



Coordinated Aquatic Monitoring Program

Annual Activity Report

2017/2018

Submitted to:

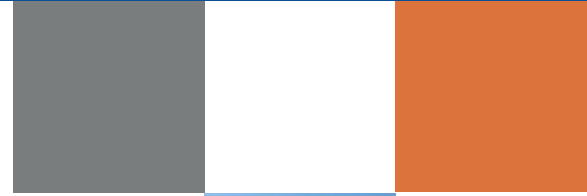
Minister of Sustainable Development

President/CEO Manitoba Hydro

Submitted by:

MOU Working Group

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Setting Lake

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1.0 Executive Summary

The 2017/18 Coordinated Aquatic Monitoring Program (CAMP) marks the tenth year of monitoring since initiation of the pilot program in 2008/09. The program was implemented to address comments received from communities and the Clean Environment Commission (CEC) about the need for system-wide monitoring to better understand the effects of hydroelectric operations on the aquatic environment. In 2006, Manitoba and Manitoba Hydro signed a Memorandum of Understanding (MOU) and the CAMP partnership was established. The MOU outlines the objectives of the program and requires an annual summary of activities, which is provided in this report.

CAMP uses an ecosystem-based monitoring approach and samples key biological/ chemical/ physical parameters at different levels of the food web. These variables, along with hydrometric data are used to describe the ecological condition and status of aquatic ecosystem health in the waterways in which MB Hydro operates. The selected parameters were scientifically determined based on the best advice of scientists and regulators that have participated in annual CAMP workshops that started in November 2007. Attendees included representatives from Manitoba Conservation and Water Stewardship, Manitoba Hydro, Fisheries and Oceans Canada, University of Manitoba, Environment Canada and North/South Consultants Inc.

The program is continuously assessed and adjusted as appropriate to ensure it maintains data consistency and scientific credibility, and is on scope for meeting the objectives of the Memorandum of Understanding.

The past year was successful and most of the fieldwork was accomplished as planned. A few sampling sites could not be visited due to high water levels and flows, which posed safety risks. Despite conditions almost all program conditions were met.

Recent developments to the program include:

- Testing the feasibility of installing water quality data loggers in generating stations for turbidity, temperature, dissolved oxygen and conductivity
- Focus on increasing communication products and plain-language documents
- Completion of the 6-Year Technical Reports

Additional items to be developed over the next few years include:

- Using a GIS-based interface for public access of CAMP data online
- Enhanced collaborations with communities
- Exploration of the addition of a shoreline health monitoring component (including erosion and wetland monitoring).



2.0 Background

The purpose of this report is to provide the signatories of the Memorandum of Understanding (MOU) with a summary of the 2017/18 Coordinated Aquatic Monitoring Program. The MOU, signed in 2006 by the Province of Manitoba and Manitoba Hydro (Appendix 1), outlines the need to develop a system-wide aquatic monitoring program to address concerns related to potential effects associated with Manitoba Hydro operations.

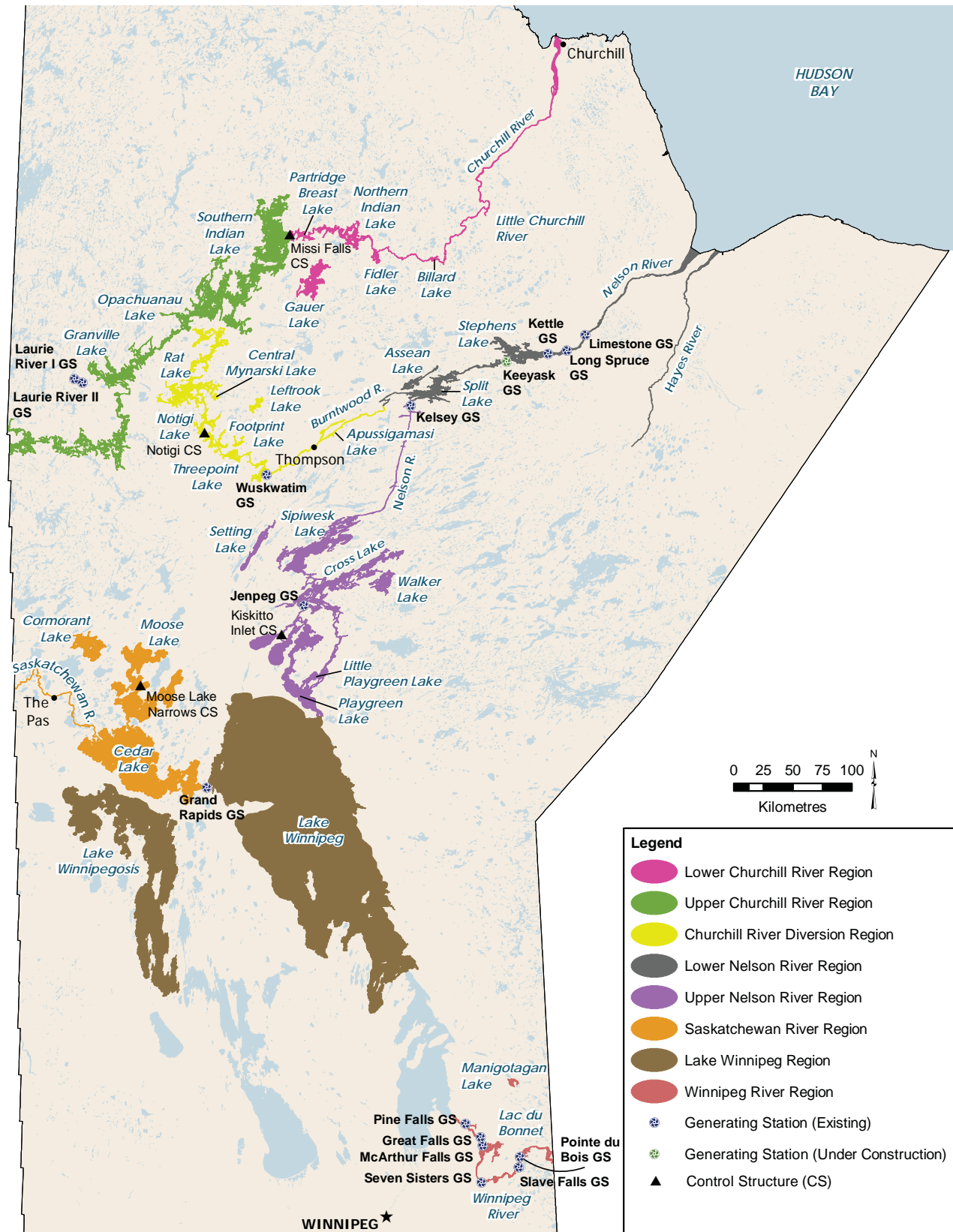
The Coordinated Aquatic Monitoring Pilot Program was developed and implemented in 2008/09 and operated for the first three years to test sampling methodologies. This 2017/18 annual activity report represents the seventh year of a fully implemented, post-pilot phase, Coordinated Aquatic Monitoring Program (CAMP).

The Program has over 50 sampling sites across eight regions of Manitoba. There is a core program that is conducted annually with additional waterbodies that are sampled in a 3 year rotation. Two components are on a longer term monitoring cycle; mercury every 3 years and sediment quality every 6 years. The adjacent map illustrates the CAMP regions.

Several meetings were held throughout the year between different groups related to CAMP, including the main working group, smaller subcommittee, broader workshops, and community meetings. The meetings were used for communication purposes, to share results, and evaluate and revise the program, as needed.



Testing water clarity from a float plane using a Secchi disc



CAMP Study Regions



3.0 Program Management

CAMP is a large program that has a broad geographic and topic scope. It is composed of waterways across Manitoba (from the Winnipeg River to the Churchill River) and it includes a multitude (hundreds) of monitoring parameters that are sampled in different waterbodies on an annual or rotational basis. To accomplish the goals of the program, many different groups (i.e., Manitoba Sustainable Development, Manitoba Hydro, environmental consultants, technical experts, lab technicians, and community members) perform various duties to:

- Plan and direct the work
- Manage and budget effectively
- Acquire resources
- Conduct field sampling
- Ensure legislative compliance
- Process and analyze results
- Report results and progress in various formats
- Manage data
- Ensure safety
- Communicate, share information, and receive feedback
- Collaborate and develop relationships
- Strive for continuous improvement

CAMP supports Water Power Act licensing, and a Working Group composed of individuals from Manitoba Hydro and Manitoba Sustainable Development directs the program. Smaller subcommittees, with subject matter experts from Manitoba Hydro, Manitoba Sustainable Development, Fisheries and Oceans Canada, Environment and Climate Change Canada, environmental consultants, and other research scientists, are also brought together occasionally to address specific topics and issues. Day to day administration, budgeting, and management of the program are conducted by Manitoba Hydro (Environmental Licensing and Protection Department) and Manitoba Fisheries staff. Monitoring activities (i.e., data collection and fieldwork) are performed by Manitoba Hydro – Hydraulic Operations Department, Fisheries and Water Quality Management staff from Manitoba Sustainable Development, and North/South Consultants Inc (on behalf of Manitoba Hydro). The Lake Winnipeg Research Consortium, performs CAMP water quality sampling in a few locations in the north basin of Lake Winnipeg from their large research vessel, the *Namao*.

