Oil Sands Monitoring Program:

Summary of 2021 Hydrologic Conditions in the Alberta Oil Sands Area

Oil Sands Monitoring Program
Technical Report Series

Summary of 2021 Hydrologic Conditions in the Alberta Oil Sands Area

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

2021 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 2021. This report is the fourth annual publication intended to provide the public with an understanding of the hydrologic conditions that were present in the Oil Sands area during each year and how they compared with historical conditions. This report is a deliverable produced by Environment and Climate Change Canada (ECCC) as part of the Surface Water Quantity Monitoring services provided by ECCC to support the Alberta Oil Sands Monitoring Program.

The ongoing collection of high quality surface water quantity data by the WSC, as part of the national surface water monitoring network, supports scientific efforts to address several of the Oil Sands Monitoring (OSM) program key questions, including those regarding establishment of baseline data, monitoring for change, and integration of environmental monitoring data to support scientific investigation into other themes (e.g. water quality, benthos, fish, etc.). All data collected by the WSC in the Oil Sands area are publicly available on the Environment and Climate Change Canada Wateroffice website in near real time for both viewing and download (https://wateroffice.ec.gc.ca/). In addition to users accessing data online, there were 61 data requests received by WSC for data from OSM funded hydrometric stations between January 1st and December 31st of 2021. This was a slight decline over previous years attributed to WSC expanding the data products available on Wateroffice this year. Of the requests for data from the OSM gauges in 2021, approximately 37% came from Academia, 34% from Consultants, 21% from Government/Utility Corps, 3% from Industry, and the remaining 5% had unknown affiliation. Some examples of scientific studies that were published in 2021, and relied in part on hydrometric data, include an investigation into benthic macroinvertebrates communities at various sites in the Oil Sands region (Arciszewksi, 2021), a study that looked at the health of fish collected in the Athabasca River near Fort McMurray (Arciszewski and McMaster, 2021), and an overview assessment of impacts of oil sands activities on river ecosystems (Culp et. al., 2021).

There were 48 hydrometric gauging stations operated by WSC in the Oil Sands area in 2021 (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 2021 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 there was little increase in flow following ice break-up. The highest flow in 2021 at this station occurred in early June coincident with a precipitation event. The measured flow fell within, or close to, the interquartile range (25th-75th percentiles) of flows for this station for the year, with periods in both the upper and lower quartiles for periods of the year. The 2021 mean flow of 360 m^3/s was 15% lower than the historical mean annual flow of 424 m^3/s over this station’s period of record. Additionally, the basin mean areal precipitation for 2021, calculated using precipitation available from the RDPA, was also shown to be lower (78%) to that of previous years (based on record from 2002 – 2021).

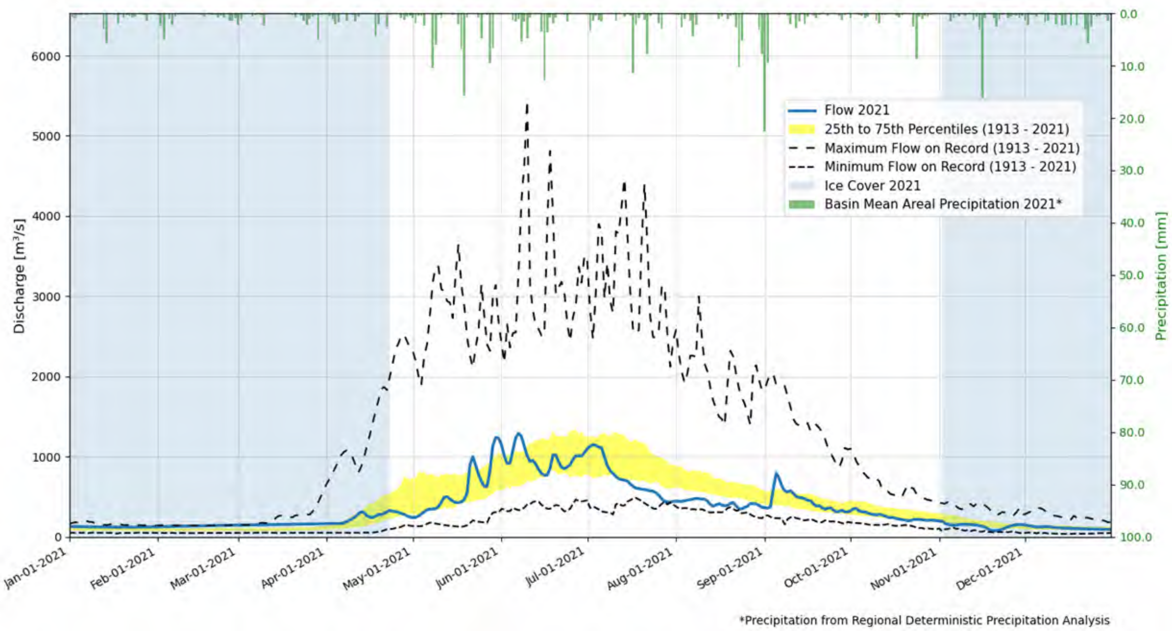

Figure 1: Annual Hydrograph for Station 07BE001 Athabasca River at Athabasca

Clearwater River above Christina River (07CD005)

Hydrometric data from this station is presented as an indicator station for tributary contributions to the Athabasca River upstream of Fort McMurray. The 2021 hydrometric data for this station (Figure 2) shows that ice break-up occurred at the beginning of May. Over winter the discharge was higher than normal, setting new record maximum daily flows. Flow peaked in mid June at 197 m^3/s and remained in the upper quartile range until early August. The 2021 mean flow of 103 m^3/s was 34% higher than the historical mean annual flow of 76.7 m^3/s over this station's period of record. Although mean flow was higher, basin mean areal precipitation for 2021, calculated using precipitation available from the RDPA, was shown to be lower (91%) to that of previous years (based on record from 2002 – 2021).

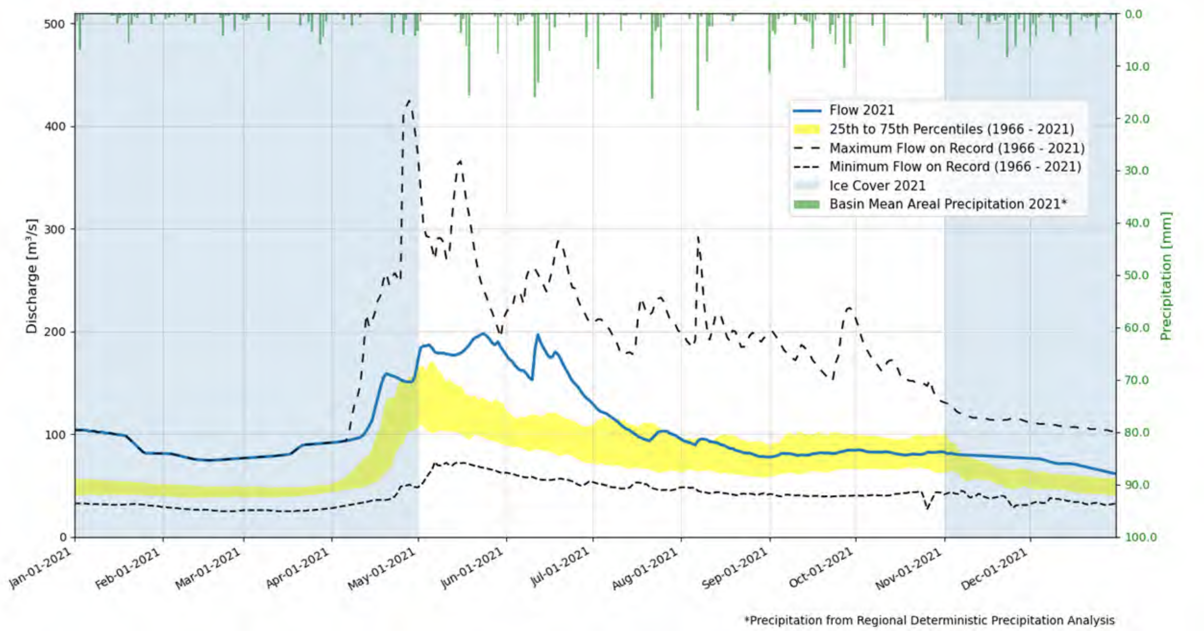

Figure 2: Annual Hydrograph for Station 07CD005 Clearwater River above Christina River

Athabasca River below Fort McMurray (07DA001)

The hydrometric data for this station (Figure 3) indicates that ice break-up occurred early May. The measured flow fell within the interquartile range (25th-75th percentiles) of flows for this station for nearly half the year and was split fairly evenly between the upper and lower quartiles for the other half of the year. The peak flow for 2021 occurred at the start of June following several precipitation events. The 2021 mean flow of 541 m^3/s was 13% lower than the historical mean annual flow of 619 m^3/s over this station's period of record. Basin mean areal precipitation for 2021, calculated using precipitation available from the RDPA, was also shown to be lower (80%) to that of previous years (based on record from 2002 – 2021).

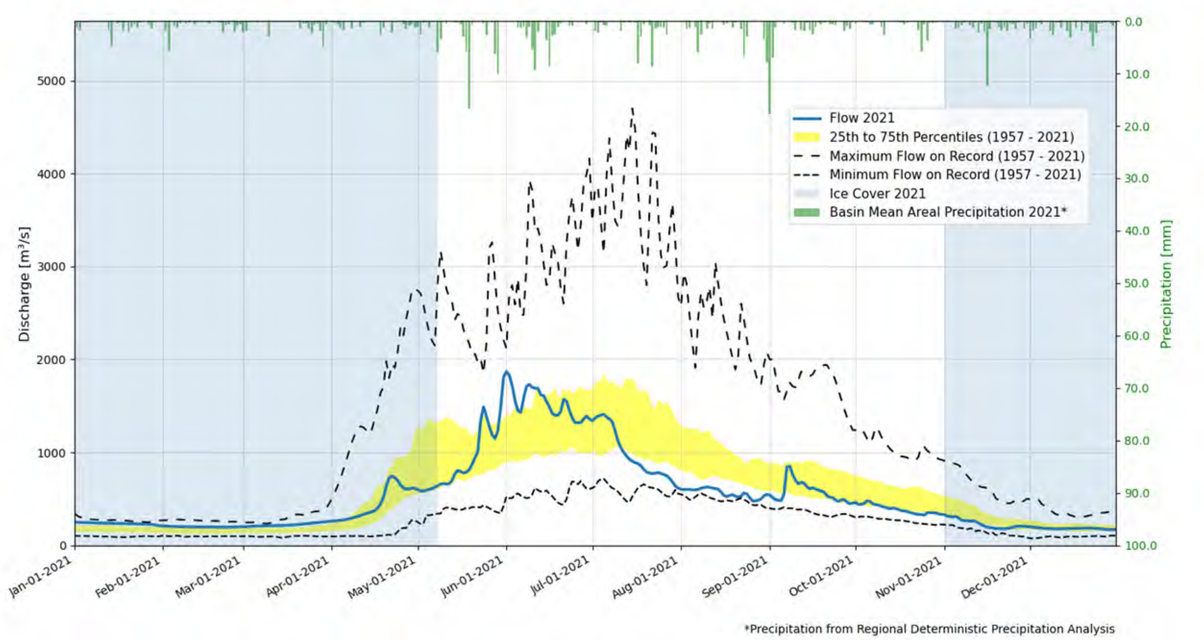

Figure 3: Annual Hydrograph for Station 07DA001 Athabasca River below Fort McMurray

Tributary Contributions to the Athabasca Main Stem

For the purposes of these annual hydrologic conditions reports a subset of tributary hydrometric stations located downstream of Fort McMurray (listed in Table 1) are assessed to determine the significance of contributions of sub basins lying to the east and west of the Athabasca River main stem. Annual hydrographs for these individual gauging stations for 2021 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 downstream of Fort McMurray

The eastern tributaries in the Oil Sands area experienced upper quartile flows following ice break-up which then fell into the normal range for the summer months. The eastern tributaries went on to record normal discharges for the remainder of the year. Overall, the 2021 mean discharge in the eastern tributaries downstream of Fort McMurray was similar to the historical mean annual discharge (97%, on average).

