
North Walnut Creek	OK520610-03-0010G	McClain		WWAC	1	*	PBCR	*	
North Fork Walnut Creek	OK520610-03-0080G	McClain		WWAC	*	*	PBCR	*	

The fish and wildlife propagation beneficial use is established to protect and maintain waters capable of supporting different high quality communities of aquatic life. The subcategories included in this beneficial use are habitat limited aquatic community, warm water aquatic community, cool water aquatic community (excluding lake waters), and trout fishery. Criteria for this beneficial use have been established for dissolved oxygen, pH, turbidity, oil and grease, toxicants, and toxicants not assessed and not likely to occur or violate criteria. If any of these criteria are violated, the use is not attained. Samples were not assessed for toxicants and a watershed-specific landuse and historical data is unavailable to determine attainment of toxicants not assessed. These categories are therefore omitted from this analysis. Additionally, biological criteria have been determined for wadable streams in six ecoregions in eastern Oklahoma. None of the ecoregions covered in this project have biocriteria established. Criteria have also been established for sediments; however, these criteria require a comparison to be made with reference streams or to historical conditions. Since the goal of this project is to establish reference streams and there is no historical data on record, sedimentation could not be included in this analysis. Oklahoma Water Resources Board 785:45 and 46, and the Continuing Planning Process maintained on the Department of Environmental Quality website contain the standards for the fish and wildlife propagation beneficial use.

A majority of the sites (62.5%) were not supporting the fish and wildlife propagation category (Table 13). Of these, 9.4% were not supporting all categories with the exception of pH. These sites included Brush Creek, Tepee Creek, and Little Elk Creek. All sites met the criteria for pH. The category most often resulting in a rating of “not supporting” was turbidity, and 56.3% of the sites failed this category. The category next resulting in a “not supporting” classification was dissolved oxygen with 28.1% of the sites failing this criterion. Five sites (15.6%) failed the oil and grease criteria.

Table 13. Fish and Wildlife Propagation Beneficial Use Support Status.

Site Name	DO	pH	Turbidity	O & G	Support Status
Roaring Creek	Supporting	Supporting	Not supporting	Supporting	**Not supporting**
Laflin Creek	Supporting	Supporting	Supporting	Supporting	Supporting
Winter Creek	Supporting	Supporting	Supporting	Supporting	Supporting
Rush Creek	Supporting	Supporting	Not supporting	Supporting	**Not supporting**
Bitter Creek, Grady County	Supporting	Supporting	Supporting	Supporting	Supporting
Little Washita River, Downstream	Supporting	Supporting	Supporting	Supporting	Supporting
Little Washita River, Caddo Co.	Supporting	Supporting	Supporting	Supporting	Supporting
Washita River # 466	Supporting	Supporting	Not supporting	Supporting	**Not supporting**
Willow Creek	Supporting	Supporting	Supporting	Supporting	Supporting
West Mud Creek	Not supporting	Supporting	Not supporting	Supporting	**Not supporting**
Dry Creek	Not supporting	Supporting	Not supporting	Supporting	**Not supporting**
Whiskey Creek	Supporting	Supporting	Supporting	Supporting	Supporting
Cottonwood Creek	Supporting	Supporting	Supporting	Supporting	Supporting
Tahoe Creek	Supporting	Supporting	Supporting	Not supporting	**Not supporting**
Blue Beaver Creek	Supporting	Supporting	Supporting	Supporting	Supporting
Brush Creek	Not supporting	Supporting	Not supporting	Not supporting	**Not supporting**
Stinking Creek	Supporting	Supporting	Not supporting	Supporting	**Not supporting**
Tepee Creek	Not supporting	Supporting	Not supporting	Not supporting	**Not supporting**
West Otter Creek	Not supporting	Supporting	Not supporting	Supporting	**Not supporting**
Little Elk Creek	Not supporting	Supporting	Not supporting	Not supporting	**Not supporting**
Turkey Creek	Supporting	Supporting	Supporting	Supporting	Supporting
Salt Fork of the Red River	Supporting	Supporting	Not supporting	Supporting	**Not supporting**
Bitter Creek, Jackson County	Supporting	Supporting	Not supporting	Supporting	**Not supporting**
Cave Creek	Supporting	Supporting	Supporting	Supporting	Supporting
Deer Creek @ County Road Bridge	Supporting	Supporting	Not supporting	Supporting	**Not supporting**
Fish Creek	Not supporting	Supporting	Not supporting	Supporting	**Not supporting**
North Elm Creek	Supporting	Supporting	Supporting	Supporting	Supporting
Crutcho Creek	Not supporting	Supporting	Not supporting	Supporting	**Not supporting**
Crooked Oak Creek	Not supporting	Supporting	Supporting	Not supporting	**Not supporting**
Buggy Creek	Supporting	Supporting	Not supporting	Supporting	**Not supporting**
North Walnut Creek	Supporting	Supporting	Not supporting	Supporting	**Not supporting**
North Fork Walnut Creek	Supporting	Supporting	Not supporting	Supporting	**Not supporting**

The primary body contact recreation beneficial use is set aside for water bodies that experience direct body contact with the possibility of ingestion. Criteria for this use are in force from May 1 to September 30 and have been established for coliform bacteria, *Escherichia coli*, and *enterococci*. Oklahoma Water Resources Board 785:45 and 46, and the Continuing Planning Process maintained on the Department of Environmental Quality website contain the standards for the primary body contact recreation beneficial use.

A preponderance of the sites (87.5%) were not supporting the primary body contact criteria (Table 14). For four of the sites, not enough information was available to determine whether or not the criteria were supported. Most sites (62.5%) did not meet the criteria for fecal coliform. Over half of the sites (68.75%) were not meeting the criteria for *enterococci* and 84.4% did not meet the criteria for *Escherichia coli*. Seventeen of the sites did not support any of the criteria for primary body contact. These included: Bitter Creek in Grady County, Bitter Creek in Jackson County, Buggy Creek, Cottonwood Creek, Crooked Oak Creek, Deer Creek at the county road bridge, Laflin Creek, Little Elk Creek, North Fork Walnut Creek, Roaring Creek, Stinking Creek, Tepee Creek, Washita River site 466, West Mud Creek, West Otter Creek, and Willow Creek.

Table 14. Primary Body Contact Recreation Beneficial Use Support Status.

