Quality Assurance Project Plan
(Missouri DNR - Level 3)
for

Pearson Creek Watershed Show-Me Yards, Neighborhoods, Farms, and Ranches Project

DRAFT

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JAMES RIVER BASIN PARTNERSHIP

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TABLE OF CONTENTS

Prepared by: 2
Approvals 2
List of Tables 4
List of Figures 4
PROJECT MANAGEMENT 5
  Project and Task Organization 5
  Problem Definition and Background 5
  Project Task Description 7
  Quality Objectives and Criteria for Measurement Data 9
  Data Quality Indicators, Definitions 9
  Special Training and Certification 10
  Documents and Records 10
DATA GENERATION AND ACQUISITION 12
  Sampling Process Design 14
  Sampling Methods 14
  Sample Handling and Custody 18
  Analytical Methods 19
  Quality Control 19
  Instrument and Equipment Testing, Inspection, and Maintenance 20
  Instrument and Equipment Calibration and Frequency 20
  Inspection and Acceptance of Supplies and Consumables 21
  Non-direct Measurements 22
  Data Management 22
ASSESSMENT AND OVERSIGHT 23
  Assessments and Response Actions 23
  Reports to Management 24
DATA VALIDATION AND USABILITY 25
  Data Review, Verification and Validation 25
  Verification and Validation Methods 26
  Reconciliation with User Requirements 26
TABLES 29
FIGURES 39
APPENDIX A. Standard Operating Procedures (SOPs) cited in this document 42
APPENDIX B. SOPs not previously reviewed under a QAPP 44
APPENDIX C. Sample Total Nitrogen Batch Report 45

List of Tables

Table 1. QAPP Distribution List with Personnel, Responsibilities and QAPP Receipt.. 29
Table 2. Project Schedule Time Line.. 30
Table 3. Sample Site Summary.. 30
Table 4. Measurement Performance Criteria. 3130
Table 5. Sampling Techniques…………………………………………………………...34
Table 6. Sample Storage Conditions for Water Quality Analytes. 35
Table 7. Maintenance and Calibration of Sampling Equipment and Analytical Instrumentation. ………………………………………………………………………………….36
Table 8. Quality Control Corrective Action Plan. (Standard Methods, 2005)................ 36

List of Figures

Figure 1. Organizational chart showing lines of authority and reporting responsibilities ………………………………………………………………………………………………..38
Figure 2. James River Basin……………………..……………………………………......39
Figure 3. Pearson Creek Watershed Sampling Sites…...……………………………......40

PROJECT MANAGEMENT

Project and Task Organization

The QAPP distribution list describes the personnel responsibilities, contact information, and QAPP copy control numbers for this project (Table 1). An organizational chart shows the lines of authority and reporting responsibilities (Figure 1). If personnel changes during this project all parties will be notified of the replacement including contact information and project responsibilities.

Problem Definition and Background

Pearson Creek watershed is located east of Springfield, Missouri and drains 61 km^2 at its confluence with the James River (MDNR, 2004) (Figure 2). The watershed is composed of mixed agricultural, urban, and forest land uses and there are management concerns that nonpoint and industrial releases may be degrading aquatic life in lower Pearson Creek (MDNR, 2005). In particular, macroinvertebrate communities are impaired in the stream segment below Jones Spring in the lower Pearson Creek. Jones Spring issues from karst fractures and receives runoff inputs from an urbanized section of Springfield. Drinking water supply may also be at risk since Pearson Creek discharges into the James River about 1 km upstream of the Blackman municipal drinking water intake and then flows into Springfield Lake (USGS, 2005). Pearson Creek is listed on the 303d list for unknown toxicity initiated by aquatic invertebrate species monitoring by City Utilities of Springfield (Youngsteadt, 1995). Additional water quality studies have been conducted by the US Geological Survey (USGS) and the Missouri Department of Natural Resources both of which were unable to determine a specific toxicant responsible for the decline in aquatic life in the Creek (Richards and Johnson, 2002; MDNR, 2005).

Pearson Creek is classified as a permanent flow (P) stream with designated uses that include livestock and wildlife watering, protection of warm water aquatic life and human health-fish consumption, and whole body contact-A as listed in Table H – Stream Classifications and Use Designations (10 CSR 20-7, 2005). Classified waters have designated uses with specific maximum chronic toxicity criteria reported in Tables A and B of 10 CSR 20-7. The State of Missouri’s Final Order of Rulemaking 10 CSR 20-7.031 Water Quality Standards RESPONSE #14-2 states that the Code of State Regulations retained the criteria shown in the Proposed Rulemaking after all comments were addressed regarding metals criteria (MDNR, 2005). Therefore the original criteria established in Tables A and B still apply to Pearson Creek. Table A – Criteria for Designated Uses lists chronic and acute toxicity criteria for waters designated Protection of Aquatic Life (AQL) dependent on the hardness of the water. The average hardness of the water samples collected from Pearson Creek from August 8, 1999 to March 24, 2005 was approximately 223 mg/l (MDNR, 2006). Based on this average hardness value, chronic toxicities for lead, zinc, and copper for Pearson Creek are 5 µg/l, 193 µ g/l, and 13µg/l, respectively. Acute toxicity levels are
136 µg/l Pb, 211µg/l Zn, and 26 µg/l Cu.

To date, few of the water samples collected from Pearson Creek have exceeded state standards set to protect aquatic life. However, some samples have yielded total nitrogen levels above the James River TMDL limit of 1.5 mg/l TN (MDNR, 2005). In addition, monitoring by local groups has shown that bacteria levels in Pearson Creek exceed state standards periodically. The City of Springfield modified its storm water monitoring efforts in 2006 to include Microtox testing to identify potentially toxic pollutants entering waterways (MDNR-ESP, 2004). The City of Springfield has not identified any toxic pollutant above detection in samples collected from Jones Branch within the Pearson Creek watershed (City of Springfield, 2009).

The Environmental Protection Agency (EPA) presented the draft Pearson Creek Total Maximum Daily Load (TMDL) to the public in September 2010 to meet the obligations of the 2001 Consent Decree, *American Canoe Association, et al. v. EPA*, No. 98-1195-CV-W in consolidation with No. 98-4282-CV-W, February 27, 2001 (EPA MO_2373, 2010). The purpose of a TMDL is to determine the maximum amount of pollutant mass (i.e. the load) a water body can assimilate without exceeding the Water Quality Standards (WQS) for that pollutant. Point sources, nonpoint sources, and a margin of safety or uncertainty are used to derive the loading capacity for the water body. The goal of the TMDL program is to restore designated beneficial uses to water bodies.

The Pearson Creek TMDL finalized in January 2011identifies the effects of urban runoff as the major threat to water quality in Pearson Creek and aims to reduce the frequency and magnitude of high flows to improve water quality. Past research was used to conclude that combined effects from “multiple stressors” from higher metals, nutrients, organic compounds, water temperature and decreased levels of dissolved oxygen and “impacts” from physical changes to bank and bed characteristics from increased storm water contributions from urban areas justified the use of stream flow targets as a surrogate for specific pollutant thresholds. A biological reference stream flow duration curve was created from combined data from Bryant Creek, Bull Creek, the North Fork, and Spring Creek and was compared to the Pearson Creek flow duration curve to set the in-stream water quality target. The Pearson Creek TMDL states that flow targets and fully supporting biological ratings for survey sites can be accomplished through actions associated with permitting processes in Greene County and Best Management Practices (BMPs) that focus on reducing storm water runoff in the watershed.

On-going urbanization within the Pearson Creek watershed, decreasing trends in the quantity and quality of aquatic life, unique karst features linking surface water to ground water, and mobilized contaminated sediment from historical land use all indicate that the Pearson Creek watershed has immediate and sustained impacts from anthropogenic and natural activities that require investigation.

The Show-Me Yards, Neighborhoods Farms and Ranches (SMYNFR) program will target suburban homeowners and small acreage land owners (300 acres or less) that do not qualify as commercial agricultural operations. This program targets landowners located in the Pearson Creek watershed. Cost share incentives will encourage these home and landowners to use Low Impact Development (LID) techniques and BMP’s as they maintain and manage their small suburban lawn, farm, or ranch. The SMYNFR program will contribute to ongoing efforts to meet Pearson Creek TMDL flow targets and fully supporting biological ratings. This QAPP supports the monitoring activities of the SMYNFR project and the objectives include:

1. Use standard methods and an approved QAPP to perform a scientific assessment of the water quality conditions present in tributary and main stem sites in the PCW.
2. Measure the levels of pH, temperature, specific conductance, dissolved oxygen, turbidity and concentrations of TN, TP, TSS, bacteria, and chlorine in base flow and storm runoff in Pearson Creek and Jones Branch and use this data to compare pre- and post BMP implementation.
3. Sample storms using auto samplers and sample baseflow manually.
4. Measure discharge at the time of sampling and where possible develop rating curves and flow duration tables to use for mass load calculations.
5. Compare findings of the current project with historical information about the measured parameters.
6. Use STEPL modeling to determine load reductions and BMP effectiveness with local discharge, water quality, watershed, and event load data used to calibrate and refine model output.
7. Evaluate water quality linkages between upland nonpoint sources and downstream TMDL water bodies.

Project /Task Description

The project schedule and time line (Table 2) and Pearson Creek Watershed water monitoring site information is included in this QAPP (Table 3). To address the objectives described above, five sources of discharge and water quality data will be collected to support the monitoring needs of the SMYNFR 319 project.

1. Stormwater runoff - The MDNR 319 staff indicated during recent correspondence that sampling over individual storm hydrographs is needed in Pearson Creek. The only way to effectively sample runoff events in a watershed this size where flows are relatively flashy, is by the use of auto-sampler devices which continuously monitor flow stage and rainfall and collect discrete water samples at pre-determined time intervals during rising limb, peak, and falling limb flow periods. With this approach, water samples can be composited over time within a single sample for a given runoff event or evaluated as a series of individual samples collected during the passage of high flow or the flood wave. This type of water quality data is very useful for determining the full range of pollutant concentrations occurring during runoff events, identifying source characteristics of specific pollutants, and accurately and precisely calculating pollutant loads. Typically one auto-sampler can sample 5 to 10 runoff events per year collecting an average of 10 samples per event at each site. Three auto-samplers will be deployed for the SMYNFR 319 project at three sites to collect runoff events.

Three auto-samplers will be purchased for stormwater sampling, there are not extra auto-samplers available for this project. Samples collected by the auto-samplers will be analyzed for total nitrogen, total phosphorus, chloride, and total suspended solids. Handheld multiprobes will collect measurements of temperature, pH, conductivity, turbidity, and dissolved oxygen.

