Monitoring for Invasive Mussels in Alberta's Irrigation Infrastructure: 2017 Report

Alberta Agriculture and Forestry
Water Quality Section

Outlet of Sauder Reservoir

January 2018

Alberta Government

Introduction and Summary

The Government of Alberta (GOA) is committed to protecting the province against aquatic invasive species (AIS), due to their negative ecological and economic effects. Invasive zebra mussels (*Dreissena polymorpha)* and quagga mussels (*Dreissena bugensis*) are of prominent concern, as these dreissenid mussels attach to any solid submerged surface and rapidly multiply due to their high reproductive rates. They are also very difficult to contain and eradicate once established. Additionally, they are spreading closer to Alberta's borders.

Alberta's irrigation industry contributes $3.6 billion to the provincial gross domestic product (GDP). Specifically, it contributes about 20% of the provincial agri-food sector GDP on 4.7% of the province's cultivated land base (Paterson Earth & Water Consulting 2015). Alberta's irrigation industry includes thirteen irrigation districts that supply water to more than 570,000 ha of farmland through infrastructure valued at $3.6 billion. This infrastructure includes 57 irrigation reservoirs along with 3,491 km of canals and 4,102 km of pipelines (ARD 2014; AF 2017). The irrigation conveyance system provides water to irrigators, municipalities, industries, and wetlands, while the reservoirs support recreational activities such as boating and fishing and provide habitat to fish and waterfowl. Invasive mussels are a concern to the irrigation industry as infestations will have a significant negative effect on water infrastructure and conveyance works due to their ability to completely clog pipelines and damage raw-water treatment systems and intakes. A draft economic report conservatively estimates that a mussel infestation would cost Alberta $75 million annually to control invasive mussels, including irrigation infrastructure (Neupane 2013).

The discovery of invasive mussels in Lake Winnipeg (2013), and suspected introductions at Tiber Reservoir in Montana (2016) are concerning because invasive mussels are typically spread among water bodies by recreational watercraft. The proximity of these affected water bodies to the province emphasizes the importance of a thorough prevention program, which includes monitoring of natural water bodies and irrigation reservoirs.

The GOA, led by the ministry of Environment and Parks (EP), in collaboration with Alberta's irrigation districts, are increasing efforts to prevent the introduction of these species to Alberta, and prepare for the possibility of mussels becoming established. While control options have been researched, there is a strong focus on prevention. Prevention efforts include education and outreach, watercraft inspections, legislation and policy, annual monitoring, and rapid response planning. 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 the invasive mussels is dependent upon annual monitoring programs.

Alberta Environment and Parks conducts annual water quality lake monitoring, which includes sampling for invasive mussel veligers — the microscopic mussel larvae. However, not all irrigation reservoirs are sampled by EP in a given year, as they rotate on an annual basis. Alberta Agriculture and Forestry's (AF's) Water Quality Section, in partnership with EP and the irrigation districts, have been conducting annual veliger monitoring at high-risk irrigation reservoirs since 2013. In addition, irrigation district staff have monitored for settled juvenile and adult mussels by deploying and checking artificial substrates in the reservoirs, and performing annual infrastructure inspections at intakes and along canals during water drawdown at the end of the growing season.

In 2013, 21 of 57 irrigation reservoirs were identified as high risk for the introduction of aquatic invasive mussels due to several favourable factors such as ideal pH and calcium levels (needed for mussel establishment and growth), and the intensity of recreational use by boaters and anglers. In 2017, Sherburne reservoir was identified as a high-risk irrigation reservoir at the request of the Alberta Irrigation Projects Association (AIPA), resulting in a total of 22 reservoirs classified as high risk.

Since 2013, AIS monitoring efforts within the province have increased, and the 22 high-risk reservoirs present a relatively high percentage of the total monitored water bodies, with 87 water bodies monitored in 2017, 79 in 2016, 74 in 2015, and 55 in 2013.

In 2017, AIPA provided further support for veliger monitoring by contracting Aquality Environmental Consulting Ltd. to conduct veliger monitoring at 12 irrigation reservoirs throughout the irrigation season.

No aquatic invasive mussels have been found during all monitoring to date (2013 to 2017), including veliger, substrate and infrastructure monitoring. The lack of detections are important to document in the event mussels are detected – this lack of detection data gives a basis for establishing a time frame for introduction and possible subsequent spread.

