QUALITY ASSURANCE PROJECT PLAN

FY-2005 Section 104(b)3 Regional Environmental Monitoring and Assessment Program (R-EMAP) Cooperative Agreement
CA# RM-832667-01

OWRB
the water agency

OKLAHOMA WATER RESOURCES BOARD
WATER QUALITY PROGRAMS DIVISION
3800 NORTH CLASSEN
OKLAHOMA CITY, OK 73118

January 2006

A. PROJECT MANAGEMENT

A1. Title and Signature Page

FY-2005 Section 104(b)3 R-EMAP Cooperative Agreement (CA# RM-832667-01)

______________________________________ Date: ____________
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Oklahoma Water Resources Board (OWRB) Monitoring Programs Coordinator

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Monty Porter
OWRB BUMP Streams Sampling Coordinator

______________________________________ Date: ____________
Jeff Everett
OWRB Quality Assurance Officer (Manager)

______________________________________ Date: ____________
Derek Smithee
Chief, OWRB Water Quality Programs Division

______________________________________ Date: ____________
Dan Butler
Oklahoma Conservation Commission (OCC) Assistant and Interim Director

______________________________________ Date: ____________
Shanon Phillips
OCC Senior Technical Writer/Analyst/Quality Assurance Officer

______________________________________ Date: ____________
Brooks Trammel
OCC Monitoring Coordinator

______________________________________ Date: ____________
Jennifer Wasinger
Office of the Secretary of Environment

______________________________________ Date: ____________
David Peck
EPA-ORD Project Officer

______________________________________ Date: ____________
Bob Ozretich
EPA Approving Official

______________________________________ Date: ____________
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A4. PROJECT/TASK ORGANIZATION

The Oklahoma Water Resources Board (OWRB) is the lead agency and will have final authority and responsibility for all project decisions and products. The OWRB will have responsibility for all reconnaissance, analyzing, and reporting of data results as well as general project oversight. The OWRB will also be responsible for field collections at approximately 50% of the sites. The Oklahoma Conservation Commission (OCC) will be a partner in all activities of the project and be included in all decisions including reconnaissance, collection, analysis, and reporting protocols. The OCC will also review all QAPP's and reports before forwarding of the products to Oklahoma's Office of the Secretary of the Environment for dissemination to the public. The OCC will act as a contractor for field collections at approximately 50% of the sites. The Oklahoma Department of Environmental Quality (ODEQ) laboratories will perform laboratory analyses for water quality samples. Outside contractors will be retained to identify all fish and macroinvertebrates collected as a part of this project.

Personnel of the OWRB-Water Quality Programs Division-Monitoring/Assessment Section (OWRB-WQPD-MAS) will perform various tasks necessary to complete the project. The OWRB personnel involved and their qualifications and responsibilities are listed below.

Derek Smithee, Division Chief, OWRB-WQPD

Mr. Smithee is responsible for all operations of OWRB Water Quality Programs Division (WQPD). He is the final decision maker for all programs in the division. Mr. Smithee has a Bachelor of Science (BS) from Oklahoma State University (OSU) and a Master of Science (MS) from the University of Oklahoma (OU). He has over 20 years experience in the field of water quality management including experience with the OWRB and ODEQ.

Bill Cauthron, Section Head, OWRB-WQPD-MAS

Mr. Cauthron is the Project Manager. He is responsible for coordinating and expediting all projects and activities under the Monitoring and Assessment section including data collection, data analysis, reporting of study results, and implementing quality assurance/quality control measures. He is also responsible for implementation of all contracts under the section. Mr. Cauthron has a BS from East Central University (ECU) and a MS from OU. He has nearly 20 years experience in the field of water quality management.

Monty Porter, Streams and Rivers Monitoring Coordinator, OWRB-WQPD-MAS

Mr. Porter is the Assistant Project Manager. He is responsible for implementing all aspects of the project including communication with outside laboratories, establishment of data quality objectives, reconnaissance, data collection, data analysis, reporting of study results, and implementing quality assurance/quality control measures. He is also responsible for maintaining standard operating procedures for all field activities and the supervision, coordination, and training of the field investigative personnel. Mr. Porter also maintains a rigorous field schedule. He will be heavily involved in the field collection activities of this project as both a team member and team leader. Mr. Porter has both a BS and a MS in Biology from the University of Central Oklahoma (UCO). He has 8 years experience in the field of water quality management and over 5 years of previous research experience with OU and UCO.

Jeff Everett, Quality Assurance/Quality Control Officer, OWRB-WQPD-MAS

Mr. Everett is the second in authority to the Division Chief on all matters concerning Quality Assurance/Quality Control including establishing of QA/QC and training procedures and implementation of remedial or corrective actions. He will be responsible for maintaining and distributing the approved QAPP and for reviewing the project as required to ensure proper quality assurance procedures are being implemented and followed. Mr. Everett has a BS from Southwest Oklahoma State University (SWOSU). He has nearly 5 years experience in the field of water quality management and 5 years of previous water chemistry work with the Oklahoma Department of Agriculture Food and Forestry (ODAFF) and private laboratories.

Chuck Potts, Senior Macroinvertebrate Taxonomist, OWRB-WQPD-MAS

Mr. Potts is the senior macroinvertebrate taxonomist. He will be responsible for coordinating with Mr. Porter and Mr. Everett the quality assurance of all macroinvertebrate samples. He will serve as an advisor for all taxonomic analysis and perform QA checks on subsamples. Mr. Potts has his BS in Biology from UCO and 36 hours of graduate credit in biology. He has more than 12 years experience performing invertebrate taxonomy as well as biologically based water resources investigations.

Jason Childress, Data and Field Collection Manager, OWRB-WQPD-MAS

Mr. Childress is a Team Leader for general monitoring activities and biological sampling. He is responsible for all data management of probabilistic projects and supervises data tracking and data entry. He is also responsible for field supervision of monitoring activities, collection of field data and samples, reconnaissance and landowner permissions, submission of samples to the laboratory, equipment maintenance, and various related duties. He will be leading one of the teams responsible for field collections for this project. Mr. Childress has a BS from ECU and a MS in Fisheries from the University of Florida. He has worked for the OWRB since May 2004. He has over 5 years of experience in various research related activities.

Lance Phillips, Water Quality Programs Specialist, OWRB-WQPD-MAS

Mr. Phillips is a Team Leader for general monitoring activities and maintains a rigorous sampling schedule. He is responsible for field monitoring activities, collection of field data and samples, reconnaissance and landowner permissions, submission of samples to the laboratory, equipment maintenance, and various related duties. He will be marginally involved as a team member in the field sampling activities of this project. Mr. Phillips has a BS from Northeastern State University. He has worked for the OWRB since January of 2004.

Chris Nickel, Water Quality Programs Specialist, OWRB-WQPD-MAS

Mr. Nickel is a Team Leader for general monitoring activities and biological sampling. He is responsible for all data management and some taxonomy of macroinvertebrate collections and supervises data tracking and data entry of macroinvertebrates. He is also responsible for field monitoring activities, collection of field data and samples, reconnaissance and landowner permissions, submission of samples to the laboratory, equipment maintenance, and various related duties. He will be leading one of the teams responsible for field collections for this project. Mr. Nickel has a BS from OSU and a MS from Clemson University. He has worked for the OWRB since May 2005. He has over 5 years of experience in various water quality related work activities.

Personnel of the Oklahoma Conservation Commission (OCC), Water Quality Division will perform field and output review tasks necessary to complete this project. The OCC personnel involved and their responsibilities are listed below.

Mike Thralls, Executive Director, OCC

Responsible for all operations of OCC including Water Quality Division operations.

Dan Butler, Assistant Director and Interim Director, OCC Water Quality Division

Responsible for all OCC Water Quality Division programs, the Program Director is the final decision making authority within the Water Quality Division. Responsible for all field-sampling activities and has an integral part of all monitoring projects participates in establishing Data Quality Objectives. Also responsible for maintaining standard operating procedures for all field activities and the supervision, coordination, and training of the field investigative personnel.

Jim Leach, Cost Share and Finance Director, OCC Water Quality Division

Second in OCC-WQD command. In addition to administrative duties, responsible for coordinating and expediting management of OCC watershed projects, both within the OCC and with contracted agencies.

Brooks Trammel, Monitoring Coordinator/Water Quality Specialist, OCC Water Quality Division

Responsible for coordinating daily monitoring activities for the Water Quality Division and supervision of monitoring personnel. Brooks assists in maintaining standard operating procedures, reviewing and modifying project QAPPs and in the training of field investigative personnel.

Crew Leaser – Responsible for collection of field data and samples, landuse and landowner surveys, submission of samples to the laboratory, submission of data to the WQ data manager, equipment maintenance, and various related duties. Also responsible for identification, enumeration, and cataloging of fish collections maintained by the OCC.

Wes Shockley, Water Quality Specialist, OCC Water Quality Division

Crew Leader - Responsible for collection of field data and samples, landuse and landowner surveys, submission of samples to the laboratory, submission of data to the WQ data manager, equipment maintenance, and various related duties.

Leonard Moore, Water Quality Specialist, OCC Water Quality Division

Responsible for collection of field data and samples, landuse and landowner surveys, submission of samples to the laboratory, equipment maintenance, and various related duties.

Jason Ramming, Water Quality Specialist, OCC Water Quality Division

Crew Leader - Responsible for collection of field data and samples, landuse and landowner surveys, submission of samples to the laboratory, submission of data to the WQ data manager, equipment maintenance, and various related duties.

Ben Berry, Water Quality Specialist, OCC Water Quality Division

Crew Leader - Responsible for collection of field data and samples, landuse and landowner surveys, submission of samples to the laboratory, submission of data to the WQ data manager, equipment maintenance, and various related duties.

Jerry Carr, Water Quality Specialist, OCC Water Quality Division

Responsible for collection of field data and samples, landuse and landowner surveys, submission of samples to the laboratory, equipment maintenance, and various related duties.

Judith Wilkins, Secretary, OCC Water Quality Division

Division secretary, file manager, and data entry.

Margaret Blevins, Data Manager, OCC Water Quality Division

Initiates and handles correspondence relating to data management including: data handling, policies, and procedures. Produces documents of various levels of complexity including data summaries. Enters and retrieves water quality data using personal computer, and receives and reviews source documents; proofs previously entered data and makes routine corrections

Gayle Bartholomew, Environmental Projects Coordinator, OCC Water Quality Division

Responsible for the administration and management of WQ projects. Monitors, reviews and coordinates: grant outputs, agreements, and WQ cost-share implementation and demonstration projects. Coordinates and authorizes the purchasing of all water quality monitoring equipment and supplies under the supervision of the WQ Asst. Director and Commission Comptroller. Coordinates with WQ staff on the creation and administration of contracts and agreements with other Agencies, Universities, and non-governmental organizations.

Shanon Phillips, Senior Technical Writer/Water Quality Analyst/Quality Assurance Officer, OCC Water Quality Division

Lead technical writer, data analyst, and field investigator. Responsible for the drafting and review of the technical reports and other information from the Division. Also responsible for all Quality Assurance efforts implemented by the OCC.

Greg Kloxin, Environmental Manager, OCC Water Quality Division

Mr. Kloxin manages 104(b)3 projects. He also has functions as a technical writer, data analyst, assistant QA officer, and field I investigator.

A5. PROBLEM DEFINITION/BACKGROUND

The Environmental Protection Agency (EPA) released guidance in 2003 establishing the "10 Required Elements of a State Water Monitoring and Assessment Program". Among other things, the document suggests, "A State monitoring program will likely integrate several monitoring designs (e.g., fixed station, intensive and screening-level monitoring, rotating basin, judgmental and probability design) to meet the full range of decision needs. The State monitoring design should include probability-based networks (at the sub-basin or state-level) that support statistically valid inferences about the condition of all state water types, over time. EPA expects the State to use the most efficient combination of monitoring designs to meet its objectives."

Oklahoma currently has several monitoring programs that meet these requirements. Several agencies conduct water quality monitoring in the State of Oklahoma that meet complementary monitoring objectives supporting the management of Oklahoma's surface waters. The two primary components of the statewide monitoring program include (a) the Beneficial Use Monitoring Program, a long-term, fixed-station trend water quality monitoring network, and (b) the Small-Watershed Rotating Basin Monitoring Program, targeting water quality and ecological conditions in waters flowing from 11-digit hydrologic units. The state recently completed a water quality monitoring strategy that describes their existing programs in detail and the monitoring objectives that cannot be met with existing resources. These objectives include the ability to make statistically valid inferences about environmental conditions throughout the state, based on a probabilistic selection of sites. Meeting this objective will improve the ability to make condition estimates required in section 305(b) of the Clean Water Act. This requirement includes a description of the quality of all lotic waters, and the extent that all waters provide for the protection and propagation of aquatic life.