2. Baseflow conditions - Previous monitoring data collected from Pearson Creek indicate that water quality can be impaired at low flow conditions especially for bacteria and total nitrogen. This situation is of particular concern in the Pearson Creek Watershed because low flow contributions come largely from springs draining a widespread underground karst network that is known to connect at the surface to various urban and rural nonpoint source areas. Therefore, baseflow sampling in karst areas can indicate the overall chronic water quality condition of the stream as affected by the combined influence of groundwater and stormwater inputs. One to two depth-integrated samples will be collected at each site each month during base or low flow periods for the SMYNFR 319 project as precipitation patterns and stage dictate. Samples will be analyzed for total nitrogen, total phosphorus, chloride, total suspended solids, total coliform, and *E.* coli. Handheld multiprobes will collect *in-situ* measurements of temperature, pH, conductivity, turbidity, and dissolved oxygen.

3. Calibration measurements for discharge-stage rating curves- To convert continuous measurements of water depth or stage at an auto-sampler station to instantaneous discharge values, additional flow area and velocity measurements are needed to develop an accurate state-discharge relationship or “rating curve.” Discharge values are needed to determine flow rates and calculate pollutant loads. Indirect methods such as the Manning equation or various weir equations can be used to calibrate stage-discharge rating curves too, but for variable cross-sections such as those found along Pearson Creek, direct discharge measurements over a range of flow conditions are more accurate. Typically, five or more calibration discharge measurements are needed for each site ranging from summer low flow to near bankfull flood stages, so at least five calibration discharge measurements will be collected for the SMYNFR 319 project.

4. Continuous USGS gaging station (non-direct measurements) - There is an active USGS gaging station (#07050690) located on lower Pearson Creek at old Sunshine Street called “Pearson Creek near Springfield”. The gage is located about 1 mi from the James River, drains 21 mi^2, and has been in operation since 1999. USGS discharge records for this gage will be used for historical analysis of flow variability in Pearson Creek. In addition, continuous and real-time discharge data from the gage will be used to calibrate the auto-sampler stage-discharge rating curve at this site, thus reducing the need for field calibration monitoring at this site.

5. Historical water quality data (non-direct measurements) - Water quality data has been previously collected from Pearson Creek by several agencies, universities, and groups for a variety of reasons. The James River Basin Water Quality Gap Analysis Report written by OEWI and MEC Water Resources in 2007 and the Pearson Creek TMDL (2011) report that relatively precise data has been collected by the USGS, Missouri State University, Watershed Committee of the Ozarks, and Springfield City Utilities. This information will be reviewed and evaluated for use in historical water trend analysis for baseline load calculations and BMP effectiveness and STEPL load reduction modeling for the SMYNFR 319 project.

In addition to the information collected by OEWRI as explained above, soil samples will be collected by JRBP on private properties within the watershed and analyzed by the MU Extension (University of Missouri Extension, 2011) to develop nutrient management plans that will assist property owners regarding fertilizer application. Nutrient management plan development is in accordance with monitoring objectives and overall SMYNFR program goals.

Project assessments will be conducted through the project and discussed in greater detail in the Assessments and Response Actions section.

Data Quality Objectives and Criteria for Measurement Data

The goal of this project is to fulfill the monitoring portion of the James River basin Partnerships' grant obligations in reporting load reductions. All field and laboratory analytical data are evaluated based on established measurement performance criteria as listed in Table 4. The data derived from this project will be used to report changes in water quality resulting from project activities, such as the implementation of best managements practices.

Data Quality Indicators, Definitions

Accuracy: a measure of the overall agreement of a measurement to a known value; includes a combination of random error (precision) and systematic error (bias) components of both sampling and analytical operations. Accuracy will be measured by analyzing a reference material and spiked matrix samples (see Table 4).

Bias: a consistent deviation of measured values from the true value, caused by systematic errors in a procedure. Bias will be measured by analyzing reference materials and spiked matrix samples (see Table 4).

Comparability: the measure of confidence that one data set can be compared to another and can be combined, if applicable, for decision making. Water samples are collected and analyzed according to the standard operating procedures used at Missouri State University and OEWRI for all water quality projects. Individual standard operating procedures reference scientific-community approved analytical methods.

Completeness: a measure of the amount of valid data needed to be obtained from a measurement system. It is expected that all samples will be collected and analyzed. The minimum amount of valid data needed for each parameter to meet project goals is 100% of the 6 storm flow sampling events that will be sampled at a minimum during the sampling period. The minimum amount of valid data needed for each parameter to meet project goals is 100% of the 16 low flow sampling events that will be sampled at a minimum during the sampling period.

Precision: a measure of the degree of agreement among replicate analyses of a sample. For this project, one sample per event will be collected in duplicate (field duplicates) and single samples per batch will be analyzed in duplicate in the laboratory (laboratory duplicates) (see Table 4).

Representativeness: the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. For the goals of this study, these runoff and baseflow event samples will be considered representative of the physical conditions found at the collection sites within the Pearson Creek Watershed.

Sensitivity: the capability of a method or instrument to discriminate between measurement responses representing different levels of the variable of interest. This is also known as the detection limit. The method detection limit (MDL) for each parameter is determined for each analytical batch (see Table 4).

Special Training and Certification

All personnel who collect and analyze water samples for this project will receive appropriate training from the OEWRI project manager and OEWRI laboratory manager for all methods needed to complete the project following the necessary SOPs and standard methods. Records of this training will be kept with other documents related to this project. The final storage location for these records will be the OEWRI office (currently room 328 Temple Hall).

Melissa Bettes of the James River Basin Partnership is a certified soil scientist in the state of Missouri and will conduct the soil sampling. The MU Extension laboratory will perform analytical procedures for the soil samples collected by JRBP. Certification and other soil records related to this project will be kept in a file at the JRBP office. Upon completion of the project, all relevant hardcopy files will be transferred to the JRBP office for long term storage.

Documents and Records

The documents and records produced for this project will be stored in the OEWRI office in a file entitled: “SMYNFR 319 (2012-2014)”. The documents listed below will be included in this file. Electronic copies of all reports, plans, and procedures will be issued to all individuals on the distribution list, unless otherwise requested. A paper copy of each document will be kept on file in the OEWRI office. The James River Basin Partnership will store these types of files associated with the soil tests and nutrient management plans at the JRBP office.

Upon completion of the project, all relevant hardcopy files will be transferred to the JRBP office for long term storage. Documents and records will be retained for a minimum of five years. After that time the documents will be reviewed and a decision to retain the records for a longer period will be made. Electronic records are retained on the server at MSU and JRBP. There is a system in place to automatically backup all data files.

Quality Assurance Project Plan (QAPP): This document will be updated as needed by the QA/QC coordinator. The MDNR project manager, through the 319 QAPP coordinator, must then approve any updates prior to those changes being distributed. Updates may require that the document be reprinted and distributed to those listed in Table 1. If the changes do not alter the plan the QA/QC coordinator may use e-mail to notify the personnel on the distribution list of the changes.

Standard Operating Procedures (SOPs): Analytical, collection, and other procedures are documented in individual SOPs. These documents are prepared, edited, and updated by the QA/QC coordinator. Project personnel are required to review all SOPs that pertain to their functions and responsibilities. Outdated SOPs are archived in the OEWRI office in both a paper and electronic versions. SOPs used for this project are listed in Appendices A and B and referenced, where necessary, throughout the document. In addition, electronic copies of the OEWRI SOPs are available at the following website: http://oewri.missouristate.edu/58411.htm.

Chain of Custody forms/Sample Log forms: Chain of custody/sample log forms are completed for each sample collection run. Copies of these forms are stored with the project data in the OEWRI office (Appendix D).

Field Notebooks: Field notebooks will be completed for this project. Any data related to this project will be recorded within the book. The field personnel will keep appropriate records of field events and include such items as sites visited, time of arrival, samples collected, weather conditions, etc. The analyst should sign or initial for each date that the notebook is used. These notebooks will be archived with the project records in the OEWRI office.

Laboratory Bench sheets: These forms are generated with each analysis. They may include forms, computer printouts, or other records of analytical procedures. Sample and quality control data will be included on these forms. These are stored with the project data file.

Quality Assurance documents: Any document that describes QA processes in the field or laboratory and related to this project will be stored in the OEWRI office with other records for this project. Some records are continuous, for example, instrument maintenance data, and remain with the instrument in log books that are attached to that instrument.

Analytical and Final Monitoring reports: A copy of all analytical reports and the final monitoring report will be kept in the OEWRI office. These reports may also include presentations given to the community as requested by the grant administrator; copies or the original will be stored in the OEWRI office.

DATA GENERATION AND ACQUISITION

Sampling Process Design

Baseline water quality analysis for this project will utilize two methods: (i) simple time series trend analysis which tests for differences in pollutant concentrations over time using regression analysis, identifying trends as increasing, variable/no trend, or decreasing over time and (ii) load duration method which combines the annual discharge frequency distribution at a site with the expected pollutant concentration or load at a given discharge to determine the flow frequency-weighted mean concentration or load. This coupled analytical approach will be used to determine annual nonpoint loads at the three sampling sites during the sampling period and the expected variability of those loads during the historical data period.

Storm water loads derived from the above analyses will be combined with data on watershed climate, soils, and land use to model load reduction and BMP effectiveness. STEPL (Spreadsheet Tool for Estimating Pollutant Load) is a customizable spreadsheet-based model for use in Excel software that can help evaluate different BMP implementation options. OEWRI will use local data to allow more representative results for the Pearson Creek Watershed.

All data collected will be used to evaluate water quality trends and loads associated with TMDL-targeted pollutants of concern as follows:

1. Discharge and water quality sampling will be used to develop load duration curves and calculate baseline pollutant loads for each of the three sampling sites.

2. Runoff and base flow concentration and annual load values will be compared to TMDL targets and regional values.

3. Historical discharge and water quality data available for each main stem site will be compared to 319 project period water quality trends and used as a base line for comparison with future water quality projects.

4. STEPL modeling for each site for this project in Pearson Creek will be used to estimate nonpoint load reductions and evaluate BMP effectiveness.

The objective of activities detailed in this QAPP is to fulfill the water monitoring portion of the James River Basin Partnerships' grant obligations. Site locations are listed in Table 3 and illustrated in Figure 3. Table 5 lists the sampling techniques at each site as well as the analytes of interest.

The sampling sites were selected based on accessibility for sampling, suitability for the project, size, water volume in the channel during baseflow conditions, location in the watershed, and land use distribution within the watershed. Sites will be sampled according to procedures in SOPs: Auto-sampler and 1040R03 Water Sampling. Depth-integrated sampling will occur at the sites during base- or low-flow conditions by suspending the sampler over the bridge at the site and sampling the entire water column. One to two depth-integrated samples will be collected at each site each month during base or low flow periods for the SMYNFR 319 project as precipitation patterns and stage dictate. Auto-samplers will be programmed to collect samples during storm or runoff events and will sample discretely throughout the entire hydrograph. Typically one auto-sampler can sample 5 to 10 runoff events per year collecting an average of 10 samples per event at each site. Auto-samplers will be programmed to collect samples at 30 minute intervals initially. Frequency of sampling will be lengthened if the entire carousel fills prior to sampling the falling limb of the hydrograph so that entire storm events are sampled. Data from the continuous stage recorders (leveloggers) will provide hydrographs of each event and those will be used to make adjustments in sampling frequency. Samples will be retrieved from auto-samplers within 12 hours of the event, if sites are inaccessible beyond the 12 hours, samples will not be collected for that event. Variability due to equipment malfunction or inaccessibility during storm events will be compensated for by additional sample collection and analysis beyond stated storm event thresholds in this QAPP unless drought conditions persist and events are non-existent. All effort will be made to ensure personnel safety as well as full datasets at each site.

