

# Oil Sands Monitoring Program: Summary of 2018 Hydrologic Conditions in the Alberta Oil Sands Area



Oil Sands Monitoring Program  
Technical Report Series

Canada 



Alberta 

# Summary of 2018 Hydrologic Conditions in the Alberta Oil Sands Area

(Based on hydrometric data collected by Environment and Climate Change Canada, National Hydrological Service)

## 2018 Overview

This annual report presents a summary of hydrometric data collected by the Water Survey of Canada (WSC) in the Alberta Oil Sands area in 2018. This report is the first of what will be an annual publication intended to provide the public with an understanding of the hydrologic conditions that were present in the Oil Sands area each year and how they compare with historical conditions.

There were 48 hydrometric gauging stations operated by WSC in the Oil Sands area in 2018 (shown on the map provided in Appendix A). Conditions at four key stations are discussed in the main body of this report and are presented from upstream to downstream as follows: Athabasca River at Athabasca, Clearwater River above Christina River (a major tributary to the Athabasca River), Athabasca River below Fort McMurray, and Athabasca River at Embarras Airport. The local contributions from the western and eastern tributaries to the Athabasca River main stem are also discussed. A summary table of all active WSC hydrometric stations within the Oil Sands area in 2018 is provided in Appendix B, and annual hydrographs are provided for all active hydrometric stations in Appendix C.

### Athabasca River at Athabasca (07BE001)

The hydrometric data for this station (Figure 1) indicates that ice break-up occurred at the start of May. The highest flow in 2018 occurred at the time of break up and this peak was in the upper quartile for this time of year based on the historical record. For the remainder of the year, the measured flow was largely within the normal range of flows for this station. The 2018 mean flow of 437 m<sup>3</sup>/s was comparable to the historical mean annual flow of 421 m<sup>3</sup>/s over this station's period of record (from 1913-2018). Precipitation measured in 2018 at the nearby Athabasca Climate Station was slightly greater (107%) than the historical mean annual precipitation.

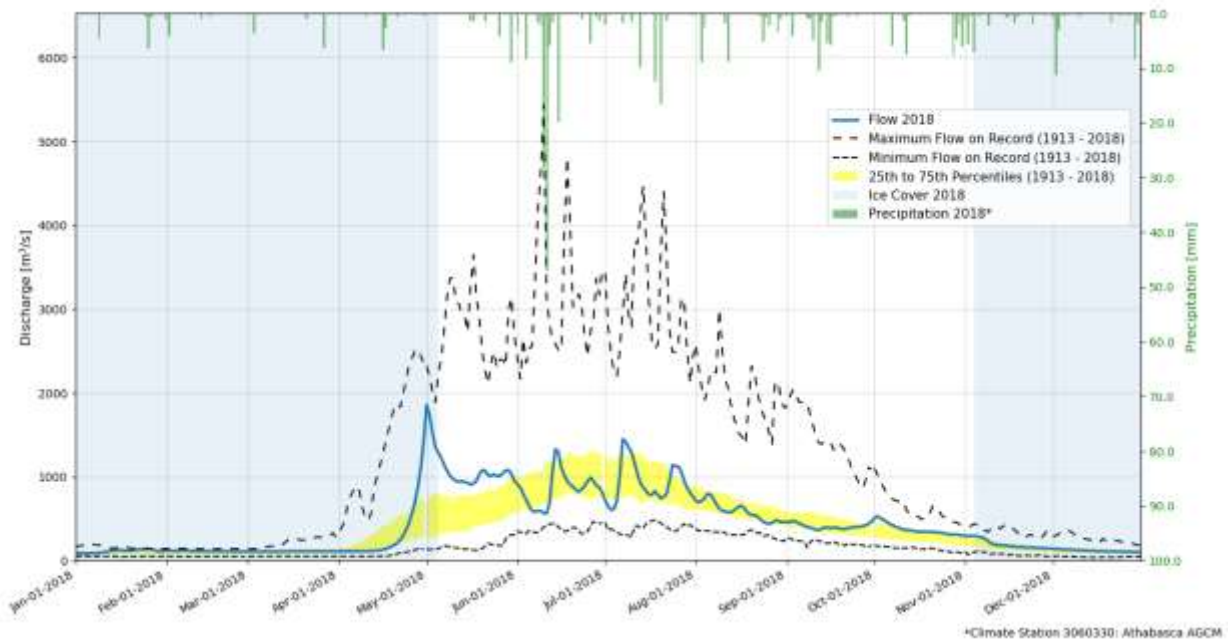


Figure 1: Annual Hydrograph for Station 07BE001 Athabasca River at Athabasca

### Clearwater River above Christina River (07CD005)

Hydrometric data from this station can be used as an indicator station for tributary contributions to the Athabasca River upstream of Fort McMurray. The 2018 hydrometric data for this station (Figure 2) shows that ice break-up occurred at the start of May. The peak flow for 2018 was experienced at that time and was in the upper quartile for that date based on the historical record. For the remainder of the year, the flow remained largely within the normal range of flows for this station. The 2018 mean flow of 73.6 m<sup>3</sup>/s is comparable to the historical mean annual flow of 73.7 m<sup>3</sup>/s over this station's 53 year period of record (from 1966-2018). Precipitation measured in 2018 at the nearby Gordon Lake Lookout Climate Station was slightly less (94.4%) than the historical mean annual precipitation.

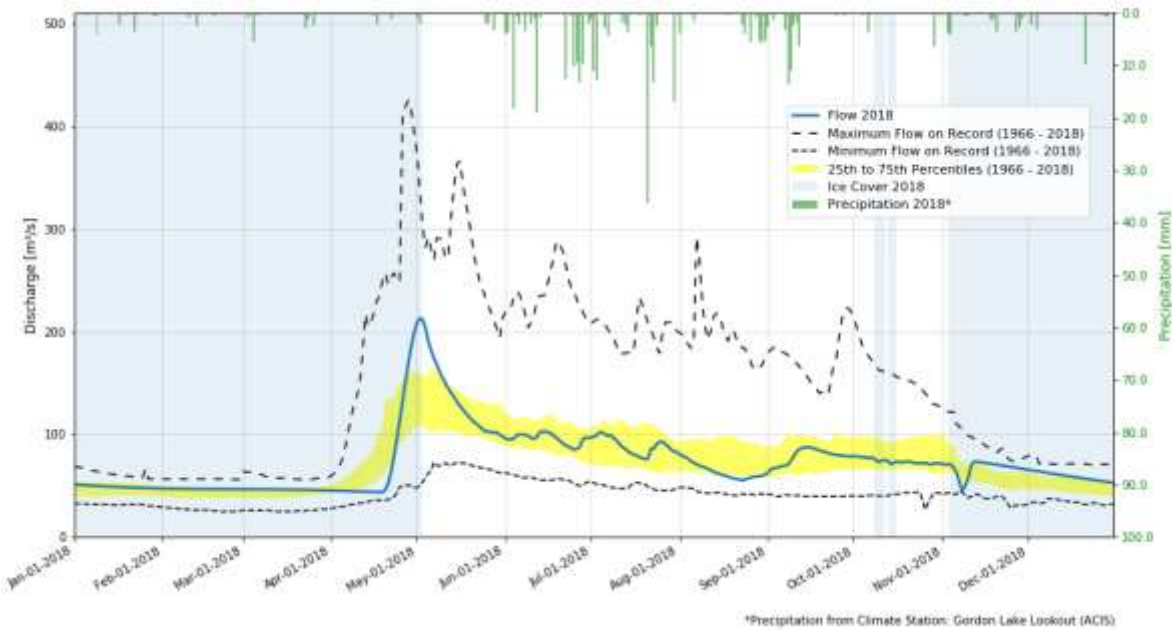


Figure 2: Annual Hydrograph for Station 07CD005 Clearwater River above Christina River

### Athabasca River below Fort McMurray (07DA001)

The hydrometric data for this station (Figure 3) indicates that ice break-up occurred at the start of May. The peak flow for 2018 occurred at that time and was in the upper quartile for that date, based on the historical record. For the remainder of the year, the flow remained largely within the normal range of flows for this station. The 2018 mean flow of 632 m<sup>3</sup>/s was comparable to the historical mean annual flow of 617 m<sup>3</sup>/s over this station's period of record (from 1957-2018). Precipitation measured in 2018 at the nearby Fort McMurray Climate Station was slightly greater (103%) than the historical mean annual precipitation.

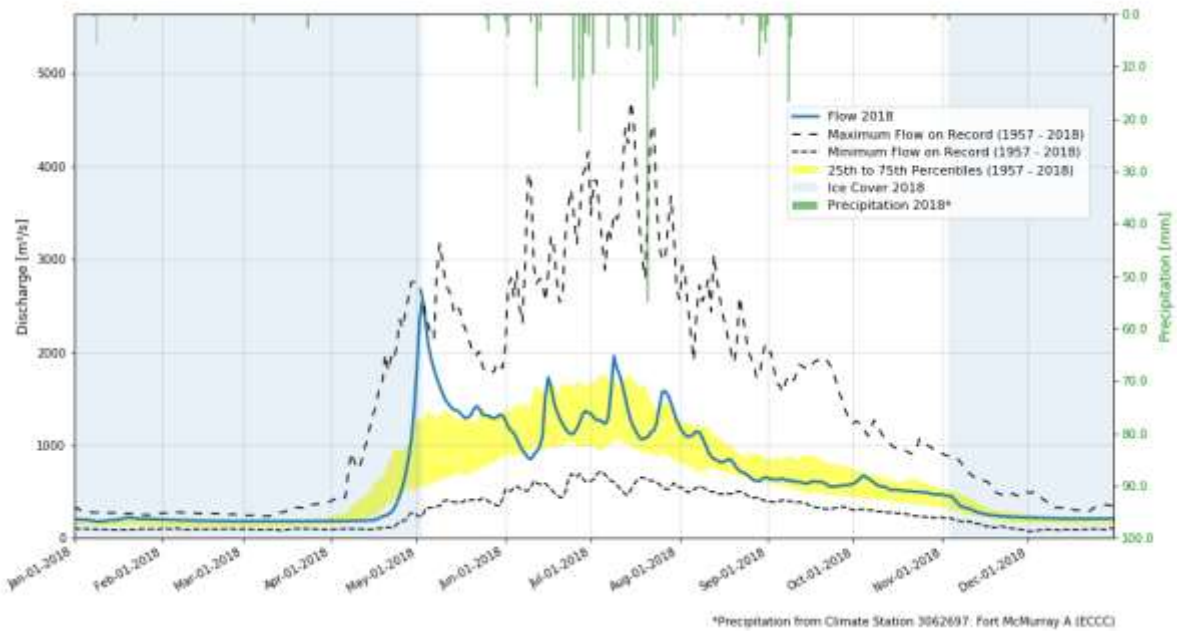


Figure 3: Annual Hydrograph for Station 07DA001 Athabasca River below Fort McMurray

### Tributary Contributions to the Athabasca Main Stem

A subset of tributary hydrometric stations located downstream of Fort McMurray (listed in Table 1) were assessed to determine the significance of contributions of sub basins lying to the east and west of the Athabasca River main stem in 2018. Annual hydrographs for these individual gauging stations are included in Appendix C.

Eastern Tributaries	Clearwater River at Draper (07CD001) Hangingstone River at Fort McMurray (07CD004) Steepbank River near Fort McMurray (07DA006) Muskeg River near Fort MacKay (07DA008) Firebag River near the Mouth (07DC001)
Western Tributaries	Poplar Creek near Fort McMurray (07DA007) Beaver River above Syncrude (07DA018) MacKay River near Fort MacKay (07DB001) Ells River at Canadian Natural Resources Limited Bridge (07DA032) Tar River near the Mouth (07DA045) Calumet River near the Mouth (07DA033) Eymundson Creek near the Mouth (07DA041) Big Creek near the Mouth (07DA040)

Table 1: Hydrometric stations used to assess contributions from eastern and western sides of the Athabasca River

The majority of the eastern tributaries in the Oil Sands area experienced normal to high peak discharges at breakup compared to previous years on record. With the exception of the Hangingstone and Steepbank Rivers, which recorded higher than average summer discharge events, the eastern tributaries recorded low to normal discharges throughout the remainder of the year. Overall, the 2018 mean discharge in the eastern tributaries downstream of Fort McMurray was less than the historical mean annual discharge (89.9%, on average).

The majority of western tributaries also experienced normal to high peak discharges at break-up compared to previous years on record. While the Calumet and Tar Rivers recorded normal conditions throughout the remainder of the year, the majority of western tributaries recorded higher than average

summer discharge events compared to previous years on record. Overall, the 2018 mean discharge in the western tributaries was greater than the historical mean annual discharge (117%, on average).

### Athabasca River at Embarras Airport (07DD001)

The hydrometric data for this station (Figure 4) indicates that spring break-up of ice occurred at the start of May, resulting in a new maximum mean daily flow for May 5<sup>th</sup> and overall a spring peak near to the historic maximum. For the remainder of the year, the measured flow was largely within the normal range of flows for this station. The 2018 mean flow of 682 m<sup>3</sup>/s is comparable with the historical mean annual flow of 693 m<sup>3</sup>/s over this station's period of record (from 1957-2018). Precipitation measured in 2018 at the nearby Meteorological Tower 1007 was also normal, at 99.2 % of the historical mean annual precipitation.

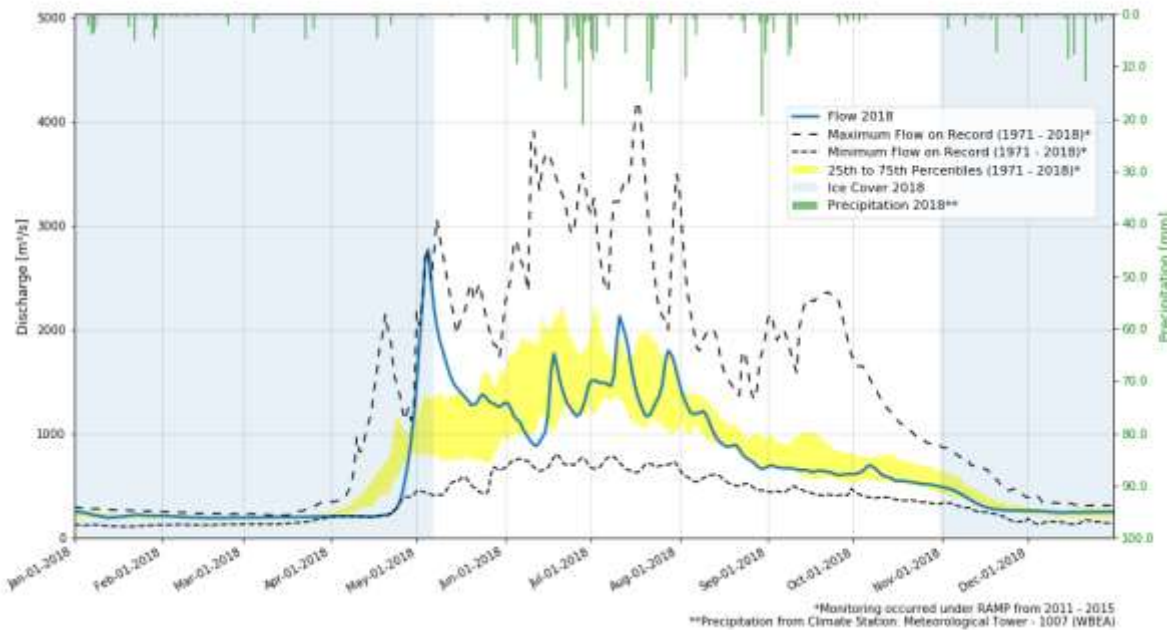


Figure 4: Annual Hydrograph for Station 07DD001 Athabasca River at Embarras Airport

### Summary

All four key stations measured higher than average spring flows coinciding with ice break-up at the start of May in 2018. However, the discharge measured at these stations largely fell within normal variability throughout the remainder of 2018.

Local contributions downstream of Fort McMurray were separated into the eastern and western tributaries. Many of the eastern tributaries showed normal to higher than average spring breakup, with lower than average discharge through the remainder of the year. The majority of the western tributaries experienced higher than average spring and summer discharge events. Overall, the 2018 mean discharge in the eastern tributaries was less than the mean annual discharge over the period of record (89.9%, on average), while the 2018 mean discharge in the western tributaries was greater than the mean annual discharge over the period of record (117%, on average).

Detailed hydrometric records for all stations operated by WSC in the Oil Sands area are publicly available on the Environment and Climate Change Canada Water Office website at <https://wateroffice.ec.gc.ca/>.

## Appendix A: Overview Maps – Alberta Oil Sands Area

Figure A1 shows all active hydrometric monitoring stations operated by WSC in 2018. Figure A2 shows all climate stations used to represent precipitation on the annual hydrographs included in the main body of this report and in Appendix C. Climate data was obtained from a number of sources, including Environment and Climate Change Canada (ECCC), Alberta Climate Information Service (ACIS), the Wood Buffalo Environmental Association (WBEA), and the Regional Aquatics Monitoring Program (RAMP).

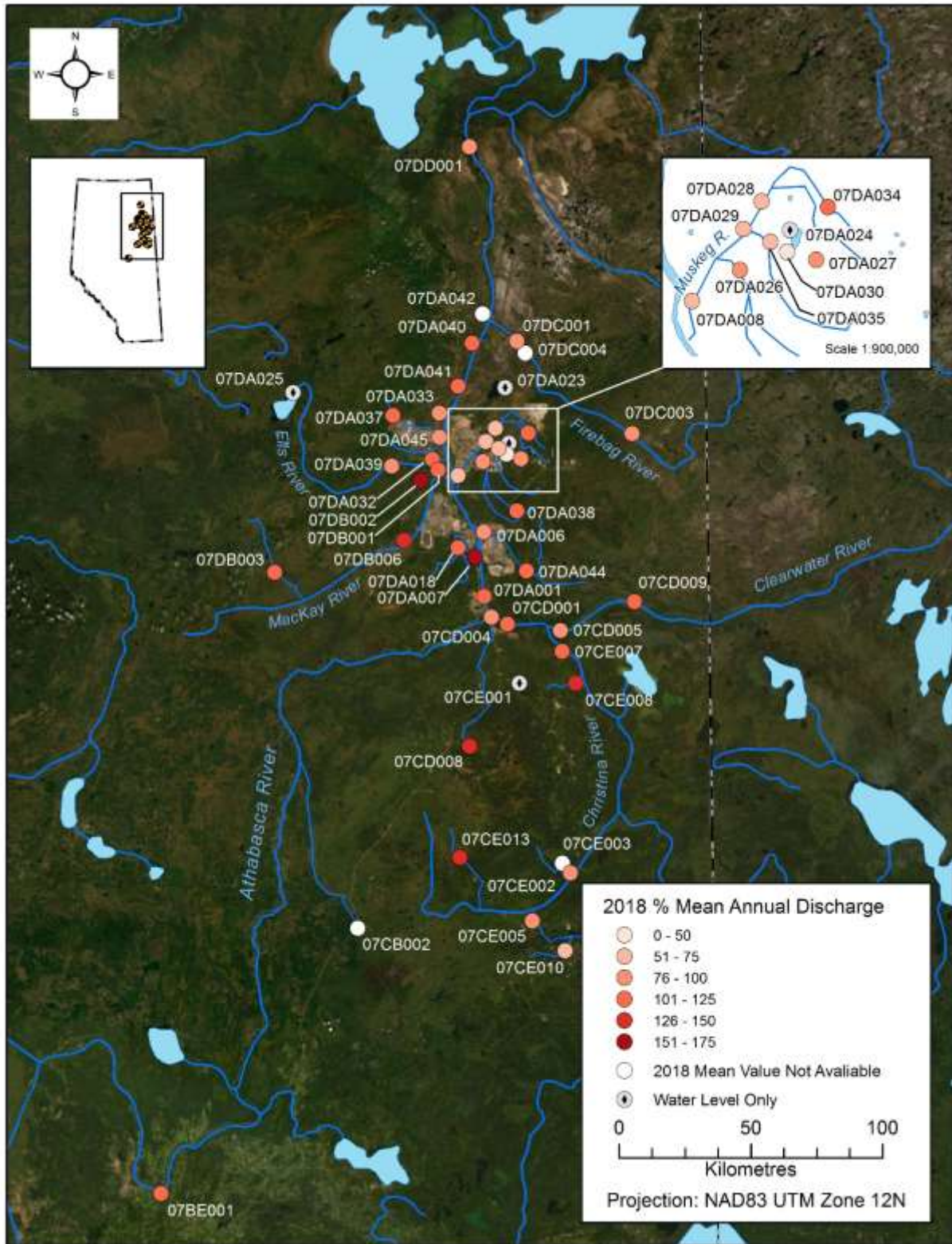


Figure A1: Active Hydrometric Stations in the Alberta Oil Sands Area in 2018

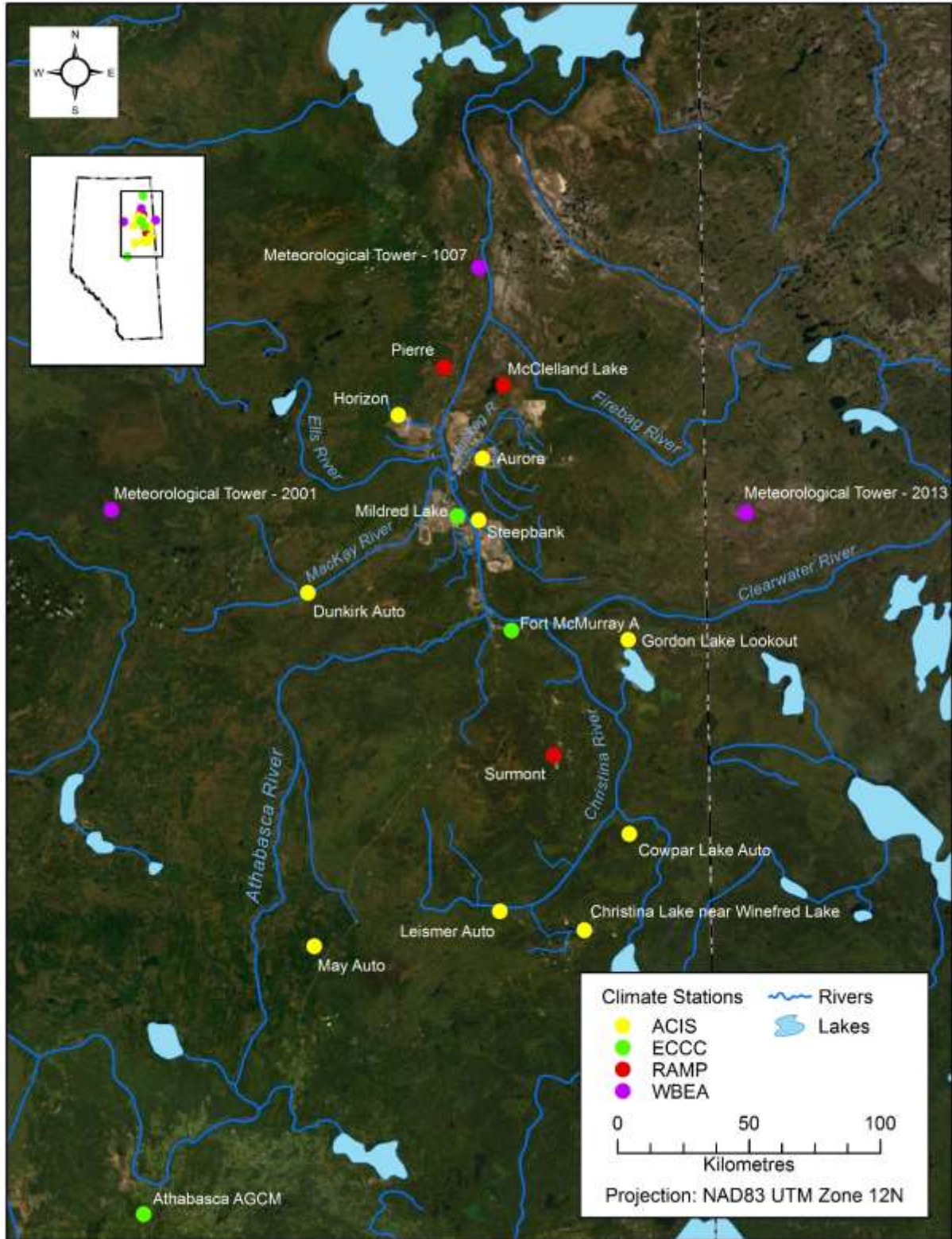


Figure A2: Climate Stations in the Alberta Oil Sands Area used in producing this Annual Report



## Appendix B: Summary – All Hydrometric Stations

The following tables summarize all active WSC hydrometric stations within the Oil Sands area in 2018. Table B1 provides a summary of all discharge stations, and Table B2 provides a summary of all level stations.

The provided mean annual discharge, mean annual yield, and mean annual level are calculated from historical water level or discharge at the selected hydrometric monitoring station over the entire period of record. This record includes monitoring that occurred under the Regional Aquatics Monitoring Program (RAMP), for which data is publicly available on the RAMP website at <http://www.ramp-alberta.org/ramp.aspx>. Data included from RAMP has not been verified by WSC.

For a given year in the record, the annual mean water level or discharge value is calculated by averaging all the daily water level or discharge values for that year. For consistency with data published on the Environment and Climate Change Canada Water Office website, the annual mean is not calculated when one or more daily mean values are missing, either because of operational problems, or where a seasonal operating schedule is in place. In those instances the data has been listed as N/A in the table.

