# QUALITY ASSURANCE PROJECT PLAN

## FY-2003 Section 104(b)3 Supplemental Project 2 (CA# X7-976525-01)—Monitoring in Support of TMDL Development in the Upper Kiamichi and Upper Little River Watersheds

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

**November 14, 2005**

## A. PROJECT MANAGEMENT

## A1. Title and Signature Page

FY-2003 Section 104(b)3 Supplemental Project 2 (CA# X7-976525-01)—
Monitoring in Support of TMDL Development in the Upper Kiamichi and Upper Little River Watersheds

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Oklahoma Water Resources Board (OWRB) Monitoring Programs Coordinator

_______________________________________________ Date: ______________
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: ______________
Jennifer Wasinger
Office of the Secretary of Environment

_______________________________________________ Date: ______________
Terry Mendiola
EPA Region VI Project Officer

_______________________________________________ Date: ______________
EPA Approving Official

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## A3. DISTRIBUTION LIST

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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, field monitoring, analyzing, and reporting of data results as well as general project oversight. The Oklahoma Department of Environmental Quality (ODEQ) laboratories will perform laboratory analyses for water quality samples.

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. With supervisor approval, he will be coordinating and conducting the metals sampling activities of this project. 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.

Matthew Rollins, Water Quality Programs Specialist, OWRB-WQPD-MAS

Mr. Rollins 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. Along with Mr. Phillips and with supervisor approval, he will be coordinating and conducting the continuous field sampling activities of this project. Mr.

Rollins has a BS from Kent State University. He has worked for the OWRB since January of 2002.

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. Along with Mr. Rollins and with supervisor approval, he will be coordinating and conducting the continuous 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.

Eugene Doussett, Water Quality Programs Specialist and Data Manager, OWRB-WQPD-MAS

Mr. Doussett is a Team Leader for general monitoring activities and maintains a rigorous sampling schedule. He also acts as the MAS Streams Data manager. 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 involved in the monitoring activities of this project. Mr. Doussett has a BS from Central State University. He has worked for the OWRB since 1979.

Matthew Schratwieser, Water Quality Programs Technician, OWRB-WQPD-MAS

Mr. Schratwieser 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 involved in the monitoring activities of this project. Mr. Schratwieser has an Associate Degree from Rose State College. He has worked for the OWRB since 2001.

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 marginally involved in the monitoring activities of 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.

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 marginally involved in the monitoring activities of 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.

## A5. PROBLEM DEFINITION/BACKGROUND

The Upper Little River and Upper Kiamichi River Watersheds are important natural resources for the state of Oklahoma. Located in southeastern Oklahoma in the Lower Red River Planning Basin, the two watersheds are not only naturally beautiful but offer many types of recreation including canoeing, kayaking and angling. Most of the streams and rivers in this area are designated as Outstanding Resource Water, and the Mountain Fork is an Oklahoma Scenic River. With mostly cool water, cobble/boulder substrates, and moderate to high gradients, the rivers and streams of the area offer a diverse habitat and support a rich aquatic community. They provide critical habitat for the threatened leopard darter (*Percina pantheria*).

In Oklahoma's 2002 Consolidated List- Category 5, a number of segments within the two watersheds are listed as impaired for various parameters related to the Fish and Wildlife Propagation Beneficial Use (Table 1). The impairment decisions are based on four years of data collection through the OWRB's Beneficial Use Monitoring Program and the Oklahoma Conservation Commission's (OCC) various non-point source monitoring programs.

Table 1. Category 5 river segments and variables listed.

| Waterbody | OK Waterbody ID | Segment Length (mi) | Variables Listed (n) |
|---|---|---|---|
| Glover River | OK410210080010 | 34 | Lead (n = 8) |
| Kiamichi River | OK410310020010 | 29 | Lead (n = 8), pH (n = 37) |
| Little River | OK410210020140 | 29 | Silver (n = 8), Lead (n = 8), pH (n = 37) |
| Mountain Fork of the Little River | OK410210060010 | 29 | Lead (n = 8), pH (n = 37) |
| Pine Creek | OK410300030580 | 23 | pH (n = ?) |