Discharge data will be obtained from the USGS gage at site 3 and continuous stage data will be downloaded from leveloggers installed at sites 1 and 2. Leveloggers and the barologger will be secured within protective PVC piping. The levelogger will be set to collect data at 15 minute intervals to start, but may adjust based upon information received during the project period to determine if the data collection interval can be scaled back (e.g. 30 minute intervals). Data will be downloaded during each site visit. Levelogger data will be downloaded by OEWRI field personnel onto a laptop in the field and then transferred to the project file on the project managers computer.

Precipitation data will be recorded from the auto-samplers and the USGS gage. The City of Springfield's rain gage network sites in the Pearson Creek Watershed will also be used to determine antecedent conditions prior to base- and low-flow sampling. Precipitation data from the AT&T Communications, Blackman Intake, and Pittman Elementary sites will be used.

Soil sampling and nutrient management plans produced by the James River Basin Partnership will provide property owners the resources to reduce nutrient loads in the watershed. Timing and location of soil tests will be determined by citizen involvement. Soil samples will be collected for the determination of soil pH, phosphorus, potassium, calcium, magnesium, organic matter, cation exchange capacity (CEC), and neutralizable acidity. The soil sampling will occur after a soil test survey has been completed and the area of the fertilized parameter will be measured following soil sampling. The JRBP's Soil Sampling and Nutrient Management Plans SOP, that is consistent with the University of Missouri Extensions soil testing procedures, will be used to collect soil samples. Additional information can be found at: http://jamesriverbasin.com/pages/soil_test. Soil test results from the MU Extension will be used to determine a 4-year nutrient management plan using NRCS-approved TRIM-N software for each participant.

Sampling Methods

The sampling sites listed in Table 3 were selected based on accessibility for sampling, suitability for the project, size, water volume in the channel during base flow conditions, location in the watershed, and land use distribution within the watershed. Figure 3 illustrates each site. Table 5 lists sampling techniques and Table 6 summarizes sample storage conditions for each parameter of interest. Water samples will be collected by OEWRI field staff and delivered to the OEWRI laboratory within the same day. Any corrective actions will be taken by field and/or laboratory personnel as deemed appropriate and communicated with the JRBP project manager and QC coordinator as needed. JRBP project manager will collect soil samples and will be responsible for taking any necessary corrective action as needed. Soil samples will be collected on day 1, allowed to dry overnight, and will be shipped to the soil laboratory on day 2.

Auto-samplers will be installed at each of the three sampling sites. Bottles will be placed in the auto-samplers prior to a sampling event and samples collected will be used to supply sample for each of the parameter-specific bottles. Parameter-specific bottles will be cleaned by OEWRI using procedures included in the Preparation of Sample Bottles For non-Metals Analyses (SOP: 0150R01 Bottle Prep non-Metals) prior to sampling events. A peristaltic pump will pull samples into individual bottles (sequential sampling) at user-defined time intervals spread throughout the entire storm event. Water samples will be collected from storm flow events that produce at least 4 samples per auto-sampler. Storm events are defined as at least 0.2 inches but less than 3 inches within a 24 hour period and are preceded by at least 24 hours with no precipitation greater than 0.1 inch. Samples will be collected during each storm event throughout each season of the 16 months of the sampling period not to exceed 8 events per year. Individual samples from each auto-sampler will be analyzed for total phosphorus, total nitrogen, and total suspended solids. All samples collected from the autosamplers will be homogenized prior to pouring and/or splitting samples into appropriate sample containers. Variability due to equipment malfunction or inaccessibility during storm events will be compensated for by additional sample collection and analysis beyond stated storm event thresholds in this QAPP unless drought conditions persist and events are non-existent. All effort will be made to ensure personnel safety as well as full datasets at each site. Information regarding equipment malfunctions or onsite issues will be immediately told to the OEWRI project coordinator, Heather Hoggard, and steps will be taken to address the issue including the deployment of OEWRI personnel to fix items such as auto-samplers. Autosamplers will be housed in securely mounted locked boxes to prevent tampering and to protect the samplers from environmental conditions. Autosamplers will be removed from the boxes and stored at OEWRI during long periods of excessive heat and as weather forecasts indicate prolonged periods with no precipitation.

Depth-integrated sampling will occur at the monitoring sites during base- or low flow periods occurring to OEWRI's Water Sampling SOP. Depth-integrated samplers have a nozzle that transfers water from the channel into the sample bottle as the sampler is lower throughout the water column to sample the entire water column. Water samples are collected within the thalwag of the channel using one continuous vertical motion throughout the entire water column without pausing when the channel bed is reached. The channel width, depth, and flow rate as well as the volume of the sample container dictate the size of nozzle used. At least one low flow sample and up to two low flow samples will be collected monthly at each monitoring site and analyzed for total phosphorus, total nitrogen, total suspended solids, and total coliforms. Real-time precipitation gages located on schools within the watershed will be used by personnel to determine when to sample base- or low flow conditions.

Surface water samples for nutrient analysis will be collected by an ISCO auto-sampler (SOP: Autosampler.pdf) during storm flow events and by the depth-integrated sampling technique (SOP: 1040R03 Water Sampling.doc) during low flow events using 1000 ml plastic bottles from flowing water at each site as listed in Table 5. Bottles will be cleaned using procedures included in the Preparation of Sample Bottles For non-Metals Analyses (SOP: 0150R01 Bottle Prep non-Metals) prior to sampling events. Both types of sampling will produce discrete samples and field blanks will be collected for each type of sampling. A field duplicate will be collected during each low flow sampling event and the site chosen to duplicate will vary. Samples will be placed on ice during transport (SOP: 1040R03 Water Sampling.doc), transferred to the laboratory with appropriate chain of custody form (SOP: 1030R01 Chain of Custody), 400 ml of sample from the original 1000 ml bottle will be split into a separate 500 ml plastic bottle, preserved with sulfuric acid to a pH ≤2, and analyzed prior to hold times which are listed in Table 6. Sample bottles will be cleaned and reused (SOP: 0150R01 Bottle Prep non-Metals). Table 7 lists equipment requiring maintenance and calibration. Multiple components of the auto-samplers are inspected weekly via protocol from SOP: Autosampler.

Surface water samples for total suspended solids and chloride will be split from the samples collected by either the ISCO auto-sampler (SOP: Autosampler.pdf) during storm flow events or by the depth-integrated sampling technique (SOP: 1040R03 Water Sampling.doc) during low flow events. Samples transferred to the laboratory with appropriate chain of custody form (SOP: 1030R01 Chain of Custody) will be split and analyzed prior to hold times as listed in Table 6. Approximately 100 ml of sample will be transferred from the original 1000ml bottle to a 100 ml glass container for chloride analysis and the remaining 500 ml will remain in the original 1000 ml sample bottle for total suspended solids analysis. Samples are not preserved with acid. Sample bottles will be cleaned and reused (SOP: 0150R01 Bottle Prep non-Metals).

Surface water samples for bacteriology analyses will be collected by the grab sampling technique (SOP: 4010R01 Ecoli IDEXX.doc) from flowing water. The 100 ml Thio-Test bag will be attached at the end of a sampling pole that is dipped into the stream to collect water for total coliform and *E.* coli analysis. One duplicate sample will be taken during each sampling event. Care will be taken to not skim the surface while collecting samples. Samples will be placed on ice during transport, transferred to the laboratory with appropriate chain of custody form (SOP: 1030R01 Chain of Custody), and processed immediately upon returning to the laboratory. The bacteriology Thio-Test bags are sterilized by the manufacturer and will be discarded after use.

A Horiba multiprobe (SOP: 1050R02 Horiba U-22.doc) will be used to collect *in situ* pH, temperature, conductivity, dissolved oxygen, and turbidity data in the field for depth-integrated samples and in the laboratory for auto-sampler collected samples. One duplicate reading for each parameter will be taken during each sampling event. Sites chosen for duplicate readings will vary. Table 7 lists equipment requiring maintenance, testing, and inspection. Horiba multiprobes are auto-calibrated before each use via protocol from SOP: 1050R02 Horiba U-22.doc and cleaned after each use.

All water quality data derived for this project will be reviewed by the analyst, the OEWRI QA/QC coordinator, and by the project supervisor. The quality control corrective action plan is detailed in Table 8. All data will be stored in Excel and Word files dedicated to this project. These electronic files are stored on the computer server with controlled access so these files will be limited to MSU personnel associated with this project. The OEWRI project manager will forward project information to additional parties.

A rating curve will be established to predict discharge based on stage recorders at all of the sites. Each monitoring site will be visited and surveyed for channel dimensions and bed slope which will be used to calculate the capacity of the channel. Discharge will be measured at sites 1 and 2 and discharge from the USGS gaging station at site 3 will be used. Discharge rating curves will be created using the gage depth – discharge relationship for each site for the range of flow expected at each site. Equations from rating curves will be used to estimate discharge based on the stage records downloaded from the stage recorder (SOP: Levelogger) installed at each site. Raw data collected at 30 minute intervals will be downloaded each time that the site is visited. Because there are inherent errors in estimating discharge from equations, the rating curve will be calibrated with field measurements of discharge at each site. A minimum of eight flow measurements at low, moderate, and high stages at each site will be used to calibrate each rating curve. Flow measurements will be collected using two types of methods. When the water level is relatively low an Acoustic Doppler Velocimeter (ADV) (SOP: Velocimeter R01) will be used. When the water level is relatively high a propeller style flowmeter (SOP: Flowmeter R01) will be used to measure an average velocity. Site 3 has a USGS gaging station already in place that provides real-time discharge data via the internet. Table 7 lists equipment requiring maintenance, testing, and inspection. Velocimeters, and flowmeters undergo a performance check before each use via protocol from SOPs: Velocimeter R01 Flowmeter R01. The final monitoring report will include a discharge calibration section.

Data processing will involve the creation of concentration and load frequency relationships using the load-duration curve method (Crawford, 1996). The influence of nutrient management plan implementation in the watershed on load reductions will be calculated from field data and estimated from a predictive model (STEPL). Spreadsheet Tool for Estimating Pollutant Load (STEPL) uses simple algorithms to calculate nutrient and sediment loads from different land uses and load reductions from implementation of BMPs. Annual nutrient loading will be calculated based on the runoff volume and pollutant concentrations. The annual sediment load from sheet and rill erosion will be calculated based on the Universal Soil Loss Equation (USLE) and the sediment delivery ratio. Loading reductions resulting from the implementation of BMPs will be computed from the known BMP efficiencies. Accuracy is primarily limited by the wide variability in event mean concentrations (EMCs) across watersheds since EMCs are used to calculate annual pollutant loadings. Water quality linkages will be evaluated between upland nonpoint sources and downstream water bodies with established TMDLs.

