

## **5. Targeted Fish Tissue and Sediment Monitoring Program**

### **(1) Background**

“It is the policy of the Commonwealth of Virginia to protect existing high quality state waters and restore all other state waters to such condition of quality that any such waters will permit all reasonable public uses and will support the propagation and growth of all aquatic life, including game fish, which might reasonably be expected to inhabit them” (Water Control Board Law, Article 1. §62.1-44.2).

The Virginia Department of Environmental Quality (DEQ) is responsible for enforcing the statutes of the State Water Control Board. The agency recognizes that many chemical pollutants discharged into state waters by point and non-point sources may impair public uses and/or aquatic life. Specifically, some of these chemical pollutants accumulate and persist in aquatic sediments and in the tissue of aquatic organisms, including game fish, at potentially toxic concentrations. In addition, chemical pollutants that bio-accumulate tend to magnify in concentration as they pass through aquatic food chains and may cause detrimental effects in consumers, including humans. To address these concerns, the Fish Tissue and Sediment Contaminants Monitoring Program (FT) unit of DEQ’s Water Quality Monitoring (WQM) Programs conducts routine studies of fish tissue and sediment samples in state waters. The program fulfills the Clean Water Act §106 United States Environmental Protection Agency (EPA) grant requirements and the code of Virginia: Article 1. §62.1-44.19:5 that direct DEQ to implement the collection and analyses of fish tissue and sediment as part of a multi-phase approach to systematically assess, manage, and communicate the associated risks of chemical contaminants in the aquatic environment.

### **(2) Objectives**

The primary objectives of the Fish Tissue and Sediment Monitoring Program are to collect the data required to assess the human health risks for individuals who may consume fish from state waters and to identify impaired aquatic ecosystems. Fish tissue and sediment monitoring is of moderate priority among the agency’s monitoring activities. Managerial discretion permits the reduction of resources dedicated to this monitoring program based on budget constraints either at the statewide or regional level, but the agency has both federal and state mandates to continue the program. Tier I and Tier II sampling carried out within the Fish Tissue and Sediment Monitoring Program contribute to the attainment of Objectives I.A (1 - 6) and I.B (7) of the WQM Strategy, respectively.

The Virginia Department of Health (VDH) uses the data generated by the program to determine the need for fish consumption advisories. The DEQ and other state and federal agencies also use the data to assess the environmental quality of Virginia’s waters. Fish tissue and sediment data have consistently been used to facilitate the attainment of the Commonwealth’s water quality goals and to provide documentation of compliance with the Clean Water Act.

### **(3) Methods**

The objectives are met through a cost efficient two-tiered sampling strategy consistent with [Federal Guidance](http://water.epa.gov/scitech/swguidance/fishshellfish/techguidance/risk/index.cfm) [http://water.epa.gov/scitech/swguidance/fishshellfish/techguidance/risk/index.cfm] for fish tissue monitoring and assessment and sediment contamination monitoring programs<sup>29</sup>. Tier I is a screening study of a relatively large number of sampling stations to identify sites where concentrations of chemical contaminants in stream sediments and/or the edible portions of commonly consumed fish species indicate potential aquatic ecosystem impairment and/or significant health risks to human consumers. If Tier I results indicate problems exist, then a second more intensive Tier II study is initiated to determine the magnitude

---

<sup>29</sup> U.S. Environmental Protection Agency (2000) Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume 1: Fish Sampling and Analysis, Third Edition. Washington, DC.

and geographical extent and potential source(s) of contamination in the sediments and/or fish. Established Quality Assurance and Quality Control (QA/QC) protocols are used throughout the program<sup>30</sup>. In addition, an agency QA / QC Project plan has been developed specifically for the Fish Tissue and Sediment Monitoring Program: ([Fish Tissue and Sediment Monitoring Program QAPjP.doc](#) [III-B-5c.doc]).

Originally, the DEQ Fish Tissue and Sediment Monitoring Program was designed to monitor all of Virginia's fourteen river basins and sub-basins on a rotational basis every five years beginning in 1995. In response to a directive from the Virginia General Assembly, DEQ increased efforts between 2000 and 2002 to conduct fish monitoring in all river basins within a three-year period. More recent reductions in state resources (both analytical budget reductions and the loss of two employees), however, have prevented DEQ from continuing this level of fish tissue and sediment monitoring until these resources can be reinstated. From 2003 through 2008, DEQ reverted to a five-year rotational monitoring plan. Approximately 60 to 100 stations were selected among two or three river basins each year, depending upon available resources. DEQ's long-term goal has been to restore the necessary resources to allow us to return to a three-year rotational monitoring program.