Table B1: Discharge Station Summary

STATION NAME	STATION ID	PERIOD OF RECORD	GROSS DRAINAGE AREA [km <sup>2</sup> ]	2018 WATER YIELD [mm]	HISTORICAL MEAN ANNUAL WATER YIELD [mm]	2018 MEAN DISCHARGE [m <sup>3</sup> /s]	HISTORICAL MEAN ANNUAL DISCHARGE <sup>[1]</sup> [m <sup>3</sup> /s]	PERCENT OF HISTORICAL MEAN ANNUAL DISCHARGE [%]
ATHABASCA RIVER AT ATHABASCA	07BE001	1913 – 2018	74600	185	178	437	421	104
ATHABASCA RIVER AT EMBARRAS AIRPORT	07DD001	1971 – 2018 <sup>[1]</sup>	155000	139	141	682	693	98.4
ATHABASCA RIVER BELOW FORT MCMURRAY	07DA001	1957 – 2018	133000	150	146	632	617	102
BEAVER RIVER ABOVE SYNCRUDE	07DA018	1975 – 2018	165	126	101	0.660	0.530	125
BIG CREEK NEAR THE MOUTH	07DA040	2011 – 2018 <sup>[2]</sup>	323	35.6	31.0	0.364	0.317	115
CALUMET RIVER NEAR THE MOUTH	07DA033	2001 – 2018 <sup>[2]</sup>	175	14.3	14.6	0.079	0.081	97.4
CHRISTINA RIVER ABOVE STATOIL LEISMER	07CE013	2013 – 2018 <sup>[2]</sup>	1030	180	127	5.88	4.13	142
CHRISTINA RIVER NEAR CHARD	07CE002	1982 – 2018	4860	125	142	19.2	21.9	87.7
CHRISTINA RIVER NEAR THE MOUTH	07CE007	2011 – 2018 <sup>[2]</sup>	13200	124	106	51.9	44.2	117
CLEARWATER RIVER ABOVE CHRISTINA RIVER	07CD005	1966 – 2018	17000	137	137	73.6	73.7	99.9
CLEARWATER RIVER AT DRAPER	07CD001	1930 – 2018	30800	133	123	130	120	108
DOVER RIVER NEAR THE MOUTH	07DB002	1975 – 2018 <sup>[3]</sup>	963	67.2	41.3	2.05	1.26	163
DUNKIRK RIVER NEAR FORT MACKAY	07DB003	1975 – 2018 <sup>[3]</sup>	1570	83.0	77.4	4.13	3.85	107
EAST JACKPINE CREEK NEAR THE 1300 FT CONTOUR	07DA038	2007 – 2018 <sup>[2]</sup>	45	131	110	0.187	0.157	119
ELLS RIVER ABOVE JOSLYN CREEK DIVERSION	07DA039	2009 – 2018 <sup>[2]</sup>	2260	90.8	92.4	6.50	6.62	98.2
ELLS RIVER AT CANADIAN NATURAL RESOURCES LIMITED BRIDGE	07DA032	2004 – 2018 <sup>[2]</sup>	2430	96.6	86.5	7.44	6.66	112
EYMUNDSON CREEK NEAR THE MOUTH	07DA041	2011 – 2018 <sup>[2]</sup>	319	51.4	43.5	0.520	0.440	118
FIREBAG RIVER NEAR THE MOUTH	07DC001	1971 – 2018	5980	120	134	22.7	25.3	89.7
FIREBAG RIVER UPSTREAM OF SUNCOR FIREBAG	07DC003	2009 – 2018 <sup>[2]</sup>	2420	118	118	9.07	9.04	100
GREGOIRE RIVER NEAR THE MOUTH	07CE008	2012 – 2018 <sup>[2]</sup>	1000	160	114	5.06	3.61	140
HANGINGSTONE RIVER AT FORT MCMURRAY	07CD004	1965 – 2018	962	113	126	3.45	3.83	90.1
HANGINGSTONE RIVER AT NORTH STAR ROAD	07CD008	2002 – 2018 <sup>[2]</sup>	113	218	147	0.782	0.528	148
HIGH HILL RIVER NEAR THE MOUTH	07CD009	2012 – 2018 <sup>[2]</sup>	1360	117	103	5.03	4.42	114
HOUSE RIVER AT HIGHWAY NO. 63	07CB002	1982 – 2018	781	N/A	N/A	N/A	N/A	N/A
IYINIMIN CREEK ABOVE KEARL LAKE	07DA027	1989 – 2018 <sup>[2]</sup>	43	108	108	0.147	0.147	100
JACKFISH RIVER BELOW CHRISTINA LAKE	07CE005	1982 – 2018 <sup>[3]</sup>	1290	107	120	4.37	4.91	89.0
JACKPINE CREEK AT CANTERRA ROAD	07DA026	1995 – 2018 <sup>[2]</sup>	343	90.9	92.9	0.988	1.01	97.8
KEARL LAKE OUTLET	07DA030	1989 – 2018 <sup>[2]</sup>	83	27.9	59.3	0.073	0.156	47.1

Table continued on next page...

STATION NAME	STATION ID	PERIOD OF RECORD	GROSS DRAINAGE AREA [km <sup>2</sup> ]	2018 WATER YIELD [mm]	HISTORICAL MEAN ANNUAL WATER YIELD [mm]	2018 MEAN DISCHARGE [m <sup>3</sup> /s]	HISTORICAL MEAN ANNUAL DISCHARGE <sup>[1]</sup> [m <sup>3</sup> /s]	PERCENT OF HISTORICAL MEAN ANNUAL DISCHARGE [%]
MACKAY RIVER AT PETRO-CANADA BRIDGE	07DB006	2008 – 2018 <sup>[2]</sup>	4130	90.2	68.4	11.8	8.95	132
MACKAY RIVER NEAR FORT MACKAY	07DB001	1972 – 2018	5570	84.4	75.4	14.9	13.3	112
MCCLELLAND LAKE OUTLET ABOVE FIREBAG RIVER	07DC004	2008 – 2018 <sup>[2]</sup>	359	N/A	50.0	N/A	0.569	N/A
MUSKEG CREEK NEAR THE MOUTH	07DA035	1989 – 2018 <sup>[2]</sup>	322	48.5	84.8	0.495	0.865	57.2
MUSKEG RIVER ABOVE MUSKEG CREEK	07DA029	1995 – 2018 <sup>[2]</sup>	567	38.0	70.1	0.682	1.26	54.1
MUSKEG RIVER ABOVE STANLEY CREEK	07DA028	2003 – 2018 <sup>[2]</sup>	440	38.9	67.3	0.543	0.939	57.8
MUSKEG RIVER NEAR FORT MACKAY	07DA008	1974 – 2018	1460	48.0	78.0	2.22	3.61	61.5
MUSKEG RIVER UPLAND	07DA034	2001 – 2018 <sup>[2]</sup>	150	66.5	60.2	0.316	0.286	110
PONY CREEK NEAR CHARD	07CE003	1982 – 2018	279	N/A	N/A	N/A	N/A	N/A
POPLAR CREEK NEAR FORT MCMURRAY	07DA007	1972 – 2018 <sup>[4]</sup>	151	303	196	1.45	0.94	154
RED CLAY CREEK NEAR THE MOUTH	07DA042	2011 – 2018 <sup>[2]</sup>	N/A	N/A	N/A	N/A	N/A	N/A
STEEP BANK RIVER BELOW NORTH STEEP BANK RIVER	07DA044	2014 – 2018 <sup>[2]</sup>	1180	136	124	5.10	4.62	110
STEEP BANK RIVER NEAR FORT MCMURRAY	07DA006	1972 – 2018	1320	122	122	5.11	5.09	100
SUNDAY CREEK ABOVE CHRISTINA LAKE	07CE010	2012 – 2018 <sup>[2]</sup>	365	90.8	167	1.05	1.93	54.4
TAR RIVER ABOVE CANADIAN NATURAL RESOURCES LIMITED LAKE	07DA037	2005 – 2018 <sup>[2]</sup>	143	93.3	83.0	0.423	0.376	113
TAR RIVER NEAR THE MOUTH	07DA045	2007 – 2018 <sup>[2]</sup>	320	29.0	29.0	0.294	0.294	100

<sup>[1]</sup> Monitoring occurred under RAMP from 2011-2015.

<sup>[2]</sup> Monitoring occurred under RAMP prior to 2017.

<sup>[3]</sup> Monitoring occurred under RAMP from 2012 – 2016.

<sup>[4]</sup> Monitoring occurred under RAMP from 1996 – 2016.

Table B2: Level Stations

STATION NAME	STATION ID	RECORD	DATUM	2018 MEAN LEVEL [m]	HISTORICAL MEAN ANNUAL LEVEL [m]	DIFFERENCE [m]
GREGOIRE LAKE NEAR FORT MCMURRAY	07CE001	1969 – 2018	Geodetic Survey of Canada	N/A	N/A	N/A
KEARL LAKE AT CANTERRA ROAD <sup>[1]</sup>	07DA024	2017 – 2018	Assumed	99.52	99.52	0
MCCLELLAND LAKE AT EAST END	07DA023	1997 – 2018 <sup>[2]</sup>	Assumed	N/A	294.564	N/A
NAMUR LAKE NEAR THE OUTLET	07DA025	2012 – 2018 <sup>[2]</sup>	Assumed	97.774	97.817	-0.043

<sup>[1]</sup> Water level data collected prior to October 21, 2017 at hydrometric station KEARL LAKE AT CANTERRA ROAD is not included in this assessment due to a shift in the assumed datum used for monitoring.

<sup>[2]</sup> Monitoring occurred under RAMP prior to 2017.

## Appendix C: Annual Hydrographs – All Hydrometric Stations

The following figures show the annual hydrographs for all active stations within the Oil Sands area in 2018. Each hydrograph includes the measured discharges/levels for 2018, the maximum and minimum discharge/level on record for each station, and the interquartile range of flows/levels (between the 25<sup>th</sup> and 75<sup>th</sup> percentiles) based on daily mean measurements over the entire period of record. Note that percentiles are not shown when the period of record does not include at least 5 years of data for a given day. As noted in Appendix B, this record includes monitoring that occurred under the Regional Aquatics Monitoring Program (RAMP). Data included from RAMP has not been verified by WSC.

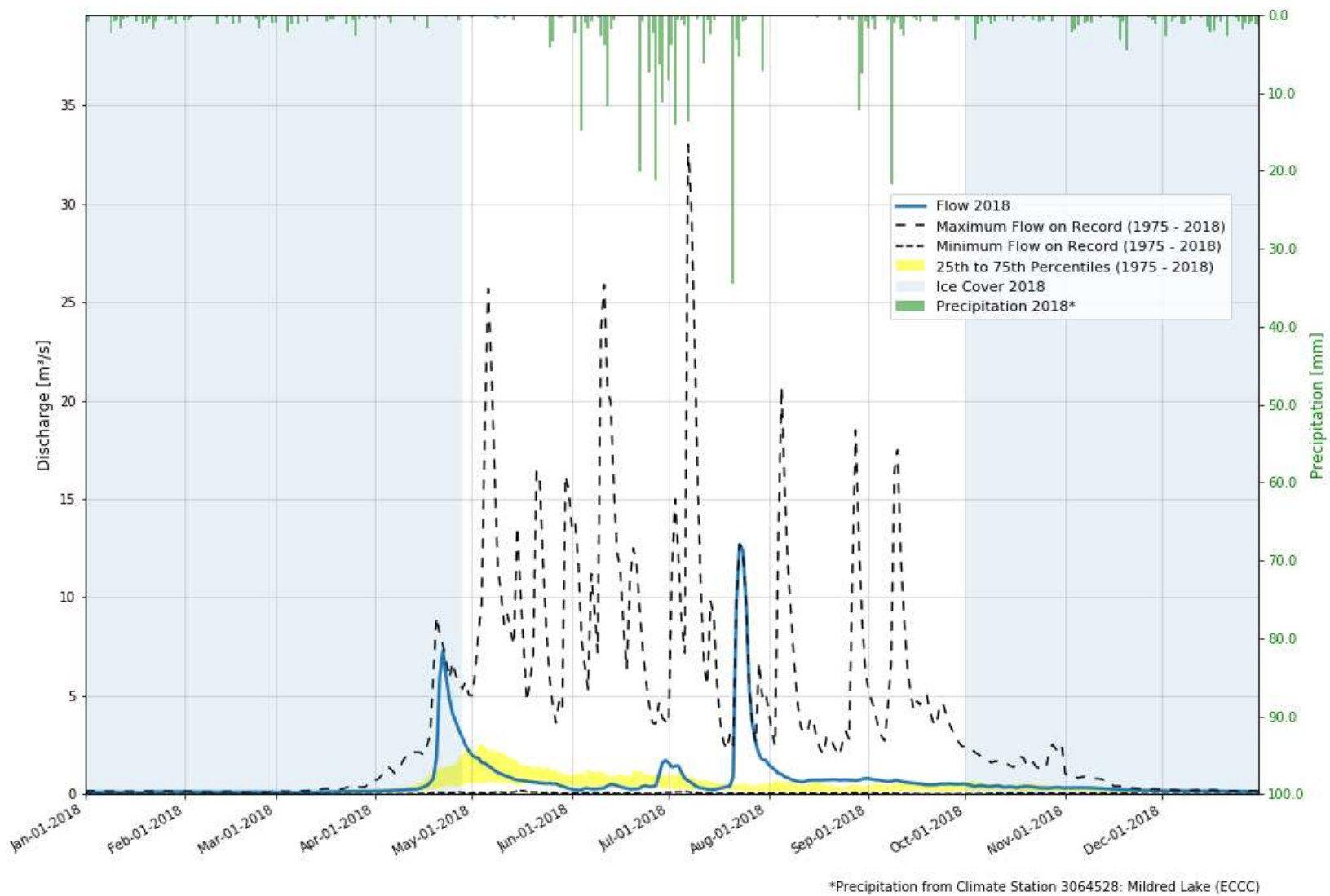


Figure C1: Beaver River above Syncrude (07DA018)

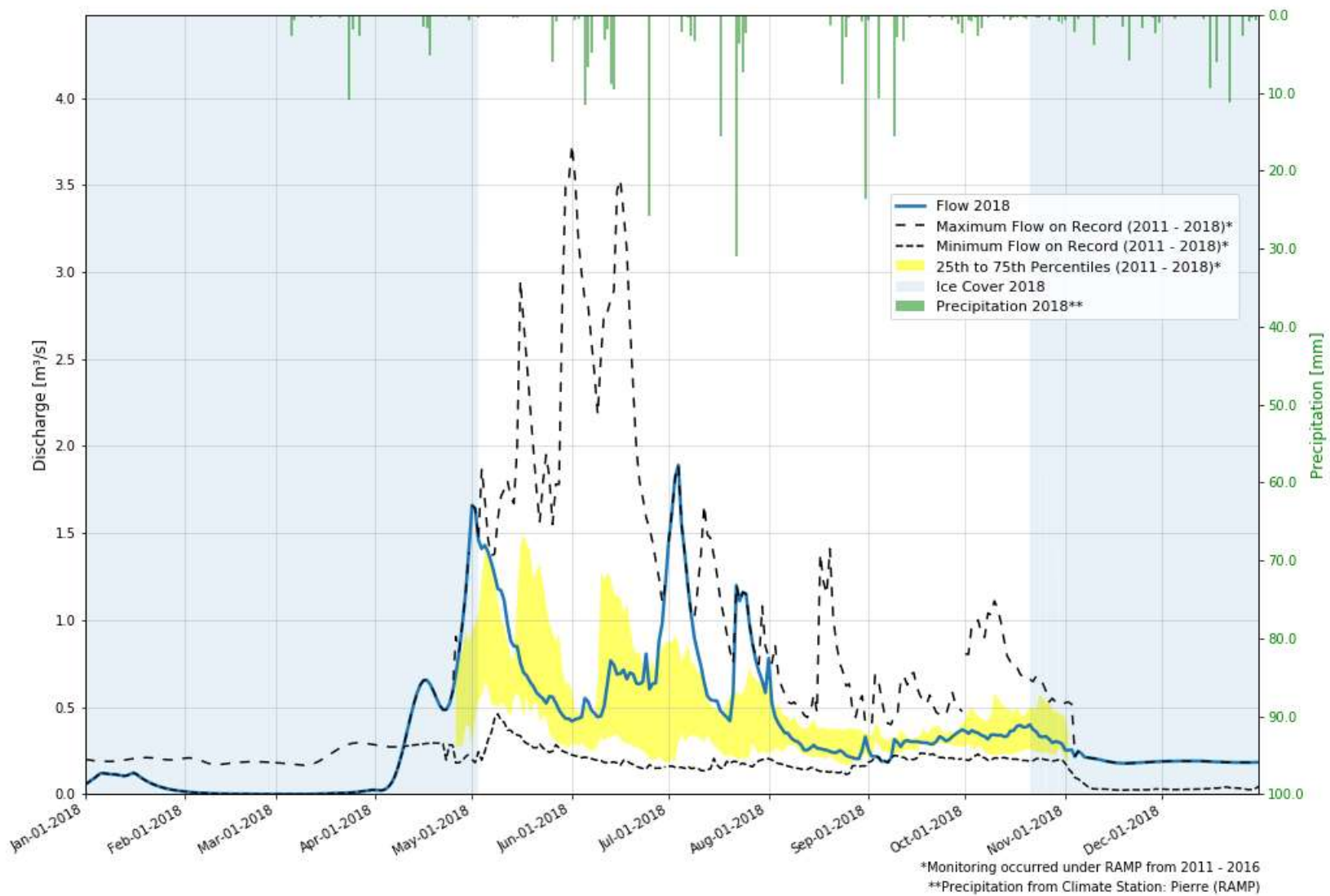


Figure C2: Big Creek near the Mouth (07DA040)

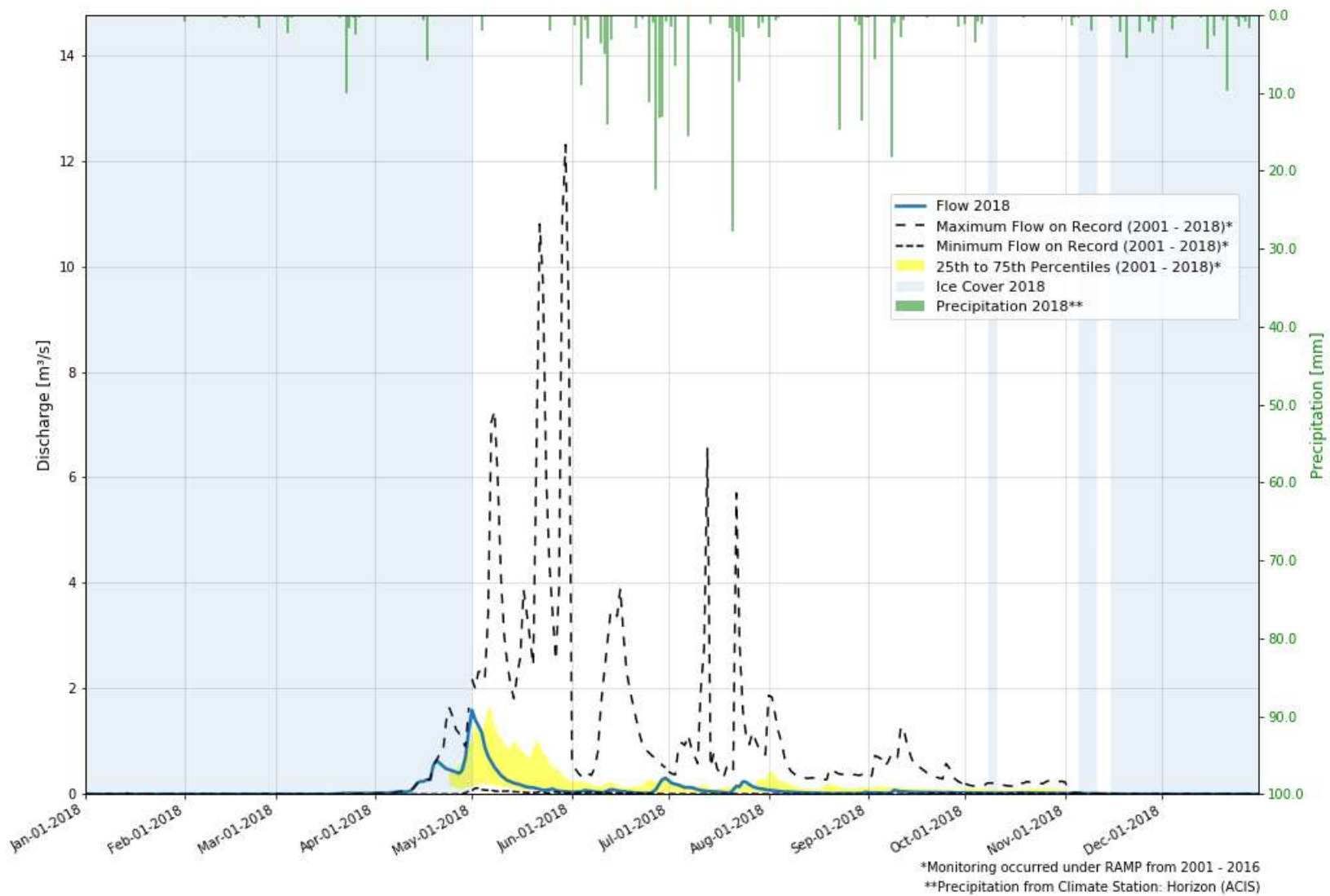


Figure C3: Calumet River near the Mouth (07DA033)



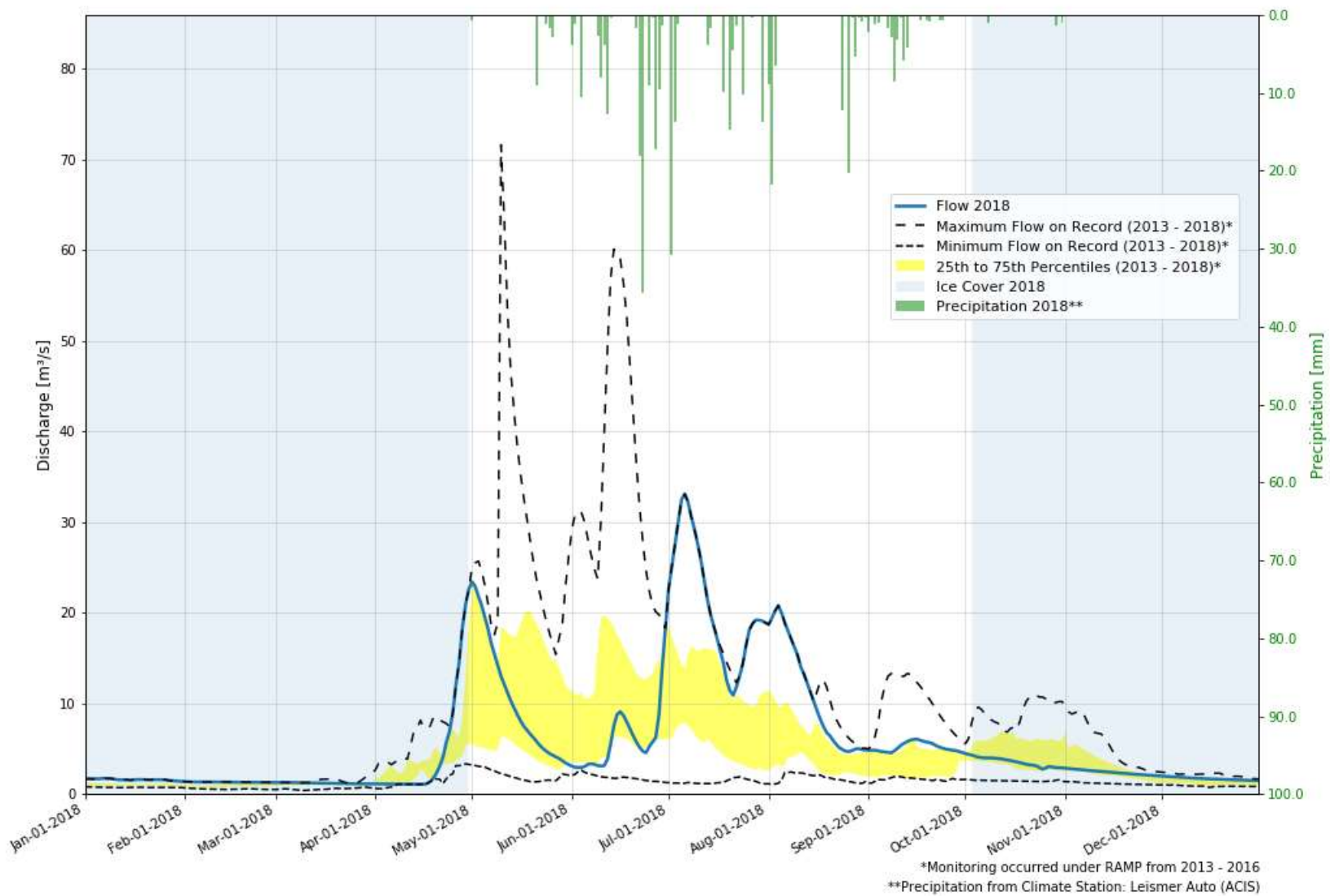


Figure C4: Christina River above Statoil Leismer (07CE013)