When compared to criteria assigned in the Oklahoma Water Quality Standards (OWQS), a number of segments are listed as impaired because of pH values below the minimum screening level. Furthermore, some streams are impaired due to exceedances of some hardness-dependent metals criteria, including those for silver and lead. Historically, pH values throughout the watersheds have been low (< 6.8) during various times of the year, and hardness values are consistently below 25 ppm. Because streams have formed on sandstone and shale substrates, carbonates are not readily available, and the streams subsequently have a low buffering capacity against various acidic inputs including acidic soils, organic matter (e.g., pine needles), and acid rain deposition. Because of these described conditions, does impairment truly exist? Oklahoma's Use Support Assessment Protocols (USAP) requires that the chemical, physical and biological causes of impairment be addressed. To fully assess Fish/Wildlife support status, all applicable criteria must be considered. For example, if biological data shows a stream to be impaired, then the stream is not supporting. The same decision criterion applies to physical and chemical criteria such as pH or metals. Considering this, the answer to the question is slightly different for the two variables in question but in both cases will require looking at both the parameter in question and the aquatic community.

According to the OWQS, pH criteria (upper and lower) do not apply when naturally occurring conditions cause values to be outside the prescribed range of 6.5 – 9.0 units. To determine whether the low pH's are naturally occurring, a large enough data set must be collected over a range of conditions absent any point source inputs. By relating pH flux to changes in flow, sediment inputs, seasonality, and duration, the influence of naturally occurring conditions can be determined. Furthermore, pH has an assigned range within the water quality standards because of its effect on the physiological processes of aquatic organisms. Therefore, it is logical to determine the health of the aquatic community when considering whether a stream is fishable. By considering both types of data, an overall assessment of health can be made and the necessity of a TMDL can be determined (Table 2).

Table 2. Assessment decision matrix for pH according to application of USAP

| Low pH caused by: | Condition of Biological Community | Support Status | Impairment Cause | TMDL Status |
|---|---|---|---|---|
| Conditions naturally occurring | Supporting | Not Impaired | N/A | unnecessary |
| Conditions naturally occurring | Not Supporting | Impaired | Not yet known | Necessary if impairment due to a pollutant |
| Conditions not naturally occurring | Supporting | Impaired | pH | Necessary for pH unless cause is by pollution such as acid rain deposition |

| Low pH caused by: | Condition of Biological Community | Support Status | Impairment Cause | TMDL Status |
|---|---|---|---|---|
| Conditions not naturally occurring | Not Supporting | Impaired | pH | Necessary for pH |

For metals listings, much of the same decision logic applies. Because of low hardness values, hardness-dependent criteria in the segments are in the parts per billion to trillion range. When the toxicity curves were developed for hardness-dependent metals such as lead and silver, criteria in this extremely low range of hardness were extrapolated from the middle portion of the curve. Therefore, these numbers may be suspect and a water effects ratio (WER) study may be necessary. From this study, site-specific criteria could be developed. However, this study is very expensive. In the near future, a more prudent approach may be to reassess the waterbodies for these constituents. Because the Oklahoma Water Quality Standards provides criteria for total recoverable metals, the BUMP program has not historically sampled for the dissolved metals fraction, but this fraction is what is available to aquatic organisms for uptake. To more accurately determine whether aquatic organisms are at risk, a resampling for dissolved constituents is necessary. In those instances where a criterion exceedance persists, an assessment of biological integrity would help to determine if the aquatic community is at risk. Similar to pH, a decision table can be formed to determine what next step should be (Table 3).

Table 3. Assessment decision matrix for metals according to application of USAP

| Dissolved Metals | Condition of Biological Community | Support Status | Impairment Cause | WER Study | TMDL Status |
|---|---|---|---|---|---|
| Supporting | Supporting | Not Impaired | N/A | No | Unnecessary |
| Not Supporting | Supporting | Impaired | Metal (e.g., lead) | Yes | Necessary depending on results of WER study |
| Supporting | Not Supporting | Impaired | Not known | No | Necessary if impairment due to a pollutant |
| Not Supporting | Not Supporting | Impaired | Metal (e.g., lead) | Yes | Necessary for metals depending on results of WER study or if impairment is due to another pollutant |

## A6. PROJECT/TASK DESCRIPTION

The main objectives for the project are:

1. Review available historical data and determine analyze trends related to seasonality, rainfall, sediment, and flows.
2. Through continuous monitoring and trend analyses, attempt to determine the cause(s) of low pH values in Pine Creek and the Kiamichi, Little and Mountain Fork Rivers and if values are impairing the Fish/Wildlife Beneficial Use.
3. Determine if the concentrations of certain dissolved metals in segments of the Kiamichi, Little, Glover, and Mountain Fork Rivers are impairing the Fish/Wildlife Beneficial Use.
4. Collect biological data on all segments to determine health and impairment status of the Fish/Wildlife Beneficial Use.
5. In the event that impairment does exist, provide data to the ODEQ for development of the TMDL.

