Environment and Climate Change Canada
Environnement et Changement climatique Canada

Standard Operating Procedures for Deployment Arrays

Scientific and Technical Team:

Jennifer Maines

Jim Syrgiannis

Leah Dirk

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Environment and Climate Change Canada
Public Inquiries Centre
7th Floor, Fontaine Building
200 Sacré-Coeur Boulevard
Gatineau QC K1A 0H3
Telephone: 819-997-2800
Toll Free: 1-800-668-6767 (in Canada only)
Email: ec.enviroinfo.ec@canada.ca

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Acronyms

ECCC	Environment and Climate Change Canada
EGA	Extended geographic area
FWQMSD	Freshwater Quality Monitoring and Surveillance Division
SPMDs	Semi-permeable membrane devices
GPS	Global Positioning System

Table of Contents

List of Figures

List of Tables

1.0 Introduction

The Freshwater Quality Monitoring and Surveillance Division (FWQMSD) of Environment and Climate Change Canada (ECCC) deploys arrays for suspending sampling devices in the Athabasca River and extended geographic area (EGA) sites located on the Slave River at Fitzgerald and the Peace River at Peace Point. Successful array deployments require pre-trip planning and thoughtful equipment design to ensure that the mooring remains stationary. Although this document contains information on array design, deployments, and retrievals, it should be noted that ongoing modifications to moorings regularly occur to potentially improve their design and allow for adaptation to environmental conditions.

2.0 General Considerations

Moorings are deployed at the beginning of the open water season, typically in May, and they are retrieved in September or October prior to freeze up. Arrays can also be deployed in the winter (typically in January) with retrievals occurring in March. At the beginning of each season, there are many considerations when deploying moorings to ensure that the devices attached to the array are deployed in the ideal location. Prior to deployment, a channel assessment is completed where the stream depth is measured across the river to identify the cross-sectional stream profile. Although deployment in the thalweg is ideal, arrays are often deployed slightly adjacent to the main flow to minimize the chance of strong currents detaching the anchor from the river bed.

3.0 Equipment

3.1 Sampling Array Equipment

The equipment required for all parts of the sampling array, excluding the buoy, should be stainless steel to minimize corrosion and avoid any chemical interference with the measurement devices. See Table 1 for a detailed list of the equipment required for a single array.

Table 1 – Equipment list for a single array in open water

Item Description	Quantity
Plow anchor (AnchorLife Pro Plow)	1
Danforth anchor (standard anchor, 6 kg [14 lb])	1
9.5 mm (3/8 inch) Gold Systems chain (these get cut into 2 m lengths)	2
4.8 mm (3/16 inch) stainless-steel aircraft cable (35 m, 7×19 pattern)	1
4.8 mm (3/16 inch) stainless-steel aircraft cable (20 m, 7×19 pattern)	2
Buoys (Polyform CM-2 Series mooring buoy – 34 cm in diameter; 25 L volume; 25 kg buoyancy; red)	1
9.5 mm (3/8 inch) stainless-steel shackles	8
Stainless-steel wire (roll) for mousing shackles	6
6.35 mm (1/4 inch) stainless-steel thimbles for cable loop ends	8
4.8 mm (3/16 inch) copper crimping sleeves (or stainless-steel if found) to connect cables	8

Table 2 – Equipment list for an array in winter

Item Description	Quantity
4.8 mm (3/16 inch) stainless-steel aircraft cable (~4 m, 7×19 pattern)	1
6.35 mm (1/4 inch) stainless-steel thimbles	2
4.8 mm (3/16 inch) copper crimping sleeves (or stainless-steel, if found)	2
Large carabiner (preferably stainless-steel)	2
Ice screws (15 cm in length)	1
Hard-plastic mooring buoy – 30 cm (12 inches); 16 kg buoyancy	1
Traffic-style pylons to mark ice holes	1
Driveway reflectors to mark ice holes (together with pylons)	1

Many factors must be considered when designing and deploying an anchoring system in rivers. The river-bed substrate, location, flow, and debris will determine the type and weight of the anchors used, as well as the scope of the cable and size of the buoys. Successful moorings deployed in the Athabasca River and EGA sites contain two different types of anchors. As seen in Figure 1, a 16 kg plow anchor is first deployed upstream, as these anchors generally reset themselves easily if either the wind or current changes direction. In addition, plow anchors effectively bury themselves into a range of river bed materials, such as mud, sand, and vegetative material, including grass. Downstream of the plow anchor, an additional Danforth anchor is deployed. Danforth anchors are light and hold very well in mud or sand. To prevent the anchors from being pulled upward, a 2 m of chain is attached to each anchor to weigh down the shank. A typical setup utilizes 35 m of cable between the plow and Danforth anchor and 20 m of cable between the Danforth anchor and the surface buoy. The scope of cable that is attached from the Danforth anchor to the buoy should have at least a 7:1 ratio, as this is effective in fast-flowing rivers and works well to keep the anchor set. The buoys used are a 34 cm diameter mooring buoy with a buoyancy of 25 kg. The size and weight of the buoys are important when considering the design of an array system, as a buoy with less buoyancy will tend to stay underwater and deflect debris easily, whereas a buoy with greater buoyancy will be less compliant against floating debris. The buoys specified above are used on the Athabasca River and EGA sites because they are well balanced, including when the sampling devices are suspended from them.

