NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
WATER MONITORING AND STANDARDS ELEMENT
BUREAU OF FRESHWATER AND BIOLOGICAL MONITORING
P.O. Box 420; Mail Code 35-01 TRENTON, NEW JERSEY

WORK/QUALITY ASSURANCE PROJECT PLAN
Fish Tissue Monitoring Program – Probabilistic Monitoring 2020

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1.0 Project Name:

Fish Tissue Monitoring Program – Probabilistic monitoring

2.0 Project Request:

Division of Water Monitoring and Standards, Bureau of Freshwater and Biological Monitoring

3.0 Date of Request:

August 2020

4.0 Date of Project Initiation:

August 2020

5.0 Project Fiscal Information: Job Number 33340000, Activity Code V6TK

6.0 Project Manager:

Brian Henning, Research Scientist 1
Bureau of Freshwater and Biological Monitoring
New Jersey Department of Environmental Protection

7.0 Quality Assurance Officer:

Melissa Hornsby, Research Scientist 1
NJDEP, Office of Quality Assurance

8.0 Special Training Needs/ Certifications

Team leaders and assistants to the project will be trained in the operation and use of all sampling equipment including the proper safety and handling procedures for electroshocking equipment. The Project Manager or designee will be responsible for coordinating the necessary training. All crew members are required to adhere to the BFBM Field Work Health and Safety Plan developed in cooperation with NJDEP Office of Occupational Health and Safety (OOHS) and any addendums to address covid-19 precautions. Crew members must also adhere to any guidance provided by OOHS during the QAPP period. The boat operator will have a valid NJ boater safety or equivalent card certification. At least 1 crew member will be Red Cross AED/CPR certified. The Project Manager or designee will be responsible for coordinating necessary training. All staff present on electrofishing boat we be given a brief training and safety demonstration by the boat operator prior to each electrofishing event. Safe electrofishing boating conditions will be confirmed by the Project Manager when there are any questions regarding the safe handling of boats on large rivers and reservoirs.

9.0 Project Description:

9.1 Background:

Fish and shellfish consumption advisories due to chemical contamination were announced in New Jersey in the 1980s and 1990s. Data from Division of Science and Research (DSR) studies revealed that unacceptable risks existed for eating certain amounts and species of fish and shellfish from some waters in the State.

Statewide advisories were issued for consumption of selected fish species due to toxic contamination. The advisories are more restrictive for pregnant women, nursing mothers and young children. Many contaminants including polychlorinated biphenyl (PCBs) and mercury have been linked to birth defects, developmental problems, neurological problems and/or cancer. Current advisories are listed on NJDEP's Website www.FishSmartEatSmartNJ.org.

In addition to posing human health consumption concerns, many toxic contaminants can result in ecological impacts to fish and other biota. One of the toxics of concern, mercury, is persistent in the environment, accumulates in biological tissue, and biomagnifies in the food chain. Due to these magnifying characteristics, adverse impacts to non-aquatic, piscivorous (fish- eating) organisms may arise from low surface water column concentrations. New Jersey's Total Maximum Daily Load (TMDL) target is 0.18 µg/g in fish tissue. This is the concentration recommended to the high-risk population as not to exceed one meal per week of top trophic level fish.

A routine tissue monitoring program was identified as a key gap in NJ's Long-term Monitoring and Assessment Strategy. Sampling fish tissue for advisories, and for assessing the CWA fish consumption use, had primarily been conducted in the past by DEP's Division of Science and Research on a research project-specific basis with external research institutions. A routine monitoring network was initially established in 2014 by the Bureau of Freshwater and Biological Monitoring (BFBM), working with DSR. This routine sampling leverages some existing monitoring program resources (e.g., electroshocking boats, supplies, and fisheries expertise) to provide regular, cost-efficient monitoring and ongoing data to meet the objectives below.

9.2 Objectives

The objective of this fish tissue probabilistic monitoring program is to collect data on finfish from New Jersey's freshwater bodies for mercury contaminants of for the following purposes:

- Provide current and more comprehensive data on concentrations of toxic contaminants in fish to assess human health risks and update/recommend fish consumption advisories.
- Provide data to assess the impairment of the fish consumption designated use of the waterbodies sampled.
- Provide data to assess the overall status and trends in levels of contaminants that contribute to use impairment and fish consumption advisories.
- Provide a statistically valid statewide estimate of total mercury concentrations in fish from public New Jersey lakes greater than 5 acres in size.

Data Quality Objectives:

For fish tissue analysis, total mercury will be measured for all fish collected. Measuring bias, precision, accuracy, and sensitivity must meet the standards outlined in USEPA Method 1631 for total mercury.

9.3 Monitoring Design/ Site Selection:

The monitoring design is Probabilistic, meaning that sites are selected randomly, and includes just lakes. Lakes were selected for the probabilistic design because they often receive more angling pressure, have greater access both to anglers and to sampling staff, and fish movement is generally limited to within each lake. A total of 50 probabilistic lakes (greater than 5 surface acres; Figure 1) were generated using a Generalized Random Tessellation Stratified (GRTS; Stevens and Olsen, 2004) survey design performed using the "sp survey" package (Kincaid and Olsen, 2016) in R (a free software environment for statistical computing and graphics). Lakes that are private (not generally open to public fishing access), tidally influenced, quarry pits (mining), retention ponds, segments of larger lakes, and waterbodies that do not constitute a "lake" are non-target sites and are not considered for sampling. This network started in 2016 and is scheduled to be completed in 5 years (2020) by sampling 10 lakes annually. The 10 probabilistic lakes sampled each year do not necessarily correspond with the current rotating basin, rather they are sampled in numerical order of the randomly generated site list. This probabilistic monitoring design will provide a statistical statewide status estimate of total mercury concentrations in fish from public New Jersey lakes greater than 5 acres in size. This data can also be used over time to assess trends every 5 years.