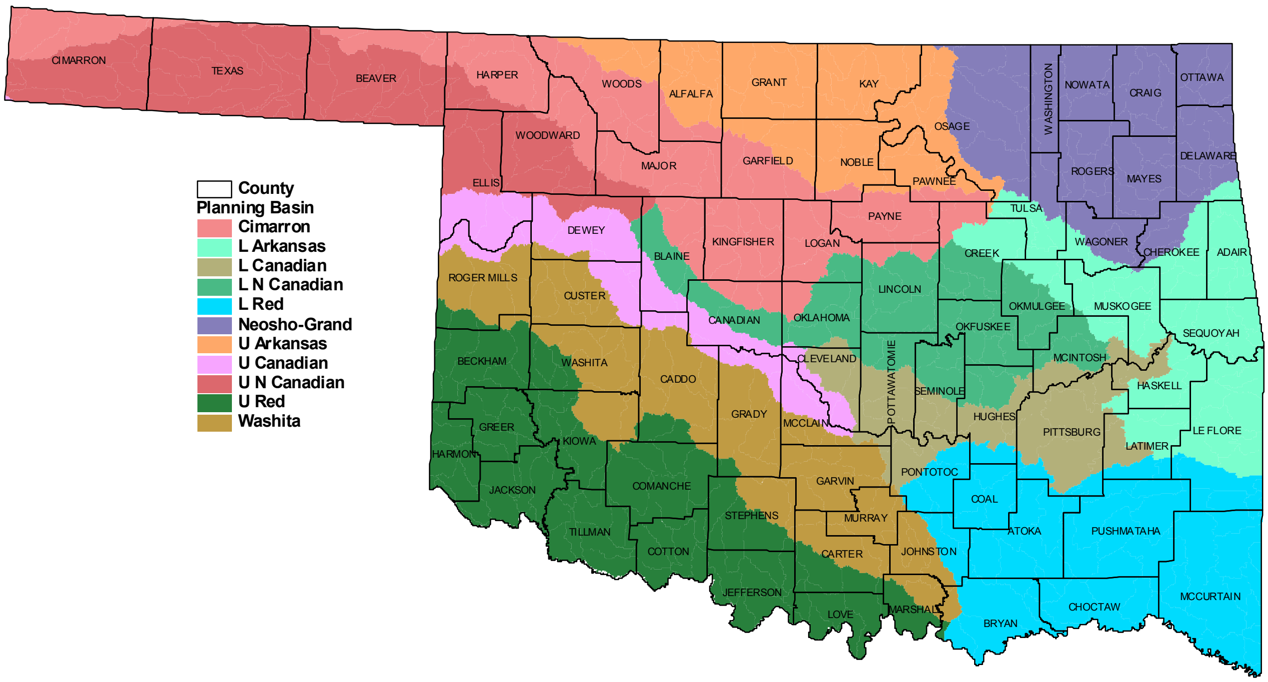
In 2001, the State requested assistance with the design of a probabilistic approach to stream and river site selection from the U.S. Environmental Protection Agency, Office of Research and Development (ORD), National Health and Environmental Effects Research Laboratory (NHEERL). In 2005, with the assistance of a Clean Water Act 104(b)3 Cooperative Agreement, Oklahoma began the study in 2005 and will continue the study with this REMAP Cooperative Agreement.

Oklahoma's probabilistic survey will be completed over a five-year period (2005-2009) with approximately 42 sites sampled annually (210 total) (Table 1). The design is stratified to allow statewide estimates (15 stations per year) as well as estimates within planning basins (27 stations per year). To date, three sources of funding have been identified to complete the initial three years of the study (126 stations). Study year one includes the Lower Red River planning basin (Figure 1) and is nearly completed. It is funded by a regional 104(b)(3) grant (30 sites) and state dollars (12 sites). Study years two and three will be funded by a combination of REMAP (74 sites) and state monies (10 sites). These years will include intensive sampling in the Grand River, Upper North Canadian River, Upper Canadian River, Upper Arkansas River, Lower Canadian River, and Cimarron River planning basins (Figure 1). Additional funding is being pursued to complete study years four and five.

Table 1. Numbers of sites within selected basins.

STUDY YEAR (SY)	PLANNING BASIN	SITES
SY-2005 (1)	Lower Red River	27
	Statewide Stations	15
SY-2006 (2)	Grand-Neosho River	15
	Upper North Canadian River	5
	Upper Canadian River	7
	Statewide Stations	15
SY-2007 (3)	Upper Arkansas River	10
	Lower Canadian River	6
	Cimarron River	11
	Statewide Stations	15
SY-2005-2007	Total Stations	126

Figure 1. State of Oklahoma Planning Basins.



A6. PROJECT/TASK DESCRIPTION

The main objectives for the project are:

1. To determine the overall health of Oklahoma's streams and rivers through a statistically valid approach.

   At the end of the project period, there will be one hundred twenty-six (126) sites available for inclusion in data analyses (Table 1). When study years four and five are completed, much more precise estimates may be possible. All planning basins will be sampled at the higher resolution scale, and the statewide estimate will include at least seventy-five (75) sites.

2. To assist the development and validation of statewide biocriteria and nutrient criteria.

   The study will yield biological, chemical, and physical data for across a gradient of environmental conditions, supporting evaluation of relationships between these indicators. This will help to calibrate the existing biocriteria ranges and established reference condition. Nutrient criteria development will be assisted in several ways. Periphyton data may assist in development of nutrient criteria. Baseflow nutrient data will help to verify regional averages when associated with data from other programs.

3. To provide an additional data layer for determining localized monitoring needs and developing short- and long-term monitoring goals.

   The data will allow for the assessment of the water quality standards for Fish & Wildlife Propagation beneficial use for additional waters in the state, some of which were previously unassessed. Observations suggesting impaired biological integrity at individual sites will identify a need for follow-up studies in local areas. Additionally, if regional numbers are not within state criteria, the area may be designated a "hot-spot" for a particular water quality issue and resources allocated.

4. To evaluate the feasibility of using land use and land cover data to predict biological integrity and target monitoring efforts.

   The delineation of watersheds upstream from each site and calculation of landscape metrics for each watershed will yield variables to be used in the development of predictive models for indicators of biological integrity.

Data will be processed through Oklahoma's Use Support Assessment Protocols (USAP) and the Continuing Planning Process (CPP) to determine if impairment exists. The USAP [Oklahoma Administrative Code (OAC) 785:46-15] can be obtained at the following OWRB website: http://www.owrb.state.ok.us/util/rules/pdf_rul/Chap46.pdf. The 2004 CPP can be obtained at the following ODEQ website: http://www.deq.state.ok.us/WQDnew/pubs/2004_cpp_final.pdf

Task 1: Completion of proposal and QAPP.
The proposal portion of the task has been completed. This Quality Assurance Project Plan is being submitted to EPA for approval.

Task 2. Reconnaissance of Site Locations and Development of Station Plans
Because the probability-based design selects sampling locations randomly, three stages of planning will be necessary prior to sampling. The initial stage of planning will be reconnaissance to determine station accessibility, locate best available routes, and seek landowner permission to enter their property. Once stations are determined to be accessible, secondary recon will be necessary to assess any special considerations at the station including hazards, time of travel, etc. The final planning stage will be the preparation of a sampling plan for each station. The status of all sites will be tracked during the reconnaissance process to ensure that sampling is complete. Because sites may be dry during the sampling period, the oversample stations will be included in the planning process. If an oversample station is required, the next eligible site on the list will

be used. The site identification number as listed in Table 2 determines site substitution order.

Task 3. Monitoring of Selected Stations

Oklahoma will begin sampling in the late spring of 2006 and continue through the fall of 2007. One sample per station will be collected to characterize the chemical and physical properties of the water. Water quality samples will be collected to determine concentrations of various nutrients, hardness, toxicants, solids, and turbidity. Each site visit will also include an assessment of physical habitat and a measurement of instantaneous discharge. General water quality variables (i.e., dissolved oxygen, temperature, pH, specific conductance, etc.) will be measured *in situ*. In addition, during defined index periods, bacteria (one collection during recreational season of May 1-September 30), fish (one collection during spring/summer index), benthic macroinvertebrates (one collection during summer index), and algae/chlorophyll-a (one collection during a late spring/summer index) will be collected. The measurement of chlorophyll-a concentration from benthic algal collections will determine algal biomass. The bacteria, algal, benthic macroinvertebrate (including independent habitat form), and complete water chemistry sample will be taken at the same time. Generally, fish and general habitat (long form) will be collected at another time. When fish are collected separately, some water quality measurements will be made including dissolved oxygen, temperature, pH, specific conductance, turbidity, alkalinity, and hardness.

Task 4. Interim Data Report

An interim data report will be provided to the EPA project officer for year one data. The interim report will be sent after all contractors and contract laboratories have provided complete data reports to the OWRB. The interim report will not include any data reduction or analysis but will only provide an accounting of the data and data quality objectives.

Task 5. Water Quality Data Report for Review

The OWRB will compile the water quality report and through the Oklahoma Office of the Secretary of the Environment (OSE) submit the report for technical review by interested state entities and the EPA.

Task 6. Final Water Quality Data Report to EPA

The OWRB will address state and EPA comments. Through OSE, the OWRB will submit a final water quality report for technical review by interested state entities and the EPA. An interim data report will be provided to the EPA project officer for year one data. The interim report will be sent after all contractors and contract laboratories have provided complete data reports to the OWRB. The interim report will not include any data reduction or analysis but will only provide an accounting of the data and data quality objectives.

<u>A7. QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA</u>

A7.1 Problem Description

The target population for the survey design includes all perennial streams and rivers within Oklahoma, excluding atypical systems with highly unique characteristics and fauna; specifically, oxbow and wetland dominated systems, and navigational channels and lock-dominated systems. An unequal probability random tessellation stratified (RTS) survey design (Stevens 1997, Stevens and Olsen 2004) was used to select stream sample sites across the state. The sample design is weighted by Strahler stream order categories to achieve an approximately equal expected sample size across stream order categories 1st, 2nd, 3rd, and 4th+ to ensure that larger order streams are represented. Both wadeable and non-wadeable waterbodies are included in the design. The site selection process included an "oversample" to provide alternate sites for those that do not fit the target population, or where access is prohibited by landowners. The original 2001 balanced sampling design was modified to a spatially stratified design to support estimates of conditions at the statewide scale within the three-year project period, and to support estimates at the scale of selected planning basins (or combinations of basins).

Oklahoma's probabilistic survey will be completed over a five-year period (study years 2005-2009) with approximately 42 sites sampled annually (Table 1). The design is stratified to allow statewide estimates as well as estimates within planning basins. During study years one through three, fifteen (15) sites will be visited at the statewide scale each year, yielding a sample size of at least forty-five (45) sites, and twenty-seven (27) sites will be visited within seven specific planning basins that have been selected for more intense sampling to yield an additional eighty-one (81) sites during the initial three years of the study. Because of the differing size or geographic area covered by each basin, the number of sites targeted within each planning basin ranges from five to twenty-seven sites. At the end of the project period, there will be one hundred twenty-six (126) sites available for inclusion in data analyses. When study years four and five are completed, much more precise estimates may be possible. All planning basins will be sampled at the higher resolution scale, and the statewide estimate will include at least seventy-five (75) sites.

As was stated above, the draw yields an ordered listing of sites that must be evaluated for accessibility, landowner access, and verification that the site is representative of the target population. All available sites for years 2 and 3 are listed in Table 2. Three stages of planning will be carried out prior to data collection. The initial stage of planning will be reconnaissance to determine station accessibility, best available routes, and landowner permission to enter their property. Once stations are determined to be accessible, secondary recon will be necessary to assess any special considerations including hazards, time of travel, etc. The final planning stage will be the preparation of a sampling plan for each station.

All selected sites will be visited once during a late spring to late summer index period in which fish assemblage will be determined and comprehensive suite of physical habitat measurements will be made. In addition, an *in-situ* water quality collection will be made including measurements for water temperature, dissolved oxygen, pH, specific conductance, and turbidity. All selected sites will be visited again during an index period from July 1st through August 30th in which a comprehensive collection of water quality chemistry and microbiology, a collection for benthic macroinvertebrates, short form physical habitat measurements, and a collection of benthic periphyton will be made. All collections will be made under base flow conditions. The data will be assessed using existing protocols for making standards attainment decisions (OWRB 1997), and by multivariate analyses to examine relationships between the indicators and landscape metrics.

Table 2. Target and oversample stations selected for SY 2006 and 2007.