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

**Task 2 and Task 3a**: **Installation of Minimonitors and Continuous Monitoring to Determine Cause(s) of pH Impairments**
An objective of this study is to determine if regionally low pH may be attributed to naturally occurring conditions. To supplement the historical data review, five (5) segments located throughout the Kiamichi and Little River Watersheds will be continuously monitored over a 12-month period (Table 4). To ensure comparability of data, several considerations were made when selecting stations (Table 4).

1. Priority is given to segments currently listed for pH as Category 5 on Oklahoma's Consolidated List (Table 1).
2. One unimpaired (pH-related) station is included in the study as control for non-point sources. Glover River is located on land managed similarly to the impaired stations in the study and should have a similar potential for non-point source impacts.
3. Similar geography and land use was deemed important. All 5 segments are predominately or fully within the Omernick's Ouachita Mountain Level III Ecoregion. Furthermore, land use is similar between all stations. The

area is predominately evergreen or mixed forests with scattered cropland and pastureland.

4. Impacts from known sources were eliminated. The Oklahoma Department of Environmental Quality (ODEQ) permits no point source discharger within each of the 5 segments.
5. So that conclusions can potentially be extrapolated throughout the entire area of interest, streams of various sizes and gradients have been included (Table 4). Streams in the study represent Strahler orders 2, 3, and 4, and stream slopes vary from 3-43 feet/mile.

Table 4. Stations to be continuously monitored for pH and/or DO.

| Station Name | BUMP Station ID | County | Watershed | Strahler Order | Slope (feet/mile) |
|---|---|---|---|---|---|
| Glover River near Glover | AT337900 | McCurtain | Upper Little River | 4 | 3 |
| Kiamichi River near Big Cedar | AT335700 | LeFlore | Upper Kiamichi River | 2 | 17 |
| Little River near Cloudy | AT337100 | Pushmataha | Upper Little River | 4 | 8 |
| Mountain Fork River near Smithville | AT338840 | McCurtain | Upper Little River | 4 | 18 |
| Pine Creek near Eubanks | N/A | Pushmataha | Upper Kiamichi River | 3 | 43 |

Data will be collected to fully determine use attainment and will include both biological collections and continuous pH monitoring. Additionally, water temperature, specific conductivity, and turbidity will be continuously monitored. Discharge data for the Kiamichi, Mountain Fork, and Glover Rivers will be obtained from the United States Geological Survey (USGS) stream gauges located at these sites. At the other two (2) stations, a stage recorder will be deployed, and a stage/discharge rating will be developed and modeled over the 12-month period using acceptable methods. Climatological data will be obtained from various sources including the Mesonet, USGS, and National Weather Service.

Continuous monitoring will provide data for various areas of analysis. Primarily, the duration and seasonality of pH fluxes can be determined. By comparing trends across stations, flow regimes, and seasons, the influence of natural conditions can be determined. If no apparent trends occur and/or natural conditions are determined to not be an influencing factor, these data sets will assist in better defining the subsequent limits set by the TMDL's. Secondly, if trends are similar throughout the watersheds, a future model may be developed that can be extrapolated to ambient data sets on other segments within the watersheds that meet the criteria described at the beginning of this section. Thirdly, specific conductance and turbidity data can provide information about pH flux. Because both parameters are influenced by runoff events and sediment loads, the effect of sedimentation on pH can be investigated. Lastly, relationship of trends to rainfall may indicate acid rain deposition. If so, cause of pH impairments may be determined to be from pollutants and the listings may be moved to category 4. The National Air Deposition Program does not maintain a station within the region, and rainfall chemistry will not be measured.