More detailed information about the program, sampling parameters, monitoring sites, and results can be found on the website at www.campmb.com.



3.1 Working Group

On March 31, 2017, a draft workplan for the 2017/18 program was presented to the MOU Working Group, which is the oversight committee identified in the MOU. Items that were presented and discussed at the meeting include:

- Review of the 2016/17 CAMP;
- Update on CAMP reporting and data management (i.e., updates on the 6-Year Report, the Data Integration Strategy, website, plain language documents);
- Presentation and discussion of proposed 2017/18 CAMP workplan (i.e., addition of two water quality sites in Lake Winnipeg (W22 and Mossy Bay), sedimentation and erosion, habitat mapping in Cedar Lake, addition of sauger to the standard list of fish sampled, zebra mussel sampling assistance for Manitoba Sustainable Development);
- Update on community dialogue efforts; and
- North/South Consultants' contract expiry on March 31, 2018 and the need to establish a new consulting agreement for ecological monitoring.

The Working Group members raised no significant concerns or issues and the 2017/18 workplan was subsequently accepted as presented. A summary of CAMP meetings is provided in Appendix 3.

3.2 Subcommittee Update

There were no specific technical subcommittee meetings during 2017/18 except for a meeting held at Grand Rapids between Manitoba Hydro and Regional Fisheries Managers from Manitoba Sustainable Development to discuss key points, results, and highlights for the 6-Year Summary Report.

3.3 Annual Workshop

Usually one annual CAMP workshop is held with approximately 30 people representing federal and provincial agencies, private consultants, research groups, and Manitoba Hydro staff. The intent of the workshop is to disseminate information related to CAMP activities and receive feedback on future directions. This year, the workshop, held on November 16, 2017, was extended to a broader audience than in the past, with the goal of increasing awareness of the program. Invitees included the usual organizations as well as members of the Clean Environment Commission, academics, consultants, advisors, and community members. Basic information about CAMP, as well as results and recent developments, were presented during the meeting. Valuable feedback was received from the audience and included: increasing the availability of plain language documents of results for the public and communities, providing more frequent updates of results, and a high interest in obtaining CAMP data (which is publicly available) for individual research purposes.



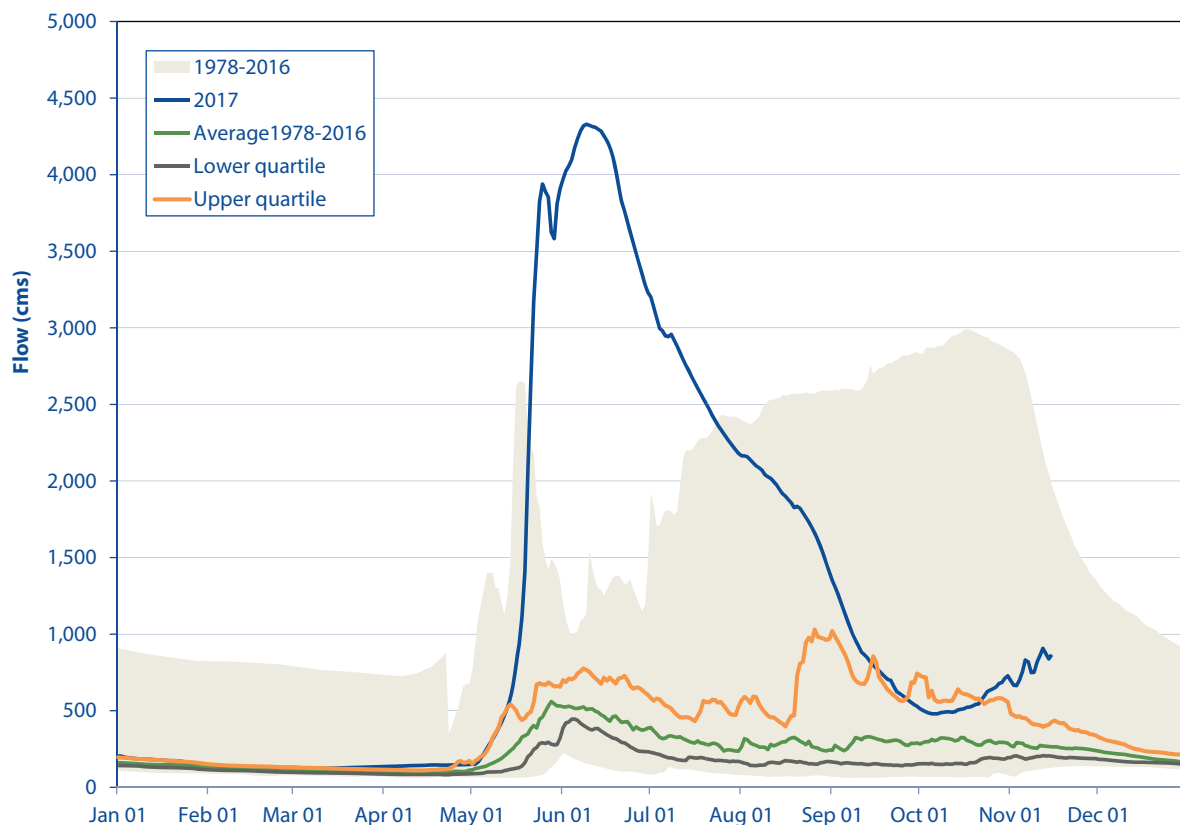
4.0 Ecosystem Monitoring

A total of 31 waterbodies or riverine reaches (22 on-system and 9 off-system) were sampled for water quality, sediment quality, benthic macroinvertebrates (BMI), and fish community during the 2017/18 monitoring period (Appendix 2). In addition, water quality was sampled at the outlets of Lake Winnipeg (Two-Mile Channel and the upper Nelson River near Warren Landing). Mercury in fish monitoring was conducted at five waterbodies, including two lakes (Leftrook and Threepoint lakes) that are monitored annually, in 2017/18. Aquatic habitat (bathymetry and substrate type) surveys were completed for Cedar Lake.

4.1 Changes

There were no substantive changes, and no new waterbodies added to the CAMP program. While no new waterbodies were added to the CAMP program in 2017/18, water quality was monitored at two new sites (one site at Big Mossy Point and a second site near the Nelson River outflow) in the north basin of Lake Winnipeg in spring, summer and fall. Extremely high water flows in the Churchill River system were encountered during the spring and summer of 2017. The high flows on the Churchill River affected some sampling, as sites could not be safely accessed. To deal with the high flows, alternative sites were chosen or some were avoided altogether. Parameters that were affected are noted in the specific sections below.

CAMP provided assistance to Manitoba Sustainable Development to collect Aquatic Invasive Species (AIS) samples. Targeted AIS sampling is not a standard CAMP monitoring



Hydrograph of the lower Churchill River showing high flows in summer 2017



parameter; however, the collection of samples in the field was accommodated during the standard CAMP monitoring program. Conducting this work is an efficient and cost-saving activity that complements the existing provincial AIS monitoring program. As such, sampling of zebra mussel veligers (i.e., microscopic larvae) was conducted during the CAMP benthic macroinvertebrate (BMI) field program at Cormorant Lake, Lake Winnipegosis, Lake Winnipeg (Mossy Bay), Threepoint Lake, Pine Falls Forebay, and Lac du Bonnet.

As in previous years, spiny waterfleas (another AIS) were incidentally collected again at Pointe du Bois and Lake Winnipeg (Mossy Bay). In 2017, a small number of spiny waterfleas were also found in CAMP samples collected at Lake Winnipeg (Grand Rapids), which is a new finding.

