METHODS FOR CONTINUOUS AUTOMATED TURBIDITY MONITORING IN BRITISH COLUMBIA, CANADA

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ABSTRACT

Introduction: Continuous automated water quality monitoring (AWQM) of turbidity is relatively new in Canada compared to traditional discrete monitoring methods.

The *Constitution Act, 1867* of Canada delineates federal and provincial legislative powers. Section 91 establishes federal jurisdiction over seacoasts and inland fisheries. Section 92 and Section 109 establish provincial jurisdiction over natural resources, which includes water. Both levels of government monitor water resources.

The Department of Environment Canada (EC) and the Department of Fisheries and Oceans Canada (DFO) regulate and monitor water resources. In BC, several ministries monitor freshwater resources including the Ministry of Forests, Ministry of Water, Land and Air Protection and the Ministry of Sustainable Resource Management (MSRM). MSRM develops and administers standard methods and protocols for monitoring water resources including water quantity and water quality. MSRM established the research and development AWQM station on the Sooke River on Vancouver Island, BC to research, test, and document new methods and protocols in the *Automated Water Quality Monitoring Field Manual* (Burke 2002).

Characteristics of the Study Area: Vancouver Island is comprised of accreted terranes. The bedrock consists of metamorphic sedimentary and volcanic rock and igneous complex, sandstone, shale and conglomerates. The overlay consists of glacial and fluvial deposition. The dominant soils include brunisols and podzols of porous gravel and quartz sand with a slightly acidic signature. The dominant biogeomatic classification is Coastal Western Hemlock (*Tsuga heterphylla*), Western Red Cedar (*Thuja plicata*) and Douglas fir (*Pseudotsuga menziesii*). The climate is wet maritime with mild wet winters and warm dry summers with a mean annual precipitation of 50 inches and mean temperature of 48 degrees Fahrenheit.

The Sooke River watershed area is 150 square miles. The headwaters consist of the Leech River complex and the Sooke Lake, which provides the drinking water for the city of Victoria. Historically, the watershed has been logged and mined. The lower Sooke River lies in a floodplain that is rural residential with homes and small hobby farms. Other stakeholder interests include active timber harvesting, development, and the T'Sou-Ke First Nations.

The mean annual discharge of the Sooke River is 335 cubic feet per second. The substrate is cobble, boulder and fines. The river supports freshwater fish species and anadromous salmon including Chum (*Oncorhynchus keta*), Chinook (*O. tshawytscha*), Coho (*O. kisutch*), and

Steelhead trout (*Salmo gairdneri*). Wildlife includes deer, bear, cougar, small mammals, raptors such as bald eagles and waterfowl.

The Sooke River AWQM Station Design: The Sooke River AWQM station is located at 48°25'28"N and 123°42'45"W. The station is a passive angle bank deployment design. Two equipment system configurations have been deployed. System A, deployed from November 2000 to October 2001, was comprised of a Forest Technology Systems (FTS) data logger, Stevens vented pressure transducer, YSI 600XL multi-sonde that measured conductivity, dissolved oxygen, pH, and temperature, and an analite turbidity sensor with a mechanical wiper arm. System B, deployed in October 2001 and currently in operation, is comprised of a Handar 555 data logger, Stevens vented pressure transducer, YSI 6820 multi-sonde that measures conductivity, dissolved oxygen, pH, temperature and turbidity with a mechanical wiper arm. The data are logged in fifteen-minute intervals and retrieved manually.

The calibrated range of the turbidity sensors is 0 to 400 NTU. The normal reported range of turbidity at this location is 0 to 5 NTU with an annual mean of 2.7 NTU where the sample number is 48 discrete measurements based on a twelve month baseline study from September 1999 to August 2000 (Burke 2000). Precipitation events elevate water flow and turbidity readings.

The Sooke River AWQM Station Operation: Station operation includes certification, bench testing, verification, and quality control and quality assurance (QA/QC). The equipment system components must be calibrated and certified by the manufacturer or authorized representative. The system must be bench tested by the AWQM technician prior to deployment The sensors must perform within specified criteria, such as within 10% of a certified standard turbidity solution, prior to deployment. The AWQM technician completes maintenance visits on a bi-weekly or monthly basis.

Verification of AWQM Turbidity Data: The AWQM technician cleans the optics on the turbidity sensor and rotates the mechanical wiper arm. The turbidity data are verified by three methods.

First, the performance, or drift, of the turbidity sensor is verified by measurements in certified standard turbidity solutions and distilled water. The solutions must be in containers that have a flat black surface to minimize local interference. The sensors have been verified using 100 NTU polymer bead solution manufactured by FTS and YSI INC. and 100 NTU formazin solution manufactured by HACH INC. The results indicate that the stability of the standard solutions varies between manufacturers.

Second, the turbidity data are verified by obtaining a discrete sample of surface water and comparing turbidity data between the AWQM turbidity sensor and a certified and calibrated HACH 2100P turbidity field meter. The results indicate that the field meters usually provide a sound comparison for low turbidity conditions; however, variance increases for higher turbidity conditions. Even so, the question remains "Which meter?" Consequently, field meter comparisons are used only as a general comparison.

Third, the turbidity data are verified by obtaining two discrete surface water samples for laboratory analysis. The first sample is obtained adjacent to the AWQM turbidity sensor *in situ* and verifies the data obtained by the AWQM turbidity sensor. A second sample is obtained from *in situ* mid-stream and is used as a measurement to determine if the AWQM sensor is obtaining data that is representative of the environmental conditions of the water body. The QA/QC for discrete samples is ten to twenty percent for replicates and blanks. The results show strong agreement between the AWQM turbidity sensor and the adjacent water column and the midstream water column. The laboratory results are the primary basis to determine if the AWQM turbidity sensor is measuring data that are representative of the environment.

Potential Interference's to AWQM Turbidity Data: The AWQM turbidity sensors are subject to specific interferences that include bio-fouling, physical fouling, signal noise, optic damage, entrained gas bubbles, sunlight spikes, hydrodynamic noise, calibration drift, temperature effects, and power-up interference (White 1999). Each potential interference must be taken into account in the system design, operation, maintenance, and data management.

Data Management: The BC MSRM developed three primary data bases: Environmental Monitoring Systems (EMS) for location information and laboratory results; Water Inventory Data Management (WIDM) for hydrometric data; and Water Quality Data Management System (WQDM) for AWQM time series and meta data. AWQM data are defined by data grades A, B, C and D, which reflect the quality of the data. The criterion are based on the performance of the equipment and the level of required QA/QC. All raw data are entered into the data warehouse and can be corrected based on data shift or drift. Data are approved and audited.

Future Study: The BC MSRM anticipates to continue to develop standard methods for other water quality variables, develop an internet based interface for data users, and integrate environmental monitoring into one data warehouse.

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