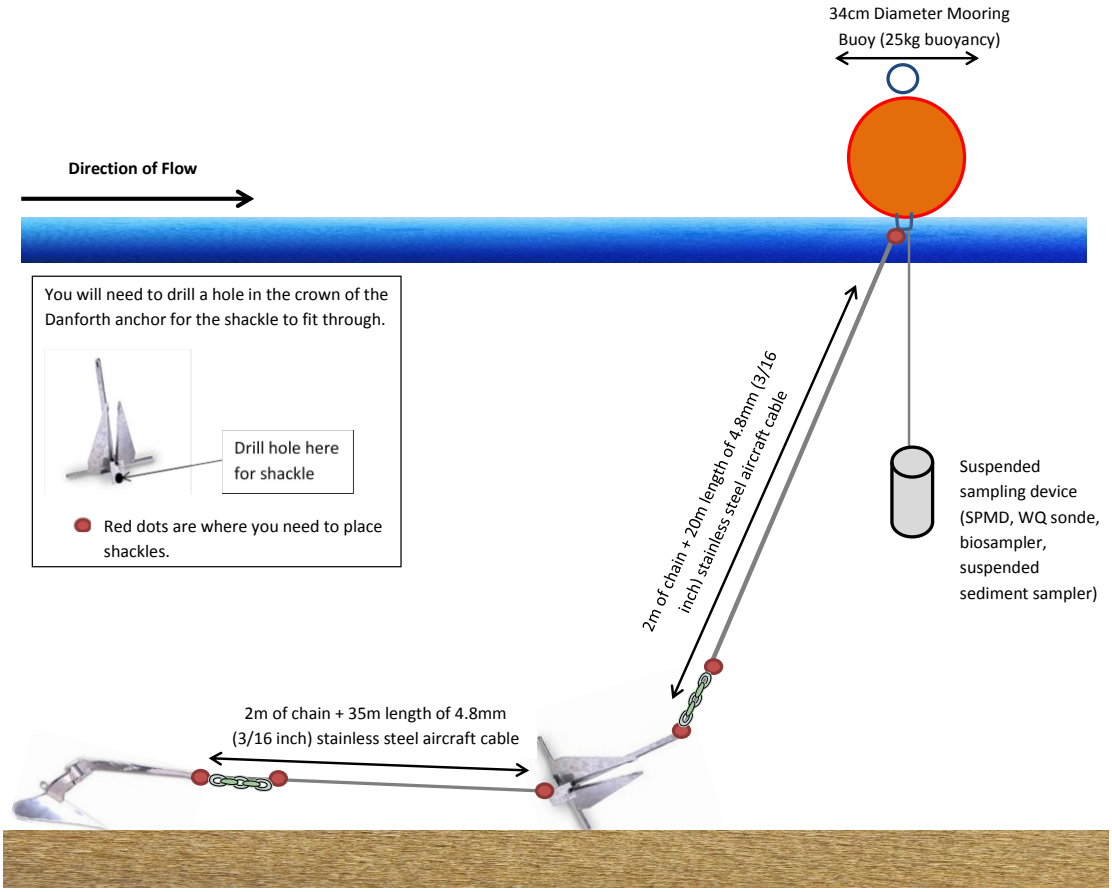

Figure 1. Open-water array design.

4.0 Methods

4.1 Suspended – Open Water

Arrays are designed and intended to suspend sampling devices. At most locations, there are multiple samplers deployed monthly. These include semi-permeable membrane devices (SPMDs), multi-parameter water-quality sondes, and biosamplers. Each of these sampling devices requires its own dedicated cable attached to the buoy. As seen in Figure 1, the ideal depth for SPMDs is 1 m below the surface. Therefore, a 1 m-long stainless-steel cable is attached to the bottom of the buoy. The cable is looped and crimped at the bottom around a thimble, which then allows the SPMD canister to be attached to the thimble via a carabiner. An additional cable is required when deploying multiple SPMD canisters. In addition to SPMDs, biosamplers may be deployed and are suspended just below the water's surface. Similar to SPMDs, the biosampler is attached by a cable, so that it hangs just above the SPMD.

4.1.1 Array Deployment and Retrievals

Equipment for array deployments, such as cables, are measured and pre-cut before going out into the field. This allows for quicker deployment with fewer tools required on the boat. To keep the cables tangle free, final equipment assembly is done on the boat prior to deployment. It is important to note that this activity requires communication between all crew members, as safety is a key concern. Cables become a safety hazard if they become entangled with workers. Once all equipment has been checked and each crew member understands their role, the mooring deployment or retrieval can commence.

