2018 Status of Surface Water Quantity Lower Athabasca Region

Air

Land

Water

Biodiversity

Reporting on the Lower Athabasca Surface Water Quantity Management Framework for January 2018 – December 2018

2018 Status of Surface Water Quantity, Lower Athabasca Region, Alberta

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Cover photo: Monica Polutranko

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Alberta’s Environmental Science Program

The Chief Scientist has a legislated responsibility for developing and implementing Alberta’s environmental science program for monitoring, evaluation and reporting on the condition of the environment in Alberta. The program seeks to meet the environmental information needs of multiple users in order to inform policy and decision-making processes. Two independent advisory panels, the Science Advisory Panel and the Indigenous Wisdom Advisory Panel, periodically review the integrity of the program and provide strategic advice on the respectful braiding of Indigenous Knowledge with conventional scientific knowledge.

Alberta’s environmental science program is grounded in the principles of:

- *Openness and Transparency.* Appropriate standards, procedures, and methodologies are employed and findings are reported in an open, honest and accountable manner.
- *Credibility.* Quality in the data and information are upheld through a comprehensive Quality Assurance and Quality Control program that invokes peer review processes when needed.
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- *Accessible Monitoring Data and Science.* Scientifically-informed decision making is enabled through the public reporting of monitoring data and scientific findings in a timely, accessible, unaltered and unfettered manner.
- *Respect.* A multiple evidence-based approach is valued to generate an improved understanding of the condition of the environment, achieved through the braiding of multiple knowledge systems, including Indigenous Knowledge, together with science.

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The author thanks technical staff in the Monitoring and Observation branch of the Resource Stewardship Division for data collection and sample processing. Thank you to Shalini Kashyap, Zahidul Islam, and Mathieu Lebel for their guidance and review of the calculations and to Janet Yan for help in extracting upstream water usage and allocation data.

The authors thank reviewers for their technical reviews and feedback, which have enhanced this work.

Reviewer 1 holds a Ph.D. in Civil Engineering, is a registered Professional Engineer in Alberta (P.Eng.), and has over 20 years of combined experience in water resources engineering practice (hydrology, hydraulics, and municipal engineering studies), management, research, and instrument set-up.

Reviewer 2 holds a Ph.D. in zoology and has more than 10 years of experience working in environmental policy, planning, and management. The reviewer is currently in a leadership and coordination role in the development and implementation of environmental management frameworks.

Reviewer 3 holds a Ph.D. in Civil Engineering (Water Resources), is a registered Professional Engineer in Alberta (P.Eng.), and has substantial experience in numerical modelling of natural water systems, and in particular modelling of the Lower Athabasca River.

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Acronyms and Abbreviations

AEP	Alberta Environment and Parks
LARP	Lower Athabasca Regional Plan
The Framework	Lower Athabasca Region Surface Water Quantity Management Framework for the Lower Athabasca River
AER	Alberta Energy Regulator
WSC	Water Survey of Canada
WURS	Alberta’s Water Use Reporting System

Executive Summary

Background

The Lower Athabasca Region Surface Water Quantity Management Framework for the Lower Athabasca River (the Framework) came into effect on October 29, 2015. The Framework establishes weekly management triggers and water withdrawal limits to enable proactive management of mineable oil sands water use from the Lower Athabasca River. The Framework also includes a series of adaptive management triggers that will signal when river flow and water use conditions are close to, or outside of, the range of predicted future conditions used in modelling and development of the weekly management triggers and water withdrawal limits.

This report presents a summary of 2018 streamflow on the Lower Athabasca River and water use by the mineable oil sands sector and other licensed users, relative to weekly management limits, and provides analyses of six of the seven adaptive management triggers. This evaluation fulfills commitments for public reporting outlined in the Framework.

2018 Results Summary

- No water withdrawal limits were exceeded;
- No adaptive management triggers were exceeded;

Introduction

The Lower Athabasca Region Surface Water Quantity Management Framework for the Lower Athabasca River (the Framework) came into effect on October 29, 2015, after the Government of Alberta committed to completing the Framework in the Lower Athabasca Regional Plan. The objective of the Framework is to manage cumulative water withdrawals to support both human and ecosystem needs, while balancing social, environmental, and economic interests. The Framework updated and replaced the *Water Management Framework: Instream Flows Needs and Water Management System for the Lower Athabasca River*, which was implemented by Alberta Environment and Fisheries and Oceans Canada in 2007 (AENV & DFO 2007). The Framework augments and complements existing policies and legislation and is consistent with other provincial policies, strategies, and frameworks, and with the stated desired outcomes for the region.

The Framework relies on three types of tools in establishing the need for and nature of a management response – indicators, weekly management triggers and water withdrawal limits, and adaptive management triggers. Weekly management triggers and water withdrawal limits only pertain to the mineable oil sands sector. They are implemented by the Alberta Energy Regulator (AER) to enable proactive management of mineable oil sands water use from the Athabasca River. Withdrawal limits generally decrease as streamflow decreases and regulatory responses are triggered when thresholds are exceeded. Indicators and adaptive management triggers pertain to all licensed water users. Indicators provide information and track changes over time and do not prompt management responses, and are all still in development. Adaptive management triggers indicate when streamflow and/or water use conditions are outside of the range of predicted future conditions, which are used in the modelling and development of the weekly management triggers and water withdrawal limits. Crossing adaptive management triggers results in a management response process, which could result in changes to weekly management triggers and withdrawal limits.

This report presents flow conditions and estimates in the Athabasca River and water use by the mineable oil sands sector, relative to weekly water withdrawal limits, and analyses of six of the Framework's seven adaptive management triggers. The seventh adaptive management trigger, which aims to relate ecological function to surface water quantity in alignment with the Lower Athabasca Region Biodiversity Management Framework, is under development and work on the ecological knowledge gaps to support the development of this trigger is ongoing.

The evaluation covers January 1 to December 31, 2018 and fulfills commitments for public reporting made in the Framework.

Lower Athabasca Region

The Lower Athabasca Regional Plan (LARP) was developed by the Government of Alberta under the Land Use Framework (Government of Alberta, 2008). The plan sets outcomes that describe what the Government of Alberta wants to accomplish at a regional level and is given legislative authority under the *Alberta Land Stewardship Act* (Government of Alberta, 2009). The LARP applies to the Lower Athabasca Region, an area approximately 93,212 square kilometers in size, located in northeastern Alberta (Figure 1). For more information on the Lower Athabasca Region, see the LARP publication (Government of Alberta, 2012).

AEP is responsible for the monitoring, evaluation and reporting on the condition of the environment in the Lower Athabasca Region, while other divisions of the Government of Alberta and regulators are responsible for management of activities and resources in response to environmental conditions.