It is recommended that monitoring continue. In the event of limited resources, infrastructure monitoring at the end of irrigation season should be prioritized since the infrastructure will have been in contact with all of the water flowing during the irrigation season.

	Good	Better	Best
	More resources and expertise →		
Methods	Monitor infrastructure	Monitor infrastructure Check PVC substrates	Monitor infrastructure Check PVC substrates Monitor for veligers
Frequency	End of season	Twice per season	Monthly during season

Continuum of monitoring options for invasive mussels in irrigation infrastructure.

Review of 2013 to 2016 monitoring program

Veliger monitoring. From 2013 to 2016, AF conducted veliger sampling at the high-risk irrigation reservoirs, and all samples have tested negative for the presence of veligers.

2013 AF monitored 15 reservoirs for veligers once during the summer, while the remaining six were monitored by EP.

2014 AF monitored 15 reservoirs for veligers twice during the irrigation season: once in June/July and once in August/September. Three other reservoirs were monitored by EP, and three were not monitored.

2015 AF monitored 18 reservoirs for veligers twice during the irrigation season: once in June/July and once in August/September, with the exception of Chin Reservoir, which was only sampled in June/July as water levels were too low to sample in August/September. The remaining three high-risk reservoirs were monitored by other agencies.

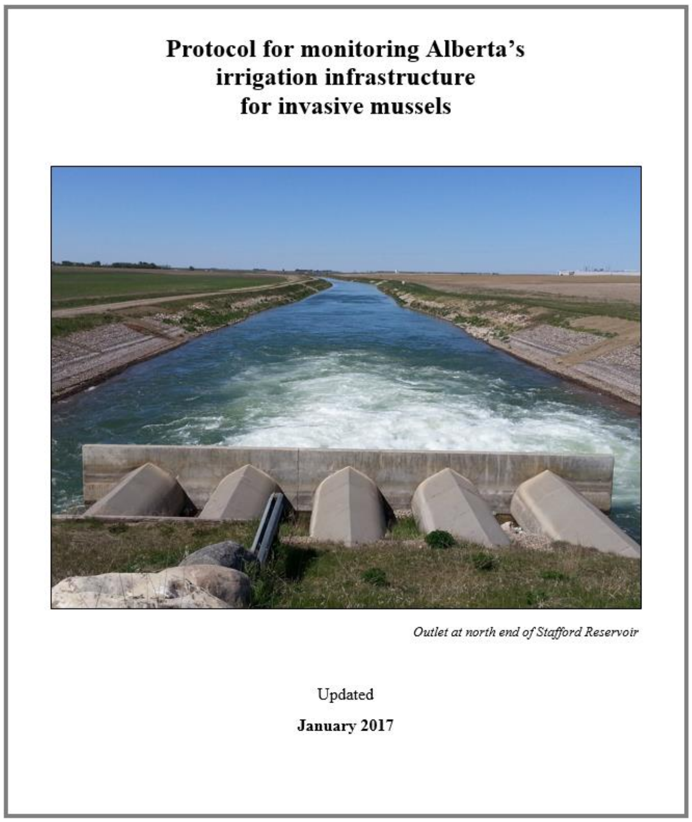
2016 AF monitored 14 reservoirs, while other agencies (EP, Alberta Lake Management Society-ALMS) monitored the remaining eight reservoirs. Nearly all high-risk irrigation reservoirs were sampled for veligers at least twice during 2016, with the exception of Milk River Ridge reservoir, which was not sampled during the August event due to insufficient canal outflow.

In 2013 and 2014, water samples were sent to RNT Consulting Inc. in Ontario for analysis. In 2015 and 2016, samples were submitted to Invert Solutions Inc. in Edmonton for analysis. Quality assurance/quality control (QA/QC) was conducted with the submission of extra blanks and duplicates to RNT Consulting Inc. in 2013 and 2014 and to Invert Solutions Inc. in 2015 and 2016 to allow for comparison between labs.

Substrate monitoring. In 2013, artificial substrates, constructed of polyvinyl chloride (PVC) pipe and filled with cement, were installed in each reservoir (Figure 1). The substrates provide a solid surface on which invasive mussels, if present, can attach, and were installed near locations and infrastructure that were easy to access, and had high boat traffic, namely docks. Substrates were checked by visual and tactile observations each month from May through October. All submitted reports in 2013 to 2017 indicated no attached mussels.

Figure 1. Artificial substrate.

