# Irrigation Reservoir Outlet Veliger Monitoring Protocol

*Spillway of Oldman River Dam and Reservoir*

Alberta Agriculture and Forestry

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**Prepared by**

Brad Calder, Research Specialist
Evan Hillman, Research Agrologist
Andrea Kalischuk, Director
Barry Olson, Research Scientist
Troy Ormann, Watershed Field Specialist
Nicole Seitz-Vermeer, Water Research Specialist

Water Quality Section
Alberta Agriculture and Forestry
Lethbridge, Alberta

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# Irrigation Reservoir Outlet Veliger Monitoring Protocol

## 1 Introduction

The invasive zebra mussels (*Dreissena polymorpha)* and quagga mussels (*Dreissena bugensis*) begin their life cycle as sexual gametes released to the surrounding freshwater by mature adults during spawning events. The eggs are externally fertilized, and mature into the juvenile stage referred to as veligers. The veligers, which are microscopic in size, remain suspended in the water column for about three weeks until settling and attachment to submerged surfaces and then develop into mature adult mussels (Figure 1). As the veligers are mobile within the water, it is possible to collect them via filtration with a plankton net.

**Figure 1.** Examples of pipes fouled by invasive mussels.

The early detection of invasive mussels may improve the chances for control, eradication, and containment by the implementation of rapid response plans. Fortunately, Alberta is currently free of invasive dreissenid mussels; however, early detection of invasive mussels is dependent upon annual monitoring programs.

Typically, water samples for veliger monitoring are collected using a motorized boat. However, access to a boat and safety issues need to be considered. The purpose of this document is to describe an alternative veliger monitoring protocol without using a boat by sampling in canals exiting irrigation reservoir outlets and at dock locations where applicable. Veligers (if present) are likely to migrate with water flow. As well, water samples collected near docks and boat launches are important for obtaining representative samples from areas with high boat traffic.

This method relies upon the assumption that samples collected from outlet canals are representative of water conditions within the reservoir, and are therefore, likely to represent the presence or absence of veligers. Samples collected from reservoir boat launches and docks can provide a further check. Sampling locations along outlet canals are strategically chosen to isolate reservoir outflows and ensure samples were representative of reservoir conditions — locations are far enough downstream of the reservoir but far enough upstream of any contributing drainage confluences.

## 2 Locations and Site Descriptions

There are 22 irrigation reservoirs that have been characterized as 'high risk' due to their use for irrigation as well as for recreational boating (Table 1, Figure 2). Sampling locations were chosen that are (1) as close to the reservoir outlets as possible, (2) downstream of heavy turbulence, and (3) upstream of any additional contributing flows. These locations may have structures that allow for easy access, such as walkways or bridges. Use of these structures is up to the discretion of the monitoring staff to ensure safety. These sites were located with a Geographic Information System (GIS) and validated by in-field ground truthing. Veliger sampling locations are listed in Appendix A.

Not all sites at each reservoirs may be sampled depending on timing and conditions. For example, Forty Mile reservoir may only be sampled at the dock depending whether or not the siphon at the pump house is providing water to the main canal.

**Table 1.** High-risk irrigation reservoirs in Alberta.

| Reservoir | Operated by | District(s) served |
|---|---|---|
| *Oldman River Basin (13 reservoirs)* | | |
| Payne Lake | EP | MVID/LID/AID |
| Jensen | EP | MID/RID/TID |
| Milk River Ridge | EP | RID/TID |
| Sherburne Reservoir | SMRID | TID/SMRID |
| Waterton Reservoir | EP | SMRID/MID/RID/UID/TID |
| St. Mary | EP | SMRID/MID/RID/TID |
| Oldman River Reservoir | EP | LNID |
| Keho | EP | LNID |
| Park Lake | LNID | LNID |
| Sauder/Rattlesnake | SMRID | SMRID |
| Forty Mile | SMRID | SMRID |
| Chin Lake | SMRID | SMRID/TID |
| Stafford | SMRID | SMRID/TID |
| *Bow River Basin (9 reservoirs)* | | |
| Chestermere | WID | WID |
| McGregor | EP | BRID |
| Travers | EP | BRID |
| Little Bow | EP | BRID |
| Badger | BRID | BRID |
| H Reservoir | BRID | BRID |
| Lake Newell | EID | EID |
| Rolling Hills | EID | EID |
| Crawling Valley | EID | EID |