**Task 3b: Metals Monitoring to Determine Fish/Wildlife Beneficial Use Support Status**

Another objective of this study is to determine the extent of impairment related to metals for the segments in Table 1. To meet the data objective requirements in Oklahoma's USAP, the four segments will be monitored at two locations each (Table 5). The primary location for each segment will at BUMP permanent monitoring station (bolded). A supplemental station will be positioned along the segment to more accurately account for distant tributaries. Instantaneous discharge and stage will be collected at each sampling event.

Stations will be monitored over a 12-month period beginning two months after the approval of the QAPP. The study is designed to account for both base and high flow conditions. Therefore, at a minimum, samples will be collected quarterly, and up to four supplemental samples may be taken to account for the base or high flow conditions. This will meet the 5 sample requirement of USAP. Parametric coverage includes, dissolved and total recoverable lead, dissolved and total recoverable copper (Little River), total hardness, other general water quality variables, and instantaneous flow and stage.

Table 5. Stations to be monitored for dissolved metals.

| Station Name | BUMP Station ID | County | Segment position |
|---|---|---|---|
| Glover River near Bethel | N/A | McCurtain | Upper to Middle |
| **Glover River near Glover** | **AT337900** | **McCurtain** | **Lower** |
| **Kiamichi River near Big Cedar** | **AT335700** | **LeFlore** | **Upper to Middle** |
| Kiamichi River near Whitesboro | N/A | LeFlore | Lower |
| Little River near Nashoba | N/A | Pushmataha | Upper to Middle |
| **Little River near Cloudy** | **AT337100** | **Pushmataha** | **Lower** |
| Mountain Fork River near Hatfield, AR | N/A | Polk | Upper |
| **Mountain Fork River near Smithville** | **AT338840** | **McCurtain** | **Middle to Lower** |

**Task 3c: Biological monitoring to determine Fish/Wildlife Beneficial Use Support Status**

Biological samples will be collected at the nine (9) stations listed in Tables 4 and 5. These collections will be multi-assemblage and will include fish and benthic macroinvertebrates as well as certain measures of physical habitat. Fish and benthic macroinvertebrates will be collected in the early summer of 2005, and benthic macroinvertebrates will be collected in the winter of 2005-2006. To determine stream health, data will be compared to several indices. Fish data will be compared to narrative biocriteria established in Oklahoma's Use Support Assessment Protocols the index of biological integrity established by the OCC's Data Gaps Project.

**Task 4 and Task 5**: **Development of Secondary QAPP and Review of Secondary Data Sources**
A Secondary Data QAPP will be written and submitted to EPA for approval. Secondary pH, copper, lead, turbidity, specific conductance, and discharge data as they relate to the segments and variables listed in Tables 1, 4, and 5 will be mined from historical monitoring programs. The data will be included in analysis.

**Task 6**: **Quarterly Supplemental Water Quality Data Report**
Quarterly reports on continuous monitoring will be submitted to the ODEQ for use in any TMDL efforts.

**Task 7**: **Water Quality Data Report to EPA for Review**
The OWRB will compile a water quality data report addressing all monitoring activities for technical review by interested state entities and the EPA.

**Task 8**: **Final Water Quality Data Report to EPA**
The OWRB will finalize the water quality data report addressing all monitoring activities and forward to interested state entities, particularly the ODEQ, and the EPA.

## A7. QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

### A7.1 Problem Description

The Upper Little River and Upper Kiamichi River Watersheds are important natural resources for the state of Oklahoma. Located in southeastern Oklahoma in the Lower Red River Planning Basin, the two watersheds are not only naturally beautiful but offer many types of recreation including canoeing, kayaking and angling. Most of the streams and rivers in this area are designated as Outstanding Resource Water, and the Mountain Fork is an Oklahoma Scenic River. With mostly cool water, cobble/boulder substrates, and moderate to high gradients, the rivers and streams of the area offer a diverse habitat and support a rich aquatic community. They provide critical habitat for the threatened leopard darter (*Percina pantheria*).

In Oklahoma's 2002 Consolidated List- Category 5, a number of segments within the two watersheds are listed as impaired for various parameters related to the Fish and Wildlife Propagation Beneficial Use (Table 1). The impairment decisions are based on four years of data collection through the OWRB's Beneficial Use Monitoring Program and the Oklahoma Conservation Commission's (OCC) various non-point source monitoring programs.