The JRBP will complete soil sampling and nutrient management plan development. Timing and location of soil tests will be determined by citizen involvement. Soil samples will be collected by JRBP using sample kits from the University of Missouri Extension Soil Testing Laboratory (SOP: Soil Sampling and Nutrient Management Plans). Soil sampling procedures that will be used are consistent with the University of Missouri Extensions procedures: http://soilplantlab.missouri.edu/soil/. Soil samples will be collected using a small shovel or soil probe. Random samples from the lawn will be taken as a whole unless there is a need to sample problem areas separately. Areas near and around driveways, sidewalks, flowerbeds, down-spouts, drip lines of trees or houses, pet waste storage areas, and septic systems will be avoided. Samples will be collected to a 3 inch depth on established lawns or to a 4-6 inch depth on un-established lawns before seeding occurs. Five or more random cores will be taken from each area of the lawn to be combined and the thatch and live plant material will be removed. The cores will be thoroughly mixed in a dry plastic bucket. A representative sample will be removed from the bucket, placed in the sampling container, and air-dried overnight. The Horticulture Soil Sample Information form will be filled out and the sample will be shipped to the MU Extension laboratory. Soil samples will be collected by JRBP but analyzed by the University of Missouri Extension Soil Testing Laboratory for soil pH, phosphorus, potassium, calcium, magnesium, organic matter, cation exchange capacity (CEC), and neutralizable acidity (Table 4). The soil sampling will occur after a soil test survey has been completed and the area of the fertilized parameter will be measured following soil sampling. Soil analysis results will be used by JRBP to develop a 4-year nutrient management plan using NRCS-approved TRIM-N software for each participant.
All soil samples from this project will be analyzed by the University of Missouri Extension Soil Testing Laboratory from Portageville, MO and soil data will be reviewed by the analyst prior to reporting. Soil amendment recommendations will be provided by University of Missouri Regional Horticulture Specialists and reviewed by supervisory

staff. The individual Nutrient Management Plans will be developed by the JRBP project manager and certified by USDA/NRCS resource conservationists.

All soil data and nutrient management plans will be stored in Excel and Word files dedicated to this project. These electronic files are stored on the computer server with controlled access so these files will be limited to MSU personnel associated with this project. The JRBP project manager will forward project information to additional parties.

Sample Handling and Custody

See Table 6 for sample handling conditions for each water quality analyte of interest for this project. Containers for soil sampling are provided by the University of Missouri Extension. Soil samples are not preserved and do not have hold times associated with the analytes of interest for this project. Soil samples are dried at <85º F and passed through a 2 mm screen prior to analysis at the laboratory (University of Missouri Extension, 2011).

Water quality parameter data is stored on the Horiba. The data will be transferred from the instrument to the laboratory computer upon return to the laboratory. Field conditions such as changes to the channel or sampler condition will be recorded in the SMYNFR 319 (2011-2013) field notebook.

Water samples are collected in appropriate bottles for each parameter. A label will be affixed to or written on each container and will contain the following information: date and time of collection, site code, project, list of analytes, and sample collector's initials (SOP: 1040R03 Water Sampling.doc). The combination of site code and project ID will provide a unique identification system per monitoring site. After collection, the bottles are placed into a cooler containing ice, the samples are transported to the laboratory and split into appropriate bottles, and the proper preservative is added to bottles for analytes requiring chemical preservation (Table 6).

A sample collection form will be completed for each set of samples. The chain of custody section of the sample collection form will be completed as the samples are transferred at the laboratory following the instructions outlined in the SOP (1030R01 Chain of Custody). Information included on the COC includes the site ID, sample type, container type, preservative, time collected, and the sampler's initials. Each sample will be tracked by this chain of custody record that serves to efficiently document the individuals who were responsible for the sample during each successive transfer of that sample to the OEWRI laboratory.

Samples that are not used for immediate analysis will be stored in the laboratory refrigerator. Upon completion of the analyses, including review of data, the sample may be discarded. Re-analysis can occur if sample remains in the bottle and the hold time has not been exceeded. At no time will a re-analysis take place on samples when the hold time has expired.

Soil samples are collected in appropriate containers. A label will be affixed to or written on each container and will contain the following information: date and time of collection, site code, project, list of analytes, and sample collector's initials (SOP: Soil Sampling and Nutrient Management Plans). After collection, the samples are air-dried, the Horticulture Soil Sample Information form is filled out, and the sample is shipped to the MU Extension laboratory. Soil boxes are pre-numbered when received by the MU Extension.

Analytical Methods

See Table 4 for a list of analytes, instruments used, responsible party for data production, SOPs, analytical method references, and method performance criteria. Analyses are completed as soon as possible after collection and within the allowable holding times. Samples are not disposed of until after the analyses are complete and data has been reviewed and approved by the laboratory and QA/QC manager.

When problems arise with the analytical method, for example, blanks exceeding the detection limit, the procedures will be reviewed by the analyst and the QA/QC coordinator and/or the project management. Corrections will be made and samples re-analyzed if possible as listed in Table 8: Quality Control Corrective Action Plan. The problem will be documented in the parameter QA/QC files.

Quality Control

Quality control is the overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet stated requirements. Quality control activities ensure that measurement systems are maintained within prescribed limits and that results are of acceptable quality. Quality control specific to field equipment and laboratory instrumentation used are provided by each individual SOP.

The quality control checks used in this project are listed in Table 4. Field and laboratory blanks and duplicates will be used as a check for precision. Matrix spikes, check standards, and calibration standards are used to measure bias and accuracy. Sensitivity is determined by analyzing equipment blanks and reagent blanks.

One field blank will be collected during each sampling event. One field duplicate will be collected for every sampling event. Laboratory duplicates will be analyzed at a frequency of one per 10 samples analyzed. One laboratory spiked sample will be analyzed for every batch of samples analyzed. The laboratory blank and check standards will be analyzed after every 10 samples analyzed.

Individual SOPs or standard methods specifically present all equations used to determine quality control measures for each parameter associated with this project. Relative percent difference (RPD) will be calculated for pairs of duplicate analyses to determine precision. The coefficient of variation (CV%) will be used to determine precision if triplicates are required for specific parameters. Accuracy will be determined by calculating RPD between multiple analyses of manufacturer- or laboratory-certified standards throughout each batch of samples. The effectiveness of digestion procedures will be determined by calculating percent recovery of matrix spike solutions. The Method Detection Limit (MDL) for each type of chemical analysis is calculated by multiplying 3.14 and the standard deviation of multiple analyses of the blank associated with the analysis. The “3.14” value is derived from the table of a one-sided *t* distribution when a 99% confidence level is desired.

Quality control data outside the acceptance limits or exhibiting a trend are evidence of unacceptable error in the analytical process. The QA/QC manager initially reviews the data prior to report tabulation. If data are outside of acceptance limits the laboratory manager and QA/QC manager determine the probable cause and make corrective actions as soon as possible to determine and eliminate the source of the error. The analyst is responsible for understanding when the analytical process is out of control. See Table 8 for error types and corrective action measures. All corrective actions taken will be recorded in the instrument log book by the analyst or laboratory manager to be used as a reference to avoid repeating the same error.

If a sample batch is reanalyzed because a QC sample was out of control, the second set of results will be reported if all QC are within established limits for the project. However, a comment will be written on the data report that the data is a reanalysis and the reason for the reanalysis will be recorded by the QA/QC manager. The initial analysis data sheet will be retained for the QC file associated with the project. All QC data, in and out of control, will be recorded on the control charts. In addition to the QA/QC and laboratory manager review of the data, the project manager and principal investigator review all field and laboratory reports before distribution.

Instrument and Equipment Testing, Inspection, and Maintenance

Field and laboratory equipment and instruments will be maintained by field and laboratory personnel to prevent down time and missed sample data. See Table 7 for a list of instrumentation and equipment and the approximate schedule for preventive maintenance. Preventive maintenance procedures and calibration procedures are also listed in the SOPs included in Table 7. Preventive maintenance activities will be recorded in the log book associated with the instrument. After a corrective activity has been completed, the instrument will be tested to ensure that it functions appropriately for the analysis in question. OEWRI has backup equipment such as multiple multiprobes and duplicate sets of instrumentation available for use if field equipment or laboratory instrumentation continues to malfunction.

For routine maintenance procedures an adequate supply of spare parts are kept on hand in the water and soil laboratory and field equipment room. New parts will be purchased before they are needed. When parts are no longer functioning, they will be replaced. If there is a major instrument break down the manufacturer may be contacted to perform a service call for repairs.

Instrument and Equipment Calibration and Frequency

Laboratory and field analytical instrumentation require calibration to ensure quality data. Calibration procedures follow the instrument manufacturer's recommendations and OEWRI SOPs. Field personnel calibrate field equipment according to Table 7 and specific OEWRI SOPs. Laboratory personnel calibrate instrumentation according to Table 7 and specific OEWRI SOPs. The QA/QC coordinator reviews all data.

Initial calibrations of field and laboratory instruments will be performed before each batch of samples. If linear regression is used to fit the calibration curve, then the minimum correlation coefficient value should be 0.995. To determine if calibration points are acceptable, compare each point to the curve and recalculate. An acceptable point will result in a calculated value of the expected value ±10% (Standard Methods, 2005). Initial calibrations are recorded by the technician and included within the data set that is reviewed by the QA/QC coordinator. Calibration is recorded in laboratory datasets for each batch analyzed. Calibration of field equipment is recorded in the field notebook associated with the project and is included in the field preparation check list.

Calibration verification will be done by analyzing a calibration standard periodically to ensure that the instrument performance has not changed. Analysis of the verification (check) standard will be after every 10 samples during the analytical run. A verification (check) standard will be acceptable if its value is within ±10% of the expected value. Instrument performance checks are recorded by the technician and included within the data set that is reviewed by the QA/QC coordinator.

See Table 7 for a list of instruments that require calibration. As detailed description of the calibration procedure is included in the respective SOPs for the analytes of interest. The project manager and laboratory manger are responsible for training field and laboratory personnel.

Inspection and Acceptance of Supplies and Consumables

Field staff will be responsible to calibrating and checking field equipment while the laboratory analyst will track laboratory instruments/equipment as specified in Table 7. Any deficiencies will be documented on the appropriate field or laboratory form/notebook and communicated to the OEWRI project manager for resolution as needed.