Almost all of the western tributary indicator stations also experienced upper quartile flows at the onset of spring, which then fell to more normal flows by July. These stations then went on to record normal discharge for the remainder of the year with annual peak flows in June coincident with precipitation. Overall, the 2021 mean discharge in the western tributaries was greater than the historical mean annual discharge (110%, on average).

Athabasca River at Embarras Airport (07DD001)

The hydrometric data for this station (Figure 4) indicates that the period of ice affected data ended in early May. The peak flow for 2021 occurred in the beginning of June following ice break-up and a series of precipitation events. The 2021 mean flow of 604 m^3/s was 14% lower than the historical mean annual flow of 703 m^3/s over this station's period of record. Basin mean areal precipitation for 2021, calculated using precipitation available from the RDPA, was also shown to be lower (82%) to that of previous years (based on record from 2002 – 2021).

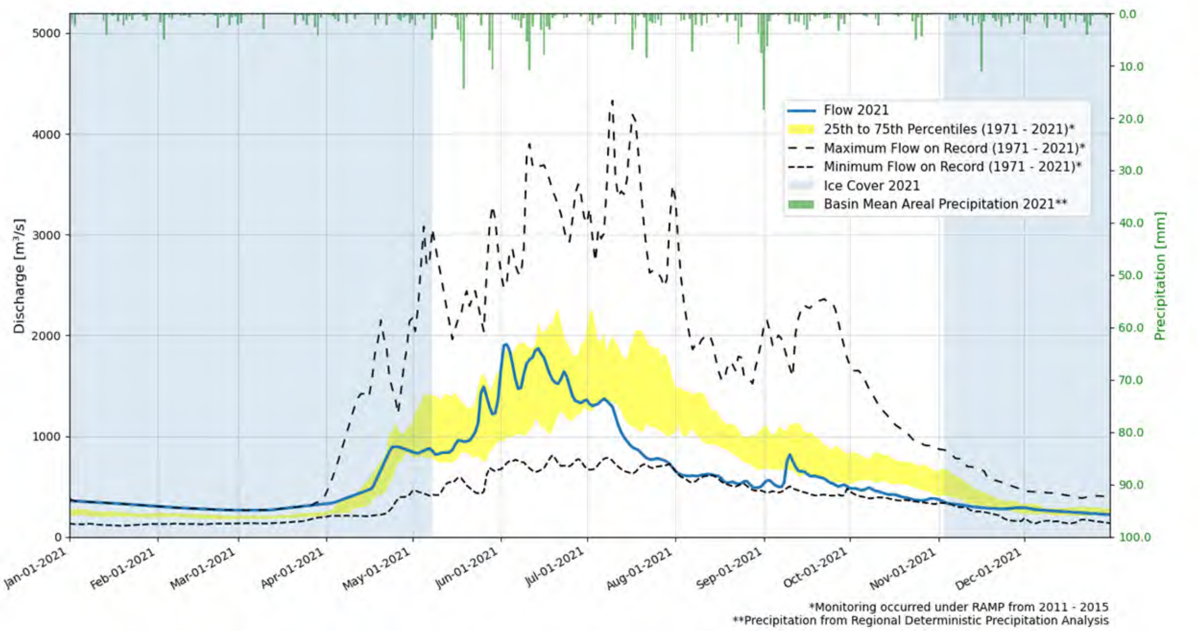

Figure 4: Annual Hydrograph for Station 07DD001 Athabasca River at Embarras Airport

Summary

Based on the historical record, the three stations on the Athabasca River main stem recorded average spring flow in May following ice break-up, with average, to below average, flow throughout the remainder of the year. The fourth key station, Clearwater River above Christina River, had above average spring flow and average flow for the remainder of the year.

The eastern and western tributaries downstream of Fort McMurray experienced above average flow around spring breakup, and average flow through the remainder of the year. Overall, the 2021 mean discharge in the eastern and western tributaries was similar to the mean annual discharge over the period of record.

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/. More information about the RDPA is available from the Meteorological Services of Canada open data documentation at https://eccc-msc.github.io/open-data/.

References:

Arciszewski, T.J. 2021. Exploring the Influence of Industrial and Climatic Variables on Communities of Benthic Macroinvertegrates Collected in Streams and Lakes in Canada's Oil Sands Region. *Environments*, 8, 123.

Arciszewski, T. and McMaster, M.E. 2021. Potential Influence of Sewage Phosphorus and Wet and Dry Deposition Detected in Fish Collected in the Athabasca River North of Fort McMurray. *Environments* 2021, 8, 14.

Joseph M. Culp, Ian G. Droppo, Peter D. di Cenzo, Alexa C. Alexander, Donald J. Baird, Spyros Beltaos, Greg Bickerton, Barrie Bonsal, Robert B. Brua, Patricia A. Chambers, Yonas Dibike, Nancy E. Glozier, Jane L. Kirk, Lucie Levesque, Mark McMaster, Derek C.G. Muir, Joanne L. Parrott, Daniel L. Peters, Kerry Pippy, and James W. Roy. Ecological effects and causal synthesis of oil sands activity impacts on river ecosystems: water synthesis review. *Environmental Reviews*. 29(2): 315-327.

Acknowledgements:

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Appendix A:
Overview Maps – Alberta Oil Sands Area

Figure A1 shows all active hydrometric monitoring stations operated by WSC in 2021. Figure A2 shows all the Regional Deterministic Precipitation Analysis (RDPA) grids within the Athabasca River at Embarras Airport (07DD001) contributing area and their 2021 annual precipitation. The daily precipitation at each of these grid points was spatially averaged over each monitoring station's contributing area and used to represent the basin mean areal precipitation on the annual hydrographs included in the main body of this report and in Appendix C. Daily RDPA data can be accessed through Meteorological Services of Canada Datamart (https://dd.weather.gc.ca/). Additional information about RDPA is available from the Meteorological Services of Canada open data documentation (https://eccc-msc.github.io/open-data/) which will also direct those interested to the online archives and re-analysis archives of RDPA data (available from January 2002 onward).

