Fish Tissue Monitoring Program (FTMP)

QUALITY ASSURANCE PROJECT PLAN

Program Administered and Plan Prepared by:
North Carolina Department of
Environment & Natural Resources
Division of Water Quality
Environmental Sciences Section
Biological Assessment Unit

Submitted to EPA December 2011
Version 1.1

Abbreviations

BAU	Biological Assessment Unit
CWA	Clean Water Act
DO	Dissolved Oxygen
DWQ	Division of Water Quality
EPA	Environmental Protection Agency
ESS	Environmental Sciences Section
FDA	Food and Drug Administration
FTMP	Fish Tissue Monitoring Program
ISU	Intensive Survey Unit
NCDENR	North Carolina Department of the Environment and Natural Resources
NCDHHS	North Carolina Department of Health and Human Services
NFQA	National Field Quality Assurance
NPDES	National Pollutant Discharge Elimination System
PQL	Practical Quantitation Limit
PTFE	Polytetrafluoroethylene (Teflon)
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
SOP	Standard Operating Procedures
TMDL	Total Maximum Daily Load
USFDA	United States Food and Drug Administration
USGS	United States Geological Survey

REVISION LOG

FISH TISSUE MONITORING PROGRAM (FTMP)
QUALITY ASSURANCE PROJECT PLAN

Note: Actions older than 5 years may be removed from this record

Date Edited	Editor	Version Edited	Section Edited	Changes/updates
12/2/2011	Jeff DeBerardinis	1.0	All sections	Updated titles of staff
12/2/2011	Jeff DeBerardinis	1.0	A3	Updated name of Project Coordinator
12/2/2011	Jeff DeBerardinis	1.0	A3	Deleted “basin”. FTMP data no longer included in BARs.
12/2/2011	Jeff DeBerardinis	1.0	A3	Deleted Assistant Environmental Biologist II
12/2/2011	Jeff DeBerardinis	1.0	A5	Updated map of fish tissue monitoring sites in NC
12/2/2011	Jeff DeBerardinis	1.0	A5	Updated ISU SOP links
12/2/2011	Jeff DeBerardinis	1.0	A5, Reporting	Deleted language and map concerning Basinwide Assessment Reports. FTMP data no longer included in BARs.
12/2/2011	Jeff DeBerardinis	1.0	A6	Deleted “Tier I”
12/2/2011	Jeff DeBerardinis	1.0	A7	Updated ISU SOP link.
12/2/2011	Jeff DeBerardinis	1.0	A8	Changed “Data Report Package” to “Data Reporting”. Deleted all language concerning fish tissue data reporting in Basinwide Assessment Reports. FTMP data is no longer included in Basinwide Assessment Reports. Added FTMP data web link.
12/2/2011	Jeff DeBerardinis	1.0	B1	Deleted language concerning Basinwide Monitoring Program. FTMP data is no longer included in Basinwide Assessment Reports.
12/2/2011	Jeff DeBerardinis	1.0	B1	Deleted all “Tier 1” and “Tier II” text, and replaced with “screening” or “intensive” where appropriate.
12/2/2011	Jeff DeBerardinis	1.0	B1	Updated FTMP and ISU SOP web link.
12/2/2011	Jeff DeBerardinis	1.0	B2	Updated ISU SOP link.
12/2/2011	Jeff DeBerardinis	1.0	B5	Deleted “and/or the Assistant Environmental Biologist II”
12/2/2011	Jeff DeBerardinis	1.0	B5	Deleted “(Tier 2)”
12/2/2011	Jeff DeBerardinis	1.0	B6	Deleted “and the Assistant Environmental Biologist II are”
12/2/2011	Jeff DeBerardinis	1.0	C1	Deleted “the Assistant Environmental Biologist II”
12/2/2011	Jeff DeBerardinis	1.0	D1	Deleted “and Assistant Environmental Biologist II”
12/2/2011	Jeff DeBerardinis	1.0	D1	Deleted “and Assistant Environmental Biologist II”
12/2/2011	Jeff DeBerardinis	1.0	D3	Deleted “Basinwide Assessment Reports and”

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SECTION A:

PROJECT MANAGEMENT

A1. Signature and Approval Sheet

Approved by:

Jeff DeBerardinis
Fish Tissue Monitoring Program Coordinator
Environmental Sciences Section, NC DWQ

12/21/11
Date

Eric D. Fleek
Biological Assessment Unit Supervisor
Environmental Sciences Section, NC DWQ

12/21/2011
Date

Joanna Gmyr
Quality Assurance Coordinator
Environmental Sciences Section, NC DWQ

12/21/2011
Date

Jay Sauber
Section Chief
Environmental Sciences Section, NC DWQ

12/21/2011
Date

Designated Approving Official
Environmental Protection Agency Region IV

Date

A2. Distribution List

Primary Distribution:

EPA, Region IV, Water Protection Division, Water Quality Planning Branch

Marion Hopkins, NC Monitoring, Grant Technical Officer
Andrea Zimmer, Monitoring and Information Analysis Section Chief
Joanne Benante, Water Quality Planning Branch Chief

NC Department of Environment and Natural Resources, Division of Water Quality

Environmental Sciences Section

Jay Sauber, Environmental Sciences Section Chief

Eric Fleek, Biological Assessment Unit Supervisor
Steven Kroeger, Ecosystems Unit Supervisor
Jason Green, Intensive Survey Unit Supervisor
Cindy Moore, Aquatic Toxicology Unit Supervisor
Jill Paxson, Estuarine Monitoring Team Leader

Jeff DeBerardinis, Fish Tissue Monitoring Program Coordinator
Joanna Gmyr, Quality Assurance Coordinator
Debra Owen, Lakes Monitoring Program Coordinator
Andrea Thomas, Ambient Monitoring System Coordinator
Bryn Tracy, Stream Fish Community Assessment Program Coordinator
Michael Walters, Benthic Macroinvertebrate Community Assessment Program Coordinator

Biological Assessment Unit Staff:
Steven Beaty, Benthic Biologist
Dee Dee Black, Benthic Biologist
Victor Holland, Benthic Biologist
Tracy Morman, Benthic Biologist
Michael Shepherd, Fisheries Biologist

Regional Office Surface Water Protection Supervisors:
Corey Basinger, Winston-Salem (WSRO)
Chuck Cranford, Asheville (ARO)
Jim Gregson, Wilmington (WiRO)
Belinda Henson, Fayetteville (FRO)
Al Hodge, Washington (WaRO)
Rob Krebs, Mooresville (MRO)
Danny Smith, Raleigh (RRO)

Planning Section

Alan Clark, Planning Section Chief

Courtesy Distribution:

Coleen Sullins, NC Division of Water Quality Director
Chuck Wakild, NC Division of Water Quality Deputy Director
Matt Matthews, Surface Water Protection Chief
Jeff Manning, Basinwide Planning Unit Supervisor
Jeff Poupart, Point Source Branch Head
Dana Satterwhite, Laboratory QA/QC Officer
Kathy Stecker, Modeling & TMDL Unit Supervisor
Kent Wiggins, Laboratory Section Chief

A3. Project Organization

The Fish Tissue Monitoring Program (FTMP) is housed within the Environmental Sciences Section of the Division of Water Quality (DWQ), within the North Carolina Department of Environment and Natural Resources (NCDENR). Activities associated with the FTMP (fieldwork, project management, QA, data management, analysis, and reporting) are performed by Biological Assessment Unit (BAU) staff members, with additional assistance provided by other staff in the Environmental Sciences Section (ESS).