Site ID	Waterbody Name	County	Latitude (DD)	Longitude (DD)	Status (0 = target; 1 = oversample)	Strahler Order
OKPB01-007	Twomile Creek	OSAGE	36.50	-96.34	0	1
OKPB01-008	Grayson Creek	PONTOTOC	34.85	-96.75	0	1
OKPB01-018	POND CR	OSAGE	36.94	-96.20	0	3
OKPB01-025	CIMARRON R	CIMARRON	36.92	-102.56	0	7
OKPB01-027	BITTER CR	JACKSON	99.39	34.78	0	4
OKPB01-029	RED ROCK CR	GARFIELD	36.51	-97.61	0	3
OKPB01-031	Unlisted	OKLAHOMA	97.18	35.72	0	3
OKPB01-032	NEOSHO R	OTTAWA	36.87	-94.89	0	7
OKPB01-033	POLECAT CR	CREEK	96.40	35.96	0	4
OKPB01-035	Unlisted	ALFALFA	36.75	-98.24	0	1
OKPB01-036	CASTON CR	LE FLORE	94.74	34.96	0	4
OKPB01-037	Unlisted	ROGER MILLS	35.91	-99.91	0	1
OKPB01-039	INDIAN CR	WOODWARD	99.30	36.36	0	3
OKPB01-041	SANDY CR	ALFALFA	98.21	36.96	0	4
OKPB01-043	CHIKASKIA R	KAY	97.36	36.91	0	6
OKPB01-045	South Turkey Creek	ELLIS	99.42	36.04	0	3
OKPB01-046	Unlisted	LE FLORE	94.70	34.58	0	1
OKPB01-047	RED R ELM FK	HARMON	99.93	35.01	0	4
OKPB01-048	WILDHORSE CR	STEPHENS	97.85	34.62	0	2
OKPB01-049	STILLWATER CR	PAYNE	96.95	36.05	0	4
OKPB01-050	SAND CR	OSAGE	96.34	36.79	0	2
OKPB01-051	GREENLEAF CR	WOODS	98.87	36.93	0	2
OKPB01-052	FOURCHE MALINE	LE FLORE	94.95	34.92	0	5
OKPB01-053	Unlisted	CUSTER	99.30	35.60	0	1
OKPB01-054	South Fork Dirty Creek	MUSKOGEE	95.21	35.45	0	4
OKPB01-055	TURKEY CR	JACKSON	99.44	34.62	0	4
OKPB01-056	Little Sandy Creek	JOHNSTON	96.55	34.30	0	1
OKPB01-057	BEAVER CR	OSAGE	96.72	36.93	0	4
OKPB01-059	CANADIAN R DEEP FK	OKMULGEE	95.94	35.57	0	6
OKPB01-060	BIRD CR	HUGHES	35.03	-96.46	0	1
OKPB01-063	CIMARRON R	KINGFISHER	36.07	-98.14	0	7
OKPB01-064	CANEY R	WASHINGTON	36.68	-95.97	0	6
OKPB01-067	HOMINY CR	OSAGE	36.39	-96.19	0	4
OKPB01-068	Unlisted	PITTSBURG	34.89	-95.56	0	2
OKPB01-072	BIG CABIN CR	CRAIG	36.79	-95.17	0	3
OKPB01-073	WOLF CR	ELLIS	36.28	-99.94	0	7
OKPB01-075	LONG CR	WOODWARD	36.70	-99.09	0	3

Site ID	Waterbody Name	County	Latitude (DD)	Longitude (DD)	Status (0 = target; 1 = oversample)	Strahler Order
OKPB01-081	Jim Creek	POTTAWATOMIE	35.21	-97.06	0	1
OKPB01-082	SPRING CR	DELAWARE	36.16	-94.86	0	3
OKPB01-086	Unlisted	OTTAWA	36.99	-95.02	0	1
OKPB01-089	ARKANSAS R SALT FK	WOODS	36.82	-98.54	0	5
OKPB01-091	CANADIAN R	ELLIS	36.00	-99.85	0	7
OKPB01-093	KIOWA CR	HARPER	36.72	-99.99	0	5
OKPB01-095	Scatter Creek	KAY	36.87	-97.26	0	1
OKPB01-101	ARKANSAS R	OSAGE	36.49	-96.85	0	7
OKPB01-103	CANADIAN R	ROGER MILLS	36.01	-99.41	0	7
OKPB01-107	OTTER CR	KINGFISHER	35.84	-98.11	0	3
OKPB01-108	Unlisted	OSAGE	36.84	-96.39	0	1
OKPB01-109	Unlisted	OSAGE	36.21	-96.03	0	1
OKPB01-110	MILL CR	MCINTOSH	35.20	-95.95	0	4
OKPB01-115	CROOKED CR	BEAVER	36.95	-100.09	0	5
OKPB01-119	RED ROCK CR	PAWNEE	36.47	-97.01	0	5
OKPB01-121	Skunk Creek	TULSA	36.39	-95.95	0	1
OKPB01-122	Peaceable Creek	PITTSBURG	34.88	-95.83	0	3
OKPB01-125	CIMARRON R	LOGAN	35.92	-97.41	0	7
OKPB01-126	LITTLE CABIN CR	CRAIG	36.66	-95.08	0	3
OKPB01-127	CHIKASKIA R	KAY	36.70	-97.25	0	6
OKPB01-128	BRUSHY CR	PITTSBURG	34.68	-95.75	0	4
OKPB01-131	Unlisted	LOGAN	35.79	-97.42	0	2
OKPB01-133	COLDWATER CR	TEXAS	36.62	-101.24	0	4
OKPB01-135	Doe Creek	WOODWARD	36.66	-99.08	0	2
OKPB01-137	BIRD CR	TULSA	36.22	-95.90	0	5
OKPB01-142	DOG CR	ROGERS	36.23	-95.59	0	2
OKPB01-143	CIMARRON R	PAYNE	36.08	-96.70	0	7
OKPB01-145	CROOKED CR	GRANT	36.77	-98.00	0	4
OKPB01-149	TWENTYFIVEMILE CR	ELLIS	36.37	-99.79	0	4
OKPB01-155	ARKANSAS R	OSAGE	36.53	-96.72	0	7
OKPB01-158	Jumper Creek	POTTAWATOMIE	34.97	-96.77	0	1
OKPB01-159	Sandy Creek	MCCLAIN	35.05	-97.51	0	2
OKPB01-161	CIMARRON R	MAJOR	36.29	-98.38	0	7
OKPB01-162	VERDIGRIS R	ROGERS	36.35	-95.69	0	7
OKPB01-167	CIMARRON R	LOGAN	35.87	-97.61	0	7
OKPB01-168	North Fork Cotton Creek	WASHINGTON	36.94	-95.90	0	2
OKPB01-171	SKELETON CR	GARFIELD	36.36	-97.80	0	4
OKPB01-172	CALIFORNIA CR	NOWATA	36.81	-95.67	0	2
OKPB01-174	Unlisted	HUGHES	35.04	-96.19	0	1
OKPB01-175	Unlisted	CLEVELAND	35.05	-97.27	0	1
OKPB01-179	BEAVER R	BEAVER	36.79	-100.80	0	8
OKPB01-183	RED ROCK CR	NOBLE	36.46	-97.19	0	5
OKPB01-185	HOMINY CR	OSAGE	36.51	-96.44	0	2
OKPB01-189	CIMARRON R	PAYNE	35.98	-97.28	0	7
OKPB01-190	CLEAR CR	CRAIG	36.85	-95.38	0	2
OKPB01-191	BEAVER R	HARPER	36.61	-99.70	0	7
OKPB01-193	BUFFALO CR	HARPER	36.78	-99.45	0	5
OKPB01-199	Spring Creek	GRANT	36.73	-97.89	0	2
OKPB01-201	Unlisted	BLAINE	35.58	-98.62	0	1
OKPB01-205	BLACK BEAR CR	PAWNEE	36.35	-96.87	0	4
OKPB01-206	VERDIGRIS R	NOWATA	36.83	-95.54	0	8
OKPB01-207	Lone Creek	DEWEY	35.97	-99.11	0	3
OKPB01-212	CIMARRON R	CIMARRON	36.90	-102.97	1	5

Site ID	Waterbody Name	County	Latitude (DD)	Longitude (DD)	Status (0 = target; 1 = oversample)	Strahler Order
OKPB01-213	WOLF CR	ELLIS	36.35	-99.69	1	7
OKPB01-215	ARKANSAS R SALT FK	KAY	36.62	-97.10	1	7
OKPB01-219	CIMARRON R	MAJOR	36.19	-98.24	1	7
OKPB01-220	Curl Creek	WASHINGTON	36.59	-95.86	1	2
OKPB01-221	BENT CR	WOODWARD	36.19	-98.99	1	4
OKPB01-223	Gar Creek	WAGONER	35.95	-95.54	1	3
OKPB01-227	Unlisted	OKLAHOMA	35.59	-97.56	1	1
OKPB01-229	CIMARRON R	WOODS	36.87	-99.35	1	7
OKPB01-230	MILL CR	MCINTOSH	35.22	-95.80	1	4
OKPB01-232	Julian Creek	POTTAWATOMIE	34.96	-96.97	1	2
OKPB01-235	Turkey Creek	PAWNEE	36.35	-96.92	1	2
OKPB01-236	CALIFORNIA CR	NOWATA	36.89	-95.73	1	1
OKPB01-239	CROOKED CR	BEAVER	36.98	-100.13	1	5
OKPB01-243	Council Creek	POTTAWATOMIE	35.12	-97.10	1	1
OKPB01-244	SPRING CR	MAYES	36.13	-95.18	1	3
OKPB01-245	CHIKASKIA R	KAY	36.98	-97.44	1	5
OKPB01-247	Tyner Creek	WASHINGTON	36.43	-95.99	1	2
OKPB01-251	COPPER CR	KINGFISHER	35.97	-98.13	1	3
OKPB01-252	LITTLE CANEY CR	WASHINGTON	36.85	-95.95	1	6
OKPB01-255	Turkey Creek	LINCOLN	35.90	-96.72	1	2
OKPB01-259	COTTONWOOD CR	LOGAN	35.85	-97.44	1	5
OKPB01-260	MADDEN CR	CRAIG	36.70	-95.41	1	1
OKPB01-261	ARKANSAS R SALT FK	ALFALFA	36.74	-98.13	1	7
OKPB01-267	ARKANSAS R	OSAGE	36.67	-97.06	1	7
OKPB01-269	DEER CR	CUSTER	35.67	-98.78	1	3
OKPB01-271	SAND CR	HARPER	36.67	-99.59	1	2
OKPB01-275	CIMARRON R	PAYNE	35.96	-96.97	1	7
OKPB01-276	ELK R	DELAWARE	36.64	-94.65	1	5
OKPB01-277	Lynch Creek	GRANT	36.82	-97.91	1	1
OKPB01-279	BOIS D'ARC CR	KAY	36.64	-97.11	1	3
OKPB01-280	GAINES CR	LATIMER	34.83	-95.47	1	4
OKPB01-282	Tomike Creek	MCCLAIN	34.92	-97.15	1	2
OKPB01-283	SKELETON CR	GARFIELD	36.23	-97.75	1	4
OKPB01-284	ROCK CR	MAYES	36.50	-95.26	1	1
OKPB01-292	LITTLE CABIN CR	CRAIG	36.82	-95.07	1	2
OKPB01-293	DRIFTWOOD CR	ALFALFA	36.89	-98.43	1	5
OKPB01-296	BIG WILDHORSE CR	PITTSBURG	34.97	-95.91	1	3
OKPB01-299	DOGA CR	OSAGE	36.60	-96.81	1	2
OKPB01-303	BEAVER R	TEXAS	36.74	-101.44	1	7
OKPB01-309	CIMARRON R	MAJOR	36.44	-98.74	1	7
OKPB01-311	Ranch Creek	TULSA	36.30	-95.87	1	1
OKPB01-315	Unlisted	PAYNE	36.09	-96.74	1	1
OKPB01-316	Choteau Creek	OSAGE	36.64	-96.16	1	1
OKPB01-317	Unlisted	ELLIS	35.98	-99.79	1	2
OKPB01-319	BEAVER R	BEAVER	36.72	-100.85	1	8
OKPB01-323	SKELETON CR	LOGAN	36.05	-97.54	1	5
OKPB01-324	CANEY R	WASHINGTON	36.45	-95.84	1	6
OKPB01-325	CANADIAN R	DEWEY	36.04	-98.91	1	7
OKPB01-327	VERDIGRIS R	ROGERS	36.19	-95.70	1	7
OKPB01-331	ARKANSAS R	OSAGE	36.59	-96.94	1	7
OKPB01-335	BEAVER R	BEAVER	36.80	-100.01	1	7
OKPB01-340	Garrett Creek	OTTAWA	36.93	-94.82	1	1
OKPB01-341	WOLF CR	WOODWARD	36.45	-99.58	1	7