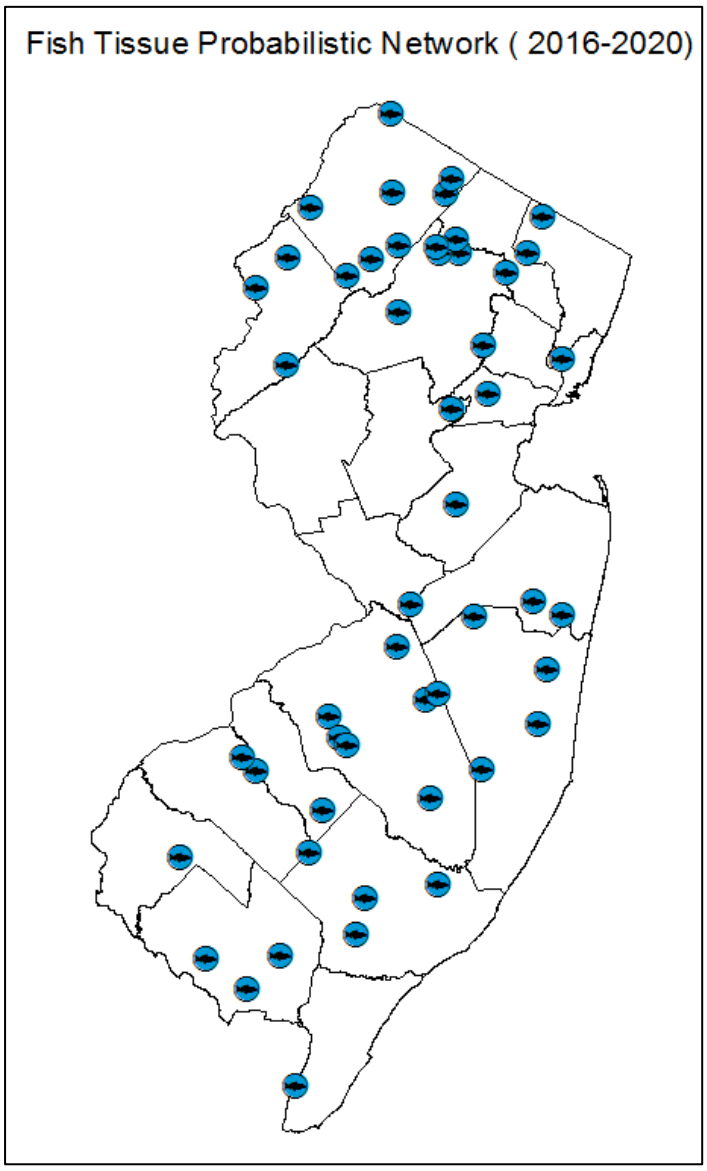

Figure 1. Probabilistic fish tissue lakes.

Site Selection:
Probabilistic Lake Network- Approximately 10 probabilistic lakes will be sampled for fish tissue each year until 50 lakes are completed (scheduled to be complete in 2020). Probabilistic lakes scheduled for sampling in 2020 are listed in Table 2b. The first 10 lakes (in sequential order) which are accessible to the sampling gear and permissible to sample will be selected. Lakes that do not meet the sampling criteria will be eliminated.

Field Collection: Sampling locations will be established using an approved global positioning system (GPS) device (Trimble GeoExplorer 2008 or newer model) at each boat launching location. Subsequently, all sampling locations will be verified by sampling staff during each sampling event using an approved GPS device. The individual location of each fish taken for sample is not recorded via GPS.

Fish will be collected primarily through DC boat electrofishing; however, other methods will be used if necessary (e.g., traps, gillnets or hook and line).

Electrofishing is inherently dangerous and therefore boat team leaders must be trained in safe electrofishing techniques and practices (including operation of electroshocking boats) to ensure safe working conditions for themselves and the field staff (AFS Professional Safety Committee 2008). Exposure to low electrical current (like that used in electrofishing) may cause death due to respiratory arrest or cardiac fibrillation (AFS Professional Safety Committee 2008). Due to these dangers, the team leader must be trained in CPR and AED procedures. All crew members are required to wear a Coast Guard approved personal flotation device (PFD), knee high rubber boots with non-slip soles, and electrician gloves rated at 7,500 watts (netters only). All crew members are required to adhere to the BFBM Field Work Health and Safety Plan developed in cooperation with NJDEP Office of Occupational Health and Safety (OOHS). Crew members must also adhere to any guidance provided by OOHS during the QAPP period.

Electrofishing is the primary sampling method. In addition to electrofishing, baited hoop nets, fyke nets, experimental gill nets or hook and line may be employed to ensure the collection of all specimens. After two attempts to capture the targeted species with electrofishing equipment, secondary sampling techniques should be employed at the discretion of the Project Manager. Hook and line sampling should only be conducted as a last resort. Nets will be set in the evening near the appropriate habitat and will be checked early the following morning to minimize mortality of incidental catch. Hoop and fyke nets will be set in a manner to ensure that there is sufficient surface air space for turtle bycatch to breathe (Larocque et al. 2012). Sampling gear and crew size will be determined by the Project Officer. A checklist of necessary sampling and safety equipment will be prepared prior to field work by the Crew lead.

It is highly desirable to collect live, intact fish that have not been mutilated by the collection gear and that do not have any skin lacerations or fin deterioration that would allow body fluids to leak out of the specimen or contaminants to pass into the specimen after collection. The USEPA recommends that fish captured in passive collection devices not remain in the water for more than 24 hours after the passive collection device is first deployed and that specimens that show any skin or fin deterioration or external lacerations of any kind not used for chemical analysis. In addition, some fish collected by electroshocking methods may have ruptured organs due to the electroshocking procedure. Fish that are found floating dead at a site should not be used for sample analysis for human risk assessments.

Fish Processing:
All fish collected for the probabilistic network are processed in the field and released back into the waterbody in which they came alive.

Previously, fish tissue mercury analysis required the specimen to be sacrificed. The more recent use of muscle plugs has eliminated the need to sacrifice the fish for mercury analysis and allows the fish to be released back into the waterbody alive. The USEPA has recently employed the use of tissue plugs for their National Rivers and Streams Assessment (NRSA) as have many state monitoring programs (e.g. New York, Kentucky, Nebraska). Studies have shown that mercury results from fish tissue plug samples harvested with biopsy tools were comparable in accuracy to results from samples collected with traditional whole body sampling methods (Baker et al., 2004). Fish tissue plugs also require less storage space in a freezer and are more cost effective to package and ship, and eliminate the fish preparation charge for whole fish by the laboratory. Whole fish samples are necessary for PCB analyses because these contaminants are known to accumulate in fatty tissue and the location and amount of tissue from muscle plugs is not sufficient for these analyses.