An abbreviated organizational chart for the Division of Water Quality is provided in Figure A3.1. Information on specific individuals' roles and responsibilities follows. Phone numbers and addresses for the offices listed can be found at http://portal.ncdenr.org/web/wq

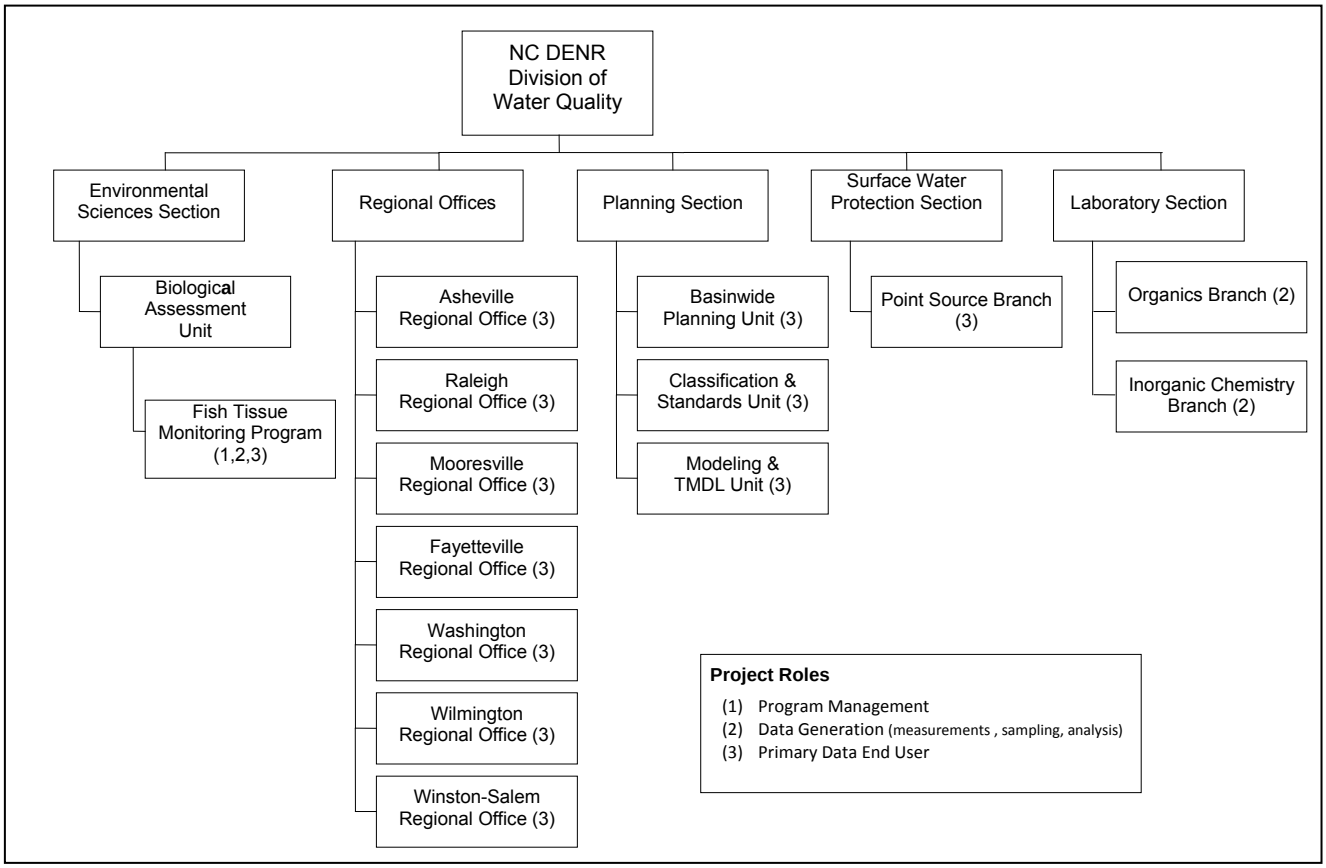

Figure A3.1 North Carolina Division of Water Quality Organizational Chart.

Project Management and Oversight

Biological Assessment Unit (BAU) Supervisor

Eric D. Fleek

Supervisor of benthic macroinvertebrate and fisheries programs. Serves as liaison between BAU and internal NC DWQ customers of BAU data as well with other divisions within NCDENR, NC Department of Transportation, EPA, U. S. Geological Survey, and various nongovernmental organizations. Ensures that all FTMP activities are conducted in accordance with all pertinent QAPP's and SOP's. Recommends new employee hires and approves changes to the FTMP.

Environmental Biologist, BAU

Jeff DeBerardinis
Project Coordinator

Prepares study plans; selects sites; informs regions, agencies, and public of fish tissue studies. Trains field staff. Ensures fish tissue samples are collected and processed in accordance with the SOP. Coordinates delivery of samples to analytical laboratory. Communicates with various agencies and regional offices to identify fish tissue concerns across the State. Tracks, receives, and analyzes fish tissue results for the Division. Enters results into DWQ fish tissue database. Conducts statistical and QA/QC analyses, researches literature, and maintains information files on fish contaminants. Generates special study and special request reports involving fish tissue data. Responds to information requests from other agencies and individuals.

Field Staff

Staff members of the Biological Assessment Unit and other units within ESS assist in the sample collection and processing aspects.

Quality Assurance Coordinator

Joanna W. Gmyr
QA Coordinator, ESS

Documents QA practices of FTMP. Maintains FTMP QAPP. Develops and recommends QA/QC improvements. Ensures that the FTMP is conducted in accordance with the FTMP QAPP.

Primary Data-End-Users

NC Department of Health and Human Services (NCDHHS)

Dr. Ken Rudo, Epidemiologist, Division of Public Health
Occupational and Environmental Epidemiology

- Analyses of DWQ fish tissue contaminant data
- Recommend fish consumption advisories for human heath to State Health director

Staff from the DHHS should:

- Provide input to the Environmental Biologist and BAU Supervisor on changes needed to the FTMP as part of a continuous program assessment process.
- Report any data anomalies to the Environmental Biologist and BAU Supervisor.
- Report any waterbodies that are in need of assessment.

Planning Section

Alan Clark, Section Chief

Supervises the Basinwide Planning Unit and the Modeling and TMDL Unit.
These units include numerous staff acting as primary end-users of data produced by the FTMP.