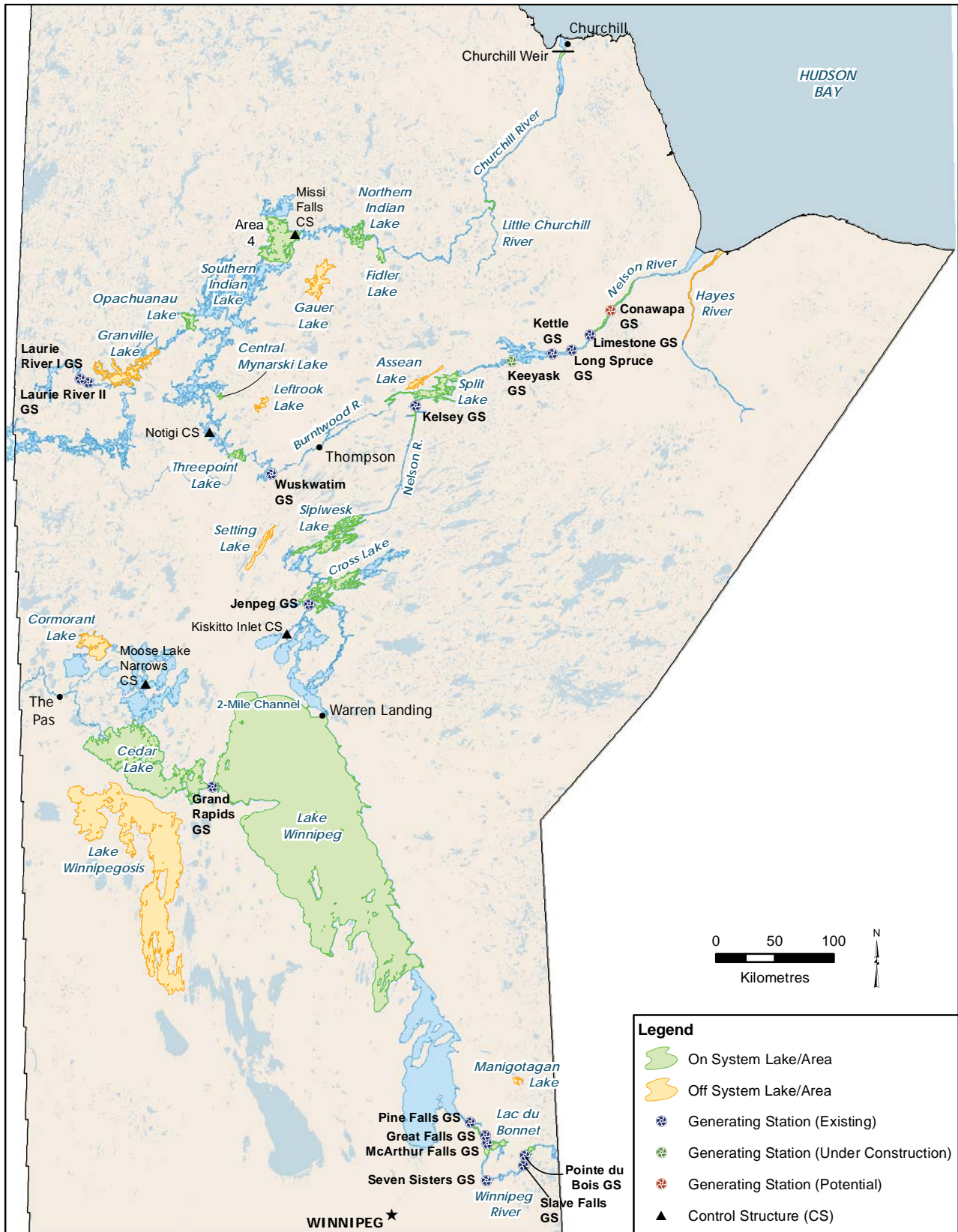
The Physical Environment sedimentation program broadened from a lake-based program to a system-wide program with continuous monitoring samplers at six locations. More details on the Physical Environment Program can be found in Section 4.9.



Churchill River at the Little Churchill River in spring 2016



Churchill River at the Little Churchill River in spring 2017



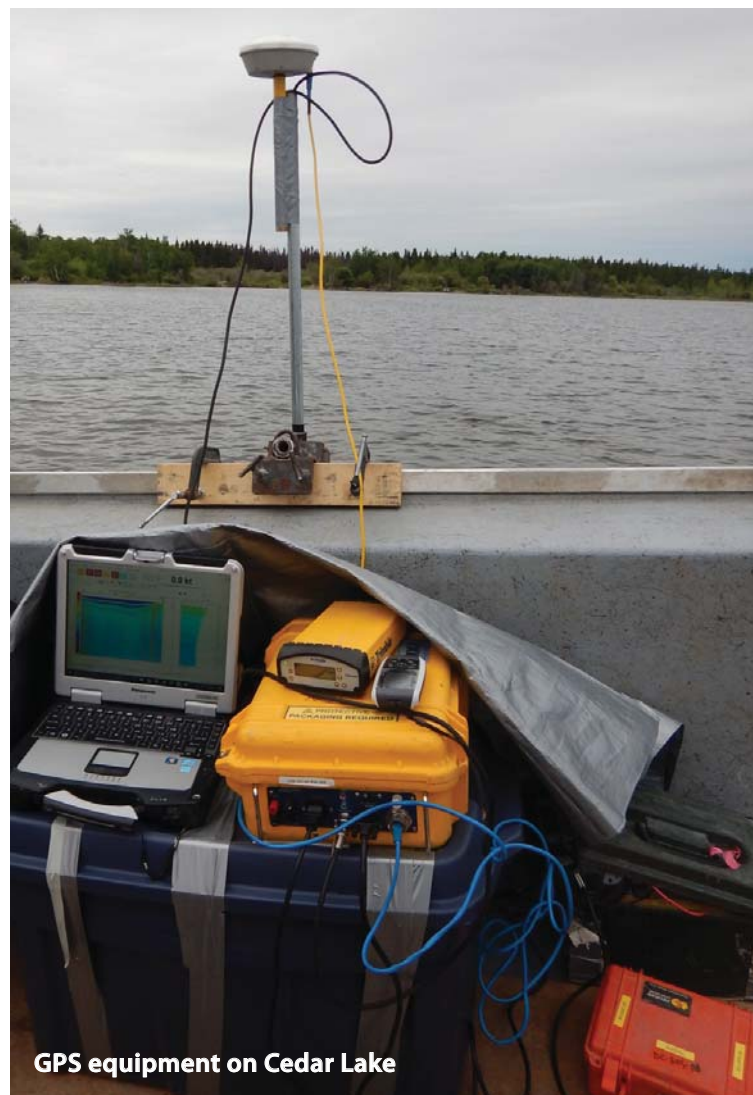
On and Off System 2017/2018 Sampling Areas



4.2 Aquatic Habitat

Characterizing the aquatic habitat of a waterbody helps inform our understanding of the ecosystem monitoring data collected on fish and invertebrates. CAMP aquatic habitat surveys are done using boat based hydroacoustic equipment to produce lake bathymetry and substrate/bottom typing. Surveys are conducted each year in a different waterbody as budget and opportunity permits. This has allowed CAMP to build an inventory of maps over time that will assist with the interpretation of monitoring results. An aquatic habitat survey was completed in a portion of Cedar Lake in spring 2016. In 2017, the habitat survey of Cedar Lake was expanded. The program was completed as planned and data from the two years of the survey were combined to produce maps of substrate and water depth.