Probabilistic Lake Network- At all probabilistic sites, 5 individual largemouth bass or 5 individual chain pickerel of similar size will be collected for total mercury analysis. If the target species are not present or are unable to be captured with the available gear at a given waterbody, an alternate species will be selected from the alternate fish list (Table 3) at the discretion of the Project Manager. The 5 fish collected should be within 75% the total length of the largest individual in the sample when possible. All persons handling the fish during fish processing shall wear new nitrile gloves and polypropylene/polyethylene bags will be used to cover the measuring board for each fish sample. All sample specimens will be measured for total length (mm) and weighed using a digital hanging scale (Brecknell ElectroSamson: ±0.5% kg) or spring scale (Pesola, accuracy: ±0.3% g). All 5 fish will have tissue plugs removed in the field using the Non-Lethal Fish Tissue Plug Collection SOP (Syracuse Research Corporation, 2003). Each specimen will have a small portion of scales removed with a sterile scalpel from the left dorsal musculature. One 8mm biopsy punch will be inserted into the muscle to remove 1 plug per fish, weighing approximately 0.5g – 0.7g of tissue per plug. Each plug will be placed into a clean glass scintillation vial with outside

label identifying the probabilistic site ID and fish species code. Probabilistic site ID and fish codes are listed in Table 4. A composite sample consisting of 1 plug per fish, from 5 individual fish of the same species (largemouth bass or chain pickerel) will create a composite sample for analysis. The vial containing the 5 fish tissue plugs will be kept in a cooler on dry ice (frozen at <0 °C) and transported back to the office. All fish collected at probabilistic sites will be released back into the lake alive after a tissue plug is removed. The tissue plugs will be kept in a frozen state in a chest freezer at the 35 Arctic Parkway office until delivered to the New Jersey Department of Health (Lab certification #11036) within 1 year of the sampling date. All fish tissue plug samples will be shipped to the NJDEP's OQA certified laboratory for analysis on dry ice.

Table 1. Summary of fish tissue probabilistic monitoring network.

Criteria	Probabilistic
Site selection	Random (computer generated)
Waterbody	Lakes
Species targeted	Largemouth bass or chain pickerel
Sample Quantity	5 individuals
Analytes	total mercury (5 fish composite)
Sample matrix	Plug (Hg)
Fish sacrificed	No

Table 2: 2020 Probabilistic Lake Network Sites

Site ID	ProbID	Waterbody	COUNTY	Longitude_dd	Latitude_dd
FTM111	FWLM2015-002	Lake Washington	PASSAIC	-74.30123575	41.02997215
FTM112	FWLM2015-046	Spring Lake	MONMOUTH	-74.02873886	40.14880282
FTM113	FWLM2015-318	Darlington Lake	BERGEN	-74.17321271	41.06343707
FTM114	FWLM2015-325	Franklin Pond	SUSSEX	-74.58569455	41.1080421
FTM115	FWLM2015-337	Lake Iliff	SUSSEX	-74.71584058	41.0316155
FTM116	FWLM2015-412	Wells Mills Reservoir	OCEAN	-74.28049768	39.79238302
FTM119	FWLM2015-426	Pigeon Swamp	MIDDLESEX	-74.48764784	40.38813727
FTM120	FWLM2015-429	Lincoln Park Community Lake	MORRIS	-74.29602633	40.93884932
FTM121	FWLM2015-435	Makepeace Lake	ATLANTIC	-74.74485423	39.54297756
FTM122	FWLM2015-469	Weldon Brook Lake	MORRIS	-74.58705638	41.00570475
FTM123	FWLM2015-262	Barbour Pond	PASSAIC	-74.18230246	40.89970856
FTM141	FWLM2015-269	Lake Neepaulin	SUSSEX	-74.62635247	41.21652582
FTM125	FWLM2015-301	Hainsville Pond	SUSSEX	-74.78571927	41.2703137
FTM126	FWLM2015-310	Great Gorge Lake	SUSSEX	-74.52068485	41.16135905
FTM127	FWLM2015-313	Spring Lake	MERCER	-74.73178108	40.19310469
FTM128	FWLM2015-368	Franklin Parker Preserve Pond	BURLINGTON	-74.53176485	39.85185514
FTM129	FWLM2015-381	George Lake	MORRIS	-74.78521415	40.80006092
FTM130	FWLM2015-411	Pines Run	CAMDEN	-75.04571044	39.81629314
FTM131	FWLM2015-417	Silver Lake	WARREN	-74.9491898	40.93605208
FTM132	FWLM2015-441	Chesler Lake	MORRIS	-74.6284824	40.87059612
FTM133	FWLM2015-448	Double Trouble State Park Lake	OCEAN	-74.23162228	39.90023077
FTM134	FWLM2015-476	Bamber Lake	OCEAN	-74.31738535	39.89301351
FTM135	FWLM2015-479	Malaga Lake	GLOUCESTER	-75.05884305	39.57847396
FTM136	FWLM2015-485	Sawmill Pond	SUSSEX	-74.68741237	41.2949689
FTM137	FWLM2015-493	Jefferson Lake	SUSSEX	-74.73549673	40.92687342
FTM138	FWLM2015-494	Lake Ames	MORRIS	-74.50237153	40.95342406
FTM139	FWLM2015-496	Pickle Factory Pond	CAPE MAY	-74.91083326	39.22767245
FTM140	FWLM2015-500	Lily Lake	ATLANTIC	-74.45832866	39.46776369

*Coordinates are approximate site locations; actual boat ramp location will be GPSed the day of sampling. Probabilistic Site IDs will be given a new FTM# site ID in the order they are sampled, on the day of sampling.

Table 3: Alternate Fish List

Common Name	Scientific Name
Rock bass	*Ambloplites rupestris*
Northern Pike	*Esox lucious*
White Perch	*Morone americana*
Striped Bass	*Morone saxatilis*
Striped x White Bass hybrid	*Morone saxatilis x chrysops*
Yellow Perch	*Perca flavescens*
Black Crappie	*Pomoxis nigromaculatus*
White Crappie	*Pomoxis annularis*
Walleye	*Sander vitreus*
White Sucker	*Catostomus commersonii*

Table 4. Fish codes of collected fishes for fish tissue monitoring.