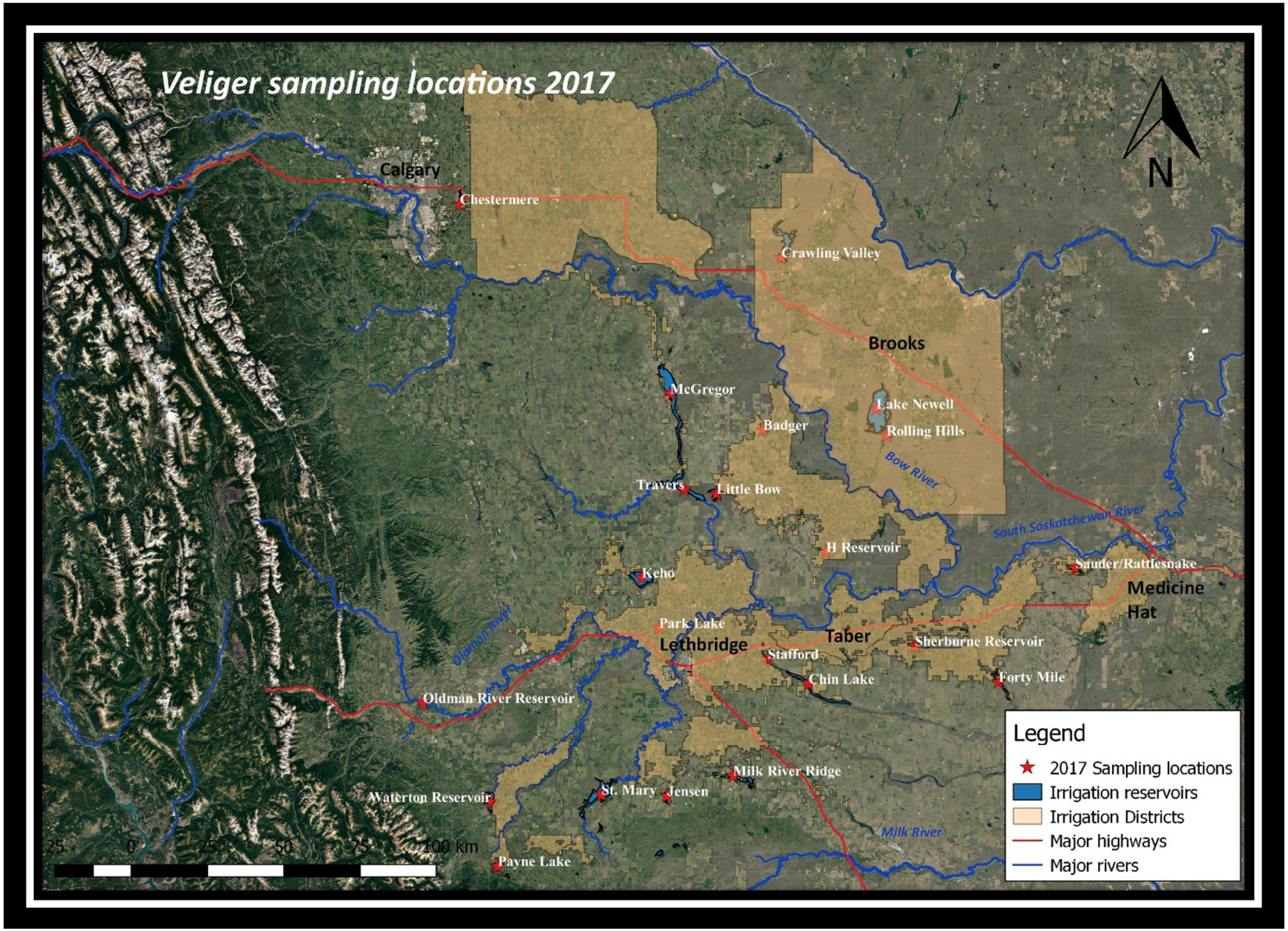



**Figure 2.** Locations of the 22 high-risk reservoirs for possible infestation of invasive mussels in southern Alberta.

## 3 Prevention of Aquatic Invasive Species

The collection and transport of water and plankton samples from waterbodies may result in the transmission and spread of aquatic invasive species (AIS) and disease that pose significant risk to the conservation and sustainability of Alberta's native species and their habitat. Preventing the spread of AIS and disease is a priority for all Albertans, and it is recommended by the Government of Alberta that anyone working in water adhere to the following decontamination methods.

Whirling disease (*Myxobolus cerebralis*), a microscopic parasite of salmonid fish, was detected in Alberta's waters in 2016 within Johnson Lake in Banff National Park. Since this detection, the Bow, Oldman, and Red Deer rivers have been infected. To limit the spread of infection, all veliger sampling efforts should be done in accordance with the Decontamination Protocol for Watercraft and Equipment (GOA 2017). The protocol requires the disinfection of sampling equipment to ensure that the disease is not accidentally spread between water bodies. Disinfection is done with the application of a Quaternary Ammonium Compound solution (QUAT $^{TM}$) to all sampling equipment in contact with water.

To prevent the accidental movement of invasive mussels between waterbodies (if present). Sampling equipment, such as the net and Secchi disk, may require further disinfection by submerging and soaking in commercial vinegar during transport between reservoirs in accordance with the Invasive Mussel Decontamination and Disinfection Procedures (GOA 2014).