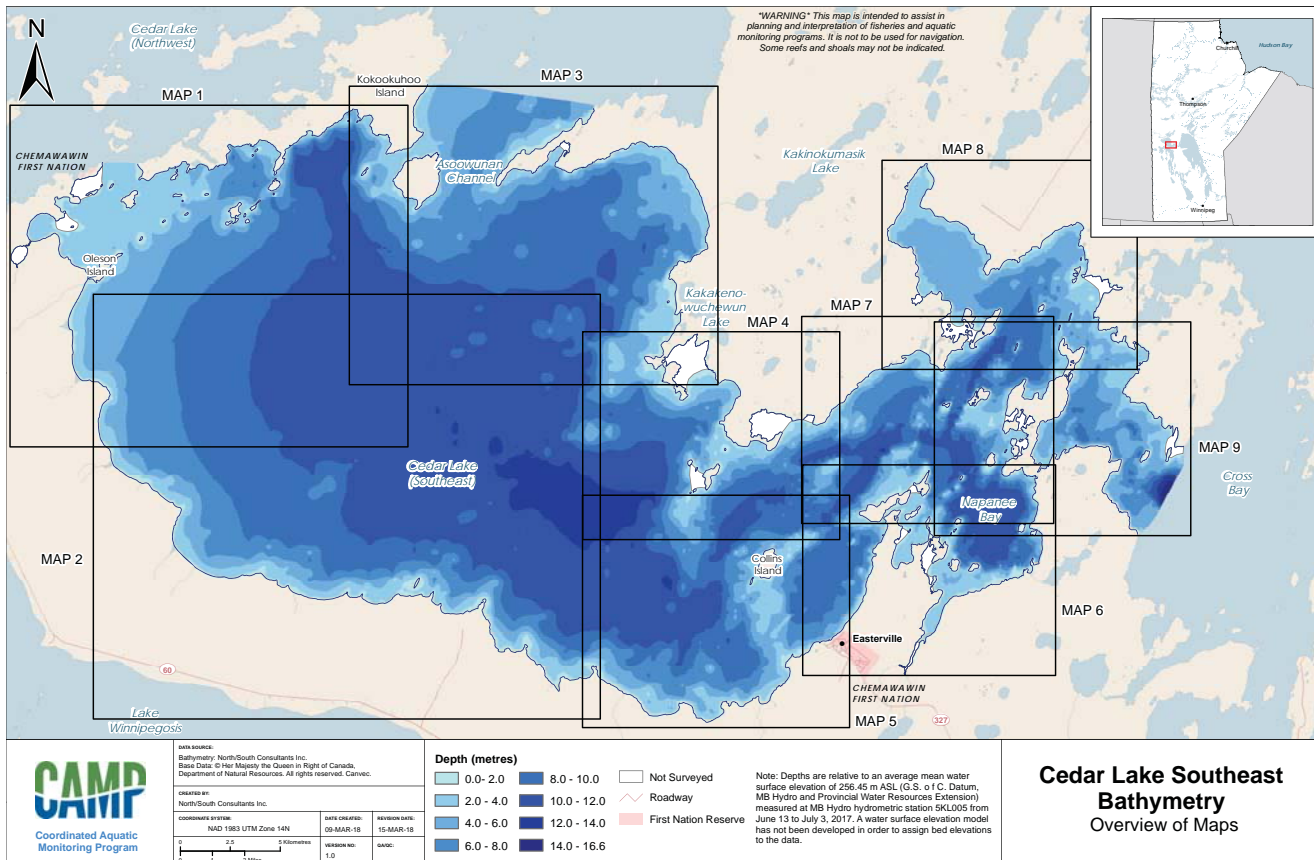
Aquatic habitat maps are available for the following waterbodies: Apussigamasi Lake; Assean Lake; Billard Lake; Cross Lake; Playgreen Lake; South Moose Lake; Southern Indian Lake; Split Lake; Threepoint Lake and Northern Indian Lake.



GPS equipment on Cedar Lake



Aerial Photo of Cedar Lake west



Cedar Lake bathymetry map

4.3 Water Quality

Water quality is sampled four times a year in CAMP annual and rotational water bodies. Three samples are collected during the open-water season (spring, summer, fall) and one



is conducted during winter, under ice-cover conditions. Over 50 parameters are analyzed in the water quality samples through in-situ or lab analysis. With a few exceptions, water quality sampling was completed at all sites as planned in 2017/18. Exceptions included the lack of sampling in spring at Lower Churchill River at the Little Churchill River and sampling at an alternate site at the lower Nelson River downstream of the Limestone Generating Station due

to high water levels and flows. Two new sites were added to CAMP in 2017, both in the north basin of Lake Winnipeg: one site at Big Mossy Point, and one site near the Nelson River outflow (Site 22).

Collecting representative samples in the Lake Winnipeg outlet area (i.e., Warren Landing and 2-Mile Channel) were challenging due to turbidity plumes from eroding shorelines (i.e., water at the outlets is not always well mixed). Sampling within the sediment plume versus outside the sediment plume will provide vastly different results. Although both conditions represent the outflow of Lake Winnipeg, it is difficult to characterize conditions in one sample or even an average of several samples from these two locations; both represent different water quality conditions that are simultaneously present.

4.4 Sediment Quality

Sediment quality is collected annually at one site at Grand Rapids by the *Namao* as part of Lake Winnipeg monitoring and rotationally at 21 sites every 6 years (Appendix 2); 2017 represented one of those sampling rotation years. Sediment quality is monitored at the same locations as the water quality sites with the exception of the site on Lake Winnipegosis, which is located near the BMI monitoring site. A new site was established at Big Mossy Point on Lake Winnipeg to match the new water quality site there. A sediment quality sample could not be collected from the lower Churchill River at the Little Churchill River due to high flows and velocities in 2017.



4.5 Benthic Macroinvertebrates

Benthic macroinvertebrates (BMI) (i.e., bugs in the sediment) are often used as indicators of ecosystem health as they are a food source (i.e., lower trophic level) for organisms higher up the food web, such as fish. As well, they are relatively sedentary and susceptible to environmental changes and can reveal trends that may be occurring.

Benthic macroinvertebrate sampling was not conducted at the lower Churchill River's Little Churchill River site because of high water levels and flows at the time of sampling. Benthic macroinvertebrate sampling was completed, as planned, at all other sites; however, additional time and effort were required during sampling, compared to previous years, to comply with AIS regulations (e.g. decontamination of gear).

The offshore BMI sampling at Grand Rapids on Lake Winnipeg revealed a new finding for that site: 10 spiny waterfleas (which are listed as Aquatic Invasive Species) were found and Manitoba Sustainable Development was notified.

BMI samples were sorted and analyzed in the laboratory over the winter.



Mayfly Nymph, a common insect in the BMI monitoring



Spiny waterflea, an aquatic invasive species



4.6 Phytoplankton

Phytoplankton are microscopic, plant-like organisms in the water column that make up the base of the food web (i.e., they are primary producers). They are an important food source and using photosynthesis they produce oxygen in the aquatic environment. An over-abundance of phytoplankton (called blooms, which can occur when nutrients are plentiful) can be detrimental to the environment as when they die and sink to the bottom their decomposition depletes oxygen and affects benthic invertebrates and fish in the area. Some algae also (e.g. blue-green algae) produce toxins. Sampling for phytoplankton helps us understand how the base of the food web is performing and how nutrient levels in the water are affecting the ecosystem.

Samples for phytoplankton analysis (i.e., community composition and biomass) were collected from all sites during the open-water and ice-cover season; samples from the four routine annual monitoring sites (Cross, Setting, Split and Assean lakes) were submitted for analysis as planned. Samples from three of the four sites in the Winnipeg River Region (Pointe du Bois forebay, Lac du Bonnet, and Manigotagan Lake) and one site in the Saskatchewan River Region (Cedar Lake – west) were also submitted for bloom monitoring in spring, as chlorophyll a concentrations exceeded the trigger of 10 µg/L. Algal bloom monitoring was also completed for Cedar Lake – southeast, one site (Site 22) in the north basin of Lake Winnipeg, and the outlet of Two-Mile Channel in summer. In fall, bloom monitoring occurred for both sites on Cedar Lake, two sites in the Churchill River Diversion Region (Leftrook and Central Mynarski lakes), and one site (near Big Mossy Point) in the north basin of Lake Winnipeg.



Water quality and phytoplankton sampling on Manigotagan Lake

4.7 Fish Community

Fish community sampling is conducted once per year at annual sites and once every three years at rotational sites. The intent of the analysis is to assess fish abundance and fish community diversity, and to collect information on fish condition and growth (e.g., length, weight, age, condition, etc.). As part of this, ageing structures are collected for target species (i.e., walleye, northern pike, lake whitefish, and sauger, and on any incidental lake sturgeon mortalities). Otoliths (ear bones) or cleithra (jaw bones) are collected and analyzed for age in a way similar to counting tree rings. Knowing the age and abundance of that age class provides insights into the condition of fish populations and the growth of younger fish into spawning stock.



Walleye otolith (ear bone) used for ageing

Fish community sampling was completed at almost all locations and sites as planned. High water levels and flows in the Churchill River affected sampling somewhat in the lower Churchill River at the Little Churchill River location during August as the amount of debris in the river was fairly high. By the time sampling was conducted in the Churchill River at the weir in September, water levels and flows had receded sufficiently that debris levels did not affect sampling appreciably. However, fish catches at this location were affected by several Harbour Seals that were in the vicinity and were feeding off the catch in the nets.

Sampling was also not undertaken at Cedar Lake – west and was instead completed at South Moose Lake in the Saskatchewan River Region. In addition, a few sites were not sampled as intended in Lac du Bonnet (10 out of 12 sites were sampled; while two were missed due to motor issues) and Lake Winnipegosis (8 of 12 sites were visited and four were missed due to weather and staffing shortages). As with other program components, additional time and effort (and sequence changes) were required for AIS decontamination.

The Manitoba Sustainable Development (NE Region) fish sex and maturity monitoring protocol was revised and is now a stand-alone document.

Fish ageing structures were collected during fish community sampling; those ageing structures were analyzed in the lab over the winter.