When compared to criteria assigned in the Oklahoma Water Quality Standards (OWQS), a number of segments are listed as impaired because of pH values below the minimum screening level. Furthermore, some streams are impaired due to exceedances of some hardness-dependent metals criteria, including those for silver and lead. Historically, pH values throughout the watersheds have been low (< 6.8) during various times of the year, and hardness values are consistently below 25 ppm. Because streams have formed on sandstone and shale substrates, carbonates are not readily available, and the streams subsequently have a low buffering capacity against various acidic inputs including acidic soils, organic matter (e.g., pine needles), and acid rain deposition. Because of these described conditions, does impairment truly exist? Oklahoma's Use Support Assessment Protocols (USAP) requires that the chemical, physical and biological causes of impairment be addressed. To fully assess Fish/Wildlife support status, all applicable criteria must be considered. For example, if biological data shows a stream to be impaired, then the stream is not supporting. The same decision criterion applies to physical and chemical criteria such as pH or metals. Considering this, the answer to the question is slightly different for the two variables in question but in both cases will require looking at both the parameter in question and the aquatic community.

According to the OWQS, pH criteria (upper and lower) do not apply when naturally occurring conditions cause values to be outside the prescribed range of 6.5 – 9.0 units. To determine whether the low pH's are naturally occurring, a large enough data set must be collected over a range of conditions absent any point source inputs. By relating pH flux to changes in flow, sediment inputs, seasonality, and duration, the influence of naturally occurring conditions can be determined. Furthermore, pH has an assigned range within the water quality standards because of its effect on the physiological processes of aquatic organisms. Therefore, it is logical to determine the health of the aquatic community when considering whether a stream is fishable. By considering both types of data, an overall assessment of health can be made and the necessity of a TMDL can be determined (Table 2).

For metals listings, much of the same decision logic applies. Because of low hardness values, hardness-dependent criteria in the segments are in the parts per billion to trillion range. When the toxicity curves were developed for hardness-dependent metals such as lead and silver, criteria in this extremely low range of hardness were extrapolated from the middle portion of the curve. Therefore, these numbers may be suspect and a water effects ratio (WER) study may be necessary. From this study, site-specific criteria could be developed. However, this study is very expensive. In the near future, a more prudent approach may be to reassess the waterbodies for these constituents. Because the Oklahoma Water Quality Standards provides criteria for total recoverable metals, the BUMP program has not historically sampled for the dissolved metals fraction, but this fraction is what is available to aquatic organisms for uptake. To more accurately determine whether aquatic organisms are at risk, a resampling for dissolved constituents is necessary. In those instances where a criterion exceedance persists, an assessment of biological integrity would help to determine if the aquatic community is at risk. Similar to pH, a decision table can be formed to determine what next step should be (Table 3).

### A7.2 Decision Identification

Decisions about the relative health of each individual site as it relates to Oklahoma water quality standards 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.

In addition, potential causes of low pH will be evaluated through use of both simple and multiple regressions (Helsel and Hirsch 1992). Results of data analysis will be provided to the ODEQ for use in listing justifications and/or writing of TMDL's.

### A7.3 Decision Inputs

To determine impairment status for the individual waterbodies, different kinds of data will be collected through field observations, biological and habitat measurements, *in situ* measurements, and laboratory analysis of the specified parameters. Water quality numerical and narrative criteria will be used to determine use attainment status, when available, in a manner consistent with the Oklahoma's USAP and CPP. Protocols for determining beneficial use support (USAP) are found in the Oklahoma Administrative Code 785:46-15, and the CPP may be found at the ODEQ website. Although assessment methodologies in the CPP are developed from the OWQS and USAP, the USAP is state rule and will be applied where the USAP and CPP may disagree. Streams will be considered non-supporting when OWQS are violated as determined by criteria and rules listed in these documents.

To determine the relationship of rainfall, discharge, specific conductance, and turbidity with pH simple and multiple regression analyses will be used to explore relationships (Helsel and Hirsch 1992). Data transformations will be applied to the variables, as necessary to produce approximate linear relationships. For each reported analysis, an $R^2$ value and regression equation will be included as well as confidence and prediction intervals around the fitted line. Regressions will be calculated at multiple confidence levels from 80-95%. In addition, presence of autocorrelation will be tested using the Durbin-Watson Statistic.