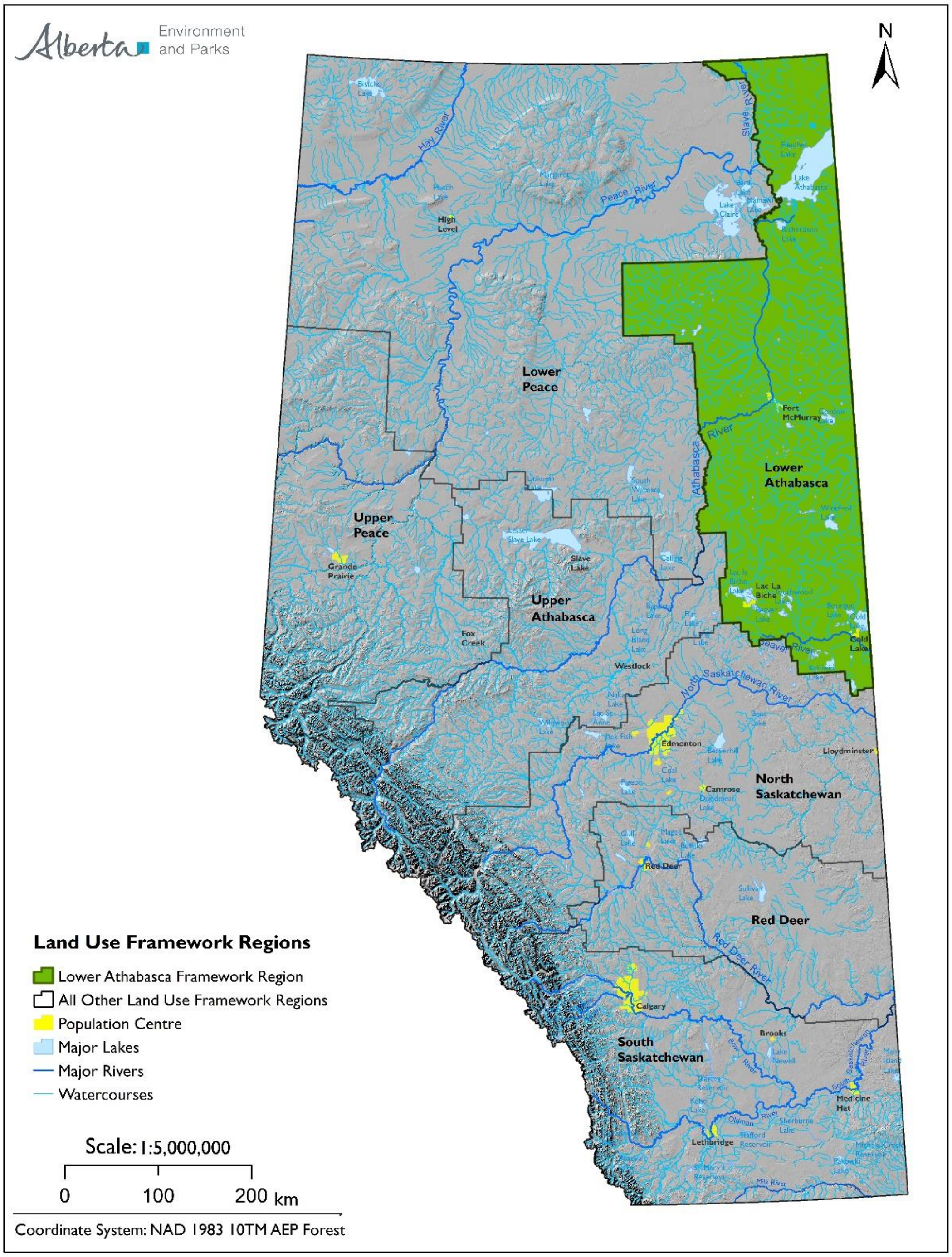

Figure 1- Location of the seven Land Use Framework Regions in Alberta. The Lower Athabasca Region is the area shaded green on the map

Data Sources

Implementation of and reporting on the Framework requires a variety of data, including both measured and modelled streamflow, water allocation and use data from the mineable oil sands sector and other licenced users. Evaluation of the management triggers and water withdrawal limits outlined in the Framework is completed for every calendar year.

Official verified daily flow rates for the Athabasca River measured at the Water Survey of Canada (WSC) Fort McMurray station (historic hydrometric data for 07DA001 "Athabasca River below Fort McMurray") are used to evaluate adaptive management triggers. This station has been monitored since 1957 and is located below Fort McMurray, downstream of the confluence with the Clearwater River and upstream of all water withdrawals by the mineable oil sands sector (Figure 2). Streamflow on the Athabasca River at Fort McMurray represents the integration of upstream hydroclimatic conditions, including rainfall, snowmelt, and glacier melt, as well as groundwater inputs (Marshall *et al.* 2011; Peters *et al.* 2013; Bawden *et al.* 2014), and upstream withdrawals and returns.

Official verified flows at the Fort McMurray station are not available in real time to determine water withdrawal limits. Therefore, weekly management triggers and cumulative withdrawal limits are evaluated using weekly flow estimates that were provided by Alberta Environment and Parks (AEP) through the Athabasca River Conditions and Use website at the start of each week, to mineable oil sands operators, the AER, and the public. These weekly flow estimates are based on the best information available at the time and are used to determine the applicable cumulative water withdrawal limit for a given week. They do not necessarily represent a weekly average flow estimate for the week or flow forecast for the following week, i.e. the flow estimate available as close as possible to the beginning of the week is used as the weekly flow.

Surface water allocations from the Athabasca River Basin are specified in Water Act licences, which are required by all water users. This data is contained in the Alberta Environment and Parks Environmental Management System (EMS). Actual water use data is reported by oil sands operators and other major water users (e.g. forestry, water management) to Alberta's Water Use Reporting System (WURS) according to the condition specified in their licences. Annual water use for all licenses upstream of the Fort McMurray station is extracted from WURS and used to calculate the upstream water use adaptive management trigger. Daily water use by mineable oil sands operators is extracted from WURS and used to calculate weekly values and evaluate weekly management triggers and cumulative withdrawal limits.