Staff from the Planning Section should:

- Provide input to the Environmental Biologist and BAU Supervisor on changes needed to the FTMP as part of a continuous program assessment process.
- Report data anomalies to the Environmental Biologist and BAU Supervisor.
- Report waterbodies in need of assessment.

Regional Office Surface Water Protection

Regional Supervisors:

James Gregson, Wilmington Regional Office
Chuck Cranford, Asheville Regional Office
Robert Krebs, Mooresville Regional Office
Belinda Hinson, Fayetteville Regional Office
Al Hodge, Washington Regional Office
Danny Smith, Raleigh Regional Office
Corey Basinger, Winston-Salem Regional Office

There are seven regional offices within the NCDENR. The regional offices perform the Department's duties on a local level and are responsible for compliance and enforcement actions.

Staff from the regional offices should:

- Provide input to the Environmental Biologist and BAU Supervisor on changes needed to the FTMP as part of a continuous program assessment process.
- Report data anomalies to the Environmental Biologist and BAU Supervisor.
- Report waterbodies in need of assessment.

Surface Water Protection Section

Matt Matthews, Section Chief

The Surface Water Protection Section includes the Point Source and the Wetlands and Stormwater branches. The Point Source Branch is responsible for administering the State's National Pollutant Discharge Elimination System (NPDES) program, which was established to control point-source discharges of water pollution. The Branch functions to protect, maintain, and enhance the State's waters by fostering compliance with North Carolina's environmental statutes, regulations, and permits. When compliance is not met, this Section may take enforcement actions.

Staff from the Section should:

- Provide input to the Environmental Biologist and BAU Supervisor on changes needed to the FTMP as part of a continuous program assessment process
- Report data anomalies to the Environmental Biologist and BAU Supervisor.
- Report waterbodies or impacts from permitted facilities in need of assessment.

U. S. EPA

EPA Region IV

- Review, provide comments, and approve QAPP and subsequent revisions on behalf of EPA Region IV.
- Perform mid-year and end-of-year assessments of all DWQ monitoring program, including the Fish Tissue Monitoring Program, to determine progress on tasks listed in the annual §106 grant work plan.

A4. Problem Definition and Background

Introduction

As part of funding agreements between the State and the U. S. Environmental Protection Agency (EPA) and to support the goals of the Clean Water Act (CWA), North Carolina agrees to monitor the waters of the state and report findings to the EPA. The CWA defines its objective as: " . . . *to restore and maintain the chemical, physical, and biological integrity of the Nation's waters, and, where attainable, to achieve a level of water quality that provides for the protection and propagation of fish, shellfish, and wildlife, and for recreation in and on the water*."

Because fish spend their entire lives in the aquatic environment, they incorporate chemicals from this environment into their body tissues. Contamination of aquatic resources has been documented for heavy metals, pesticides, and other complex organic compounds. Once these contaminants reach surface waters, they may be available for bioaccumulation, either directly or through aquatic food webs and may accumulate in fish and shellfish tissues. Results from fish tissue monitoring can serve as an important indicator of further contamination of sediments and surface water.

Fish Tissue Monitoring Program Objectives

The DWQ utilizes several programs and tools to assess the quality of the state's waters. The primary objective of the Fish Tissue Monitoring Program is to provide fish contaminant data for waterbodies to the NCDHHS for human fish consumption, Basinwide Planning Unit for Use Support, and the Planning Section for Basinwide Water Quality Management Plans. Secondary objectives of the FTMP are to provide data suitable for supporting the following DWQ activities:

- Planning Section:
  - Biennial 303(d) and 305(b) reporting to EPA, including identification of areas of impairment or degradation,
  - TMDL development,
  - Prioritization of restoration activities, and
  - Background information for Use Attainability studies.
- Surface Water Protection Section:
  - Identification of background levels of constituents for determination of NPDES permit limits, and
  - Identification of dischargers causing unacceptable impacts.
- Regional Offices:
  - Background information to assist with water quality management activities in each region.

A5. Project/Task Description and Schedule

Overview

The Fish Tissue Monitoring Program (FTMP) is the primary process within NCDENR to monitor fish tissue contaminants across the state of North Carolina. The program has been in existence since the late 1970's. Its core mission is to sample accessible and publicly fished sites for the presence of fish tissue contaminants. Contamination of aquatic resources has been documented for heavy metals, pesticides, and other complex organic compounds across North Carolina. Once these contaminants reach surface waters, they may be available for bioaccumulation, either directly or through aquatic food webs, and may accumulate in fish and shellfish tissues. Results from fish tissue monitoring can serve as an important indicator of further contamination of sediments and surface water. Data generated from the program are also forwarded to the NC Department of Health and Human Services (NCDHHS) for use in posting fish consumption advisories across the State.

Approximately 500 sites, located primarily in the Piedmont and Coastal Plain, have been assessed by the FTMP (Figure A5.1). Approximately 30 sites (both new and existing) are sampled each year. Most of the stations are located at boat ramps, public access areas, lakes, reservoirs, estuaries, and/or streams accessible by boat. Wadeable and lower Strahler order rivers are also monitored but not as frequently.

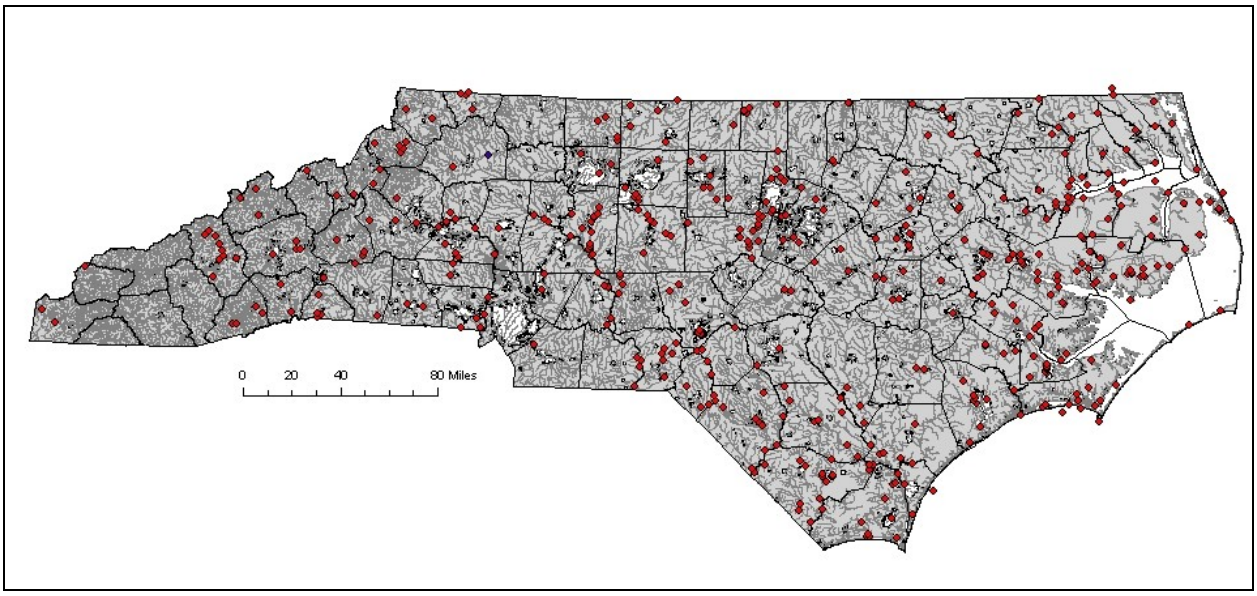

Figure A5.1 Fish Tissue Monitoring Sites, 1980 – 2010.