### A7.4 Study Boundaries

The study is spatially limited to Omernick's Ouachita Mountain Level III Ecoregion. Specifically, the study is limited to the stream segments listed in Tables 1, 4, and 5. Application of analysis outside of the segments studied will not be addressed by this study.

Several things temporally limit the study. First, continuous monitoring and metals sampling will occur over 1 calendar year encompassing the spring, summer, fall, and winter seasons, and will be conducted over both base and high flow conditions. Secondly, biological sampling will occur over set biological index habitat periods. The index habitat period for the fish assemblage in Oklahoma is May 15th through September 15th. This period may be extended to October 1st if stream has not risen above summer seasonal base flow. The summer index habitat period for the macroinvertebrate assemblage in Oklahoma is July 1st through September 15th, and the winter index period is December 1st through January 15th. However, macroinvertebrate collections will be completed in as short a time period as possible beginning July 1st in the summer and December 1st in the winter. 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 study is hydrologically limited by both a variety of conditions. Sites may not be accessible due to ephemeral conditions caused by drought. They may also be inaccessible due to unseasonably heavy rainfall. To avoid bias, biological sampling should always be done during base flow time periods. 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. So that the macroinvertebrate and algal communities can reestablish, sites should not be sampled for at least 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 Fish/Wildlife Propagation beneficial use 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 and the program designed to yield data that are representative of the water quality of the stream segment being monitored at the time sample collection occurs. For streams, data collected in one segment is not used to report on use support for other segments of the stream system or watershed. In addition, to meet requirements in USAP related to reach length of a segment that may be represented by a sampling station, more than one sampling station may have been located on a waterbody.

### 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 for each use support is defined by the data requirements outlined in USAP. In general, ten (10) samples are required for general water quality parameters and five (5) samples are required for metals analysis. Because data may be rejected based upon duplicate or blank samples, up to eight (8) sampling events may occur for metals. Additionally, if enough samples exist to make a decision of impairment, less than the minimum may be collected. In certain cases, this minimum may not be achievable for fish flesh and is not guaranteed by the OWRB. One sample is required for biological and habitat analysis. Completeness required for continuous monitoring will be 85% of the calendar year with no one season missing more than ½ of the total season. To meet completeness for continuous monitoring, units may remain deployed past the initial 12 months.

**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 1, 2, and 3, respectively. Instrument collected field values will initially be stored to the decimal place represented in Table 1 under the column titled “precision”. Values used and reported in the Final Report will be reported to the decimal place listed in Table 1 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:

$$RPD = \frac{((C_1 - C_2)/C1:C2mean)}{C_1 - C_2} x100$$

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 6. 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 |
|---|---|---|---|---|---|
| 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 |
| Total Alkalinity | 2320-B | Hach Test Kit | 10 – 4000 | 1-5 mg/L | HACH Digital Titration Test |
| Continuous Nephelometric Turbidity | 2130-B | Multiparameter Instrument | 0 to 999 NTU | 0. 1 NTU | ± 1% of reading(0 –100 NTU) and ± 3% of reading (100 – 400 NTU) |
| Instantaneous 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% | |
| Continuous Inside Stage | Recording Gage | Gas Bubbler | 0 to 34.60 feet at a calibrated pressure of 0 to 15 PSI | 0.05% | ± 0.007 foot |
| Instantaneous Outside Stage | Non-recording Gage | Wire Weight Gage | 0 to 100 feet | 0.1% | ± 0.01 foot |
| Rainfall | Recording Gage | Tipping Bucket | Rate = 0-25 inches per hour | 0.01 inches/every 4 hours | 0.01 inch |

Table 7. Method Detection Limits and Acceptable Limits for Field Duplicates.