Common Name	Scientific Name	Fish Code
American eel	*Anguilla rostrata*	AE
Black Crappie	*Pomoxis nigromaculatus*	BC
Bluegill	*Lepomis macrochirus*	BG
Brown bullhead	*Ameiurus nebulosus*	BBH
Chain pickerel	*Esox niger*	CP
Channel catfish	*Ictalurus punctatus*	CCF
Common carp	*Cyprinus carpio*	CC
Flathead catfish	*Pylodictis olivaris*	FHCF
Lake trout	*Salvelinus namaycush*	LT
Landlocked Atlantic salmon	*Salmo salar*	LAS
Largemouth bass	*Micropterus salmoides*	LMB
Muskellunge	*Esox masquinongy*	MKY
Northern Pike	*Esox lucius*	NP
Pumpkinseed	*Lepomis gibbosus*	PS
Redbreast	*Lepomis auritus*	RBS
Rock bass	*Ambloplites rupestris*	RB
Smallmouth bass	*Micropterus dolomieu*	SMB
Striped bass	*Morone saxatilis*	SB
Striped bass x White bass hybrid	*Morone saxatilis x chrysops*	HSB
Walleye	*Sander vitreus*	WYE
White catfish	*Ameiurus catus*	WCF
White Crappie	*Pomoxis annularis*	WC
White Perch	*Morone americana*	WP
White Sucker	*Catostomus commersoni*	WS
Yellow bullhead	*Ameiurus natalis*	YBH
Yellow perch	*Perca flavescens*	YP

For probabilistic samples, the Probabilistic site ID will be given an FTM number for each site. The alphanumeric identifier for each individual fish will combine the site ID, fish code, and species sample number. For example, if 5 chain pickerel were sampled from a probabilistic lake, such as FTM121, the following sample alphanumeric identifiers would be used on the datasheet: FTM121CP0120, FTM121CP0220,

FTM121CP0320, FTM121CP0420, FTM121CP0520. The vial containing the 5 fish plug composite sample will be labeled with the site ID, fish code, and four-digit sampling year (FTM121CP2020).

Equipment Decontamination: To prevent the potential spread of nuisance or invasive organisms and macrophytes from waterbody to waterbody, all equipment (boats, nets, boots, etc.) is decontaminated between site visits by scrubbing/cleaning with a dilute solution of commercial disinfectant (Simple Green), followed by a rinse with fresh water and allowed to thoroughly dry.

9.4 Laboratory Analysis

The New Jersey Department of Health (NJDOH; Lab certification #11036) will analyze all samples using USEPA method 1631. For mercury analysis, a composite sample consisting of 1 plug per fish, from 5 individual fish of the same species (largemouth bass or chain pickerel) will be prepared for total mercury analysis.

Samples shall be stored frozen (-20 C) until processing in the laboratory. The maximum holding time for plugs is 1 year (Table 5). All transfers of samples will be properly documented throughout transport and analysis (internal lab chain-of-custody). All laboratory equipment will be properly calibrated as per each method completed. Careful cleaning of all laboratory equipment and instruments using the appropriate soaps, solvents, acids, and double deionized water will be employed throughout this program.

9.5 Shipment of Samples

All fish samples will be placed into coolers with each individual sample documented on the designated lab chain of custody form sealed inside a plastic bag (see Appendix B). All fish tissue plug samples will be delivered to the designated laboratory for analysis on dry ice. All coolers are sealed with packaging tape, and a custody seal is placed over the lid.

10.0 Schedule of Tasks and Products

Project Requested: August 2020
Station Selection: February 2020
Work/Quality Assurance Plan: March - April 2020
Sampling Activities: August – November 2020
Laboratory Activities (sample submission and analysis): November 2020 – December 2020
Data Reports: data tables (hardcopy and electronic) as laboratory results become available.

11.0 Resource Needs

BFBM will need 1 additional hourly staff to complete this project.

12.0 Quality Assurance

12.1 Laboratory Analysis: The total mercury will be analyzed by the New Jersey Department of Health (Lab certification #11036) using USEPA method 1631. Any laboratory used shall be certified by NJDEP's OQA for the requested parameters. The reporting levels, listed below, are required for this project.

Table 5. Fish tissue storage and analysis information by analyte.

Parameter	Method	Detection Level	Holding Time	Preservative	Plug/Fillet
Total Mercury	USEPA 1631	0.0896 ng/g	1 year	Ice to 4ºC in field. Freeze within 24 hours.	Plug

12.2 Sample Containers: Sample containers shall be dedicated, single-use.

12.3 Sample Retention: All samples must be retained by the laboratory until such time that the BFBM approves the reported results.

13.0 Data Quality Requirements

Analytical samples will be done by the methods specified in this QAPP and for which the laboratory has certification. Quality control procedures (including required calibrations, equipment cleaning, and other quality control procedures required by regulation or by the method shall be defined in the laboratory's Quality Manual or Standard Operating Procedures (SOPs). The QM and SOPs must be approved by the OQA.

14.0 Data Completeness

A total of 5 fish will be composited for probabilistic sites. Plug samples will consist of fish of similar size; the smallest fish will be no less than 75% of the size of the largest fish in the plug or composite sample. Adult fish of a size targeted by anglers will be collected for human health criteria. Fish samples will be collected during peak water temperatures (>10 ° C) and high productivity (i.e., May through November) in 2020.

15.0 Sample Custody Procedures

Chain of custody will be required for all samples as per N.J.A.C. 7:18-9.3(b). Laboratories performing the analysis will provide chain of custody forms.

16.0 Data Validation

The Project Manager is responsible for all initial data validation. If apparent anomalous data are suspected, the Project Manager and/or the Supervisor will review the sampling procedures with the field sampler to make sure the proper collection and preservation procedures were followed. If the data is still suspect, the laboratory will be contacted. An internal review of their laboratory procedures and/or calculations used in the analysis of the suspect sample, with special emphasis on transcription of data to assure that no transposition of figures occurred will be conducted. The laboratory will be asked to check on equipment calibration. They may be further requested to reanalyze the retained portion of the sample. If no problems are found in the analytical laboratory procedures, the data may then be compared to any historical data that might have been collected at the same site prior to the most recent sampling event to see if similar anomalies might have been found previously. The suspect data may also be compared to literature values or standard analytical treatises to verify whether the results are within the limits of accuracy of the test method.

If no obvious problems are found after these reviews, the complete data set will be reported with the suspect data identified as such. The BFBM will then conduct its own review of the data, as it relates to the objectives(s) and data accuracy required in this project.

17.0 Performance System Audits

All NJ certified laboratories used are subject to audits and to the requirements of the OQA Laboratory Certification Program as well as internal performance evaluations. The OQA will be notified of field monitoring schedules for possible audits.