Fish Tissue Indicators

The FTMP evaluates fish tissue contaminants across North Carolina using guidelines described in the EPA guidance document *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories (USEPA, 2007)*. Target analytes include mercury, heavy metals, PCB's, PBDE's, and chlorinated pesticides. A list of routine FTMP target analytes is summarized in Appendix 2. In evaluating fish tissue analysis results, several different types of criteria are used. Human health concerns related to fish consumption are screened by comparing results with federal Food and Drug Administration (FDA) action levels (USFDA, 1980), Environmental Protection Agency (USEPA) recommended screening values, and criteria adopted by the North Carolina State Health Director (Appendix 1). At the request of the Water Quality Section, the N.C. Division of Occupational and Environmental Epidemiology evaluates individual parameter results that appear to be of potential human health concern.

Other Water Quality Indicators
Although fish tissue contaminants are the primary tool used by the FTMP, other water quality measurements (water temperature, dissolved oxygen, pH, and specific conductance) are also monitored at every site in accordance with the ISU SOP:
http://portal.ncdenr.org/c/document_library/get_file?uuid=522a90a4-b593-426f-8c11-21a35569dfd8&groupId=38364

Sampling Schedule
Fish tissue monitoring sites are sampled yearly, usually between April and November. A yearly schedule of fish survey sites is generated from the following:

- Sites to assess mercury bioaccumulation issues,
- Special study requests from regional offices and other agencies,
- Sites where contaminant data is incomplete or absent, and/or
- Sites where contaminants have been elevated or are suspected.

Sampling Methods Overview

Fish Tissue Collection
The FTMP field and laboratory methods are described in detail in the ESS Fish Tissue Assessment SOP (Appendix 1). Additional information on sample collection activities is also available in section B2 of this document. In most cases, the FTMP employs electrofishing as the primary means of fish collection. Collections on lakes and non-wadeable streams are usually accomplished using a boat-mounted electrofisher, which is powered by a 2.5-watt or a 7.5-watt generator. Collections on wadeable streams are accomplished using backpack electrofishing techniques. Refer to the Stream Fish Community Assessment SOP (Appendix 4) for details on this method.

Packaged fish are immediately placed on wet ice and chilled to 4°C for transport back to the ESS laboratory. Individual fish are identified to species under the supervision of an experienced biologist familiar with North Carolina fish fauna. Samples are processed by ESS staff members and either sent directly to the Division's Analytical Chemistry Laboratory (or an alternative analytical laboratory) or immediately frozen and stored at –20°C for later analysis. Turnaround times for analytical results are usually one month for metals analyses and several months for pesticide and organics analyses.

Water Quality Field Measurements
Measurements taken in the field include water temperature, pH, specific conductance, and dissolved oxygen. Field measurements are discrete and are made *in situ* by field staff at the time of the station visit. All field measurements are performed in accordance with Section III of the ISU SOP http://portal.ncdenr.org/c/document_library/get_file?uuid=522a90a4-b593-426f-8c11-21a35569dfd8&groupId=38364

Data Management
Field measurements and observations are recorded on the Fish Tissue Survey Information form (Appendix 1). Field data are compiled, quality assured, and entered into the FTMP electronic database. Fish tissue results are received from the analytical laboratory as hardcopy reports. Analytical results are compiled, quality assured, and entered into the FTMP electronic database. Hardcopy reporting sheets are archived at ESS for database verification. All results are warehoused in the FTMP database, which is a Microsoft Access® 2007 database. The database is updated whenever sample analyses are completed and received or when errors in previously entered data are identified.

Reporting
The primary forms of reporting within the FTMP include: Reports to the NCDHHS and other agencies, and site-specific special study reports. The information may be incorporated into Basinwide Water Quality Management Plans and required biennial reports to EPA for inventory and impairment (combined 303(d)/305(b) reporting). Data are uploaded annually to the BAU's Internet web page for public dissemination.

Tissue results are used for Biennial 303(d) and 305(b) reporting to EPA, including identification of areas of impairment or degradation. Impairment can lead to further actions by other DWQ programs, such as

intensive studies, development of TMDLs or other strategies, and implementation of additional pollutant controls.

Reports to NCDHHS and Other Agencies
ESS fish tissue results are reported to the NCDHHS and other state agencies *via* formal reports and internal memoranda. These reports are approved by the BAU Supervisor and the ESS Section Chief and kept on file at the ESS laboratory.

Special Study Reports
Results of special studies are summarized in formal reports and internal memoranda. These reports are approved by the BAU Supervisor and the ESS Section Chief and forwarded to the appropriate party or regional office staff. Copies are kept on file at the ESS laboratory.

A6. Quality Objectives and Criteria

Components of a quality assurance and quality control plan are described in the Fish Tissue Assessment SOP (Appendix 1). All investigations conducted by the FTMP follow a written study plan that is approved before the actual sampling is conducted. The FTMP QAPP addresses activities that are conducted by the FTMP on a regular basis. Fish tissue samples are collected and prepped by the FTMP. The samples are then sent to the Division's Analytical Chemistry Laboratory for analytical analyses, which are beyond the scope of the FTMP QAPP and are regulated by the Quality Assurance Manual for the NC Division of Water Quality Laboratory Section (Appendix 3).

Bias

The FTMP is conducted according to a non-random sampling design; therefore, bias will exist due to site locations (i.e., sites that can be safely accessed by the sampling crew while wearing a backpack electrofisher or sites that can be accessed by boat).

Other sources of bias include:

- Sampling is performed under existing flow and water clarity conditions. Ideally, monitoring is conducted under low to normal flow conditions with clear or slightly turbid water clarity. Sampling is not conducted if the water is so turbid that fish cannot be seen or if the water level is so high or swift that sampling would jeopardize the safety of the staff.
- Almost all sites are located within the vicinity of bridge crossings and boat ramps for ease of access and to avoid trespassing on private property.
- Target fish are of the size range normally caught by most fishermen. Small and very large fish are released or not targeted.

Using consistent sampling and laboratory methods and data analyses as describe in the Fish Tissue Assessment SOP (Appendix 1) minimizes bias from other sources.