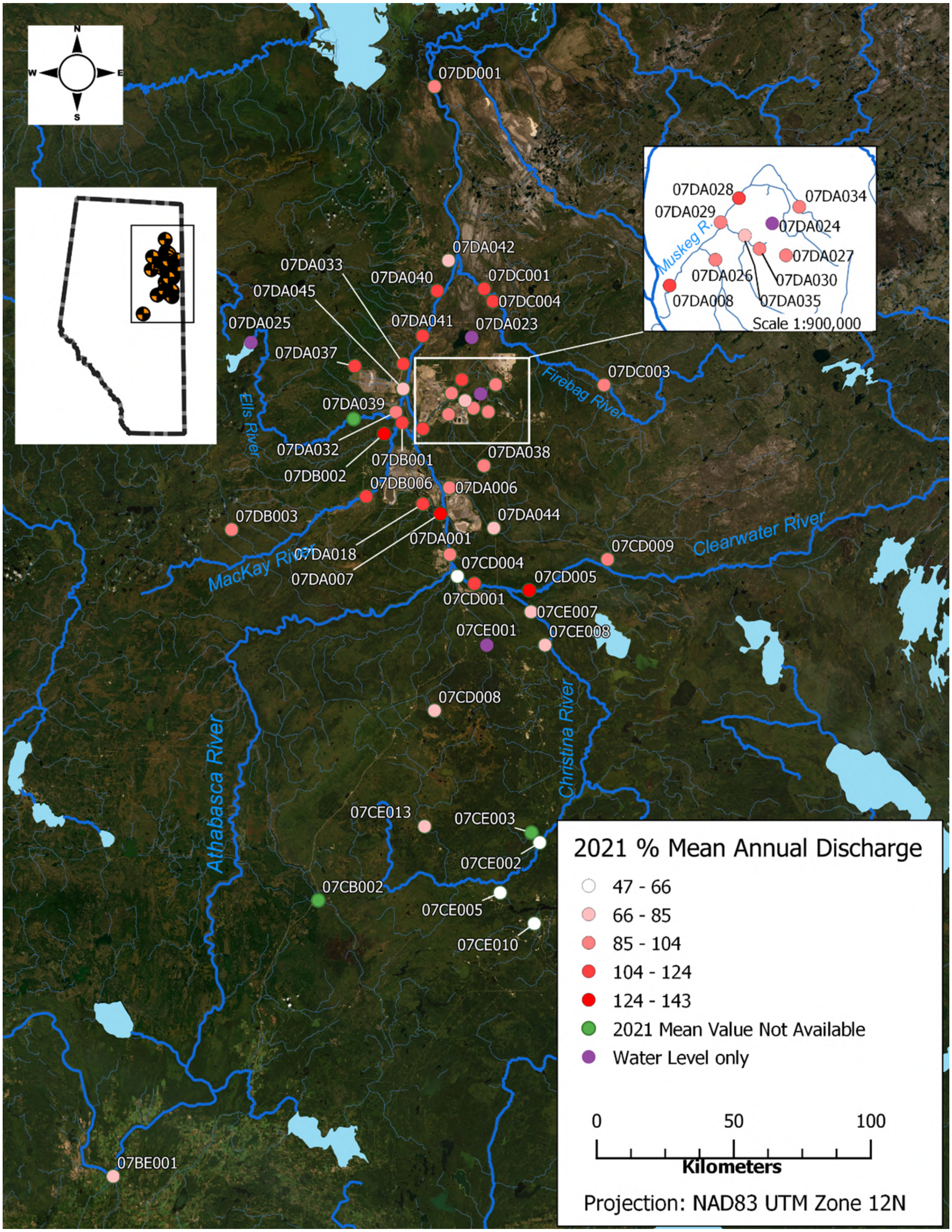


Figure A1: Active Hydrometric Stations in the Alberta Oil Sands Area in 2021

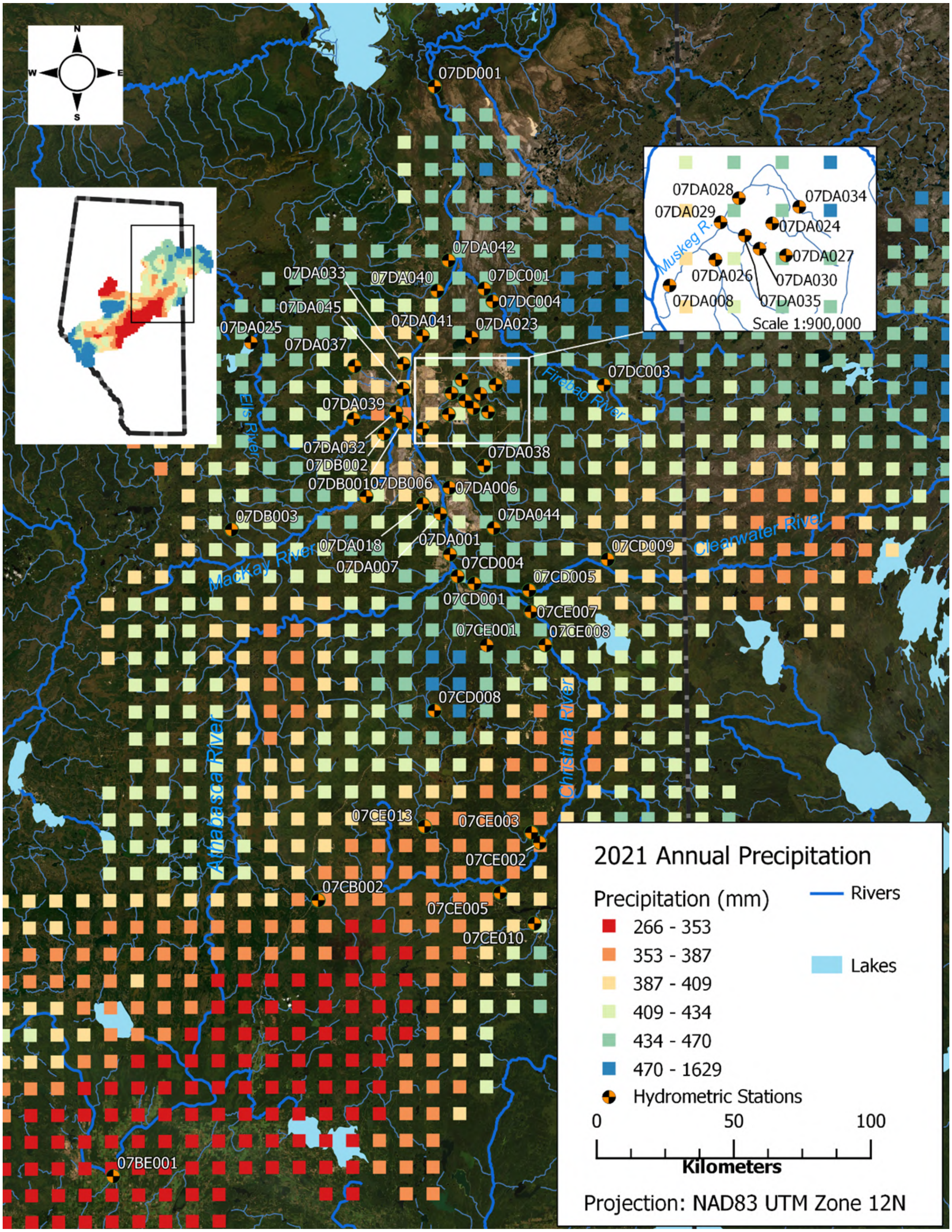


Figure A2: Regional Deterministic Precipitation Analysis (RDPA) gridded annual precipitation over the Alberta Oil Sands Area (Contributing area to Athabasca River at Embarras Airport – 07DD001) used in producing this Annual Report

Appendix B:
Summary – All Hydrometric Stations

The following tables summarize all active WSC hydrometric stations within the Oil Sands area in 2021. 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 of operational problems the data has been listed as N/A in the table, while a dash has been used for the stations with a seasonal operating schedule.

Table B1: Discharge Station Summary

STATION NAME	STATION ID	PERIOD OF RECORD	GROSS DRAINAGE AREA [km²]	2021 WATER YIELD [mm]	HISTORICAL MEAN ANNUAL WATER YIELD [mm]	2021 MEAN DISCHARGE [m³/s]	HISTORICAL MEAN ANNUAL DISCHARGE[1] [m³/s]	2021 AS A PERCENT OF HISTORICAL MEAN ANNUAL DISCHARGE [%]
ATHABASCA RIVER AT ATHABASCA	07BE001	1913 – 2021	74600	152	179	360	424	84.9
ATHABASCA RIVER AT EMBARRAS AIRPORT	07DD001	1971 – 2021 [1]	155000	123	143	604	703	85.9
ATHABASCA RIVER BELOW FORT MCMURRAY	07DA001	1957 – 2021	133000	128	147	541	619	87.4
BEAVER RIVER ABOVE SYNCRUDE	07DA018	1975 – 2021	165	120	111	0.630	0.579	109
BIG CREEK NEAR THE MOUTH	07DA040	2011 – 2021 [2]	323	72.0	63.3	0.737	0.648	114
CALUMET RIVER NEAR THE MOUTH	07DA033	2001 – 2021 [2]	175	47.8	40.4	0.265	0.224	118
CHRISTINA RIVER ABOVE STATOIL LEISMER	07CE013	2013 – 2021 [2]	1030	101	140	3.31	4.58	72.3
CHRISTINA RIVER NEAR CHARD	07CE002	1982 – 2021	4860	71.4	137	11.0	21.1	52.1
CHRISTINA RIVER NEAR THE MOUTH	07CE007	2011 – 2021 [2]	13200	88.2	115	36.9	47.9	77.0
CLEARWATER RIVER ABOVE CHRISTINA RIVER	07CD005	1966 – 2021	17000	191	142	103	76.7	134
CLEARWATER RIVER AT DRAPER	07CD001	1930 – 2021	30800	143	125	140	122	115
DOVER RIVER NEAR THE MOUTH	07DB002	1975 – 2021 [3]	963	94.0	66.2	2.87	2.02	142
DUNKIRK RIVER NEAR FORT MACKAY	07DB003	1975 – 2021 [3]	1570	90.9	95.9	4.52	4.77	94.8
EAST JACKPINE CREEK NEAR THE 1300 FT CONTOUR	07DA038	2007 – 2021 [2]	45	161	175	0.229	0.249	92.0
ELLS RIVER ABOVE JOSLYN CREEK DIVERSION	07DA039	2009 – 2021 [2]	2260	N/A	117	N/A	8.4	N/A
ELLS RIVER AT CANADIAN NATURAL RESOURCES LIMITED BRIDGE	07DA032	2004 – 2021 [2]	2430	103	104	7.93	7.99	99.2
EYMUNDSON CREEK NEAR THE MOUTH	07DA041	2011 – 2021 [2]	319	91.0	80.4	0.92	0.813	113
FIREBAG RIVER NEAR THE MOUTH	07DC001	1971 – 2021	5980	157	142	29.7	26.9	110
FIREBAG RIVER UPSTREAM OF SUNCOR FIREBAG	07DC003	2009 – 2021 [2]	2420	141	141	10.8	10.8	100
GREGOIRE RIVER NEAR THE MOUTH	07CE008	2012 – 2021 [2]	1000	96.2	131	3.05	4.15	73.5
HANGINGSTONE RIVER AT FORT MCMURRAY	07CD004	1965 – 2021	962	78.4	127	2.39	3.86	61.9
HANGINGSTONE RIVER AT NORTH STAR ROAD	07CD008	2002 – 2021 [2]	113	118	165	0.423	0.591	71.6
HIGH HILL RIVER NEAR THE MOUTH	07CD009	2012 – 2021 [2]	1360	129	130	5.57	5.60	99.5
HOUSE RIVER AT HIGHWAY NO. 63	07CB002	1982 – 2021 [5]	781	-	-	-	-	-
IYINIMIN CREEK ABOVE KEARL LAKE	07DA027	1989 – 2021 [2]	43.0	151	164	0.206	0.223	92.4
JACKFISH RIVER BELOW CHRISTINA LAKE	07CE005	1982 – 2021 [3]	1290	63.8	121	2.61	4.93	52.9
JACKPINE CREEK AT CANTERRA ROAD	07DA026	1995 – 2021 [2]	343	117	122	1.27	1.33	95.5
KEARL LAKE OUTLET	07DA030	1989 – 2021 [2]	83.0	87.1	88.6	0.229	0.233	98.3

Table continued on next page…

STATION NAME	STATION ID	PERIOD OF RECORD	GROSS DRAINAGE AREA [km²]	2021 WATER YIELD [mm]	HISTORICAL MEAN ANNUAL WATER YIELD [mm]	2021 MEAN DISCHARGE [m³/s]	HISTORICAL MEAN ANNUAL DISCHARGE[1] [m³/s]	2021 AS A PERCENT OF HISTORICAL MEAN ANNUAL DISCHARGE [%]
MACKAY RIVER AT PETRO-CANADA BRIDGE	07DB006	2008 – 2021 [2]	4130	88.6	81.8	11.6	10.7	108
MACKAY RIVER NEAR FORT MACKAY	07DB001	1972 – 2021	5570	90.6	81.0	16.0	14.3	112
MCCLELLAND LAKE OUTLET ABOVE FIREBAG RIVER	07DC004	2008 – 2021 [2]	359	84.6	69.4	0.963	0.789	122
MUSKEG CREEK NEAR THE MOUTH	07DA035	1989 – 2021 [2]	322	93.0	111	0.949	1.13	84.0
MUSKEG RIVER ABOVE MUSKEG CREEK	07DA029	1995 – 2021 [2]	567	77.9	75.1	1.40	1.35	104
MUSKEG RIVER ABOVE STANLEY CREEK	07DA028	2003 – 2021 [2]	440	81.8	73.9	1.14	1.03	111
MUSKEG RIVER NEAR FORT MACKAY	07DA008	1974 – 2021	1460	89.9	83.2	4.16	3.85	108
MUSKEG RIVER UPLAND	07DA034	2001 – 2021 [2]	150	103	110	0.491	0.522	94.1
PONY CREEK NEAR CHARD	07CE003	1982 – 2021 [5]	279	-	-	-	-	-
POPLAR CREEK NEAR FORT MCMURRAY	07DA007	1972 – 2021 [4]	151	322	226	1.54	1.08	143
RED CLAY CREEK NEAR THE MOUTH	07DA042	2011 – 2021 [2]	N/A	N/A	N/A	0.657	0.793	82.8
STEEPBANK RIVER BELOW NORTH STEEPBANK RIVER	07DA044	2014 – 2021 [2]	1180	129	167	4.82	6.26	77.0
STEEPBANK RIVER NEAR FORT MCMURRAY	07DA006	1972 – 2021	1320	120	131	5.02	5.48	91.6
SUNDAY CREEK ABOVE CHRISTINA LAKE	07CE010	2012 – 2021 [2]	365	65.5	141	0.758	1.63	46.5
TAR RIVER ABOVE CANADIAN NATURAL RESOURCES LIMITED LAKE	07DA037	2005 – 2021 [2]	143	119	104	0.537	0.472	114
TAR RIVER NEAR THE MOUTH	07DA045	2007 – 2021 [2]	320	67.2	89.0	0.681	0.902	75.5

[1] Monitoring occurred under RAMP from 2011-2015.
[2] Monitoring occurred under RAMP prior to 2017.
[3] Monitoring occurred under RAMP from 2012 – 2016.
[4] Monitoring occurred under RAMP from 1996 – 2016.
[5] Seasonally operated

Table B2: Level Stations

STATION NAME	STATION ID	RECORD	DATUM	2021 MEAN LEVEL [m]	HISTORICAL MEAN ANNUAL LEVEL [m]	DIFFERENCE [m]
GREGOIRE LAKE NEAR FORT MCMURRAY	07CE001	1969 – 2021 [1]	Geodetic Survey of Canada	-	-	-
KEARL LAKE AT CANTERRA ROAD [2]	07DA024	2017 – 2021	Assumed [3]	N/A	99.547	N/A
MCCLELLAND LAKE AT EAST END	07DA023	1997 – 2021 [4]	Assumed [3]	294.698	294.588	0.110
NAMUR LAKE NEAR THE OUTLET	07DA025	2012 – 2021 [4]	Assumed [3]	97.924	97.870	0.054

[1] Seasonally operated

[2] 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.