| Parameter | Method | Meter / Kit | Acceptable precision for low level field duplicates | Acceptable precision for high level field duplicates | Method Detection Level* |
|---|---|---|---|---|---|

| 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 |
| Specific Conductance | 2510-B | Multiparameter Instrument | 75-125% | 90-110% | 0.1 mS/cm |
| pH | 4500 H-B | Multiparameter Instrument | 75-125% | 90-110% | 0.01 su |
| Continuous Nephelometric Turbidity | 2130-B | Multiparameter Instrument | 75-125% | 90-110% | 0. 1 NTU |
| Instantaneous Nephelometric Turbidity | 2130-B | Hach 2100P | 75-125% | 90-110% | 0.01 NTU |
| Metals (dissolved and total recoverable lead and silver) | 200.7 and 200.8 | ODEQ | 75-125% | 90-110% | 5 ug/L |

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

Table 8. Acceptable Precision for Biological Assessments.

| Activity | Parameter | Precision (RPD) Faulkner 1994 |
|---|---|---|
| Fish collection: seine/electrofish | No. individuals<br>No. species | 50%<br>15% |
| Benthic macroinvertebrate collection | No. individuals<br>No. Taxa | 50%<br>15% |
| Benthic macroinvertebrate taxonomy | Taxonomic Identification to appropriate level | 99% |
| Habitat assessment | Habitat assessment score<br>Average depth<br>Average width<br>Percent cover | 15%<br>15%<br>15%<br>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 4) 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 4. 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 4.

Table 9. 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, biological, and habitat properties of each site. Chemical and physical analysis will consist of measurements of instantaneous and continuous turbidity, pH, specific conductivity, water temperature, stage, and turbidity, and continuous rainfall as well as instantaneous alkalinity, total hardness, discharge and dissolved and total recoverable metals (lead and silver). Biological characteristics will be measured using fish and benthic macroinvertebrates. To measure habitat, an assessment will accompany each fish and macroinvertebrate collection. All measurements are considered critical for determining the support status of the streams and/or performing regression analyses. Continuous stage will be modeled using a stage/discharge rating.

### B1.1. ANTICIPATED PROJECT ACTIVITIES AND TIME TABLE

**Task 2 and Task 3a**: **Installation of Minimonitors and Continuous Monitoring to Determine Cause(s) of pH Impairments**
Will be implemented by the OWRB. Activity will begin in March 2006 and end by April 2007.

**Task 3b: Metals Monitoring to Determine Fish/Wildlife Beneficial Use Support Status**
Will be implemented by the OWRB. Activity will begin in March 2006 and end by April 2007.

**Task 3c: Biological monitoring to determine Fish/Wildlife Beneficial Use Support Status**
Will be implemented by the OWRB. Activity will begin in March 2006 and end by April 2007.

**Task 4 and Task 5**: **Development of Secondary QAPP and Review of Secondary Data Sources**
Will be implemented by the OWRB. Activity will begin in April 2006 and end by November 2006.

**Task 6**: **Quarterly Supplemental Water Quality Data Report**
Will be implemented by the OWRB. Activity will begin in March 2006 and be delivered quarterly.

**Task 7**: **Water Quality Data Report to EPA for Review**
Will be implemented by the OWRB. Activity will begin in January 2007 and end by June 2007.

**Task 8**: **Final Water Quality Data Report to EPA**
Will be implemented by the OWRB. Activity will begin in June 2007 and end by September 2007.

### B1.2. SAMPLE SITE SELECTION

Stations selected for sampling the water bodies are listed in Tables 1, 4, and 5. Spatial constraints are defined by the USAP. In most cases, data collection will be limited spatially to the waterbody in question. This report will not predict the cause of low pH outside of the streams monitored. The reach length that a particular station represents may exceed the 10 mile or 25 limitation depending on several factors including hydrological influences, location of point source discharges, consistency of land uses, and available access. Sampling locations must be outside of regulatory mixing zones. Each site had field visits to verify that acceptable conditions existed for monitoring activities. These visits also generated the basic geographic information including a legal description and latitude/longitude.

### 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 5. 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 10. Sampling frequency for All Water Quality Parameters

| Parameter | Collection Frequency |
|---|---|
| Instantaneous turbidity, pH, specific conductivity, water temperature, outside stage, discharge and turbidity | During each collection calibration and in-field collection |
| Continuous turbidity, pH, specific conductivity, water temperature, inside stage, turbidity, and rainfall | Continuously logged every 15 minutes for the duration of the project |
| Metals | Quarterly and during base and high flow conditions |
| Benthic Macroinvertebrates | Two collections—summer and winter |
| Fish | One collection |
| Flow | With each assessment. |
| Habitat | During each field collection (will have forms tailored to the algal and macroinvertebrate collections) |

## <u>B2. SAMPLING METHODS REQUIREMENTS</u>

Field sampling and analysis methods for all types of samples are described by APHA (1995), EPA (1977, 1979b), Welch (1948), Lind (1979), 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. Continuous Recording of Physical/Chemical Parameters Using a Multi-Parameter Instrument
6. 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.