Site Name	Fecal Coliform	*Escherichia Coli*	*Enterococci*	Support Status
Roaring Creek	Not supporting	Not supporting	Not supporting	**Not supporting**
Laflin Creek	Not supporting	Not supporting	Not supporting	**Not supporting**
Winter Creek	Not enough info	Not enough info	Not enough info	Not enough info
Rush Creek	Not enough info	Not enough info	Not enough info	Not enough info
Bitter Creek, Grady County	Not supporting	Not supporting	Not supporting	**Not supporting**
Little Washita River, Downstream	Not enough info	Not enough info	Not supporting	**Not supporting**
Little Washita River, Caddo Co.	Not enough info	Not enough info	Not supporting	**Not supporting**
Washita River # 466	Not supporting	Not supporting	Not supporting	**Not supporting**
Willow Creek	Not supporting	Not supporting	Not supporting	**Not supporting**
West Mud Creek	Not supporting	Not supporting	Not supporting	**Not supporting**
Dry Creek	Not enough info	Not supporting	Not supporting	**Not supporting**
Whiskey Creek	Not enough info	Not supporting	Not supporting	**Not supporting**
Cottonwood Creek	Not supporting	Not supporting	Not supporting	**Not supporting**
Tahoe Creek	Not supporting	Not supporting	Not enough info	**Not supporting**
Blue Beaver Creek	Not enough info	Not enough info	Not supporting	**Not supporting**
Brush Creek	Not supporting	Not supporting	Not supporting	**Not supporting**
Stinking Creek	Not supporting	Not supporting	Not supporting	**Not supporting**
Tepee Creek	Not supporting	Not supporting	Not supporting	**Not supporting**
West Otter Creek	Not supporting	Not supporting	Not supporting	**Not supporting**
Little Elk Creek	Not supporting	Not supporting	Not supporting	**Not supporting**
Turkey Creek	Not supporting	Not enough info	Not supporting	**Not supporting**
Salt Fork of the Red River	Not enough info	Not enough info	Not supporting	**Not supporting**
Bitter Creek, Jackson County	Not supporting	Not supporting	Not supporting	**Not supporting**
Cave Creek	Not enough info	Not supporting	Not supporting	**Not supporting**
Deer Creek @ County Road Bridge	Not supporting	Not supporting	Not supporting	**Not supporting**
Fish Creek	Not supporting	Not enough info	Not supporting	**Not supporting**
North Elm Creek	Not enough info	Not enough info	Not enough info	Not enough info
Crutcho Creek	Not enough info	Not supporting	Not supporting	**Not supporting**
Crooked Oak Creek	Not supporting	Not supporting	Not supporting	**Not supporting**
Buggy Creek	Not supporting	Not supporting	Not supporting	**Not supporting**
North Walnut Creek	Not enough info	Not enough info	Not enough info	Not enough info
North Fork Walnut Creek	Not supporting	Not supporting	Not supporting	**Not supporting**

The secondary body contact recreation beneficial use applies from October 1 to April 30. This is established for water bodies where ingestion of water is not anticipated and is usually associated with activities like boating, fishing, or wading. The Use Support & Assessment Protocol (USAP) for secondary body contact recreation is five times the criteria from primary body contact.

A large majority (78.1%) of the sites failed the secondary body contact recreation beneficial use, mostly due to exceedances of the *enterococci* criteria (Table 15). There was insufficient data from all sites to determine whether fecal coliform bacteria exceedances occurred. Stinking Creek failed only the *E. coli* criteria, while Crooked Oak Creek failed both *E. coli* and *enterococci* categories.

Table 15. Secondary Body Contact Recreation Beneficial Use Support Status.

Site Name	Fecal Coliform	*Escherichia Coli*	*Enterococci*	Support Status
Roaring Creek	Not enough info	Not enough info	Not supporting	**Not supporting**
Laflin Creek	Not enough info	Not enough info	Not supporting	**Not supporting**
Winter Creek	Not enough info	Not enough info	Not supporting	**Not supporting**
Rush Creek	Not enough info	Not enough info	Not enough info	Not enough info
Bitter Creek, Grady County	Not enough info	Not enough info	Not supporting	**Not supporting**
Little Washita River, Downstream	Not enough info	Not enough info	Not supporting	**Not supporting**
Little Washita River, Caddo Co.	Not enough info	Not enough info	Not enough info	Not enough info
Washita River # 466	Not enough info	Not enough info	Not supporting	**Not supporting**
Willow Creek	Not enough info	Not enough info	Not supporting	**Not supporting**
West Mud Creek	Not enough info	Not enough info	Not enough info	Not enough info
Dry Creek	Not enough info	Not enough info	Not supporting	**Not supporting**
Whiskey Creek	Not enough info	Not enough info	Not supporting	**Not supporting**
Cottonwood Creek	Not enough info	Not enough info	Not supporting	**Not supporting**
Tahoe Creek	Not enough info	Not enough info	Not supporting	**Not supporting**
Blue Beaver Creek	Not enough info	Not enough info	Not enough info	Not enough info
Brush Creek	Not enough info	Not enough info	Not supporting	**Not supporting**
Stinking Creek	Not enough info	Not supporting	Not enough info	**Not supporting**
Tepee Creek	Not enough info	Not enough info	Not supporting	**Not supporting**
West Otter Creek	Not enough info	Not enough info	Not supporting	**Not supporting**
Little Elk Creek	Not enough info	Not enough info	Not supporting	**Not supporting**
Turkey Creek	Not enough info	Not enough info	Not supporting	**Not supporting**
Salt Fork of the Red River	Not enough info	Not enough info	Not supporting	**Not supporting**
Bitter Creek, Jackson County	Not enough info	Not enough info	Not supporting	**Not supporting**
Cave Creek	Not enough info	Not enough info	Not supporting	**Not supporting**
Deer Creek @ County Road Bridge	Not enough info	Not enough info	Not enough info	Not enough info
Fish Creek	Not enough info	Not enough info	Not supporting	**Not supporting**
North Elm Creek	Not enough info	Not enough info	Not enough info	Not enough info
Crutcho Creek	Not enough info	Not enough info	Not supporting	**Not supporting**
Crooked Oak Creek	Not enough info	Not supporting	Not supporting	**Not supporting**
Buggy Creek	Not enough info	Not enough info	Not enough info	Not enough info
North Walnut Creek	Not enough info	Not enough info	Not supporting	**Not supporting**
North Fork Walnut Creek	Not enough info	Not enough info	Not supporting	**Not supporting**

Eighteen sites were not meeting the less stringent secondary body contact recreation criteria levels during primary body contact recreation season (Table 16). This is of concern as the secondary body contact recreation limits are five times those of the primary body contact recreation limits. Most of these exceedances were accumulated through surpassing the acceptable levels of *enterococci*. Two sites exceeded the criteria for fecal coliform bacteria and four sites exceeded that for *E. coli*. Stinking Creek did not meet any secondary body contact recreation levels during body contact recreation season.