Adequate quantities of supplies and consumables are inventoried for this project. When the number of items needed begins to run low, replacements are ordered from the vendor. Chemicals are ordered as needed for laboratory analyses by the laboratory manager. Reference standards for calibrating instruments are received with “certificates of analysis” documents from the supplier. “Critical” supplies and consumables are listed specifically for each analyte of interest within the respective SOP for that analyte. Specific supply sources and acceptance criteria are also listed in specific SOPs for each analyte. The laboratory manager will receive and inspect supplies and consumables upon delivery and return them if they do not met specifications. There are no field supplies beyond coolers and a field notebook required for this project.

Bottles used to collect samples will be reused throughout the sampling period. Individual parameter bottles used to store splits of samples will also be reused throughout the sampling period. All sample bottles will be emptied, rinsed with tap water, washed with a 2% solution of Citranox, rinsed with deionized water (DI), soaked in 10% hydrochloric acid or nitric acid (depending on the parameter to be collected in the bottle) overnight and rinsed with DI water again (SOP: 0150R01 Bottle Prep non-Metals). The bottles are allowed to drain dry and then are stored in sealed plastic containers until use. Sample blanks will routinely be analyzed for all of the parameters of interest. The hydrochloric and nitric acid solutions will be tested by the cleanliness of the bottles as indicated by the results of the blank for each batch. If the bottles show no residual for the parameters of interest, then the acid solutions will be considered “clean” enough for this procedure. The solution will not be re-used beyond six months after its preparation.

Analysts will employ good laboratory practices and observe all processes for changes that may be caused by a new batch of supply items. If a process does appear to be affected by a supply item, a corrective action response will be initiated. This may require discontinuing the use of that item and ordering replacement items as well as reviewing protocol with the analyst.

Non-direct Measurements

One non-direct discharge measurement is required for this project. That measurement will be taken from the USGS gage on Pearson Creek http://waterdata.usgs.gov/usa/nwis/uv?07050690. Precipitation data will also be referenced from a website maintained by the City of Springfield: www.123mc.com/ . Precipitation gages supported by this network that are within the project watershed include: AT&T Communications, Blackman Intake, and Pittman Elementary. Precipitation from these sites will be monitored in addition to auto-sampler and USGS precipitation data to assist with low and base flow sample collection.

Data Management

Data are generated in many steps from field sample collection to laboratory analyses, calculations, and observations. All data are recorded on laboratory bench sheets, field notebooks, in instrument data loggers, or on instrument software. Field personnel will transfer all digital and hardcopy data to the QA/QC coordinator after each sampling event for review. Upon passing QA/QC review, field reports will be produced and signed, and transferred (digital and hardcopy versions) to the project manager. Laboratory personnel will transfer all digital and hardcopy data to the QA/QC coordinator after each analytical batch for review. Upon passing QA/QC review, laboratory reports will be produced and signed, and transferred (digital and hardcopy versions) to the project manager. The principal investigator and QA/QC coordinator will review and sign all field and laboratory reports as they are generated. The following are the procedures that will be followed for managing data for each type of data collection.

Field notebooks: The field notebook will be similar to item number 8152-55 manufactured by Sokkia and will be titled “SMYNFR 319 (2012-2014)”. This book has water resistant surfaced pages. Notes are written in indelible ink. Field personnel will record all field observations in this book at the time of their visit. The date, time, sites visited, samples taken, other personnel present, weather conditions, and other information deemed necessary and appropriate will be recorded. Personnel should initial or sign each page. The notebook will be dedicated to this project. When the book is filled or the project completed, the notebook will be stored in the OEWRI office.

Laboratory bench sheets: Bench sheets will be completed for every analysis. Methods that require bench sheets have the sheets available as attachments within the SOP. The laboratory analyst will record all information on the forms using indelible ink. QC calculations, for example, spike percent recovery, will be recorded on the form in the "Comments" section of the bench sheet. Errors are crossed out with a single line, the correct entry is made and the analyst initials the correction. Completed data are transcribed into an Excel spreadsheet for further use. Completed bench sheets are stored with the project file in the OEWRI office.

Field Instrumentation: Data internally stored in the horiba, level loggers, and auto-samplers will be downloaded to the laptop computer file titled "SMYNFR 319 (2012-2014)". This raw instrument data will be downloaded by field personnel and transferred to appropriate personnel (Heather Hoggard who is the OEWRI project manager and Marc Owen who will write the discharge-calibration report) and stored in the SMYNFR 319 (2012-2014) folder on each of their computers, all raw data will be saved to a file of the same name on the OEWRI server as well. The raw data will be transferred to an Excel file for processing and review. A backup copy of all processed data will be stored on the SMYNFR 319 (2012-2014) removable drive. All hardcopy data will be stored in the project manager's project file to back up digital data.

Laboratory Instrumentation: Data internally stored on a computer associated with a laboratory instrument will be saved to the file titled "SMYNFR (2012-2014)". Raw instrument data will be stored in an SMYNFR (2012-2014) folder of the QC coordinator's computer as well. The raw data will be transferred to an Excel file for processing and review. A backup copy of all processed data will be stored on the SMYNFR (2012-2014) removable drive. All hardcopy data will be stored in the project manager's project file to backup digital data.

The OEWRI project manager will be responsible for data management throughout the monitoring and processing portions of the project. Data records will be stored by OEWRI for a minimum of five years after the completion of the project. After five years the data will be reviewed to determine if any part of the data may be discarded. The decision to retain archived data will be made by JRBP and OEWRI.

ASSESSMENT AND OVERSIGHT

Assessments and Response Actions

The project's activities will be assessed to identify and correct any potential or existing problems before the data is affected. A readiness review will be conducted prior to starting the project. Proficiency test samples will be procured for assessing analytical skill. A surveillance assessment will be conducted throughout the project. Assessments will be conducted by QA and/or QC coordinator. Information will be recorded and submitted to QA coordinator for review and response. Each of these assessments is discussed below. Table 8 provides a summary of QC corrective actions.

Readiness Review: Prior to the initiation of sampling, the QC Coordinator will review with the project graduate assistants and laboratory personnel all aspects of sampling and analyses. Items that will be covered in this assessment are: location and preparation of sample bottles; use of chain of custody forms; analytical processes including necessary quality control analyses; sample site locations including site codes; the use of field instrumentation and sampling devices; and how to transfer data after it is generated.

Proficiency Testing: A sample with a known-concentration of analyte will be purchased from an appropriate vendor, such as, the USGS (http://bqs.usgs.gov/srs/) or Environmental Resource Associates (http://www.eraqc.com). The sample will be assigned to the analyst without informing the analyst of the sample's source. The sample will be treated the same as other samples. The results will be evaluated by the QA/QC coordinator.

Surveillance Assessment: Surveillance is the observation of ongoing work to document conformance with specified requirements and/or procedures, such as those given in the QAPP or in SOPs. These observations will be continuous throughout the project and will be conducted by the QA/QC coordinator and the project manager. All field data will be reviewed as generated and laboratory data will be reviewed on a per batch per analyte frequency. Any deficiencies or problems detected will be addressed immediately upon detection. Surveillance and review will continue to ensure that corrections have been implemented for all future uses. Documentation may include hand written notes, copies of e-mail, or other forms that will be stored in the project file. Also the MDNR reserves the rights to conduct sight visits or field audits to ensure samples are collected and analyzed in accordance to the QAPP.

Reports to Management

Analytical reports for each parameter of interest from water samples will be prepared by the QC coordinator. Event reports for each sampling event will be prepared by the OEWRI project manager. Analytical reports similar to the one included in Appendix C, will be provided to JRBP after each batch has been analyzed. Analytical reports will be combined along with *in-situ* data collected in the field to produce the event reports. The longest hold time for the analytes of interest is 28 days, so the event reports will be sent to JRBP within 35 days of the event. Any deficiencies or corrective actions taken during the event will be noted on the event report. These will be issued as a Word or Excel files in an e-mail attachment to the JRBP grant executive administrator and will be followed by a signed hardcopy report sent by mail sent to the JRBP grant executive administrator. Copies of all reports will be stored in the project file in the OEWRI office.

Analytical reports and recommendations for each parameter of interest from soil samples will be prepared by the MU extension. Nutrient management reports for each property will be prepared by the JRBP project manager. These may be issued as e-mail messages or as a Word or Excel file in an e-mail attachment. Copies of all reports will be stored in the project file in the JRBP office.

Melissa Bettes, JRBP project management, will forward information to the grant executive administrator to provide to outside agencies including MDNR oversight personnel associated with this project. The JRBP project management will provide quarterly reports to the MDNR as listed in the general schedule and milestones section of the nonpoint source implementation grant application. The monitoring report is due to JRBP on January 31, 2014.

DATA VALIDATION AND USABILITY

Data Review, Verification and Validation

These procedures are summarized as follows: data are reviewed for completeness and correct calculations, data are verified against quality control parameters, and data are validated against project goals and objectives.

<u>Data Review</u>: Sample collection forms, field instrument data printouts, laboratory bench sheets, and other sources of project data will be reviewed for transcription, calculation, reduction, and transformation errors by the QC coordinator and project manager. Data review is also a completeness check to determine if there are any deficiencies such as missing or lost data. Errors will be corrected when found. Missing data will be noted in the project narrative of the final report. The project analysts, OEWRI QC coordinator, and project management will review all data. All event reports to JRBP will reviewed by the principal investigator prior to release.

<u>Data Verification</u>: Data verification is the evaluation of the data collected for the project compared to the requirements outlined in this QAPP, the original project agreement, and SOPs. Analytical data are compared to required levels of precision and accuracy as outline in each analyte's SOP. If the levels are not met, then a cause for the discrepancy will be determined. The result of this determination will be whether the data may be used with qualifications or not used. After the verification process it may be possible to recollect or reanalyze. The analyst, QC coordinator, project management, and principal investigator are all responsible for data verification during the project.

<u>Data Validation</u>: One goal of data validation is to evaluate whether the data quality goals established during the planning phase have been achieved. Using the reviewed and verified data, the validation process compares the results with the objectives of the project stated in the background section. Data quality goals established during the planning phase will be under constant review by OEWRI, JRBP, and MDNR. The amount of valid data required for accurate assessment of project goals will be achieved

as detailed by this QAPP and could include additional event sampling beyond states specified. The limits of the data and outliers in the data will be discussed within the final monitoring report.

Verification and Validation Methods

The verification method includes checking all bench sheets, data forms, and records for complete and accurate transcription of data, correct calculations, and appropriate comparison of quality control data to established limits. The reviewer will indicate on any form verified that this process has occurred. Any deviations from expected values will be noted on the report forms. Corrections can be made by crossing out the incorrect value with a single line, writing in the correct value, and initialing the correction. The QA/QC coordinator is responsible for verification of field and laboratory data and verification will occur per batch immediately after receipt.

The validation method involves reviewing the data and reports and comparing that information to what was expected as outlined in this document. The project manager and principal investigator are responsible for validation of the data. Validation will occur on a per event basis immediately after all data is compiled for each event. Deviations from what is required will be noted and a comment will be added to the final event report indicating whether, or how, the deficiency will affect final interpretations of data associated with that analyte. Event reports will be submitted to the JRBP project manager within 36 days of the batch analysis.