Representativeness

The primary selection criterion for target species is to choose those commonly caught and consumed locally and of harvestable size. In freshwater ecosystems, one bottom feeding and one predator fish species should be collected. In estuarine/marine ecosystems, either one bivalve species and one finfish species or two finfish species should be collected. Generally, at least ten individuals of each target species are collected. The survey method involves sampling a tiny fraction of the fish population present at a site and may or may not completely represent the variability of pollutants in the population.

Field and Laboratory Measurements

Individual fish are measured and weighed at the ESS laboratory to ensure accuracy. Total length is measured to the nearest centimeter on a standard Wildco® measuring board. The total weight of each fish is measured to the nearest 0.1 gram on an electronic scale.

In the field and laboratory, taxonomic keys listed in the "References" section of the Stream Fish Community Assessment SOP (Appendix 4) are used to ensure consistent and accurate identification of fish species. Target species lists are generated from the DWQ Fish tissue database using species data from previous sampling trips.

Single measurements of water temperature, dissolved oxygen, specific conductance, and pH are made with calibrated meters. The measurements are taken just below the stream surface. No effort is made to determine spatial or temporal variability in the measurements at a specific site.

Comparability

Fixed station locations and the Fish Tissue Assessment SOP (Appendix 1) ensure that comparable samples are taken at each site visit. Deviations from the SOP or from the written study plan due to unusual sampling situations are documented in the appropriate report or memorandum. Calibration procedures ensure accuracy and comparability of water quality measurements. To assess total variability, duplicate samples are prepared from at least 10% of the fish samples. Sample duplicates are prepared using tissue from the same fillet or composite homogenate. Duplicates are assigned a "dummy"

sample identification, which is recorded in the processing laboratory log. The analytical laboratory does not receive this information.

During intensive studies, portions of at least 10% of the prepared homogenates will be frozen at -20°C and archived at the Division's Water Quality Laboratory for a period of at least 6 months after completion of the study. This is done in case of analytical problems or the need for future references.

Completeness

It is expected that some sites will not be sampled due to problems such as inclement weather, poor water clarity, extremes in flows, equipment malfunctions, vacant positions, and staffing during the field season. As many sites as possible are sampled during the field season given existing staffing resources. Invariably some Basinwide Assessment Program “fixed” sites will not be sampled and may not be re-sampled until the next monitoring cycle.

A7. Special Training/Certification

Field Staff

Fieldwork for the FTMP is normally conducted by a staff of three, of which one, preferably two, trained biologists, are the lead investigators. The Environmental Biologist requires considerable knowledge of biological communities, aquatic ecosystems, and the interactions of chemical characteristics with biology as they relate to water quality. The Environmental Biologist should have graduated from a four-year college or university with a major in biology, environmental science, ecology, or a related natural science curriculum. The Environmental Biologist should be trained in meter use and calibration according to Section III of the ISU SOP (http://portal.ncdenr.org/c/document_library/get_file?uuid=522a90a4-b593-426f-8c11-21a35569dfd8&groupId=38364). The Environmental Biologist should also be experienced in boat handling and boating safety. All staff involved in electrofishing activities should be trained in First Aid and CPR and should be familiar with standard electrofishing safety procedures. Annual recertification in First Aid and CPR is recommended.

FTMP samples are collected under the following annual collection permits:

- Scientific/Educational Collection Permit from the NC Division of Marine Fisheries and
- Collecting License and Endangered Species Permit from the North Carolina Wildlife Resources Commission's Division of Inland Fisheries.

There is currently no formal documentation of training, but field staff members are assessed on an ongoing basis by the Environmental Biologist to ensure field staff members are performing activities in accordance with all pertinent SOP's and the FTMP QAPP.

Laboratory Staff

All fish samples are prepped at the ESS laboratory under direct supervision of the Environmental Biologist according to Section 3.4 of the Fish Tissue Assessment SOP (Appendix 1). The Division's Analytical Chemistry Laboratory staff is trained according to the Quality Assurance Manual for the North Carolina Division of Water Quality Laboratory Section (Appendix 3).

A8. Documentation and Records

Quality Assurance Information, SOP, and Other Support Documentation

Once all approval signatures have been obtained, the QA Coordinator will electronically distribute copies of the approved QAPP to persons on the distribution list in Section A2 of this document. Copies must be disseminated within 30 days of final approval. The original hardcopy with approval signatures will be kept on file in the QA Coordinator's office in the ESS building. Field staff and new employees are provided a copy of the QAPP from the Environmental Biologist.

The QA Coordinator is to be notified of changes made to the SOP or any other documentation referenced by this QAPP. The QA Coordinator will be responsible for distributing the information, as described above. The QA Coordinator will also be responsible for maintaining current copies of all documents directly associated with the FTMP.

Field staff members that regularly assist in FTMP activities are responsible for reviewing the FTMP QAPP annually. The Environmental Biologist will maintain documentation of staff review of the FTMP QAPP.

The FTMP is an ongoing project; therefore, this QAPP will be reviewed on at least an annual basis. If appropriate, any changes or updates will be made as part of the annual review; however, critical revisions may be made at anytime. The QA Coordinator is responsible for completing revisions, obtaining signatures of approval, and disseminating the revised document to those on the distribution list within 30 days of final approval. The version or revision number and date shall be easily identifiable by the document control information on each page. A complete list of all revisions/updates will be provided with each annual update.

Project Records

Hardcopies of the following records are maintained for at least five years in the Environmental Biologistist's office:

- Study Plans
- Fish Tissue Survey Information Forms (Appendix 1)
- Fish Tissue Raw Data Sheets (Appendix 1)
- Meter Calibration Sheets (Appendix 5)
- Analytical Laboratory Reports
- Special Study Memoranda
- Reports to NCDHHS and other agencies

Electronic Data Storage

All field and laboratory measurements and analytical data are ultimately warehoused in the Fish Tissue Assessment database (Microsoft Access® 2007). A copy of the database exists on BAU's drive on the ESS server. Tape backups are run daily on the ESS servers. The database is updated on an as-needed basis whenever samples are completed or whenever errors in previously entered data are identified. Details of electronic data management and warehousing methods are further described in Section B10 of this document.

Data Reporting

All available historic and current raw data, station visit comments/observations, and station information, including HUC8digit, latitude, an longitude are stored electronically in the Fish Tissue Assessment database. All fish tissue data are made publically available via the ESS website at http://portal.ncdenr.org/web/wq/ess/bau/fish-tissue-data Raw and analyzed fish tissue data are also provided to staff from other state and federal agencies, private consultants, academia, municipalities, private citizens, etc. via special study reports and on the ESS web site.

SECTION B:

DATA GENERATION AND ACQUISITION

B1. Sampling Process Design

The FTMP is the primary process within NCDENR to monitor fish tissue contaminants across the State. The program has been in existence since the late 1970's. Its core mission is to sample accessible and publicly fished sites for the presence of fish tissue contaminants. Sites are assessed as part of regional or watershed-specific special studies.