However, in 2009, the program was temporarily suspended due to inadequate funding as a result of State government budget reductions. The program was redesigned and restarted in 2012 on a much smaller scale than previous monitoring efforts. The refined program will focus primarily on TMDL support and follow up monitoring of watersheds which are under fish consumption advisories. Up to 20 sites will be scheduled annually for follow up monitoring to track changes in levels of PCBs and/or Mercury in fish tissue to support TMDL efforts. The analyses of PAHs and pesticides have been eliminated to moderate analytical costs.

### **Tier I**

Traditionally, Tier I sampling stations have been selected on a rotational river basin approach among the fourteen river basins and sub-basins in Virginia. Several criteria are used to select the sampling stations including:

- (a) Correspondence with the DEQ-Waste division to identify contaminated waste sites that may impact tissue and sediments in aquatic environments,
- (b) Regional office recommendations,
- (c) Extensive literature searches,
- (d) Important recreational and/or commercial fisheries,
- (e) Proximity to point source discharges,
- (f) Spatial distribution among sample stations, and
- (g) Requests from VDH.

As an example of a Tier I sampling plan, the linked documentation from "[2009 Fish and Sediment Monitoring Plan](#)" [III-B-5a.pdf] lists the stations intended to be sampled by the program during the 2009 field season. The final selection of sampling sites, however, can only be confirmed once field reconnaissance has been conducted. The most up to date developments, sampling plans, and results for the Fish Tissue and Sediment Monitoring Program are posted on the Internet on the [Fish Tissue and Sediment Monitoring Program](#) WebPages.

---

<sup>30</sup> U.S. Environmental Protection Agency (2000) Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume 2: Risk Assessment and Fish Consumption Limits, Third Edition. Washington, DC.

[<http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityMonitoring/FishTissueMonitoring.aspx>]

Fish are collected by boat mounted or backpack electro-fishing equipment in freshwater. Gill nets and line fishing are used in saltwater. Five to ten individuals of the same species, approximately the same size, are typically sampled at each station. A top level predator (e.g. largemouth bass), a mid level predator (e.g. bluegill), and a bottom feeder (e.g. catfish species) are usually targeted at Tier I sampling stations. Adult fish are collected because their potential for exposure to environmental contamination has occurred over a longer period of time, in comparison to juvenile fish. The fish collected are weighed (grams), measured (centimeters - total length), wrapped in aluminum foil, and placed in sealed, appropriately labeled plastic bags. During sample processing, the contract laboratory removes filets (skin on) of fish of the same species and combines the filets to make a composite sample. Tissue samples for each species are analyzed for organic compounds, trace metals, percent moisture, and percent lipid.

Tier I analytical results for chemical contaminants in fish tissue are expressed on a wet weight basis and are compared with Water Quality Standards based tissue values (TVs) or tissue screening values (TSVs) that are computed using [EPA-provided risk assessment techniques](#) (National Guidance) for non-carcinogen and carcinogen effects

[[http://water.epa.gov/scitech/swguidance/fishshellfish/techguidance/risk/volume2\\_index.cfm](http://water.epa.gov/scitech/swguidance/fishshellfish/techguidance/risk/volume2_index.cfm)]. The TVs are equivalent to the concentration in edible fish tissue that is the basis of the numerical water quality criterion for the specific toxic pollutant and the TSVs are comparable tissue values for toxic pollutants that do not have a corresponding Virginia numerical water quality criterion. Typically, the TV and TSV calculations use:

- (a) A  $10^{-5}$  risk level, as adopted by the State Water Control Board, for calculating allowable extra lifetime risk for cancer
- (b) An average human body weight of 70 kg (average adult body weight),
- (c) An average fish consumption rate of 17.5 grams/day (general U.S. population),
- (d) And a reference dose (RfD) for non carcinogen effects or an oral dose slope for carcinogenic effects ([EPA IRIS database system](#) – Integrated Risk Information System) [<http://www.epa.gov/iris/>].

Sediment samples are also collected at the sampling station in pre-cleaned sample containers using established protocols. The fish and sediment samples are frozen until they are processed by the contract laboratory. The sediment samples are analyzed for organic compounds, trace metals, and total organic carbon (TOC).

Analytical results for chemical contaminants in sediment are expressed on dry weight basis and are compared to screening values (SVs) that are either Consensus Based Probable Effects Concentrations (PECs) for freshwater sediments<sup>31</sup> or for saltwater sediment, Effects Range-Low (ER-L) and Effects Range-Median (ER-M)<sup>32</sup> SVs provided by the National Oceanic and Atmospheric Administration to assess the potential effects of sediment contamination to aquatic life.