[3] Conversions to CGVD 2013 Datum available on Wateroffice.

[4] 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 2021. Each hydrograph includes the measured discharge/level for 2021, the maximum and minimum discharge/level on record for each station, and the interquartile range of flow/level (between the 25th and 75th 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, the statistical record used includes monitoring that occurred under the Regional Aquatics Monitoring Program (RAMP). Data included from RAMP has not been verified by WSC.

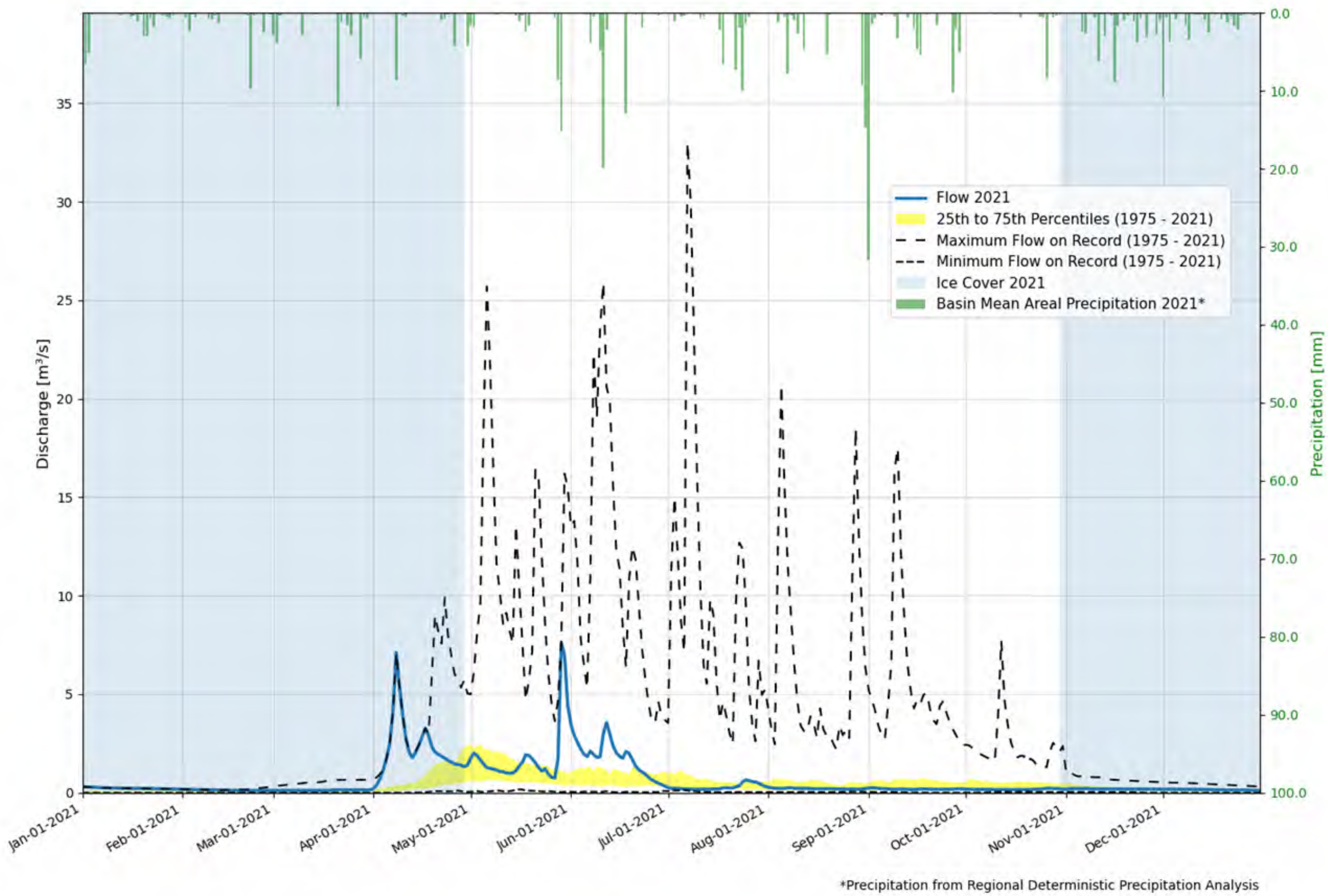


Figure C1: Beaver River above Syncrude (07DA018)

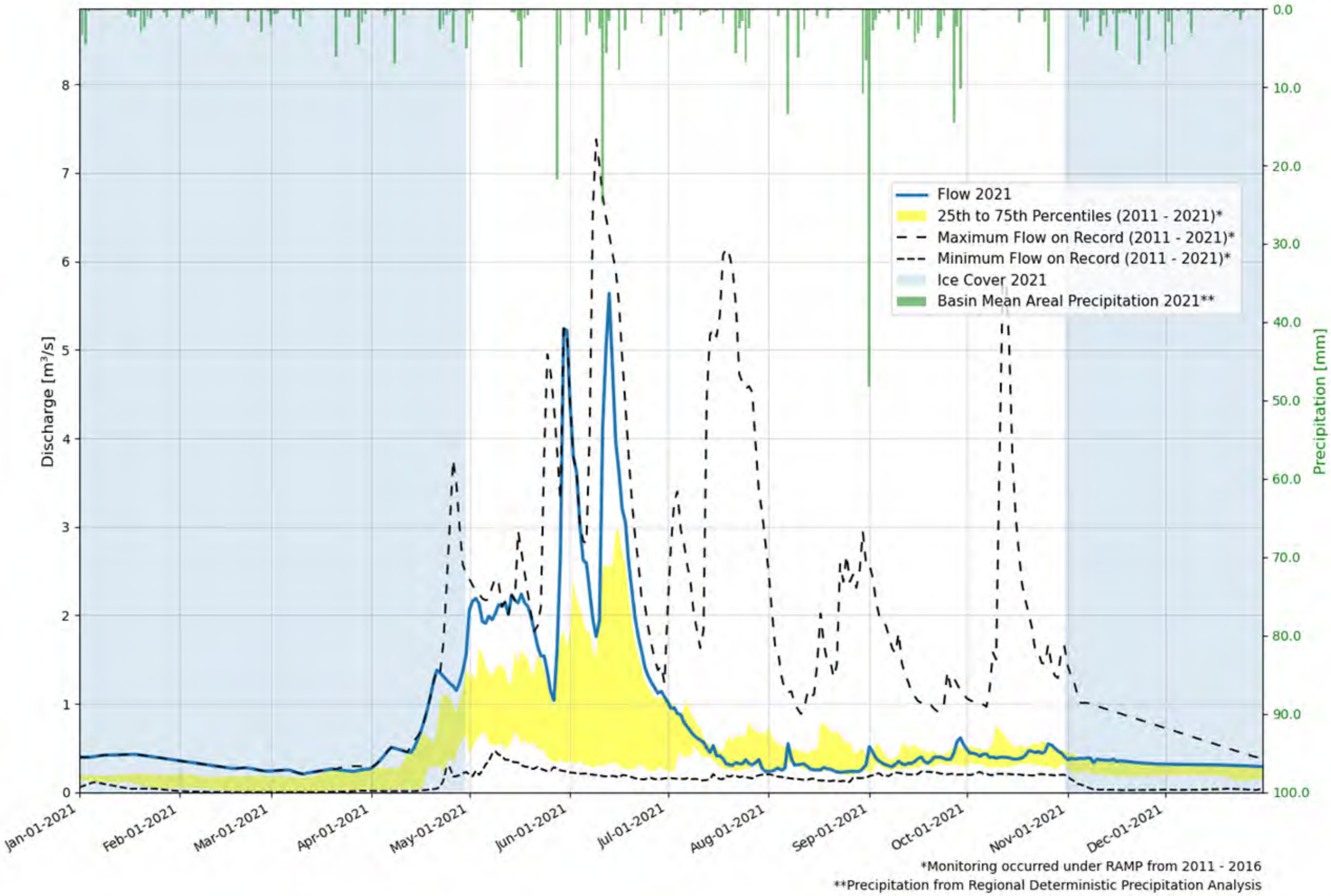


Figure C2: Big Creek near the Mouth (07DA040)