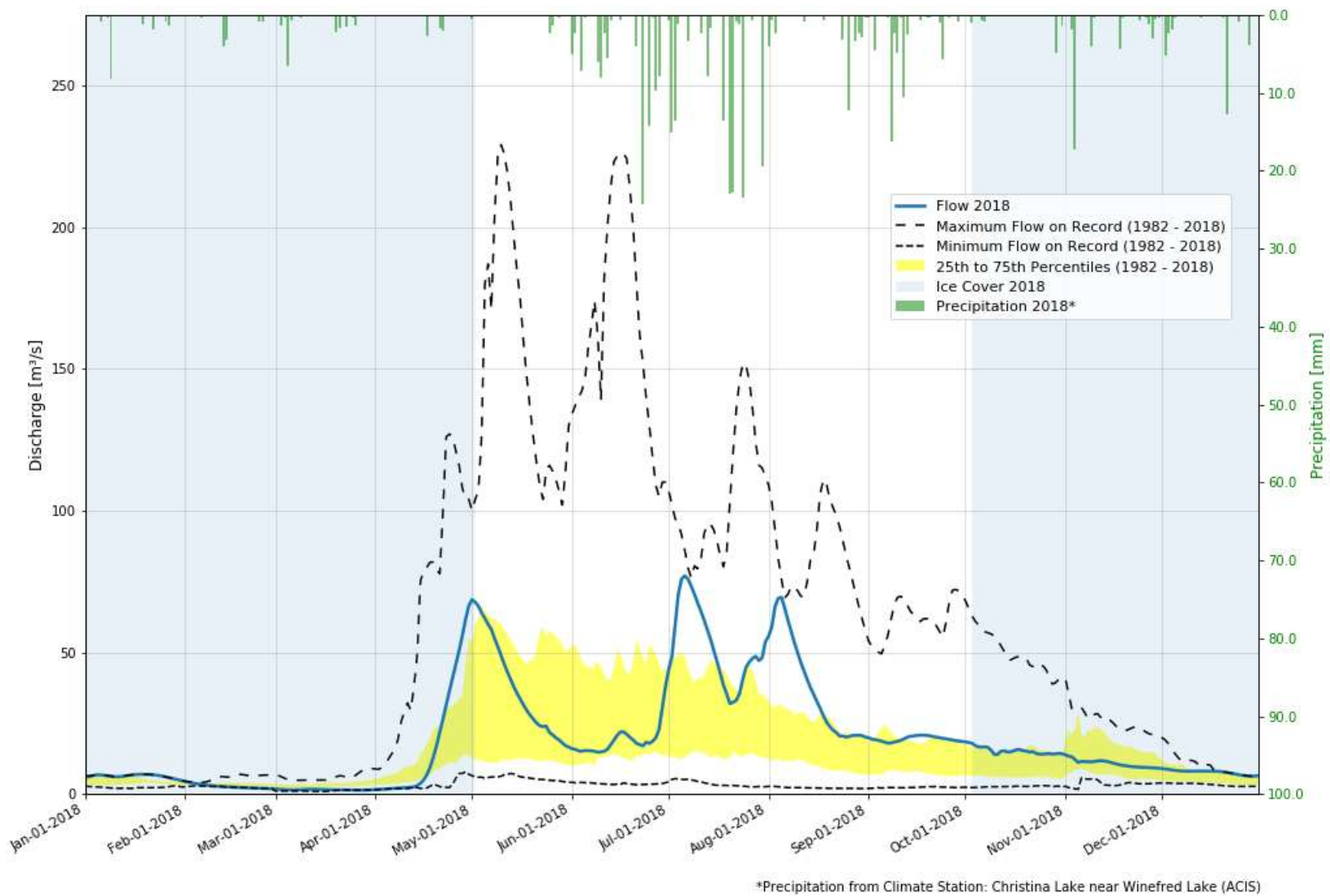


Figure C5: Christina River near Chard (07CE002)

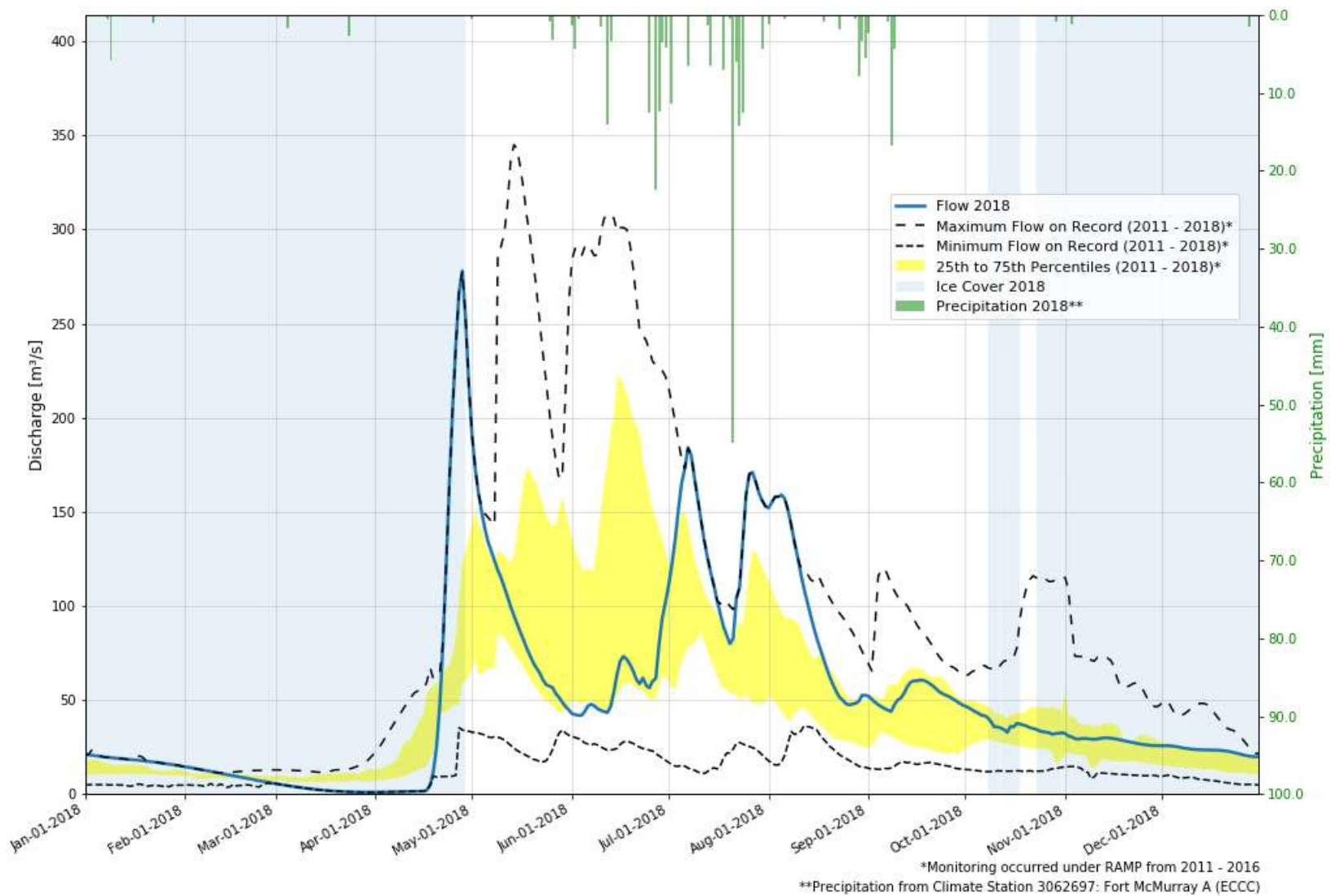


Figure C6: Christina River near the Mouth (07CE007)

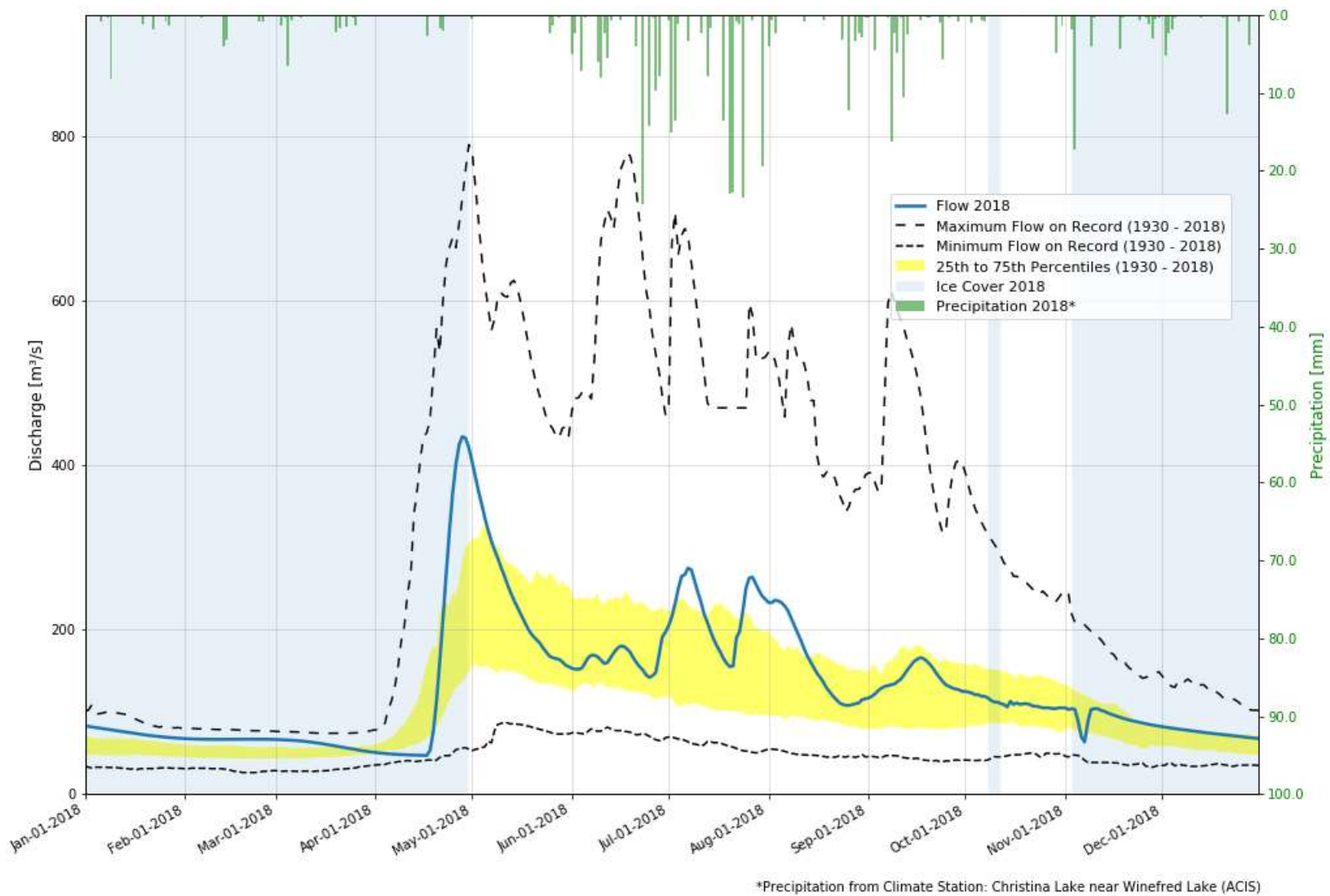


Figure C7: Clearwater River at Draper (07CD001)

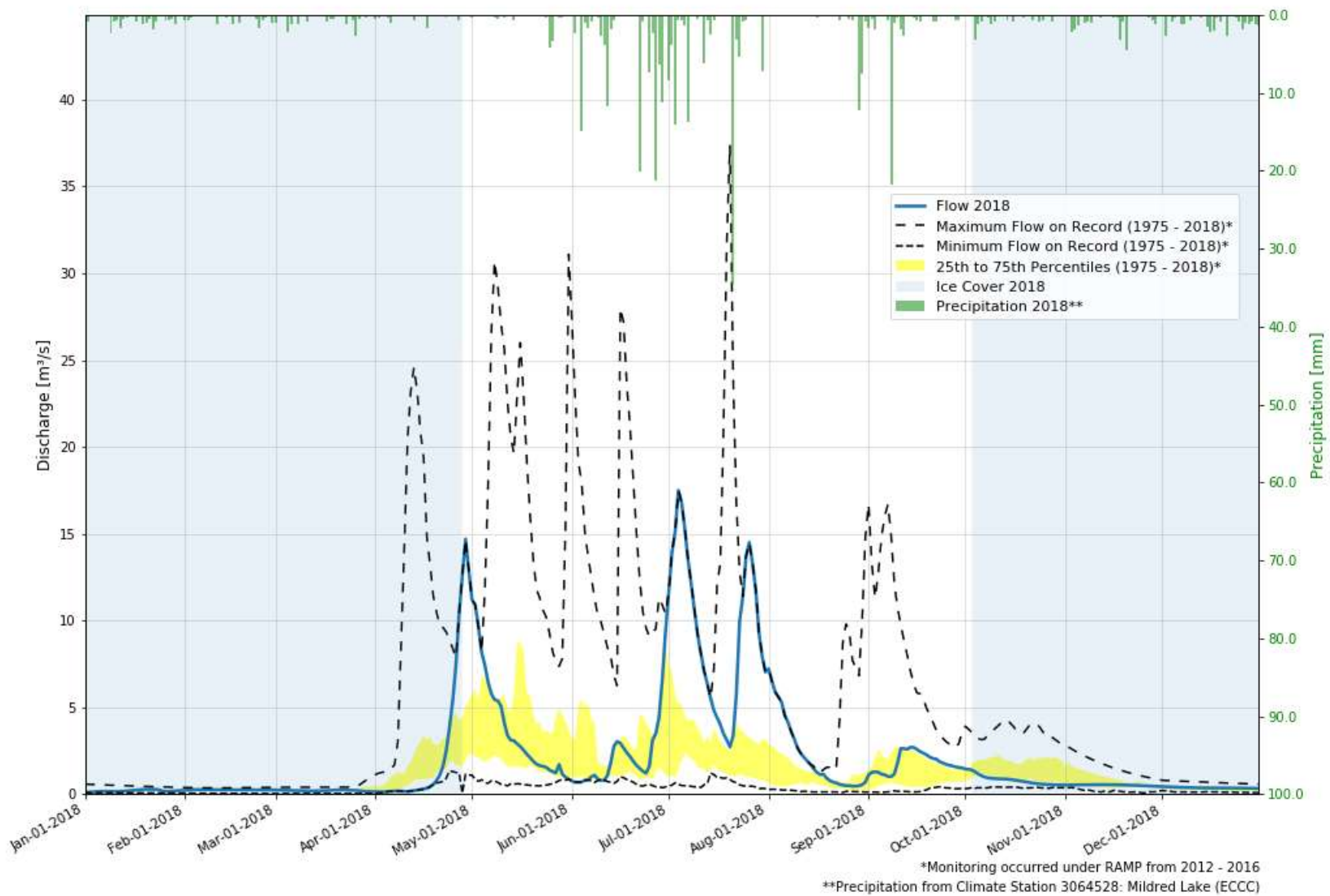


Figure C8: Dover River near the Mouth (07DB002)

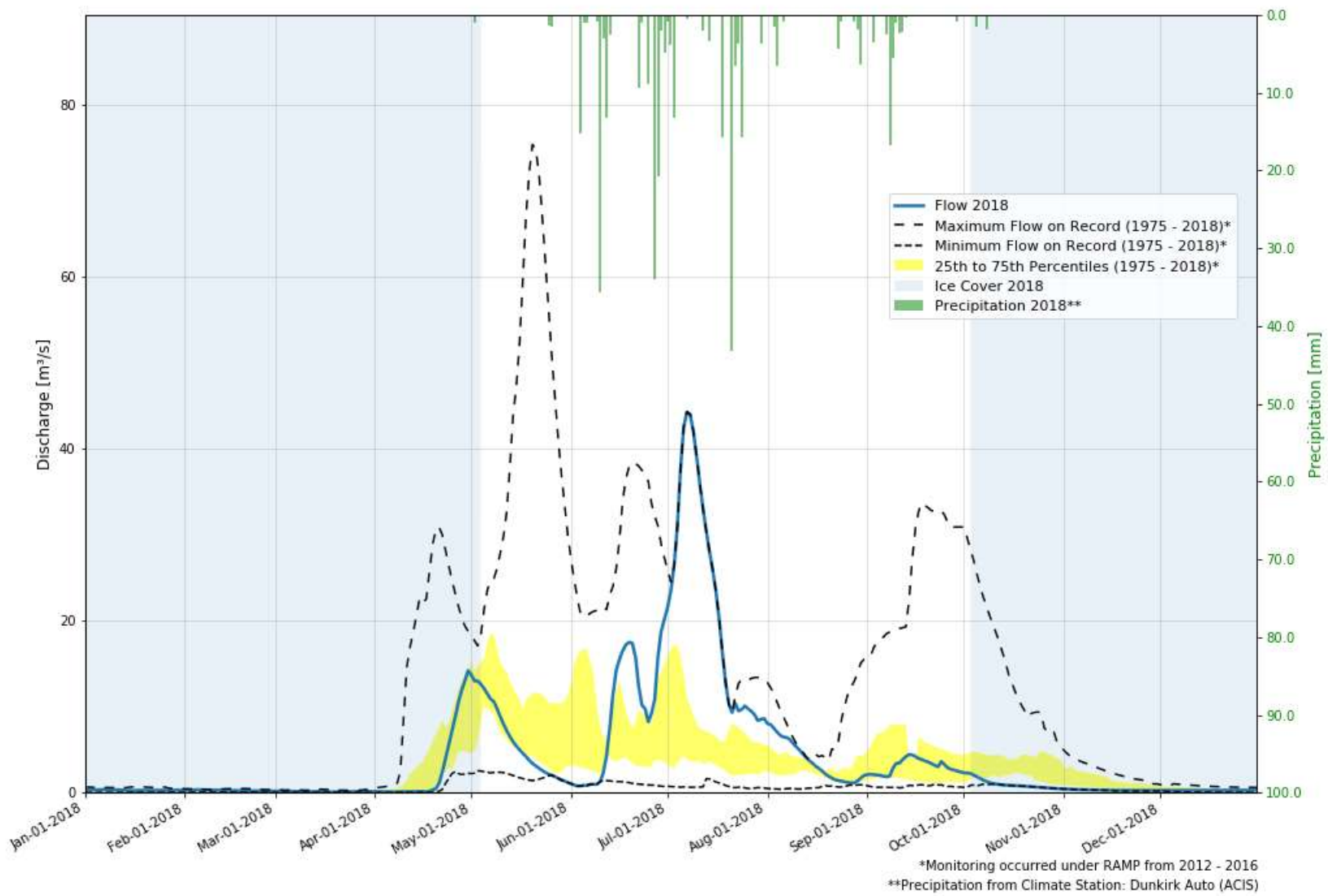


Figure C9: Dunkirk River near Fort MacKay (07DB003)

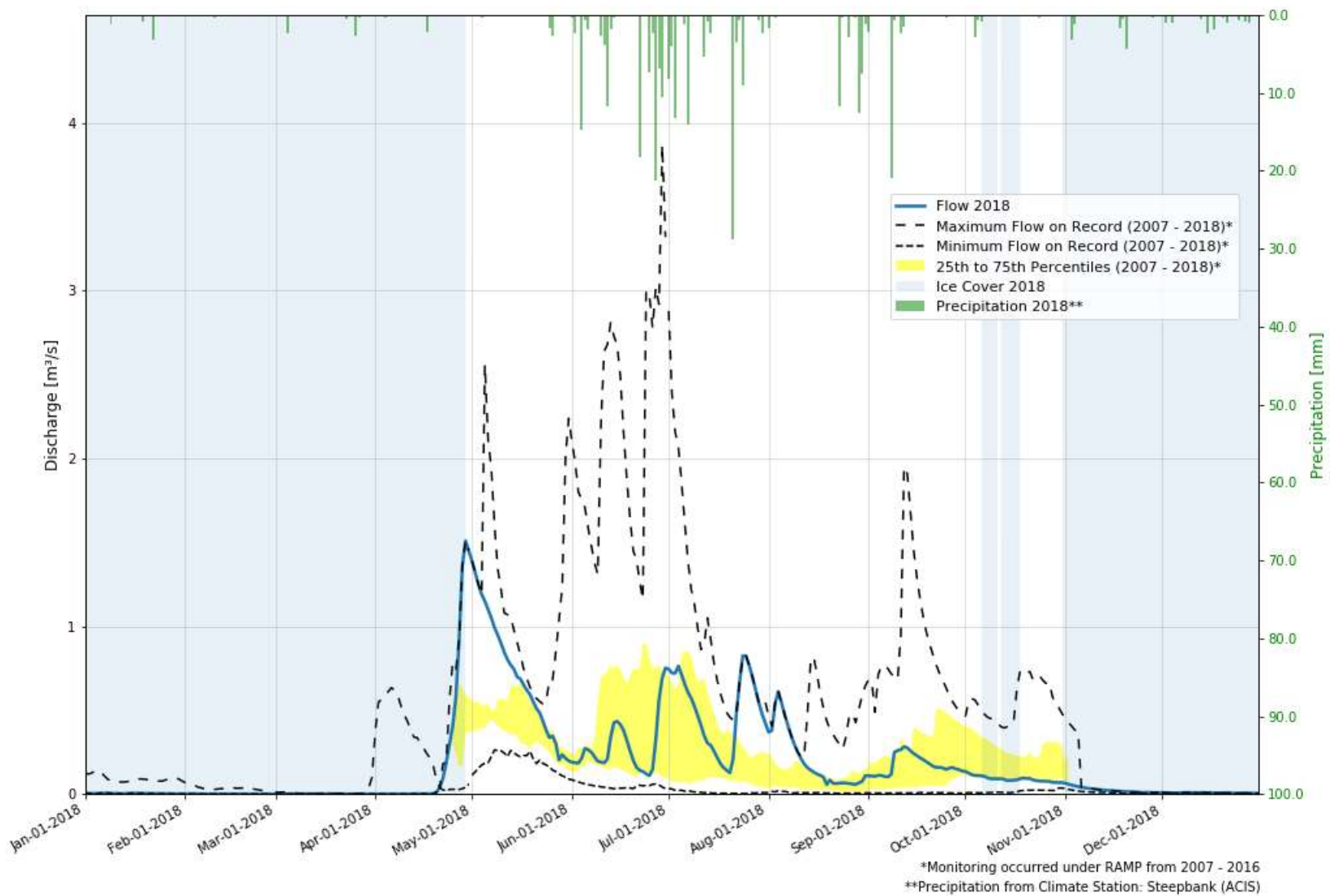


Figure C10: East Jackpine Creek near the 1300 FT Contour (07DA038)

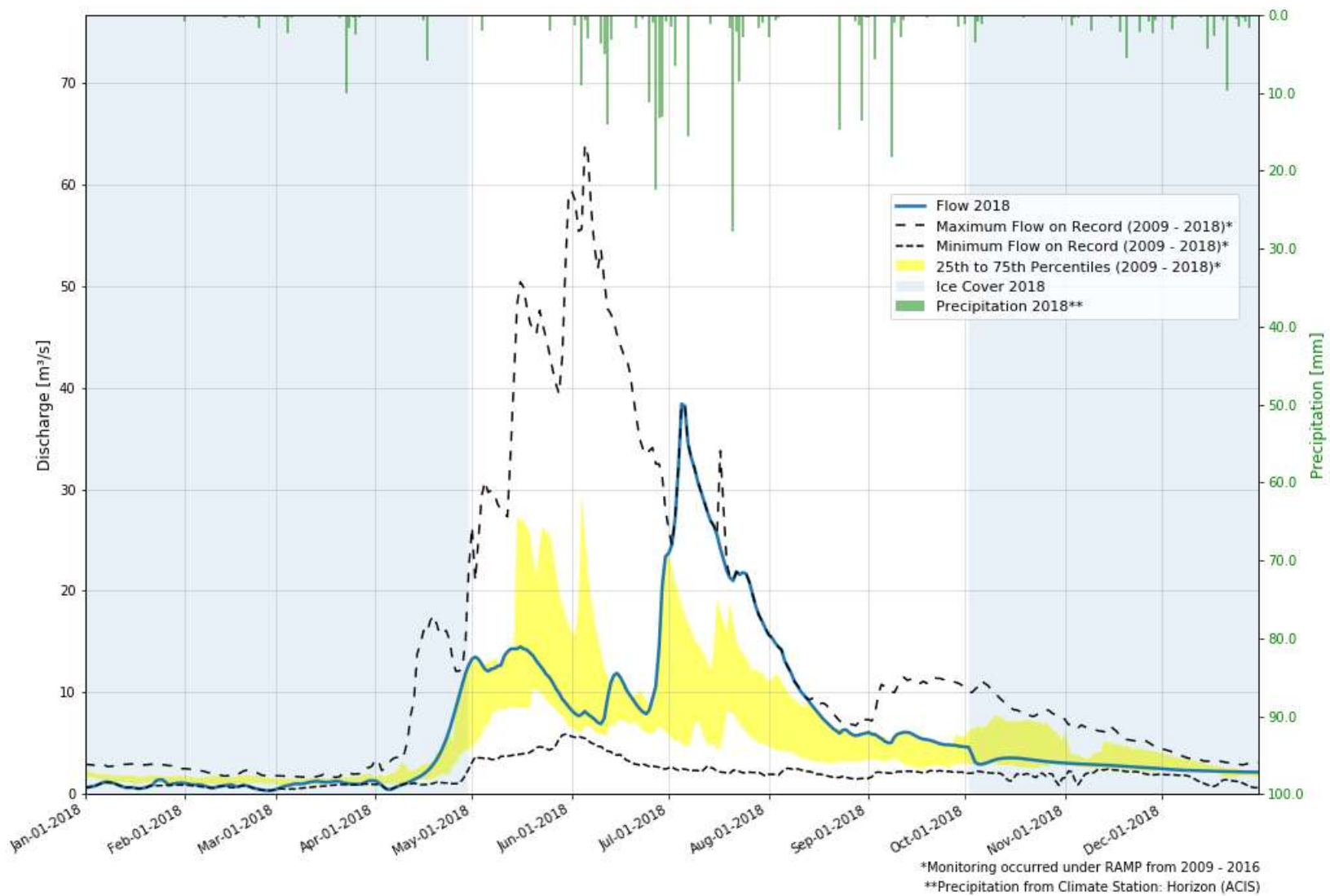


Figure C11: Ells River above Joslyn Creek Diversion (07DA039)