Gill netting on Pointe du Bois forebay

4.8 Mercury in Fish

Mercury in fish is monitored in CAMP waterbodies every three years, except for two sites that are monitored annually (Threepoint and Leftrook lakes). Fish tissue samples (i.e., muscle) were collected during fish community monitoring at each of the four waterbodies that were scheduled to be sampled in 2017 (Threepoint, Leftrook and Sipiwesk lakes and the lower Churchill River at the Churchill Weir). Sampling was also undertaken at Cedar Lake – southeast in 2017 as sampling was not completed at this site in 2016, as previously scheduled. Although not scheduled to occur in 2016/17, mercury samples were also collected from Cormorant Lake; the Cormorant Lake site is a rotational site and was scheduled for mercury monitoring in 2019/20. The samples that were collected will not be wasted and will be analyzed in 2018/19. The regular monitoring schedule on Cormorant Lake will resume in 2019/20.



After collection, mercury samples were analyzed over the winter in the laboratory. Communities have expressed an interest in the CAMP mercury results and would like to receive data more quickly than the three-year reports. This is valuable feedback and we are striving to make data available more quickly. The implementation of the ArcGIS Online platform will help alleviate this concern.



4.9 Physical Environment

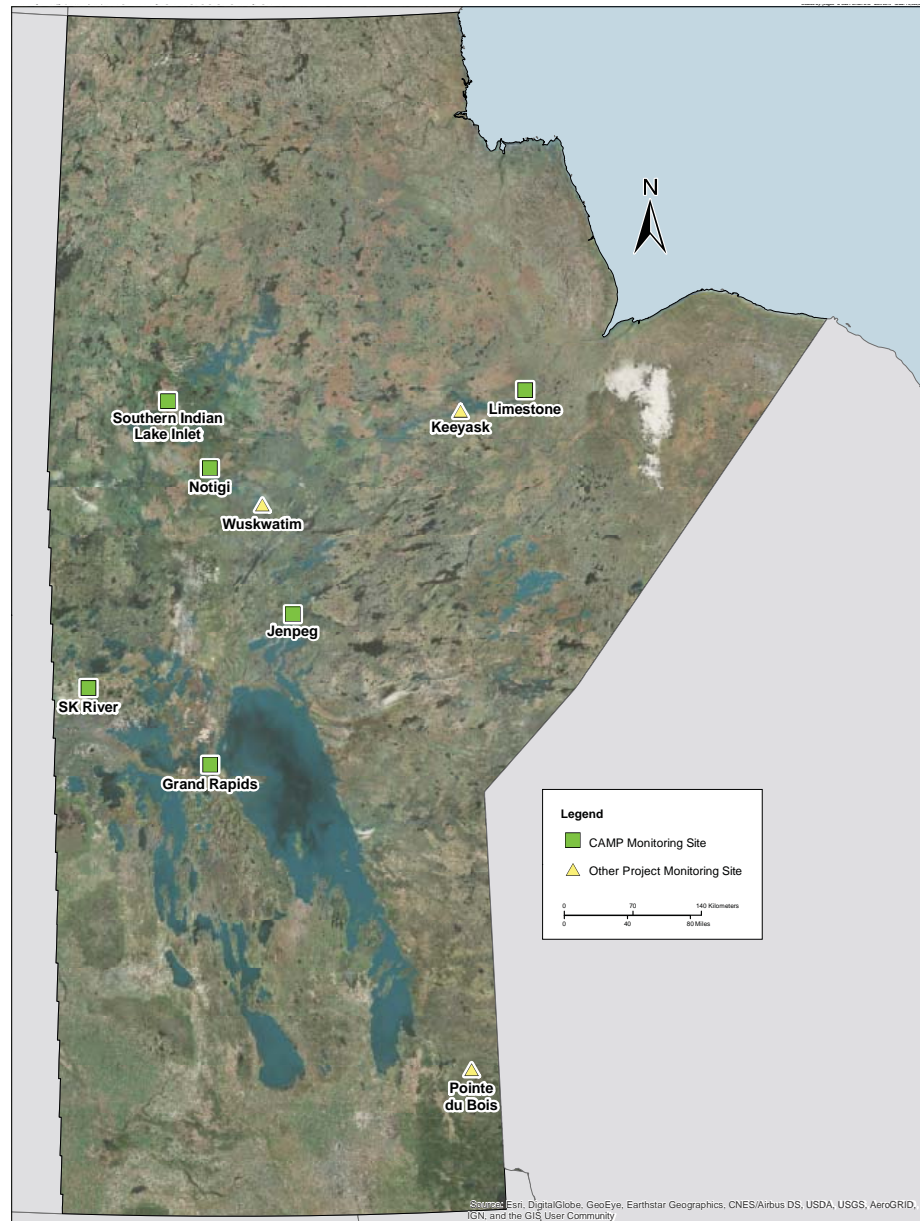
4.9.1 Sedimentation Monitoring

System-wide sedimentation monitoring began in 2017. The adjacent figure illustrates where six continuous water-quality monitoring stations were installed during the open-water season at the following sites:

- Limestone Generating Station forebay
- Inlet of Southern Indian Lake (upper Churchill River)
- Notigi forebay
- Jenpeg Generating Station forebay
- Saskatchewan River near The Pas
- Grand Rapids Generating Station forebay

Monitoring at each site includes near continuous monitoring of turbidity, temperature, dissolved oxygen and conductivity and monthly site visits to maintain the monitoring equipment and collect water samples for laboratory testing of total suspended solids (TSS). The data will be used to understand temporal changes in turbidity and by proxy suspended sediment concentration and using a turbidity – TSS relationship an estimation of the sediment load.

Early results from this monitoring show a strong correlation between turbidity (i.e., sediment plumes) and wind events. Wind appears to be a stronger factor in causing sedimentation than river flows or water levels, particularly on the Burntwood and Nelson River systems. As monitoring continues, investigations will continue to determine if this is the case across the system or only applies to particular areas.



Sedimentation monitoring sites

Prior to 2017, monitoring programs were conducted in Playgreen Lake in 2013, Southern Indian Lake in 2014 and 2015, and the length of the upper Nelson River in 2016 to gain an understanding of the environment in these areas. CAMP also shares data from other Physical Environment monitoring programs associated with Wuskwatim, Pointe du Bois, and Keeyask to help understand sediment transport across the system. The information from all of these programs has been instrumental in developing the continuous monitoring and remote sensing capabilities.

Monitoring equipment has been installed inside the Jenpeg and Limestone generating stations as test sites for some water quality parameters (turbidity, temperature, dissolved oxygen and conductivity). Results within the stations will be compared with results collected in the rivers to determine if results are similar. Installing equipment within the generating stations would be favourable for a few reasons – the sites are more accessible than equipment in the river, it's safer, and it allows monitoring during the shoulder seasons (i.e., before ice on and after ice off). Results will continue to be evaluated to determine the feasibility of moving continuous monitoring out of the rivers and into the stations. Preliminary results show strong correlations between the river sites and the stations sites. Future plans include testing more sites for monitoring raw water within stations.

The continuous monitoring provides an opportunity for potential major future enhancements to the water quality program by monitoring key parameters such as nutrients and algae continuously.