Reconciliation with User Requirements

The goal of this project is to fulfill the water monitoring portion of the JRBPs grant obligations that include assessing the influence of nutrient management plans on the reduction of nutrient, suspended solids, and bacteria loads in the Pearson Creek Watershed and other management practices implemented during the project period as stated within the projects subgrant agreement. This goal will be met by processing data generated by following the procedures outlined in this QAPP and specifically stated in associated SOPs or standard methods. Uncertainty values associated with each analytical batch of data will be reported on each individual event report. These individual event reports will be saved by the project manager as well as transferred to the JRBP grant executive administrator for quarterly reporting. Specific procedures used to derive uncertainty data exists in each individual SOP. A sample analytical report is included in Appendix C illustrating how OEWRI reports nutrient data per batch. Event reports will be similar.

Soil tests and nutrient management plans produced by the James River Basin Partnership will provide property owners with the resources to reduce nutrient loads in the Pearson Creek Watershed. JRBP will present findings upon request and will enhance educational efforts associated with the grant.

The water monitoring report will include: data from site monitoring; empirical multi-variable regression models that predict pollutant loadings at sites as a function of land use, storm event characteristics, and hydrology; modeling results estimating the influence of nutrient management plan implementation in the watershed on load reduction; frequency of exceedance of pollutant concentrations over TMDL limits; and comparison of current findings to historical information about the measured parameters. The final report will also include any discussions regarding data limitation due to variables such as weather, equipment malfunctions, or data loss.

OEWRI will present findings upon request and will make recommendations for future studies based on pollutant concentrations and trends as necessary.

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TABLES

Table 1. QAPP Distribution List with Personnel, Responsibilities and QAPP Receipt.

Name and Title	Organization	Address	Responsibilities	Contact Information	QAPP Receipt/ Control number
Dr. Robert T. Pavlowsky Director, Principal Investigator	OEWRI	MSU, Temple Hall, GGP, 901 South National, Springfield, MO, 65897	Overall supervision and QA of entire project. Review data. Assign tasks. Procure funding.	417-836-8473 BobPavlowsky@MissouriState.edu	1
Heather Hoggard OEWRI Laboratory Director, QA/QC Mang. OEWRI Project Mang.	OEWRI	MSU, Temple Hall, GGP, 901 South National, Springfield, MO, 65897	QAPP writing. Coordination of field monitoring and sample analysis. QA/QC, analytical and event reporting, final monitoring report writing.	417-836-3198 hhoggard@MissouriState.edu	2
Marc Owen Research Specialist II	OEWRI	MSU, Temple Hall, GGP, 901 South National, Springfield, MO, 65897	Discharge and calibration. Sampling design and field support. Modeling.	417-836-3197 MOwen@MissouriState.edu	3
Joe Pitts JRBP Grant Executive Administrator	James River Basin Partnership	MSU, PCOB, Rm 225 , 117 Park Central Square, Springfield, MO, 65806	Overall JRBP supervision and task assignment.	417-836-8878 joepitts@missouristate.edu	4
Melissa Bettes JRBP Project Mang.	James River Basin Partnership	MSU, PCOB, Rm 225 , 117 Park Central Square, Springfield, MO, 65806	Provide educational services, urban soil sampling, individual nutrient management plans, and BMP implementation.	417-836-4847 MelissaBettes@missouristate.edu	5
Trish Rielly Grant Project Manager	Missouri Department of Natural Resources Water	MDNR, DEQ, Nonpoint Source Unit, PO Box 176, Jefferson City, MO, 65102	MDNR grant oversight.	(573) 526-5297 trish.rielly@dnr.mo.gov	6

Name and Title	Organization	Address	Responsibilities	Contact Information	QAPP Receipt/ Control number
	Protection Proram				

Table 2. Project Schedule Time Line.

Activity	Date (MM/DD/YYYY)	
	Anticipated Start Date	Anticipated Completion Date
QAPP Writing, Autosampler Installation and Testing	03/01/2012	06/30/2012
Sample Collection, Laboratory Analysis, Discharge Data Collection, Historical Data Collection	06/01/2012	09/30/2013
Data Processing and STEPL Modeling	09/30/2013	11/30/2013
Final Discharge and Monitoring Report to JRBP	11/30/2013	01/31/2014

Table 3. Sample Site Summary (Coordinate system = UTM NAD83 Zone 15)

Site ID	Site Name	Location	UTM Northing	UTM Easting	Drainage Area (km2)	%High Density Urban	%Low Density Urban	% Barren	% Crops	% Grass/ Pasture	% Forest	% Water
1	Upper Pearson	SH YY	4,119,560.789	484,842.280	25.8	3.4	4.7	1.2	8.2	70.7	11.4	0.3
2	Jones Spring Br.	Jones Mill Ln.	4,115,912.114	481,195.205	2.7	21.6	49.6	0	1.1	18.1	9.5	0.1
3	Pearson Creek USGS Station	FR 148	4,114,627.579	482,371.466	53.4	4.7	12.3	0.6	5.5	61.3	15.2	0.4

Table 4. Measurement Performance Criteria.

Matrix = Water	**Sampling Procedure = Auto-sampler or depth-integrated.**			
Parameter ***Instrument Used - Responsible Party***	**SOP** ***Analytical Method Ref.***	**Data Quality Indicator**	**Measurement Performance Criteria**	**QC Sample Type to Assess Measurement Performance***
Total Nitrogen	3020R01 TotalN	Accuracy	± 20%	LB, LS
Genesys 10S UV-Vis spectrophotometer - OEWRI	*Crumpton, Isenhart, and Mitchel (1992)*	Bias	± 20%	LB, LS
		Precision	± 20% RPD	LD
		Sensitivity	≤ 0.1 mgN/L	MDL, LRB
Total Phosphorus	3010R01 TotalP	Accuracy	± 20%	LB, LS
Genesys 10S UV-Vis spectrophotometer - OEWRI	*EPA 365.2, with the size of the sample reduced*	Bias	± 20%	LB, LS
		Precision	± 20% RPD	LD
		Sensitivity	≤ 0.005 mgP/L	MDL, LRB
Total Suspended Solids	TSSolids	Accuracy	± 20%	LB
Filtration apparatus - OEWRI	*Standard Methods 2540D and EPA 160.2*	Bias	± 20%	LB
		Precision	± 20% RPD	LD
		Sensitivity	≤ 0.5 mg/L	MDL, LRB
Chloride	Chloride	Accuracy	± 10%	LB, LS
Accumet excel XL25 dual channel pH/Ion meter	*Ion Selective Electrode - Electric potential across chloride-specific membrane – Accumet Concepts*	Bias	± 10%	LB, LS
		Precision	± 10% RPD	LD
		Sensitivity	≤ 0.1 mg Cl/L	MDL, LRB

Matrix = Water	**Sampling Procedure = Auto-sampler or depth-integrated.**			
Parameter ***Instrument Used - Responsible Party***	**SOP** ***Analytical Method Ref.***	**Data Quality Indicator**	**Measurement Performance Criteria**	**QC Sample Type to Assess Measurement Performance***
Escherichia coli and Total Coliform	6010R01 Ecoli IDEXX	Accuracy	NA	ND
IDEXX system -OEWRI	*IDEXX copyright*	Bias	NA	ND
		Precision	± 20% RPD	FD, LD
		Sensitivity	1 MPN/100mL	LRB
Temperature	Horiba	Accuracy	NA	ND
Horiba U-22XD Multi-Parameter Water Quality Monitoring System - OEWRI	*Horiba user's manual*	Bias	NA	ND
		Precision	± 20% RPD	FD, LD
		Sensitivity	0º C	Ice bath
Conductivity	Horiba	Accuracy	± 20%	LB, LS
Horiba U-22XD Multi-Parameter Water Quality Monitoring System - OEWRI	*Horiba user's manual*	Bias	NA	ND
		Precision	± 20% RPD	FD, LD
		Sensitivity	0 mS/m	LRB
Dissolved Oxygen	Horiba	Accuracy	± 20%	LB, LS
Horiba U-22XD Multi-Parameter Water Quality Monitoring System - OEWRI	*Horiba user's manual*	Bias	NA	ND
		Precision	± 20% RPD	FD, LD
		Sensitivity	0 mS/m	LRB
Turbidity	Horiba	Accuracy	± 20%	LFB
Horiba U-22XD Multi-Parameter Water Quality Monitoring System - OEWRI	*Horiba user's manual*	Bias	± 20%	LFB
		Precision	± 20% RPD	LD, FD
		Sensitivity	1 NTU	LRB

Matrix = Soil	**Sampling Procedure = Soil probe.**			
Parameter Instrument Used-Responsible Party	**SOP Analytical Method Ref.**	**Data Quality Indicator**	**Measurement Performance Criteria**	**QC Sample Type to Assess Measurement Performance***
Soil pH	Soil Sampling and Nutrient Management Plans	Accuracy	± 20%	LB, LS
Commercial pH meter - MU	*Water (pHw)*	Bias	± 20%	LB, LS
		Precision	0.1 to 0.2 unit	LD
		Sensitivity	0.1 unit	LRB
Soil Phosphorus	Soil Sampling and Nutrient Management Plans	Accuracy	± 5% CV	LB, LS
Spectrophotometer - MU	*Bray I and Bray II*	Bias	± 5% CV	LB, LS
		Precision	± 5% CV	LD
		Sensitivity	0.1 ppm	LRB
Soil Potassium, Soil Calcium, Soil Magnesium	Soil Sampling and Nutrient Management Plans	Accuracy	± 10% CV	LB, LS
AAS - MU	*Ammonium Acetate Extraction*	Bias	± 20%	LB, LS
		Precision	± 10% CV	LD
		Sensitivity	Varies reported per sample	LRB
Soil Organic Matter	Soil Sampling and Nutrient Management Plans	Accuracy	± 20%	LB, LS
Muffle Furnace -MU	*LOI*	Bias	± 20%	LB, LS
		Precision	1 to 4% CV	LD
		Sensitivity	0.2 to 0.5% OM	LRB

Matrix = Water	**Sampling Procedure = Auto-sampler or depth-integrated.**			
Parameter ***Instrument Used - Responsible Party***	**SOP** ***Analytical Method Ref.***	**Data Quality Indicator**	**Measurement Performance Criteria**	**QC Sample Type to Assess Measurement Performance***
Soil Cation Exchange Capacity	Soil Sampling and Nutrient Management Plans	Accuracy	± 10% CV	LB, LS
Calculator - MU	*Calculated using K, Ca, and Mg data*	Bias	± 20%	LB, LS
		Precision	± 10% CV	LD
		Sensitivity	Varies reported per sample	LRB
Soil Neutralizable Acidity	Soil Sampling and Nutrient Management Plans	Accuracy	± 20%	LB, LS
Commercial pH meter - MU	*New Woodruff Buffer Method*	Bias	± 20%	LB, LS
		Precision	0.1 unit	LD
		Sensitivity	1 meq/100g	LRB

*LB = Laboratory Blank (reference sample), LS = Laboratory Spike, LD = Laboratory Duplicate, FD = Field Duplicate, LRB = Laboratory Reagent Blank, MDL = Method Detection Limit, ND = Not Determined, NA = Not Applicable, RPD = Relative Percent Difference

Table 5. Sampling Techniques.