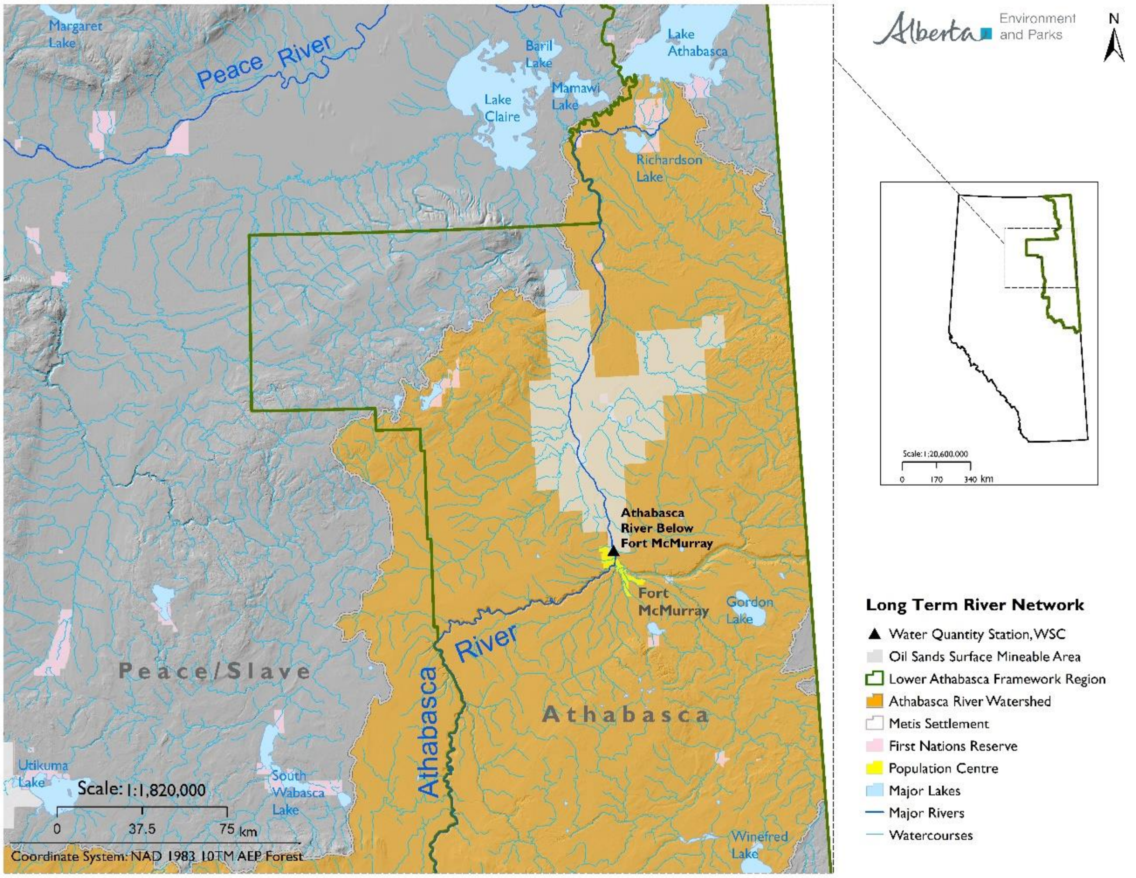

Figure 2- Location of Water Survey of Canada Fort McMurray station (WSC gauge 07DA001 "Athabasca River below Fort McMurray") in the Lower Athabasca Region of Alberta.

Weekly and Adaptive Management Triggers Overview

The weekly management triggers and withdrawal limits established in the Framework set the maximum cumulative water withdrawals permitted by mineable oil sands operators from the Athabasca River. The weekly management triggers and water withdrawal limits are divided into five seasons: Mid-Winter, Early Spring, Late Spring, Summer/Fall, and Early Winter. Each of these seasons has distinct weekly flow triggers and corresponding cumulative water withdrawal limits. The weekly triggers and limits are implemented and tracked by the AER.

Adaptive management triggers signal when river flow and water use conditions are close to the bounds of, or outside of, the range of predicted future conditions used in modelling and development of the weekly management triggers and water withdrawal limits.

Seven adaptive management triggers are included in the Framework, the first six of which are included in this report:

1. Upstream water use
2. Changes to long-term seasonal flow in the Athabasca River
3. Changes to oil sands water use
4. Cumulative oil sands water use, relative to weekly flow
5. High oil sands water use during low summer/fall flows
6. Preliminary Aboriginal Navigation Index (ANI)
7. Ecological indicators and triggers (under development)

Weekly Management Triggers and Cumulative Withdrawal Limits

The AER tracks and reports annually on the performance of mineable oil sands operators relative to the weekly water withdrawal limits identified in the Framework. These limits are cumulative and represent the total permitted withdrawal by oil sands operators combined each week, based on flow estimates determined by Alberta Environment and Parks (Table 1). Water withdrawals remained below these limits for the reporting period, January 1 to December 31, 2018. Water withdrawals by oil sands operators have not exceeded weekly withdrawal limits since the implementation of the management framework in October 2015. Weekly flows and associated water withdrawal limits are given in Figure 3 and withdrawal limits compared to actual water use are shown in Figure 4 and provided in tabular form in Appendix A. Actual water withdrawals remain relatively constant throughout the year, while streamflow and withdrawal limits are lowest during the winter period when precipitation is falling as snow and the river is ice-covered. Streamflow peaks during spring, driven by upstream snowmelt, and remains relatively high throughout the open water season. Consequently, withdrawal limits are highest during this period.

Oil sands operators using water from the Lower Athabasca River develop and submit annual Oil Sands Mining Water Management Agreements by November 1st of each year as identified in the Framework. Two water management agreements covering 2018 were delivered by the mineable oil sands operators (agreements for the 2017-2018 and 2018-2019 periods). These agreements specify the share of the available water for each of the individual mine operators during different seasons and under different stream flow conditions to ensure that the weekly cumulative water withdrawal limits under the Framework are not exceeded.

Table 1- Weekly flow triggers and cumulative water use limits on the Lower Athabasca River for mineable oil sands operations

Mid Winter (January 1 to April 15) Weeks 1-15	
Weekly Flow Triggers (m^3/s)	Cumulative Water Withdrawal Limits
more than 270 m^3/s	16 m^3/s
150 to 270 m^3/s	6% of Weekly Flow
91.6 to 150 m^3/s	9 m^3/s
87 to 91.6 m^3/s	Weekly Flow minus 82.6 m^3/s
less than 87 m^3/s	4.4. m^3/s

Early Spring (April 16 to May 6) Weeks 16-18	
Weekly Flow Triggers (m^3/s)	Cumulative Water Withdrawal Limits
more than 98.6 m^3/s	16 m^3/s
87 to 98.6 m^3/s	Weekly Flow minus 82.6 m^3/s
less than 87 m^3/s	4.4. m^3/s

Late Spring (May 7 to June 10) Weeks 19-23	
Weekly Flow Triggers (m^3/s)	Cumulative Water Withdrawal Limits
more than 102.6 m^3/s	20 m^3/s
87 to 102.6 m^3/s	Weekly Flow minus 82.6 m^3/s
less than 87 m^3/s	4.4. m^3/s