Table 16. Secondary Body Contact Recreation exceedances during Body Contact Recreation Season.

Site Name	Fecal Coliform	*Escherichia coli*	*Enterococci*	SBCR levels during PBCR time frame
Roaring Creek	Not enough info	Not enough info	**Not supporting**	**Not supporting**
Laflin Creek	Not enough info	Not enough info	**Not supporting**	**Not supporting**

Winter Creek	Not enough info	Not enough info	Not enough info	Not enough info
Rush Creek	Not enough info	Not enough info	Not enough info	Not enough info
Bitter Creek	Not enough info	Not enough info	Not enough info	Not enough info
Little Washita River, Grady Co.	Not enough info	Not enough info	Not enough info	Not enough info
Little Washita River, Caddo Co.	Not enough info	Not enough info	Not enough info	Not enough info
Washita River # 466	Not enough info	**Not supporting**	**Not supporting**	**Not supporting**
Willow Creek	Not enough info	Not enough info	**Not supporting**	**Not supporting**
West Mud Creek	Not enough info	Not enough info	Not enough info	Not enough info
Dry Creek	Not enough info	Not enough info	**Not supporting**	**Not supporting**
Whiskey Creek	Not enough info	Not enough info	**Not supporting**	**Not supporting**
Cottonwood Creek	Not enough info	Not enough info	**Not supporting**	**Not supporting**
Tahoe Creek	Not enough info	Not enough info	Not enough info	Not enough info
Blue Beaver Creek	Not enough info	Not enough info	**Not supporting**	**Not supporting**
Brush Creek	Not enough info	**Not supporting**	**Not supporting**	**Not supporting**
Stinking Creek	**Not supporting**	**Not supporting**	**Not supporting**	**Not supporting**
Tepee Creek	Not enough info	Not enough info	**Not supporting**	**Not supporting**
West Otter Creek	Not enough info	**Not supporting**	**Not supporting**	**Not supporting**
Little Elk Creek	Not enough info	Not enough info	**Not supporting**	**Not supporting**
Turkey Creek	Not enough info	Not enough info	**Not supporting**	**Not supporting**
Salt Fork of the Red River	Not enough info	Not enough info	Not enough info	Not enough info
Bitter Creek	Not enough info	Not enough info	**Not supporting**	**Not supporting**
Cave Creek	Not enough info	Not enough info	**Not supporting**	**Not supporting**
Deer Creek @ County Road Bridge	Not enough info	Not enough info	**Not supporting**	**Not supporting**
Fish Creek	Not enough info	Not enough info	Not enough info	Not enough info
North Elm Creek	Not enough info	Not enough info	Not enough info	Not enough info
Crutcho Creek	Not enough info	Not enough info	Not enough info	Not enough info
Crooked Oak Creek @ HWY 13 Bridge	**Not supporting**	Not enough info	**Not supporting**	**Not supporting**
Buggy Creek	Not enough info	Not enough info	Not enough info	Not enough info
North Walnut Creek	Not enough info	Not enough info	Not enough info	Not enough info
Walnut Creek, North Fork	Not enough info	Not enough info	Not enough info	Not enough info

The public and private water supply designation sets up criteria for certain organic and inorganic materials, radioactive materials, coliform bacteria, oil and grease, general criteria, and protection for fish consumption. Further details can be found in Oklahoma Water Resources Board 785:45 and 46, and the Continuing Planning Process document maintained on the Department of Environmental Quality website. These two documents contain the standards for the public and private water supply beneficial use.

One quarter of the sites failed criteria for the public and private water supply category (Table 17). The four sites categorized as not supporting Crooked Oak Creek, Little Elk Creek, Stinking Creek, and Tahoe Creek. Crooked Oak Creek was not supporting in both the oil and grease category and the total coliform category. Of those sites not meeting the criteria, most failed to meet the oil and grease category. West Mud Creek does not have a beneficial use designated for public and private water supply. In any event, there was not enough information to determine whether or not it met the criteria for public and private water supply. Brush Creek, Tepee Creek and Crutcho Creek also are not designated as public and private water supply sources; however, if they were, they currently do not meet the criteria.

Table 17. Public and Private Water Supply Beneficial Use Support Status.

Site Name	Oil and Grease	Total Coliform	Support Status
Roaring Creek	Supporting	Supporting	Supporting
Laflin Creek	Supporting	Supporting	Supporting

Winter Creek	Supporting	Supporting	Supporting
Rush Creek	Supporting	Supporting	Supporting
Bitter Creek, Grady County	Supporting	Supporting	Supporting
Little Washita River, Downstream	Supporting	Supporting	Supporting
Little Washita River, Caddo Co.	Supporting	Supporting	Supporting
Washita River # 466	Supporting	Supporting	Supporting
Willow Creek	Supporting	Supporting	Supporting
West Mud Creek	Supporting	Not enough info	***Not enough info***
Dry Creek	Supporting	Supporting	Supporting
Whiskey Creek	Supporting	Supporting	Supporting
Cottonwood Creek	Supporting	Supporting	Supporting
Tahoe Creek	Not supporting	Supporting	**Not supporting**
Blue Beaver Creek	Supporting	Supporting	Supporting
Brush Creek	Not supporting	Supporting	**Not supporting**
Stinking Creek	Supporting	Not supporting	**Not supporting**
Tepee Creek	Not supporting	Supporting	**Not supporting**
West Otter Creek	Supporting	Supporting	Supporting
Little Elk Creek	Not supporting	Supporting	**Not supporting**
Turkey Creek	Supporting	Supporting	Supporting
Salt Fork of the Red River	Supporting	Supporting	Supporting
Bitter Creek, Jackson County	Supporting	Supporting	Supporting
Cave Creek	Supporting	Supporting	Supporting
Deer Creek @ County Road Bridge	Supporting	Supporting	Supporting
Fish Creek	Supporting	Supporting	Supporting
North Elm Creek	Supporting	Supporting	Supporting
Crutcho Creek	Supporting	Not supporting	**Not supporting**
Crooked Oak Creek	Not supporting	Not supporting	**Not supporting**
Buggy Creek	Supporting	Supporting	Supporting
North Walnut Creek	Supporting	Supporting	Supporting
North Fork Walnut Creek	Supporting	Supporting	Supporting

The agriculture beneficial use has been established to protect waters used for livestock and crop irrigation from toxicity due to excessive salinity. Further details can be found in Oklahoma Water Resources Board 785:45 and 46, and the Continuing Planning Process maintained on the Department of Environmental Quality website which contain the standards for the Agriculture beneficial use.