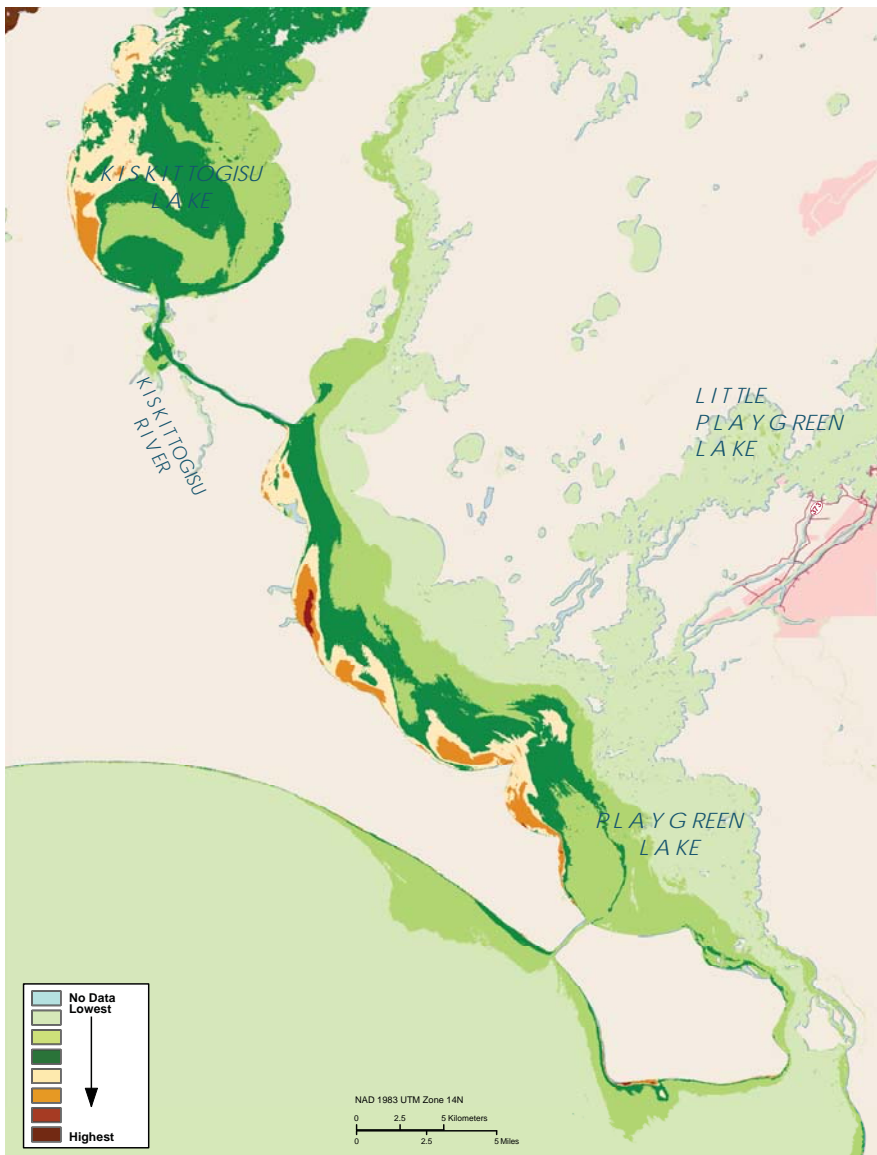
Water quality meter recently installed in the Jenpeg Generating Station

4.9.2 Remote Sensing

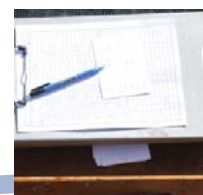
Several years ago, the Working Group identified the benefits of using remote sensing information to enhance CAMP monitoring. Since then, work has continued to bring the pieces together to be able to apply remote sensing information to the program. CAMP physical environment monitoring has started using remote sensing imagery to develop large scale water body maps of generalized sedimentation levels. Mathematical relationships have been developed that correlate image colour bands from satellites (i.e., LandSat, Sentinel) with observed levels of suspended sediment in the water. The relationships relied on the CAMP data collected in Playgreen Lake and Southern Indian Lake in 2013 to 2015, along with data from the Wuskwatim Generating Station project. These projects were initiated with the specific intent of developing and validating a model to interpret remote sensing.

A challenge in developing these relationships is having sufficient field data to correlate with available satellite imagery.

By combining the imagery and mathematical models, estimates of Total Suspended Solids (TSS) can now be made for some waterbodies. The mathematical algorithms continue to be refined as data are collected because different waterbodies have different TSS structures and properties; this results in different imagery reflections and colour presentation. Relationships for remote sensing have been developed for the Lower Nelson River and Burntwood River/Wuskwatim Lake. Split Lake has been mapped but different bodies of water converge (Burntwood and upper Nelson River) and therefore more than one relationship would be needed to cover the different "packages" of water throughout the lake.



Remote sensing satellite imagery showing TSS levels



4.10 Sediment Coring In Southern Indian Lake

Occasionally, CAMP undertakes research projects outside of the regular monitoring program. This year we were able to analyze one of the sediment cores that was collected in Southern Indian Lake during the previous winter (March 2017). The cores were collected and analyzed by experts at the Institute of Environmental Change and Society at the University of Regina and J.D. Mollard and Associates (2010) limited.

Three cores were collected from which one core was chosen for multi-proxy analyses, with the objective of demonstrating how the use of the multiple fossil proxies can improve understanding of the historical changes in Southern Indian Lake during the past 50 years, and to comment on how these data can be used to interpret changes in the north basin for a period spanning the pre- and post Churchill River Diversion transition to the present.

Overall, the different biological proxies analyzed from the single core were consistent in showing a decline in littoral (i.e., light-penetrating) habitats after impoundment. The authors noted that Southern Indian Lake is a large lake with several distinct basins and caution should be exerted in using the data from this single core to be a definitive statement on changes to the aquatic habitat of the entire lake. Additional testing of the other two cores may be done in the future.

Information about the coring program was presented at the Southern Indian Lake Environmental Steering Committee meeting (June 21, 2017) and the fall CAMP workshop (November 17, 2017) (Appendix 4). The coring report is available on the CAMP website at <http://www.campmb.com/reports/>.



Sediment coring in Southern Indian Lake

5.0 Communications

Increasing awareness of CAMP with communities and the sharing of information and results have become a top priority for the program. The program has evolved from successfully establishing the technical parameters of the program into needing to more effectively communicate the data and value of the program. CAMP data and information have been shared in several venues and formats and we are continuing to work to provide plain language documents and materials that are accessible to wider audiences.

5.1 Community Meetings

Consistent with every year to date, CAMP representatives from Manitoba Sustainable Development presented and discussed CAMP at a variety of community meetings in 2017/18. Communications focused on program updates, monitoring locations, and preliminary results of the 6-Year Report. A list of these community meetings is provided in Appendix 4.

5.2 Reporting

The Six-Year Technical Reports for each CAMP sampling region from 2008 to early 2014 of the Program have been completed. The reports reviewed all the data from that period and identified trends in key aquatic indicators. A Plain Language Summary document of the 6-Year Report is currently being prepared, which follows a "Pathways of Effects" format. Once the summary report is complete, the International Institute for Sustainable Development - Experimental Lakes Area (IISD-ELA) will be asked to review the summary and technical reports to build on the established program and to identify ecological trends and hypotheses that they think could be considered in the future.

The CAMP website (www.campmb.com) will continue to be updated with data as it is collected, and made available to the public. Reports, posters and other news are also being added, as available.

5.3 Data Sharing

Requests for CAMP data continue to be received from the public. Eight requests for data were received in 2017/18, and included universities, Indigenous communities, students, and consultants. Currently, data must be manually extracted from the database and forwarded to the requester. To streamline this process and make the data more accessible, we are working on implementing a map-based interface on the website (i.e., ArcGIS Online).