## 4 Safety

All sampling locations must be confirmed upon arrival at the irrigation reservoir using the coordinates provided in Appendix A. It is important to obtain a representative sample of irrigation water, be it flowing from the reservoir outlet or from water at the docks and boat launches. All samples must be collected from a safe and secure point, to prevent the loss of equipment and life. Take notes if the sample is collected at a location different from those listed in Appendix A.

Ensure staff wear proper personal protective equipment (PPE) including personal flotation devices (PDF), latex gloves, and protective eyewear. Read and retain a copy of the safety data sheet (SDS) of all sample preservatives used, and ensure that all PPE is used in accordance to the SDS. Flammable preservatives must be stored and transported in a safe manner.

## 5 Determining Water Turbidity and Velocity

The first measurements taken is the turbidity and velocity of water, if possible. Turbidity will be determined either with a Secchi disk (Figure 3a,b), particularly at the dock locations, or as a visual measurement on a 1-to-5 scale (Table 2). Ideally, approximately 1000 L of water should be filtered through the net for 'clean water' and 500 L for 'turbid water' (Figure 3c,d). Turbid or algae-laden waters impede the detection of veligers and thus reduced volume assists the analyst in distinguishing between veligers and other biological and inert debris. Detailed instructions are

outlined in the detailed procedures section below and in Appendix B. The velocity can be determined with the Swoffer (Figure 4a,b). The propeller component of the Swoffer is attached to a sampling pole, and provides a velocity reading representative of where veliger samples are taken.

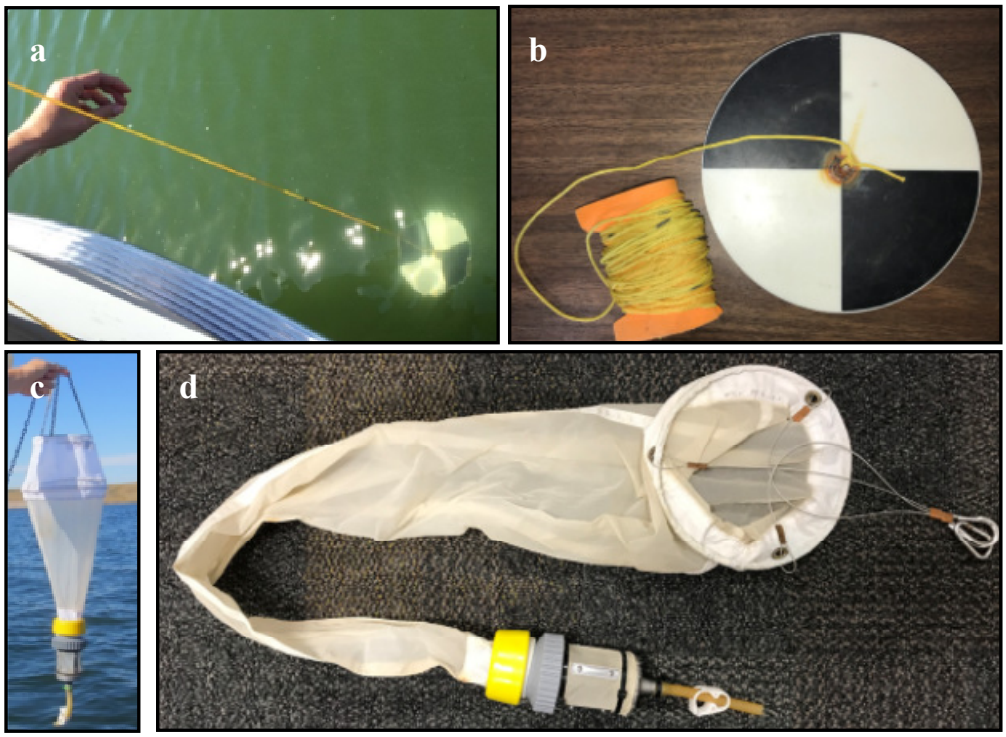



**Figure 3.** Veliger sampling equipment, (a,b) Secchi disk and (c,d) plankton net.

**Table 2.** Turbidity Scale — use a 50-cm depth (approximately) for the turbidity reading.

| Turbidity rating | Description | Observation |
|---|---|---|
| 1 | Clear | Can read a newspaper under water |
| 2 | Low Turbidity | Can see bottom of the canal |
| 3 | Moderately turbid | Cannot see the bottom of the canal |
| 4 | Highly turbid | Can only see part of a submerged sampling pole bottle |
| 5 | Very turbid | Cannot see beyond the surface of the water |