Less than half of the sites (34.4%) failed the criteria for the agriculture category (Table 18). Of the total eleven sites failing, three failed both the chloride and sulfate categories. Those three sites are Brush Creek, Fish Creek, and Stinking Creek. Most of the sites (72.7%) failing support of the Ag Use category did not meet the criteria for chlorides.

Table 18. Agriculture Beneficial Use Support Status.

Site Name	Chloride	Sulfates	Support Status
Roaring Creek	Supporting	Supporting	Supporting
Laflin Creek	Supporting	Supporting	Supporting
Winter Creek	Supporting	Supporting	Supporting

Rush Creek	Not supporting	Supporting	**Not supporting**
Bitter Creek, Grady County	Supporting	Supporting	Supporting
Little Washita River, Downstream	Supporting	Supporting	Supporting
Little Washita River, Caddo Co.	Supporting	Supporting	Supporting
Washita River # 466	Supporting	Supporting	Supporting
Willow Creek	Supporting	Supporting	Supporting
West Mud Creek	Supporting	Supporting	Supporting
Dry Creek	Not supporting	Supporting	**Not supporting**
Whiskey Creek	Supporting	Supporting	Supporting
Cottonwood Creek	Supporting	Not supporting	**Not supporting**
Tahoe Creek	Supporting	Not supporting	**Not supporting**
Blue Beaver Creek	Supporting	Supporting	Supporting
Brush Creek	Not supporting	Not supporting	**Not supporting**
Stinking Creek	Not supporting	Not supporting	**Not supporting**
Tepee Creek	Not supporting	Supporting	**Not supporting**
West Otter Creek	Supporting	Supporting	Supporting
Little Elk Creek	Supporting	Supporting	Supporting
Turkey Creek	Supporting	Supporting	Supporting
Salt Fork of the Red River	Supporting	Supporting	Supporting
Bitter Creek, Jackson County	Not supporting	Supporting	**Not supporting**
Cave Creek	Supporting	Supporting	Supporting
Deer Creek @ County Road Bridge	Supporting	Not supporting	**Not supporting**
Fish Creek	Not supporting	Not supporting	**Not supporting**
North Elm Creek	Supporting	Supporting	Supporting
Crutcho Creek	Supporting	Supporting	Supporting
Crooked Oak Creek	Not supporting	Supporting	**Not supporting**
Buggy Creek	Supporting	Supporting	Supporting
North Walnut Creek	Supporting	Supporting	Supporting
North Fork Walnut Creek	Supporting	Supporting	Supporting

The aesthetics beneficial use was formulated to prevent floating materials, objectionable odors, and suspended substances, etc. from resulting in objectionable conditions in the state's waters. Further details can be found in Oklahoma Water Resources Board 785:45 and 46, and the Continuing Planning Process maintained on the Department of Environmental Quality website which contain the standards for the aesthetics beneficial use.

A majority of the sites (84.4%) did meet the criteria for aesthetics (Table 19). Five of the sites did not meet the criteria for oil and grease causing them not to be supporting. These sites included Crooked Oak Creek, Tahoe Creek, Brush Creek, Tepee Creek, and Little Elk Creek.

Table 19. Aesthetics Beneficial Use Support Status.

Site Name	Oil and Grease	Support Status
Roaring Creek	Supporting	Supporting
Laflin Creek	Supporting	Supporting
Winter Creek	Supporting	Supporting
Rush Creek	Supporting	Supporting

Bitter Creek, Grady County	Supporting	Supporting
Little Washita River, Downstream	Supporting	Supporting
Little Washita River, Caddo Co.	Supporting	Supporting
Washita River # 466	Supporting	Supporting
Willow Creek	Supporting	Supporting
West Mud Creek	Supporting	Supporting
Dry Creek	Supporting	Supporting
Whiskey Creek	Supporting	Supporting
Cottonwood Creek	Supporting	Supporting
Tahoe Creek	Not supporting	**Not supporting**
Blue Beaver Creek	Supporting	Supporting
Brush Creek	Not supporting	**Not supporting**
Stinking Creek	Supporting	Supporting
Tepee Creek	Not supporting	**Not supporting**
West Otter Creek	Supporting	Supporting
Little Elk Creek	Not supporting	**Not supporting**
Turkey Creek	Supporting	Supporting
Salt Fork of the Red River	Supporting	Supporting
Bitter Creek, Jackson County	Supporting	Supporting
Cave Creek	Supporting	Supporting
Deer Creek @ County Road Bridge	Supporting	Supporting
Fish Creek	Supporting	Supporting
North Elm Creek	Supporting	Supporting
Crutcho Creek	Supporting	Supporting
Crooked Oak Creek	Not supporting	**Not supporting**
Buggy Creek	Supporting	Supporting
North Walnut Creek	Supporting	Supporting
North Fork Walnut Creek	Supporting	Supporting

Four of the sites (Crooked Oak Creek, Tepee Creek, Brush Creek, and Tahoe Creek) did not support any of the beneficial use categories (Table 20). North Elm Creek was supporting all beneficial uses with the exception of primary body contact recreation; there was insufficient data to make a determination on this category.

Table 20. Summary Table of Support Status for All Beneficial Uses.

Site Name	F&WP	PBCR	SBCR	PPWS	Agriculture	Aesthetics
Roaring Creek	**Not supporting**	**Not supporting**	**Not supporting**	Supporting	Supporting	Supporting
Laflin Creek	Supporting	**Not supporting**	**Not supporting**	Supporting	Supporting	Supporting
Winter Creek	Supporting	Not enough info	**Not supporting**	Supporting	Supporting	Supporting
Rush Creek	**Not supporting**	Not enough info	Not enough info	Supporting	**Not supporting**	Supporting
Bitter Creek, Grady County	Supporting	**Not supporting**	**Not supporting**	Supporting	Supporting	Supporting
Little Washita River, Downstream	Supporting	**Not supporting**	**Not supporting**	Supporting	Supporting	Supporting
Little Washita River, Caddo Co.	Supporting	**Not supporting**	Not enough info	Supporting	Supporting	Supporting
Washita River # 466	**Not supporting**	**Not supporting**	**Not supporting**	Supporting	Supporting	Supporting
Willow Creek	Supporting	**Not supporting**	**Not supporting**	Supporting	Supporting	Supporting
West Mud Creek	**Not supporting**	**Not supporting**	Not enough info	Not enough info	Supporting	Supporting
Dry Creek	**Not supporting**	**Not supporting**	**Not supporting**	Supporting	**Not supporting**	Supporting
Whiskey Creek	Supporting	**Not supporting**	**Not supporting**	Supporting	Supporting	Supporting
Cottonwood Creek	Supporting	**Not supporting**	**Not supporting**	Supporting	**Not supporting**	Supporting
Tahoe Creek	**Not supporting**	**Not supporting**	**Not supporting**	**Not supporting**	**Not supporting**	**Not supporting**
Blue Beaver Creek	Supporting	**Not supporting**	Not enough info	Supporting	Supporting	Supporting
Brush Creek	**Not supporting**	**Not supporting**	**Not supporting**	**Not supporting**	**Not supporting**	**Not supporting**