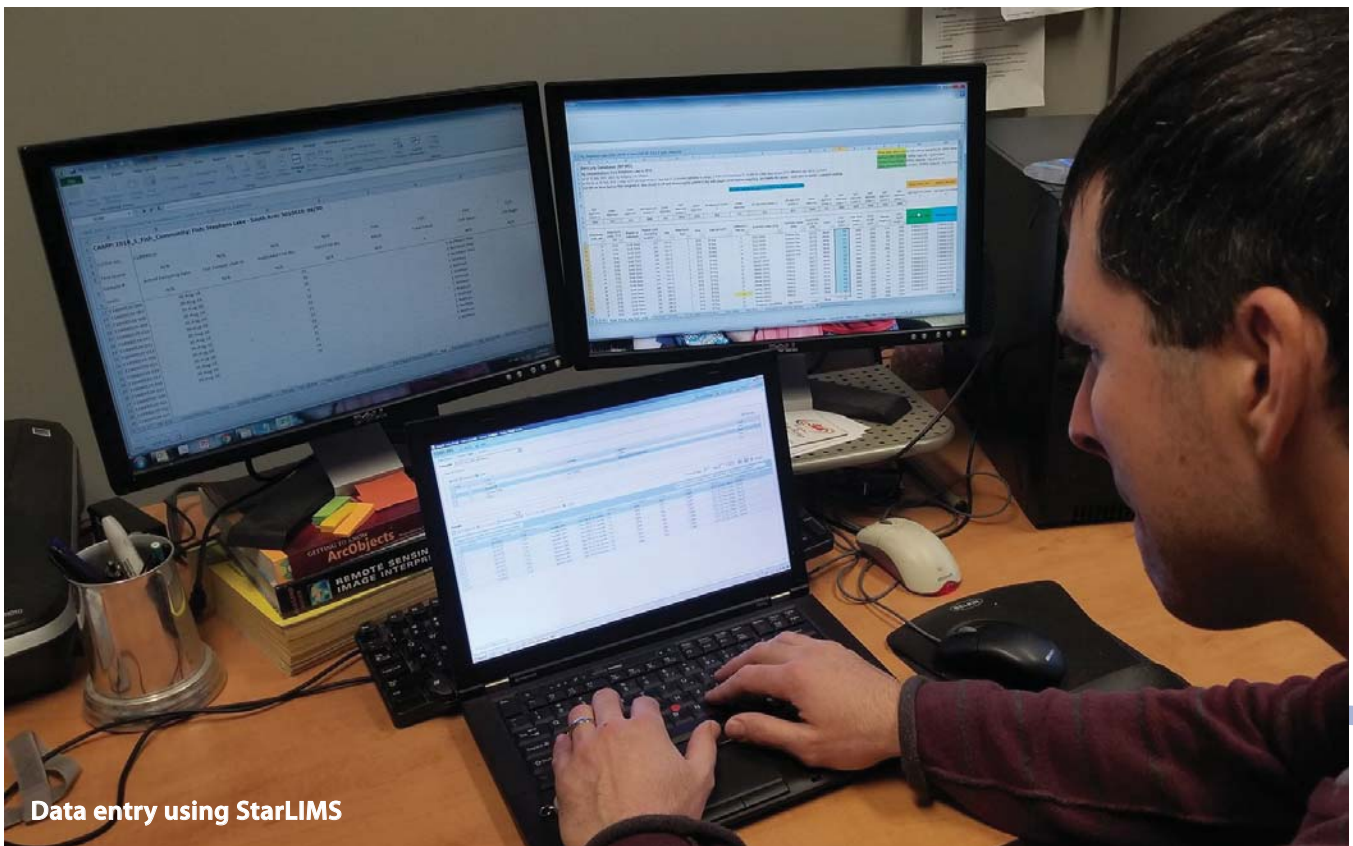


6.0 Data Management

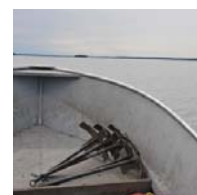
The first year of using StarLIMS (EnvIS-LIMS) for managing CAMP sample collection, lab results and data review, is now coming to a close with most of the system bugs and workflow issues resolved. Using StarLIMS increases data integrity and streamlines workflows with the laboratories.

The CAMP data integration strategy is now underway with the implementation of ArcGIS Online (AGOL). AGOL provides the interactive map based platform for the sharing of CAMP-related data sets from various sources such as biological/chemistry data from EnvIS and EnvIS-LIMS, water level data, and erosion and sediment data as a cloud/web-based service. This data sharing and data collaboration environment can also be used for implementing data surveys, which can be leveraged for citizen science initiatives.

The 2017 CAMP website charting updates will be completed once the 2017 data reviews are completed in EnvIS-LIMS. These updates will be done on an annual basis. The charting data is managed with the use of data templates populated by North-South Consultants, which are then loaded to the CAMP website database by Manitoba Hydro. Loading new data to the website database dynamically updates the charts on the website. Further updates to some of the charts are being evaluated.



Data entry using StarLIMS





Sediment Coring Expedition on Southern Indian Lake

7.0 Emerging Items

7.1 Sediment and Erosion Monitoring

The sediment and erosion monitoring program has been evolving and a “shoreline health” component for CAMP is being considered that would include erosion monitoring and help address CAMP’s program objectives. Shoreline erosion monitoring will likely use remote sensing to better assess broad areas for larger-scale erosion.

7.2 Aquatic Ecosystem Data Collection Contract

The aquatic ecosystem data collection contract that was held by North/South Consultants Inc. expired on March 31, 2018. Three proposals for the upcoming monitoring term were received and reviewed. North/South Consultants Inc. was the successful vendor and was awarded the next monitoring contract.





8.0 Conclusion

CAMP has grown and evolved with the direction and assistance of regulatory agencies' managers and scientists, as well as academia. It is now quite stable and is moving towards enhanced communications as a focus. Plain language documents, website updates, public meetings and more accessible data are a few of the ways that the Working Group is making CAMP information more available. The value of the program continues to increase as data are acquired; however, the true benefit lies in use of the data to promote a better understanding of the environmental impacts of providing hydroelectricity.

The future intention for CAMP is to continue to inform and support decision making processes at various levels. The information will continue to be used for Water Power Act licensing processes, as well as for the assessment of other smaller site maintenance and repair activities. Regulators use the information to identify licencing / operational constraints and to support their ongoing management activities by having a better understanding of hydroelectric environmental impacts. As well, CAMP is structured so that data will support future provincial broad-area or watershed planning in Manitoba Hydro's system.

Overall, CAMP is a positive, high-profile program that benefits both Manitoba and Manitoba Hydro. CAMP is expected to continue to grow in utility and contribute to the reputational benefit for both organizations in the coming years.



6.0 Appendices

Appendix 1: Memorandum of Understanding

Memorandum of Understanding about Program of LWR/CRD Monitoring Activities, dated October 16 , 2006.

The Government of Manitoba and Manitoba Hydro are committed to work together on matters relating to monitoring of hydrometric (water level and stream flow) and environmental data in certain areas in the Lake Winnipeg Regulation and Churchill River Diversion system.

Manitoba and Manitoba Hydro have the common objective of developing a program of activities (“the activities”), building on the existing monitoring program of Manitoba Hydro, that would provide objective information about hydrometric and environmental effects of hydro-electric development on agreed rivers and lakes comprising the Lake Winnipeg Regulation and Churchill River Diversion systems (“the system”). The information from the activities could be of benefit to Manitoba, Manitoba Hydro and other interested parties, including communities in the area of the Lake Winnipeg Regulation/Churchill River Diversion project. Objectives of the program of activities would include:

- (a) assisting in evaluating whether and to what extent the water regime in areas of the system is or will be affected by the addition of additional hydro-electric facilities;
- (b) assisting in identifying adverse effects and positive effects resulting from effects on the water regime; and
- (c) assisting in considering measures that may be undertaken to address any identified adverse effects.

Manitoba and Manitoba Hydro may establish additional objectives of the activities.

Manitoba and Manitoba Hydro recognize that Manitoba Hydro has made commitments to monitoring and follow up programs as part of the environmental licensing process for the Wuskwatim Generating Station. These commitments will be considered in developing the activities.

The program of activities will be reviewed each year and annual workplans will be developed by Manitoba and Manitoba Hydro to assist in achieving the program of activities. The agreed workplan for the fiscal year ending March 31, 2007 is attached as Appendix A to this Memorandum.

Manitoba and Manitoba Hydro will consider methods of making information from the activities available to interested parties.



It is intended that the nature and scope of activities will be developed starting in Fiscal Year 2006-07 (starting April 1, 2006) and will continue until Manitoba and Manitoba Hydro agree to no longer proceed with a program of activities.

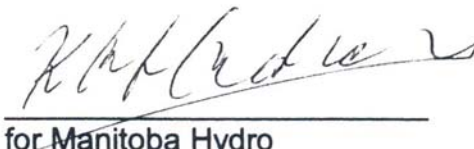
As part of the development of the annual program of activities, Manitoba and Manitoba Hydro will consider the resources each will provide in order to carry out the activities

It is intended that Manitoba and Manitoba Hydro personnel will prepare an Annual Report to be delivered to the Minister of Water Stewardship and the Minister of Conservation, on behalf of Manitoba and to the President and CEO of Manitoba Hydro. Additional reports may be prepared as Manitoba and Manitoba Hydro determine to be appropriate. The Annual Report may include:

- a description of the activities for that year;
- a description of any information determined as a result of the activities;
- information about any circumstances where water levels or flows were outside of ranges provided for in licences;
- methods of making the information available to interested parties and to the public;
- any other matters that are considered appropriate. It is expected that Manitoba and Manitoba Hydro will make the Annual Reports available to the public.