The first anchor deployed is the plow anchor (furthest upstream). The 35 m of cable attached to the plow anchor is then let out into the river. The end of the 35 m of cable can then be attached to the Danforth anchor with a shackle. Once the cable is securely attached to the Danforth anchor, the Danforth anchor can be dropped into the river while letting out the remaining 20 m of cable followed by the buoy. Once the buoy is in place, the sampling devices can be attached to it via the cable and carabiner. GPS track packs can be attached to the top of the buoy to monitor the position of the buoy/array.

At the end of the open-water season, moorings are retrieved from the river. Similar to deployments, this task requires communication between all crew members to ensure that everyone is aware of their role and the potential hazards. Once the buoy is removed from the water, the crew retrieves the 20 m of cable until the Danforth anchor is pulled out of the water. To keep cables tangle free, it is recommended that the cables be detached from the anchors as the anchors are pulled into the boat. The remaining 35 m of cable can then be pulled out of the water followed by the plow anchor.

4.2 Suspended – Under Ice

Under-ice array deployments are typically performed in the same location on the river as are open-water deployments. The equipment required for under-ice deployments is listed in Table 2. Prior to array deployments, snow and slush ice should be cleared from the ice surface prior to auguring a hole in the ice. To prevent gas and oil contamination of the sampling equipment, the use of an electric ice auger is preferred. Similar to open-water deployments, a stainless steel aircraft cable, 4.8 mm in diameter (3/16-inch), is used to hang the sampling devices from a surface buoy. A total cable length of approximately 4 m is required. Then, 2 m to 3 m of cable are used to hang the sampling devices from the bottom of a hard-plastic buoy to a depth of 1 m below the ice. It is important to note that this anchor simply rests on the ice surface above the augured hole in the ice. Approximately 1 m of cable is used to secure the buoy to the ice surface using an ice screw anchor tethered to the ring atop the buoy (Figure 2).

Figure 2. Suspended under-ice design.

When retrieving the under-ice sampler and mooring, multiple holes should be augured around the plastic buoy, but not through to the water, as seen in Figure 3. This prevents water from percolating upwards and freezing onto the cable. When there are only a few centimetres of ice left, the augured holes can then be drilled or chiseled through with an ice pick to allow the buoy to float freely, as seen in Figure 4. The entire assembly can then be retrieved.

Figure 3. Retrieving under-ice sampling equipment.

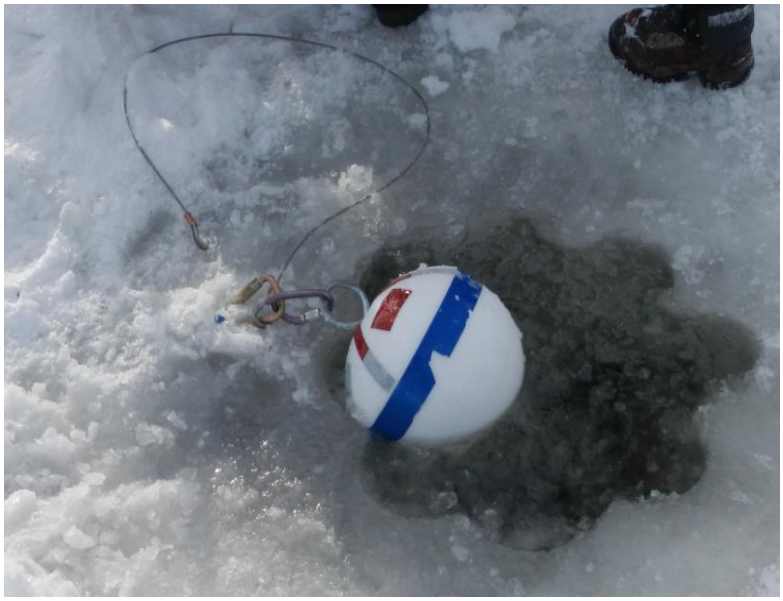

Figure 4. Retrieving the buoy.

5.0 Safety

All crew members should be familiar with the protocols required for deploying or retrieving an on-ice buoy/anchoring system, as this activity can create large, open-water holes through the ice. A pre-trip plan should be discussed with all personnel to ensure that everyone understands their role and is aware of the potential hazards when out on the river. When dealing with ropes and cables, work gloves should be worn to prevent scratches, rope burns, cable punctures, and cuts. During deployments and retrievals, it is crucial to be aware of loose cables to prevent entanglement with crew members. All crew members should have the required training found in the National FWQMS Occupational Safety and Health Training Manual, as well as the appropriate personal protective equipment.

Additional information can be obtained at:

Environment and Climate Change Canada
Public Inquiries Centre
7th Floor, Fontaine Building
200 Sacré-Coeur Boulevard
Gatineau QC K1A 0H3
Telephone: 1-800-668-6767 (in Canada only) or 819-997-2800
Email: ec.enviroinfo.ec@canada.ca