Stinking Creek	**Not supporting**	**Not supporting**	**Not supporting**	**Not supporting**	**Not supporting**	Supporting
Tepee Creek	**Not supporting**	**Not supporting**	**Not supporting**	**Not supporting**	**Not supporting**	**Not supporting**
West Otter Creek	**Not supporting**	**Not supporting**	**Not supporting**	Supporting	Supporting	Supporting
Little Elk Creek	**Not supporting**	**Not supporting**	**Not supporting**	**Not supporting**	Supporting	**Not supporting**
Turkey Creek	Supporting	**Not supporting**	**Not supporting**	Supporting	Supporting	Supporting
Salt Fork of the Red River	**Not supporting**	**Not supporting**	**Not supporting**	Supporting	Supporting	Supporting
Bitter Creek, Jackson County	**Not supporting**	**Not supporting**	**Not supporting**	Supporting	**Not supporting**	Supporting
Cave Creek	Supporting	**Not supporting**	**Not supporting**	Supporting	Supporting	Supporting
Deer Creek @ County Road Bridge	**Not supporting**	**Not supporting**	Not enough info	Supporting	**Not supporting**	Supporting
Fish Creek	**Not supporting**	**Not supporting**	**Not supporting**	Supporting	**Not supporting**	Supporting
North Elm Creek	Supporting	Not enough info	Not enough info	Supporting	Supporting	Supporting
Crutcho Creek	**Not supporting**	**Not supporting**	**Not supporting**	**Not supporting**	Supporting	Supporting
Crooked Oak Creek	**Not supporting**	**Not supporting**	**Not supporting**	**Not supporting**	**Not supporting**	**Not supporting**
Buggy Creek	**Not supporting**	**Not supporting**	Not enough info	Supporting	Supporting	Supporting
North Walnut Creek	**Not supporting**	Not enough info	**Not supporting**	Supporting	Supporting	Supporting
North Fork Walnut Creek	**Not supporting**	**Not supporting**	**Not supporting**	Supporting	Supporting	Supporting

3.4 FINAL SCORING AND STREAM SELECTION

Results of the final scoring matrix are included below (Table 21). Six high quality reference stream candidates (5 for CGP and 1 for COTP) were proposed based on the data analysis for this project alone. Again, due to the fragmentation and thus inferior representation of the SWT and the COTP ecoregions, a more conclusive reference stream determination must (and will) be made at later point using statewide data coverage composited from this and other projects.

4.0 CONCLUSIONS

Due to the necessity to report results specific to the project of interest (i.e., Task 500 data only), certain ecoregions (for this project, the South-West Tablelands) are particularly depauparate in representation. The results of this project will be collated with those of similar projects and analyzed as a statewide composite. This will result in a better representation and hopefully characterization of each ecoregion than the results of this project alone. Likewise, even the well represented ecoregion, the Central Great Plains, will be represented by many additional sites when the rest of the state is considered. **Because this selection of reference streams is based on a partial sample of each ecoregion, all reference stream determinations should be considered provisional. They will almost certainly change to some degree when they are ranked with additional streams.**

The screening and scoring methodology developed and implemented for this project appears to be useful (i.e., better sites near the top, poor sites near the bottom). Additionally, the different categories upon which streams were judged, fish, invertebrates, WQ and habitat, generally agree with each other. There are expected exceptions however such as when a stream with high quality habitat has a water quality problem sufficient to harm the biota. Instances such as this cause the habitat score to disagree with the scores from water quality or fish or benthic macroinvertebrates. The scoring matrix was designed so that category could be sorted a number of ways to afford determination of “best of, worst of” scenarios. The use of ranks for final scoring was thought to afford a certain “power” to the analysis common to nonparametric designs. Often the utility of multimetric indices can be diluted by error introduced in point assignments. Ranking of criterion exceedances of statistical descriptors for a parameter of interest (e.g., median, lower quartile, upper quartile) could be useful when data volume necessary to score a metric is lacking.

Table 21. Final Scoring Matrix Indicating Candidate Reference Streams (shaded rows).

SiteName	WBID	County	Ecoregion	FISH	HABITAT	BUGS (summer only)	WATER QUALITY	TOTAL SCORE
Little Washita River, Caddo Co.	OK310820-02-0010F	Caddo	CGP	1.5	1	2.5	2.4	7.4
Deer Creek @ County Road Bridge	OK311800-00-0070C	Greer	CGP	2	1	3.0	2.8	8.8
Bitter Creek	OK310820-01-0030G	Grady	CGP	1	2	2.8	3.0	8.8
Cave Creek	OK311600-02-0140G	Greer	CGP	1.5	2.5	2.5	2.4	8.9
Whiskey Creek	OK311210-00-0140D	Comanche	CGP	2.5	3.5	1.5	2.0	9.5
North Fork Walnut Creek	OK520610-03-0080G	McClain	CGP	1	2.5	2.8	3.2	9.6
Blue Beaver Creek	OK311310-02-0060G	Comanche	CGP	2	2	3.7	2.1	9.8
Roaring Creek	OK310810-02-0170G	Grady	CGP	1	4	2.5	2.8	10.3
Turkey Creek	OK311510-02-0060G	Beckham	CGP	3.5	1.5	2.2	3.7	10.8
Buggy Creek	OK520610-02-0120G	Caddo	CGP	1.5	4	3.0	3.1	11.6
West Otter Creek	OK311500-02-0040G	Kiowa	CGP	2	2.5	3.7	3.6	11.7
Tahoe Creek	OK311300-03-0070G	Caddo	CGP	3.5	1.5	4.2	2.8	11.9
Cottonwood Creek	OK311210-00-0150G	Comanche	CGP	2.5	3	2.7	3.8	11.9
North Walnut Creek	OK520610-03-0010G	McClain	CGP	1	4.5	4.0	2.6	12.1
Salt Fork of the Red River	OK311600-02-0010G	Jackson	CGP	3.5	3	4.5	1.9	12.9
Little Washita River, Downstream	OK310820-02-0010B	Grady	CGP	5	3	4.3	2.1	14.4
Little Elk Creek	OK311500-03-0040G	Kiowa	CGP	4	1.5	5.0	4.1	14.6
Tepee Creek	OK311500-01-0110G	Kiowa	CGP	5	2	5.0	2.8	14.8
Willow Creek	OK310830-06-0030H	Caddo	CGP	7	4	2.7	2.3	16.0
Stinking Creek	OK311500-01-0050G	Jackson	CGP	2.5	3	5.8	6.1	17.4
Washita River # 466	OK310830-03-0010G	Washita	CGP	7	3	3.3	4.1	17.4
Bitter Creek	OK311600-02-0110G	Jackson	CGP	6.5	1	5.5	5.3	18.3
Brush Creek	OK311310-03-0050G	Tillman	CGP	5.5	4.5	4.5	4.4	18.9
Crooked Oak Creek	OK520520-00-0150G	Oklahoma	CGP	7	3	5.8	3.8	19.6
Rush Creek	OK310810-05-0010H	Garvin	COTP	1.5	1	2.0	1.9	6.4
Winter Creek	OK310810-02-0220G	Grady	COTP	1	2.5	2.0	1.7	7.2
Crutcho Creek	OK520520-00-0070B	Oklahoma	COTP	1.5	1	3.3	2.7	8.5
Dry Creek	OK311200-00-0080G	Stephens	COTP	2	1.5	2.5	3.4	9.4
Laflin Creek	OK310810-02-0200G	Grady	COTP	4	2	1.7	2.1	9.8
West Mud Creek	OK311100-04-0080G	Jefferson	COTP	3	2	2.7	5.7	13.3
North Elm Creek	OK311800-00-0170G	Beckham	SWT	1	1	1.5	2.4	5.9
Fish Creek	OK311800-00-0130G	Greer	SWT	1	1.5	1.7	3.0	7.2