Manitoba and Manitoba Hydro may amend this Memorandum from time to time by further Memorandum.


for Manitoba


for Manitoba Hydro

Oct. 16, 2006
Date

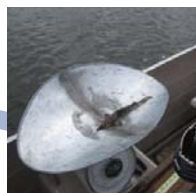
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Appendix 2: 2017/18 CAMP Sampling Schedule

Region	Site	On-system	Off-system	Fish Community
Winnipeg River	Pointe du Bois Forebay	X		Annual
	Lac du Bonnet	X		Annual
	Manigotagan Lake		X	Annual
	Pine Falls Forebay	X		17/18 & 20/21
Saskatchewan River	Cedar Lake - southeast	X		Annual
	Cormorant Lake		X	Annual
	Cedar Lake - west	X		17/18 & 20/21
Lake Winnipeg	Lake Winnipeg - Mossy Bay	X		Annual
	Lake Winnipeg - Grand Rapids	X		Annual
	Lake Winnipeg - Sturgeon Bay	X		Annual
	Lake Winnipeg - Big Mossy Point	X		
	Lake Winnipeg - Site 22	X		
	Lake Winnipegosis		X	Annual
Upper Churchill River	Southern Indian Lake (Area 4)	X		Annual
	Granville Lake		X	Annual
	Opachuanau Lake	X		17/18 & 20/21
Lower Churchill River	Northern Indian Lake	X		Annual
	Churchill R. at Little Churchill R.	X		Annual
	Gauer Lake		X	Annual
	Fidler Lake	X		17/18 & 20/21
	Lower Churchill R. at Churchill Weir	X		17/18 & 20/21
Churchill River Diversion	Threepoint Lake	X		Annual
	Leftrook Lake		X	Annual
	Central Mynarski Lake	X		17/18 & 20/21
Upper Nelson River	Cross Lake - West basin	X		Annual
	Setting Lake		X	Annual
	Sipiwesk Lake	X		17/18 & 20/21
	Nelson River: d/s Sipiwesk Lake to Kelsey GS	X		17/18 & 20/21
	2-Mile Channel	X		
	Warren Landing	X		
Lower Nelson River	Split Lake	X		Annual
	Assean Lake		X	Annual
	Nelson R. Mainstem - d/s Limestone GS	X		Annual
	Hayes River		X	Annual
	Burntwood River - First Rapids to Split Lake	X		17/18 & 20/21

Sampling conducted by **MSD - Water Quality Section**, **MSD - Fisheries Branch**, and **Consultants**



Water Quality	Benthic Invertebrate	Hg in Fish	Sediment Quality	Phytoplankton Community
Annual	Annual		17/18	
Annual	Annual		17/18	
Annual	Annual		17/18	
17/18 & 20/21	17/18 & 20/21			
Annual	Annual	17/18	17/18	
Annual	Annual		17/18	
17/18 & 20/21	17/18 & 20/21			
	Annual			
Annual (site W2)	Annual		Annual (site W2)	
Annual			17/18	
Annual				
Annual	Annual		17/18	
Annual	Annual		17/18	
Annual	Annual		17/18	
17/18 & 20/21	17/18 & 20/21			
Annual	Annual		17/18	
Annual	Annual		17/18	
Annual	Annual		17/18	
17/18 & 20/21	17/18 & 20/21			
17/18 & 20/21	17/18 & 20/21	17/18 & 20/21		
Annual	Annual	Annual	17/18	
Annual	Annual	Annual	17/18	
17/18 & 20/21	17/18 & 20/21			
Annual	Annual		17/18	Annual
Annual	Annual		17/18	Annual
17/18 & 20/21	17/18 & 20/21	17/18 & 20/21		
17/18 & 20/21	17/18 & 20/21			
Annual				
Annual				
Annual	Annual		17/18	Annual
Annual	Annual		17/18	Annual
Annual	Annual		17/18	
Annual	Annual	1	17/18	
Annual	17/18 & 20/21		17/18	



Appendix 3: Summary of 2017/18 CAMP Meetings

Spring MOU Working Group Meeting – March 31, 2017

Objective: To review and endorse the 2017/18 workplan with the Working Group

Attendees: CAMP Working Group (members from Manitoba Sustainable Development and Manitoba Hydro)

AGENDA

- Review of 2016 Working Group meeting summary and action items
- Review the 2016/17 CAMP
 - Update on additional work completed – Southern Indian Lake coring
- Reporting Update and New Initiatives
 - 6-Year Report, IISD-ELA review
 - Data Integration Strategy & Website
 - CAMP logo/branding and standard templates
- Discussion of proposed 2017/18 CAMP work plan
 - Ecosystem Monitoring
 - Addition of water quality Site W22 & Mossy Bay (Lake Winnipeg)
 - Sediment and Erosion
 - Activities outside of the scheduled work:
 - Continuation of habitat mapping on Cedar Lake
 - Addition of sauger to the standard list of fish sampled
 - Zebra Mussel sampling
 - Update on the system-wide community dialogue

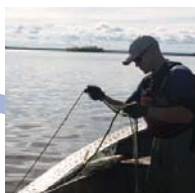
Subcommittee Meeting for Discussion of 6-Year Report

Objective: to review the technical information from the 6-year report and identify highlights and trends for the summary report.

Attendees: Fisheries Managers from Northern and Western Regions, Manitoba Hydro

AGENDA

- Review and discuss the CAMP 6-Year Synthesis Ecosystem Summaries (i.e., pathways of effects) for each of the eight regions



- Subject matter experts will critically assess hydraulic conditions for each region, physical environment characteristics, and likely effects on the aquatic environment (i.e., water quality, fish community, lower trophic, mercury).
- Compare the expected results with the information in the technical documents of the 6-year synthesis report

Annual Workshop – November 16, 2017

Objective: To increase awareness of the program and share CAMP progress and opportunities

Attendees: Manitoba Sustainable Development, Manitoba Hydro, Clean Environment Commission, Communities, Advisors, Consultants, Students, Academics

AGENDA

- CAMP Components and Progress
- Review of 2017 Aquatic Ecosystem Monitoring Field Season
- Update on Sedimentation Monitoring Program
- Sediment coring project in Southern Indian Lake
- Data Integration Strategy Update
- Overview of CAMP Data and Research Opportunities
- Forward Looking
- Open Discussion/
Feedback

In addition to the aforementioned meetings, regular administrative monthly meetings are held with CAMP participants from Manitoba Fisheries, Manitoba Water Stewardship, Manitoba Hydro, and consultants. The purpose of these meetings is to discuss day-to-day progress, planning, budget, and address any issues that arise.



Appendix 4: Community Meetings/Engagement Activities

This is the tenth year of CAMP and most communities and/or Resource Management Boards are aware of the program. Until the Six Year Report is ready, there is no specific material to distribute.

Community/Resource Management Board meetings were attended by Don Macdonald, Regional Fisheries Manager (unless otherwise noted):

April 25-26, 2016 - Sustainable Development NE Region: Regional Meeting

Meeting with Sustainable Development staff from communities throughout northern Manitoba. These staff live in the northern communities that CAMP focuses on. Described the CAMP Six Year Report and the plan to have it ready by summer, followed by the CAMP plain language summary by fall. Described the year's field programs, the collection of sediment cores from Southern Indian Lake and the use of remote sensing to monitor suspended sediments.

May 25, 2016 - Norway House Fisherman's Association

Described the year's field program in the Norway House area. Mentioned how the 2013 turbidity monitoring stations had contributed to the calibration of a remote sensing model for Playgreen Lake that worked on the upper Nelson River. The President of the Association objected to the fact that CAMP data had been used to state that Playgreen Lake fish stocks are OK, when clearly Walleye stocks are not. He was referring to the Clean Environment Commission (CEC) report on Lake Winnipeg Regulation.

June 21, 2016 - Southern Indian Lake Environmental Steering Committee

Provided an update on the analysis of cores collected from three sites on Southern Indian last March.

December 6, 2016 - Southern Indian Lake Environmental Steering Committee

A fisher on the committee requested a summary of what CAMP data shows about Northern Indian Lake fish stocks. Presented and discussed the results from the analysis of a core collected from Area 4 of Southern Indian Lake last March.

December 12-13, 2016 - Sustainable Development NE Region - Regional Meeting

Presented and discussed the results from the analysis of a core collected from Area 4 of Southern Indian Lake last March.

January 11, 2017 - York Factory Cree Nation

Participated by teleconference in a meeting with the Chief, his advisor and Manitoba Hydro staff to present CAMP. The history of CAMP, its objective, governance and the monitoring sites in the area were described. The use of remote sensing to determine turbidity and the



challenges of doing this on the lower Nelson were described. The Cree Nation is interested in water quality monitoring, sedimentation around Port Nelson and the impact of sediment on the estuary. There were several ideas on how the Cree Nation could conduct studies that were complementary to CAMP monitoring. The Cree Nation is interested in hosting a meeting to talk about monitoring ideas.

January 31, 2017 - Southern Indian Lake Environmental Steering Committee

The Committee decided to invite Russ Schmidt to a future meeting to present on the plans for CAMP sediment and erosion monitoring. Reported the results of fish data collected on Northern Indian Lake, comparing it with historical information from the RCEA.

April 5, 2017 - Southern Indian Lake Environmental Steering Committee

The Committee reviewed potential projects for the coming year, several of which were intended to be complimentary to CAMP monitoring. These included using remote sensing to identify areas generating large amounts of turbidity and verifying the results on the ground, developing community presentations using CAMP fish mercury monitoring results to allow people to make informed decisions about the relative risks and benefits of consuming fish and analyzing the two remaining sediment cores from Southern Indian Lake.





Coordinated Aquatic Monitoring Program

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