18.0 Data Reporting

18.1 Preliminary Reporting of Data

Preliminary analytical data will be reported to BFBM, from the laboratory employed for this project, in electronic format as agreed in the contract to the Project Manager, within 21 calendar days from receipt of sample. Samples which yield results considered anomalous by the Project Manager will be validated as specified in section 16.0, Data Validation, before the holding time of the retained sample is expired. If the results remain suspect after an internal review of the laboratory procedures, calculations, and/or on transcription of data has been conducted, then the sample shall be reanalyzed by the laboratory using the retained portion of the sample. This reanalysis shall be performed within the parameter holding time.

18.2 Final Reporting of Data

Final analytical data will be reported to BFBM, from the laboratory employed for this project, in the form of an electronic data delivery as agreed to in the contract within 40 calendar days from receipt of sample. All data shall be reported in a complete and concise fashion and shall meet the reporting requirements of NJAC 7:18. Routine quality control results must be retained on file for review by the BFBM and the OQA.

19.0 Data Storage and Distribution

Sampling results will be stored locally in a Microsoft Access database. Data will be entered into New Jersey's Water Quality Data Exchange (WQDE) and will be accessible through the USEPA, USGS and National Water Monitoring Council's Water Quality Portal, as well as the BFBM website by June the following year data is verified. All raw data records shall be maintained for a period of no less than five years.

20.0 Assessment, Oversight, and Response

The Project Manager will be responsible for the oversight of all activities relating to this project. The Project Manager will assess field collection functions and make corrections when necessary to maintain the data accuracy as defined in this plan.

21.0 Corrective Action

If any changes or modifications are made to this plan regarding data collection, as it relates to the objectives(s) and data accuracy required in this project, all original signees of the QAPP will be notified. If a laboratory cannot be secured for analysis, or the contract award is delayed and frozen samples will expire per method requirements, all signees of the QAPP will be notified.

22.0 Addendum

Final Site Selection (as requested by OQA):

Literature cited

Baker, R. F., P. J. Blanchfield, M. J. Paterson, R. J. Flett, and L. Wesson. 2004. Evaluation of nonlethal methods for the analysis of mercury in fish tissue. Transactions of the American Fisheries Society 133:568–576.

Larocque, S.M., Cooke, S.J., Blouin-Demers, G., 2012. A breath of fresh air: avoiding anoxia and mortality of freshwater turtles in fyke nets by the use of floats. Mar. Freshw. Res. 22, 198–205.

Kincaid, T. M. and Olsen, A. R. (2016). spsurvey: Spatial Survey Design and Analysis. R package version 3.3.

Stevens, D. L., Jr. and A. R. Olsen (2004). "Spatially-balanced sampling of natural resources." Journal of American Statistical Association 99(465): 262-278.

Syracuse Research Corporation. 2003. Non-Lethal Fish Tissue Plug Collection. Washington, D.C.: U.S. Environmental Protection Agency. SOP #EH-07.

APPENDIX A:
Data Management Tables

For Data Management purposes, Water Chemistry is defined as parameters analyzed by a lab; Field measurements are defined as analyze immediately parameters.

Inventory

Geographic Regions	Rivers, lakes and reservoirs
Counties	Atlantic, Bergen, Burlington, Camden, Cape May, Gloucester, Hunterdon, Mercer, Middlesex, Monmouth, Morris, Ocean, Passaic, Somerset, Sussex, Warren
Dates	5/1/2020- 11/1/2020
Status	Future/Planned
Sample Frequency	Once

Seasons Sampled	Spring, Summer, Fall
Waterbody Type	River/Stream, lakes, reservoirs
Salinity Category	Fresh
Tidal Influence	Non-tidal, tidal
Project Description	The objective of this project is to collect total mercury data in fish tissue to: • Provide current and more comprehensive data on concentrations of toxic contaminants in fish in order to assess human health risks and update/recommend fish consumption advisories. • Provide data to assess the impairment of the fish consumption designated use of the waterbodies sampled. • Provide data to assess the trends in levels of contaminants that contribute to use impairment and fish consumption advisories.
Parameters analyzed type	Metals

Data Management Supplement

QAPP network path file location?	V:\LUM\BFBM\Bfbm\Quality Assurance Plans\Calendar Year 2020 QAPPs\FishTissue_Probabilistic2020_FINAL
Where will data be recorded in field (media)	Paper
If on tablets or phones, will download at office occur or will you connect wirelessly?	
If on tablets or phones, who will do the download?	
If data collected electronically, where will it be stored?	access database ,V:\LUM\BFBM\Lakes and Fishibi\FISH\Fish Tissue Monitoring\Database\FTM.accdb
Format to be received from Lab	text
Method of receipt from lab/s	email attachment
Personnel receiving outside lab data	Brian Henning

Is data expected to go to WQDE/STORET?	Yes
Data manager - (Bureau and Name)	BFBM Leigh Lager

Table 1. Site list

Station ID (WQDE compliant and referenced)	Waterbody/Location	Latitude-dd	Longitude-dd	County	Site exists in WQDE already?	Location Type
FTM111	Lake Washington	-74.3012	41.02997215	PASSAIC	No	Lake
FTM112	Spring Lake	-74.0287	40.14880282	MONMOUTH	No	Lake
FTM113	Darlington Lake	-74.1732	41.06343707	BERGEN	No	Lake
FTM114	Franklin Pond	-74.5857	41.1080421	SUSSEX	No	Lake
FTM115	Lake Iliff	-74.7158	41.0316155	SUSSEX	No	Lake
FTM116	Wells Mills Reservoir	-74.2805	39.79238302	OCEAN	No	Lake
FTM119	Pigeon Swamp	-74.4876	40.38813727	MIDDLESEX	No	Lake
FTM120	Lincoln Park Community Lake	-74.296	40.93884932	MORRIS	No	Lake
FTM121	Makepeace Lake	-74.7449	39.54297756	ATLANTIC	No	Lake
FTM122	Weldon Brook Lake	-74.5871	41.00570475	MORRIS	No	Lake
FTM123	Barbour Pond	-74.1823	40.89970856	PASSAIC	No	Lake
FTM124	Lake Neepaulin	-74.6264	41.21652582	SUSSEX	No	Lake
FTM125	Hainsville Pond	-74.7857	41.2703137	SUSSEX	No	Lake
FTM126	Great Gorge Lake	-74.5207	41.16135905	SUSSEX	No	Lake
FTM127	Spring Lake	-74.7318	40.19310469	MERCER	No	Lake
FTM128	Franklin Parker Preserve Pond	-74.5318	39.85185514	BURLINGTON	No	Lake
FTM129	George Lake	-74.7852	40.80006092	MORRIS	No	Lake
FTM130	Pines Run	-75.0457	39.81629314	CAMDEN	No	Lake
FTM131	Silver Lake	-74.9492	40.93605208	WARREN	No	Lake
FTM132	Chesler Lake	-74.6285	40.87059612	MORRIS	No	Lake
FTM133	Double Trouble State Park Lake	-74.2316	39.90023077	OCEAN	No	Lake
FTM134	Bamber Lake	-74.3174	39.89301351	OCEAN	No	Lake
FTM135	Malaga Lake	-75.0588	39.57847396	GLOUCESTER	No	Lake
FTM136	Sawmill Pond	-74.6874	41.2949689	SUSSEX	No	Lake
FTM137	Jefferson Lake	-74.7355	40.92687342	SUSSEX	No	Lake
FTM138	Lake Ames	-74.5024	40.95342406	MORRIS	No	Lake
FTM139	Pickle Factory Pond	-74.9108	39.22767245	CAPE MAY	No	Lake
FTM140	Lily Lake	-74.4583	39.46776369	ATLANTIC	No	Lake