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Appendix A

Intensive Assessment Site List

Stream Name	Stream Order	Project (Task 500=SW; Task 400=NW)	WBID	County	Ecoregion	Section	Township	Range	Lat (decimal degrees)	Long (decimal degrees)	TOTAL HABITAT	TOTAL WQ
Laflin Ck	3	Task 500	OK310810-02-0200	Grady	Cntrl OK/TX Plns	4/9'	5N	5W	34.9279	97.7268	54.44	78
Winter Ck	4	Task 500	OK310810-02-0220	Grady	Cntrl OK/TX Plns	19/30	6N	5W	34.9713	97.7738	43.79	83
Rush Ck	4	Task 500	OK310810-05-0010	Garvin	Cntrl OK/TX Plns	9/10'	3N	2W	34.7433	97.4048	30.28	80
West Mud Ck	4	Task 500	OK311100-04-0080	Jefferson	Cntrl OK/TX Plns	27/28	5S	5W	34.0886	97.7198	86.71	70
Dry Ck	3	Task 500	OK311200-00-0080	Stephens	Cntrl OK/TX Plns	12/13'	3S	8W	34.3039	97.9992	64.1	80
Crutcho Ck	2	Task 500	OK520520-00-0070	Oklahoma	Cntrl OK/TX Plns	27/28	12N	2W	35.4859	97.4061	103.3	26
Roaring Ck	4	Task 500	OK310810-02-0170	Grady	Ctrl Gt Plns	35/36	5N	6W	34.8627	97.8112	88.91	78
Bitter Ck	5	Task 500	OK310820-01-0030	Grady	Ctrl Gt Plns	NW 9	6N	6W	35.0131	97.8434	91.55	78
Little Washita River	3	Task 500	OK310820-02-0010	Caddo	Ctrl Gt Plns	23/26	5N	10W	34.8843	98.2196	93	73
Little Washita River	4	Task 500	OK310820-02-0010	Grady	Ctrl Gt Plns	25/26	6N	7W	34.9635	97.8996	102.8	73
Washita River	6	Task 500	OK310830-03-0010	Washita	Ctrl Gt Plns	11/14'	10N	16W	35.3492	98.8574	79.07	36
Willow Ck	2	Task 500	OK310830-06-0030	Caddo	Ctrl Gt Plns	10/14'	9N	12W	35.262	98.4508	46.62	75
Whiskey Ck	3	Task 500	OK311210-00-0140	Comanche	Ctrl Gt Plns	20/29	3N	9W	34.71	-98.1688	41.95	73
Cottonwood Ck	2	Task 500	OK311210-00-0150	Comanche	Ctrl Gt Plns	21/22	3N	9W	34.7239	-98.1405	47.54	68
Tahoe Ck		Task 500	OK311300-03-0070	Caddo	Ctrl Gt Plns	NW/NW 13	5N	12W	34.9131	98.4092	86.3	70
Blue Beaver Ck	2	Task 500	OK311310-02-0060	Comanche	Ctrl Gt Plns	NC 22	2N	13W	34.63086429	98.55201699	55.2	83
Brush Ck	3	Task 500	OK311310-03-0050	Tillman	Ctrl Gt Plns	15	3S	14W	34.3013	-98.6441	35.56	73
Stinking Ck	4	Task 500	OK311500-01-0050	Jackson	Ctrl Gt Plns	30/31	2N	19W	34.6084	99.233	100.9	26
Tepee Ck	4	Task 500	OK311500-01-0110	Kiowa	Ctrl Gt Plns	22/27	5N	19W	34.8711	99.1838	89.81	70
West Otter Ck	4	Task 500	OK311500-02-0040	Kiowa	Ctrl Gt Plns	4/9'	2N	17W	34.6669	98.9946	92.33	68
Little Elk Ck	3	Task 500	OK311500-03-0040	Kiowa	Ctrl Gt Plns	2/11'	7N	18W	35.1023	99.0742	97.35	46
Turkey Ck	4	Task 500	OK311510-02-0060	Beckham	Ctrl Gt Plns	NE15	9N	24W	35.42138889	100.21	91.35	83
Salt Fork of the Red River	5	Task 500	OK311600-02-0010	Jackson	Ctrl Gt Plns	16/21	2N	21W	34.6379	99.4089	70.94	78
Bitter Ck	3	Task 500	OK311600-02-0110	Jackson	Ctrl Gt Plns	NE/NE 3	1N	21W	34.5941	99.387	81.71	38
Cave Ck	3	Task 500	OK311600-02-0140	Greer	Ctrl Gt Plns	NW 34	5N	24W	35.45527778	100.1994444	100.9	75
Deer Ck	3	Task 500	OK311800-00-0070	Greer	Ctrl Gt Plns	13/14	6N	24W	34.9887	99.6951	104.5	70
Crooked Oak Ck	2	Task 500	OK520520-00-0150	Oklahoma	Ctrl Gt Plns	12/13'	11N	3W	35.4352	97.474	86.58	48
Shell Ck	2	Task 500	OK520530-00-0030	Canadian	Ctrl Gt Plns	24	12N	6W	35.5079	-97.7901	89.49	76
Buggy Ck	3	Task 500	OK520610-02-0120	Caddo	Ctrl Gt Plns	4/5'	10N	9W	35.3757	98.1659	92.65	68
N. Walnut Ck	4	Task 500	OK520610-03-001	McClain	Ctrl Gt Plns	SE 23	7N	3W	35.0635	97.4851	44.45	75
N. Fork Walnut Ck	4	Task 500	OK520610-03-0080	McClain	Ctrl Gt Plns	SW 15	8N	4W	35.1643	97.6142	59.86	78
Fish Ck	3	Task 500	OK311800-00-0130	Greer	Sthwstrn Tbllnds	SE6	6N	25W	35.0192	99.8804	82.09	68
N. Elm Ck	3	Task 500	OK311800-00-0170	Beckham	Sthwstrn Tbllnds	17/21	7N	26W	35.0733	99.9591	99.41	73
Cottonwood Ck	4	Task 400	OK620910-04-0010	Logan	Cntrl OK/TX Plns	13/18	15N	4/3W	35.7729	97.5668	72.67	78
Chisolm Ck	3	Task 400	OK620910-04-0100	Logan	Cntrl OK/TX Plns	33/4	15/14	3W	35.7256	97.5269	93.9	48
Washita River	6	Task 400	OK310830-03-0010	Custer	Ctrl Gt Plns	8/17'	12N	17W	35.523	99.0208	90	68
Beaver Ck	4	Task 400	OK310830-03-0190	Custer	Ctrl Gt Plns	1/31'	12/13N	17W	35.5514	98.9458	85.79	45
West Barnitz Ck	3	Task 400	OK310830-03-0230	Custer	Ctrl Gt Plns	9/10'	15N	19W	35.7972	99.2163	95.48	73
Washita River	5	Task 400	OK310840-02-0010	Roger Mills	Ctrl Gt Plns	23/24	15N	26W	36.27722222	100.5480556	98.04	68
Bear Ck	6	Task 400	OK520620-01-0120	Blaine	Ctrl Gt Plns	SW 17	14N	13W	35.6874	98.6086	39.76	63
Trail Ck	4	Task 400	OK520620-02-0090	Dewey	Ctrl Gt Plns	13/18	17N	16/15	35.9565	98.848	44.49	75
West Beaver Ck	3	Task 400	OK620900-03-0260	Logan	Ctrl Gt Plns	19/30	19N	2W	36.1013	97.4436	89.36	68
Stillwater Ck	3	Task 400	OK620900-04-0270	Payne	Ctrl Gt Plns	5	19N	1W	36.1499	97.3296	86.05	71
Elm Ck	4	Task 400	OK620910-02-0270	Blaine	Ctrl Gt Plns	35/2	20/19	11W	36.1591	98.3447	79.96	45
Otter Ck	4	Task 400	OK620910-03-0040	Logan	Ctrl Gt Plns	6/7'	19N	3W	36.1447526	97.55282768	90.54	80
Skeleton Ck	4	Task 400	OK620910-03-0240	Garfield	Ctrl Gt Plns	24/25	22N	6W	36.3616	97.8006	78.74	38
Deer Ck	4	Task 400	OK620910-04-0120	Logan	Ctrl Gt Plns	19/30	15N	3W	35.7552	97.563	106.4	45