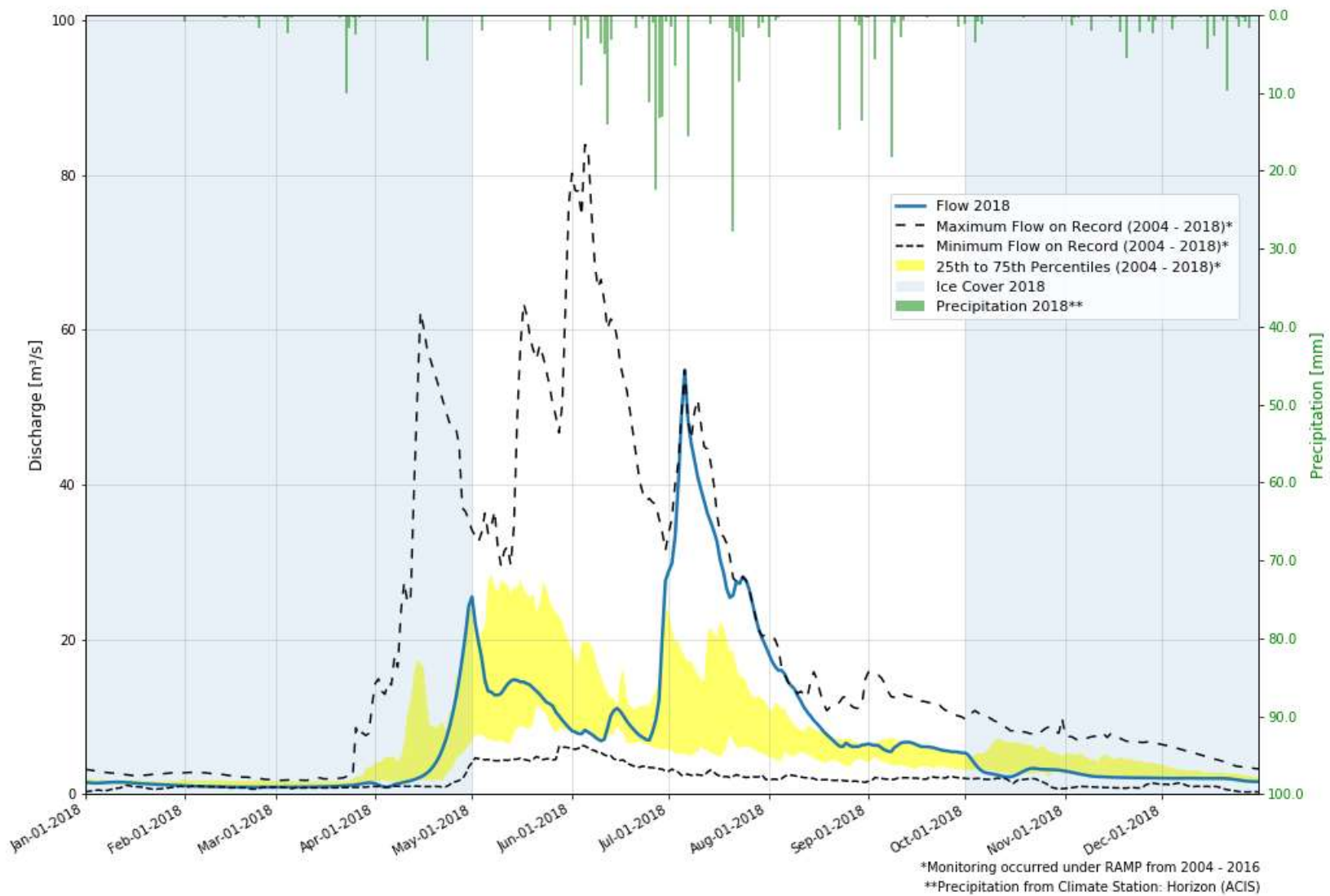


Figure C12: Ells River at Canadian National Resources Limited Bridge (07DA032)

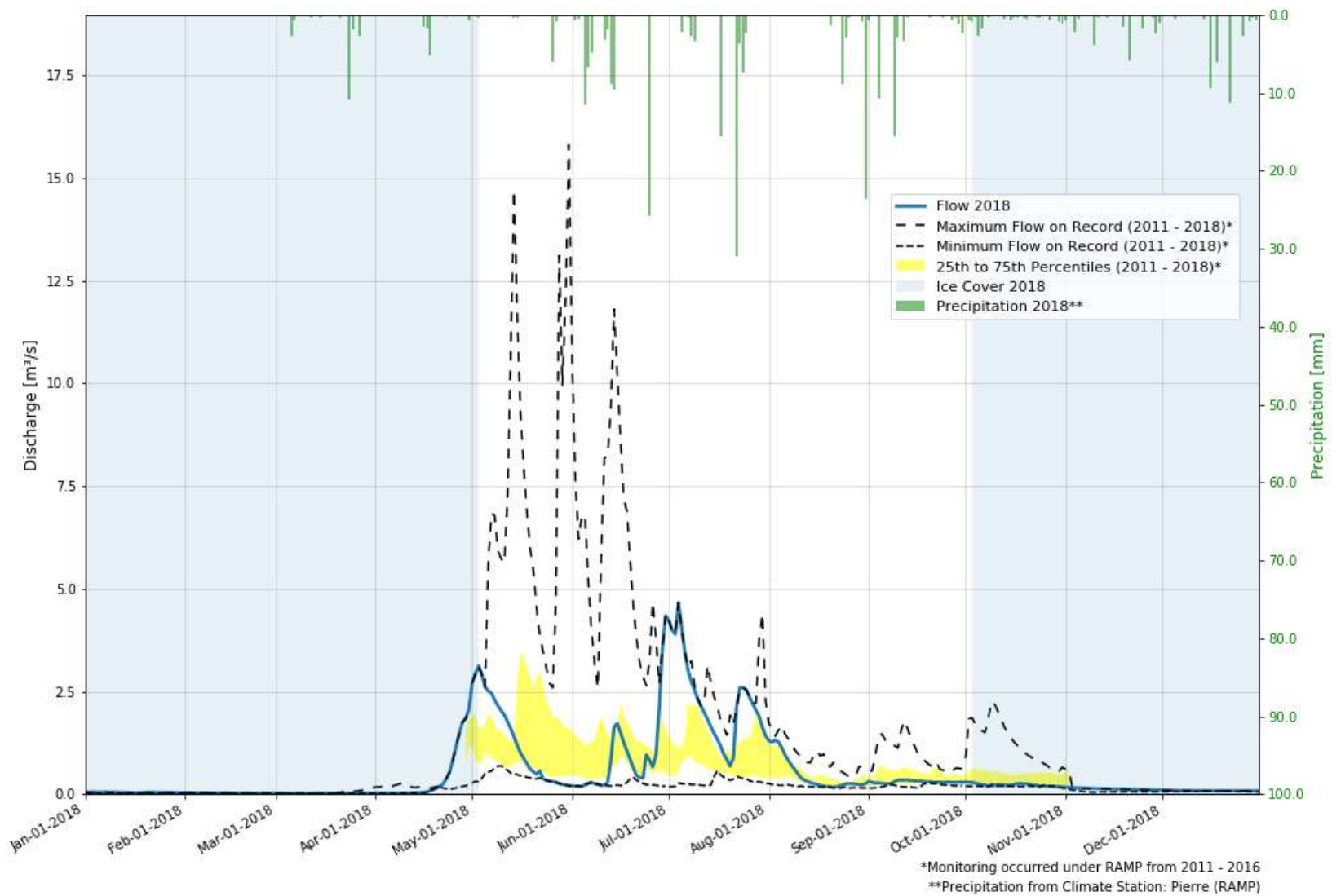


Figure C13: Eymundson Creek near the Mouth (07DA041)

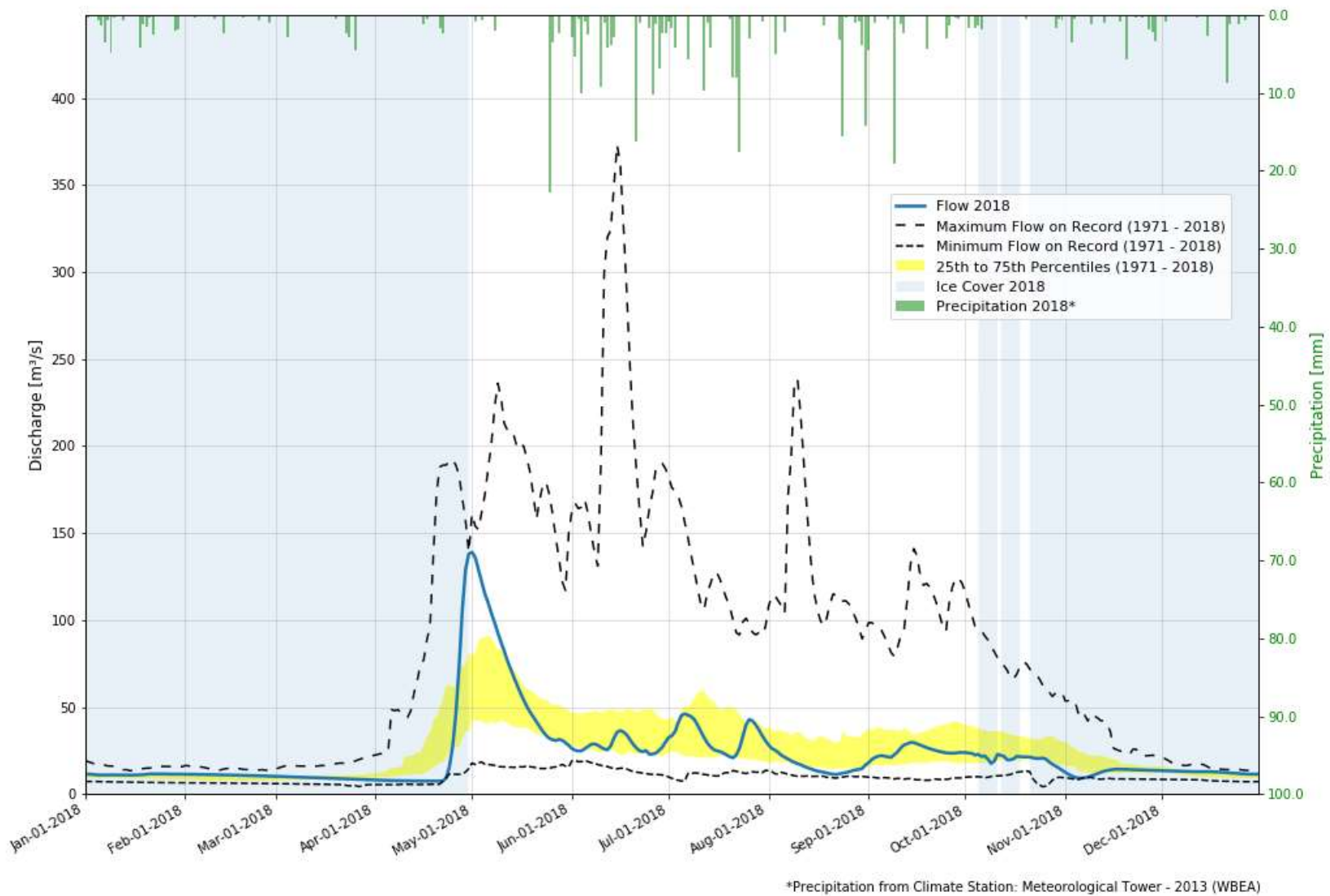


Figure C14: Firebag River near the Mouth (07DC001)

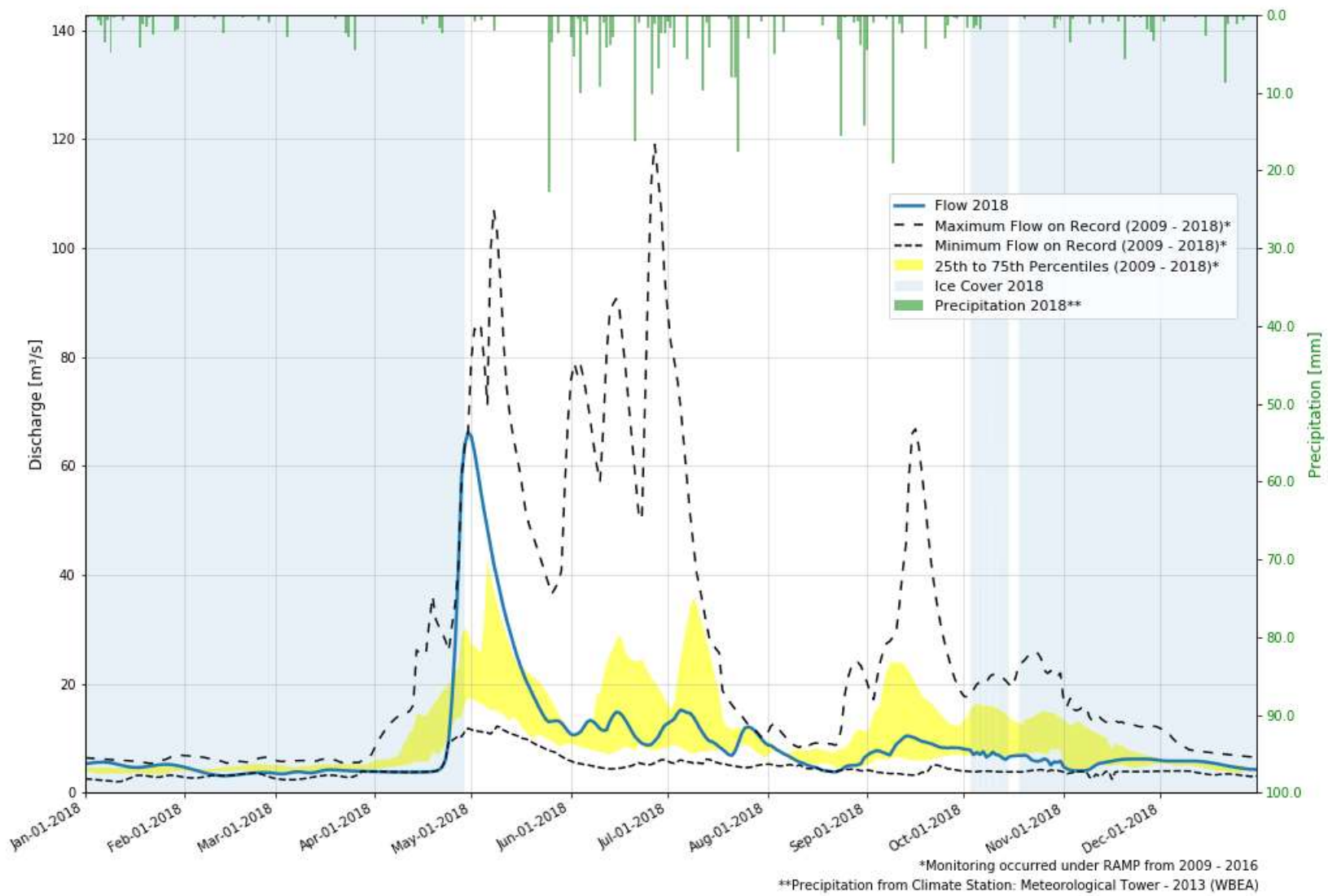


Figure C15: Firebag River upstream of Suncor Firebag (07DC003)

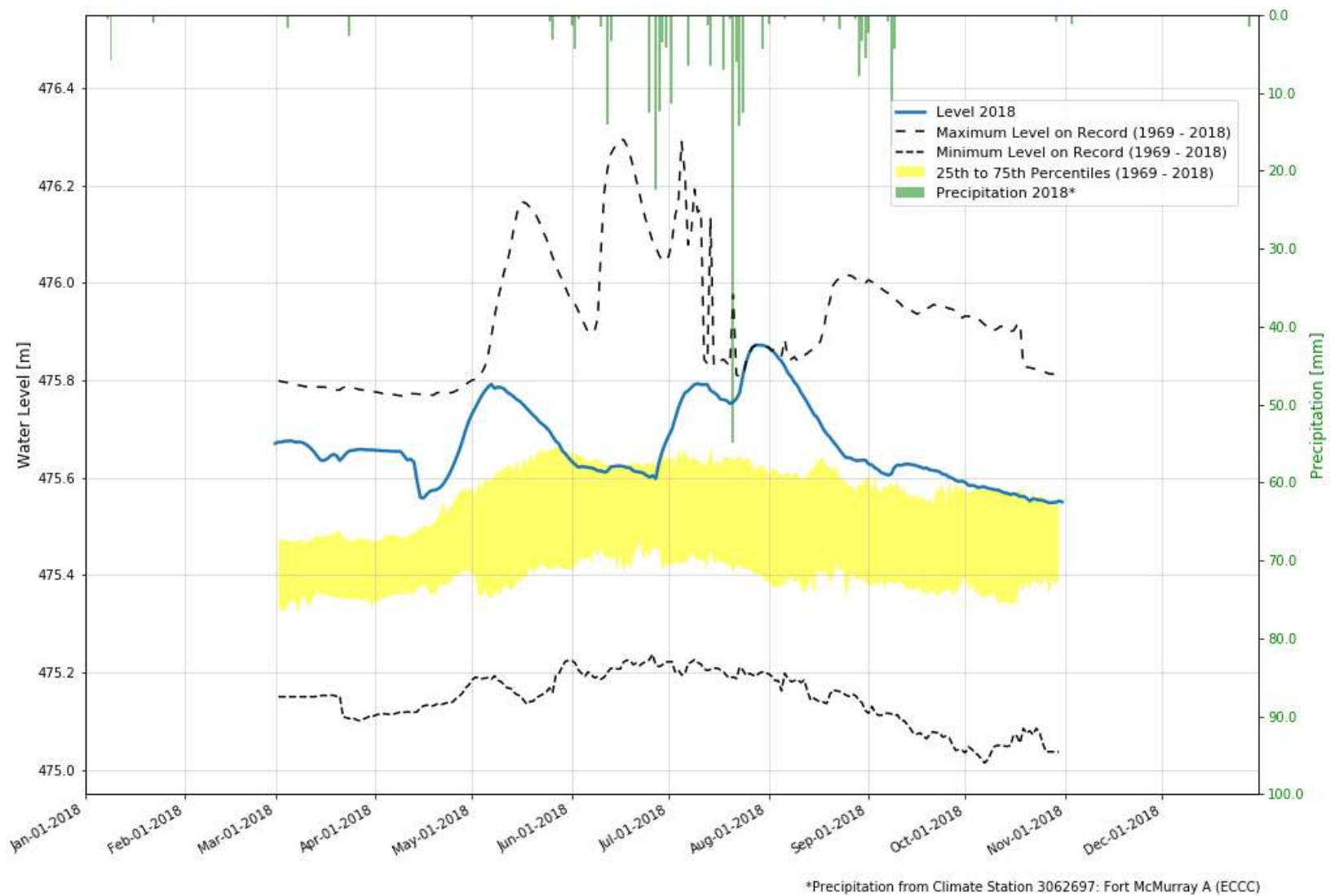


Figure C16: Gregoire Lake near Fort McMurray (07CE001)

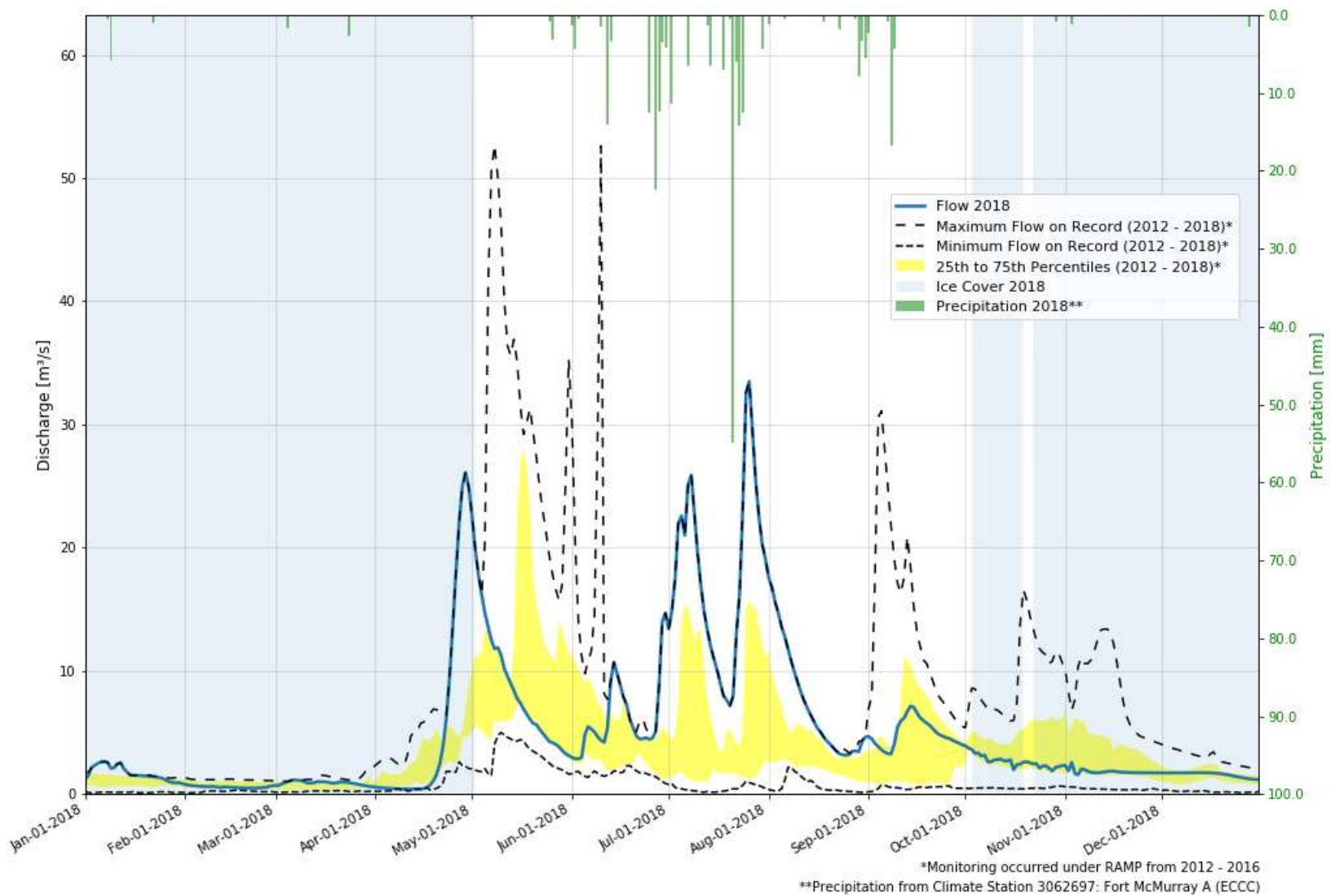


Figure C17: Gregoire River near the Mouth (07CE008)