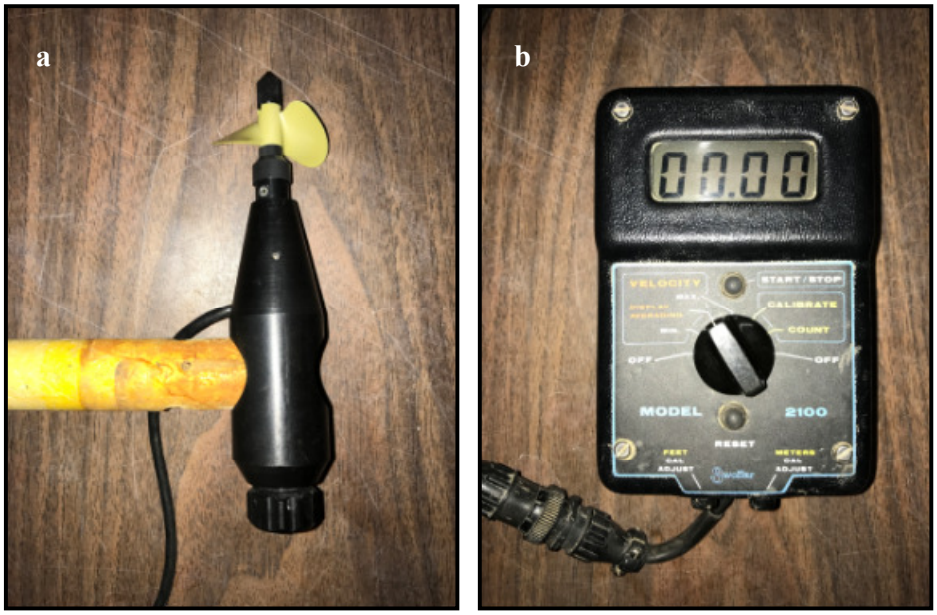
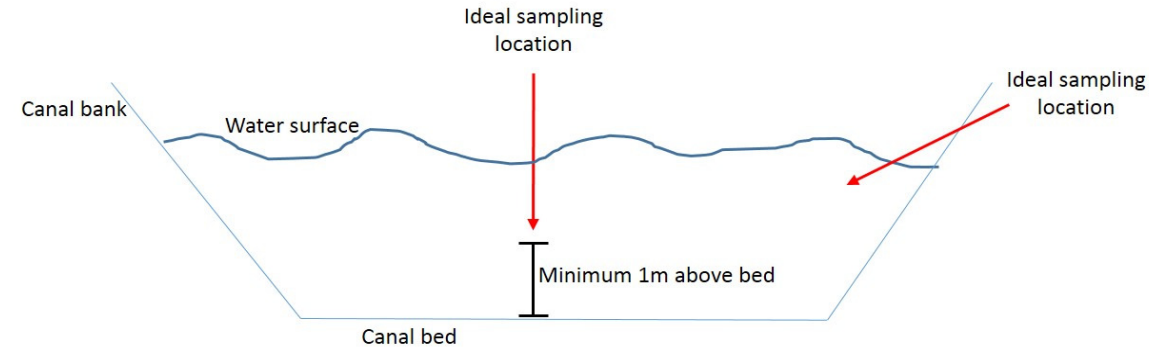


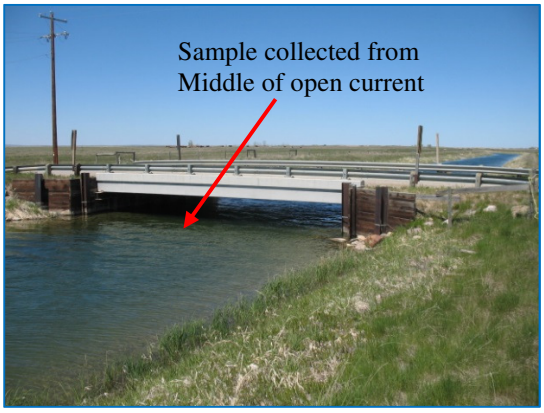
**Figure 4.** Swoffer (a) propeller and (b) model 2100 current velocity meter.

## 6 Sampling in Flowing Water (Canal)

If possible, samples should be taken from two locations at each canal site: one in the open current/channel and one near the shore/bank (Figure 5). If veligers are present, they will be carried downstream in the open current, but are more likely to settle near the shore where velocities are slightly slower (Marsden 1992). If the site has a bridge or walkway, it should be used for the open-current sample. For an open-current sample, the net should be suspended to no deeper than 1 m off the bottom of the canal bed, to avoid disturbing the bottom sediment. For shore-based sampling where water will be shallower, it is important the net does not reach the bottom sediments. Filter volumes based on velocity are outlined in Table 3. If an open-current and shore-based samplings are possible at the site, these times and volumes should be divided equally between both sampling locations at each site in order to yield the desired total filtered volume. For example, if the turbidity is 'clear water', then approximately 500 L should be filtered at the open-current location and 500 L filtered at one shore location for a total of 1000 L of filtered water at that site. Similarly, if only shore-based sampling is possible, take a sample from each bank and divide the volumes between them. The two samples (either one open-current sample and one shore sample or two shore samples) are then combined into one sample for analysis. Detailed instructions are outlined in the procedures section below. Field equipment and supplies required for the procedure are listed in Table 4.




**a**




**b**

**c**

**Figure 5.** At each (a) canal outlet location, two samples should be taken, including (b) one from the middle of the open current and (c) and one near the shore. If an open current measurement is not possible, samples should be taken from both shores.