Site ID	Waterbody Name	County	Latitude (DD)	Longitude (DD)	Status (0 = target; 1 = oversample)	Strahler Order
OKPB01-343	BITTER CR	KAY	36.82	-97.26	1	4
OKPB01-347	BLACK BEAR CR	GARFIELD	36.36	-97.50	1	3
OKPB01-348	Fish Creek	WASHINGTON	36.70	-95.88	1	1
OKPB01-355	COTTONWOOD CR	LOGAN	35.76	-97.63	1	4
OKPB01-357	EAGLE CHIEF CR	WOODS	36.69	-98.69	1	3
OKPB01-360	LITTLE R	SEMINOLE	35.02	-96.61	1	4
OKPB01-363	BLACK BEAR CR	NOBLE	36.34	-97.19	1	4
OKPB01-367	BEAVER R	CIMARRON	36.60	-102.88	1	4
OKPB01-369	CANADIAN R	CLEVELAND	35.03	-97.35	1	4
OKPB01-372	BEATY CR	DELAWARE	36.36	-94.73	1	3
OKPB01-373	CIMARRON R	BEAVER	36.95	-100.03	1	7
OKPB01-375	BIRD CR	TULSA	36.28	-95.95	1	5
OKPB01-376	PEACABLE CR	PITTSBURG	34.82	-95.77	1	4
OKPB01-379	CIMARRON R	PAYNE	36.01	-96.82	1	7
OKPB01-380	CANEY R	WASHINGTON	36.83	-95.95	1	6
OKPB01-385	Unlisted	CLEVELAND	35.35	-97.64	1	1
OKPB01-387	SKELETON CR	LOGAN	36.09	-97.67	1	5
OKPB01-388	Elm Creek	CRAIG	36.69	-95.16	1	1
OKPB01-389	ARKANSAS R SALT FK	WOODS	36.94	-98.77	1	5
OKPB01-391	VERDIGRIS R	ROGERS	36.23	-95.72	1	7
OKPB01-395	Dugout Creek	OSAGE	36.84	-96.57	1	1
OKPB01-399	DUCK POND CR	BEAVER	36.70	-100.31	1	3
OKPB01-404	CHOUTEAU CR	MAYES	36.20	-95.36	1	2
OKPB01-405	BITTER CR	KAY	36.92	-97.26	1	4
OKPB01-407	ARKANSAS R	OSAGE	36.39	-96.55	1	7
OKPB01-411	COPPER CR	KINGFISHER	35.95	-98.05	1	3
OKPB01-412	Mission Creek	OSAGE	36.87	-96.10	1	2
OKPB01-419	SKELETON CR	LOGAN	36.00	-97.48	1	5
OKPB01-420	BIG CABIN CR M FK	CRAIG	36.74	-95.22	1	2
OKPB01-421	EAGLE CHIEF CR	ALFALFA	36.51	-98.43	1	4
OKPB01-424	SCIPIO CR	PITTSBURG	35.09	-95.92	1	4
OKPB01-427	Unlisted	KAY	36.87	-96.86	1	1
OKPB01-429	Unlisted	BLAINE	35.62	-98.42	1	1
OKPB01-431	CLEAR CR	ELLIS	36.54	-99.94	1	4
OKPB01-433	Unlisted	CANADIAN	35.37	-97.69	1	1
OKPB01-437	BUFFALO CR	HARPER	36.84	-99.60	1	5
OKPB01-438	Unlisted	HASKELL	35.24	-95.44	1	2
OKPB01-440	Unlisted	PONTOTOC	34.89	-96.65	1	1
OKPB01-443	LAGOON CR	CREEK	36.13	-96.53	1	4
OKPB01-444	BIG CR	CRAIG	36.94	-95.37	1	2
OKPB01-447	BEAVER R	BEAVER	36.70	-100.91	1	8
OKPB01-451	SAND CR	MAJOR	36.31	-98.42	1	2
OKPB01-452	Double Creek	WASHINGTON	36.53	-95.96	1	1
OKPB01-453	CANADIAN R	DEWEY	36.00	-99.29	1	7
OKPB01-455	Unlisted	ROGERS	36.08	-95.54	1	1
OKPB01-459	RED ROCK CR	NOBLE	36.49	-97.05	1	5
OKPB01-463	Unlisted	ELLIS	36.48	-99.67	1	3
OKPB01-468	CIMARRON R	CIMARRON	36.92	-102.73	1	7
OKPB01-469	N CANADIAN R	WOODWARD	36.46	-99.43	1	7
OKPB01-471	POND CR	GRANT	36.68	-97.61	1	4
OKPB01-475	TURKEY CR	MAJOR	36.43	-98.13	1	3
OKPB01-476	CANEY R	WASHINGTON	36.71	-95.96	1	6
OKPB01-477	N CANADIAN R	WOODWARD	36.24	-99.05	1	7

Site ID	Waterbody Name	County	Latitude (DD)	Longitude (DD)	Status (0 = target; 1 = oversample)	Strahler Order
OKPB01-483	COTTONWOOD CR	LOGAN	35.79	-97.51	1	5
OKPB01-485	SAND CR	HARPER	36.71	-99.50	1	4
OKPB01-488	LITTLE R	SEMINOLE	35.13	-96.70	1	4
OKPB01-491	BLACK BEAR CR	PAWNEE	36.35	-96.67	1	4
OKPB01-492	VERDIGRIS R	NOWATA	36.88	-95.60	1	8
OKPB01-493	Unlisted	DEWEY	35.91	-99.30	1	2
OKPB01-495	BEAVER R	BEAVER	36.81	-100.47	1	7
OKPB01-500	HONEY CR	DELAWARE	36.54	-94.72	1	3
OKPB01-501	Deer Creek	KAY	36.92	-96.99	1	1
OKPB01-503	HOMINY CR	OSAGE	36.34	-96.11	1	4
OKPB01-504	PEACABLE CR	PITTSBURG	34.85	-95.82	1	3
OKPB01-507	CIMARRON R	KINGFISHER	35.92	-97.84	1	7
OKPB01-508	COTTON CR	WASHINGTON	36.93	-95.81	1	2
OKPB01-515	Unlisted	LOGAN	36.00	-97.48	1	2
OKPB01-516	White Oak Creek	CRAIG	36.58	-95.16	1	2
OKPB01-517	DRIFTWOOD CR	ALFALFA	36.92	-98.50	1	4
OKPB01-519	BIRD CR	ROGERS	36.21	-95.76	1	5
OKPB01-523	LITTLE BEAVER CR	KAY	36.87	-96.80	1	3
OKPB01-525	DEER CR	CUSTER	35.73	-98.86	1	3
OKPB01-527	BEAVER R	BEAVER	36.76	-100.10	1	7
OKPB01-531	DUGOUT CR	LINCOLN	35.93	-97.04	1	3
OKPB01-532	Armstrong Branch	MAYES	36.43	-95.18	1	1
OKPB01-533	SAND CR	GRANT	36.88	-98.02	1	4
OKPB01-535	Boar Creek	OSAGE	36.37	-96.30	1	3
OKPB01-536	Unlisted	LATIMER	34.82	-95.35	1	3
OKPB01-538	CANADIAN R	CLEVELAND	34.94	-97.21	1	4
OKPB01-539	UNCLE JOHNS CR	KINGFISHER	35.82	-97.92	1	4
OKPB01-540	BUCK CR	OSAGE	36.94	-96.44	1	2
OKPB01-547	CIMARRON R	PAYNE	35.94	-97.16	1	7
OKPB01-548	Unlisted	OTTAWA	36.87	-94.94	1	1
OKPB01-549	ARKANSAS R SALT FK	ALFALFA	36.76	-98.17	1	7
OKPB01-552	MILL CR	MCINTOSH	35.20	-95.90	1	4
OKPB01-555	ARKANSAS R	OSAGE	36.52	-96.82	1	7
OKPB01-557	Unlisted	CUSTER	35.63	-98.69	1	1
OKPB01-559	BEAVER R	TEXAS	36.67	-101.70	1	5
OKPB01-561	Dead Woman Creek	CADDO	35.49	-98.49	1	1
OKPB01-565	CIMARRON R	WOODS	36.64	-99.01	1	7
OKPB01-567	Bull Creek	OSAGE	36.46	-96.10	1	3
OKPB01-571	Hellroaring Creek	PAWNEE	36.30	-96.63	1	2
OKPB01-572	Turkey Creek	OSAGE	36.76	-96.05	1	1
OKPB01-573	CANADIAN R	ELLIS	35.87	-99.73	1	7
OKPB01-575	BEAVER R	TEXAS	36.72	-101.32	1	7
OKPB01-579	Unlisted	LOGAN	36.05	-97.36	1	1
OKPB01-580	CANEY R	TULSA	36.40	-95.80	1	6
OKPB01-581	CANADIAN R	DEWEY	35.96	-99.02	1	7
OKPB01-583	ADAMS CR	WAGONER	36.06	-95.71	1	1
OKPB01-587	RED ROCK CR	NOBLE	36.48	-97.15	1	5
OKPB01-591	N CANADIAN R	WOODWARD	36.37	-99.21	1	7
OKPB01-596	SPRING R	OTTAWA	36.86	-94.76	1	6
OKPB01-597	ARKANSAS R SALT FK	GRANT	36.66	-97.78	1	7
OKPB01-599	ARKANSAS R SALT FK	KAY	36.66	-97.40	1	7
OKPB01-603	Buffalo Creek	GARFIELD	36.17	-97.92	1	3
OKPB01-604	VERDIGRIS R	NOWATA	36.75	-95.59	1	8

Site ID	Waterbody Name	County	Latitude (DD)	Longitude (DD)	Status (0 = target; 1 = oversample)	Strahler Order
OKPB01-613	Unlisted	ALFALFA	36.81	-98.31	1	1
OKPB01-616	CANADIAN R	HUGHES	35.06	-96.06	1	7
OKPB01-619	SAND CR	OSAGE	36.75	-96.31	1	2
OKPB01-621	Unlisted	ELLIS	35.95	-99.52	1	1
OKPB01-623	CIMARRON R	CIMARRON	36.93	-102.43	1	7
OKPB01-629	CIMARRON R	WOODS	36.51	-98.87	1	7

A7.2 Decision Identification

Decisions about the relative health of each individual site will be based on the existing State of Oklahoma Use Support Assessment Protocols for biological assemblages. The protocols, adopted in Oklahoma Administrative Code (OAC) 785:46-15, (http://www.owrb.state.ok.us/util/rules/pdf_rul/Chap46.pdf) include fish index of biological integrity (IBI) scores for ecoregions throughout the state. In addition, state agencies frequently use a multi-metric index for evaluating macroinvertebrate health. Efforts are underway to refine these assessment methods, and the refinements will be incorporated into decision-making and reporting for this study.

A7.3 Decision Inputs

Data for selected indicators will be summarized on a statewide basis, and at the scale of selected planning basins or combinations of basins, using cumulative distribution functions with confidence bounds, as described by Diaz-Ramos et al. (1996), with assistance from the EPA ORD Monitoring Design and Analysis Team. The indicators will include the fish and macroinvertebrate assemblage index values, described above, and other selected indicators of interest, such as the observed distribution of phosphorous concentrations and percent sand/silt in bed sediment. Data summaries for individual physical habitat attributes and water column chemistry variables will be limited to specific geographic areas to classify sites and account for naturally-occurring differences.

The relative risk for biological integrity associated with water column and physical habitat stressors will be determined by examining the strength of associations between indications of impairment of biological integrity and individual stressors, as described by Van Sickle (2004). The approach requires setting thresholds for poor conditions associated with individual stressors, some of which exist in the form of numeric water quality standards criteria, and the indicators of biological integrity. Then, a two-way contingency table will be used to quantify the strength of the association. Individual stressors will then be ranked by the relative risk posed to biological integrity.

Predictive model(s) will be developed to evaluate the feasibility of using land use and land cover data within watersheds to target monitoring efforts toward waterbodies with a high probability of impaired biological integrity, generally following methods described in published literature (Diamond et al. 2002, Harding et al. 1998, Jordan and Vaas 2000, Richards et al, 1996, Sponseller et al. 2001, Teels and Danielson 2001, Wang et al 2001). First, data collected from individual sites will be split into two groups with one group to be used for development of models, and the other to be used for testing and model validation. Second, Pearson-product moment correlations and linear regression analyses will be applied to explore relationships between individual land use and land cover metrics, calculated at watershed and several riparian corridor scales, and indicators of biological integrity, in an attempt to identify the most meaningful predictor metrics. Data transformations will be applied to the variables, as necessary to produce approximate linear relationships (Helsel and Hirsch 1992). Third, the variables will be tested in multiple linear regression models for the ability to predict depauperate biological assemblages.

A7.4 Study Boundaries

The study is spatially limited to rivers and streams as they run through Oklahoma and specifically to sites that will be randomly generated by the staff of the EPA's NHEERL. To identify the target population streams, USEPA's River Reach File 3 (RF3) at a 1:100,000 scale will be used as the sampling frame. An unequal probability random tessellation stratified (RTS) survey design with an oversample (Stevens, 1997) was used to select the stream sample sites. Stevens and Olsen (1999) describe the RTS design applied to streams. To ensure sampling would occur in the higher order streams, the sample design was weighted by Strahler stream order categories to achieve an approximately equal expected sample size across stream order categories 1st, 2nd, 3rd, and 4^{th}-5^{th}, and 6^{th}-7^{th}.

The study is temporally limited by biological index habitat periods. The index habitat period for the fish assemblage in Oklahoma is May 15^{th} through September 15^{th}. This period may be extended to October 1^{st} if stream has not risen above summer seasonal base flow. The summer index habitat period for the macroinvertebrate assemblage in Oklahoma is July 1^{st} through September 15^{th}, but macroinvertebrate collections will be completed in as short a time period as possible beginning July 1^{st}. In some smaller streams, macroinvertebrate samples may be collected earlier in late spring if it is determined that streams may go dry. Because an independent habitat form is utilized for macroinvertebrate sampling, collections may be done separately from fish collections. The index period for microbiological collections is defined as the recreation season in OAC 46:15 as May 1^{st} through September 30^{th}. The index periods for benthic algal collections will be base flow time periods during a late spring/summer index period. Samples will be collected at least 10 days after any event that delivers at least ½ inch of rain. Assessment of beneficial uses at individual sites using chemical, and physical parameters will be of limited utility because of the need for seasonality in sample collections. However, data will be useful when basins are analyzed as a whole. The bacteria, algal, benthic macroinvertebrate (including independent habitat form), and complete water chemistry sample will be taken at the same time. Generally, fish and general habitat (long form) will be collected at another time. When fish are collected separately, some water quality measurements will be made including dissolved oxygen, temperature, pH, specific conductance, turbidity, alkalinity, and hardness.