Kingfisher Ck	5	Task 400	OK620910-05-0010	Kingfisher	Ctrl Gt Plns	16/17	16N	7W	36.44055556	98.63388889	94.67	73
Trail Ceek	2	Task 400	OK620910-05-0020	Kingfisher	Ctrl Gt Plns	32/5	17/16N	6W	36.50611111	98.435	91.92	78
Cottonwood Ck	4	Task 400	OK620920-01-0080	Major	Ctrl Gt Plns	21/22	22N	12W	36.3632	98.4796	43.03	70
Griever Ck	3	Task 400	OK620920-01-0130	Major	Ctrl Gt Plns	36	22N	16W	36.3395	98.8583	63.38	78
Traders Ck	4	Task 400	OK620920-02-0170	Woodward	Ctrl Gt Plns	22/27	26N	19W	36.711	99.2318	60.89	78
Buffalo Ck	5	Task 400	OK620920-05-0010	Harper	Ctrl Gt Plns	32/33	27N	20W	36.7705	99.3665	41.08	75
Cimarron River	6	Task 400	OK620930-00-0010	Harper	Ctrl Gt Plns	SE23	29N	26W	36.9774	99.9756	27.55	83
Spring Ck	3	Task 400	OK621000-02-0130	Grant	Ctrl Gt Plns	1/12'	26N	7W	36.7529	97.9022	78.09	68
Turkey Ck	3	Task 400	OK621010-01-0230	Woods	Ctrl Gt Plns	14/15	27N	14W	36.8238	98.6839	99.96	55
Sandy Ck	5	Task 400	OK621010-02-0010	Alfalfa	Ctrl Gt Plns	18/19'	29N	9W	36.8404	98.2022	66.71	75
North Canadian River	6	Task 400	OK720500-01-0010	Woodward	Ctrl Gt Plns	8	20N	17W	36.2305	99.0416	65.34	78
Persimmon Ck	4	Task 400	OK720500-01-0150	Woodward	Ctrl Gt Plns	30/31	21N	18W	36.2615	99.1728	67	78
Clear Ck	4	Task 400	OK720500-02-0070	Harper	Ctrl Gt Plns	24/25	25N	25W	36.6224	-99.851	36.33	80
Wolf Ck	5	Task 400	OK720500-03-0010	Woodward	Ctrl Gt Plns	19/30	23N	22W	36.4493	99.588	76.96	80
Bitter Cr.	4	Task 400	OKTEMP-0036	Kay	Ctrl Gt Plns	**14/23	28N	1W	36.89805556	97.27361111	100.1	78
Bois d'Arc Cr.	4	Task 400	OKTEMP-0054	Kay	Ctrl Gt Plns	NW 32	26N	2E	36.68916667	97.11833333	100	78
Duck Cr.	3	Task 400	OKTEMP-0182	Kay	Ctrl Gt Plns	11,15/14	27N	1E	36.82444444	97.17416667	95.2	75
Quartermaster Ck	5	Task 400	OK310840-01-0060	Custer	Sthwstrn Tbllnds	15/16	14N	20W	35.6863	99.3228	105.8	70
Canadian River	6	Task 400	OK520620-03-0010	Dewey	Sthwstrn Tbllnds	25	18N	20W	36.0006	99.2906	23	75
Trib to Canadian River	1	Task 400	OK520620-03-0050	Dewey	Sthwstrn Tbllnds	36/31	17N	20/19	35.9124	99.2739	44.76	78
Red Ck	2	Task 400	OK520620-03-0110	Dewey	Sthwstrn Tbllnds	5	18N	20W	35.9777	99.3485	88.08	70
Yellowstone Ck	4	Task 400	OK621010-01-0270	Woods	Sthwstrn Tbllnds	21	29N	16W	36.9769	98.9286	81.67	70
Beaver River	6	Task 400	OK720500-02-0010	Harper	Sthwstrn Tbllnds	9/10'	26N	25W	36.7503	-99.8906	33.98	75
Kiowa Ck	5	Task 400	OK720500-02-0130	Beaver	Sthwstrn Tbllnds	20/29	2N	27E	36.6164	-100.165	43.49	73
Beaver River	6	Task 400	OK720500-02-0140	Beaver	Sthwstrn Tbllnds	31/32	4N	27E	36.7678	-100.1817	25.83	73
Palo Duro Ck		Task 400	OK720500-02-0500	Texas	Sthwstrn Tbllnds	*23/14	1N	18E			89.48	65
Buzzard Ck	3	Task 400	OK720500-03-0080	Ellis	Sthwstrn Tbllnds	1/12"	21N	24W	36.3192	99.7243	53.36	78
Cimarron River	5	Task 400	OK720900-00-0180	Cimarron	Sthwstrn Tbllnds	4	5N	1E	36.9265	-102.9587	63.57	75
South Carrizzo		Task 400	OK720900-00-0200	Cimarron	Sthwstrn Tbllnds	NW 18	4N	2E			83.82	65
North Carrizzo		Task 400	OK720900-00-0250	Cimarron	Sthwstrn Tbllnds	34	6N	1E			55	51
Kiowa Ck	5	Task 400	OK720500-02-0130	Harper	Wstrn Hgh Pl	14/15	26N	26W	36.7371	-99.9805	39.31	61
Clear Ck		Task 400	OK720500-02-0300	Beaver	Wstrn Hgh Pl	*8/9	2N	24E			90.92	70
Corrumpa Ck		Task 400	OK720510-00-0275	Cimarron	Wstrn Hgh Pl	EB 7	2N	1E			66.05	63
Cimarron River	5	Task 400	OK720900-00-0010	Cimarron	Wstrn Hgh Pl	NE 9	5N	5E	36.9193	-102.5965	100	45