Summer/Fall (June 11 to October 28) Weeks 24-43	
Weekly Flow Triggers (m^3/s)	Cumulative Water Withdrawal Limits
more than 111.6 m^3/s	29 m^3/s
87 to 111.6 m^3/s	Weekly Flow minus 82.6 m^3/s
less than 87 m^3/s	4.4. m^3/s

Early Winter (October 29 to December 31) Weeks 44-52	
Weekly Flow Triggers (m^3/s)	Cumulative Water Withdrawal Limits
more than 200 m^3/s	16 m^3/s
150 to 200 m^3/s	8% of Weekly Flow
94.6 to 150 m^3/s	12 m^3/s
87 to 94.6 m^3/s	Weekly Flow minus 82.6 m^3/s
less than 87 m^3/s	4.4. m^3/s

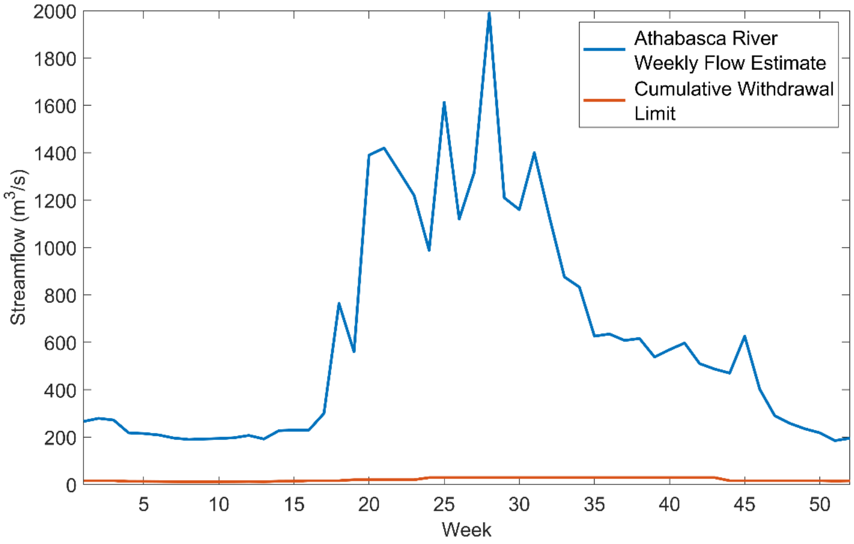

Figure 3- Streamflow compared to cumulative withdrawal limits from January 1 to December 31, 2018. Cumulative withdrawal limits represent the total permitted withdrawal by oil sands operators (combined) each week, and are determined by weekly streamflow estimates provided by AEP.

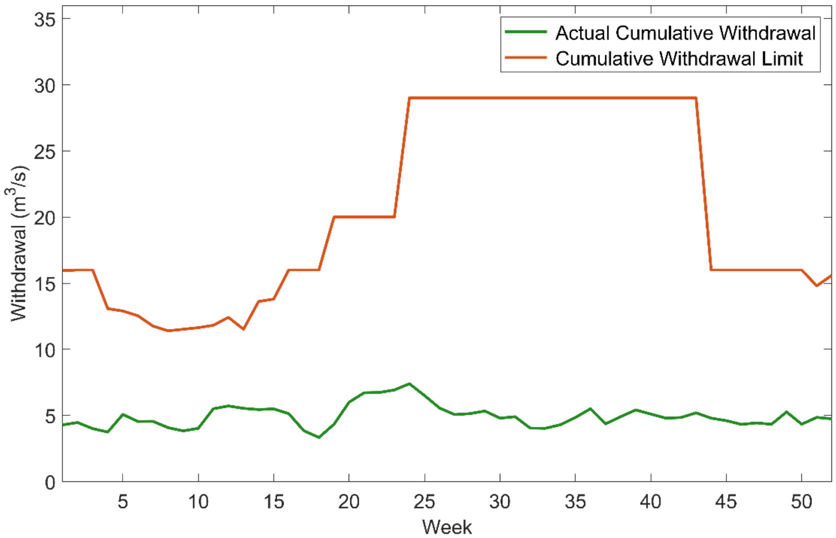

Figure 4- Cumulative withdrawal limits compared to actual withdrawal rates from January 1 to December 31, 2018. Cumulative withdrawal limits represent the total permitted withdrawal by oil sands operators (combined) each week, and are determined by weekly streamflow estimates provided by AEP.

Adaptive Management Triggers

Adaptive management triggers are designed to indicate when river flow or water use conditions are close to the bounds of or outside of the modelled predictions used to develop the Framework. Results of six of the seven adaptive management triggers for 2018 are summarized below. The seventh trigger, relating ecological function to surface water quantity, is under development.

Upstream Water Use

Trigger exceedance occurs when:

- Net water allocation[1] upstream of Fort McMurray reaches or exceeds 160 million m^3/year (approximately 5 m^3/s).
- Actual reported net water use upstream of Fort McMurray reaches or exceeds 60 million m^3/year (approximately 2 m^3/s).

In 2018, the gross water allocation upstream of Fort McMurray was 258 million m^3, with 162 million m^3 of this volume required to be returned to the river after use. The net water allocation of 95 million m^3 is therefore less than the 160 million m^3 allocation trigger.

Licence holders representing approximately 86% of the total allocated volume upstream of Fort McMurray in 2018 are required to report water use under the terms of their licences. Actual water use information is, therefore, not available for approximately 14% of the total allocation volume. The non-reporting users represent a significant water allocation volume and, therefore, it is critical to account for this water use to best estimate actual net water use. The calculation of actual reported net water use, and consequently, the evaluation of this trigger exceedance, relies on assumptions regarding the non-reporting users. Previous reporting periods (2015-2016 and 2017) calculated actual reported net water use under the assumption that non-reporting users utilized and returned water at the same ratio as the reporting users. For 2018, licence holders reporting water use utilized 52% of their total allocated diversion volume and returned 63% of their allocated return volume. Applying these utilization and return ratios to the non-reporting licence holders results in an estimated gross upstream diversion of 135 million m^3, an estimated actual return flow of 102 million m^3, and the estimated net upstream water use is 32 million m^3, which is below the 60 million m^3 water use trigger. However, given the uncertainty associated with non-reporting users, the

[1] Water allocations do not directly reflect actual water use. Rather, an allocation volume represents the maximum amount of water granted for use on an annual basis. Licences consists of three components: consumption, losses, and return flow.

estimated net upstream water use may be as low as 18 million m^3 (assuming non-reporting licences use none of their allocated volume) or as high as 55 million m^3 (assuming non-reporting licences use their full allocated diversion volume and return none of the allocated return volume). Neither of the minimum or maximum estimates are realistic, but even the maximum estimate remains below the trigger threshold. It is recognized that the methodology used to calculate net water use of non-reporting licence holders requires refinement and a scientifically based review of calculation methods is ongoing.