The study will be hydrologically limited by a variety of conditions. Sites may be inaccessible due to ephemeral conditions caused by drought or unseasonably heavy rainfall. To avoid bias, biological sampling will be done during base flow time periods, because fish collections may be biased due to gear (seines and dipnets) inefficiency in higher flows. Macroinvertebrate samples may be biased because substrate is depopulated during higher flows. Therefore, sites will not be visited for data collection within 10 days after a return to base flow.

There are some practical Constraints on Data Collection. Experience has shown that many planned water quality sampling events have been delayed or canceled for one reason or another. Possible reasons that the current study may be delayed include:

1. Poor meteorological conditions.
2. Poor hydrological conditions, including both ephemeral conditions due to drought and flows above seasonal base flow.
3. Unavailability of field monitoring personnel.
4. Catastrophic equipment failure.
5. Site inaccessibility due to landowner issues.
6. Other unpredictable situations.

A7.5 Decision Rule

The support status of individual streams for the aesthetics, primary body contact, and fish and wildlife propagation beneficial uses will be evaluated. Protocols for determining beneficial use support are found in the USAP and CPP. Streams will be considered non-supporting when Oklahoma Water Quality Standards are violated as determined by criteria and rules listed in OWQS and implemented in these documents. The condition of the biological community will be made using approved narrative criteria in the USAP or the index of biological integrity and reference conditions developed in the Oklahoma Conservation Commission’s Data Gaps Project.

A7.6 Limits on Decision Errors

The need to define acceptable decision error for determining if a stream is impaired is abrogated by data requirements and decision criteria set forth in OAC 785:46-15. However, this section will define general quality assurance objectives related to representativeness, comparability, completeness, precision, and accuracy for all parameters monitored.

A7.6.1 Representativeness

Sample stations were selected randomly using a probability-based sampling design to yield data that are representative of the water quality of the total population of perennial stream and river miles in Oklahoma. Sites are further weighted by Strahler order to ensure that all stream sizes are given equal weight. With this design, statistically valid assumptions may be made about the entire population by measuring the characteristics of a representative subset. For individual stream assessments for CWA 303(d) purposes, data collected in one segment will not be used to report on use support for other segments of the stream system or watershed.

A7.6.2 Comparability

To ensure comparability and uniformity of assessments, all data are collected in accordance with the Standard Operating Procedures of the OWRB as defined in Section B2 Sampling Method Requirements. Additionally, all analytical methods to be used are described in American Public Health Association Standard Methods: 19th Edition (1995) or EPA publications (1977, 1979b) and will be further described in documents referenced in the individual SOPs. The methods and quality assurance procedures described in this plan will be followed throughout the life span of the project such that information collected will be comparable from one sampling period to the next and with other studies where equivalent analytical methods and quality assurance procedures are utilized.

A7.6.3 Completeness

The completeness required is defined by the sample design. To ensure that statistically valid assumptions may be made for all streams in the state, 210 target sites must be completed in the course of the 5-year study. Furthermore, target sites must be taken from the list of randomly generated sites. If target sites are deemed to be inaccessible during reconnaissance, a new site will be chosen from the oversample list. The first oversample site on the list will be chosen as a new target site when a site is considered unsampleable. The site identification number as listed in Table 2 determines site substitution order. **Completeness** or percent of complete measurements (%C) will be assessed as follows:

$$\%C = \frac{v}{T} \times 100$$

Where v = the number of measurements judged valid and entered into the data management system, and T = the total number of planned measurements. Completeness will be assessed independently for each indicator or data type.

A7.6.4 Precision and Accuracy

Precision and accuracy of all data must, of course, be as true as possible. As a general rule, precision and accuracy must be within + or - 10% except for parameters approaching detection limits, where practical considerations require a wider range of acceptable precision and accuracy. The precision and accuracy criteria presented in the Oklahoma Department of Environmental Quality (ODEQ) State Environmental Laboratory Quality Assurance Plan (QTRACK No. 00-182) are suitable for these projects. ODEQ ensures data quality through the use of analysis of control charts for precision and accuracy following Section 1020 of Standard Methods (1992). With these charts, Warning Limits of + or - 2 standard deviations and Control Limits of + or - 3 standard deviations are established. General acceptance limits for field duplicates are based on Table 1020:I of the Standard Methods (1992). Acceptable precision for water quality parameters and biological assessments are shown in Tables 3, 4 and 5, respectively. Instrument collected field values will initially be stored to the decimal place represented in Table 3.3 under the column titled “precision”. Values used and reported in the Final Report will be reported to the decimal place listed in Table 3 under the column titled “Calibrated Accuracy”.

The following procedures are intended to support the measurement and data quality objectives described above:

Precision in water sample collections will be assessed from duplicate analyses by relative percent difference (RPD) as follows:

$$RPD = ((C_1 - C_2)/average(C_1 + C_2)) \times 100$$

Where C_1 = the larger of the two values and C_2 = the smaller of the two values. Precision in the statistical parameters to be estimated will be assessed by comparison of the width of confidence intervals with the stated data quality objective.

Accuracy in individual water samples will be determined from the difference between observed values and known standard reference media.

Table 3. Summary table of field measured water quality variables and their associated range of values for precision and accuracy.

Parameter	Method	Meter / Lab	RANGE OF VALUES	PRECISION	CALIBRATED ACCURACY
Dissolved Oxygen	4500-G	Multiparameter Instrument	0 to 20 ppm	0.01 ppm	± 2% of reading
Specific Conductance	2510-B	Multiparameter Instrument	0 to 150 mSiemens/cm	0.1% of reading	± 0.5% of reading
PH	4500 H-B	Multiparameter Instrument	0 su to 14 su	0.01 su	± 0.2 su
Temperature		Multiparameter Instrument	-5˚C to 45˚C	0.02˚C	± 0.2˚C
Total Hardness	8226	Hach Test Kit	10 – 4000	1-5 mg/L	HACH Digital Titration Test

Parameter	Method	Meter / Lab	RANGE OF VALUES	PRECISION	CALIBRATED ACCURACY
Total Alkalinity	2320-B	Hach Test Kit	10 – 4000	1-5 mg/L	HACH Digital Titration Test
Nephelometric Turbidity	2130-B	Hach 2100P	0 to 999 NTU	0.01 NTU	± 2% of reading
Instantaneous Discharge	Electromagnetic	Marsh McBirney	0.031-9.0 cfs	10-15%	
Instantaneous Discharge	Mechanical	Pygmy Meter	0.031-3.5 cfs	5-15%	
Instantaneous Discharge	Mechanical	Price Type AA	0.031-9.0 cfs	5-15%	

Table 4. Method Detection Limits and Acceptable Limits for Field Duplicates and/or Replicates.

Parameter	Method	Meter / Kit	Acceptable precision for low level field duplicates	Acceptable precision for high level field duplicates	Method Detection Level*
Alkalinity	2320-B	Hach Kit	75-125%	90-110%	10-25 mg/L
Hardness	8226	Hach Kit	75-125%	90-110%	10-25 mg/L
Nephelometric Turbidity	2130-B	Hach 2100P	75-125%	90-110%	0.01 NTU
Ammonia	350.1	ODEQ	75-125%5	90-110%	0.05 mg/L
Total Kjeldahl Nitrogen	351.2	ODEQ	75-125%	90-110%	0.05 mg/L
Nitrate	353.2	ODEQ	75-125%	90-110%	0.05 mg/L
Nitrite	353.2	ODEQ	75-125%	90-110%	0.05 mg/L
Sulfate	375.4	ODEQ	75-125%	90-110%	10 mg/L
Chloride	325.2	ODEQ	75-125%	90-110%	10 mg/L
Arsenic, Total	200.7	ODEQ	75-125%	90-110%	10 ug/L
Barium, Total	200.7	ODEQ	75-125%	90-110%	5 ug/L
Cadmium, Total	200.8	ODEQ	75-125%	90-110%	0.18 ug/L
Calcium, Total	200.7	ODEQ	75-125%	90-110%	1 ug/L
Chromium, Total	200.7	ODEQ	75-125%	90-110%	5 ug/L
Copper, Total	200.8	ODEQ	75-125%	90-110%	0.08 ug/L
Iron, Total	200.7	ODEQ	75-125%	90-110%	10 ug/L
Lead, Total	200.8	ODEQ	75-125%	90-110%	0.12 ug/L
Mercury, Total	245.1	ODEQ	75-125%	90-110%	0.5 ug/L
Nickel, Total	200.7	ODEQ	75-125%	90-110%	5 ug/L
Potassium, Total	200.7	ODEQ	75-125%	90-110%	1 ug/L
Selenium, Total	200.7	ODEQ	75-125%	90-110%	5 ug/L
Silver, Total	200.8	ODEQ	75-125%	90-110%	0.04 ug/L
Sodium, Total	200.7	ODEQ	75-125%	90-110%	<1 ug/L
Thallium, Total	200.7	ODEQ	75-125%	90-110%	5 ug/L
Zinc, Total	200.7	ODEQ	75-125%	90-110%	5 ug/L
Ortho Phosphorus	365.1	ODEQ	75-125%	90-110%	0.005 mg/L

Parameter	Method	Meter / Kit	Acceptable precision for low level field duplicates	Acceptable precision for high level field duplicates	Method Detection Level*
Total Phosphorous	365.3	ODEQ	75-125%	90-110%	0.005 mg/L
Total Dissolved Solids	160.1	ODEQ	75-125%	90-110%	1 mg/l
Total Suspended Solids	160.2	ODEQ	75-125%	90-110%	1 mg/l
E. Coli	9223	ODEQ	50-150%	75-125%	10 cfu/mL
Enterococcus	9230C	ODEQ	50-150%	75-125%	10 cfu/mL
Chlorophyll-a	10200H	ODEQ	25-175%	50-150%	0.1 mg/m3

*Method detection limits reported by ODEQ Environmental Laboratory using Method 1030E from Standard Methods (APHA, AWWA, WPCF 1992).

Table 5. Acceptable Precision for Biological Assessments.

Activity	Parameter	Precision (RPD) Faulkner 1994
Fish collection: seine/electrofish	No. individuals No. species	50% 15%
Benthic macroinvertebrate collection	No. individuals No. Taxa	50% 15%
Benthic macroinvertebrate taxonomy	Taxonomic Identification to appropriate level	99%
Habitat assessment	Habitat assessment score Average depth Average width Percent cover	15% 15% 15% 20%

A8. SPECIAL TRAINING REQUIREMENTS/CERTIFICATION

Principle investigators are defined as team leaders. This designation may be made upon the leader of a multi-person or single person team. Principle investigators for these projects are required to have degrees and/or experience with biological or other applicable sciences. In addition, training is required for all SOPs dealing with water quality and quantity collections and measurements as well as habitat assessments and biological collections. In-house training will be conducted for the use of all meters and digital titrators used for water quality or quantity measurements. Investigators must be familiar with OWRB SOP document and all training will follow the methods outlined in that document. Extra training will be provided when new SOPs are developed. Training of field crews will be done through dry run exercises in the laboratory to familiarize field crews with sample collection, sample preservation, instrument operation, calibration, and maintenance. In addition, when new personnel are hired or new methods developed, qualified staff will train on sample collection, measurement, and field analysis methods through side-by-side field trips. These trips will familiarize staff with SOP requirements. When training is considered adequate, a qualified staff member will conduct a formal QA check with field staff for adherence to SOPs. The Division maintains literature in the library including but not limited to regional taxonomic keys for fish and macroinvertebrates, sampling methods and design, etc.

For habitat assessments, field QA sessions will include a side-by-side measurement of all metrics with all qualified personnel. Calculating a mean score for all team leaders creates a data standard for the assessment. Team leaders and other staff are then compared to the mean and a percent difference is calculated for each metric. An acceptable percent difference is ½ of the scoring category range.

Investigators are tested for identification abilities with a statewide assemblage of fish fauna before fish collections begin. These fish are comprised of species that are typically found in Oklahoma stream systems. The majority of the test specimens include fish with larger body sizes that are typically field identified and/or found in large numbers. Species of special concern such as the Arkansas River Shiner are also utilized during the testing procedure to insure endangered or threatened species may be correctly identified and released. A test score on critical species of 95% or better must be achieved before the investigator will be a field crew leader. Investigators that score under 95% will not collect without direct supervision of the crew leader.

Investigators are tested for macroinvertebrate subsampling abilities before samples are discarded. To be certified, the employee must subsample 4 out of 5 samples from different substrates missing no more than 10% of the taxa picked. In addition, 2 follow-up annual QA checks will be conducted for each certified picker.

A9. DOCUMENTATION AND RECORDS

Field observations and water quality data will be recorded in a standardized data format (Table 6) in field sheets, chains of custody, lab sheets, and record books as demonstrated in various OWRB SOPs. All field sheets used in-stream will be printed on waterproof paper. Hard copies of all data acquired will be maintained in a data notebook for each project for 10 years. The data manager will check Field notes and lab sheets for completion before placing in the data notebook. Chains of custody will be checked by the data manager for signature and sample number before inclusion in the data notebook. In addition, data will be maintained in an electronic format as denoted in Table 6. All physical and chemical data used in analyses will be maintained in the OWRB Water Quality Database. Field data will be manually entered while most laboratory data will be transferred from the laboratory and uploaded automatically. Lab data will be checked for completeness and any data not uploaded automatically will be manually entered. All biological and habitat data will be manually entered into the OWRB Biological database. For reporting purposes, data will be documented in tables, graphs, etc. as defined in Table 6.