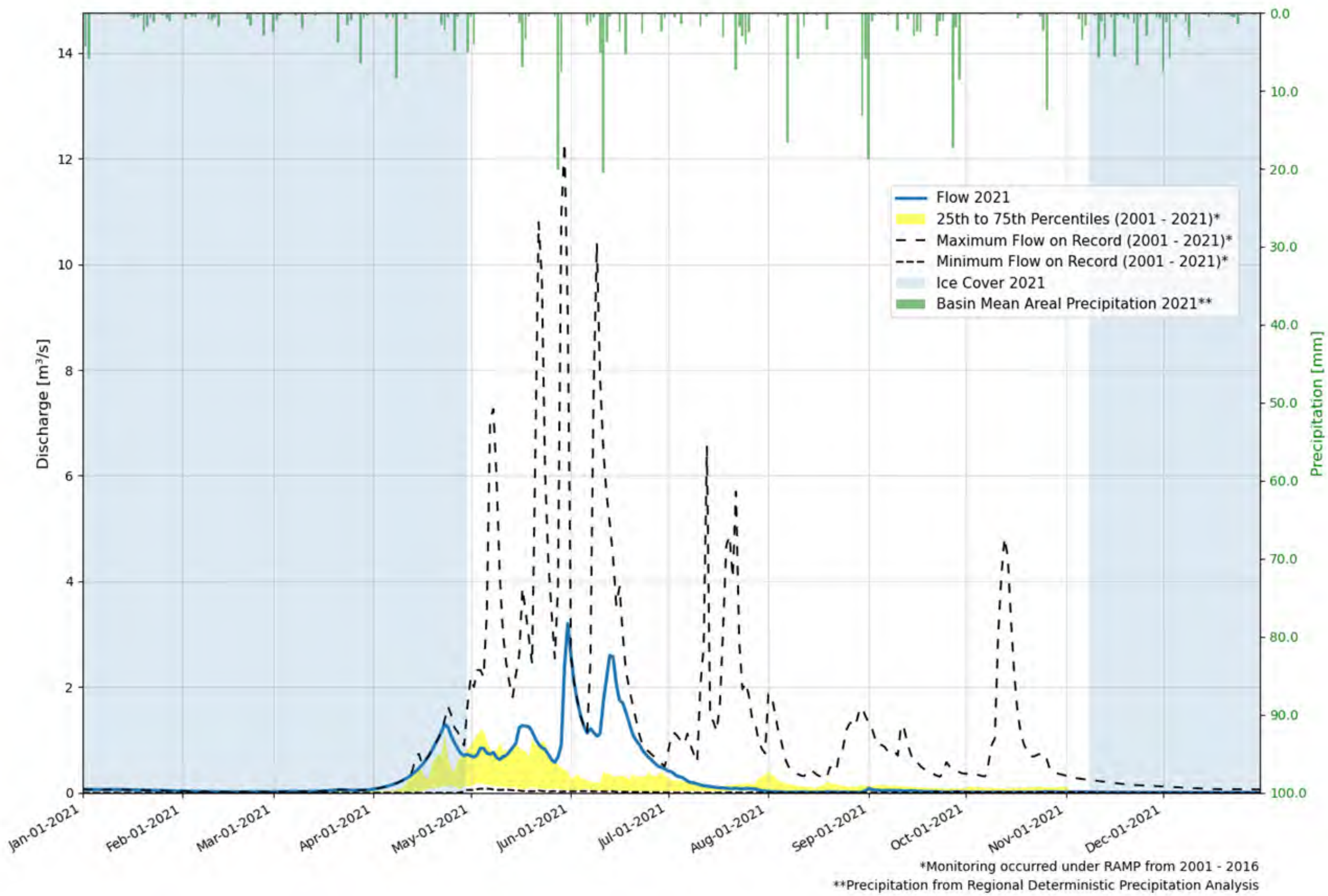


Figure C3: Calumet River near the Mouth (07DA033)

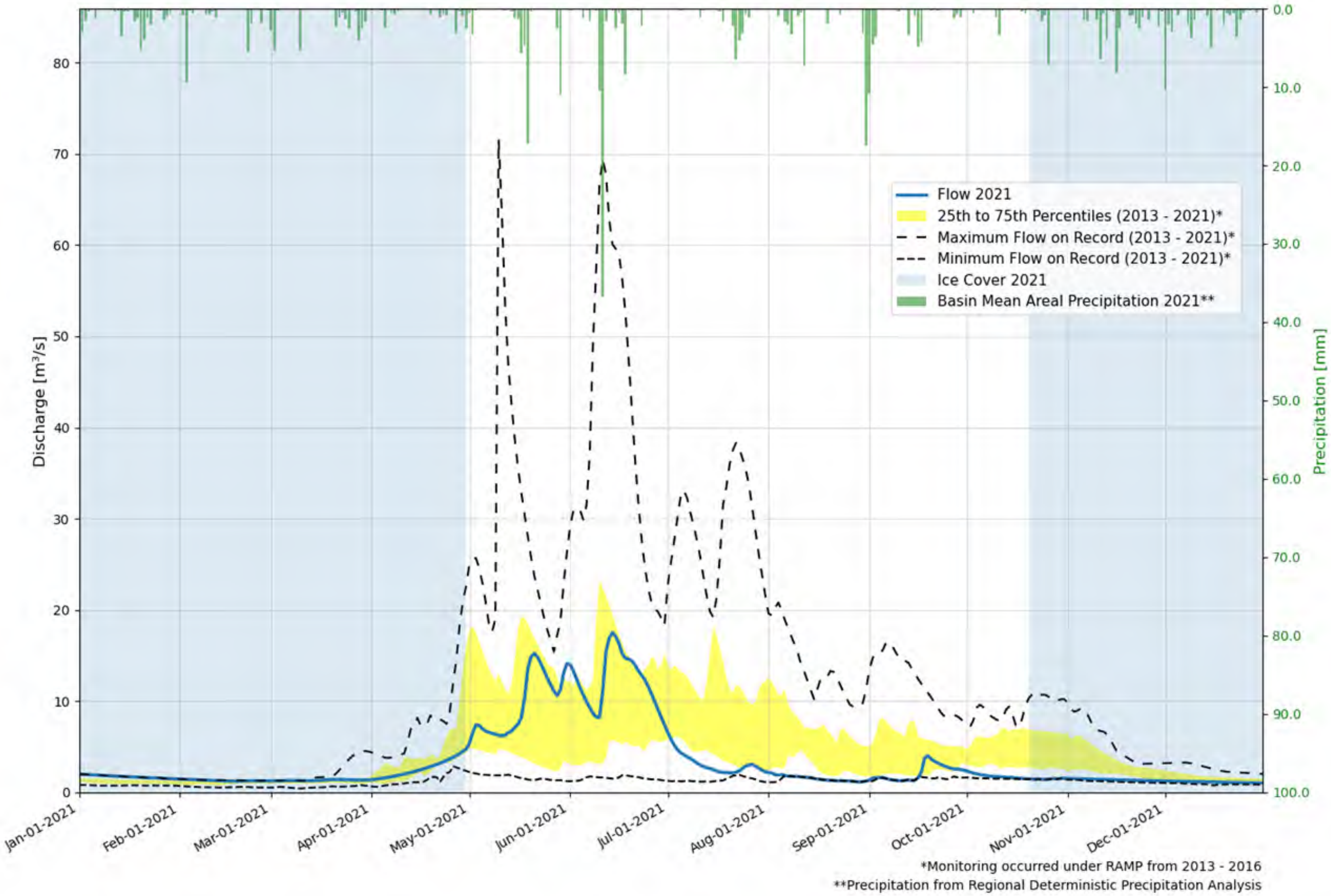


Figure C4: Christina River above Statoil Leismer (07CE013)

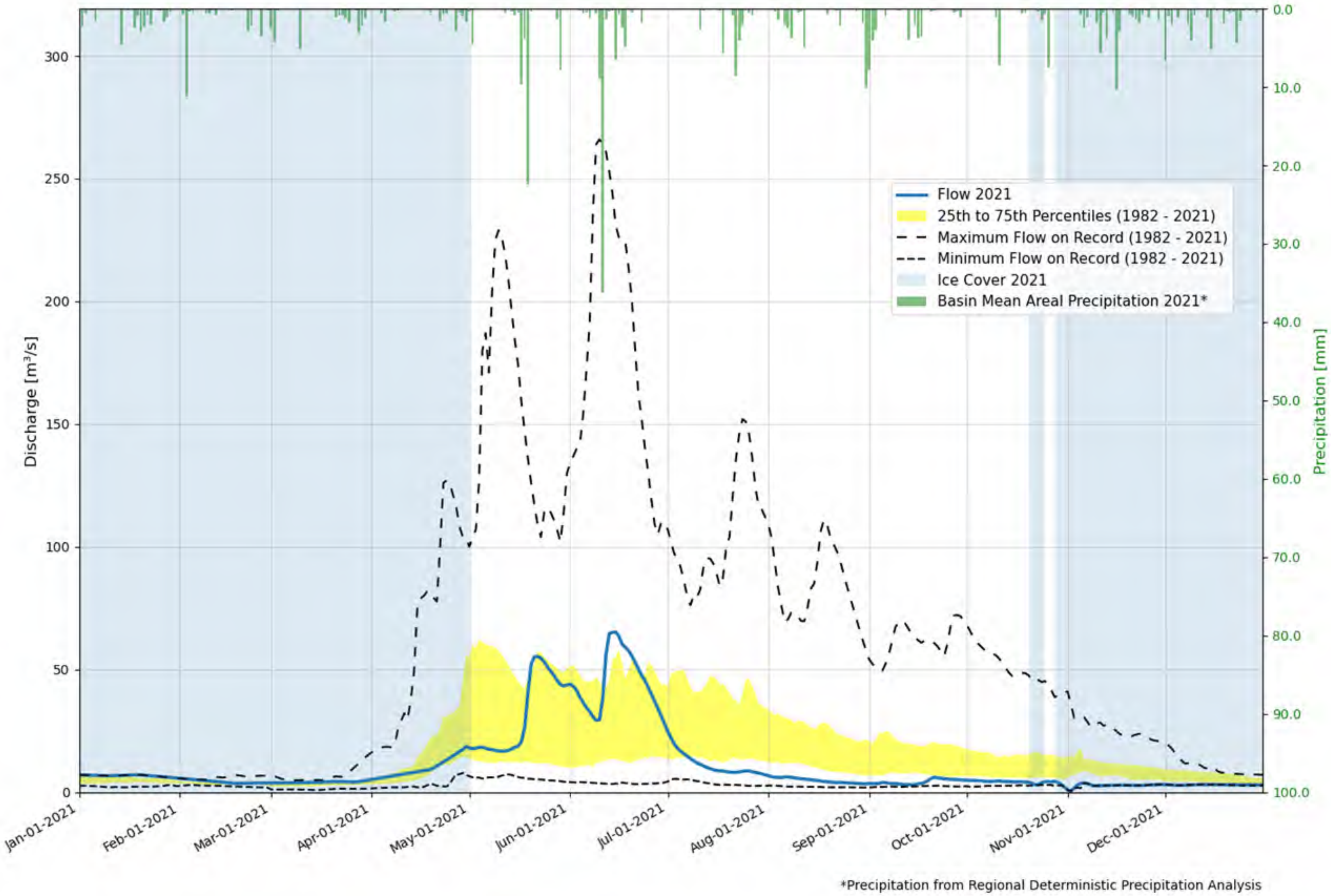


Figure C5: Christina River near Chard (07CE002)