For each calibration or visit to a continuously recording minimonitor, an incident form is completed. Included in the form are several actions related to calibration of the instrument, observations of installation, and downloading of data. Incident sheets are maintained in the project notebook kept in the Division library. Electronic data downloads are maintained in spreadsheets for each site.

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**

Metals collections 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 11. Field samples collected for laboratory analysis of metals 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 two narrow-mouthed, 1-L polyethylene bottles and is preserved with nitric acid (labeled "$HNO_3$") with subsequent storage to 4°C.

**Table 11. 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 |
| Nephelometric Turbidity | Polyethylene | Ice, 4 °C | 24 hours |
| Total Hardness | Polyethylene | Ice, 4 °C, acid ($H_2SO_4$) to pH < 2 | 6 months |
| Copper | Polyethylene | Ice, 4 °C, acid ($HNO_3$) to pH < 2 | 6 months |
| Lead | Polyethylene | Ice, 4 °C, acid ($HNO_3$) to pH < 2 | 6 months |
| 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. The collector and/or analyst reserve space at the bottom of the laboratory results sheet for comments. 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 Tables 12. 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 instantaneous measurements—Includes measurements for specific conductance (mSiemens/cm), water temperature (°C), turbidity (NTU), 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 continuously recorded measurements—Includes measurements for specific conductance (mSiemens/cm), water temperature (°C), turbidity (NTU), and pH (standard units). Readings are taken every 15 minutes at the area installation.

3. Additional 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.

7. Instantaneous Outside Stage is measured using a surveyed wire weight gage referenced to a datum.

8. Continuous Inside Stage is measured using a gas bubbler recording every 15 minutes.

**Table 12. Parameters, Methods, Meters, and Method Detection Levels for Each Field Measured Parameter.**

| Parameter | Method | Meter/Kit | Method Detection Level |
|---|---|---|---|
| Specific Conductance | 2510-B | Multiparameter Instrument | 1.0 uS |
| pH | 4500 H-B | Multiparameter Instrument | 0.01 standard unit |
| Temperature | | Multiparameter Instrument | -5.0˚C |
| Total Hardness | 8226 | Hach Test Kit | 1 ppm |
| Total Alkalinity | 2320-B | Hach Test Kit | 1 ppm |
| Continuous Nephelometric Turbidity | 2130-B | Multiparameter Instrument | 0.1 NTU |
| Instantaneous 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 |
| Continuous Inside Stage | Recording Gage | Gas Bubbler | 0.007 foot |
| Instantaneous Outside Stage | Non-recording Gage | Wire Weight Gage | 0.01 foot |
| Rainfall | Recording Gage | Tipping Bucket | 0.01 inch |

## 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 metals 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.

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 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 2 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.

Quality control (QC) of instantaneously measured 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.

Quality control (QC) of continuously measured field parameters will be achieved through regular in-field calibration of field meters. 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.

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.

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.

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. 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 turbidity probes consists of cleaning, repair, and/or replacement of parts or reference solutions as required. Maintenance of dissolved oxygen, pH, thermometer, turbidity, 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:

- 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 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 for the test instruments and in the field for the field minimonitors. 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 will maintain one backup instrument.

## B7. INSTRUMENT CALIBRATION AND FREQUENCY

The OWRB regularly calibrates all instruments. Instrument calibrations are maintained in logbooks for each instrument. Multi-parameter test instruments will be calibrated prior to every field-sampling event, and in-field monitors will be calibrated regularly. Specific calibration procedures are outlined in the Multi-Parameter Instrument SOP's. 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 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.

## 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 8.

**Table 13. Assessment and Response Actions**

| ASSESSMENT | RESPONSE |
|---|---|
| Field Systems Audit:<br>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:<br>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:<br>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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