Table 6. Documentation and Format of Data Collected.

Data Type	Primary reporting format	Computer format	Final reporting format	Final data archive
Water Quality Field Physical and Chemical Data	Water Quality Field Notes	OWRB Water Quality Database	Tables, graphs, etc.	STORET, OWRB Water Quality Database & Project Notebook
Instrument Calibration and Field QA Data	Instrument Book and Laboratory Sheets	OWRB Water Quality Database	QA Summary Report	OWRB Water Quality Database & Project Notebook
Water quality lab analysis	Lab Report Sheets and Electronic Transfers	OWRB Water Quality Database	Tables, graphs, etc.	STORET, OWRB Water Quality Database & Project Notebook
Water quality lab analysis - blanks, duplicates	Lab Report Sheets and Electronic Transfers	OWRB Water Quality Database	QA Summary Report	STORET, OWRB Water Quality Database & Project Notebook
Water quality lab analysis – fish flesh toxics	Lab Report Sheets and Electronic Transfers	OWRB Water Quality Database	Tables—will not be assessed in final report but will be sent to the ODEQ	STORET, OWRB Water Quality Database & Project Notebook
Habitat assessment	Standardized Field Sheets	OWRB Biological Database	Habitat metrics	OWRB Biological Database and Project Notebook
Fish collections	Standardized Fish Collection Sheets, Lab Data Sheets and Electronic Transfers	OWRB Biological Database	Tolerance & diversity indices; final report and list of species collected	OWRB Biological Database and Project Notebook; OK Museum of Natural History & EPA BIOS when appropriate
Benthic macro-invertebrate collections	Standardized Macroinvertebrate Collection Sheets and Lab Data Sheets and Electronic Transfers	OWRB Biological Database	Tolerance & diversity indices; list of species collected	OWRB Biological Database and Project Notebook; OK Museum of Natural History & EPA BIOS when appropriate

B. MEASUREMENT AND DATA ACQUISITION

B1. SAMPLING PROCESS DESIGN

In order to determine the support status of each site and the causes of impairment, parameters will be measured to determine chemical, physical, bacteriological, biological, and habitat properties of each site. Chemical and physical analysis will consist of measurements of turbidity, pH, dissolved oxygen (DO), alkalinity, specific conductivity, water temperature, instantaneous discharge, nitrate (NO_3), nitrite (NO_2), orthophosphate (PO_4), total phosphorous (TP), total Kjeldahl nitrogen (TKN), ammonia (NH_3), total suspended solids (TSS), certain metals (as listed in Table 4), and total hardness. To determine algal biomass, chlorophyll-a will be measured from sestonic and benthic algal samples collected during a late spring/summer index periods. Bacteriological monitoring will consist of monitoring for *Enterococcus* and *Escherichia coli*. Biological monitoring will consist of a one-time collection of fish and benthic macroinvertebrates. To measure habitat, an assessment will accompany each fish and macroinvertebrate collection. In addition, observations of periphyton/algae, odor, excessive bottom deposits, surface scum, oil/grease, and foam will be recorded. All measurements are considered critical for determining the support status of the streams. The bacteria, algal, benthic macroinvertebrate (including independent habitat form), and complete water chemistry sample will be taken at the same time. Generally, fish and general habitat (long form) will be collected at another time. When fish are collected separately, some water quality measurements will be made including dissolved oxygen, temperature, pH, specific conductance, turbidity, alkalinity, and hardness.

B1.1. ANTICIPATED PROJECT ACTIVITIES AND TIME TABLE

Task 2. Reconnaissance of Site Locations and Development of Station Plans
Will be implemented by the OWRB. Activity will begin in December 2005 and end by April 2006.

Task 3. Monitoring of Selected Stations
Will be implemented by the OWRB. Activity will begin in May 2006 and end by October 2007.

Task 4. Interim Data Report
Will be implemented by the OWRB. Activity will begin in November 2006 and end by May 2007.

Task 5. Water Quality Data Report for Review
Will be implemented by the OWRB. Activity will begin in November 2007 and end by February 2008.

Task 6. Final Water Quality Data Report to EPA

Will be implemented by the OWRB. Activity will begin in February 2008 and end by June 2008.

B1.2. SAMPLE SITE SELECTION

Sample sites have been generated by random and include all perennial streams and rivers in the state of Oklahoma. Site selection was further weighted by Strahler order so that larger rivers and streams would have an equal chance of selection. Stations were further subdivided by planning basin. Planning basins to be sampled as part of this project are listed in Table 1and a list of potential sites is available in Table 2 of this document. Stations are divided into 2 categories—target and oversample stations. Through a series of reconnaissance activities, the sampleability of target stations will be determined. When a target station is determined to be unsampleable, the first available oversample station will be recategorized as a target station and included in the sample.

B1.3. SAMPLING FREQUENCY

Activities to finish the project will be initiated as soon as the QAPP is approved. Parameters will be sampled at the frequencies listed in Table 7. If problems arise in the sampling program, the water body will be re-sampled at the earliest convenient date to accurately represent water quality conditions during the appropriate sampling event.

Table 7. Sampling frequency for All Water Quality Parameters

Parameter	Collection Frequency
Physical and chemical field parameters	Once
Chemical "lab samples"	Once
Benthic Macroinvertebrates	Once
Fish	Once
Flow	With each habitat assessment.
Habitat	Once
Bacteria	Once

B2. SAMPLING METHODS REQUIREMENTS

Field sampling and analysis methods for all types of samples are described by APHA (1995), EPA (1977, 1979b), Welch (1948), Lind (1985), Wetzel and Likens (1979), OWRB Standard Operating Procedures (SOPs), USGS manuals for "Field Water-Quality Methods for Surface Water", and OWRB Technical Report 99-3 (1999). SOPs are available at the OWRB website. Much of the equipment used in sampling is described in the method SOP that uses the equipment.

Equipment SOPs:

1. Measurement of Hardness and Alkalinity
2. Measurement of Turbidity
3. Use of Floats to Determine Stream Discharge
4. Recording of Physical/Chemical Parameters Using a Multi-Parameter Instrument
5. Cleaning of Glassware and Sampling Equipment

Methods SOPs:

1. Collection of Water Quality Samples
2. Measurement of Stream Discharge
3. Collection of Sestonic and Benthic Chlorophyll-a Samples
4. Collection of Fish
5. Collection of Benthic Macroinvertebrates
6. Collection of Habitat Information
7. Forms

The Project Manager with the concurrence of the Water Quality Division Chief and QA Officer will be responsible for implementing any corrective activities associated with the sampling program.

B3. SAMPLE HANDLING AND CUSTODY REQUIREMENTS

B3.1 Field Measurements

A sample handling and custody program has been established to provide a written record of sample handling procedures and transfer of sample custody from field to laboratory personnel. Documentation of sample handling and transfer from field collection to delivery of data results to the investigator(s) is essential in the quality assurance and control process. All records are duplicated to prevent loss in case one set is misplaced or destroyed. Example field notes for all measurement listed above are included with the OWRB QMP (QTRACK No. 03-275) and in the Forms SOP of this document. Please refer to them for details.

Field observations, discharge, stage, total alkalinity (steams), total hardness (steams), nephelometric turbidity, multi-parameter data, and meteorological data will be recorded in the Water Quality Field Notes for each station. These forms are verified by the data manager for completeness and forwarded to data processing for entry into the Water Quality Database. After entry into the database, forms are transferred to a project notebook kept in the Division library.

Discharge measurement notes are completed for each measurement taken. These notes are transferred to an electronic format and saved to the OWRB network and compact disc. Hardcopies of the discharge measurement notes are maintained in the project notebook kept in the Division library. Discharge measurements collected via discharge computers are downloaded to the OWRB network and copied to compact disc. Hardcopies of these electronic notes are maintained in the project notebook kept in the Division library.

Biological and Habitat Notes are completed for each field collection. These notes are transferred to an electronic form in either Microsoft Excel® or the Water Quality Biological Database housed in Microsoft Access® format.

B3.2 Samples Collected for Laboratory Analysis

Many of the variables measured require laboratory analysis. This necessitates the transfer of samples from field sampling personnel to laboratory analyst personnel. OWRB personnel fill out a Sample Analysis Request Form and a Chain of Custody Form (See examples in the OWRB QMP and Forms SOP) prior to sample submittal to the laboratory. The Sample Analysis Request Form includes information identifying each sample by sampler name, station name, station ID, date, time collected, and parameters to be analyzed. A space is left on the form for the receiving laboratory to record the laboratory tracking number. The Chain of Custody Form records the sampling personnel, station name, number of bottles per sample, and the date and time of sample collection. Upon sample arrival at the laboratory, laboratory personnel officially receive the collected samples from OWRB personnel. The laboratory assigns an identification number to each sample and writes the assigned number on the Sample Analysis Request form. The time and date the samples are received is recorded on the Chain of Custody form. The designated laboratory representative receiving sample custody signs the Chain of Custody form as does the OWRB personnel relinquishing sample custody. A space is provided on both forms to allow for any comments to be recorded by either OWRB personnel or laboratory receiving personnel. Upon completion of both forms, a photocopy is made with the laboratory retaining one document and the OWRB receiving the other document.

Samples presented for chemical analysis require certain containers, preservatives, and holding times. Containers and preservatives are outlined in detail in the narrative below. In addition, containers, preservatives, and holding times are outlined for each parameter and presented in Table 8.

Field samples collected for laboratory analysis of metals and inorganics will be labeled at the time of collection. Labeled information will include project code, stream name, collection date, and preservative used. All information except collection date is contained on a printed label attached one day before sample collection. Collection date is recorded with a waterproof marker. Each sample will consist of up to three narrow-mouthed, 1-L polyethylene bottles. One bottle is preserved with sulfuric acid (labeled “H_2SO_4“) to reduce the sample pH to 2.0 units with subsequent storage on ice at 4°C. A second bottle is preserved with ice (labeled “ICE”) to 4°C. A third bottle is preserved with nitric acid (labeled “HNO_3“) to reduce the sample pH to 2.0 units with subsequent storage on ice at 4°C.

Field samples collected for laboratory microbiological analysis will be labeled at the time of collection. Labeled information will include project code, stream name, collection date, collection time, and preservative used. All information except collection date and time is contained on a printed label attached one day before sample collection. Collection date and time is recorded with a waterproof marker. Each sample will consist of two sealable, 100-mL polyethylene bottles. Both bottles are double bagged in plastic ziplock baggies and preserved with ice (labeled "ICE") to 4°C. One bottle is used for analysis of *E. coli*, and the second bottle is used for the analysis of Enterococci.

Table 8. Containers, preservation methods and holding times for water quality samples collected for laboratory analysis.

PARAMETER	CONTAINER	PRESERVATIVE	HOLDING TIME
Total Alkalinity	Polyethylene	Ice, 4 °C	24 hours
Ammonia Nitrogen	Polyethylene	Ice, 4 °C, acid (H_2SO_4) to pH < 2	7 days
Nitrate Nitrogen	Polyethylene	Ice, 4 °C	48 hours
Nitrite Nitrogen	Polyethylene	Ice, 4 °C	48 hours
Nitrate + Nitrite Nitrogen	Polyethylene	Ice, 4 °C, acid (H_2SO_4) to pH < 2	28 days
Kjeldahl Nitrogen	Polyethylene	Ice, 4 °C, acid (H_2SO_4) to pH < 2	7 days
Total Nitrogen	Polyethylene	Ice, 4 °C, acid (H_2SO_4) to pH < 2	48 hours
Total Phosphorus	Polyethylene	Ice, 4 °C, acid (H_2SO_4) to pH < 2	28 days
Orthophosphate	Polyethylene	Ice, 4 °C	48 hours
Nephelometric Turbidity	Polyethylene	Ice, 4 °C	24 hours
Chlorophyll-a	Polyethylene	Ice, 4 °C, dark	30 days
Total Suspended Solids	Polyethylene	Ice, 4 °C	7 days
Total Hardness	Polyethylene	Ice, 4 °C, acid (H_2SO_4) to pH < 2	6 months
Phenolphthalein Alkalinity	Polyethylene	Ice, 4 °C	24 hours
Metals	Polyethylene	Ice, 4 °C, acid (HNO_3) to pH < 2	6 months
Escherichia coli	Sterilized Polyethylene	Ice, to < 10 °C	24 hours
Enterococci	Sterilized Polyethylene	Ice, to < 10 °C	24 hours
Fecal Coliform	Sterilized Polyethylene	Ice, to < 10 °C	24 hours
Benthic Macroinvertebrate	Polyethylene	Ethanol	Indefinite w/ proper preservation
Fish	Polyethylene	Formalin (fixative); Ethanol (preservative)	Indefinite w/ proper preservation

Final laboratory results will be reported to the OWRB Project Manager and Database Manager in both a hardcopy format and in a database format for direct upload to the Water Quality Database. Hardcopy sheets are placed in the project notebook after internal review. An example of reported laboratory analytical results is included with the agency QMP document. Each report contains information identifying the Project Manager, sample number, sample date, and results of the analyses. Space is reserved at the bottom of the laboratory results sheet for comments by the collector and/or analyst. Once the OWRB receives sample analyses, the official chain of custody "cycle" has been completed. Staff with the OWRB work closely with contract laboratory personnel to ensure that all procedures are correctly followed and data is delivered to the Project Manager in a timely manner. Once data is received it is reviewed for completeness and accuracy by field staff with further review conducted by the Water Quality Programs Division Database Manager. Any problems identified will be resolved as quickly as possible with cooperation between the Database Manager and the contract laboratory. If problems cannot be resolved between the Database Manager and the laboratory, then the project coordinator will work with the contract laboratory with the involvement of the OWRB QA Officer as required. If problems still cannot be resolved, the OWRB QA Officer and the Water Quality Programs Division Chief will work with the contract laboratory to resolve the issue.