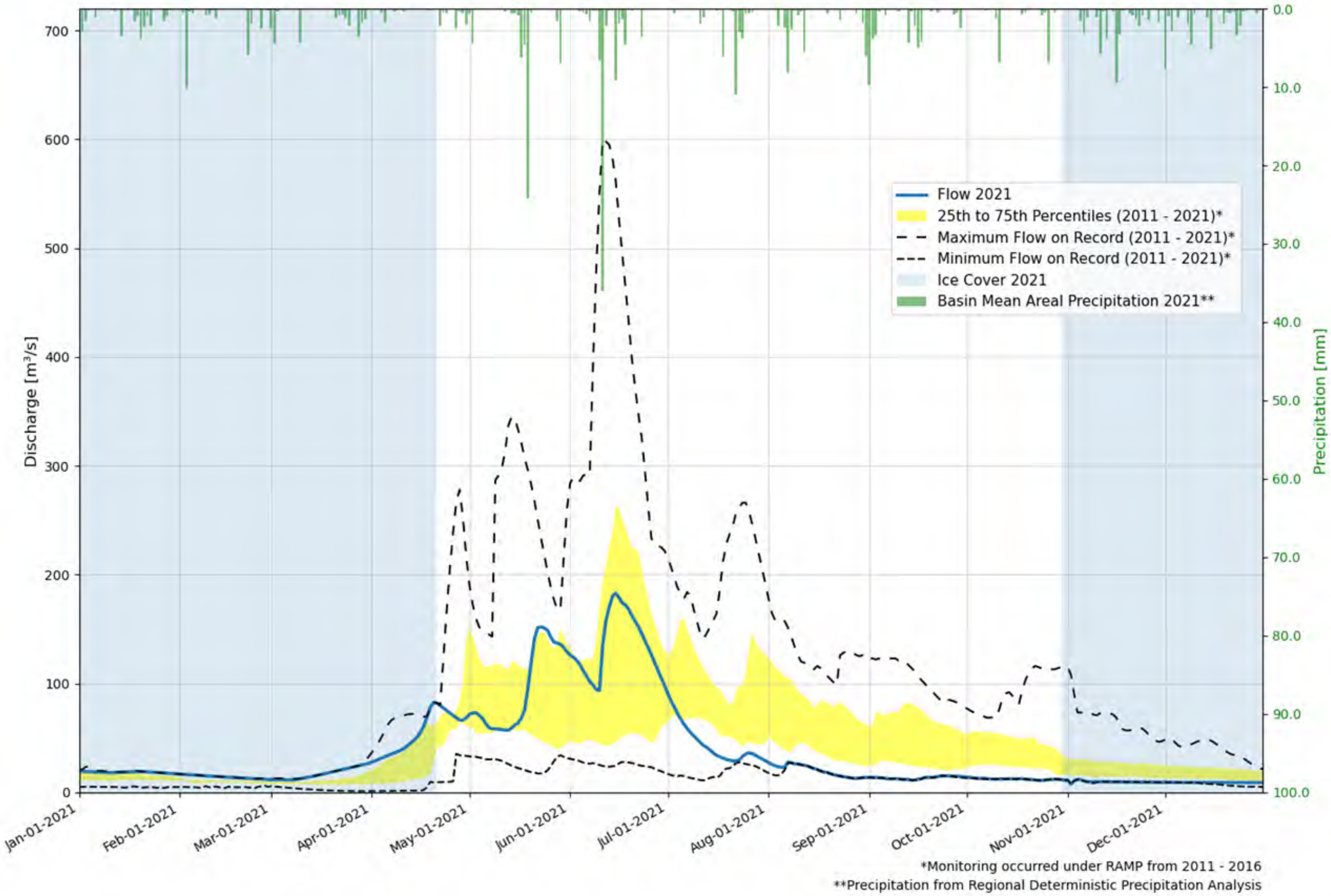


Figure C6: Christina River near the Mouth (07CE007)

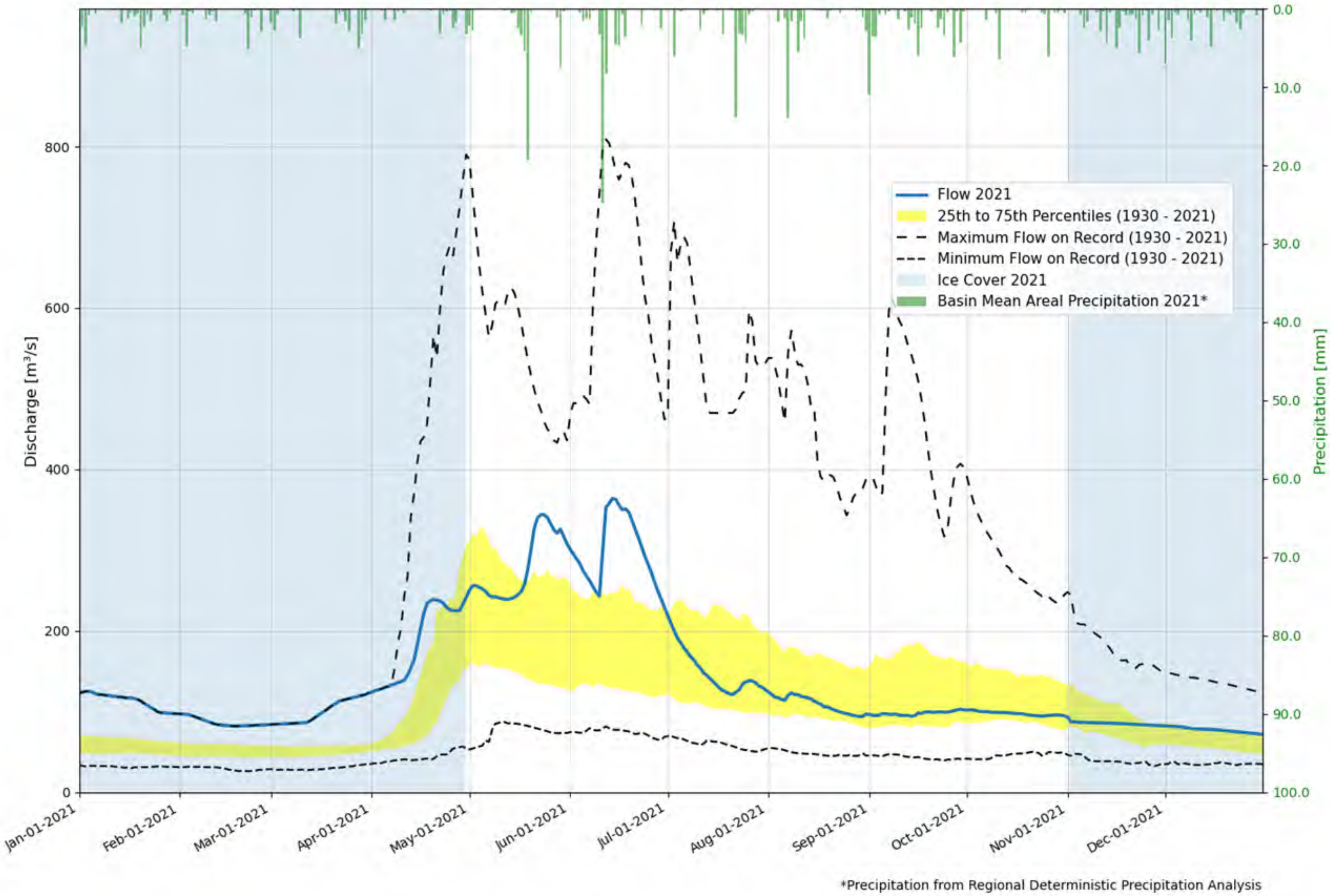


Figure C7: Clearwater River at Draper (07CD001)

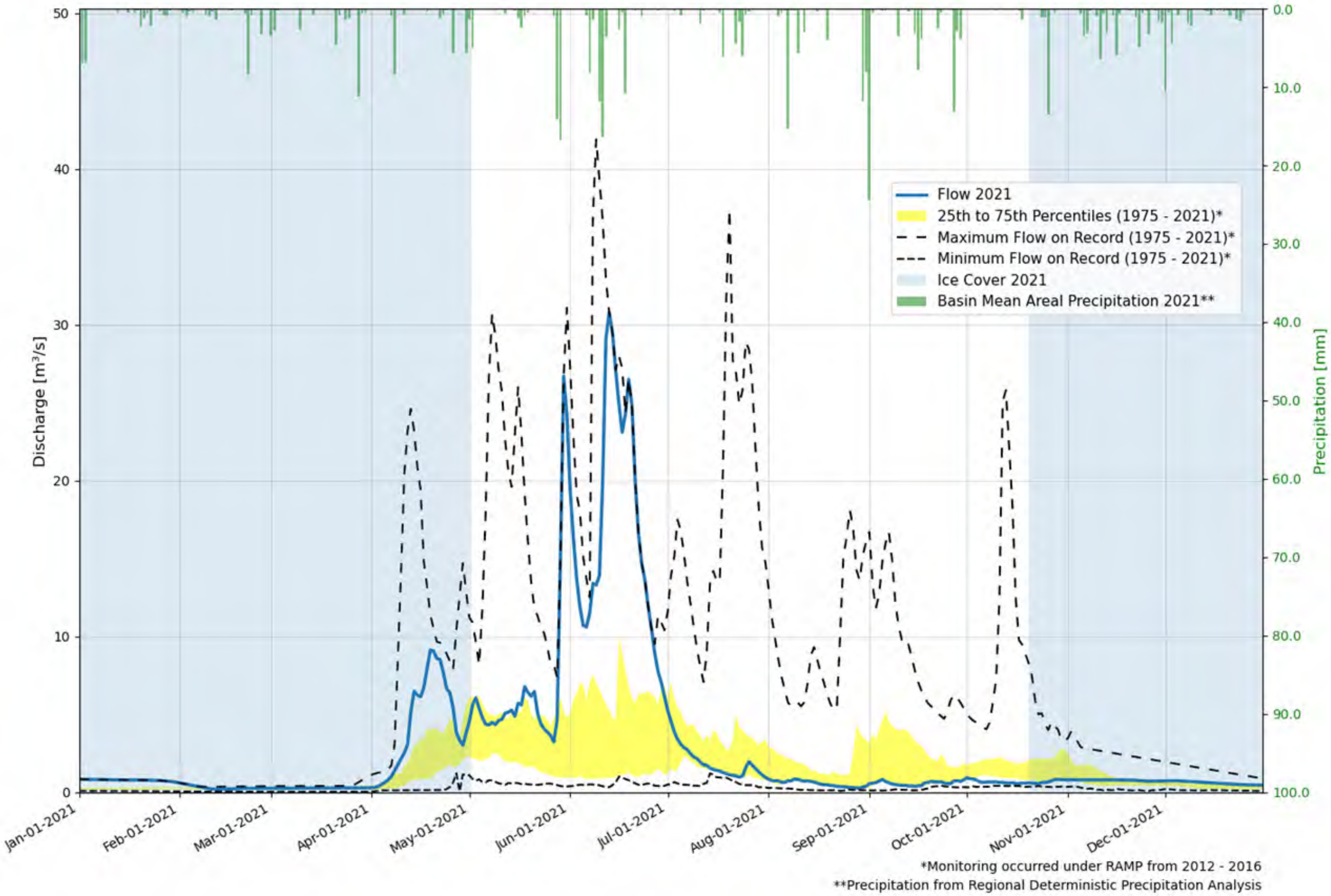


Figure C8: Dover River near the Mouth (07DB002)