**Table 3.** Filtered volumes for a 20.3-cm (8-inch) diameter plankton net.

| Desired volume filtered (L) | Approximate velocity (km/h) | Approximate velocity (m/s) | Approximate submersion time of net (s) |
|---|---|---|---|
| 504[z] | 1 | 0.28 | 56 |
| 1008[y] | 1 | 0.28 | 111 |
| 504 | 2 | 0.56 | 28 |
| 1008 | 2 | 0.56 | 56 |
| 504 | 3 | 0.83 | 19 |
| 1008 | 3 | 0.83 | 38 |
| 504 | 4 | 1.11 | 14 |
| 1008 | 4 | 1.11 | 28 |
| 504 | 5 | 1.39 | 11 |
| 1008 | 5 | 1.39 | 22 |
| 504 | 6 | 1.67 | 9 |
| 1008 | 6 | 1.67 | 19 |
| 504 | 7 | 1.94 | 8 |
| 1008 | 7 | 1.94 | 16 |
| 504 | 8 | 2.22 | 7 |
| 1008 | 8 | 2.22 | 14 |
| 504 | 9 | 2.50 | 6 |
| 1008 | 9 | 2.50 | 13 |
| 504 | 10 | 2.78 | 6 |
| 1008 | 10 | 2.78 | 11 |

[z] For high-turbid water.
[y] For low-turbid water.

**Table 4.** List of required equipment and supplies.

| | | |
|---|---|---|
| • plankton sampling net<br>• sampling pole with net attachment<br>• preservative – Commercial isopropanol[z], baking soda<br>• measuring vials<br>• rinsing/squirt bottle<br>• Swoffer | • sampling bottles<br>• Secchi disk<br>• stopwatch<br>• vertical tow chain<br>• field sheets<br>• rubbermaid tub<br>• vinegar<br>• ice packs<br>• cooler | • life jacket, and throw bag<br>• gloves<br>• safety glasses<br>• GPS unit<br>• cell phone<br>• camera<br>• sunscreen, bug spray<br>• field binder<br>• calculator |

[z] Commercial grade 99% isoproponal.

## 7 Detailed Procedure

### 7.1 Water turbidity

- Determine the turbidity of the water, either with the Secchi disk (i.e., at dock locations), or rating the turbidity on a scale (scale 1–5) (i.e., at canal outlet locations). A Secchi disk reading may be preferable for slower velocities.
    - Secchi disk: Measure the depth to where the Secchi disappears. Bring it back up to where it re-appears and measure the depth. The halfway point between these two depths is the Secchi disk reading (i.e., disappears at 3 m, reappears at 2.5 m, Secchi measurement is 2.75 m). If this reading is 2.5 m or greater, filter 1000 L of water; if it is less, filter 500 L of water. Record the measurement on the field sheet (Appendix C). A Secchi disk should not be used in fast flows that impede the disk from remaining completely horizontal when measuring turbidity.
    - Turbidity scale: Use approximately a 50-cm depth for the turbidity reading. For scale values less than or equal to 3, consider the water 'clear' and filter 1000 L (Table 2). For scale values greater than 3 then filter 500 L. Record the scale value on the field sheet.

### 7.2 Canal outlet (horizontal tow)

- Determine the velocity of flow where the net will be placed using the Swoffer. Record on field sheet. If value is greater than 0.15 m/s, then proceed. If not, go to Section 7.3.
- Using these two values (turbidity and velocity), refer to Table 3 and determine how much water should be filtered based on turbidity, and how long to submerge the net based on velocity.
- Soak the body of the net in canal water prior to use.
- Rinse the net with canal water to dislodge any attached material prior to sampling.
    - Attach the bucket to the net — make sure the plug is in place.
- Fill the Nalgene squirt bottle with canal water that was filtered through the net mesh.
- Attach the net to the sampling pole with the attachment.
    - For an open-channel location, lower the net into the water off the bridge or walkway. Submerge the net for the allotted time.
    - For the shore-based location, extend the pole as far out into the canal as possible. Lower the net to a depth no less than 1 m off bottom making sure it stays in a horizontal position with the flow of the water. Submerge the net and allow water to flow through it for the allotted time (Figure 6).
- Bring the net out of the water, and rinse the outer sides of the net two to three times with canal water. Do not splash rinse water into the net opening, or let it drop below the water surface. Fill the Nalgene squirt bottle from the canal or reservoir (Figure 7a).
- If the sample in the net is particularly 'green' (i.e., lots of algae), separate the bucket from the net, place the lower end of the bucket into the 1-L sample bottle and then remove the plug and drain the sample and water into the bottle (Figure 7b). Rinse the bucket contents into the bottle with the squirt bottle previously filled with filtered net water. Pour the sample back into the net (stopper attached to bottom), and concentrate the sample such that it will fit into half the 250-mL sample bottle (Figure 7c).
- If the sample is 'clean', separate the bucket from the net, place the lower end of the bucket into the 250-mL sample bottle then remove the plug and drain the sample and

water into the bottle. Rinse the bucket contents into the bottle with the squeeze bottle previously filled with filtered net water.