Infrastructure monitoring. It was recognized that the PVC substrates may provide limited surface area for mussels to settle on, and that submerged irrigation infrastructure would provide a much larger surface area. In 2015, AF developed a protocol for monitoring irrigation infrastructure for irrigation district staff to follow when monitoring their infrastructure for invasive mussels (Figure 2). The protocol includes information on how to identify mussels; prioritizes what structures to monitor in reservoirs, canals, and hydro facilities; and what to do if mussels are found attached to any infrastructure. The protocol includes general reporting sheets that can be altered to fit the nature of each structure, as well as a decision flow chart for the visual inspection process (Appendix A). The protocol was updated in 2017 and shared with EP, and they have since committed to inspect irrigation infrastructure that they own and operate, much of which provides water to the irrigation districts. To date, no invasive mussels have been reported from infrastructure inspections.


Protocol for monitoring Alberta's irrigation infrastructure for invasive mussels

Outlet at north end of Stafford Reservoir

Updated

January 2017

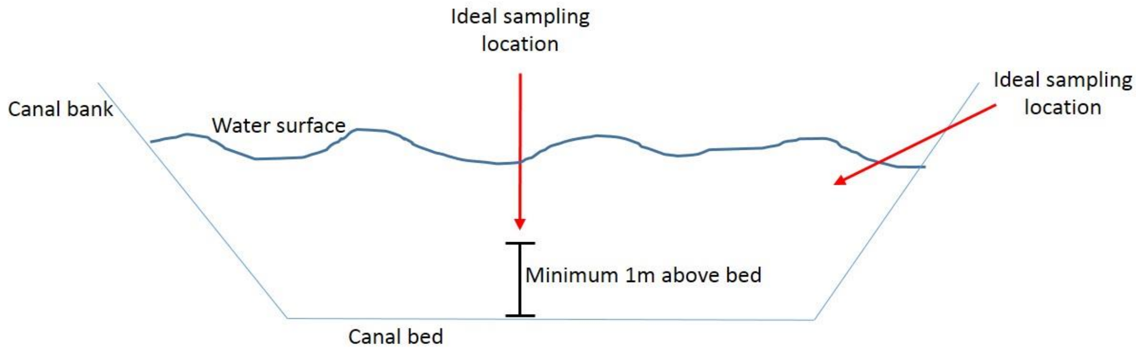
Figure 2. Protocol for monitoring Alberta's Irrigation Infrastructure for invasive mussels.

Change in Methods from 2015 to 2016

For the first three seasons (2013, 2014, and 2015), veliger sampling was completed in each of the identified reservoirs using a small, motorized boat, and followed the Provincial Surface Water Plankton Collection Protocol (ESRD 2013) developed by Alberta Environment and Sustainable Resource Development. It took about two to three weeks per sampling event for AF staff to sample the reservoirs. Sampling was often delayed or postponed due to moderate to high winds. Even on calm days (wind less than 30 km/h) operating a small boat poses safety risks. Thus, in 2016, the veliger monitoring methods were revised to collect samples from canals near reservoir outlets, and at dock locations were applicable, without using a boat. The outlet monitoring protocol methods will allow the irrigation districts to adopt veliger monitoring as part of their routine activities.

This method relies upon the assumption that the sample collected from the outlet canals is considered representative of water conditions within the reservoir, and are therefore likely to represent the presence, or absence of veligers. To support this assumption, additional samples were collected from the reservoir boat launches and docks. Sampling locations along outlet canals were strategically chosen to isolate reservoir outflow and ensure samples were representative of reservoir condition — locations were far enough downstream of the reservoir but far enough upstream of any contributing drainage confluences.

The reservoir outflow sampling method is composed of several steps. Turbidity is first measured with a Secchi disk, or turbidity scale, and flow velocity is determined using a Swoffer flow meter. These parameters help determine how much water to filter, and sampling time. Water is then filtered through a 20-cm diameter plankton sampling net. Ideally, approximately 1000 L of water should be filtered for low turbidity conditions, and 500 L for high turbidity conditions, per reservoir. Turbid or algae-laden waters impede the detection of veligers and thus a reduced sample volume assists the analyst in distinguishing between veligers and other biological and inert debris. Two locations were sampled to create a composite: an open current/mid-channel location and a shore/bank location. Water samples from each location were then combined into one composite sample representing the entire reservoir (Figure 3). Sampling was performed by submerging the sampling net with the opening oriented upstream into canals, using a vertical tow in deep reservoirs (<5 m), or by using a horizontal net sweep in shallow reservoirs (<5 m). Samples were obtained from within the water column no less than 1 m above the canal bed.