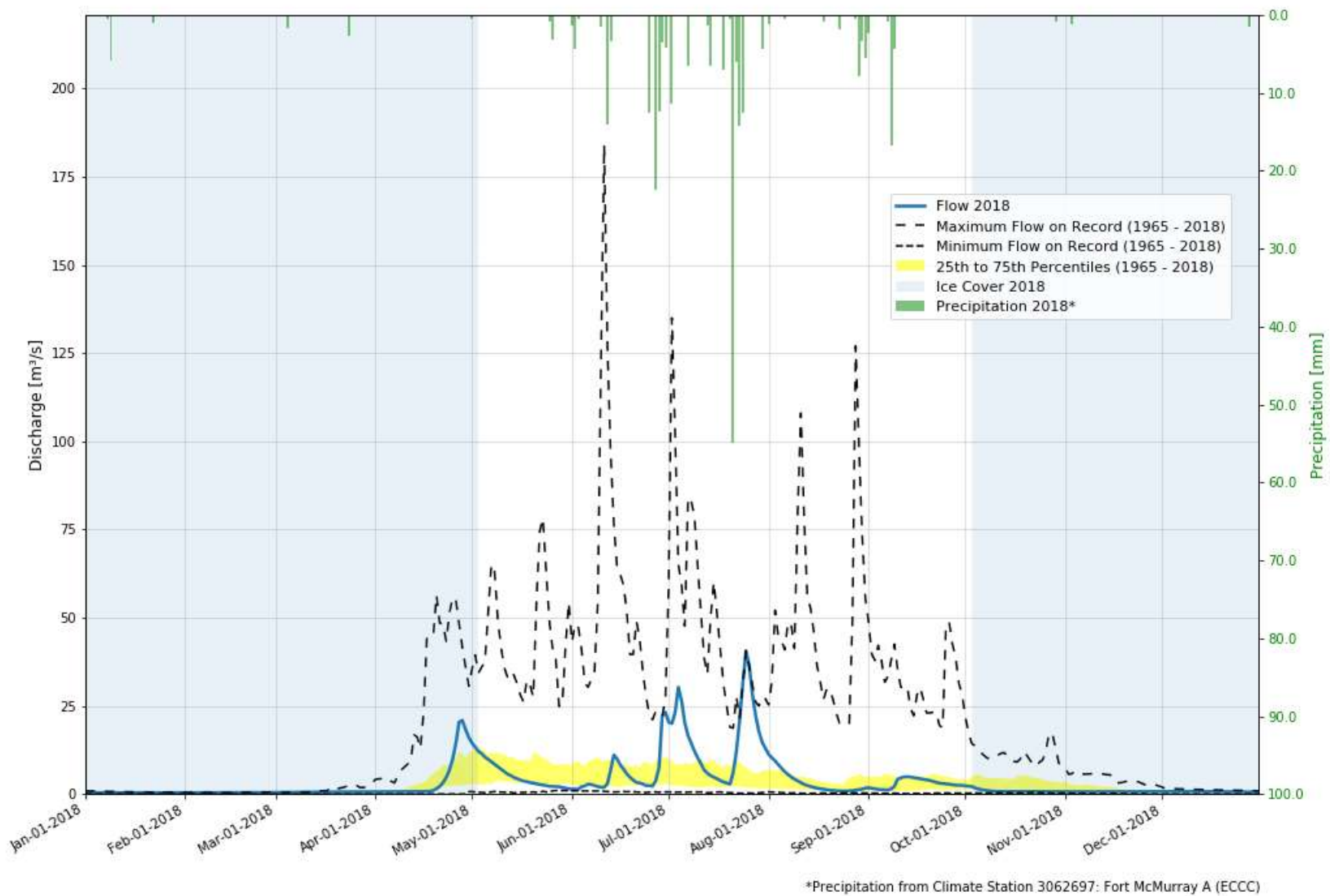


Figure C18: Hangingstone River at Fort McMurray (07CD004)

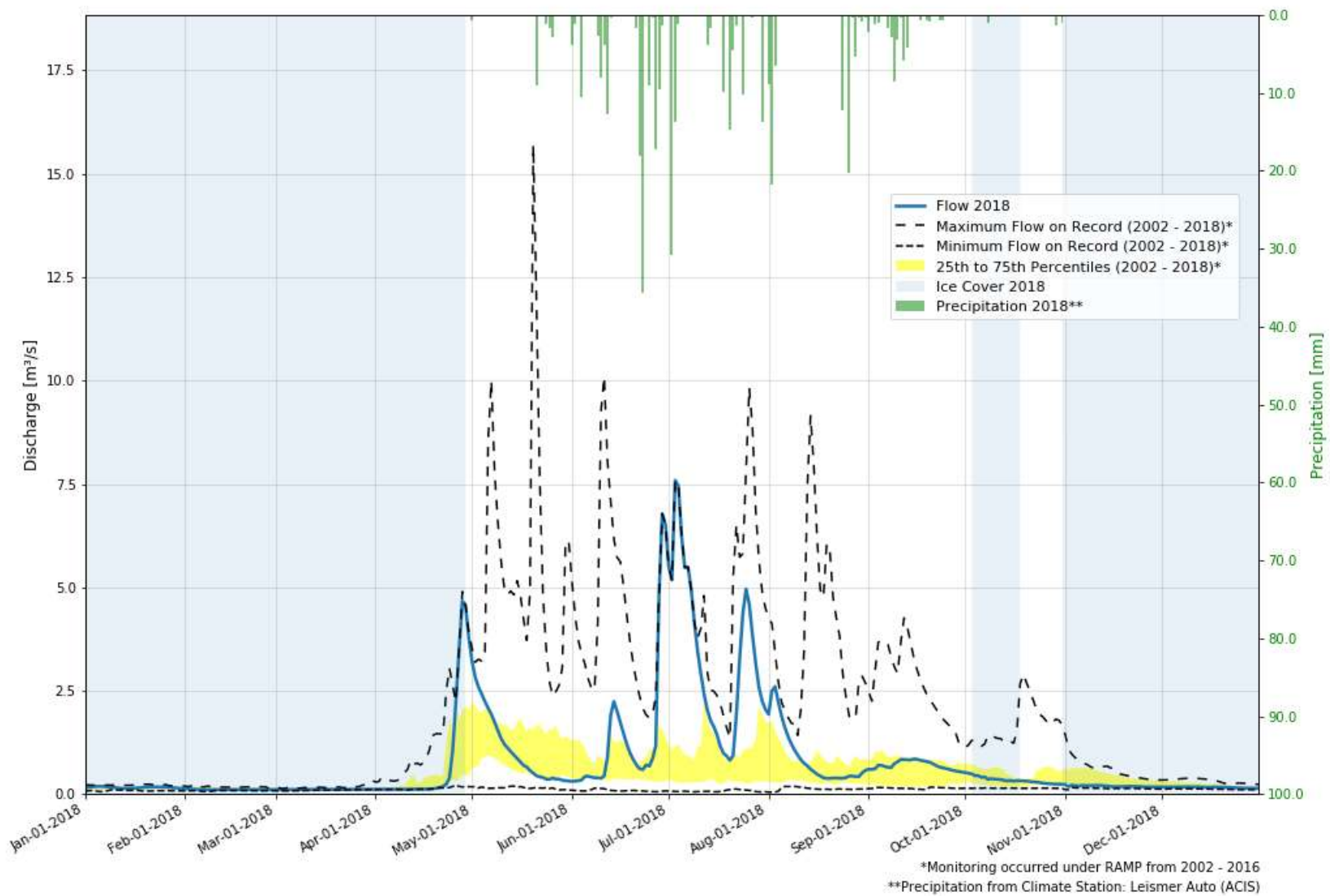


Figure C19: Hangingstone River at North Star Road (07CD008)



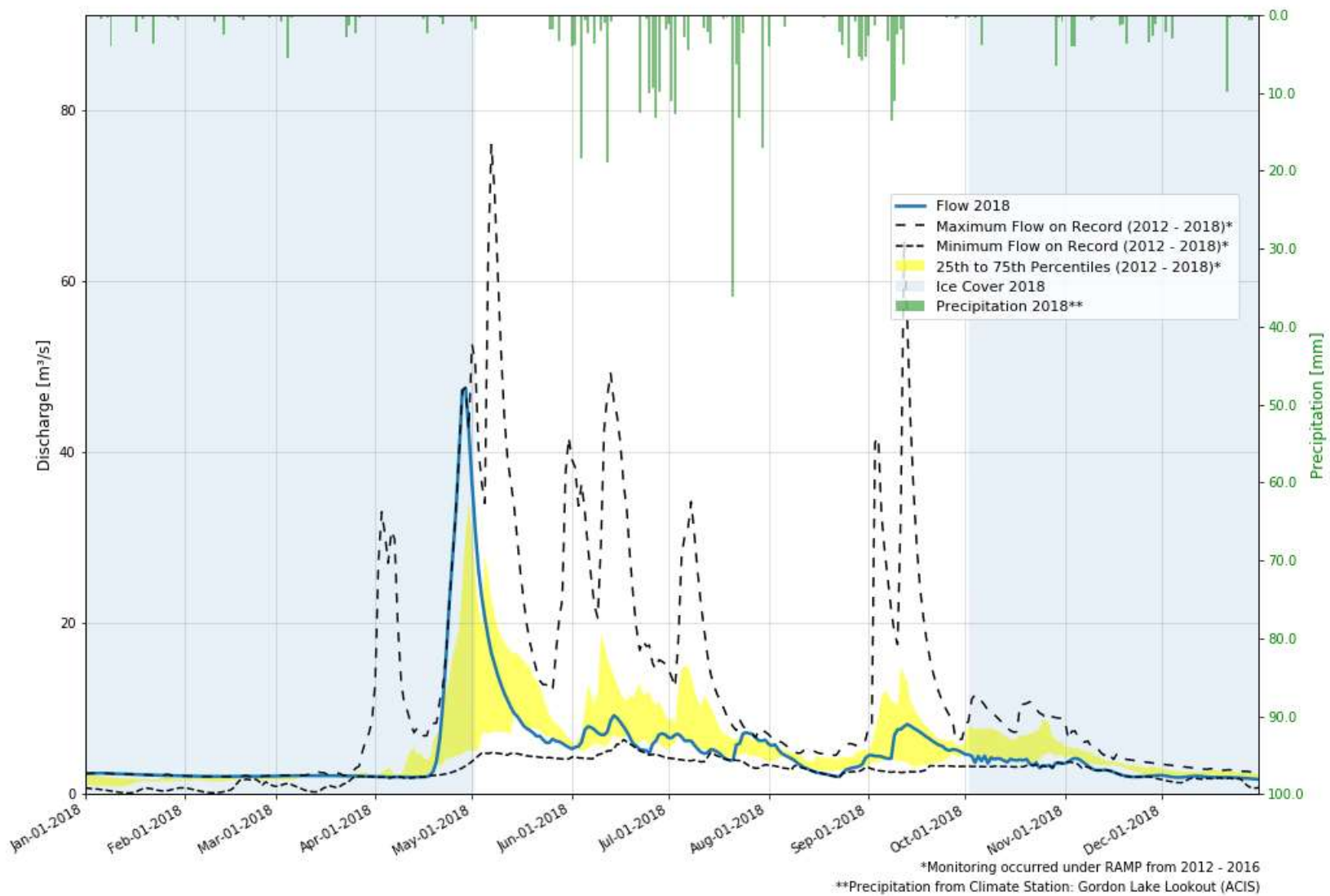


Figure C20: High Hill River near the Mouth (07CD009)

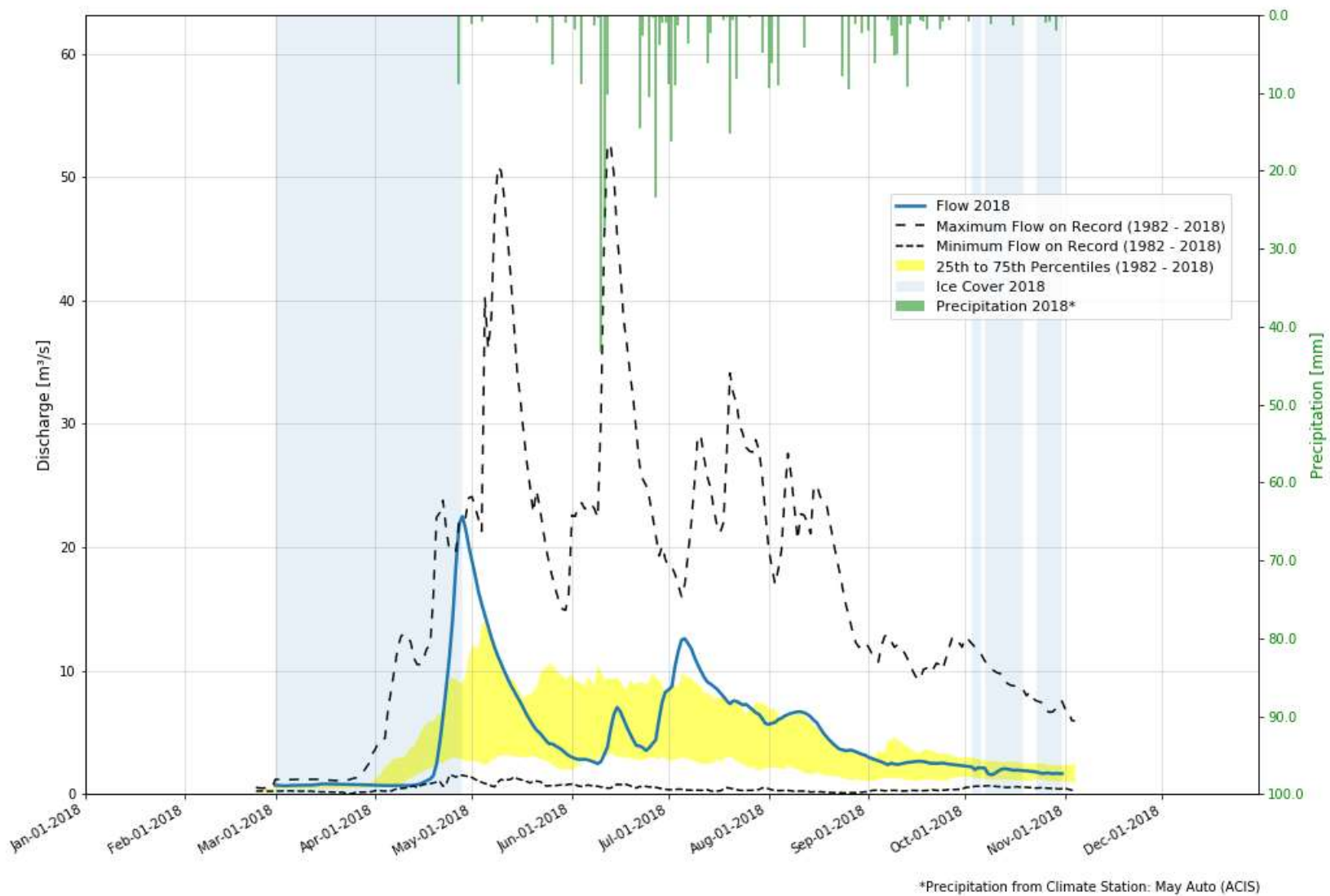


Figure C21: House River at Highway No. 63 (07CB002)

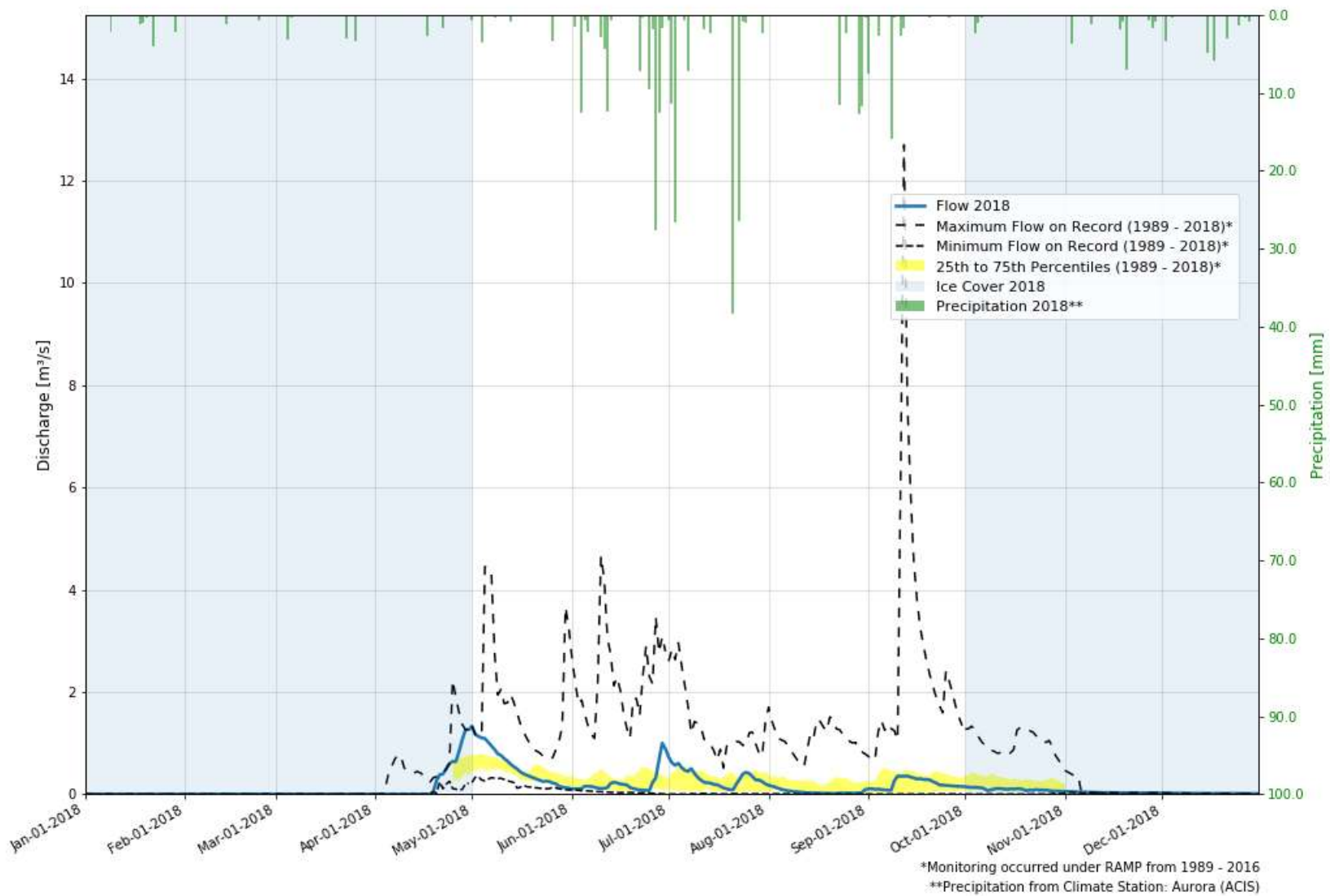


Figure C22: Iyininim Creek above Kears Lake (07DA027)

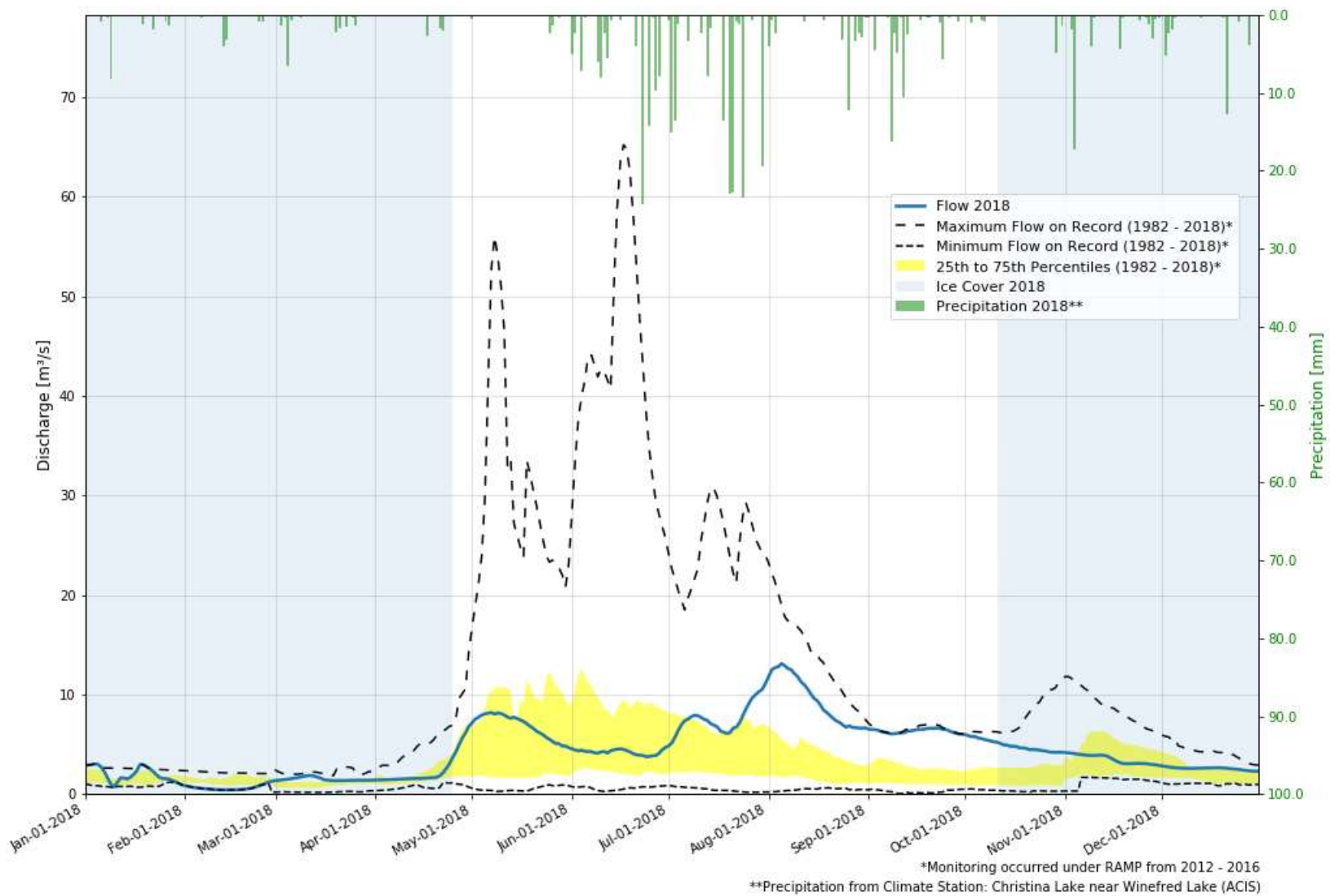


Figure C23: Jackfish River below Christina Lake (07CE005)

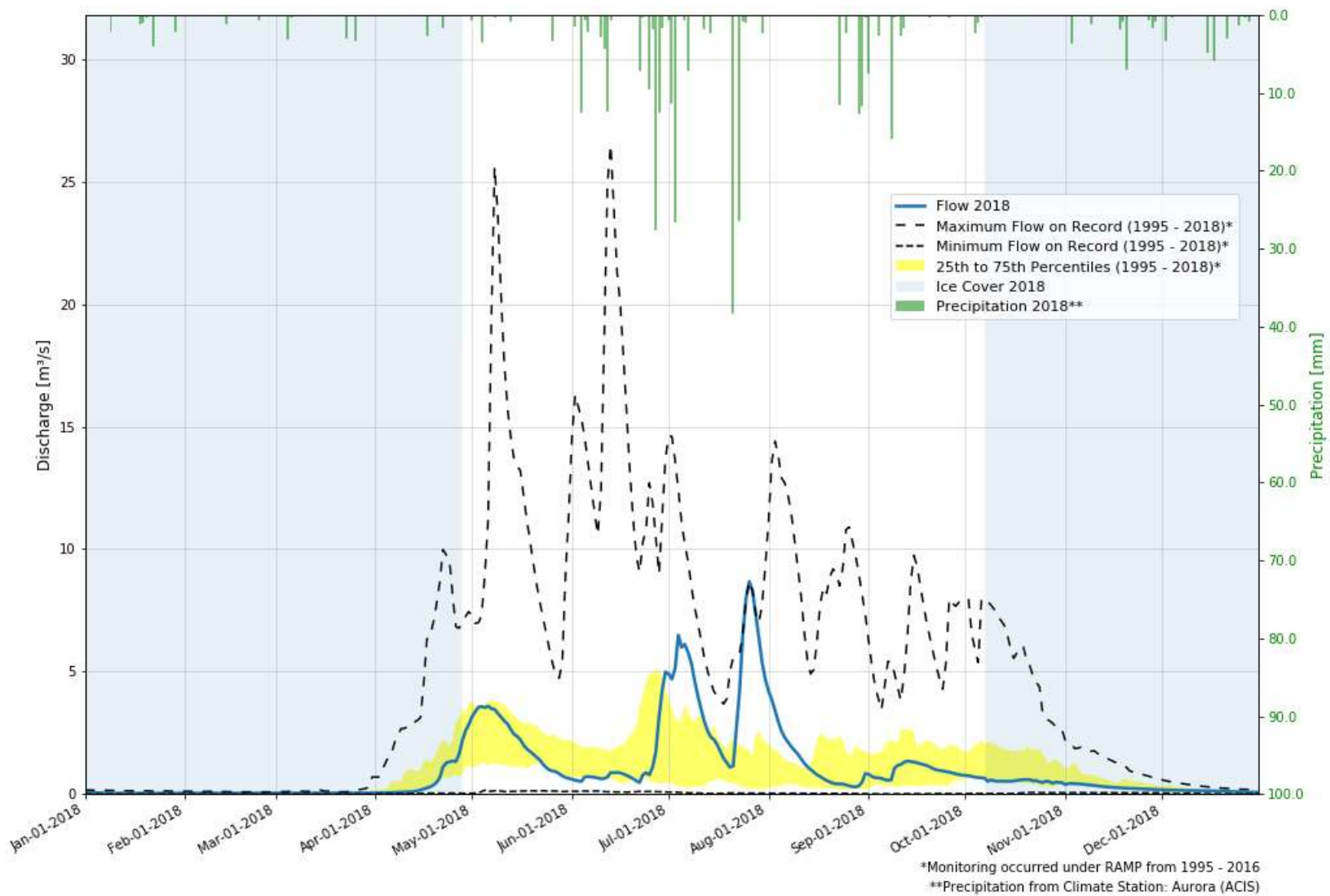


Figure C24: Jackpine Creek at Canterra Road (07DA026)