Based on the above calculations, the Upstream Water Use trigger was not exceeded in 2018.

Changes to Long-term Seasonal Low Flow in the Athabasca River

Trigger exceedance occurs when:

- Median seasonal flow for a given season drops below the specified Long-Term Seasonal Low Flow Threshold values (Table 2) three or more times within any 10 consecutive year period.

From 2009 to 2018, median seasonal flow remained above the respective Low Flow Threshold each year (Figure 5). In 2015, flow was very close to, but remained slightly above the Low Flow Threshold in the Summer season. There was no exceedance of the Long-term Seasonal Flow trigger in the 10 year period from 2009 to 2018.

Table 2- Long-Term Seasonal Low Flow Adaptive Management Thresholds and 2018 Seasonal Flows.

Weeks	Season	Low Flow Threshold (m^3/s)	2018 Seasonal Flow (m^3/s)
1 to 15 (January 1 – April 15)	Mid-Winter	91.3	185
16 to 18 (April 16 – May 6)	Early Spring	173	608
19 to 23 (May 7 – June 10)	Late Spring	442	1336
24 to 33 (June 11 – August 19)	Summer	636	1256
34 to 43 (August 20 – October 28)	Fall	298	596
44 to 52 (October 29 – December 31)	Early Winter	105	224

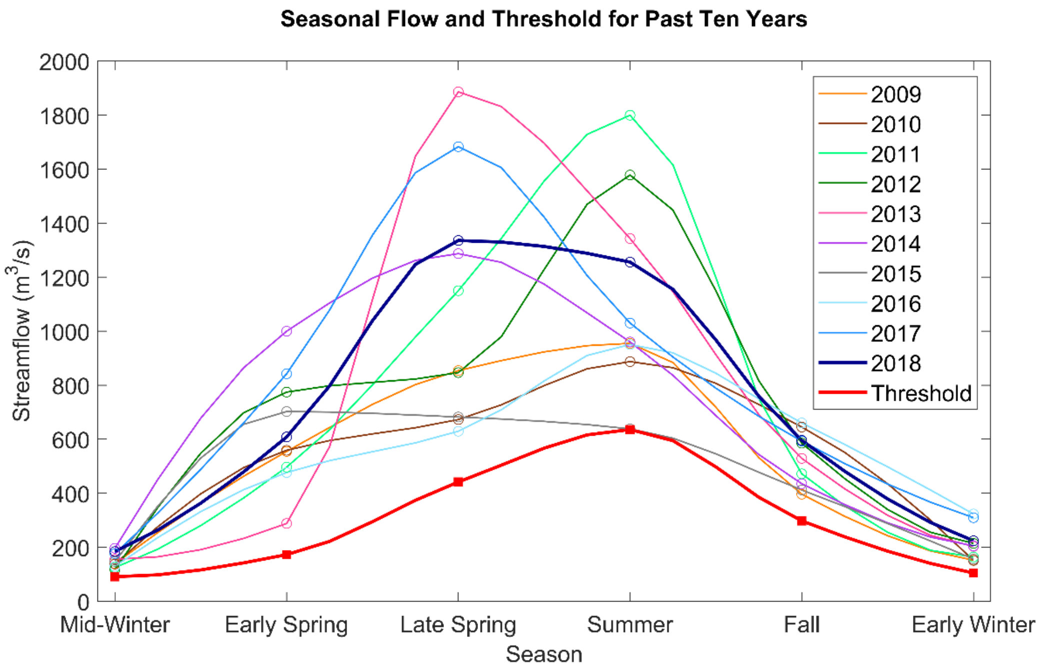

Figure 5- Comparison of seasonal low flow threshold and median flow for 2009-2018.

Long-Term Seasonal Flow Exceedance Indicator (supporting indicators)

The Framework identifies Long-Term Seasonal Flow Exceedance Indicators (Table 3), derived by determining the number of times over ten consecutive years that modelled weekly average flows would drop below a series of key flows, given a moderate climate change scenario. Weeks are divided into the winter (ice covered) and open water seasons. These indicators were designed to identify changes to river flows that might be occurring over a wider range of flows than just the very low flows utilized in the 'Changes to Long-term Seasonal Low Flows in the Athabasca River' adaptive management trigger. However, given the ten-year period of analysis, flow variability may be influenced by low-frequency and/or persistent modes of climate variability, such as the Pacific Decadal Oscillation (PDO) or El Niño-Southern Oscillation (ENSO). The PDO oscillates between positive and negative phases with periodicities of multiple decades (Mantua and Hare 2002). Positive (La Niña) and negative (El Niño) phases of ENSO persist for approximately 9-12 months and occur every 3-5 years. Negative phases of the PDO and positive phases of ENSO are associated with higher than average streamflow, where positive PDO and negative ENSO phases are associated with lower than average streamflow in Alberta (St, Jacques et al. 2014; Rood et al. 2015). Given the duration of the PDO and ENSO phases, ten-year flow may be anomalously high or low and may not be indicative of longer-term changes. The Long-Term Seasonal Flow Exceedance Indicators are not intended to initiate a management response, but rather, to inform an understanding of potential changes to river flow and support investigation and development of management actions when there are exceedances of adaptive management triggers.

Between 2009 and 2018, the number of winter weeks when the flow was below the thresholds was lower than the number predicted by the climate change scenarios (Table 3) for key flow rates below 1000 m^3/s, and equal to the predicted frequency for 1000 m^3/s and 1600 m^3/s (Figure 6). During the open water period the number of weeks when the flow was below the given thresholds (Table 3) was lower than the frequency predicted in the Framework (Figure 7). Based on the results of this indicator, there is no indication of significant change in the flow regime over this ten-year time period.

Table 3- Long-Term Seasonal Flow Exceedance indicators. The predicted number of weeks (over a consecutive 10-year period) below key flows, based on a moderate climate change scenario.