Table 2. Parameters

STATION ID	Field Msr/Obs	Flow	Water Chemistry	Continuous Monitoring	Biological	Sediment	Bacteria Collection	Habitat	Metrics	Indices
FTM111	No	No	Yes	No	No	No	No	No	No	No
FTM112	No	No	Yes	No	No	No	No	No	No	No
FTM113	No	No	Yes	No	No	No	No	No	No	No
FTM114	No	No	Yes	No	No	No	No	No	No	No
FTM115	No	No	Yes	No	No	No	No	No	No	No
FTM116	No	No	Yes	No	No	No	No	No	No	No
FTM119	No	No	Yes	No	No	No	No	No	No	No
FTM120	No	No	Yes	No	No	No	No	No	No	No
FTM121	No	No	Yes	No	No	No	No	No	No	No
FTM122	No	No	Yes	No	No	No	No	No	No	No
FTM123	No	No	Yes	No	No	No	No	No	No	No
FTM124	No	No	Yes	No	No	No	No	No	No	No
FTM125	No	No	Yes	No	No	No	No	No	No	No
FTM126	No	No	Yes	No	No	No	No	No	No	No
FTM127	No	No	Yes	No	No	No	No	No	No	No
FTM128	No	No	Yes	No	No	No	No	No	No	No
FTM129	No	No	Yes	No	No	No	No	No	No	No
FTM130	No	No	Yes	No	No	No	No	No	No	No
FTM131	No	No	Yes	No	No	No	No	No	No	No
FTM132	No	No	Yes	No	No	No	No	No	No	No
FTM133	No	No	Yes	No	No	No	No	No	No	No
FTM134	No	No	Yes	No	No	No	No	No	No	No
FTM135	No	No	Yes	No	No	No	No	No	No	No
FTM136	No	No	Yes	No	No	No	No	No	No	No
FTM137	No	No	Yes	No	No	No	No	No	No	No
FTM138	No	No	Yes	No	No	No	No	No	No	No
FTM139	No	No	Yes	No	No	No	No	No	No	No
FTM140	No	No	Yes	No	No	No	No	No	No	No

Table 3. Partners

STATION ID	Field Msr/Obs	Flow	Water Chemistry	Continuous Monitoring	Biological	Sediment	Bacteria Collection
FTM111	No	No	DEP	No	No	No	No
FTM112	No	No	DEP	No	No	No	No
FTM113	No	No	DEP	No	No	No	No
FTM114	No	No	DEP	No	No	No	No
FTM115	No	No	DEP	No	No	No	No
FTM116	No	No	DEP	No	No	No	No
FTM119	No	No	DEP	No	No	No	No
FTM120	No	No	DEP	No	No	No	No
FTM121	No	No	DEP	No	No	No	No
FTM122	No	No	DEP	No	No	No	No
FTM123	No	No	DEP	No	No	No	No
FTM124	No	No	DEP	No	No	No	No
FTM125	No	No	DEP	No	No	No	No
FTM126	No	No	DEP	No	No	No	No
FTM127	No	No	DEP	No	No	No	No
FTM128	No	No	DEP	No	No	No	No
FTM129	No	No	DEP	No	No	No	No
FTM130	No	No	DEP	No	No	No	No
FTM131	No	No	DEP	No	No	No	No
FTM132	No	No	DEP	No	No	No	No
FTM133	No	No	DEP	No	No	No	No
FTM134	No	No	DEP	No	No	No	No
FTM135	No	No	DEP	No	No	No	No
FTM136	No	No	DEP	No	No	No	No
FTM137	No	No	DEP	No	No	No	No
FTM138	No	No	DEP	No	No	No	No
FTM139	No	No	DEP	No	No	No	No
FTM140	No	No	DEP	No	No	No	No

Table 4. Water Chemistry

Analysis (lab name)	EPA Characteristic Name	Method Speciation Name	Result Sample Fraction	Result Measure Unit	Result Value Type	Sample Collection Type	Sample Collection Equipment
New Jersey Department of Health(Lab certification #11036)	Mercury	NA	Total	ng/g	Actual	plug	Miscellaneous (Other)

Table 5. Lab Worksheet

	Laboratory	Lab Number	Method	Method ID Context	Method Detection Limit	units	Holding Time	Preservative
Total Mercury	New Jersey Department of Health	11036	1631	USEPA	0.0896	ng/g	1 year	Ice to 4ºC in field. Freeze within 24 hours.