A detailed sampling plan is developed by the Environmental Biologist and approved by the BAU Supervisor prior to initiating any studies. At minimum, a study should involve a two-tiered approach:

- Screening studies, identify sites where commonly consumed fish species are contaminated with target analytes and may pose a risk to human health.
- Intensive studies characterize the magnitude and geographical extent of contamination in harvestable fish at sites identified in screening studies. Intensive studies should be designed to verify results of screening studies.

Target Species

The primary selection criterion for target species is to choose those that are commonly consumed locally and are of harvestable size. In freshwater ecosystems, one bottom feeding and one predator fish species are collected. In estuarine/marine ecosystems, either one bivalve species and one finfish species or two finfish species are collected. Second and third choice target species are selected in the event that the recommended target species are not collected at the site. Generally, at least ten individuals of each target species are collected.

Sample Type

To ensure even distribution of contaminants throughout tissue samples and to facilitate extraction and digestion of samples, the fillets from individual fish must be ground and homogenized prior to analysis. The fillets from an individual fish may be ground and homogenized separately or combined, depending on the analytical requirements and the sample size. Composite samples are homogeneous mixtures of samples from at least four but no more than ten individual fishes of the same species collected at a particular site during the same time period and analyzed as a single sample. Fish used in a single composite should be of similar size such that the smallest individual in a composite is no less than 75 percent of the total length (size) of the largest individual. Final individual or composite samples should be composed of at least 100 g of tissue to ensure an adequate amount of material for analysis.

Site Locations

Sites are established at publicly accessible, fixed locations (i.e., specific latitude and longitude), generally near boat ramps, public access areas, lakes, reservoirs, estuaries, and streams accessible by boat. Wadeable and lower Strahler orderrivers are also monitored. Locations and their geo-references are identified using handheld GPS units or Maptech Terrain Navigator ® software. Stations are strategically located to monitor a specific area of concern such as:

- Mercury bioaccumulation issues,
- Survey requests from regional offices and other agencies,
- Sites where contaminant data is incomplete or absent, or
- Sites where contaminants have been elevated or are suspected.

A current listing of FTMP sample sites is located at http://portal.ncdenr.org/web/wq/ess/bau/fish-tissue-data .

Adjustments to site locations and sampling regimens may be made with sufficient reason, such as:

- Safety concerns of field staff,
- Changes to location accessibility,
- Reason for sampling is no longer valid (i.e., a discontinued discharge),
- Emergence of new water quality concerns, or
- Resource constraints, particularly staff vacancies.

If any of these concerns arise, the Environmental Biologist will meet with the BAU Supervisor to determine if it is appropriate for sampling activities at the site to be discontinued.

Indicators Measured

The FTMP evaluates fish tissue contaminants across North Carolina using guidelines described in the EPA guidance document *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories (USEPA, 2007)*. The program routinely evaluates those contaminants listed in Appendix 2. Contaminants in fish tissue are measured according to Section 5 of the Quality Assurance Manual for the North Carolina Division of Water Quality Laboratory Section (Appendix 3).

All other field measurements (water temperature, pH, specific conductance, and dissolved oxygen) are conducted in accordance with the ISU SOP: http://portal.ncdenr.org/c/document_library/get_file?uuid=522a90a4-b593-426f-8c11-21a35569dfd8&groupId=38364 . Field measurements are performed to monitor environmental conditions at a site during sampling and to provide additional information related to catch rates, species present, and electrofisher settings.

Sampling Frequency

The FTMP conducts fish tissue sampling in all of North Carolina's physiographic provinces (Figure B1.1) in both wadeable and non-wadeable waters. Approximately 25 to 30 sites are sampled annually. Watershed-specific special study sites are usually sampled only once and may be sampled at any time between March and October.

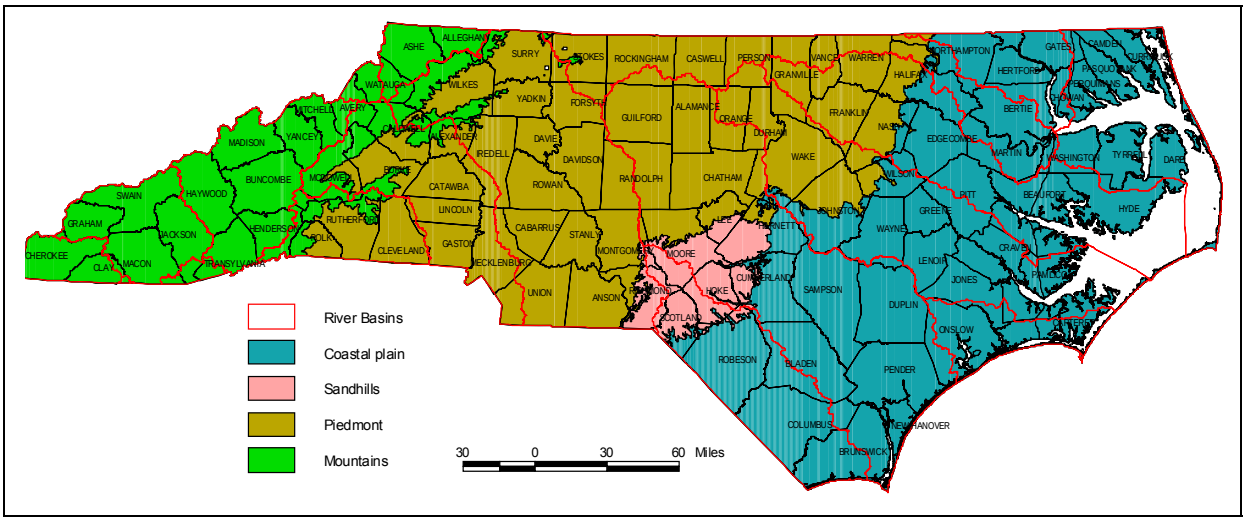

Figure B1.1 Physiographic Regions and River Basins in North Carolina.

B2. Sampling Methods

Sample Collection

Methods for collecting fish tissue samples are described in Sections 3.2 and 3.3 of the Fish Tissue Assessment SOP (Appendix 1). In most cases, the FTMP will employ electrofishing as the primary means of fish collection. Collections on lakes and non-wadeable streams are usually accomplished using a boat-mounted electrofisher powered by a 2.5-watt or a 7.5-watt generator. Collections on wadeable streams are accomplished using backpack electrofishing techniques described in the Stream Fish Community Assessment SOP (Appendix 4). Fish are packaged and placed immediately on wet ice and chilled to 4°C for transport back to the ESS laboratory.

Upon arrival at the ESS laboratory, fish are inspected for condition, measured and weighed to the nearest centimeter and 0.1 gram respectively, and processed according to Section 3.4 of Appendix 1.

Other water quality measurements collected in the field include water temperature, pH, specific conductance, and dissolved oxygen. All field parameter measurements are performed in accordance with Section III of the ISU SOP (http://portal.ncdenr.org/web/wq/ess/isu).