- Combine the open-current and shore samples together, or, if an open-current sample cannot be obtained, combine two shore samples together.
- Preserve the final sample with 100 mL of alcohol preservative (isopropanol) and add 0.5 mL of baking soda powder ($NaHCO_3$) (the baking soda powder raises the pH to make sure the veliger shells do not disintegrate) (Figure 7d,e).
- Place samples in a cooler with ice packs.
- Enter the filtered volume onto the field sheet.
- Place anything that has come into contact with the water into the vinegar solution for disinfection. Allow the materials to soak before using again.

**Figure 6.** Canal outlet sampling of H reservoir.


**Figure 7.** Veliger sampling equipment (a) Nalgene squirt bottle, (b) composite bottle, (c) sample bottle, (d) alcohol preservative, and (e) baking soda preservative.

**7.3 Low-velocity canal locations (horizontal sweep)**

In low-velocity conditions (<0.15 m/s), the net will fail to remain parallel to the flow and will become vertical. In these conditions, conduct a horizontal sweep. However, if the canal is not flowing, sampling does not have to be completed.

- Using the Secchi disk or turbidity scale and the velocity as measured by the Swoffer, determine how much water is to be filtered for a 20.3-cm diameter net opening.
    - Clean water (1–3 scale or >2.5 m Secchi), filter for 31 m
    - Turbid water (4–5 scale or <2.5 m Secchi), filter for 15.4 m
- Sweeps should be conducted 1 m off the bottom.
- Soak the sampling net within the canal before use.
- For sample collection from bridges, sweep across the channel perpendicular to the flow for the required distance.
- For sample collection from banks, sweep by walking upstream in a continuous motion for the required distance. Do not sweep downstream. To allow for some water flow, and assuming a walking speed of 1 m/s, use the following equation.

$$Distance\ of\ sweep = \frac{Water\ to\ be\ sampled\ (15.4\ or\ 31\ m)}{Assumed\ walkng\ speed\ \left(1\frac{m}{s}\right) + Canal\ Flow\ (\frac{m}{S})}$$

$$example: \quad Distance\ of\ sweep = \frac{15.4\ m}{1\ m/s + 0.15\ m/s} = 15.7\ m$$

- Remove the net and rinse down the outsides with canal water in the Nalgene bottle.
- Continue with sample concentration, bottling, and preservation as outlined above.

**7.4 Dock locations (vertical tow; depth >5 m)**

- Determine depth of water (using either the Secchi disk chord or tow chain). If greater than 5 m, then proceed. If not, go to Section 7.5.
- Using the Secchi disk reading only, determine how much water is to be filtered
    - Clean water (>2.5 m secchi), filter for 31 m
    - Turbid water (<2.5 m secchi), filter for 15.4 m
- Soak the body of the net in reservoir water prior to use.
- Rinse the net with lake water to dislodge any attached material prior to sampling.
    - Attach the bucket to the net — make sure the plug is in place.
- Fill the Nalgene squirt bottle with reservoir water that has been filtered through the net mesh.
- Lower the net to a depth 1 m off the bottom making sure it stays in a vertical position. The length of a single tow will be the depth of water less 1 m.
- Raise the net vertically at a continuous rate of 0.5 m/s.
- At the surface, rinse down the outer sides of the net two or three times with reservoir water. Do not splash rinse water into the net opening, or let it drop below the surface.
- The completion of multiple vertical tows will be required for water depths less than 15.4, and 31 m to reach the full tow distance.
    - Example, 5.2 passes of 6 m is equivalent to a 31 m tow.

- Following the completion of each vertical tow, collect the sample form the net and continue with sample concentration, bottling, and preservation as outlined above.
- Following the collection of the sample from each vertical tow, continue with subsequent tows as outlined above until the filter distance is reached.

**7.5 Dock locations (horizontal sweep; depth <5 m)**

- Using the Secchi disk reading only, determine how much water is to be filtered.
    - Clean water (>2.5 m secchi), filter for 31 m
    - Turbid water (<2.5 m secchi), filter for 15.4 m
- Sweeps should be conducted 1 m off the bottom.
- Soak the sampling net within the reservoir before use.
- Sweep either 31 m (clean water) or 15.4 m (turbid water) horizontally in a continuous motion (Figure 8).
    - Smaller sections may be swept multiple times to reach the full sweep distance.
        - Example, 5.2 passes of 6 m is equivalent to a 31 m sweep.
    - Longer passes are, however, preferred as the potential of sampling the same parcel of water is less.
- Remove the net and rinse down the outsides with reservoir water in the Nalgene bottle.
- Continue with sample concentration, bottling, and preservation as outlined above.