APPENDIX B:
Lab Chain of Custody - New Jersey Department of Health(Lab certification #11036)

Field ID Number: FTM040LMB0117D

New Jersey Department of Health
Environmental and Chemical Laboratory Services
PO Box 361, Trenton, NJ 08625-0361
Phone: 609-530-2820
ORGANIC AND INORGANIC CHEMISTRY SAMPLE SUBMITTAL
(See Instructions)

Lab Sample Number (For Lab Use Only):

AGENCY INFORMATION

Submitting Agency	Send Results To	Agency No.	Project Name
NJDEP- BFBM			NJDEP Freshwater Fish Tissue Monitoring
Street Address	**Final Report Option** ☐ Tier 1 ☐ Tier 2	**Would you like copies of the internal chain of custody forms sent with your report?** ☐ Yes ■ No	**Project Code**
35 Arctic Parkway	**Electronic Report Option** ☐ EDD ☐ E-2		**Memo Number**
City, State, Zip Code	**Phone**	**Fax**	**Email**
Trenton, NJ, 08625	609-292-0427		Brian.Henning@dep.nj.gov

SAMPLE INFORMATION

Sample Point/Station ID Number/Water Facility ID: FTM040	Collection Date (YY/MM/DD): 17/07/17	**Sample Type**
Sampling Site/Facility/Supply/Location/Sampling Point ID	Coll. Time (24h) Start: 1200 — Coll. Time (24h) End: ____	**Non-Potable:** ☐ Stream/Surface ☐ Ground Water ☐ Private W… ☐ Septic ☐ Ocean/Saline ☐ Sedime… ☐ Tissue ☐ Sewage: ■ Raw ☐ Effluent ☐ Industrial: ☐ Raw ☐ Effluent
Waterbody Name: Assunpink Lake	Sample Retention: Retain? ☐ No ■ Yes Duration ____	
Municipality/County: Upper Freehold/ Monmouth	Type of Sampling Event: ■ Regular ☐ Compliance ☐ Repeat ☐ Non-Regulatory ☐ Other	**Potable:** ☐ Ground Water R… ☐ Sourc… ☐ Confirmation ☐ Raw ☐ …ished ☐ Private Well ☐ At Source ☐ Flushed ☐ 1st Draw ☐ Lead Source Line ☐ Surface H_2O Intake ☐ Distribution System
Sampling Point Street Address	If Repeat or GWR, List Original Lab Sample No.	
	Sample Collector: Brian Henning	**Fraction:** ■ Total ☐ Dissolved
PWSID	Trip #	**Other:** ■ FISH
		Priority: ■ Routine ☐ Priority ☐ Emergency

FIELD INFORMATION

Air Temp °C	Water Temp °C	Stream Flow-CFS
Weather Conditions	Sample pH (Field)	Gage Height-Ft.
Preserved in: ☐ Field ☐ Lab Date: __/__/__ Time: ____	DO (mg/l) DO% Sa…	Spec.Cond. (µS/CM) Salinity (ppm)
Chlorine Residual	Sample Depth	Tide Stage
Comments/Field Checks	Barometric Pressure (mmHg)	Turbidity (NTU)

ANALYSIS REQUESTS

Metals

☐ Ag..... Silver ☐ Mg..... Magnesium
☐ Al .....Aluminum ☐ Mn .... Manganese
☐ As ..... Arsenic ☐ Mo .... Molybdenum
☐ B.....Boron ☐ Na.....dium
☐ Ba..... Barium ☐ Ni.....
☐ Be.....Beryllium ☐ Pb.....Lead
☐ Ca..... Calcium ☐ Sb.....Antimony
☐ Cd.....Cadmium ☐ Se.....lenium
☐ Co..... Cobalt ☐ Si.....Silica
☐ CR-T....Chromium ☐ Tl.....Thallium
☐ Cu.....Copper ☐ U.....Uranium
☐ Fe ..... Iron ☐ V.....Vanadium
☐ K.....Potassium ☐ Zn.....Zinc

Preferred Methodology
☐ EPA 200.7 / 200.9 ☐ EPA 200.8

Residues
☐ Total Suspended Solids (TSS)
☐ Total Solids (TS)
☐ Total Dissolved Solids (TDS)
☐ Settleable Solids (SS)
☐ Total Volatile Solids (TVS)

General
☐ Alkalinity
☐ Bromide by IC
☐ Chloride
☐ Chloride by IC
☐ Chromium, Hexavalent
☐ Chromium, Hexavalent by IC
☐ Color
☐ Conductance
☐ Cyanide
☐ Dissolved Oxygen
☐ Fluoride
☐ Fluoride by IC
☐ Hardness
☐ MBAS
☐ Odor
☐ pH
☐ Phenols (PW)
☐ Phenols (NPW)
☐ Sulfate by IC
☐ Sulfate Lachat
☐ Turbidity

Mercury
☐ Mercury by EPA 245.1
■ Low Level Mercury EPA 1631E

Nutrients
☐ Nitrite
☐ Total Phosphorus
☐ Ammonia
☐ Nitrate (Calculated)
☐ Nitrogen, Total (Calculated)
☐ Nitrite + Nitrate
☐ Ortho Phosphorus
☐ Total Kjeldahl Nitrogen (TKN)

Organics (Drinking Water)
☐ EPA 504.1 - EDB, DBCP,123TCP
☐ EPA 505 - Chlordane
☐ EPA 505 - Toxaphene
☐ EPA 507 - N and P containing Pesticides
☐ EPA 515.3 - Chlorinated Acid Herbicides
☐ EPA 524.2 - Purgeables
☐ EPA 525.2 - Liquid-Solid Extractables
☐ EPA 531.1 - N-Methylcarbamoyloximes and N-Methylcarbamates

Organics (Non-Potable Water)
☐ EPA 624 – Purgeables
☐ EPA 625 - Base/Neutral and Acid Extractables

Demands
☐ Total Organic Carbon (TOC)
☐ Dissolved Organic Carbon (DOC)
☐ Chemical Oxygen Demand (COD)

Suggested Dilutions
☐ BOD5 ☐ BOD20 ____ ____ ____
☐ CBOD5 ☐ CBOD20 ____ ____ ____

Other
☐ _____ ☐ _____ ☐ _____

Relinquished By:	Affiliation:	Received By:	Affiliation:	Date/Time	Reason for Custody Change
Name (Print): Brian Henning		Name (Print):			
Signature:	NJDEP-BFBM	Signature:			
Name (Print):		Name (Print):			
Signature:		Signature:			

CHEM-44
FEB 16

APPENDIX C:

Non-Lethal Fish Tissue Plug Collection

SOP #EH-07

Non-Lethal Fish Tissue Plug Collection

(Adapted from ERT/REAC SOP)

SOP #EH-07

Non-Lethal Fish Tissue Plug Collection

(*Adapted from ERT/REAC SOP*)

TABLE OF CONTENTS

TECHNICAL STANDARD OPERATING PROCEDURE
NON-LETHAL FISH TISSUE PLUG COLLECTION

1.0 SCOPE AND APPLICATION

Because fish spend their entire life in a particular waterbody they can be important indicators of water quality, especially toxic pollutants (e.g., pesticides and trace elements). Toxic pollutants which may be present in the water column or the sediments at concentrations below our analytical detection limits may be exhibited in fish tissue analysis due to bioaccumulation.