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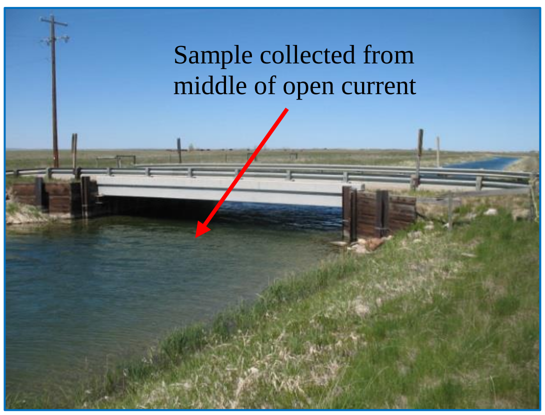

b

c

Figure 3. 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 either shore.

The 2017 Monitoring Season

Veliger monitoring. In 2017, EP again included veliger monitoring in their annual monitoring program, and monitored 87 high-risk irrigation reservoirs.

Alberta Agriculture and Forestry staff monitored all of the 22 high-risk irrigation reservoirs twice during 2017 (Figure 4; Table 1) with the exception of direct sampling from Chin reservoir. The revised veliger sampling protocol resulted in a shorter amount of time required for each sampling event (June/July, and August/September). Specifically, the new protocol took one week to sample all reservoirs as compared to two to three weeks using a boat. Up to four reservoirs could be sampled in one day.

To support the expansion of the field sampling program, AF purchased three new custom plankton sampling nets from Wildlife Supply Company® (Wildco) for the 2017 veliger sampling season. The custom Wisconsin plankton nets measured 7.62 cm x 74 cm with a 63-µm screen. The net filtered the sample into the Dolphin™ Bucket of with 100-mL volume and 63-µm screen (Figure 5).

Figure 5. Plankton sampling net.

However, challenges were still encountered during the 2017 field program. Site access to collect samples was a challenge at some locations such as Chin reservoir (Figure 6). Docks and boat ramps were chosen as sampling locations because it is assumed that such areas would be the first to yield a positive test for veligers (if present) due to high boat traffic. Sampling at docks and boat ramps was done by performing a horizontal sweep within the water column at 1 m above the bottom of the reservoir at shallow reservoirs (<5 m), and vertical tow at deep reservoirs (>5 m). However, 2016 and 2017 had minimal precipitation and warm temperatures during the summer months, and at times, the reservoir levels were so low that the docks became beached. Low water levels in the reservoirs cause low-flow conditions in the canals as well. Thus, the canal sampling protocol had to be modified again for 2017. Low-flow conditions limited the effectiveness of plankton sampling because insufficient current velocity prevented the net from staying open when submerged in the water current, thereby resulting in a non-representative sample. The new protocol made accommodations for low-flow conditions by including instructions for a horizontal upstream sweep. The horizontal upstream sweep was performed in low flows (<0.15 m/s) for low turbidity conditions (36 m), or high turbidity conditions (18 m). The use of the revised methodology in 2017 allowed for the successful collection of water samples from low-flow conditions. The protocol has been updated and provided to the irrigation districts for their use. Finally, the Swoffer flow meter malfunctioned at one instance during the monitoring program, as the water velocity of the outlet canal is required to determine the net submergence time it was measured using the float method. The malfunction was due to corrosion of the electrical contacts, maintenance and cleaning of the equipment remedied the problem.

All AF samples were submitted to EP's Alberta Environmental and Science Division (EMSD), who contracted the analysis to Invert Solutions. Invert Solutions was used in 2017 for routine veliger analysis in Alberta, as well as analysis of suspect specimens taken from watercraft during watercraft inspections. The use of an in-province lab has resulted in reduced turnaround time, which becomes important if any samples test positive for veligers.

Figure 6. Chin reservoir boat launch and dock not sampled during the August 2017 sampling events, due to low water level.