**Figure 8.** Horizontal sweep of dock at Waterton reservoir.

**7.6 Boat ramp location (horizontal sweep; no dock is present)**

- Using the water turbidity scale, determine how much water to filter.
    - Clean water (1–3 scale), filter for 31 m
    - Turbid water (4–5 scale), filter for 15.4 m
- Sweeps should be conducted a minimum of 1 m off the bottom.
- Soak the sampling net within the reservoir before use.
- Sweep back and forth across the boat ramp at a consistent speed (Figure 9).
    - Smaller sections may be swept multiple times to reach the full sweep distance.
        - Example, 5.2 passes of 6 m is equivalent to a 31 m sweep.
- Remove the net and rinse down the outsides with reservoir water in the Nalgene bottle.
- Continue with sample concentration, bottling, and preservation as outlined above.

**Figure 9.** Horizontal sweep of boat launch at McGregor reservoir.

*Note: As waders are required to collect boat ramp samples, the waders must be disinfected following use at each site. Waders should be sprayed down with disinfectant solution. If possible, alternate sampling between partners/waders to increase the disinfectant exposure times.*

### 7.7 Handling samples

After the sample is preserved in the bottle, ensure to fill in each space on the label:

1. Reservoir the outlet comes from (specify canal name/location) or reservoir name (specify dock location). Recall that some reservoirs will have two samples/bottles; one for the canal and one for the dock or boat launch.
2. Date of collection
3. Total number of metres filtered
4. Total volume of alcohol isopropanol preservative used in the sample
5. Name of collector(s)
6. Other relevant observations

Ensure that the alcohol isopropanol preservative is stored safely, and place the samples in a fridge (4$^{o}$C). Submit samples to a commercial laboratory for analysis. Retain field sheets for documentation. Submit samples biweekly for analysis to the commercial laboratory.

## 8 References

Government of Alberta (GOA). 2017. Decontamination protocol for watercraft and equipment. Alberta Environment and Parks, Edmonton, Alberta.

Government of Alberta (GOA). 2014. Decontamination and disinfection procedures. Alberta Environment and Parks, Edmonton, Alberta.

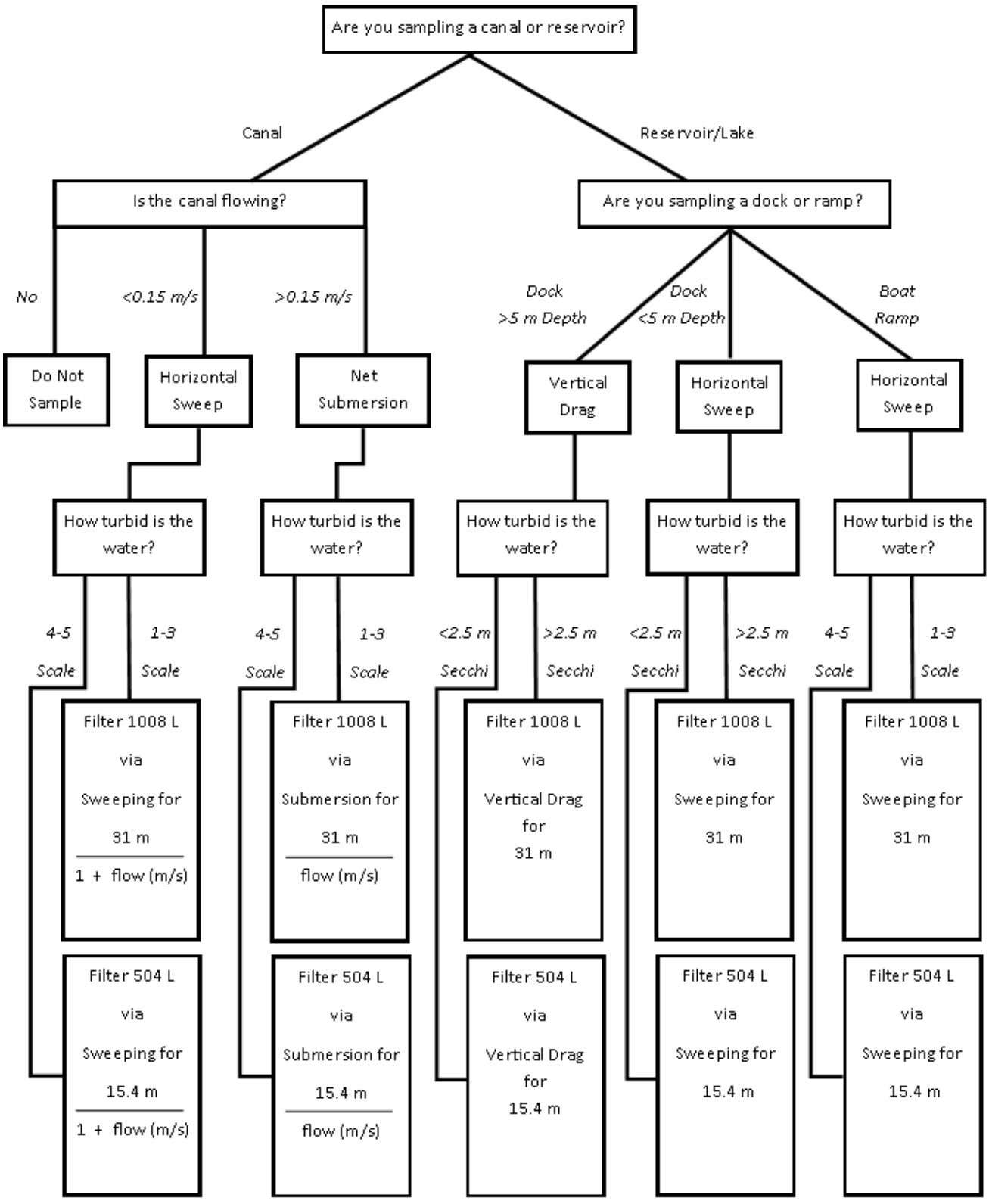
Marsden, J.E. 1992. Standard protocols for monitoring and sampling zebra mussels. Illinois Natural History Survey. Biological Notes 138. 40 pp.