In addition to the ISU SOP citations in Table B2.1, the instruction manual for the appropriate meter should also be consulted.

Table B2.1 Field Measurement Method References and Reporting Levels.
Adopted from the Intensive Survey Unit's SOP (http://portal.ncdenr.org/web/wq/ess/isu).

Parameter	NC DWQ's Intensive Survey Unit's SOP & Section[1]	EPA method	Reported to Nearest
Dissolved oxygen	III.3	360.1	0.1 mg/L
pH	III.4	150.1	0.1 s. u.
Water temperature	III.1	170.1	0.1 ºC
Specific conductance	III.5.2	120.1	1 µmhos/cm

[1] Section numbers III.1 - III.5 refer to use of YSI combination meters and Fisher Scientific Accumet pH meters.

Any irregularities or problems encountered by field staff members are communicated to the Environmental Biologist and the BAU Supervisor who assess the situation, consult with other project personnel if needed, and recommend a course of action for resolution. Deviations from these procedures due to unusual sampling situations shall be documented in the appropriate report or memorandum.

Composite Sampling

All samples are prepared under controlled conditions at the ESS laboratory. Composite samples are homogeneous mixtures of samples from at least four but no more than ten individual fishes of the same species collected at a particular site during the same time period and analyzed as a single sample. Specimens used in a single composite should be of similar size such that the smallest individual in a composite is no less than 75 percent of the total length (size) of the largest individual. Final individual or composite samples should be composed of at least 100 g of tissue to ensure an adequate amount of material for analysis.

B3. Sample Handling and Custody

All samples are to be handled by the Environmental Biologist and in accordance with Section 3.3 of the Fish Tissue Assessment SOP (Appendix 1). Whole fish samples are returned to the ESS Laboratory, and the sample information is recorded on the Fish Tissue Raw Data Sheet (Appendix 1). These datasheets are stored in the Environmental Biologist office in a 3-ring binder labeled "Field Data Sheets". Samples that cannot be processed within 48 hours are frozen as whole fish, delivered to the ESS laboratory as soon as possible, and stored at -20°C in a locked freezer located in the fish-processing lab until processing can be performed. Tissue samples are stored according to the guidelines in Table B3.1.

Table B3.1 Recommended Container Materials and Preservation of Fish Tissue Samples
From receipt at sample processing laboratory to analysis (USEPA, 2007).

Analyte	Matrix	Sample Container	Preservation
Mercury	Tissue (fillets and edible portions, homogenates)	• Plastic, • Borosilicate Glass, • Quartz, or • PTFE	Freeze at ≤ -20°C
Other Metals	Tissue (fillets and edible portions, homogenates)	• Plastic, • Borosilicate Glass, • Quartz, or • PTFE	Freeze at ≤ -20°C
Organics	Tissue (fillets and edible portions, homogenates)	• Borosilicate Glass, • PTFE, • Quartz, or • Aluminum Foil	Freeze at ≤ -20°C
Metals and Organics	Tissue (fillets and edible portions, homogenates)	• Borosilicate Glass, • Quartz, or • PTFE	Freeze at ≤ -20°C

PTFE = polytetrafluoroethylene (Teflon)

Collection Number

After inspection and acceptance at the ESS laboratory, each FTMP sample is assigned a unique number. The tracking number includes the year and is consecutive during the period from January 1 to December 31. This number is recorded on the Fish Tissue Raw Datasheet (Appendix 1) to ensure sample integrity and as a means to track sample disposition.

B4. Analytical Methods

All analytical analyses of fish tissue samples are conducted by the Division's Analytical Chemistry Laboratory (or an alternative analytical lab, when necessary). Analytical lab procedures are conducted in accordance with the Quality Assurance Manual for the North Carolina Division of Water Quality Laboratory Section (Appendix 3). Turnaround times for analytical results are usually one month for metals analyses and several months for pesticide and organics analyses.

B5. Quality Control

Field Activities

Fish samples are collected and handled in the field under the supervision of the Environmental Biologist.. Fish collected for analyses are shipped to the processing laboratory in such a manner as to prevent decomposition or contamination as described in Section 3.3 of the Fish Tissue Assessment SOP (Appendix 1).

Field water quality instruments are calibrated for each sampling trip prior to departure from the ESS Laboratory and are calibrated daily, usually at night, if the sampling trip extends overnight. For "day-trip" sampling, the instruments are calibrated every morning before departure from the ESS Laboratory. Meter calibrations for dissolved oxygen (DO), pH, and specific conductance are checked after each sampling event to confirm that significant drift has not occurred and that the data collected is accurate and representative. If final calibration readings are beyond acceptable limits (DO = $\pm$0.5; pH = $\pm$0.2; conductance = $\pm$10%), the data are discounted and are not entered in the database.

FTMP Laboratory Activities

The following components of the quality assurance and quality control plan for sample processing are described in Section 3.5 of the Fish Tissue Assessment SOP (Appendix 1):

- Prepare duplicate samples of at least 10% of fish samples and submit to analytical lab for analyses.
- For Intensive Studies, freeze and archive 10% of prepared homogenates for at least 6 months after study is completed.
- The Division will split sample homogenates with other analytical labs for analyses at least twice per year. Variability must be within 2 standard deviations of the mean to be considered acceptable.

Analytical Laboratory Activities

Components of the analytical laboratory quality assurance and quality control plan are described in the Quality Assurance Manual for the North Carolina Division of Water Quality Laboratory Section (Appendix 3).

B6. Equipment Testing, Inspection, and Maintenance

A routine preventative maintenance program minimizes the occurrence of instrument and equipment failures. Preventative maintenance is limited because most of the sampling and measuring equipment is electronic (i.e., no movable parts to repair). As a result, most repairs occur when the equipment no longer functions.

The Environmental Biologist is responsible for regular cleaning, inspection, and maintenance of their assigned equipment. All equipment should be visually inspected at each site for damage or dirt and repaired or cleaned before use. Required maintenance is shown in Table B6.1. Operators' manuals for all equipment should be consulted for manufacturer's recommendations for inspection, maintenance, and repair.

Table B6.1 Water Quality Field Instrumentation Maintenance.

Instrument	Task	Frequency
YSI 85 Dissolved Oxygen/ Conductivity/ Temperature Meter	Check battery level	Daily
	Inspect membrane for holes, tears, bubbles, fouling or other damage	Daily
	Replace membrane and potassium Chloride solution	As needed if damaged; dissolved oxygen is not calibrating; or calibrations do not hold; responding slowly, showing excessive drift, or providing erratic readings
	Inspect gold cathode	As needed, when replacing membrane
	Clean cathode	As needed, if tarnished or plated
Fisher Scientific Accumet pH Meter	Inspect probe for bubbles and electrolyte level	Daily
	Top off probe potassium chloride electrolyte level	As needed
	Replace probe	As needed if damaged, not calibrating or calibrations do not hold, responding slowly, showing excessive drift, or providing erratic readings

B7. Instrument Calibration and Frequency

Water Quality Field Instrumentation

All field meters are inspected and calibrated before each sampling trip and at the end of each day used. Pre- and post-sampling calibration information is recorded on the Field Meter Calibration Sheet (Appendix 5). Calibration sheets are kept on file at the ESS laboratory. The specific calibration procedures are documented in each meter's instruction manual. Two-point calibrations are performed for specific conductance and pH. Dissolved oxygen meters are calibrated using the air calibration method.