Prevention of Aquatic Invasive Species

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. Following this detection, the Bow, Oldman, and Red Deer rivers have been infected. To limit the spread of infection, all AF veliger sampling efforts was done in accordance with the Decontamination Protocol for Watercraft and Equipment (EP 2017). The protocol requires the disinfection of sampling equipment to ensure that the disease is not accidentally spread among water bodies. Disinfection is done with the application of a Quaternary Ammonium Compound solution (QUAT ™) to all sampling equipment in contact with water.
To prevent the accidental movement of invasive mussels among water bodies (if present), sampling equipment, such as the net and secchi disk, were further disinfected by submerging and soaking in commercial vinegar during transport between reservoirs in accordance with the Invasive Mussel Decontamination and Disinfection Procedures (EP 2014).

Substrate monitoring. Artificial PVC substrates were installed in the reservoirs by irrigation district staff in 2017. Substrates were checked monthly from May to October and reports were submitted to AF. The results were then forwarded to EP. The substrate monitoring and reporting continued to improve in 2017 compared to previous years. The vigilance of the irrigation district staff was evident with consistent monthly reporting, communication, and questions.

Online substrate reporting has been recognized as a more efficient way to report substrate findings. In 2017, the online AIS reporting tool, Early Detection and Distribution Mapping System (EDDMapS) — a web-based mapping system for invasive species distribution reports — was introduced by EP as a means to document invasive species sightings. The EDDMapS is undergoing further testing before distribution to the irrigation districts.

Irrigation infrastructure monitoring. The irrigation districts began to use the 2017 protocol for monitoring irrigation infrastructure during the 2017 season. Irrigation district and EP operations staff have been asked to fill out reporting sheets, even if nothing is found, and keep the reports on file for future reference in case a detection occurs.