## Appendix A. Site Inventory

| Reservoir | Sampling location coordinates | | | | | |
|---|---|---|---|---|---|---|
| | Dock | | Boat launch | | Outlet | |
| Payne Lake | 49.102740° | -113.642767° | 49.102495° | -113.642952° | 49.105645° | -113.630497° |
| Jensen | 49.327161° | -112.897235° | -- | -- | 49.317863° | -112.890020° |
| Milk River Ridge | 49.362649° | -112.561518° | 49.362634° | -112.561367° | 49.400483° | -112.606345° |
| Sherburne | -- | -- | 49.755812° | -111.743170° | 49.761452° | -111.725822° |
| Waterton | 49.329762° | -113.683707° | 49.330184° | -113.683314° | 49.320179° | -113.663431° |
| St. Mary | -- | -- | 49.360591° | -113.119450° | 49.358395° | -113.075691° |
| Oldman River | 49.569587° | -113.891485° | 49.569587° | -113.891485° | 49.557531° | -113.888541° |
| Keho | -- | -- | 49.936145° | -112.987062° | 49.955123° | -112.949190° |
| Park Lake | 49.815663° | -112.917310° | 49.815628° | -112.917631° | 49.804809° | -112.925057° |
| Sauder/Rattlesnake | 49.980838° | -110.997498° | 49.980838° | -110.997498° | 49.984704° | -110.990592° |
| Forty Mile | 49.672426° | -111.424226° | 49.672202° | -111.424525° | 49.698346° | -111.427661° |
| Chin Lake | 49.602113° | -112.191365° | 49.602113° | -112.191365° | 49.684388° | -112.357390° |
| Stafford | 49.727462° | -112.457269° | 49.727462° | -112.457269° | 49.744290° | -112.463118° |
| Chestermere | -- | -- | 51.051173° | -113.821407° | 51.017423° | -113.818423° |
| McGregor | 50.236412° | -112.852162° | 50.236053° | -112.852708° | 50.268066° | -112.820393° |
| Travers | -- | -- | 50.191003° | -112.732873° | 50.176481° | -112.708013° |
| Little Bow | -- | -- | 50.197389° | -112.664520° | 50.207744° | -112.668328° |
| Badger | -- | -- | 50.383642° | -112.477758° | 50.368222° | -112.436666° |
| H Reservoir | -- | -- | 50.031883° | -112.176720° | 50.007330° | -112.165286° |
| Lake Newell | 50.453815° | -111.913895° | 50.453797° | -111.913990° | 50.492608° | -111.902200° |
| Rolling Hills | 50.373643° | -111.908775° | 50.373514° | -111.908584° | 50.372780° | -111.882198° |
| Crawling Valley | 50.860304° | -112.386569° | 50.860764° | -112.386226° | 50.855630° | -112.359099° |

-- = not used

**Appendix B.** Protocol decision flowchart.



**Appendix C.** Field sheet.

| **Irrigation Reservoir Veliger Monitoring Field Sheet** | | |
|---|---|---|
| Irrigation district | Composite time: mst | Lab: |
| Sampler's name(s): | Date: | |
| Veliger sample # | Day | Month Year |
| | | |
| **Irrigation Reservoir:** | Decontamination record | |
| | | |
| Sample matrix | Substrate observations: | |
| Type | | |
| Collection | Sampling location 1: | Turbidity: |
| Amount of alcohol preservative used (mL): | GPS latitude: | Haul depth: |
| Substrates checked: | GPS longitude: | # of hauls taken |
| Secchi measurement (m): | Comments: | Meters sampled: |
| Bottom depth measurement (m): | | |
| Net description: | | |
| | | |
| | Sampling location 2: | Turbidity: |
| Weather description: | GPS latitude: | Haul depth: |
| | GPS longitude: | # of hauls taken |
| Wind direction: | Comments: | Meters sampled: |
| Air temperature (°C): | | |
| Wave height (m): | | |
| Cloud cover (%): | | |
| | | |
| Comments and observations: | | |
| | | |
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