Typical whole fish or skin on fillet fish tissue collection methods require the fish to be sacrificed. This can be problematic when there is a need to collect large trophy sized fish for contaminant analysis or when a large sample size is necessary for statistical analysis. The following describes an alternative method for the collection of fish tissue samples which uses a tissue plug instead of a skin on fillet. This method is advantageous in that it eliminates the need to kill the fish to obtain a fish tissue sample for mercury analysis. Secondly, skin on fillet sampling required homogenizing of samples through a grinder. Although the grinder is cleaned between samples, the risk of sample contamination is a concern. The plug method uses clean equipment and supplies each time a sample is collected, thus reducing the risk of sample contamination.

2.0 METHOD SUMMARY

In general, a plug tissue sample is collected by inserting a biopsy punch into a de-scaled meaty section of a live fish. After plug collection, an antibiotic salve is placed over the wound and the fish is released.

3.0 SAMPLE PRESERVATION, HANDLING, AND STORAGE

Fish for heavy metal analysis that includes mercury should be placed in glass sample jars or double packaged in plastic bags. If the fish specimens are double packaged in plastic bags, they should first be wrapped in aluminum foil. Each sample should be correctly labeled and the label should be visible on the outside of the package.

Fish tissues that are being analyzed for contaminants should be kept on ice (32^{o}F or 0^{o}C) immediately after field processing and should be frozen as soon as possible. Once frozen, the samples should not be allowed to thaw and should be delivered to the analytical laboratory as soon as possible to meet analytical holding times. The laboratory should be contacted to verify sample holding times for parameters to be analyzed. A laboratory sample chain-of-custody form should be properly completed at the time of collection and kept with the sample cooler until delivery to the laboratory. Standard information includes contact information, sample identification, sample date and time, number of packages per sample, analyses required, and custody signatures.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

There are two primary interferences or potential problems with fish tissue sampling. These include cross-contamination of samples and improper sample collection.

- To avoid cross-contamination, equipment used for the removal of fish tissues should be properly decontaminated between samples, such as knives used to filet fish. Other equipment, such as a biopsy punch, should be disposed of after each use. Once processed, fish specimens will either be stored in a glass jar when small enough or wrapped in aluminum foil and placed within double ziploc bags.

- Improper sample collection can involve direct contact of a captured fish with stream sediment, shoreline soil, boat floor, or other potential sources of chemical contamination (e.g. as may happen when a live fish is dropped during handling). Fish with foreign debris on the body should be adequately rinsed with site water before plug or filet samples are collected.

One or more of the sampling team members should have experience with the following aspects of fish tissue plug sampling:

- ✓ Safety issues associated with working near water at the study area stations.
- ✓ Fish species identification.
- ✓ Prior experience with fish sampling techniques described above.

5.0 EQUIPMENT/APPARATUS

- Glass cutting board.
- Fish measuring board.
- Fish weigh scale.
- Plastic bags.
- Sterile 20mL glass scintillation vials, ultra clean.
- Coolers with ice or frozen gel packs.
- Field Data and Sample Log forms.
- Sample labels.
- Latex gloves.
- 8 millimeter disposable biopsy punch (Acuderm brand Acu-Punch or equivalent).
- Decontaminated scalpel for scale removal
- Laboratory pipette bulb.
- Antibiotic salve.
- Pen.

6.0 REAGENTS

- 10 percent nitric acid rinse made from ultra-pure certified trace-metal grade concentrated nitric acid.
- 70 percent ethanol
- Laboratory-grade deionized water (for rinsing cutting equipment and board between samples)

7.0 PROCEDURES

1. Fish should be collected, held, and processed for physical measurements following guidelines provided in SOP #EH-07. Fish selected for tissue plug sampling should include up to five fish per species of similar size ranges. As a general guideline, the largest and smallest fish within each group should not exceed the average length of the group by more than 25%.

2. On left side dorsal area of fish, clear a small area of scales with a decontaminated scalpel.

3. Wearing clean double latex gloves, insert the 8 millimeter biopsy punch into the fish through the scale free area. The punch is inserted with a slight twisting motion cutting the skin and muscle tissue. Once full depth of punch is achieved a slight bending or tilting of the punch is needed to break off the end of the sample. Remove the biopsy punch taking care to ensure the sample remains in the punch. ***Note: The sample should result in a minimum of a 0.5 to 0.7 grams of fish tissue for mercury analysis.***

4. Apply a generous amount of antibiotic salve to the plug area and gently return the fish to the water.

5. Using a laboratory pipette bulb placed on the end of the biopsy punch, give a quick squeeze, blowing the tissue sample into a sterile 20 milliliter scintillation vial.

6. Dispose of gloves and biopsy punch.

7. Label the vial with the appropriate sample ID.

8. Immediately place vial in a plastic ziploc bag and put the bag and its contents in a cooler on ice or gel packs.

9. Fill out the appropriate Sample Identification, Custody, and Record Forms.

10. Place samples in a freezer within 48 hours to await analysis.

8.0 CALCULATIONS

This Section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

The following QA/QC procedures apply to fish collection and field processing:

a. All data will be documented on field data sheets or in logbooks. Photo documentation will be done when possible.

b. A sample plan, including numbers, target species, and sample size will be prepared before field work begins.

c. A field form will be developed which details the steps in the equipment decontamination process so that steps can be checked on the form as completed.

d. A low-level field check sample (designed to detect sample handling contamination) will be opened in the field, with the handling procedures mirroring the field sample collection method (e.g., place on cutting board, cut, put in new sample container, and submit to in-house lab for analysis). The field check sample matrix will be muscle tissue with a known mercury concentration, supplied by the National Institute of Standards and Technology.

10.0 DATA VALIDATION

Data generated will be reviewed according to the Quality Assurance Project Plan (QAPP).

11.0 HEALTH AND SAFETY

All sampling teams will perform sample collection in accordance with the health and safety requirements of their parent organization.

Any time fish are collected, water and boat safety precautions must be taken. Wading can be dangerous, especially in swift currents or if the bottom is uneven or algae-covered. Samplers should always work in pairs, and wader belts should be worn to prevent waders filling with water if fall occurs.

Many fish species have sharp fin rays, spines, and teeth, and may quickly cause lacerations or puncture wounds. Handle all fish with appropriate caution, and wear gloves or use pliers when necessary. A first aid kit should be kept at the job site.