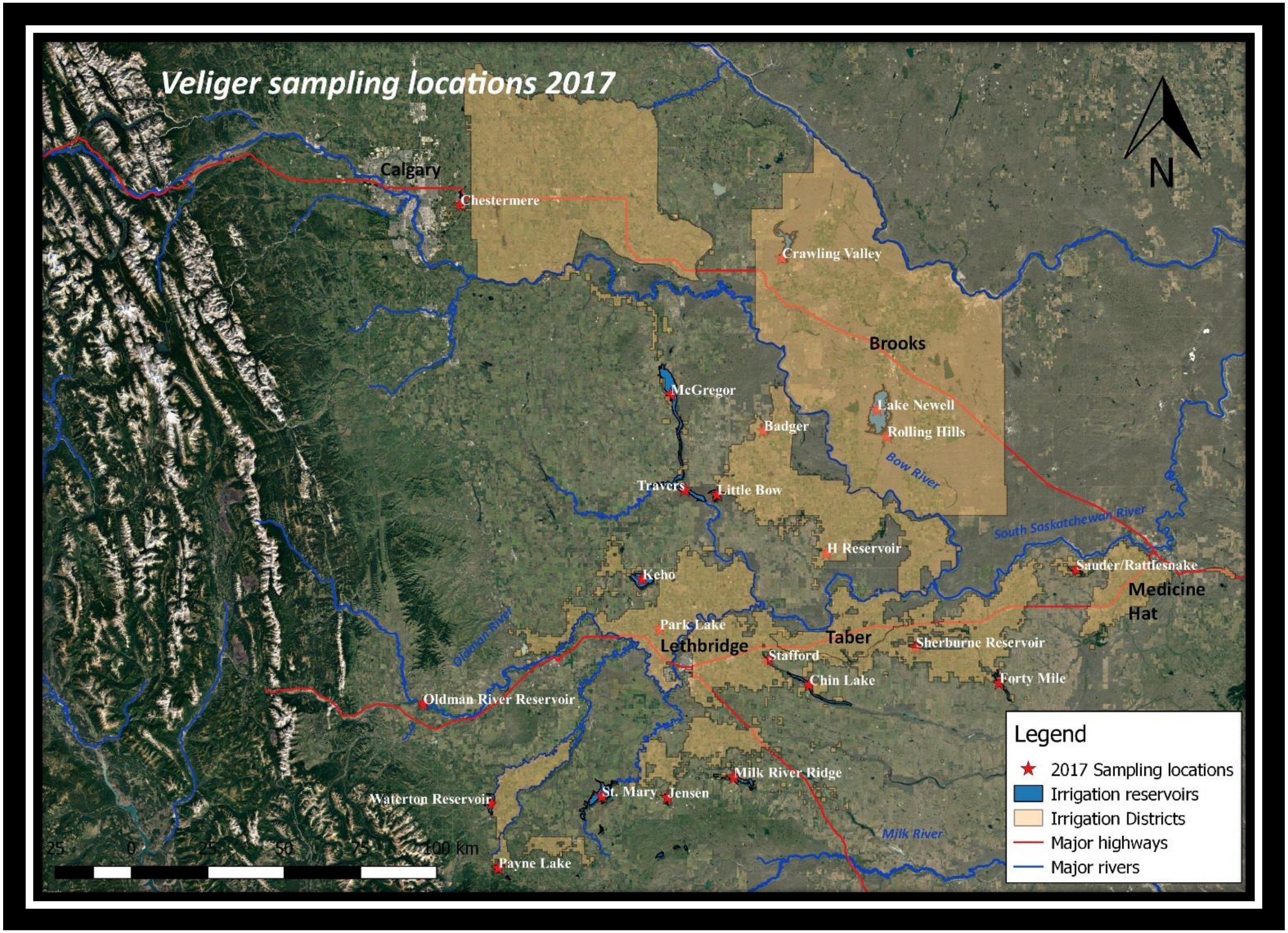

Figure 4. Map of locations where AF performed veliger sampling in 2017.

Table 1. **Monitoring in high-risk irrigation reservoirs in 2013 to 2017.**

				2013			**2014**			**2015**			**2016**			**2017**		
	Reservoir or Lake	**District(s) served**	**Operated by**	**Veliger (AF)**	**Veliger (EP)**	**Substrate monitoring**	**Veliger (AF)**	**Veliger (Other)**	**Substrate monitoring**	**Veliger (AF)**	**Veliger (Other)**	**Substrate monitoring**	**Veliger (AF)**	**Veliger (Other)**	**Substrate monitoring**	**Veliger (AF)**	**Veliger (Other)**	**Substrate monitoring**
1	Chestermere	WID	WID		✓	WID/Town of Chestermere	✓		WID/Town of Chestermere		✓	WID		✓	WID	✓	✓	WID
2	Lake Newell	EID	EID		✓	EID	✓		EID	✓		EID		✓	EID	✓	✓	EID
3	Rolling Hills	EID	EID	✓		EID	✓		EID	✓		EID	✓		EID	✓		EID
4	Crawling Valley	EID	EID	✓		EID	✓		EID	✓		EID			EID	✓	✓	EID
5	Travers	BRID	EP		✓	BRID	✓		BRID	✓		BRID		✓	BRID	✓	✓	BRID
6	McGregor	BRID	EP		✓	BRID	✓		BRID	✓		BRID	✓		BRID	✓	✓	BRID
7	Badger	BRID	BRID	✓		BRID			BRID	✓		BRID	✓		BRID	✓		BRID
8	H Reservoir	BRID	BRID	✓		BRID			BRID	✓		BRID	✓		BRID	✓		BRID
9	Little Bow	BRID	EP	✓		BRID			BRID	✓		BRID	✓		BRID	✓		BRID
10	Keho	LNID	EP	✓		LNID	✓		LNID	✓		LNID		✓	LNID	✓	✓	LNID
11	Park Lake	LNID	LNID	✓		LNID	✓		LNID	✓		LNID		✓	LNID	✓		LNID
12	Oldman River Reservoir	LNID	EP	✓		EP/TPR		✓	EP/TPR		✓	EP/TPR		✓	EP/TPR	✓	✓	EP/TPR
13	Chin Lake	SMRID/TID	SMRID	✓		SMRID	✓		SMRID	✓		SMRID	✓		SMRID	✓	✓	SMRID
14	Sauder/ Rattlesnake	SMRID	SMRID	✓		SMRID		✓	SMRID	✓		SMRID	✓		SMRID	✓		SMRID
15	Forty Mile	SMRID	SMRID		✓	SMRID	✓		SMRID	✓		SMRID	✓		SMRID	✓	✓	SMRID
16	Stafford	SMRID/TID	SMRID		✓	SMRID	✓		SMRID	✓		SMRID	✓		SMRID	✓	✓	SMRID
17	St. Mary	SMRID/MID/ RID/TID	EP	✓		MID		✓	MID	✓		MID	✓		MID	✓	✓	MID
18	Waterton Reservoir	SMRID/MID/ RID/UID/TID	EP	✓		UID	✓		UID		✓	UID	✓		UID	✓	✓	UID
19	Jensen	MID/RID/TID	EP	✓		MID	✓		MID	✓		MID	✓		MID	✓		MID
20	Milk River Ridge	RID/TID	EP	✓		RID	✓		RID	✓		RID	✓		RID	✓	✓	RID
21	Payne Lake	MVID/LID/ AID	EP	✓		MVID/EP	✓		MVID/EP	✓		MVID/EP	✓		MVID/EP	✓	✓	MVID/EP
22	Sherburne	SMRID	SMRID													✓	✓	TID