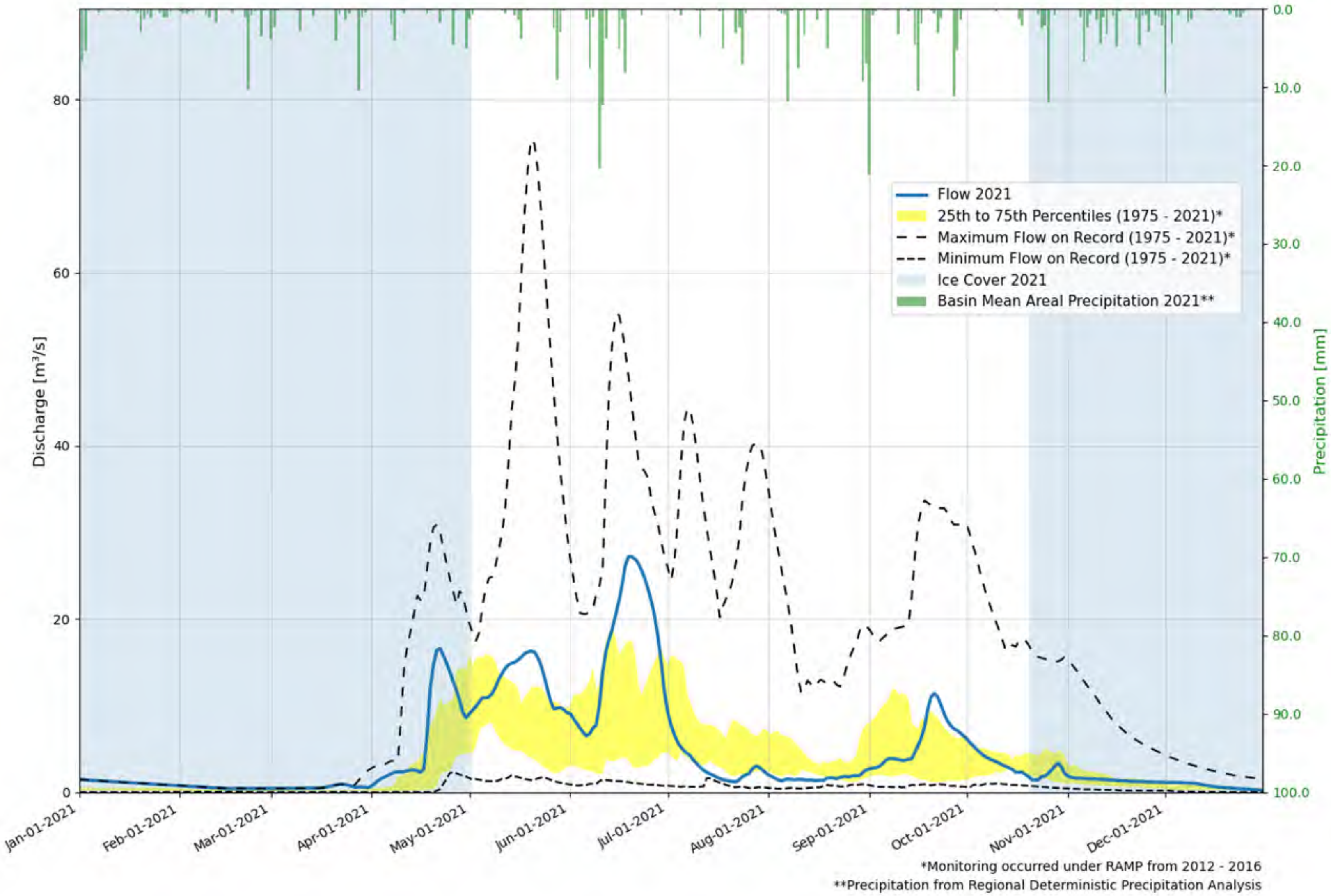


Figure C9: Dunkirk River near Fort MacKay (07DB003)

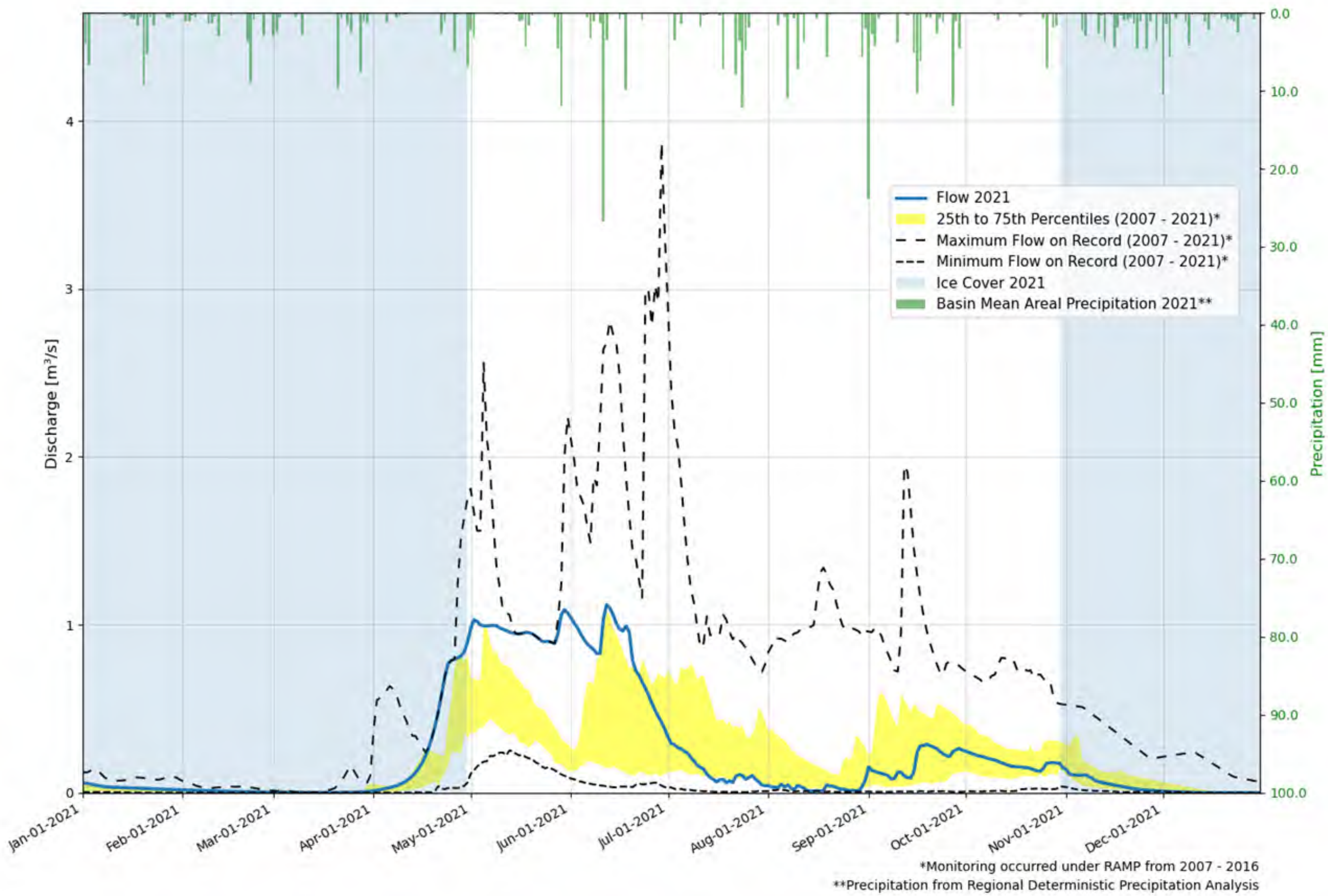


Figure C10: East Jackpine Creek near the 1300 FT Contour (07DA038)

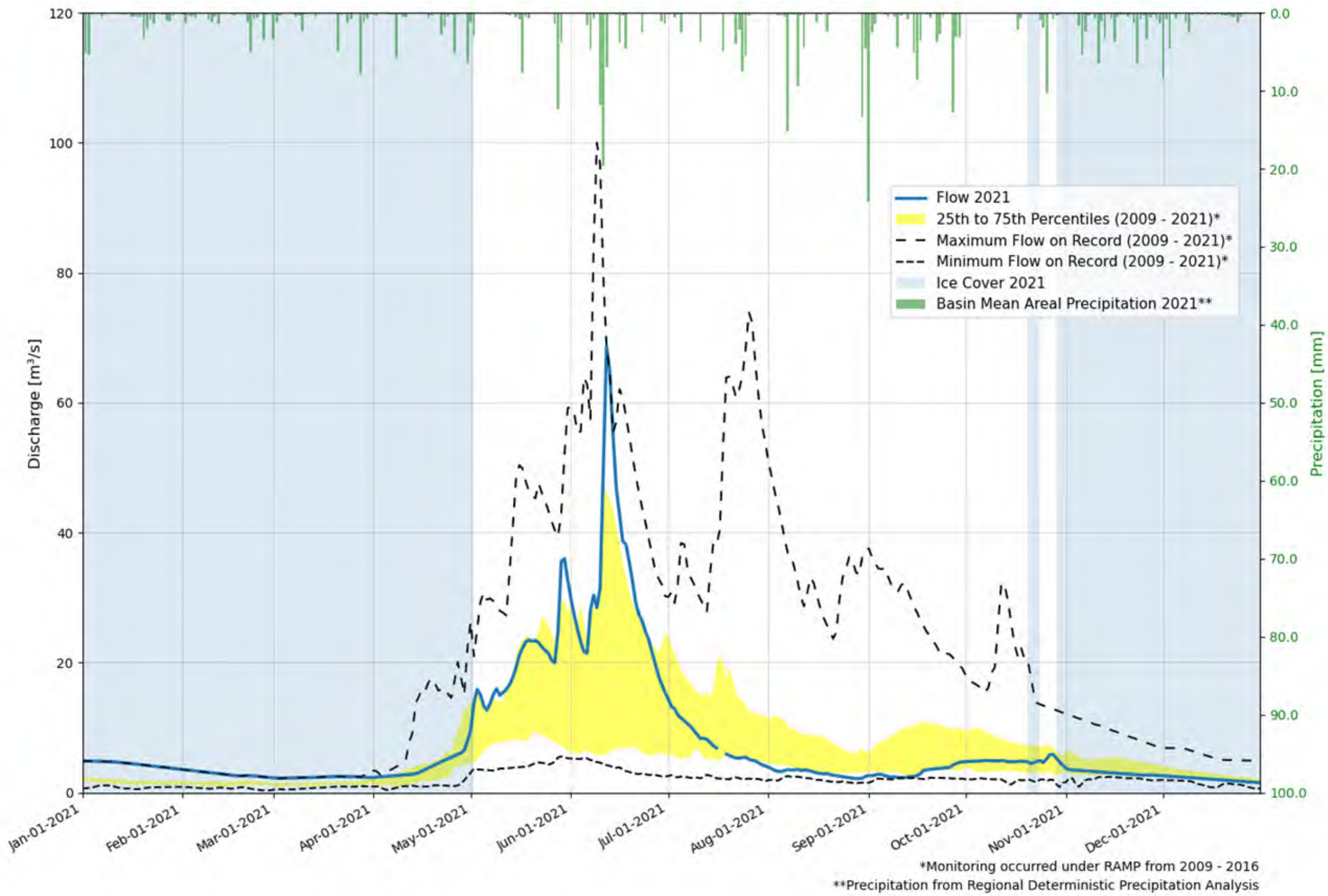


Figure C11: Ells River above Joslyn Creek Diversion (07DA039)