For details on the internal operations of the analytical laboratory in regards to data entry, laboratory tracking procedures, and sample custody (sample handling, storage, and disbursement) please refer to ODEQ QMP (QTRACK No. 00-182).

B4. ANALYTICAL METHODS REQUIREMENTS

B4.1FIELD METHODS REQUIREMENTS

Field analytical procedures are described in various OWRB SOP documents. The methods and meters required to perform field water quality and quantity analyses are listed in Table 9. Reporting of failures in field analytical procedures and the implementation of corrective action for any failure in field analytic procedures is the responsibility of the Project Officer. Field methods are described in short below.

1. Multi-parameter instrument direct measurements—Includes measurements for dissolved oxygen (mg/l), specific conductance (μSiemens/cm), water temperature (°C), oxidation-reduction potential (Redox) (mV), and pH (standard units). One reading is taken at the area of fastest and deepest at approximately the middle of the water column.

2. Multi-parameter instrument indirect measurements—Includes measurements for % Dissolved oxygen saturation (based on temperature and dissolved oxygen), salinity (ppm; based on specific conductance), total dissolved solids

(TDS; based on specific conductance and temperature). One reading is taken at the area of fastest and deepest water at approximately the middle of the water column.

3. Nephelometric Turbidity (NTU) sample is taken from the water quality sample. Measurement is made using a Hach 2100P turbidometer.

4. Total Alkalinity sample is taken from the water quality sample. Measurement is made using a HACH® Total Alkalinity Kit.

5. Total Hardness sample is taken from the water quality sample. Measurement is made using a HACH® Total Hardness Kit.

6. Instantaneous Discharge is measured by taking a composite of readings using mechanical velocity (pygmy or Price AA) or electromagnetic meters. Floats may be used when point discharges are below the method detection limit of instruments. In addition, discharge may be taken from a nearby data collection platform or by measuring stage and comparing to a known rating.

Table 9. Parameters, Methods, Meters, and Method Detection Levels for Each Field Measured Parameter.

Parameter	Method	Meter/Kit	Method Detection Level
Dissolved Oxygen	4500-G	Hydrolab Series 4 or 4a	0.1 ppm
Specific Conductance	2510-B	Hydrolab Series 4 or 4a	1.0 uS
pH	4500 H-B	Hydrolab Series 4 or 4a	0.01 standard unit
Temperature*		Hydrolab Series 4 or 4a	-5.0˚C
Total Dissolved Solids	Calculation based on specific conductance and water temperature.	Hydrolab Series 4 or 4a	1 ppm
Total Hardness		Hach Test Kit	1.0 ppm
Total Alkalinity	2320-B	Hach Test Kit	1.0 ppm
Nephelometric Turbidity	2130-B	Hach 2100P	0.1 NTU
Instantaneous Discharge	Electromagnetic	Marsh McBirney	0.1 cfs
Instantaneous Discharge	Mechanical	Pygmy Meter	0.031 cfs
Instantaneous Discharge	Mechanical	Price Type AA	0.031 cfs

B4.2 CHEMICAL LABORATORY METHODS REQUIREMENTS

Samples will be collected at each station for water quality indicators that require laboratory analysis. Collection techniques, holding times, storage procedures, and laboratory analyses utilized in this study are those recommended by Lind (1985), Standard Methods (APHA 1995), and USEPA (1977). For detailed laboratory procedures refer to ODEQ QMP (QTRACK No. 00-182). Reporting of failures in laboratory analytical procedures and implementation of corrective action for any failure in laboratory procedures is the responsibility of ODEQ Laboratory Director, Chris Armstrong, who is responsible for all aspects of the laboratory operation. Irreconcilable analytical problems and contract management with the laboratory is the responsibility of the OWRB Water Quality Programs Division Chief.

B5. QUALITY CONTROL REQUIREMENTS

A series of blanks, duplicates, and replicates will be collected for inorganic, organic, bacteriological, and chlorophyll samples. In addition, a blank for field DI water and cleaning methods will be conducted weekly. Methods for preparing field blanks, field duplicate samples, and replicate samples are described in the various OWRB SOP documents. Field measured total alkalinity, total hardness, and turbidity samples will be controlled through this process.

The OWRB collects various types of blank samples to control each part of the sampling process. Types of blank samples that may be associated with this project include:

1. **Analytical Blank Sample—**Because the OWRB uses reagent grade water to rinse equipment both in the laboratory cleaning process and during field sampling, it is important that this water be tested prior to use for detectable levels of chemicals included in the study. One sample is collected for each "sampling week". The sample is collected from reagent grade water provided by the analytical laboratory. The sample will include 1-liter bottles for ice preservation, sulfuric acid preservation, metals, chlorophyll, and field parameters (turbidity, hardness, and alkalinity). The bottle will be labeled with a QA code "31".

2. **Laboratory Blank Sample—**Because the OWRB regularly laboratory cleans all plastic and glass sample collection equipment, it is important to ensure that the equipment is free of detectable levels of chemicals included in the study prior to use in sample collection. One sample is collected for each "sampling week". The sample is collected by running reagent grade water through all plastic or glass equipment that will be used in the field during a particular sampling week. The sample will include 1-liter bottles for ice preservation, sulfuric acid preservation, metals, chlorophyll, and field parameters (turbidity, hardness, and alkalinity). The bottle will be labeled with a QA code "32".

3. **Field Blank Sample—**The OWRB regularly reuses splitter churns during weekly sampling. The churns are used at a maximum of five sites and are rinsed with reagent grade water between each use. To ensure that the equipment is free of detectable levels of chemicals included in the study

prior to use in sample collection, a field blank sample is pulled between pulled before the churn is laboratory cleaned. One sample is collected for each "sampling day" or in an arrangement otherwise made by the project manager. The sample is collected by running reagent grade water through any plastic or glass that is used at more than one station. Normally, this will only be the splitter churn. Water should be aliquoted in a manner that is consistent with normal sampling procedures. The sample will include 1-liter bottles for ice preservation, sulfuric acid preservation, metals, chlorophyll, and field parameters (turbidity, hardness, and alkalinity). Label with a QA code "33".

The OWRB also collects other types of samples to control the sampling process. Those QA/QC samples that may be associated with this project include:

1. **Duplicate Sample—**The OWRB regularly uses splitter churns to aliquot composited samples. For most sampling programs, at least one sample is collected for each "sampling trip". The sample is collected by using a "splitter churn" to divide water from one sample site into two "equivalent" split samples. The sample will include 2 sets of 1-liter bottles for ice preservation, sulfuric acid preservation, metals, chlorophyll, and field parameters (turbidity, hardness, and alkalinity). Label one sample set with an "11" (environmental sample) and the other sample set with a "21" (duplicate sample set) in the QA code. For probabilistic sampling, samples are normally collected using the "point grab" method, which does not use a splitter churn for compositing. Therefore, this type of QA/QC sample will rarely be needed. However, if sampling crews determine that some sort of composite is necessary to adequately represent a site, a duplicate sample must be collected.
2. **Replicate Sample—** For most sampling programs, the OWRB regularly collects a replicate sample for each "sampling trip". The sample is collected by repeating the exact sampling process (e.g., point grab) to collect two independent sample sets. The sample will include 2 sets of 1-liter bottles for ice preservation, sulfuric acid preservation, metals, chlorophyll, and field parameters (turbidity, hardness, and alkalinity). Label one sample set with an "12" (environmental sample) and the other sample set with a "22" (replicate sample) in the QA code. This sampling program will regularly collect replicate samples.

Laboratory quality control sample results will be tracked by constructing a tabular summary by date for each quality control method (blank, duplicate, and replicate). For blank samples above the stated detection limit, the potential percent contribution of the blank value to environmental samples will be calculated. Samples that have a potential percent contribution of greater than 5% will be considered questionable. Duplicate and/or replicate samples will be presented in a table with calculations for the difference between the values. These variances will then be compared to acceptable limits for precision and accuracy outlined in Table 4 of this document. When samples are outside the acceptable interval, data will be considered questionable. When using data for assessment of beneficial use impairment, the interval will be placed around the reported value to determine if an incorrect decision of support or impairment may occur from erroneous data. Furthermore, when data is questionable, reported values will be presented with the associated interval of the duplicate or replicate data. Analytical and laboratory blanks will be collected during each sample week, and replicate samples will be collected at 10% of all sampled sites. Field blanks and duplicate samples should be collected as necessary.

Quality control (QC) of field parameters will be achieved through regular calibration of field meters and kits and the quarterly calibration check of all meters and kits in use by the OWRB. These methods are described in SOPs for the various meters and kits.

The QC of laboratory parameters will be achieved through regular submittal of duplicate and replicate samples as well as various types of blank samples. These methods are described in the SOPs for various water quality collection methods. Laboratory uses of internal QC checks are described in the ODEQ Laboratory Quality Assurance Plan. The ODEQ Laboratory also uses a frequency of at least ten percent of all samples analyzed for analysis of blanks, spikes, and duplicates. An approved copy of the ODEQ Laboratory Quality Assurance Plan is on file in the EPA Region VI office. In addition, revisits will occur at approximately 10% of stations.

Quality control of flow measurements will be achieved by conducting a replicate measurement at 10% of all sites. Side by side measurements will also be taken on a yearly basis. Mechanical meters will be calibrated (spin test), cleaned, and oiled at the beginning of each day and the end of each measurement. Electromagnetic meters will be calibrated (zero flow test) at the beginning of each day and cleaned at the end of each measurement. In addition, revisits will occur at approximately 10% of stations.

Quality control of habitat assessment will be achieved through strict adherence to the habitat assessment SOP and deployment of trained investigators. Quality control for biological assessments will follow the suggestions in: *Revision to Rapid Bioassessment Protocols For Use in Streams and Rivers: Periphyton, Benthic, Macroinvertebrates, and Fish, EPA 841-D-97-002*. Field investigators are field audited once each year to insure compliance to the SOPs developed and maintained by the OWRB. Field QA sessions will include a side-by-side measurement of all metrics with all personnel. Calculating a mean score for all team leaders creates a series of metric standards for the assessment. Team leaders and other staff are then compared to the mean and a percent difference is calculated for each metric. An acceptable percent difference is ½ of the scoring category range. In addition, revisits will occur at approximately 10% of stations.

Quality control of fish and benthic macroinvertebrate collections will be achieved through careful application of methods as described in the SOPs and documentation of any deviation from the prescribed methods. For fish collections, this includes use of variously sized seine nets (width and depth) and electrofishing on each sampling event. Replicate habitat and biological collections will be made at approximately 10% of stations. Acceptable precision for biological revisits is given in Table 5. The sample will include application of all collection protocols at a nearby, similar reach on the same waterbody. The reach will not be randomly chosen. In addition, revisits will occur at approximately 10% of stations.

Quality control of laboratory processing of fish collections will be achieved by the use of proper taxonomic techniques and regionally appropriate keys. Fish identified outside of their reported ranges will be forwarded to other taxonomists within the state for confirmation. These requirements will be outlined in the services contract with the qualified taxonomist. Data will be archived with the Oklahoma Museum of Natural History.

Quality control of laboratory processing of benthic macroinvertebrates will be accomplished by the use of proper taxonomic techniques and regionally appropriate keys. Additionally, a different taxonomist will reidentify one in ten samples. The laboratory will also maintain a voucher library of all collections.

B6. INSTRUMENT/EQUIPMENT TESTING, INSPECTION & MAINTENANCE

The manufacturer provides procedures and a schedule for routine maintenance, inspection, and testing of each instrument. Other maintenance is required when calibration procedures, precision, and accuracy do not fall within acceptable limits. All maintenance, testing, and inspections are maintained in logbooks for each instrument. Maintenance of the thermometer probe, pH probe, specific conductance probe, and dissolved oxygen probe consists of cleaning, repair, and/or replacement of parts or reference solutions as required. Maintenance of dissolved oxygen, pH, thermometer, and specific conductance probes will occur on at least a monthly basis or more often as conditions warrant. Such maintenance is recorded in a logbook kept with each field-monitoring instrument. Maintenance of the HACH® Turbidometer 2100P consists of cleaning, repair, or replacement of parts as recommended by the manufacturer. Velocity meter maintenance, testing, and inspection procedures are outlined in the Measurement of Discharge SOP. These procedures occur before each measurement and weekly when sampling trips are completed.