Sampling Device or Procedure	Sites	Flow Conditions	Number Collected	Sample Type	Analytes
Auto-sample	1, 2, & 3	Storm flow/ Runoff	Average of 7 per event, at least four samples per event	Discrete	1.Total Suspended Solids 2. Nutrients (total phosphorus, total nitrogen) 3. Chloride
Depth-Integrated Sample	1, 2, & 3	Low flow/ Baseflow	1 per event	Discrete	1.Total Suspended Solids 2. Nutrients (total phosphorus, total nitrogen) 3. Chloride 4. Total Coliform and *E.* coli
Multi-probe	1, 2, & 3	All	1 per sample	Discrete	Temperature, Specific Conductivity, pH, Dissolved Oxygen, Turbidity

Table 6. Sample Storage Conditions for Water Quality Analytes.

Analyte	Bottle Type	Bottle Size	Preservative	Holding time	SOP Reference
Total Nitrogen	Plastic	500 ml	H_2SO_4 to pH ≤ 2 Ice	28 days	3020R01 TotalN
Total Phosphorus	Plastic	500 ml	H_2SO_4 to pH ≤ 2 Ice	28 days	3010R01 TotalP
Total Suspended Solids	Plastic	1000 ml	Ice	7 days	TSSolids
Chloride	Glass	100 ml	Ice	28 days	Chloride R01
Total Coliform and *E.* coli	Thio-bag	100 ml	Ice	3 hours	4010R01 Ecoli IDEXX
Field Parameters	These parameters are collected *in situ*.				
pH	none	none	none	none	1050R02 Horiba U-22
Temperature	none	none	none	none	1050R02 Horiba U-22

Conductivity	none	none	none	none	1050R02 Horiba U-22
Dissolved Oxygen	none	none	none	none	1050R02 Horiba U-22
Turbidity	none	none	none	none	1050R02 Horiba U-22
Velocity	none	none	none	none	Velocimeter R01 or 2060R01 Flow Meter

Table 7. Maintenance and Calibration of Sampling Equipment and Analytical Instrumentation.

Equipment / Instrument	**Maintenance and Calibration Activity**	**Frequency**	**Parameter**	**SOP/Method Reference**
Field Equipment				
Horiba	Auto Calibration	Before each use	pH, Conductivity, Dissolved Oxygen, and Turbidity	1050R02 Horiba U-22
	Cleaning	After each use		
	Manual Calibration	Monthly		
	Battery replacement	As needed		
	Rebuild DO Sensor, Recharge pH Probe	As needed		
Autosampler	Inspect the pump for wear	Weekly	Storm Event Sample Collection, Precipitation	Autosampler
	Clean the pump tubing housing	Weekly		
	Clean the suction line, strainer, and pump tube	Weekly		
	Check the humidity indicator	Weekly		
	Check the controller's internal battery status	Weekly		

Equipment / Instrument	**Maintenance and Calibration Activity**	**Frequency**	**Parameter**	**SOP/Method Reference**
	Exchange external battery	As needed		
Stage Recorder	Clean casing, circulation holes, and the optical infrared “eyes”	Each visit	Continuous Stage	Levelogger
Velocimeter	Performance Check	Before each use	Discharge	Velocimeter R01
Flow Meter	Performance Check	Before each use	Discharge	2060R01 Flow Meter
Laboratory Equipment				
Chloride Meter	Create calibration curve	For each use	Chloride	Chloride R01
Spectrophotometer	Create calibration curve	For each use	Total P	3010R01 Total P
Spectrophotometer	Create calibration curve	For each use	Total N	3020R01 Total N

Table 8. Quality Control Corrective Action Plan. (Standard Methods, 2005)

QC Type and Error	Corrective Action	Comment*
Laboratory Reagent Blank > MDL	1. Analyze another blank; if 2nd LRB is acceptable, then data is acceptable. 2. If 2nd LRB fails, then re-prepare and re-analyze affected samples	These data are associated with an LRB result that is > the MDL for this analyte.
Spiked samples (LS) fails	1. If Reference sample (LS) is acceptable, then qualify the data 2. If LS and LB fail, then re-prepare and reanalyze the affected samples.	These data are associated with a LS recovery result that is > UCL (or < LCL).
Laboratory Blank (LB) fails	1. Analyze another LB. 2. If 2nd LB fails then check another source for the reference material. 3. If the 2nd source is acceptable, then re-prepare and reanalyze affected samples.	These data are associated with a LB recovery result that is > UCL (or < LCL).
Calculations	1. Check calculations for error, correct if found	No comment needed for corrected calculations.
Calibration Standards fail	1. Check calibration standards against the reference sample. 2. If calibration standards fail then re-prepare and reanalyze the calibration standards and affected samples.	No comment needed for reanalyzed calibration standards.
*If the QC sample fails and the samples cannot be reanalyzed, then record the comment on the data sheet.		
UCL = Upper Control Limit, LCL = Lower Control Limit		

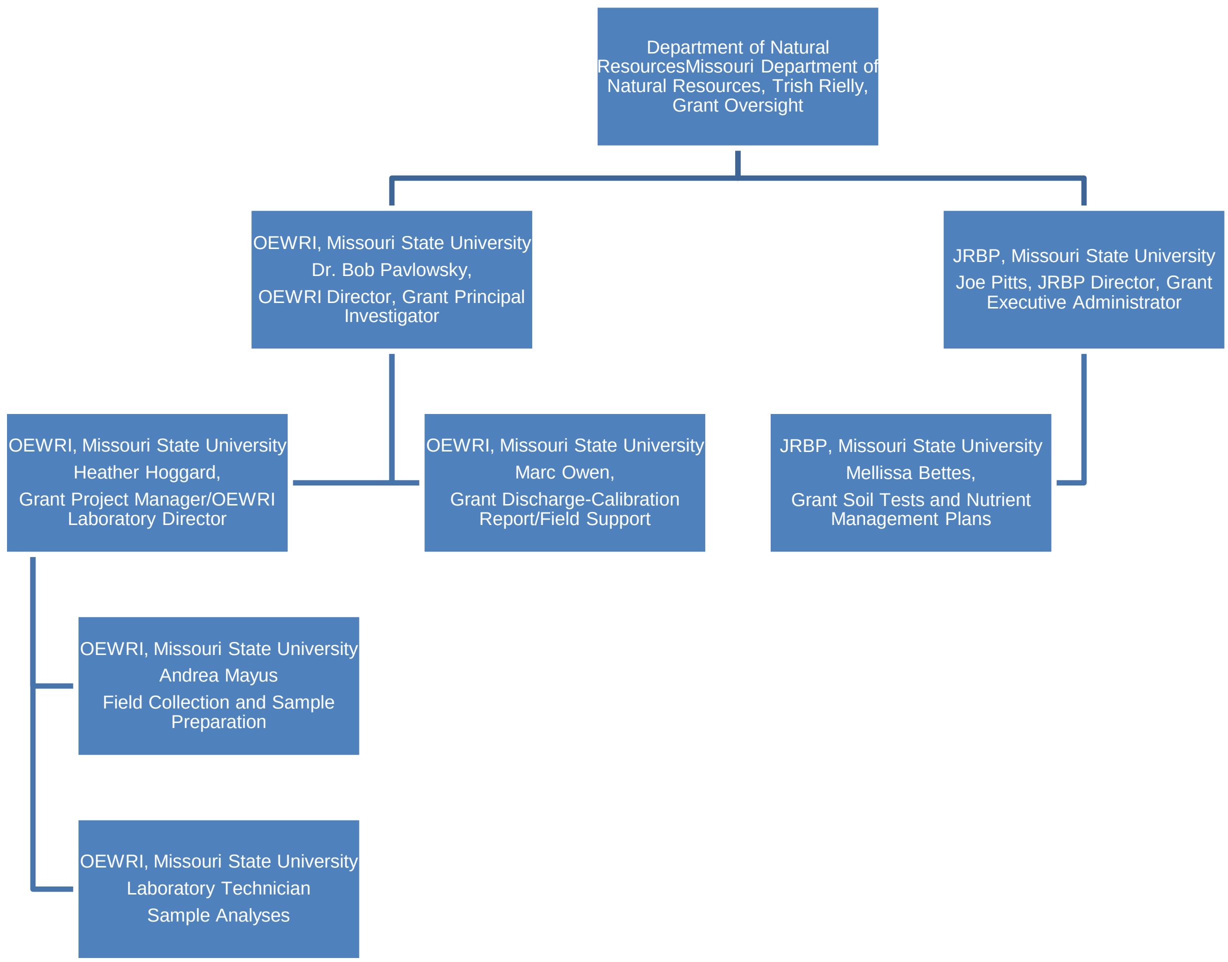

Figure 1. Organizational chart showing lines of authority and reporting responsibilities.