Weekly Mean Flow Rate (m^3/s)	# of Weeks Below Flow, Over 10-Year Period (2009-1028)			
	Winter (weeks 44-15)		Open Water (weeks 16-43)	
	Threshold	2018 Reporting	Threshold	2018 Reporting
87	9	0	0	0
100	37	0	1	0
125	96	29	1	0
150	131	91	1	0
200	184	170	4	0
270	221	209	13	3
400	237	230	60	18
600	240	238	133	89
1000	240	240	241	192
1600	240	240	275	253

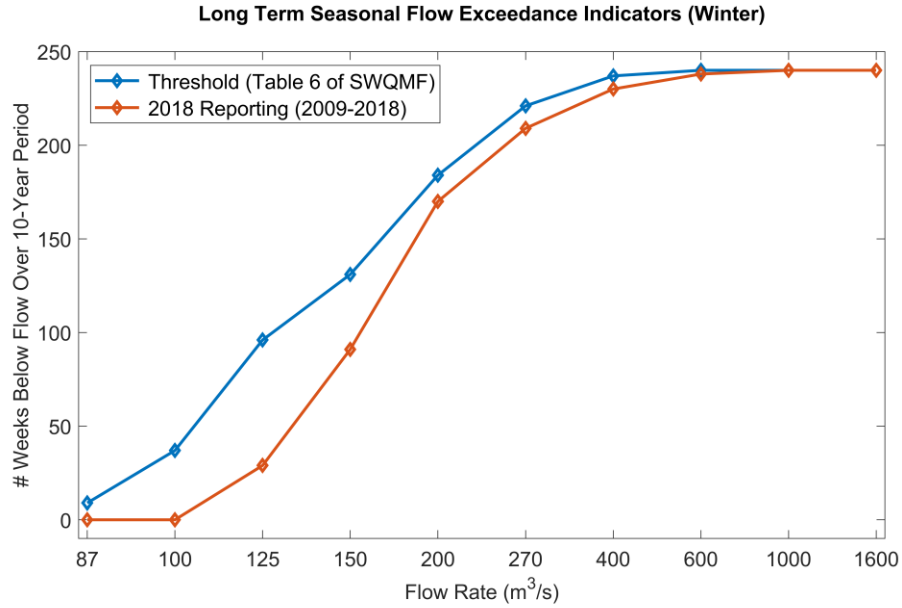

Figure 6- Evaluation of Long-Term Seasonal Flow Exceedance indicators from 2009 to 2018, for the winter season. Actual number of weeks below key flows is lower than or equal to the predicted number of weeks for all key flows.

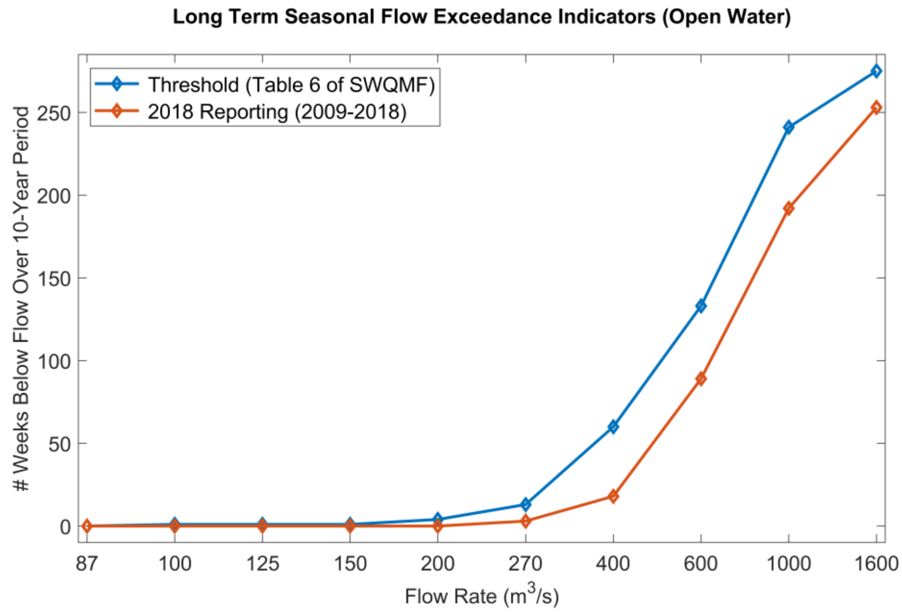

Figure 7- Evaluation of Long-Term Seasonal Flow Exceedance indicators from 2009 to 2018, for the open water season. Actual number of weeks below key flows is lower than the predicted number of weeks for all key flows.

Changes to Oil Sands Water Use

Trigger exceedance occurs when:

- Cumulative annual water withdrawals by the oil sands sector exceed 441 million m^3/year (14 m^3/s).

In 2018, the cumulative water withdrawal (gross) by the oil sands mining sector was 156.0 million m^3/year (5.0 m^3/s); therefore, the Oil Sands Water Use trigger was not exceeded.

Cumulative Oil Sands Water Use, Relative to Weekly Flow

Trigger exceedance occurs when:

- Cumulative (mineable and in situ) oil sands water use is equal to or greater than 10 per cent of the flow measured at the Fort McMurray station for six or more weeks during the winter period of any given year (weeks 1 to 15 and 44 to 52); or
- Cumulative (mineable and in situ) oil sands water use is equal to or greater than 6 per cent of the flow measured at the Fort McMurray station for six or more weeks during the open water period of any given year (weeks 16 to 43); or
- Cumulative (mineable and in situ) oil sands water use is equal to or greater than 15 per cent of the flow measured at the Fort McMurray station for a single week at any time of the year.

There are two winter (ice covered) periods in the 2018 calendar year - the winter beginning on week 44 of 2017 and extending to week 15 of 2018, and beginning on week 44 of 2018 (Figure 8). For the purposes of trigger exceedance calculation, this report is concerned with the cumulative number of weeks over the two winter periods in 2018 (weeks 1-15 and 44-52). In 2018, weekly water withdrawal by mineable and in situ oil sands producers from the Athabasca River ranged from 1.80% to 3.12% of the measured flow during the early 2018 winter period (weeks 1-15) and from 1.04% to 2.43% of the measured flow during the late 2018 winter period (weeks 44-52). During the open water period (weeks 16-43), weekly water withdrawals ranged from 0.16% to 2.21% of measured flow. Therefore, the Cumulative Oil Sands Water Use, Relative to Weekly Flow trigger was not exceeded.