---

<sup>31</sup> MacDonald, D.D., C.G. Ingersol, and T.A. Berger. 2000. Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

<sup>32</sup> Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environmental Management 19:81-97.

## Tier II

If Tier I analytical results indicate TVs or TSVs have been exceeded and QA/QC measures have been achieved, then an intensive Tier II investigation may be conducted. The unique features of Tier II investigations are (1) sample replication and (2) multiple station sampling, which allow statistical confidence to be placed around the data points and the contaminant's spatial distribution characterization respectively. Hence, Tier II investigations typically involve laboratory analysis of five to ten individual file samples or multiple composite samples of two or three top- or mid-level predators and one or two bottom feeders at each station to increase the statistical power of comparisons. As in Tier I data analysis, Tier II analytical results are compared to the risk based TVs and/or TSVs calculations and appropriate QA/QC procedures are followed.

### (4) Fish Tissue and Sediment Data Application

Once the results of fish tissue and sediment samples collected for this monitoring program are received from the analytical laboratory and are summarized and entered into tables, the DEQ Water Quality Monitoring Programs posts the data on the [Fish Tissue and Sediment Monitoring Program](http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityMonitoring/FishTissueMonitoring.aspx) WebPages [http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityMonitoring/FishTissueMonitoring.aspx]. Fish tissue data are assessed using a risk based approach in accordance with EPA guidelines. Fish tissue data are subsequently provided to the VDH which issues [Fish Consumption Advisories](http://www.vdh.state.va.us/epidemiology/DEE/publichealthtoxicology/Advisories/index.htm) when deemed necessary.

[http://www.vdh.state.va.us/epidemiology/DEE/publichealthtoxicology/Advisories/index.htm] Sediment data are compared to NOAA sediment ER-M SVs for saltwater or estuarine sites and PECs for freshwater sites. Samples that exceed ER-M SVs or PECs provide an indication that a moderate to relatively high degree of sediment contamination exists.

In addition, reports are sent to the DEQ Central and appropriate Regional Offices, where they are used primarily by water quality managers to help identify areas of water quality impairment. A summary of fish tissue and sediment collections and analyses is also included in the biennial 305(b)/303(d) Integrated Water Quality Assessment Report to EPA and Congress, as required by the Federal Clean Water Act. The 305(b) report serves as the State's primary problem assessment report, and directs continuous planning and implementation activities, in coordination with the 305(b) Action Plan, Water Quality Management Plan, and the Priority Water Bodies 303(d) Report.

On July 1, 1997, Virginia Senate Bill No. 1122<sup>33</sup> was passed into state law. That law expanded fish tissue and sediment monitoring data application in water quality assessment and reporting requirements by the DEQ. The law provides for the "...increased use, as necessary, beyond 1996 levels, of sediment monitoring ... and fish tissue monitoring, and provides for specific assessments of water quality based on the results of such monitoring..." in 305(b) and 303(d) reports. The updated 305(b) reporting requirements for fish tissue and sediment monitoring results are specified in the agency's biennial [Water Quality Assessment Guidance Manual](http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityAssessments.aspx)

[http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityAssessments.aspx].

---

<sup>33</sup> Virginia Senate Bill No. 1122. 1997. A Bill to Amend the Code of Virginia by adding Chapter 3.1 of Title 62.1 an article numbered 4.1, consisting of sections numbered 62.1-44.19:4 through 62.1-44.19:8, relating to Water Quality Monitoring, Information and Restoration Act.

### **(5) Plan and Schedule**

The fish tissue and sediment contaminants monitoring program is an integral element of the DEQ strategy to investigate water quality conditions of the state's aquatic resources. Such specialized sampling programs have been used by the DEQ for decades and, although subject to periodic modifications and adaptations to resource availability, this program is considered to be a fully implemented and permanent module of the WQM strategy.

For further information on the Targeted Fish Tissue and Sediment Monitoring Program, please contact:

Gabriel A. Darkwah  
Virginia Department of Environmental Quality  
629 East Main Street  
P.O. Box 1105  
Richmond, VA 23218  
(804) 698-4127  
[Gabriel.Darkwah@deq.virginia.gov](mailto:Gabriel.Darkwah@deq.virginia.gov)

or

Richard G. Browder  
Virginia Department of Environmental Quality  
629 East Main Street  
P.O. Box 1105  
Richmond, VA 23218  
(804) 698-4134  
[Richard.Browder@deq.virginia.gov](mailto:Richard.Browder@deq.virginia.gov)