Table 2. Provincial veliger monitoring program in 2017 (EP = Alberta Environment and Parks; ALMS = Alberta Lake Management Society; AF = Alberta Agriculture and Forestry; EMSD = Alberta Environmental and Science Division; AIPA = Alberta Irrigation Projects Association. Reservoir names in bold indicate high-risk irrigation reservoirs sampled by agencies other than AF.

Southern Water bodies
Pine Coulee Reservoir
Lee Lake
Crawling Valley Reservoir
Eagle Lake
Bullshead Reservoir
Milk River
Oldman River Reservoir
Police Outpost Lake
Twin Valley Reservoir

Central Alberta Recreational Lakes Program - ALMS/EP EMSD
Lacombe Lake

EP Parks Division
Beaver Lake
Chain Lake Reservoir
Dillberry Lake
Elkwater Lake
Ghost Reservoir
Gull Lake
Lac La Biche
Lake Newell Reservoir
Lower Kananaskis
Musreau Lake
Ross Lake
Spray Lakes Reservoir
Sturgeon Lake
Upper Kananaskis reservoir
Wabamun Lake
Winagami Lake

AIPA- Aquality Environmental Consulting Ltd.
Chestermere
Chin Lake Reservoir
Forty Mile Reservoir
Keho Lake Reservoir
McGregor Reservoir
Milk River Ridge Reservoir
Payne Lake Reservoir
Sherburne Reservoir
St. Mary Reservoir
Stafford Reservoir
Travers Reservoir
Wateron Reservoir

Long-Term Lake Network– EP EMSD
Ethel Lake
Amber River
Utikumasis Lake
Hutch Lake
Cold Lake
Baptiste Lake North, South Basins

ALMS
Alix Lake
Antler Lake
Buffalo Lake
Birch Lake
Burnstick Lake
Calling Lake
Crane Lake
Garner Lake
Gleniffer Lake Reservoir
Half Moon Lake
Haunted Lake
Island Lake (near Athabasca)
Jackfish Lake
Kehewin Lake
Lac bellevue
Laurier Lake
Lessard Lake
Long Island Lake, South
Long Lake
Minnie Lake
Moose Lake
Muriel Lake
Narrow Lake
Pigeon Lake
Pine Lake
Skeleton Lake North / South
Touchwood Lake

ALMS - Provincial Parks Lake Monitoring Program
Gregoire Lake
Steele Lake
Long Lake
Crimson Lake
Miquelon Lake

North West Regional Lakes – EP EMSD Edmonton Office
Primrose Lake
Hay/ Zama Lakes

AF/ Irrigation Districts (Southern Alberta)
Chestermere
Lake Newell
Crawling Valley Reservoir
Travers Reservoir
McGregor Reservoir
Badger Reservoir
H Reservoir
Little Bow Reservoir
Keho Lake Reservoir
Park Lake Reservoir
Oldman River Reservoir
Chin lake Reservoir
Sauder Reservoir
Forty Mile Reservoir
Stafford Reservoir
St. Mary Reservoir
Waterton Reservoir
Jensen Reservoir
Milk River Ridge Reservoir
Payne Lake Reservoir
Sherburne Reservoir

Acknowledgements

This report was prepared by Brad Calder. Thanks to Dr. Ron Zurawell, Trina Ball, and Brittany Kereliuk from EP for their assistance with materials, shipping logistics, and substrate specimen analysis. Special recognition to Troy Ormann, Paul Graveland, Evan Hillman, Bryce Steeves, Dorothy Graham, and Lauren Jackson from Alberta Agriculture and Forestry for their assistance with veliger sampling, and updating the outlet monitoring protocol. Andrea Kalischuk, Barry Olson, and Nicole Seitz Vermeer of Alberta Agriculture and Forestry are also thanked for their review of this report. Thanks as well to the irrigation districts and their staff for deploying, checking, and reporting their findings from the artificial substrates.

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Appendix A.
Outlet monitoring protocol flowchart.