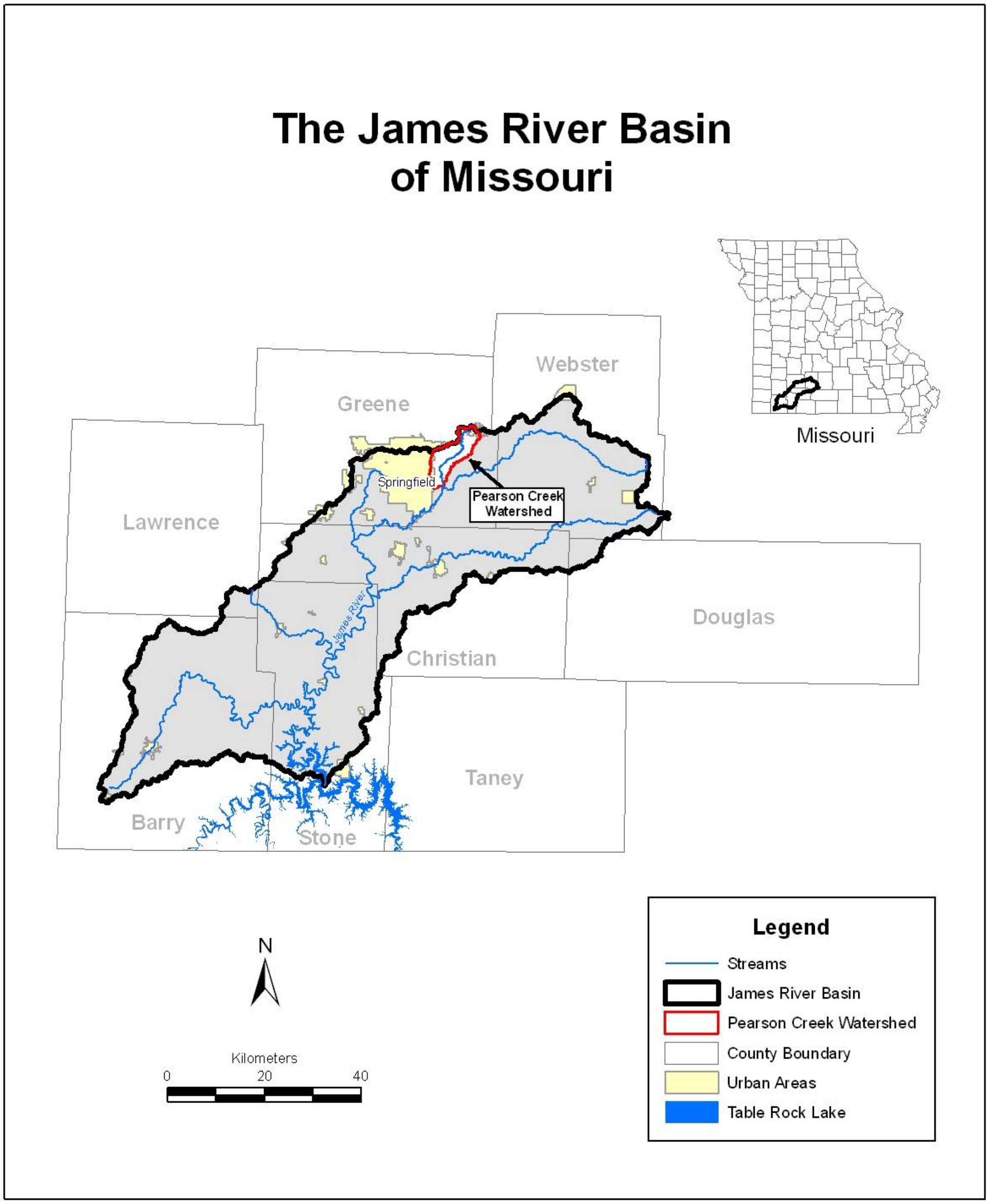

Figure 2. James River Basin.

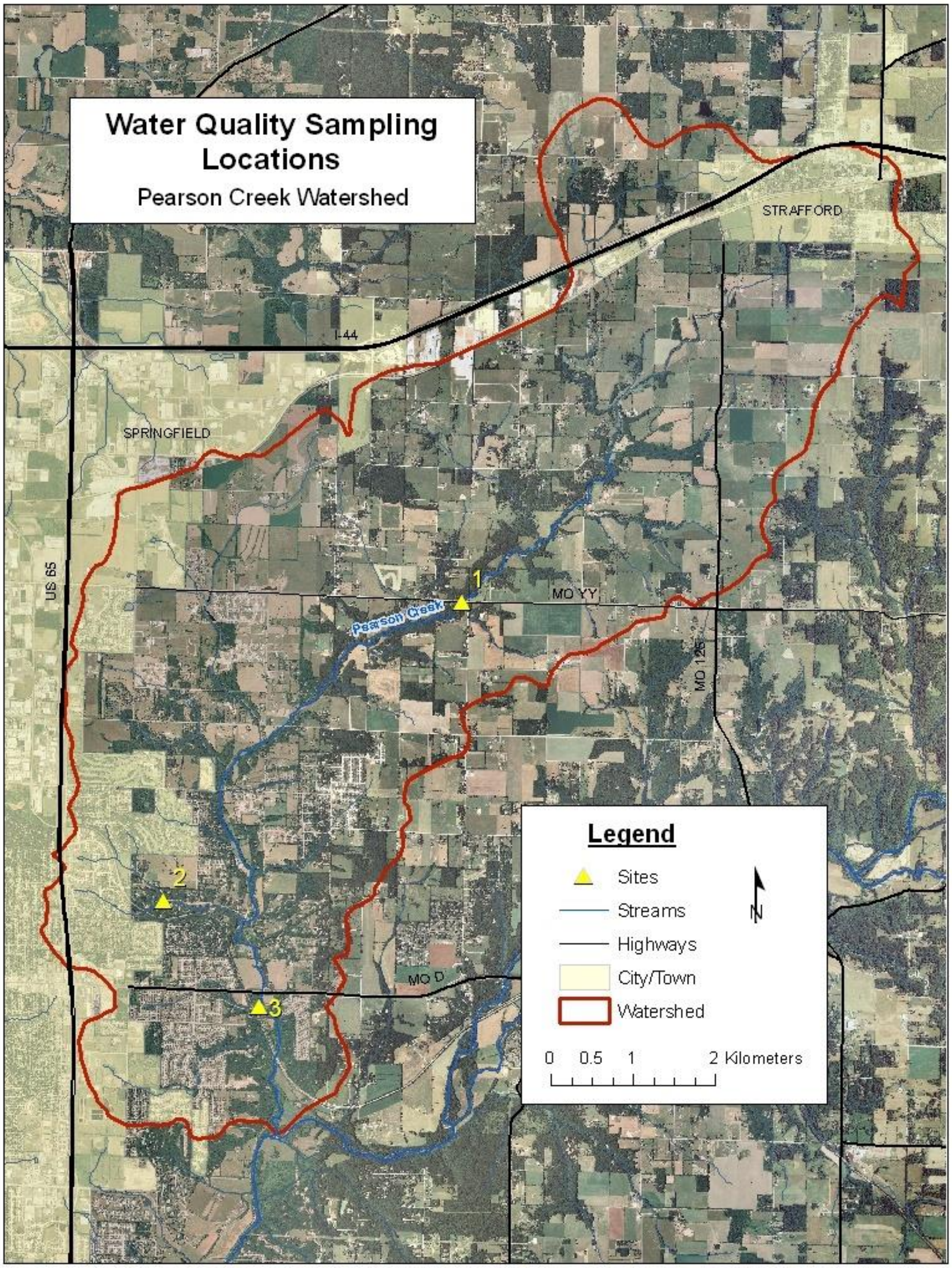

Figure 3. Pearson Creek Watershed and Sampling Sites

APPENDIX A. Standard Operating Procedures (SOPs) cited in this document http://oewri.missouristate.edu/58411.htm.

Document Number	Title	Status
1050R01 Horiba U-22.doc	Horiba U-22XD Multi-Parameter Water Quality Monitoring System	Final
Chloride	accumet Excel XL25 Meter	Final
0150R01 Bottle Prep non-Metals	Preparation of Sample Bottles For non-Metal Analyses	Final
3020R03 Total N	Total Nitrogen	Final
3010R02 Total P	Total Phosphorus	Final
TSSolids	Total Suspended Solids	Final
Velocimeter R01	Operation of the SonTek/YSI FlowTracker Handheld Acoustic Doppler Velocimeter (ADV)	Final
2060R01 Flow Meter	Operation of the Global Water Flow Meter, Model FP201	Final
1040R03 Water Sampling	Water Sample Collection	Final
1030R01 Chain of Custody	Chain of Custody	Final

APPENDIX B. Standard Operating Procedures (SOPs) not previously reviewed under a QAPP.

These SOPs are attached.

Document Number	Title	Status
Soil Samping and NMPs	Soil Sampling and Nutrient Management Plans	Under Review
Levelogger	Installation, Operation, and Maintenance of the Solinst Levelogger Gold and Baralogger Gold (Model 3001)	Under Review
Autosampler	Operation and Maintenance of the Teledyne ISCO 6712 Portable Sampler and Water Quality Monitoring Station	Under Review

APPENDIX C. Sample Total Nitrogen Batch Report.

MISSOURI STATE UNIVERSITY
OEWRI
Ozarks Environmental and Water Resources Institute

Heather Hoggard - Laboratory Manager
phone: 836-3198
email: hhoggard@missouristate.edu

To: Heather Hoggard
OEWRI
Missouri State University
RE: James SS & DS

Laboratory Testing Results
Total Nitrogen (mg/l)

Sample ID	Collection	Received	Analysis	Analyst	TN conc	OEWRI SOP	QC Check	QA/QC Mng	Detection Limit (mg/l)	Laboratory Reagent Blank (mg/l)	Replicate (%)	Laboratory Spike (%)
(code)	(date)	(date)	(date)	(initials)	(mg/l)	(code)	(date)	(initials)	(≤ 0.1 mg/l)	(≤ 0.1 mg/l preferred)	(±20% required)	(100 ±20% required)
F	12/4/2008	12/4/2008	12/14/2008	JH	1.91	3020R02	12/15/2008	HH	0.001	-0.001	-3.5	106.5
F-FD	12/4/2008	12/4/2008	12/14/2008	JH	2.10	3020R02	12/15/2008	HH	0.001	-0.001	-3.5	106.5
JK1	12/4/2008	12/4/2008	12/14/2008	JH	1.00	3020R02	12/15/2008	HH	0.001	-0.001	-3.5	106.5
JK2	12/4/2008	12/4/2008	12/14/2008	JH	0.93	3020R02	12/15/2008	HH	0.001	-0.001	-3.5	106.5
JK3	12/4/2008	12/4/2008	12/14/2008	JH	0.89	3020R02	12/15/2008	HH	0.001	-0.001	-3.5	106.5
J-SR	12/4/2008	12/4/2008	12/14/2008	JH	4.37	3020R02	12/15/2008	HH	0.001	-0.001	-3.5	106.5
J-SR-FB	12/4/2008	12/4/2008	12/14/2008	JH	0.13	3020R02	12/15/2008	HH	0.001	-0.001	-3.5	106.5
P	12/4/2008	12/4/2008	12/14/2008	JH	2.05	3020R02	12/15/2008	HH	0.001	-0.001	-3.5	106.5
W	12/4/2008	12/4/2008	12/14/2008	JH	1.76	3020R02	12/15/2008	HH	0.001	-0.001	-3.5	106.5

Verification of Quality Control: EXAMPLE FOR SMYNFR 319 QAPP
Heather L Hoggard Signature Date

Final check and approved for release by:
Dr. Robert T. Pavlowsky Signature Date

APPENDIX D. Water Sampling Chain of Custody form.

Missouri State University
Ozarks Environmental and Water Resources Institute
Springfield, Missouri
Sample Collection

Sampling Date: ________________ Project: ___________________________

Analyses Required: ____

Site ID	Sample Type[1]	Sample Matrix[2]	Container Type[3]	Preservative[4]	Time Collected	Sampler's Initials

1. Sample Type: Grab or Composite.
2. Sample Matrix: water, sediment, etc.
3. Container Type: e.g., 1 L plastic bottle, 250 mL glass bottle, 100 mL Whirl-Pak bag, etc.
4. Preservative: indicate the concentration and amount used if applicable (e.g., H_2SO_4 to pH < 2).

Chain of Custody

Samples Collected by: ______________________ ______________________

Released to lab by: ______________________ Date: ___________ Time: ___________

Received for lab by: ______________________ Date: ___________ Time: ___________

Laboratory storage location: ______________________________________