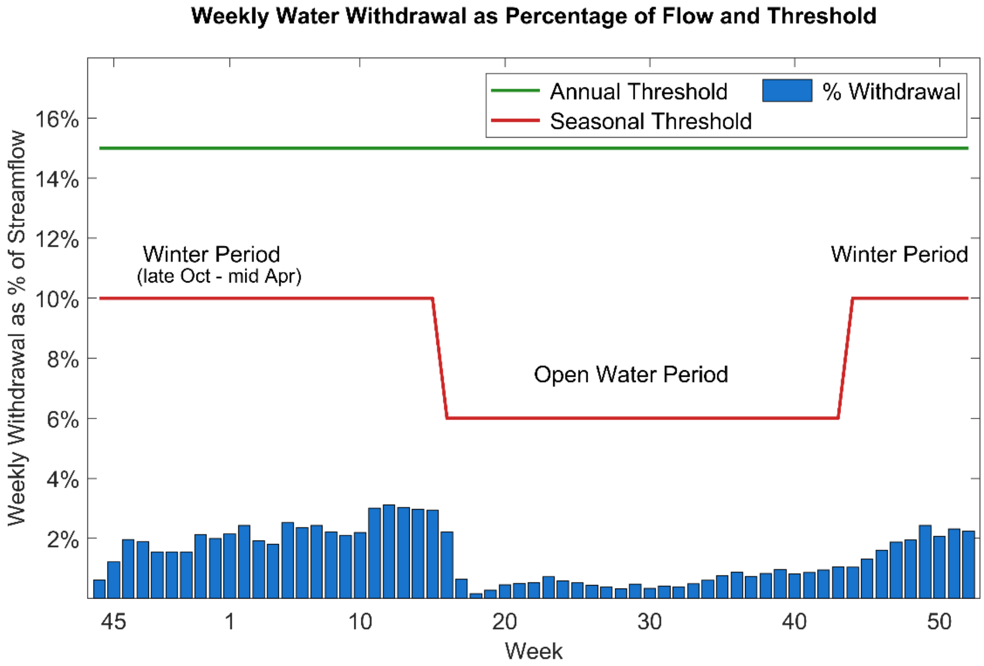

Figure 8- Weekly water withdrawal during early winter (late October 2017 – mid-April 2018), open water (mid-April – late October), and late winter (late October – end December) 2018 as percentage of flow, compared to annual and seasonal thresholds.

High Oil Sands Water Use During Low Summer and Fall Flows

Trigger exceedance occurs when:

- Cumulative oil sands water use exceeds the predicted full build-out scenario (16 m^3/s) during any week in the Summer/Fall season (weeks 24 to 43) in which the average weekly flow is less than 400 m^3/s.

In 2018, average weekly flow was above 400 m^3/s every week in the Summer/Fall seasons (weeks 24 to 43; Figure 9). Flows ranged from 1620 m^3/s to 492 m^3/s. Weekly water withdrawals were well below 16 m^3/s, ranging from 4.03 m^3/s to 7.40 m^3/s (Figure 10). Therefore, the High Oil Sands Water Use During Low Summer/Fall Flows was not exceeded in 2018.

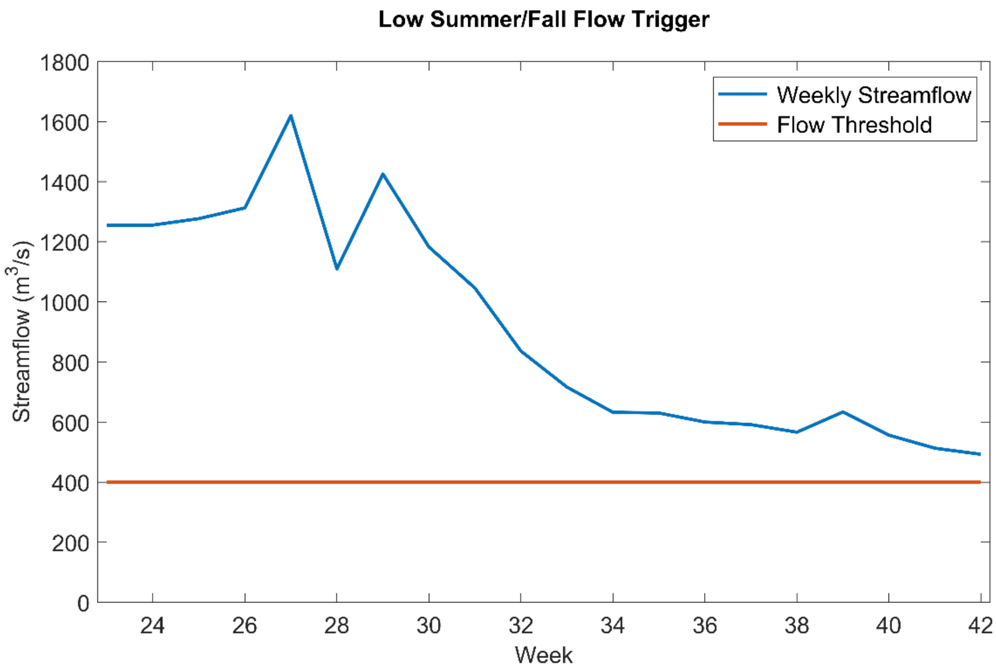

Figure 9- Streamflow for summer and fall (weeks 24-43), 2018 compared to the weekly flow threshold.

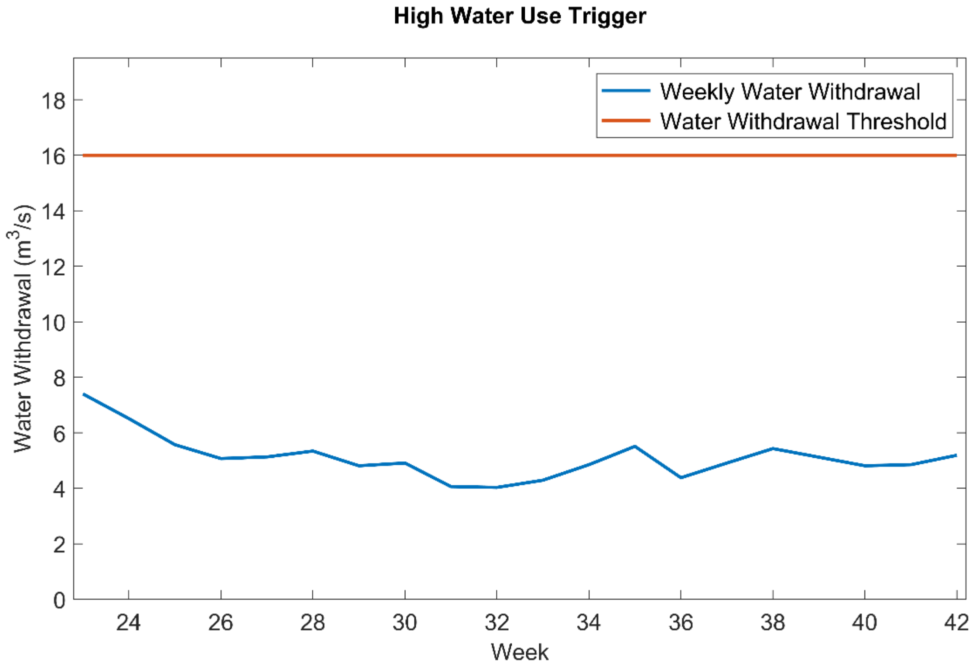

Figure 10- Weekly water withdrawal for summer and fall (weeks 24-43), 2018 compared to the threshold.

Preliminary Aboriginal Navigation Index (ANI)

Trigger exceedance occurs when:

- The fall season (weeks 34 to 43) ANI decreases by 10% after accounting for withdrawals.