*Values of zero mean no water was present at time of evaluation

APPENDIX B

ABBREVIATED HABITAT AND WATER QUALITY DATA SHEET AND SCORING MATRIX

Appendix B. Field Sheet and Scoring Matrix for the Abbreviated Habitat and Water Quality Assessments.

Stream Name ____________ WBID __________________ Legal ___________________ Observer(s) ______________

Date ___________________ County _________________ Lat/Long ________________ Direction: Upstream / Downstream

Time ___________________ Ecoregion ______________ Start Point _______________

Flow Condition
(circle one) bf se

Flow ________**c.f.s.**
(circle one) est.
mea.

Periphyton Type
(dominant & subdominant)

fil diat _____
fil green _____
B G mat _____
gel dia _____
lemanea _____
other _____

Estimated average Thalweg depth _____
Estimated maximum depth _____
Estimated % of Thalweg deeper than 0.5m _____
Estimated % of Thalweg deeper than 1.0m _____
Estimated average stream width _____

Periphyton Density
(max pp > 50% aerial coverage)

sparse _____
moderate _____
abundant _____

% of 400 meters composed of
pool ______
run ______
riffle ______

D.O. (riffle) ______ pH ______ Turb. ______ Temp. ______ Cond. ______ Alk. ______

<u>Habitat Score</u>

Metric
1. Instream cover................................. _____
2. Pool bottom substrate....................... _____
3. Pool variability................................. _____
4. Canopy cover................................... _____
5. Presence of Rocky, Runs & Riffles... _____
6. Flow at base elevation...................... _____
7. Channel Alteration............................ _____
8. Channel Sinuosity............................. _____
9. Bank Stability.................................. _____
10. Bank Vegetative Stability................. _____
11. Dominant Vegetation....................... _____

Total .... ____

<u>Water Quality Score</u>

Dissolved Oxygen Score ________

Turbidity Score ________

pH Score ________

Livestock dropping Score ________

Periphyton Score ________

Land Use Score ________

Point Source Score ________

Total ________

<u>Field Observations</u>

<u>Observation</u>	<u>Stream length</u>
1) Oil & grease ……………………	_______
2) Offensive odor …………………	_______
3) Unpleasant appearance – color ….	_______
4) Excessive floating debris, bottom deposits, scum, foam, trash, or other misc. junk ………..	_______
5) Excessive growths of filamentous periphyton, phytoplankton (i.e., floating mats or pea soup), and/ or macrophytes …………………	_______

<u>Other observations of significance:</u>

Page 2 of Assessment

Dissolved Oxygen 10 points possible

<50% saturation or > 150% saturation = 0 pts ________
>50% <150% = 10 pts

Turbidity 10 points possible ________

0 - 3 NTU	10 pts
3.01 - 10	8 pts
10.01 - 20	5 pts
20.01 - 30	3 pts
30.01 - 50	1 pts
> 50	0 pts

pH 10 points possible ________

6 - 9	10 pts
9.01 - 9.5 or 5.5-5.99	5 pts
9.51 - 9.99 or 5.01 to 5.49	3 pts
10.0 or 5.0	0 pts

Livestock droppings 10 points possible ________

within	0 - 1 per 1000 m^2	10 pts
bankfull	2 - 50 per 1000 m^2	5 pts
elevation	> 50 per 1000 m^2	0 pts

Periphyton density 10 points possible ________

Sparse .... 10 pts
Moderate .... 5 pts
Abundant .... 0 pts

If periphyton is dominated by Lemanea, score 10 points.
Use the thickness of the majority of periphyton.

Point Source 25 points possible ________

a no point source within 15 stream miles .... 25 pts
b minor municipal within 10-15 stream miles .... 20 pts
c minor municipal within 5-10 stream miles .... 15 pts
d minor municipal within 0-5 stream miles .... 10 pts
or
major municipal within 10-15 stream miles
e major municipal within 5-10 stream miles .... 5 pts
f major municipal within 0-5 stream miles .... 0 pts
industrial pt source bpj ___ pts

Land Use 10 points possible ________

a > 50% of watershed cultivated or > 10% urban ...... 0 pts
b 10-50% cultivated or 2-10% urban .... 5 pts
c 0-10% cultivated or 0-2% urban .... 10 pts