Standards are selected so that they bracket the range of measurements expected that day. Traceable pH buffers (standards) and specific conductance standards are purchased. Specific conductance is typically calibrated using 500µS/cm and 1000 µS/cm standards. pH meters currently in use require standards of 4.0, 7.0, and 10.0 s.u.

All samples are weighed on balances that are properly calibrated and of adequate accuracy and precision to meet program data quality objectives. Balance calibration should be checked at the beginning of each weighing session.

B8. Inspection/Acceptance for Supplies and Consumables

All instruments, work surfaces, and containers used to process samples are made of materials that can be easily cleaned and are not themselves potential sources of contamination. Equipment used in processing samples for organics analyses is composed of stainless steel, anodized aluminum, borosilicate glass, polytetrafluoroethylene (PTFE), or ceramic. Equipment used in processing samples for metals analyses is composed of high-quality corrosion-resistant stainless steel (when nickel and chromium are not analytes of concern), PTFE, ceramic, polypropylene, or polyethylene. The Environmental Biologist is responsible for the procurement and maintenance of all equipment and consumables associated with the FTMP.

B9. Acquired Data (Non-Direct Measurements)

All data will be generated through the FTMP field activities and subsequent laboratory analyses, with two exceptions:

- Geo-referenced (latitude and longitude) data are obtained from Maptech Terrain Navigator® software or from a Garmin GPS meter.
- Target species lists are generated from the DWQ Fish tissue database using species data from previous sampling trips.

Both datasets are used for planning and site characterization before site visits.

B10. Data Management

Data from the Fish Tissue Survey Information Sheets and analytical laboratory reports are manually keyed into the Fish Tissue Assessment database (Microsoft Access® 2007) by the Lead Environmental Biologist. The Environmental Biologist reviews the data for completeness, errors, unlikely or impossible values, *etc*. Questionable records are checked against hard copy raw data and laboratory sheets kept on file at ESS.

Analytical data reported below the method detection limit, including a datum reported as *Not Detected* or *No Observed Response*, is assigned a value of one-half the Practical Quantitation Limit (PQL). The PQL serves as a practical and routinely achievable detection limit. A datum reported at or above the PQL is used as reported. The following statistics are calculated for each sampled species at each site:

- Range of target analyte concentrations,
- Arithmetic mean of target analytes,
- Standard deviation of mean target analyte concentrations, and
- Number of samples.

Data are kept current and correct through tools such as update and append queries within the database, input requirements built into the software, and through frequent searches and analyses. Copies of the database reside on the ESS server. Tape backups are run daily on the ESS servers. The database is updated on an as-needed basis when samples are completed or when errors in previously entered data are identified. Hardcopy field data and reporting sheets are archived at ESS for database verification.

SECTION C:

ASSESSMENT AND OVERSIGHT

C1. Assessments and Response Actions

The Environmental Biologist is responsible for the FTMP and serves as the coordinator and the liaison between the program, the BAU, the ESS, the Basinwide Planning Unit, and other data users. All laboratory work, including fish handling and processing, is conducted by the Environmental Biologist or trained ESS staff members who are familiar with all pertinent SOP's. All laboratory work is conducted in accordance with the current SOP and under the direct supervision and guidance of the Environmental Biologist. Issues with any aspect of the program are immediately reported to the Environmental Biologist, who will assess the issue, consult with the BAU Supervisor and other associated parties, and determine the appropriate course of action.

Annually, all field staff participate in USGS's National Field Quality Assurance (NFQA) Program. The NFQA is a yearly proficiency test for pH and specific conductance. Staff who do not receive satisfactory results are provided additional field meter training and retested. The QA Coordinator oversees the NFQA program for ESS.

C2. Reports to Management

The Environmental Biologist reports monthly on the status of FTMP projects *via* staff meetings, internal memoranda, and e-mail correspondence. Reports are submitted to the BAU supervisor and/or ESS Section Chief. FTMP activities are also included in the monthly ESS Update.

The Environmental Biologist maintains documentation of all changes made to FTMP databases as well as changes to tissue criteria, SOP's, and field procedures. All program changes and modifications are conveyed to the BAU supervisor as needed.

SECTION D:

DATA VALIDATION AND USABILITY

D1. Data Review, Verification, and Validation

Data verification and validation occurs at every step of data generation and handling. The Environmental Biologist and assisting staff are responsible for verifying that all records and results produced or handled are completely and correctly recorded, transcribed, and transmitted. The Environmental Biologist also responsible for ensuring that all activities (sampling, measurements, and analyses) comply with all requirements outlined in the FTMP QAPP and SOP. The Environmental Biologist is responsible for final verification and validation of all results.

Invalid sample data are not used in the FTMP. The data are considered invalid if the sample was:

- Collected or handled under suspect conditions (e.g., samples collected by untrained staff or where the methods could not be verified),
- Collected and handled according to methods that do not conform to all pertinent SOP's,
- Contaminated during collection or handling, or
- Not properly preserved and/or handled, resulting in deteriorated specimens.

Sample data are also considered invalid if post-sampling meter calibrations for dissolved oxygen (DO), pH, and specific conductance are beyond acceptable limits (DO = $\pm$0.5; pH = $\pm$0.2; conductivity = $\pm$10%). If meter calibrations are not within the acceptable limits, the data are discounted and are not entered in the database.

Data are kept current and correct through tools such as update and append queries within the database, input requirements built into the software, and through frequent searches and analyses. Copies of the database reside on the ESS server. Tape backups are run daily on the ESS servers. The database is updated on an as-needed basis when samples are completed or when errors in previously entered data are identified. Hardcopy field data and reporting sheets are archived at ESS for database verification.

D2. Validation and Verification Methods

The Environmental Biologist reviews all results to ensure accuracy and completeness. Questionable records are checked against and compared to hardcopies of raw data and laboratory sheets kept on file at ESS. When necessary, field and analytical laboratory staff are contacted to verify data records.

A datum reported below the method detection limit, including a datum reported as *Not Detected* or *No Observed Response* will be assigned a value of one-half the Practical Quantitation Limit (PQL). The PQL serves as a practical and routinely achievable detection limit. A datum reported at or above the PQL will be used as reported.

D3. Reconciliation with User Requirements

After the data have been analyzed and summarized, results from the program are communicated *via* ESS Chief-approved internal, site-specific memoranda.

Statistical validation methods are not used to determine possible anomalies or outliers of the data.

Any issues encountered in meeting the performance criteria as stated in Section A6 of this document (or limitations in the use of data) are documented in the final report.

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