The Athabasca River is an important navigational route that provides access to traditional activities for First Nations and Métis communities. Navigation can be challenging during periods of low flow, including fall when low flows can persist for weeks or months before winter freeze up. Calculation of the ANI is based on a range of stream flow navigability and is intended to provide advanced notice of potential change in river navigability. The trigger represents a change in water depth of less than 3 cm at a specific point in the river where navigation is particularly challenging and is unlikely to represent an immediate limitation to navigation or river access.

In Fall (weeks 34 to 43) 2018, the weekly decrease in ANI ranged from 2.41% to 0.88% and the average ANI decreased by 1.48% after accounting for water withdrawals for the oil sands sector from the Athabasca River (Figure 11). A summary of the weekly and seasonal ANI before and after withdrawals is provided in Figure 12. The Preliminary Aboriginal Navigation Index trigger was not exceeded in 2018.

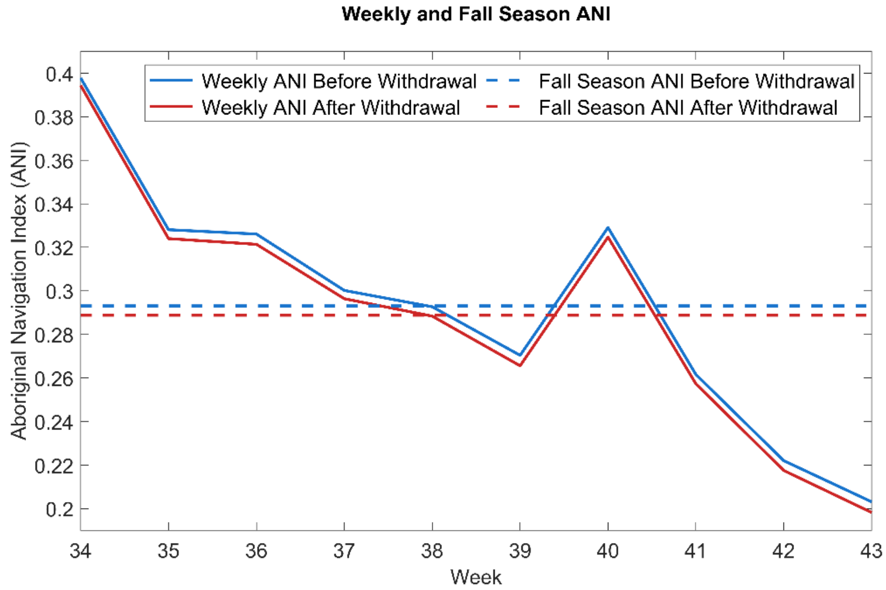

Figure 11- Fall (weeks 34 to 43) 2018 weekly and seasonal percent changes in the Aboriginal Navigation Index compared with the threshold.

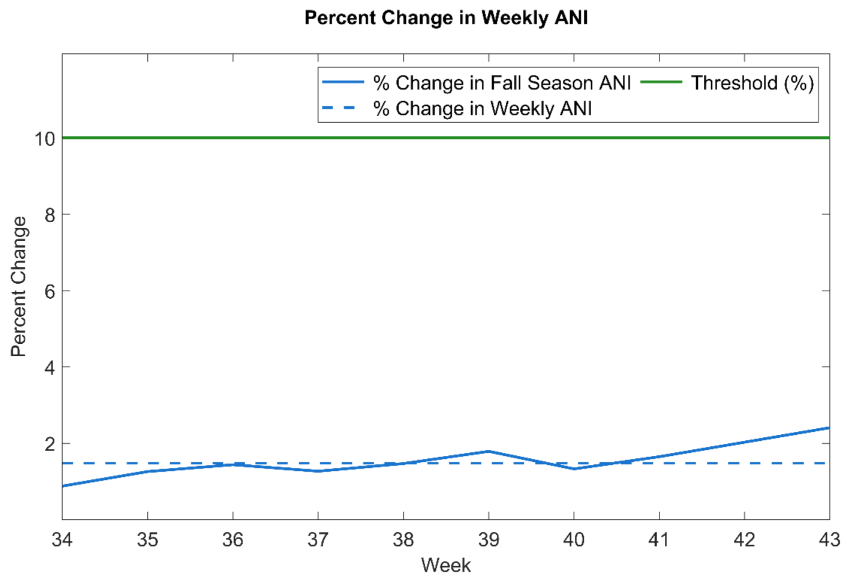

Figure 12- Fall (weeks 34 to 43) 2018 weekly and seasonal Aboriginal Navigation Index, before and after accounting for withdrawals.

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Appendix A: Summary of the weekly management triggers and cumulative withdrawal limits

Summary of the weekly management triggers and cumulative withdrawal limits since the Surface Water Quantity Management Framework took Effect

Year	Week	Weekly Flow Estimates (m3/s)	Cumulative Withdrawal Limit (m3/s)	Actual Cumulative Withdrawal (m3/s)
2018	1	266	15.96	4.29
2018	2	279	16	4.47
2018	3	272	16	4.01
2018	4	218	13.08	3.75
2018	5	215	12.9	5.08
2018	6	209	12.54	4.55
2018	7	196	11.76	4.56
2018	8	190	11.4	4.08
2018	9	192	11.52	3.84
2018	10	194	11.64	4.03
2018	11	197	11.82	5.51
2018	12	207	12.42	5.72
2018	13	192	11.52	5.54
2018	14	227	13.62	5.45
2018	15	230	13.8	5.50
2018	16	230	16	5.14
2018	17	300	16	3.85
2018	18	764	16	3.34
2018	19	560	20	4.34
2018	20	1390	20	6.01
2018	21	1420	20	6.72
2018	22	1321	20	6.74
2018	23	1220	20	6.93
2018	24	988	29	7.40
2018	25	1613	29	6.51
2018	26	1120	29	5.56
2018	27	1317	29	5.07
2018	28	1990	29	5.14
2018	29	1210	29	5.34
2018	30	1160	29	4.80
2018	31	1400	29	4.91
2018	32	1130	29	4.05

2018	33	876	29	4.03
2018	34	833	29	4.30
2018	35	626	29	4.85
2018	36	635	29	5.51
2018	37	608	29	4.37
2018	38	616	29	4.91
2018	39	538	29	5.42
2018	40	569	29	5.11
2018	41	597	29	4.80
2018	42	510	29	4.85
2018	43	487	29	5.20
2018	44	470	16	4.80
2018	45	626	16	4.61
2018	46	402	16	4.33
2018	47	290	16	4.44
2018	48	258	16	4.34
2018	49	235	16	5.27
2018	50	218	16	4.34
2018	51	185	14.8	4.86
2018	52	195	15.6	4.75