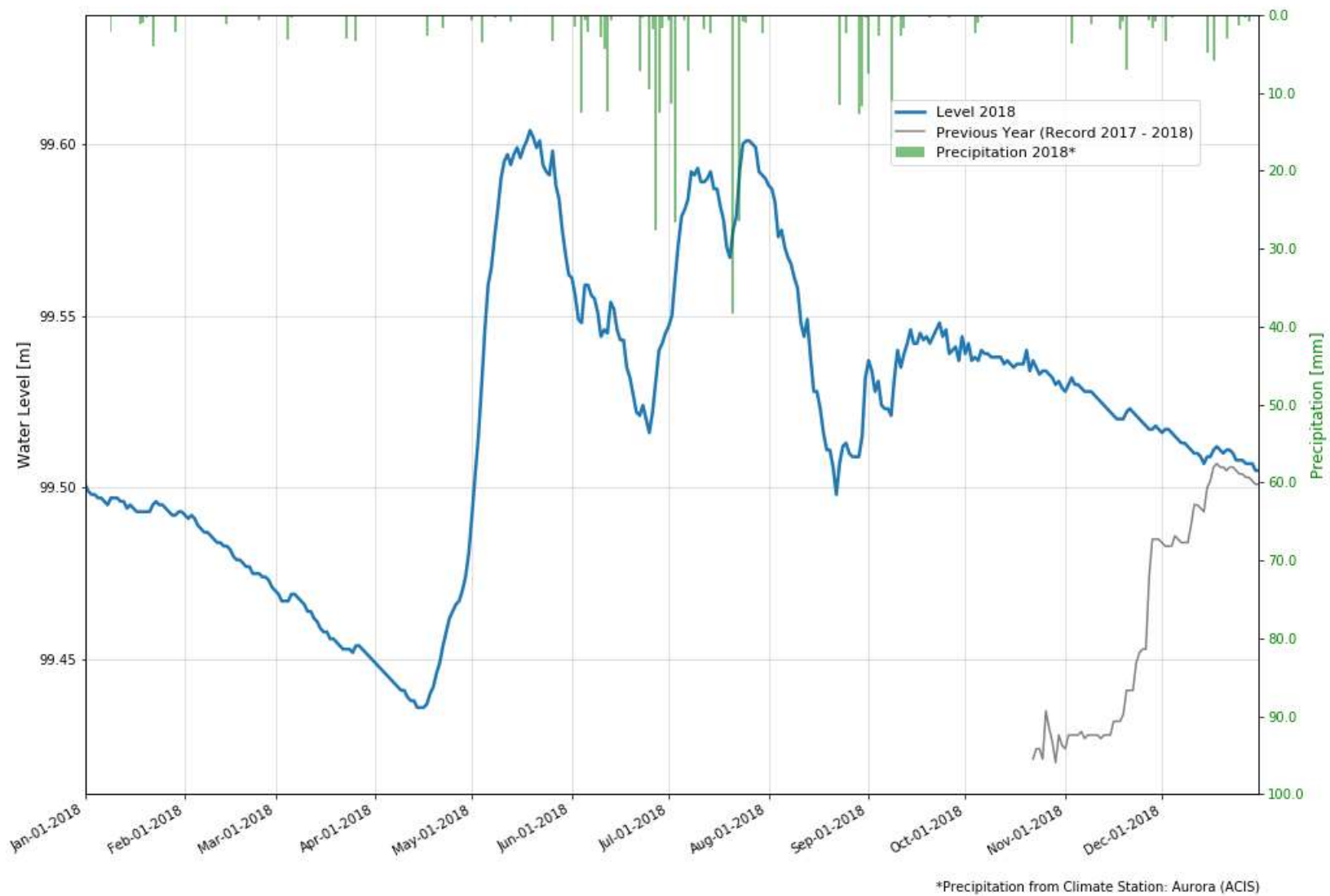


Figure C25: Kears Lake at Canterra Road (07DA024)

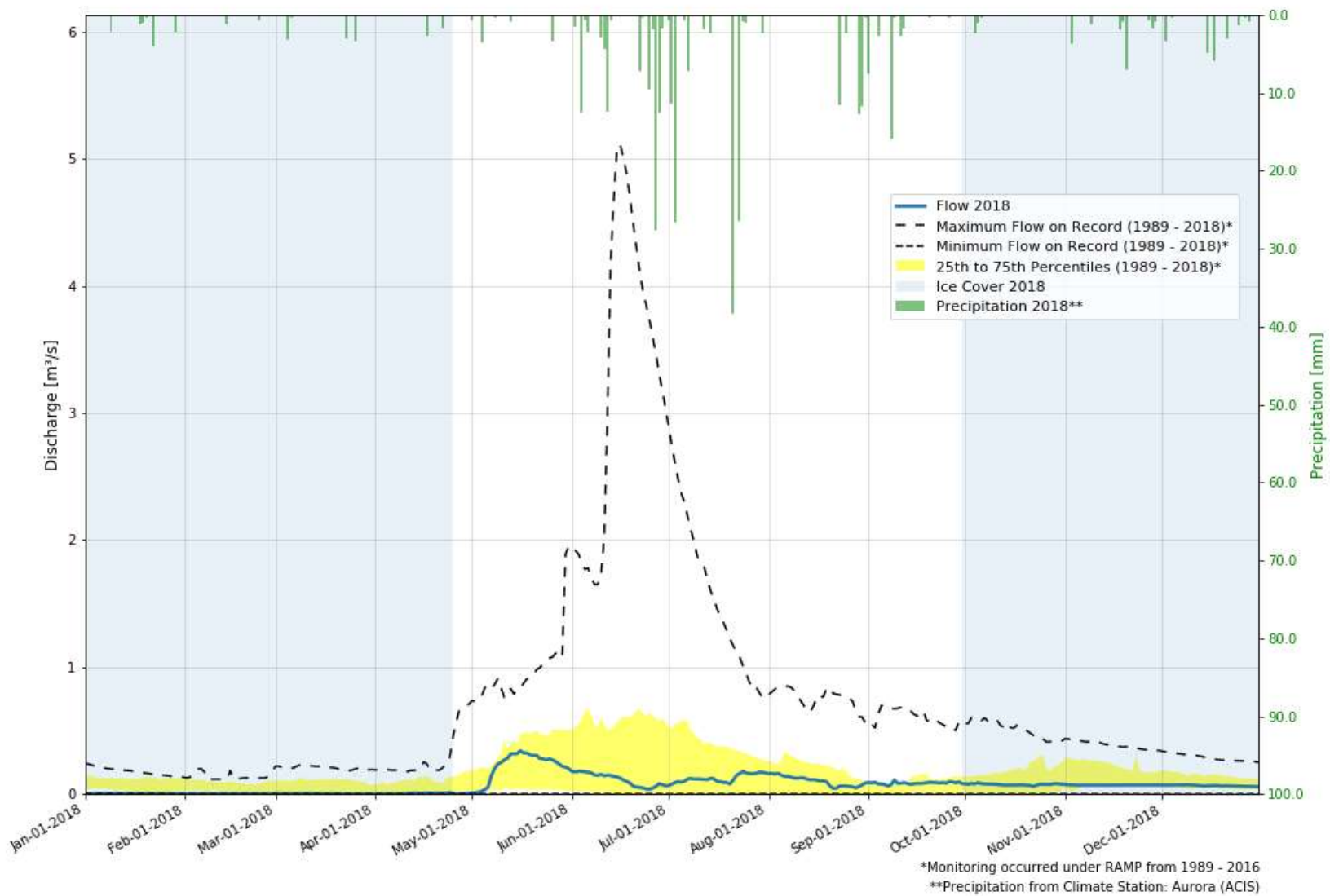


Figure C26: Kears Lake Outlet (07DA030)

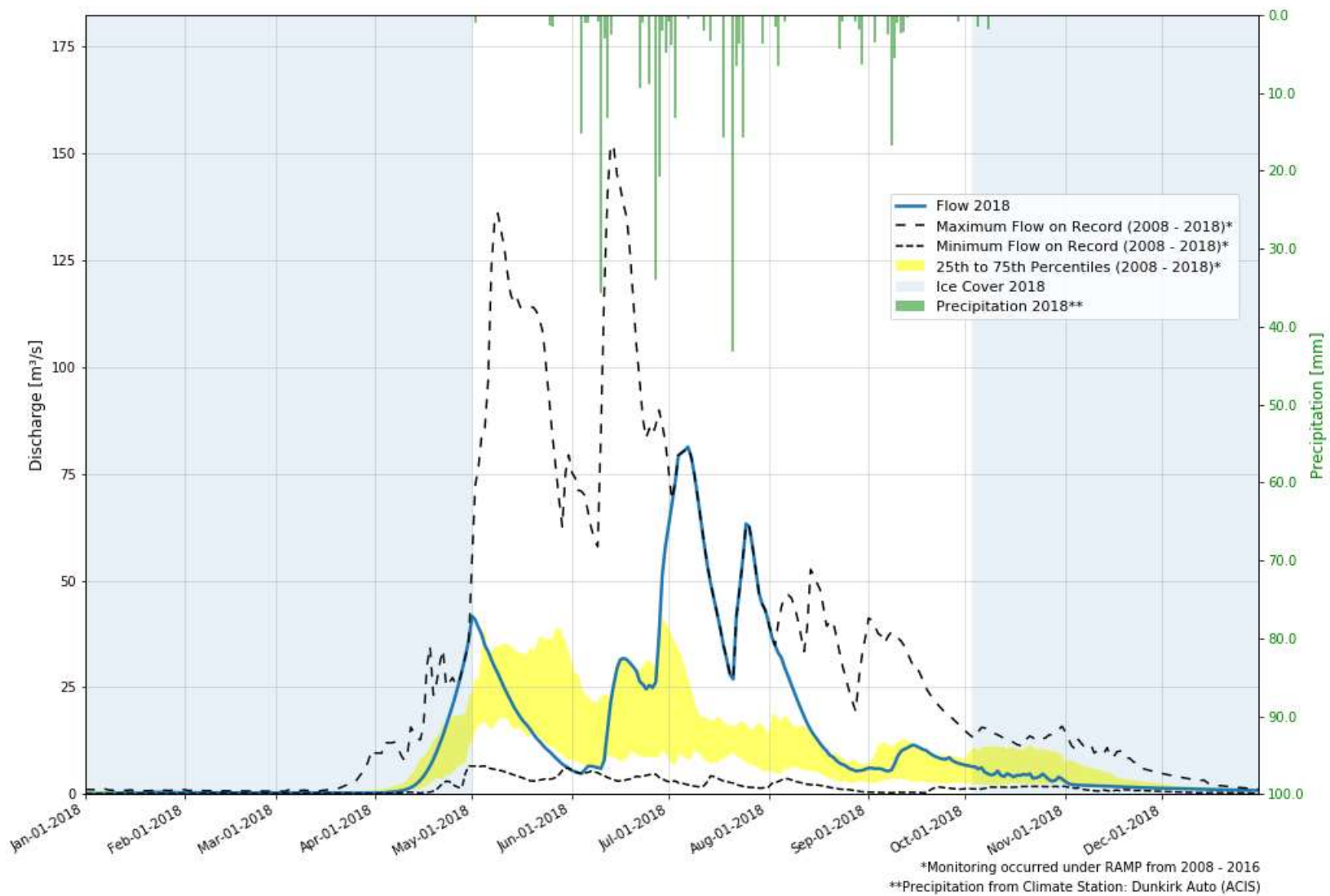


Figure C27: MacKay River at Petro-Canada Bridge (07DB006)



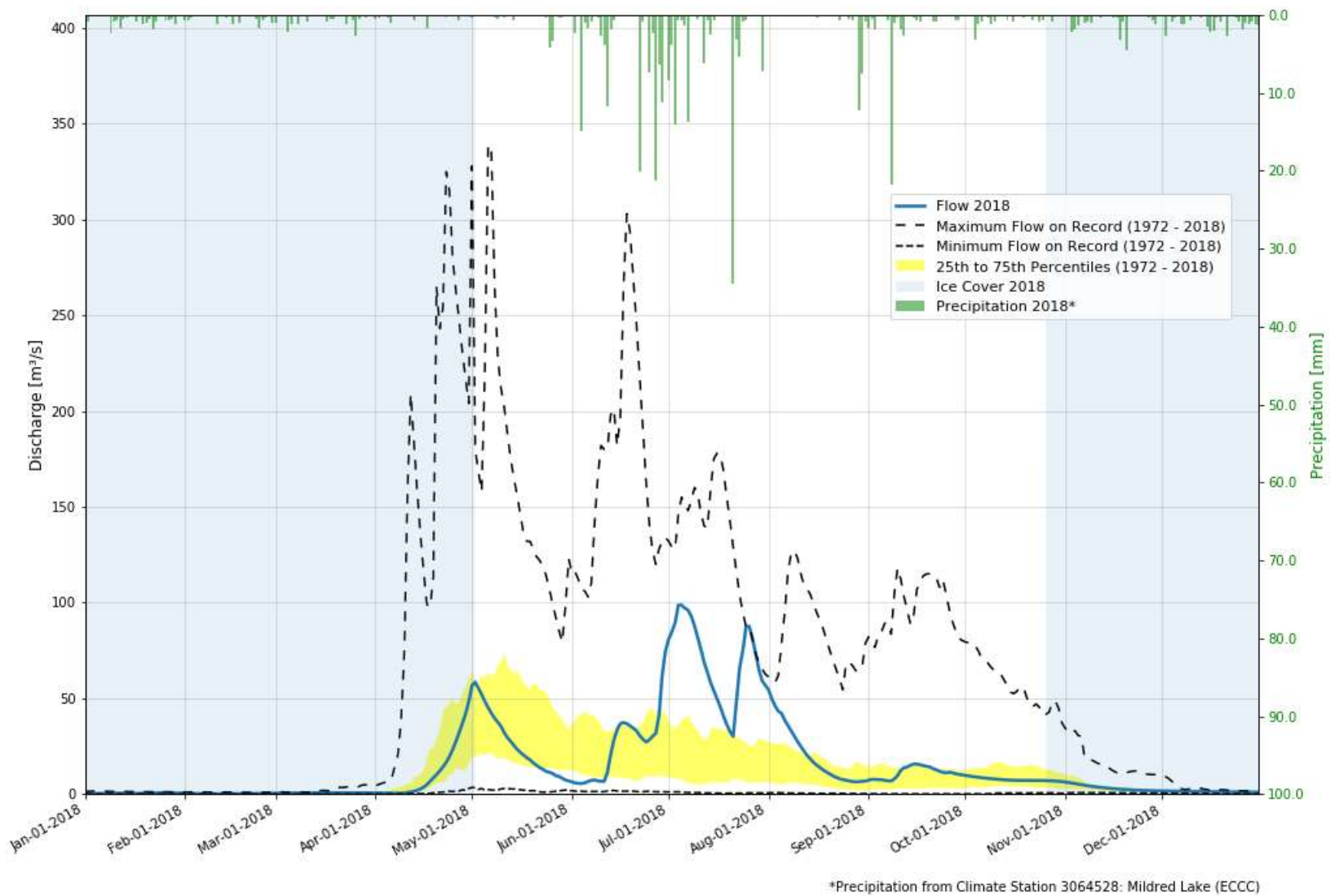


Figure C28: MacKay River near Fort MacKay (07DB001)

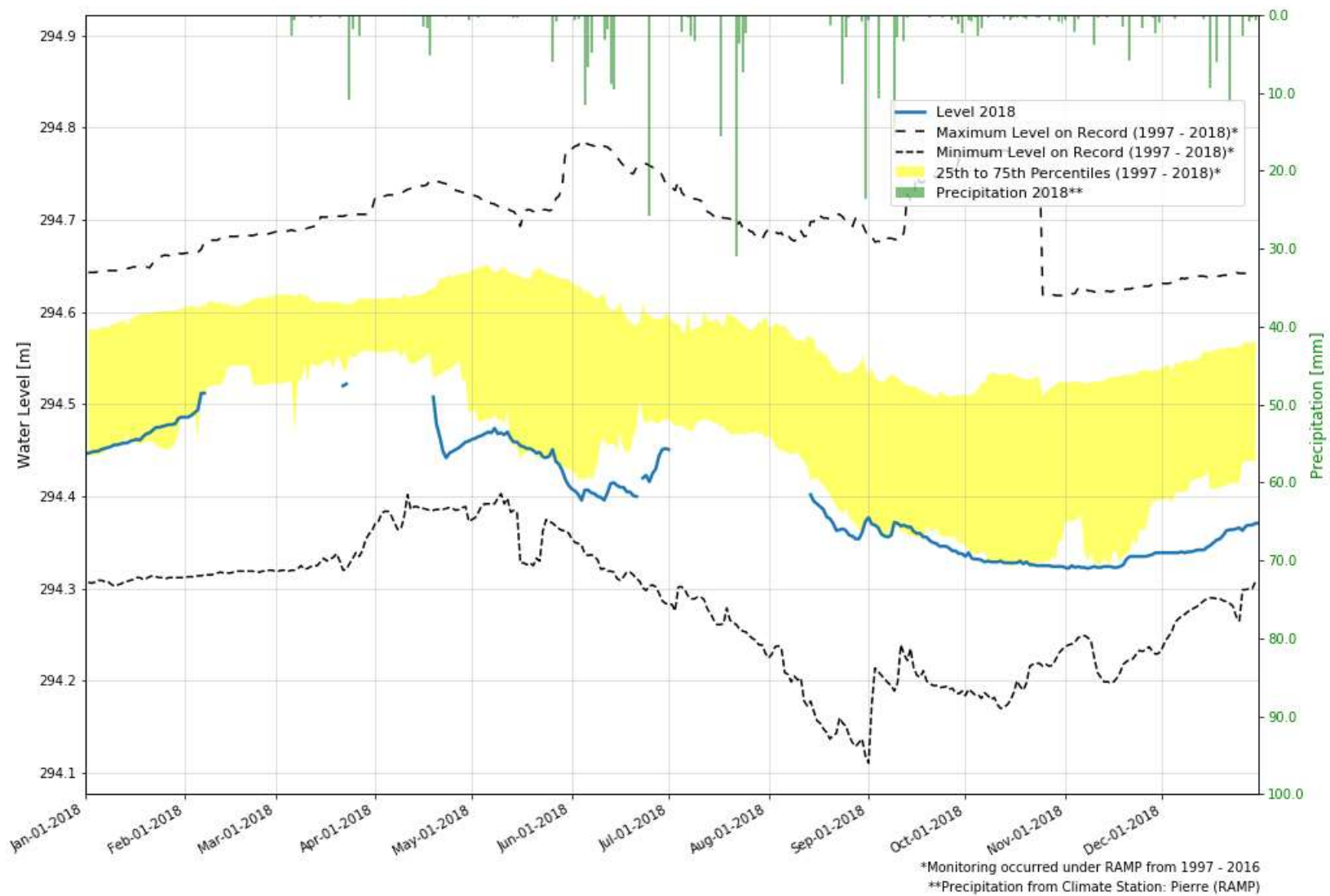


Figure C29: McClelland Lake at East End (07DA023)

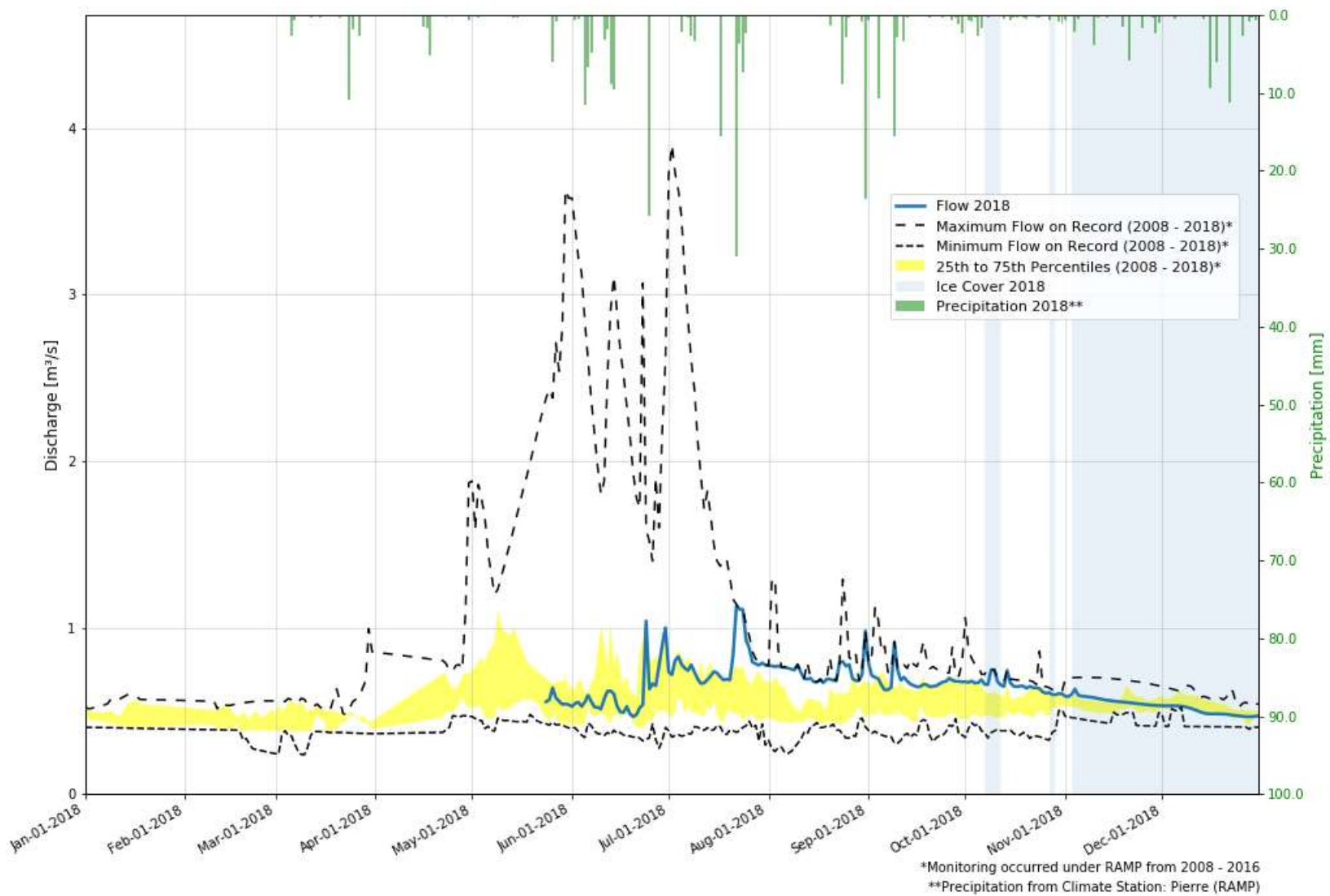


Figure C30: McClelland Lake Outlet above Firebag River (07DC004)

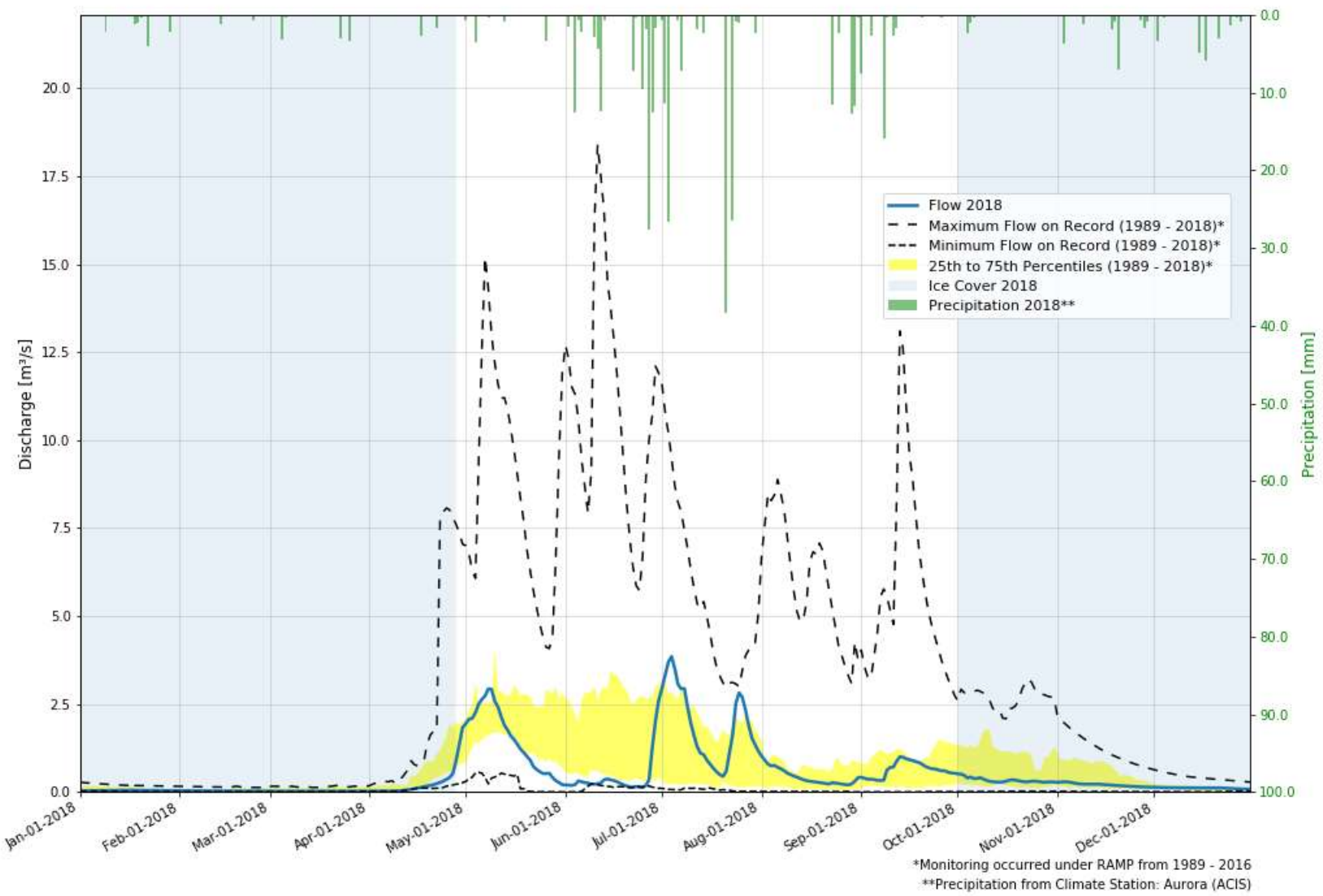


Figure C31: Muskeg Creek near the Mouth (07DA035)