Repairs to agency equipment or instruments will be made by OWRB or OCC personnel when possible and by the manufacturer when necessary. All of the parts listed below are currently available on the OWRB and OCC premises or in vehicles for use when necessary. Spare parts are maintained and monitored by the Project Manager. Project manager ensures that depletion does not occur through semi-annual inventories. A list of critical spare parts would include the following:

- Stock of dissolved oxygen membrane, O-rings, electrolyte solution
- Various spare probes for multi-parameter instruments
- Spare cables for all instruments
- Spare batteries for all applications
- Spare lamps and vials for turbidometer
- Spare glassware and plastic ware for all kits
- Spare plastic ware for depth-integrated samplers
- Spare filtering and tissue grinding kits for chlorophyll-a
- Spare parts for mechanical velocity meters
- Spare cabling attachments for sounding winches

Quality control of field-measured parameters consists of testing instrument readings against a known standard. This comparison between the field instrument and a known value will occur prior to each field trip. If an instrument or piece of equipment cannot meet calibration specifications, then the instrument will be repaired in-house until it can meet specifications. If the instrument cannot be repaired in-house then it will be shipped back to the manufacturer for repair and an analogous instrument will be utilized for data collection. The OWRB maintains several instruments for back-up purposes.

B7. INSTRUMENT CALIBRATION AND FREQUENCY

The OWRB regularly calibrates all instruments. Instrument calibrations are maintained in logbooks for each instrument. All multi-parameter instruments will be calibrated prior to every field-sampling event. Furthermore, instruments will be calibrated in the field when certain conditions apply. These include but are not limited to: 1) measured data is outside a previously calibrated range (e.g., pH is calibrated to a range of 7 and 10 and the current measurement or historical data is 6.8 standard units), 2) a parameter used in calibration (e.g., barometric pressure in the calibration of dissolved oxygen) has changed significantly, or 3) needed maintenance is performed (e.g., the changing of a dissolved oxygen sensor membrane). Specific calibration procedures are outlined in the Multi-Parameter Instrument SOP. Turbidometer calibration procedures are outlined in the Turbidity Measurement SOP. Primary calibration for each turbidometer instrument will occur as recommended by the manufacturer. Secondary calibration of the HACH® instrument using secondary standards with known values will occur prior to sample analysis. Velocity meter calibration procedures are outlined in the Measurement of Discharge SOP. Calibration occurs before each measurement and weekly when sampling trips are completed.

B8. INSPECTION/ACCEPTANCE REQUIREMENTS FOR SUPPLIES

All supplies are inspected upon receipt for completeness and integrity. All reagents are checked for expiration dates and shelf life. Damaged, incomplete, and expired supplies will not be used and will be returned to the supplier. Supplies will be checked quarterly for expiration. If supplies are deemed expired, damaged, or contaminated, they will be disposed of in a proper manner and replaced immediately.

B9. DATA ACQUISITION REQUIREMENTS

Data acquired for use in this project from outside sources will be reviewed for completeness, quality, and how it meets the data quality objectives. Data collection protocols and laboratory QA for the ODEQ can be found in ODEQ QMP (QTRACK No. 00-182). Field data collected by the COE, United States Geological Survey (USGS), and other agencies or entities that have collected pertinent water quality data on Oklahoma's streams will be used where appropriate. Data quality review will be documented through the outside source's Quality Assurance Project Plan. All data from outside sources will be cited appropriately.

B10. DATA MANAGEMENT

Data collected will be entered into the OWRB's Water Quality Database for long-term storage. Data may also be transferred into a spreadsheet, statistical package, or other software packages for data analysis and graphical interpretation purposes. OWRB personnel will perform entry of data into the database or other software package(s). The contract laboratory supplies the OWRB Database Manager with the laboratory results in an electronic format compatible with the OWRB database structure. This allows OWRB staff to avoid data entry of laboratory information and requires staff to only enter field-collected information. OWRB staffs conduct checks of the electronic data to verify accuracy, and contract laboratory personnel review their electronic data for completeness and accuracy before it is submitted to the OWRB for our approval. Upon completion of data entry, the database is double-checked for completeness/and accuracy. Values acquired from samples taken following methods described in previous sections and assessed according to the USAP and SOP are assumed to be valid data until proven otherwise. For this reason, extreme values will not be treated as an "outlier" and excluded from data analysis. The Project Manager will be responsible for data analysis, validation and reporting. Standard statistical values, including means, ranges, and standard deviations, will be computed for all data from all stations when appropriate. Additional analyses will be designed and implemented by the Project Manager to meet the stated data quality objectives for the project.

B10.1 Data Flow Upon Receipt from Contract Laboratory

To insure against loss of data, original laboratory data sheets and chains of custody will be filed in chronological order by month and kept in the project notebook upon receipt. Streams data will be stored electronically in the Water Quality Database, the Water Quality Biological Database, and in the OWRB network. All electronic transfers from analytical laboratories will be maintained on the OWRB network. In addition all electronic transfers and data stored in a non database format will be backed up to compact disc.

The Quality Assurance (QA) Officer will review the data for completeness and identify any problems or gross errors (i.e. violation of holding times). The Project Manager and the contract Laboratory Director will resolve problems with incomplete data and obvious reporting errors. Data where holding times have been violated will be flagged and discarded as appropriate. The QA officer in concert with the Project Manager will take action to resolve any problems leading to violation of holding times. Upon verification of data completeness, the Database Manager, or other designated staff, will enter the data into the appropriate electronic format. Flagged data will also be entered with an appropriate data quality code.

Quality assurance related blank, duplicate, and replicate sample data would be analyzed at this time. A hard copy of the quality assurance data will be given to the QA officer for review. The QA officer will flag data sets with unacceptable values. Data will be flagged as unacceptable according to criteria outlined in this QAPP and the OWRB Quality Management Plan. The Water Quality Division Database Manager or his designee will enter QA flags in the appropriate electronic storage venue.

B10.2 OWRB Data Base Inventory
Primary storage of data will be on the OWRB computer network. A directory of these databases will be maintained for ease of retrieving data for specific projects.

B10.3 Back-up Schedule for Insurance of Data Integrity
The primary data storage files will be backed-up on a weekly basis using *File Safe* software and are stored offsite. Personal computers used for data manipulation, reporting, etc. will be backed-up at this time also. Backups will be done prior to any repairs, moves, and/or procedures that may threaten data integrity. In addition, electronic transfers and data not stored in a database format will be backed up on compact disc.

B10.4 Computer Security Policy
Access to primary data storage is limited to personnel designated by Derek Smithee, Water Quality Programs Division Chief or the designated Project Manager. Anti-virus software is installed on all OWRB computers and anti-virus checks are routinely performed. A user-identification name or number and password are required before an individual can gain access to the agency network, which limits routine access to information by unauthorized personnel.

B10.5 Data Manipulation and Reporting
OWRB staff use various programs for routine data manipulation/graphical representation. Microsoft Excel® is commonly used for graphical representations and may be used for simple analysis such as descriptive statistics. Statistica, Minitab v.13 or above, or WQStat Plus is generally used to perform robust or complex statistical analyses.

B10.6 Computer Hardware Requirements and Inventory

Excepting GIS applications, the computer hardware required for data management for OWRB water quality projects do not exceed commonly used IBM compatible personal computers. The OWRB GIS staff determines GIS hardware requirements and purchases. In general, all Water Quality Division staff utilizes Pentium 4 computers with 256K RAM. A field notebook computer is available for field staff to utilize if so desired.

B10.7 Data Archival Policy

The OWRB and cooperating agencies will enter all appropriate data into the EPA STORET system. Hard copies of the data will be stored upon project completion in OWRB files for at least ten years after project completion. The Project Manager or his/her designee will maintain a project notebook of the field and laboratory data sheets, discharge and survey notes, chains of custody, and any and all raw data during this period. In addition an electronic copy of all data will be provided to the EPA Project Officer.

C. ASSESSMENT/OVERSIGHT

C1. ASSESSMENTS AND RESPONSE ACTIONS

Regular assessments and audits of all protocols will be performed. These reviews and appropriate responses are outlined in Table 10.

Table 10. Assessment and Response Actions

ASSESSMENT	RESPONSE
Field Systems Audit: Early in the sampling program and once each year, each field procedure will be compared with the written SOP for compliance. Field audits will include inspection of all equipment used and system performance.	Any inconsistency/deficiency affecting data quality between the SOP and the procedures observed will be reported to the Project Officer, Project Manager, and appropriate field personnel. Response to any inconsistency or deficiency will be the responsibility of the project officer and may include additional training, purchase of additional equipment, changes in personnel, and revision of the SOP. Depending on the problem, additional assessments may be recommended. Remedial actions will be reported to the QA Officer and Project Manager.
Data Management Review: Data management protocol requires frequent communication between data management and the QA Officer. The data management system will be reviewed, in detail, quarterly for backup status and data completeness.	Data management and resolution of data entry problems are the responsibility of the QA officer and Project Manager.
Data Reporting & Interpretation Review: Each report, prior to release, undergoes an internal review process of the technical writers, Project Officer, and Division Chief.	The technical writing staff will resolve comments and difference of data interpretation.

The ODEQ currently operates the Oklahoma Laboratory Certification Program for laboratories performing analyses on samples collected in the State of Oklahoma. This program is designed to insure that chemical water analysis and biological data are reliable and accurate for scientific and legal purposes. To be certified, a laboratory is required to employ qualified personnel, possess adequate equipment and facilities, maintain adequate quality control, pass on-site inspection, and analyze accurately an appropriate set of reference samples provided by EPA. Reference samples are sent and certification must be renewed on an annual basis. Any laboratory that submits chemical or biological data to the ODEQ to fulfill waste disposal permit or research requirements, must be certified for the appropriate variables. The ODEQ laboratory is certified for all variables at the present time.

C2. REPORTS TO MANAGEMENT

Evaluation of data quality will occur on a weekly basis as a result of instrument calibration and submission of quality control samples to the analytical laboratory. Instrument maintenance logbooks will be kept with the field instruments and therefore available for examination on an as needed basis. Management will be informed when calibration is not possible and corrective actions will be implemented. Replacement or repair of the affected part or parts will be performed if required. Management will also be informed on a monthly basis of the project status and project problems. Summary tables of quality control results are immediately available to management through the OWRB computer network system. Access to such information is limited to personnel in the Monitoring Section, the Water Quality Programs Division Chief, and the Division Administrative Assistant.

When it is determined that data received from the analytical laboratory is "incomplete", through results of blank and/or replicate samples, management will be informed and any needed actions will subsequently be taken. Most reports made to management will be by the Project Manager, however, occasions may arise when the OWRB QA Officer will deal directly with management. The OWRB QA Officer will be notified when recurring problems with instruments or contract laboratories are compromising achievement of data quality objectives. If data quality objectives cannot be met due to laboratory or instrument errors, the Project Manager and OWRB QA Officer in concert will work with agency management to solve project QA problems and recommend corrective action procedures.

D. DATA VALIDATION AND USABILITY

D1. DATA REVIEW, VALIDATION, AND VERIFICATION REQUIREMENTS

Data collected will be entered into the OWRB's Water Quality Database or a spreadsheet (Microsoft Excel® software). OWRB personnel will perform entry of data into the database or spreadsheet. Upon completion of entry the resulting database will be double-checked for completeness and to confirm that parameter values are matched with the correct stations, depths, etc. Any result measured as the result of a sample taken according to the methods described in previous sections and meeting the acceptance criteria outlined in this document will be assumed to be valid data until proven otherwise. For this reason, extreme values will not be treated as an "outlier" and excluded from data analysis. The Project Manager will be responsible for data analysis, validation, verification, and reporting. Standard statistical values, including means, ranges, and standard deviations, will be computed for all data from all stations when appropriate. Additional analysis will be designed and implemented by the Project Manager to achieve the stated objectives of the project.

D2. VALIDATION AND VERIFICATION METHODS

Through the data management process as described in Section B10, data is reviewed several times. Data validation is an integral part of this process. The mechanism for this was previously described in Sections B10 and D1. All data will be routinely reviewed for abnormalities, inconsistencies, or unusual results. If any of these occur, the data will be traced back to look for possible causes of the error. In the event that no error is found, the data will be assumed to be normal and appropriate for use in project reports and in decision-making. If an error is found and no resolution can be arrived at concerning its source or cause, the data will be discarded.

D3. RECONCILIATION WITH DATA QUALITY OBJECTIVES

Data collected that is within the limits of precision and accuracy stated in this document will be considered "complete". Data collected that falls outside of the stated limits of precision and accuracy will be considered "incomplete". Previous narrative describes specific routine procedures to be followed during the project period to determine whether collected data is "complete" or "incomplete". Data determined to be "incomplete" will be reported to the Quality Assurance Manager and corrective actions will be taken if necessary. Data determined to be "incomplete" will not be incorporated into the Final Report.

Reports will be written in accepted scientific form and will include data tables, graphs, figures, and other graphical representations as needed. Appropriate narrative to describe study methodology, data presentation and discussion, and study conclusions generated from analysis of the collected information will be presented in the Final Report. All data used to support conclusions regarding use support, pollutants present and possible pollutant sources will be reported within the narrative of the Final Report or will be available at the OWRB central office.

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