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TECHNICAL OPERATING PROCEDURE

PROCEDURE TITLE:

Procedures for Conducting Time-of-Travel Studies with Fluorescent Dye

APPLICABILITY:

Procedure applies to the measurement of time-of-travel of stream water using Rhodamine WT (20% solution) and Uranine (fluorescein) dye slugs. For procedure on conducting dye feeds for dilution studies see TOP:003.x.

PRINCIPLE:

Time-of-travel is used to schedule lampricide applications and analysis.

SAMPLE COLLECTION AND PRESERVATION:

Samples of water containing fluorescent dye are collected by hand or by automatic water sampler (IOP:002.x and IOP:003.x). Water samples are usually analyzed immediately, but if storage is necessary the samples are labeled and refrigerated. Subsequent analysis is completed as soon as possible.

EQUIPMENT REQUIRED:

I. Equipment for sampling

A. Sample bottles of sufficient volume for measurement of samples. Maximum requirement is about 500 mL for Turner Designs Fluorometer with a flow through cell configuration.

B. Sigma or ISCO brand automatic sampler

II. Fluorescent dyes

A. Rhodamine WT (20% solution)

B. Uranine (fluorescein)

III. Analytical equipment

A. Fluorometer (IOP:004.x, , IOP:004.xB, and IOP:004.xC)

POTENTIAL INTERFERENCES:

There can be significant loss of Rhodamine WT to adsorption on clay. Ambient air temperatures below 32^0 F will cause freezing in the suction hose of the automatic sampler if left exposed. If an intake is not suspended above stream bottom, silt and other debris will obstruct hose. If two units are set next to each other electro-magnetic interference may occur.

SAFETY:

No special safety precautions

DISPOSAL:

Not applicable

REAGENTS:

Not applicable

PROCEDURES:

I. A time-of-travel investigation is indexed to the discharge of the stream section under study. A stream discharge measurement is conducted prior to the application of dye according to (TOP:001.x).

A. Time-of-travel is measured by monitoring the downstream progress of the dye at selected sites. Water samples are either taken by hand or collected by automatic water samplers (TOP:022.x).

B. The time-of-travel is the time necessary for the dye to reach maximum concentration at each sampling site.

II. For calibration of fluorometers using Rhodamine 100 nL/L standard solution, see TOP:003.x

III. Quantity of Rhodamine dye for a dye slug is determined by the formula:

$Vd = Q * C * T/10^9$

Where:

Vd = volume of dye (L)
Q = discharge (L/sec; 1 cms= 1000 L/sec)
C = average concentration of dye desired at most distant sample site (nL/L)

T = approximate flow time to most distant sample site (sec)

Note: Concentrations are based on volume: volume relationships.

Example: Discharge of stream is 100 cfs (2.83 cms; cfs=cms x 35.3)
Desired Dye Concentration is 5.0 nL/L
Flow Time Estimate is 5 h

Vd = 2.83 x 1000 x 5 x 5 x 60 x 60 / 1,000,000,000
Vd = 0.2547 L or 255 mL

Uranine dye is generally applied at a rate of 1-pound product per 50 cfs stream discharge.

IV. A single injection of dye is usually made at a proposed lampricide application site. The dye is mixed with stream water and poured uniformly across the flow of the stream. The time of application and other details (amount of dye used, discharge value, staff gauge reading, application location, etc.) are recorded.

V. The presence or absence of Rhodamine dye in samples is determined on site or in a lab using a fluorometer (IOP:004.x, , IOP:004.xB, and IOP:004.xC) . Arrival times of Uranine dye are determined visually. The times of sample collections are recorded.

REFERENCES:

Replogle, J.A., L.E. Myers and J.B. Brust. Flow Measurements with Fluorescent Tracers. Proceedings of the American Society of Civil Engineers. 1966.

Wilson, J.F. Jr. Time-of-Travel Measurements and Other Applications of Dye Tracing. Internat. Assoc. Sci. Hydrol. Pub. No. 76. 1968.

This procedure has been reviewed and approved by the undersigned representatives of the U.S. Fish and Wildlife Service and Fisheries and Oceans Canada.

Jessica M. Barber
Digitally signed by JESSICA BARBER
Date: 2021.02.11 14:03:19 -05'00'

REVIEWED/APPROVED_____ DATE_____
Field Supervisor (U.S.)

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Program Manager (Canada)

Revision No.	Date	Person(s) Responsible	Description
31	2/1/21	Benson Solomon, Lauren Freitas, Shawn Robertson, Chris Gagnon	Removed obsolete calibration and IOPs