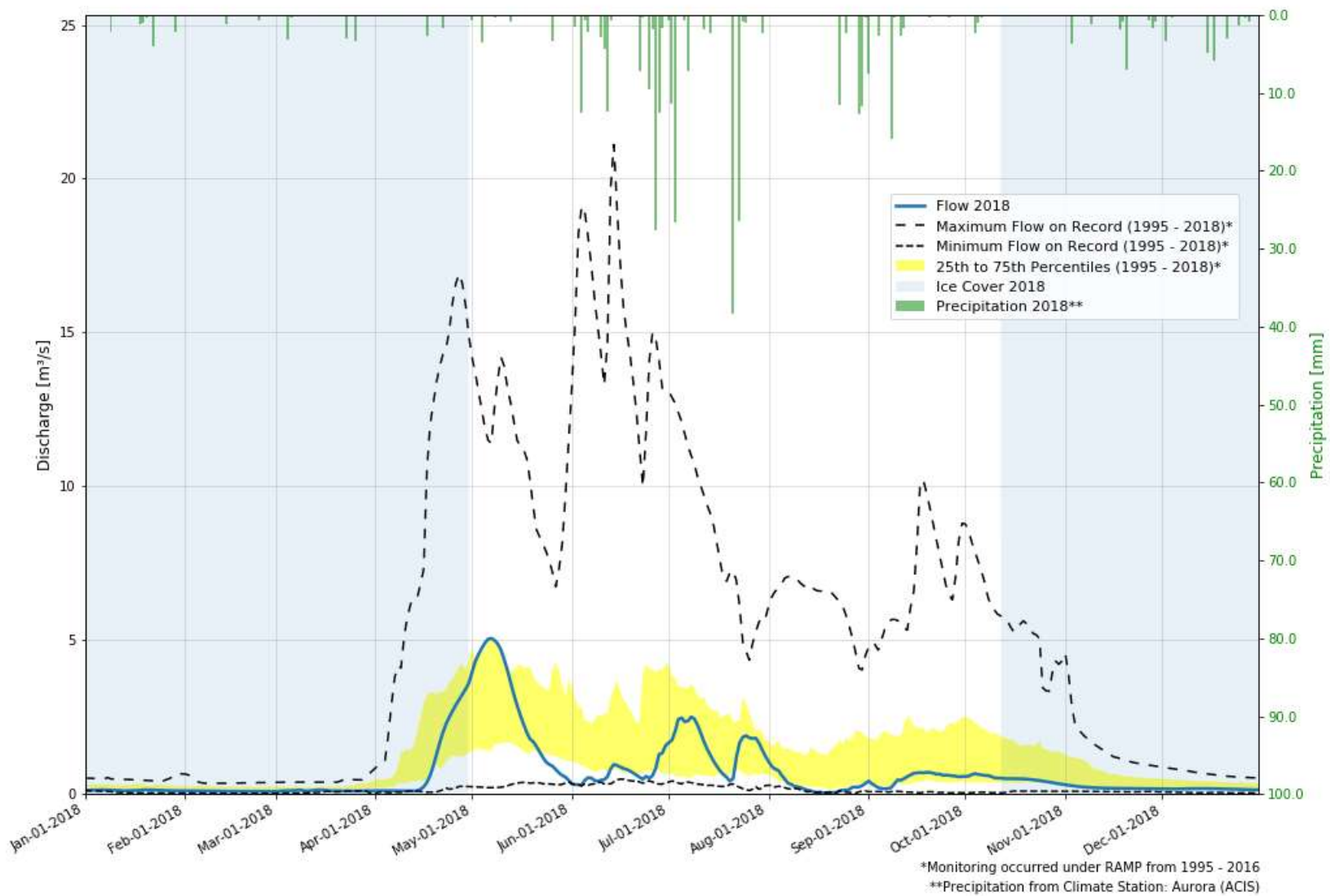


Figure C32: Muskeg River above Muskeg Creek (07DA029)

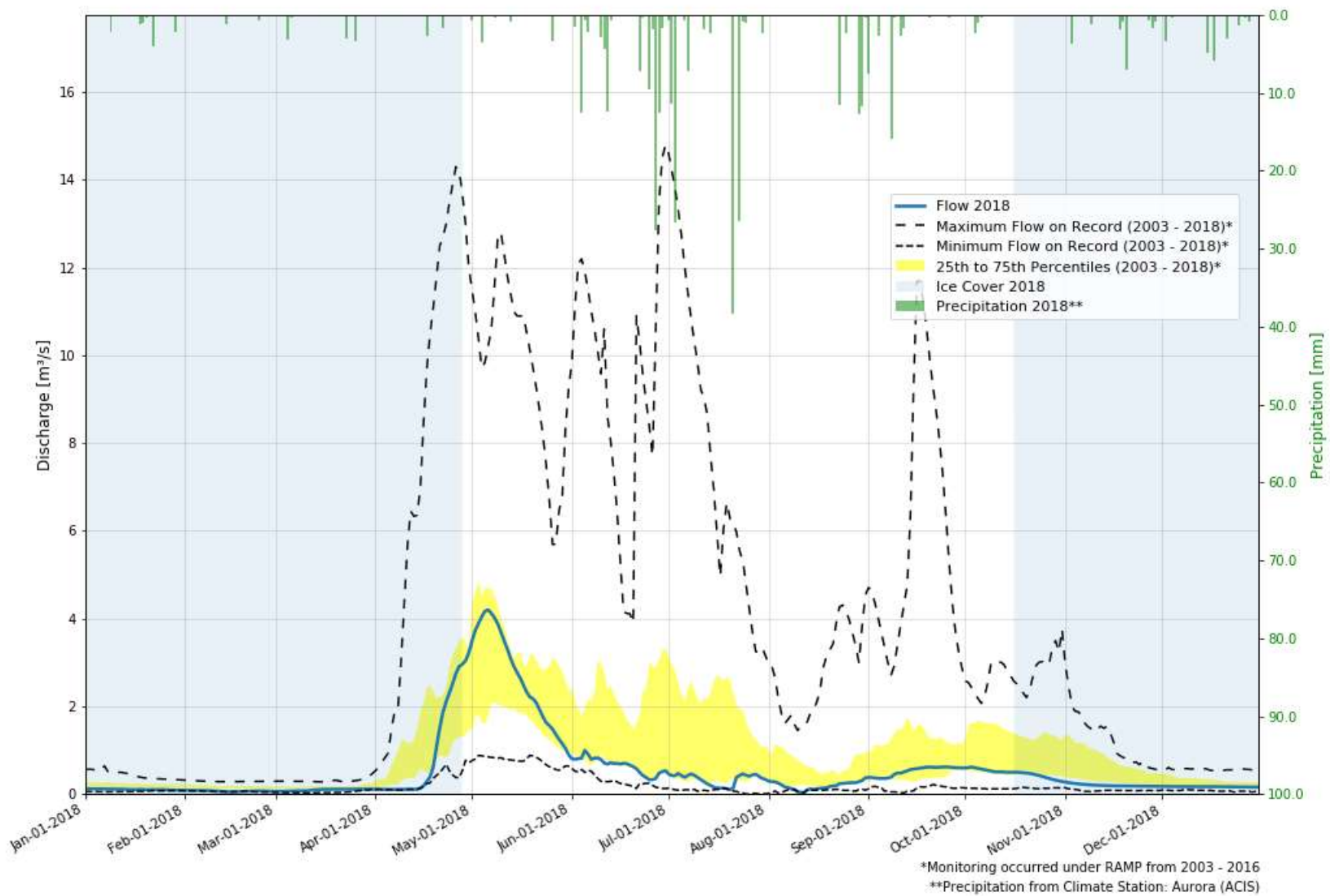


Figure C33: Muskeg River above Stanley Creek (07DA028)

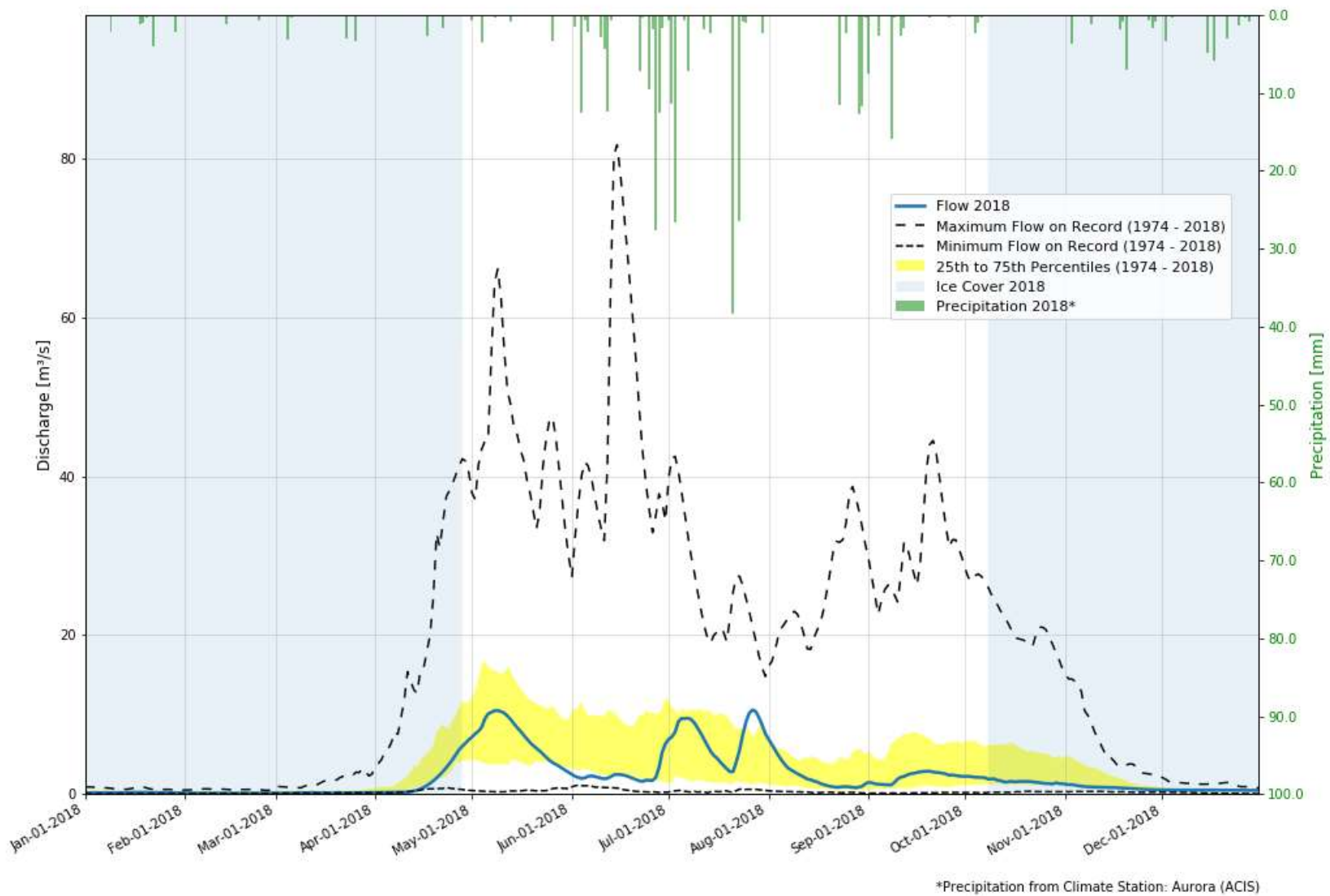


Figure C34: Muskeg River near Fort MacKay (07DA008)

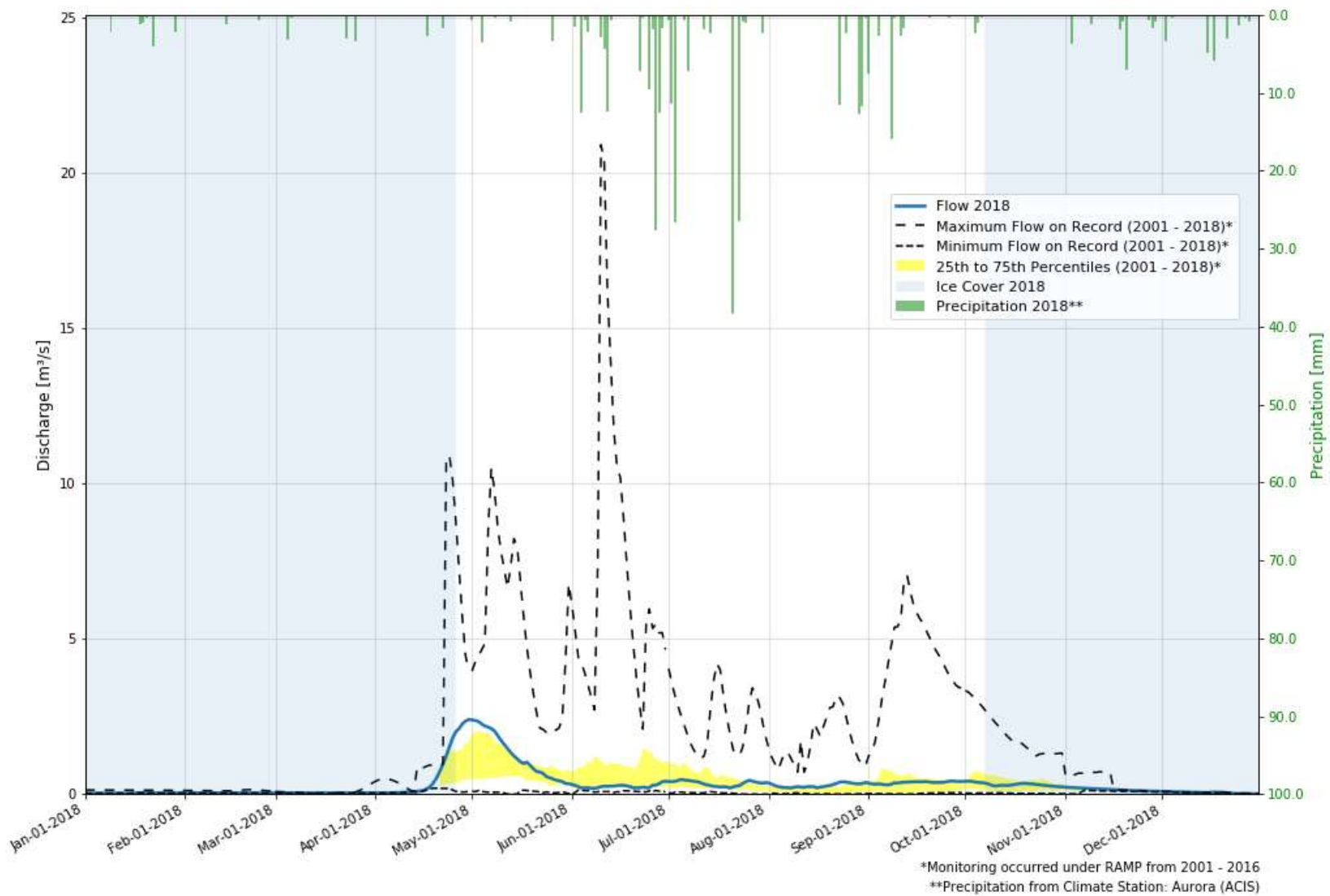


Figure C35: Muskeg River Upland (07DA034)



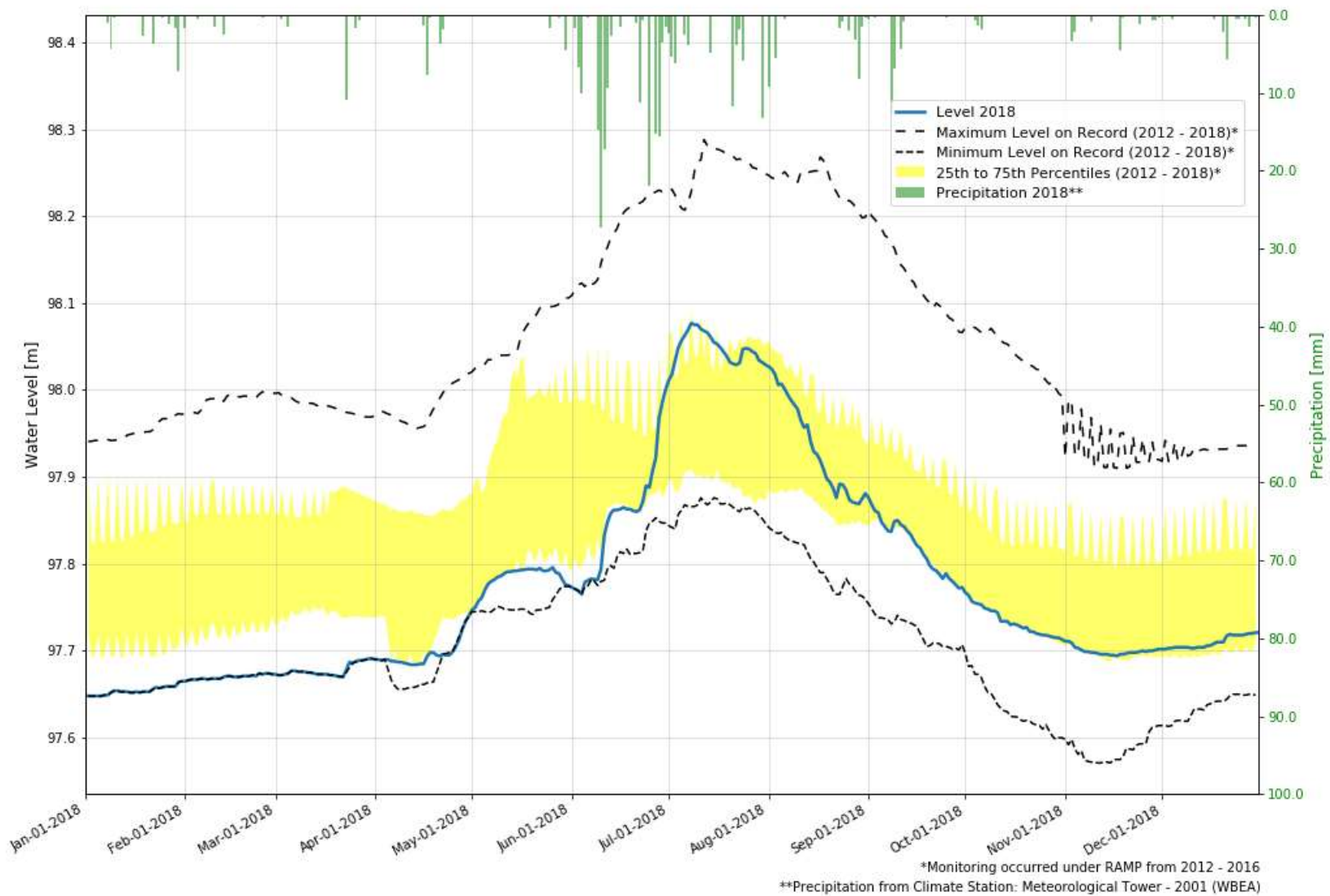


Figure C36: Namur Lake near the Outlet (07DA025)

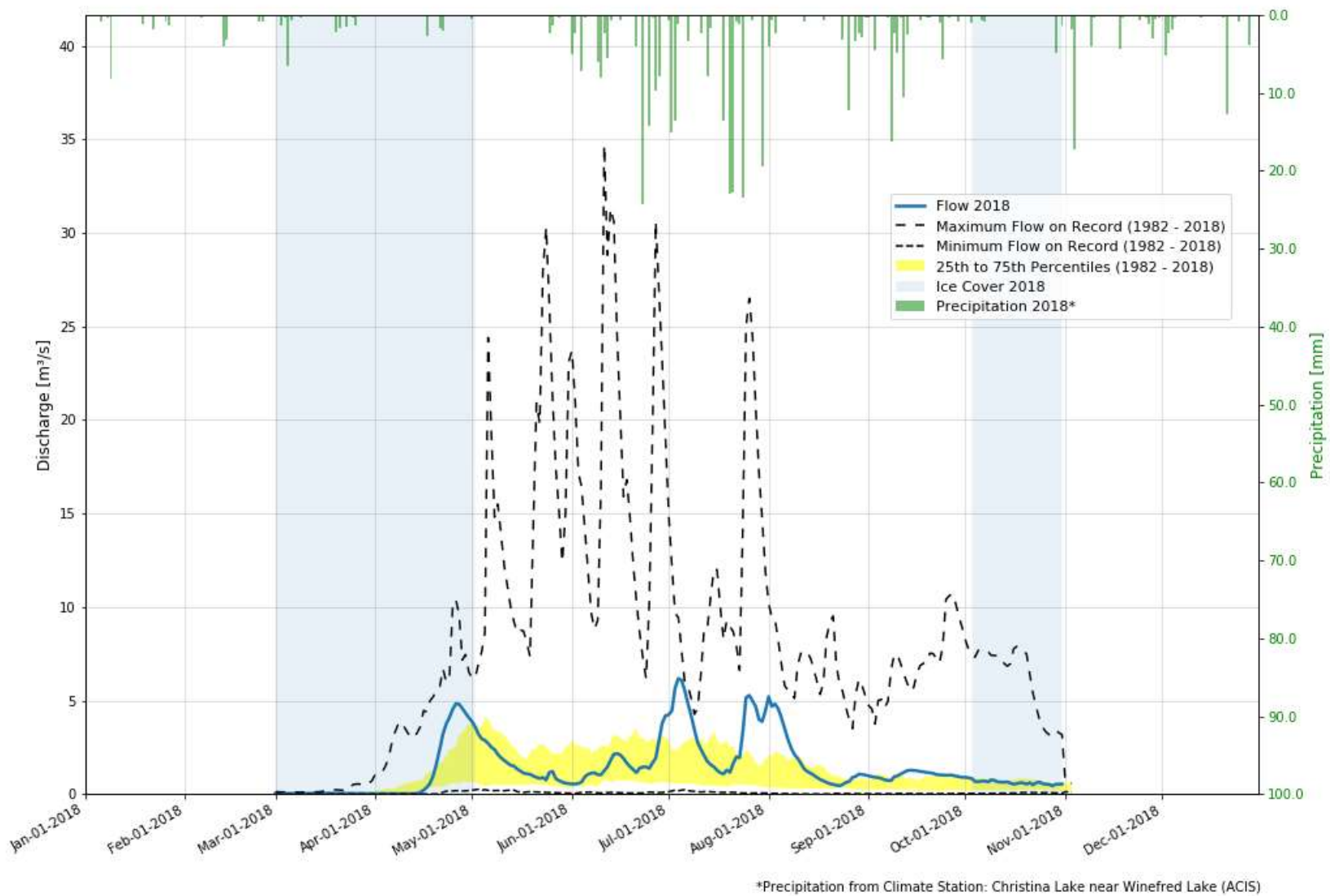


Figure C37: Pony Creek near Chard (07CE003)

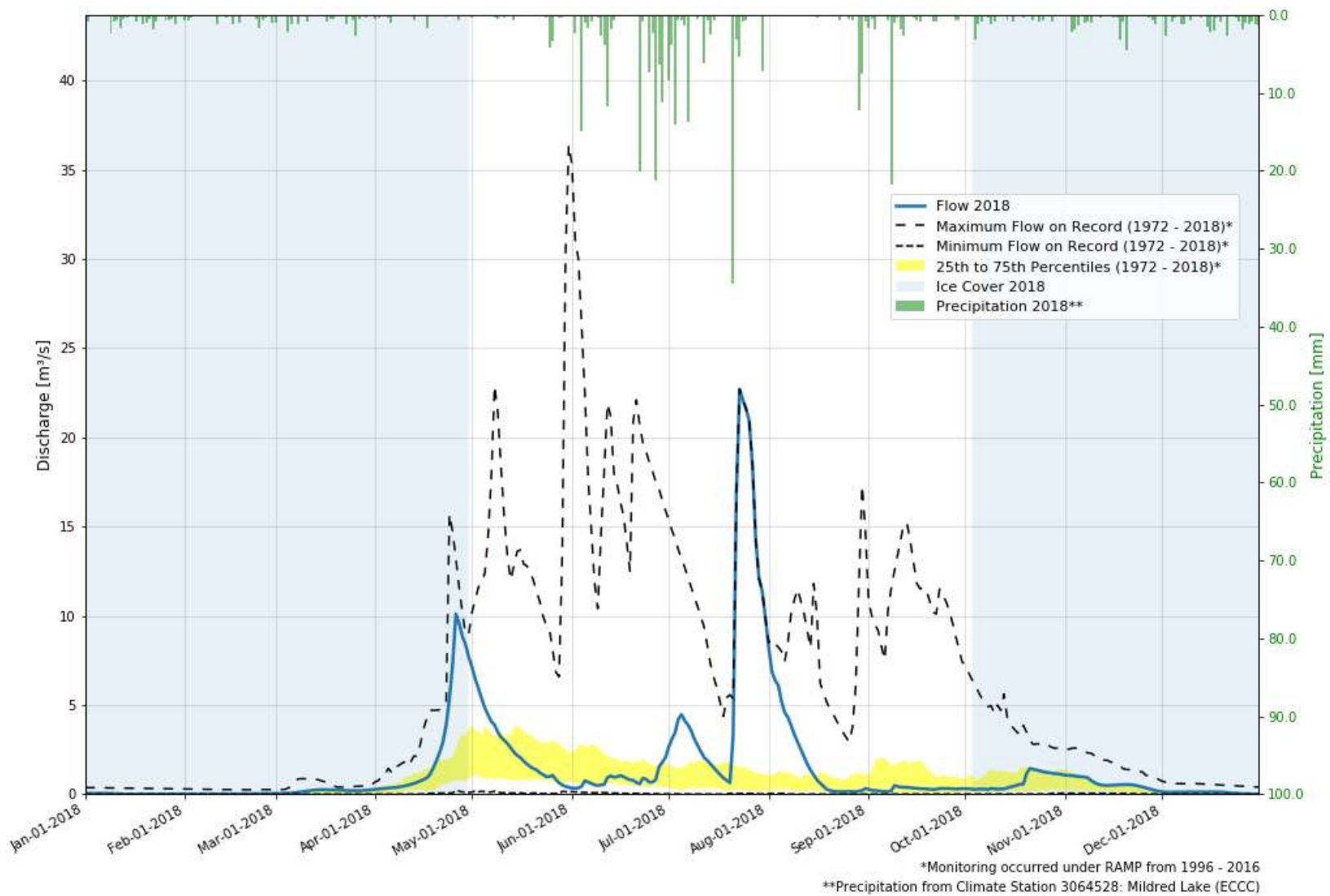


Figure C38: Poplar Creek near Fort McMurray (07DA007)

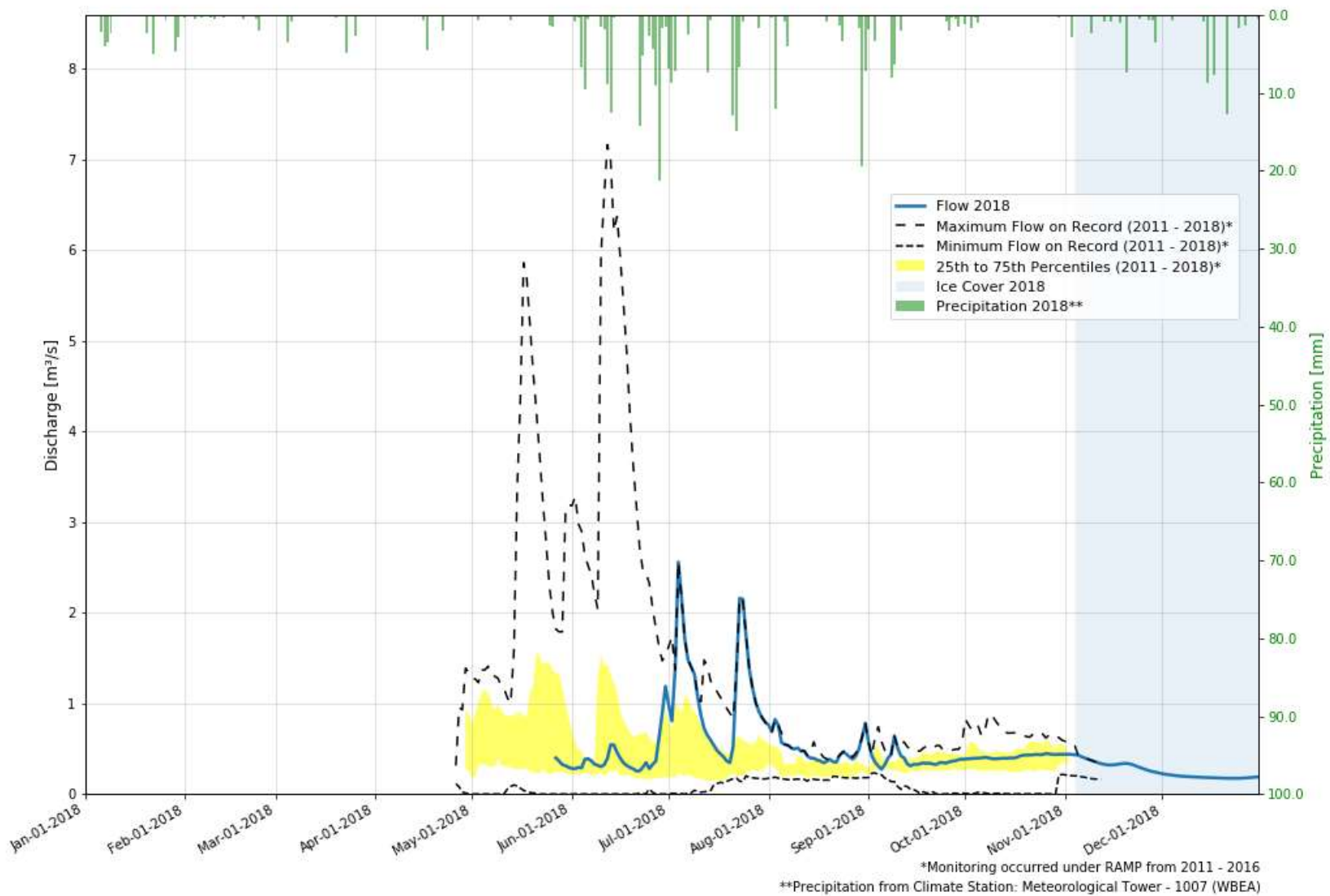


Figure C39: Red Clay Creek near the Mouth (07DA042)

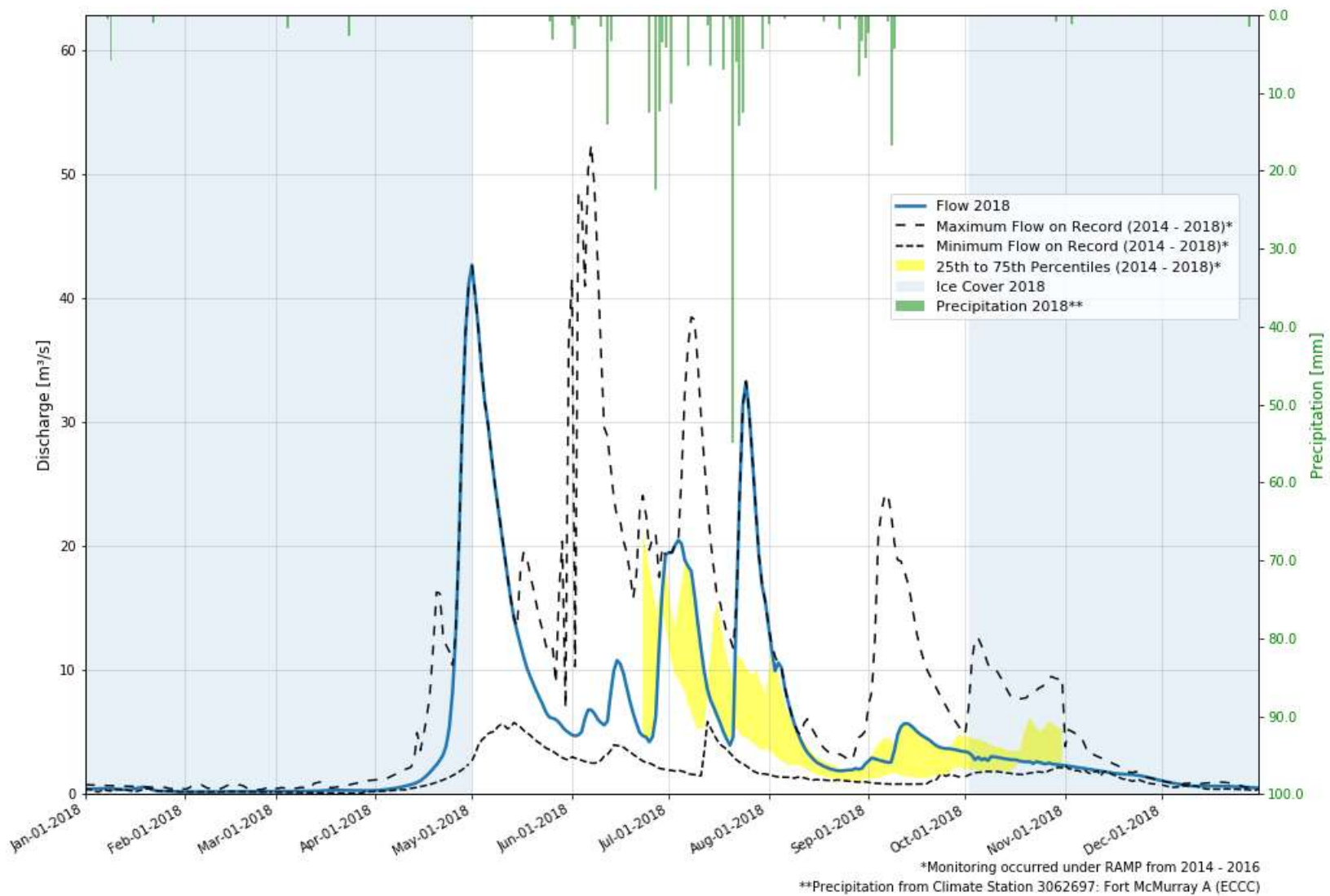


Figure C40: Steepbank River below North Steepbank River (07DA044)

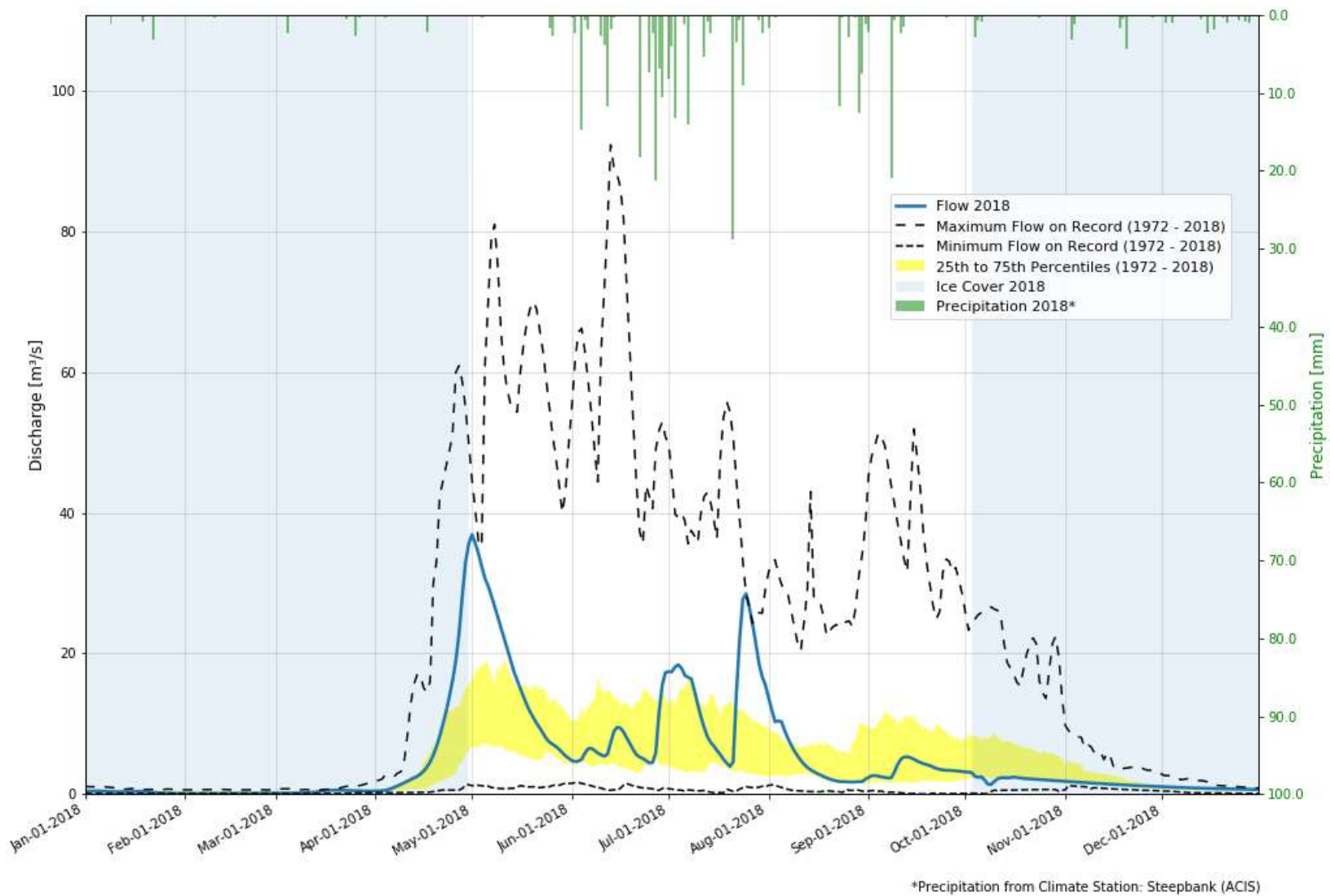


Figure C41: Steepbank River near Fort McMurray (07DA006)

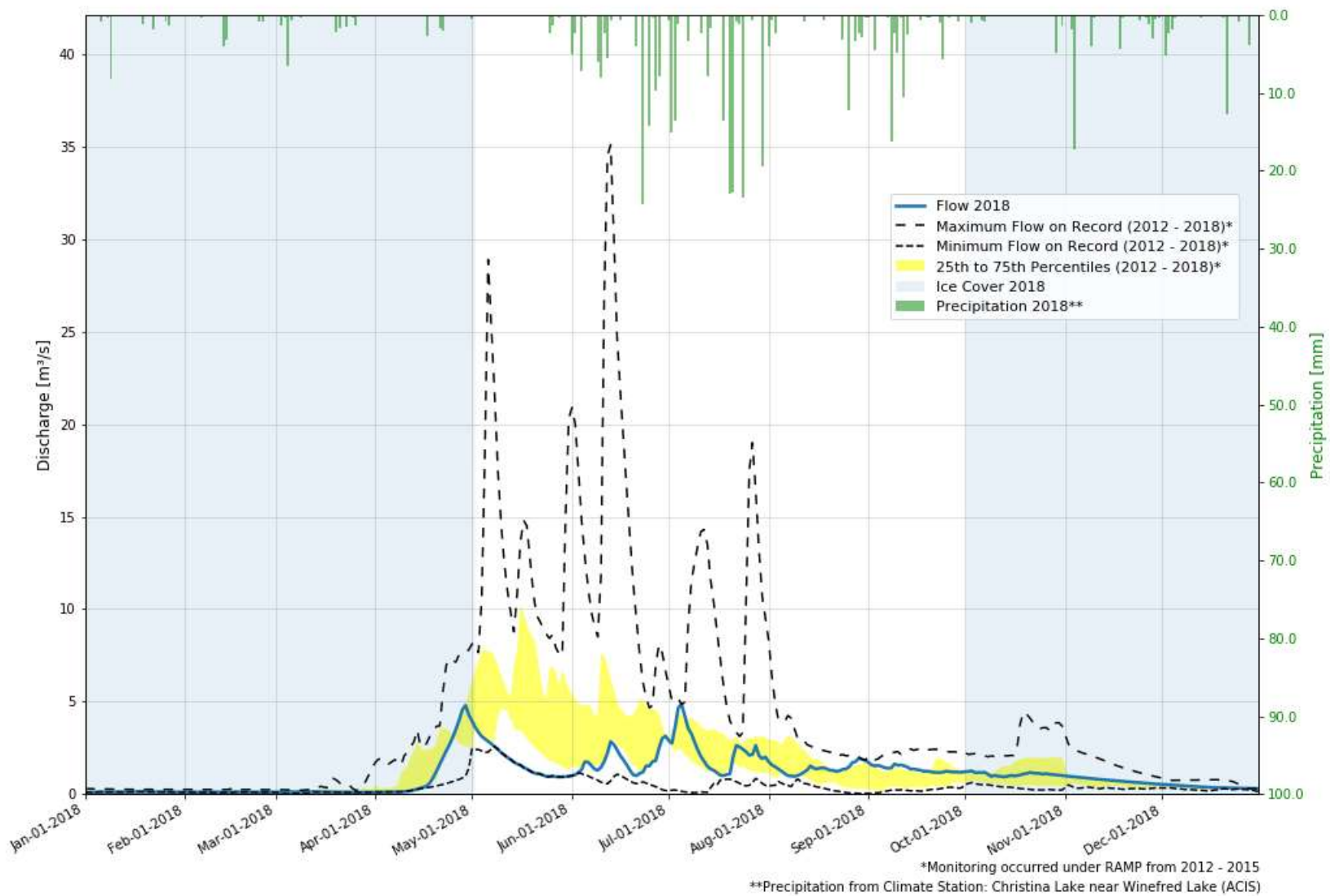


Figure C42: Sunday Creek above Christina Lake (07CE010)

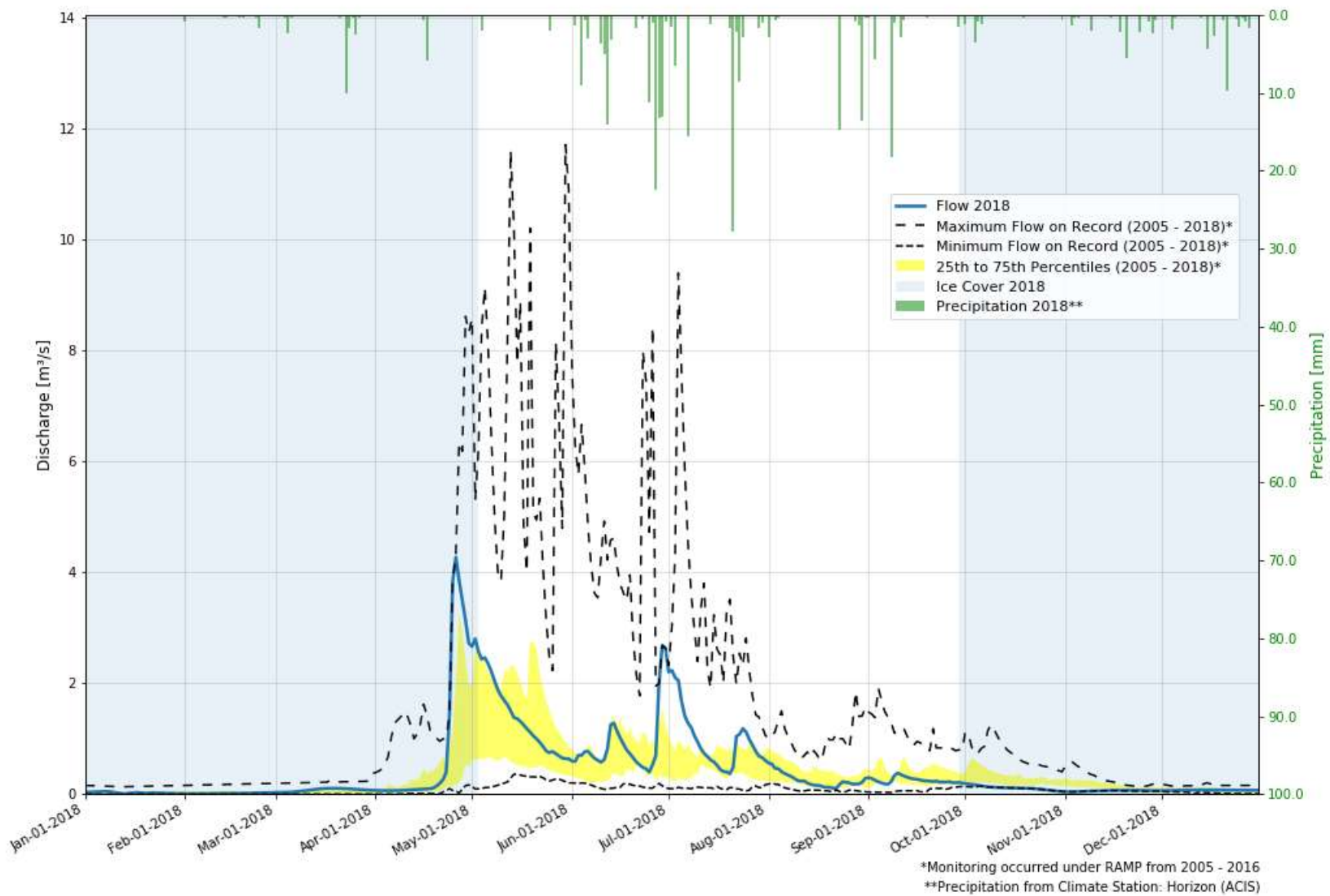


Figure C43: Tar River above Canadian Natural Resources Limited Lake (07DA037)



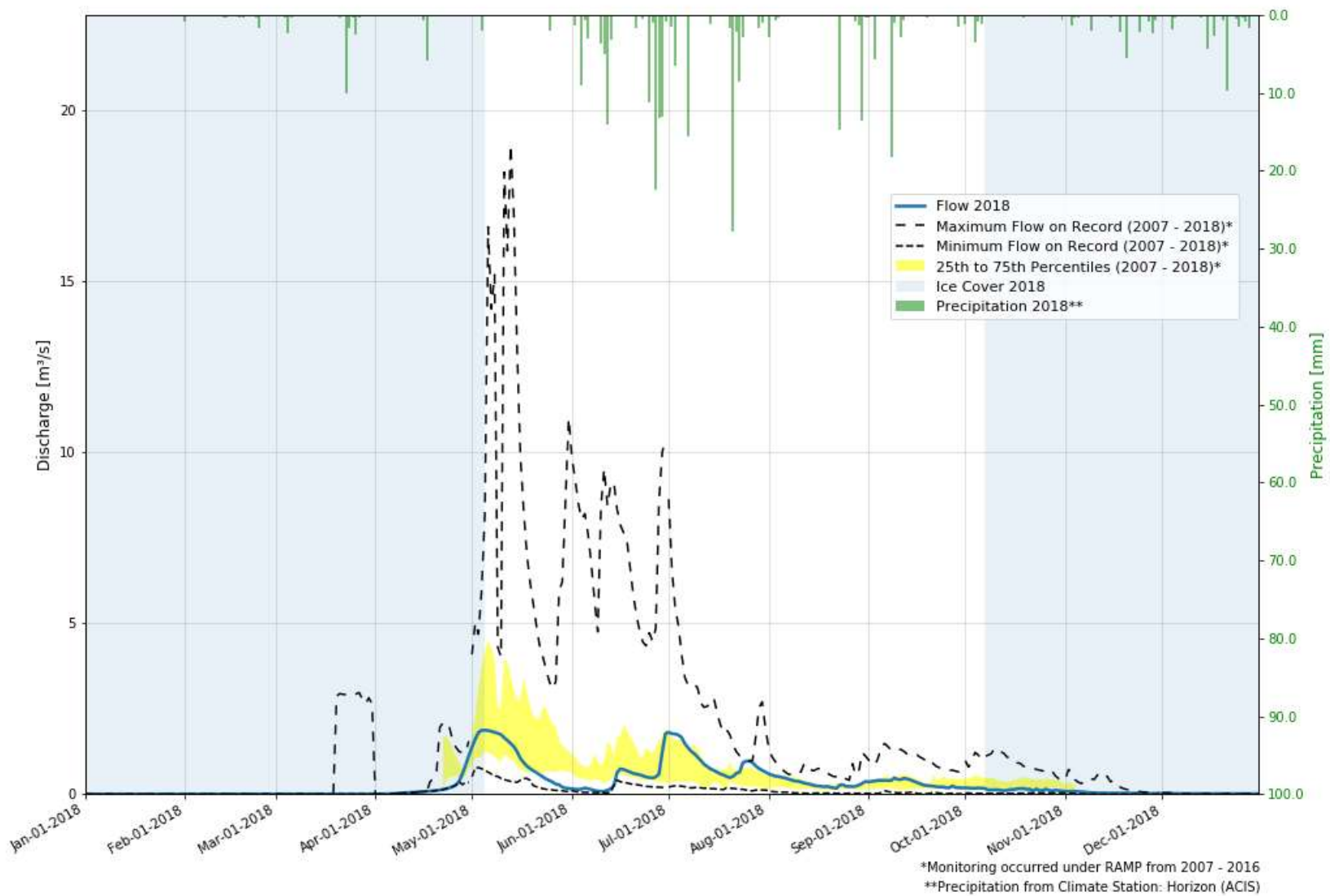


Figure C44: Tar River near the Mouth (07DA045)