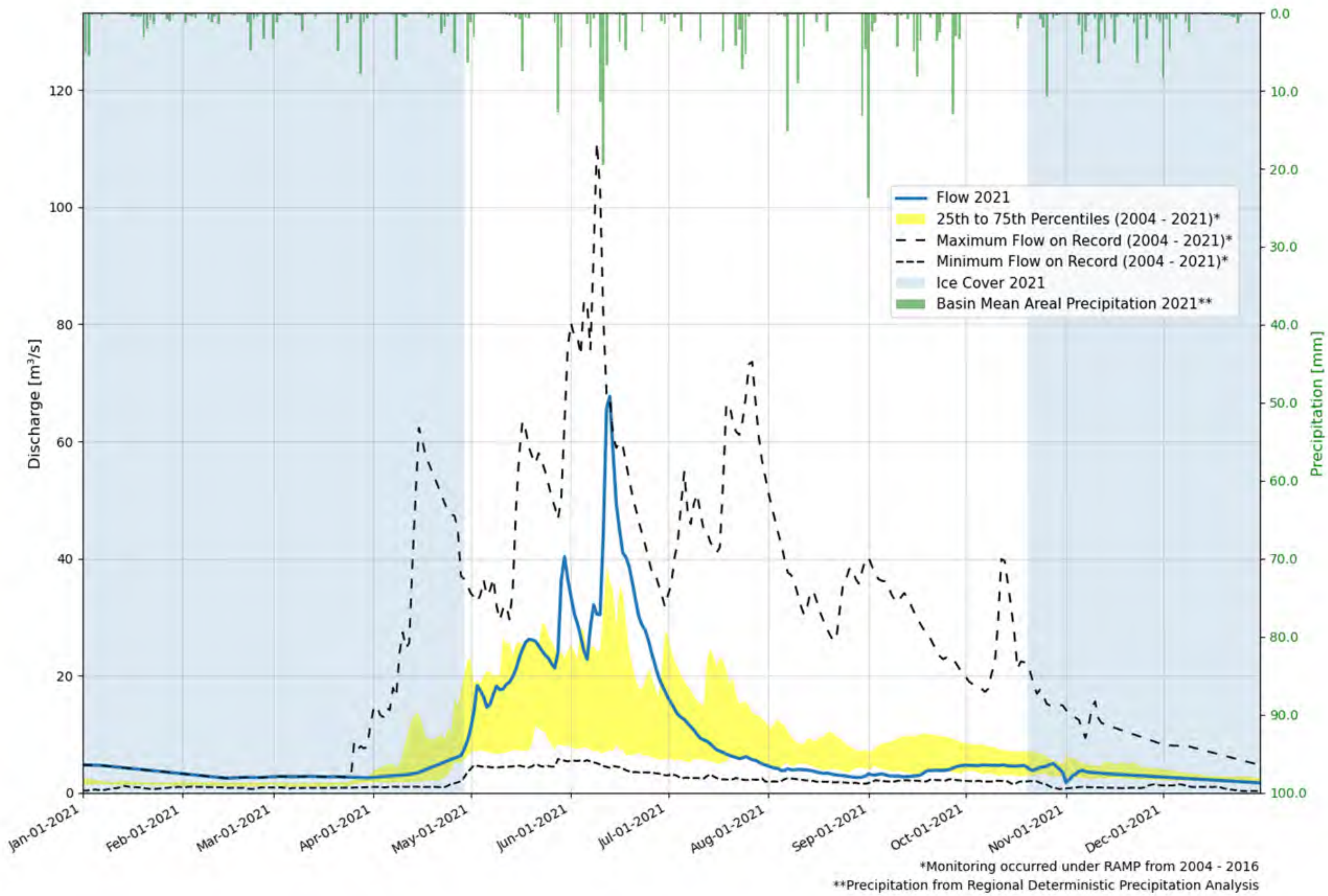


Figure C12: Ells River at Canadian National Resources Limited Bridge (07DA032)

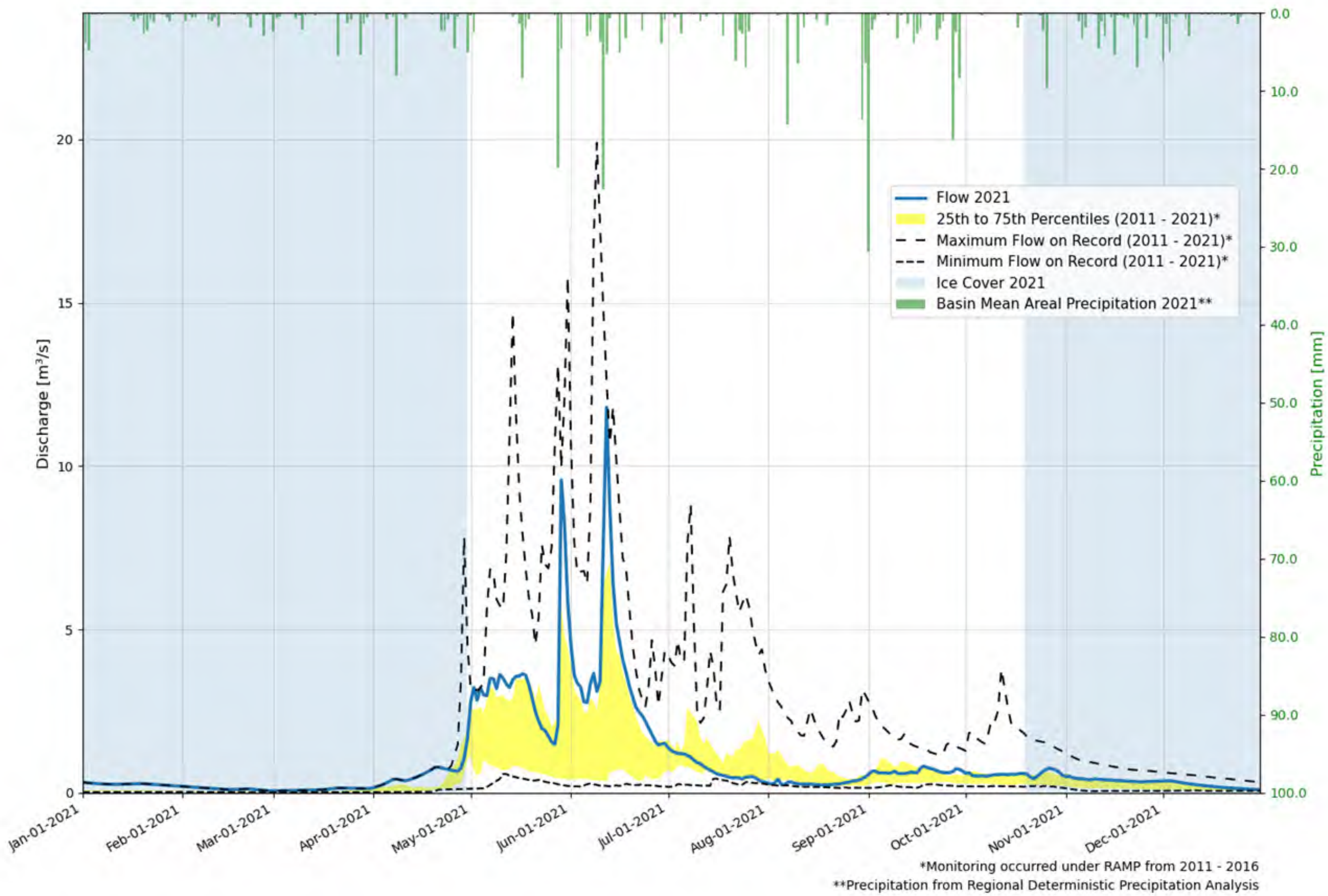


Figure C13: Eymundson Creek near the Mouth (07DA041)

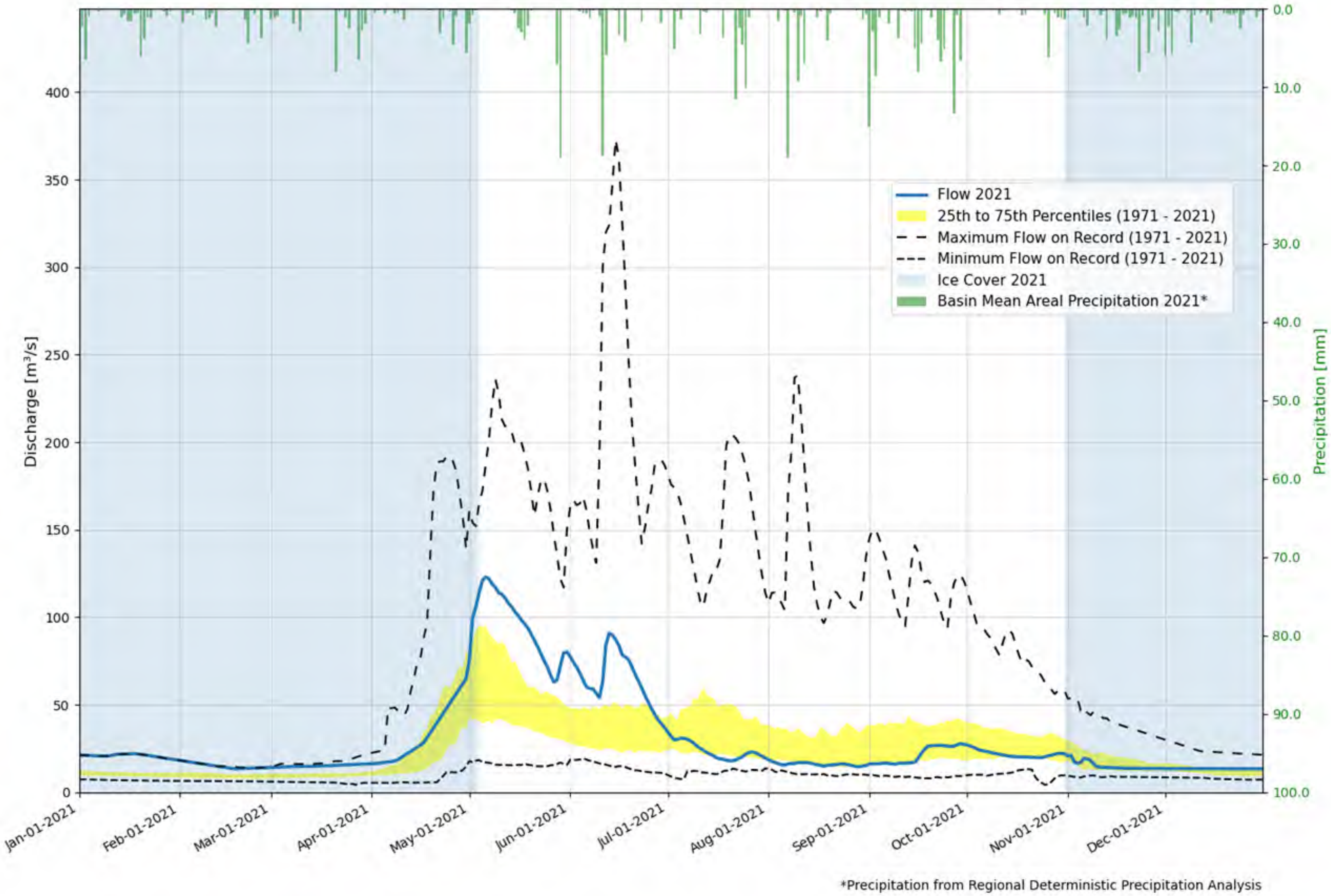


Figure C14: Firebag River near the Mouth (07DC001)

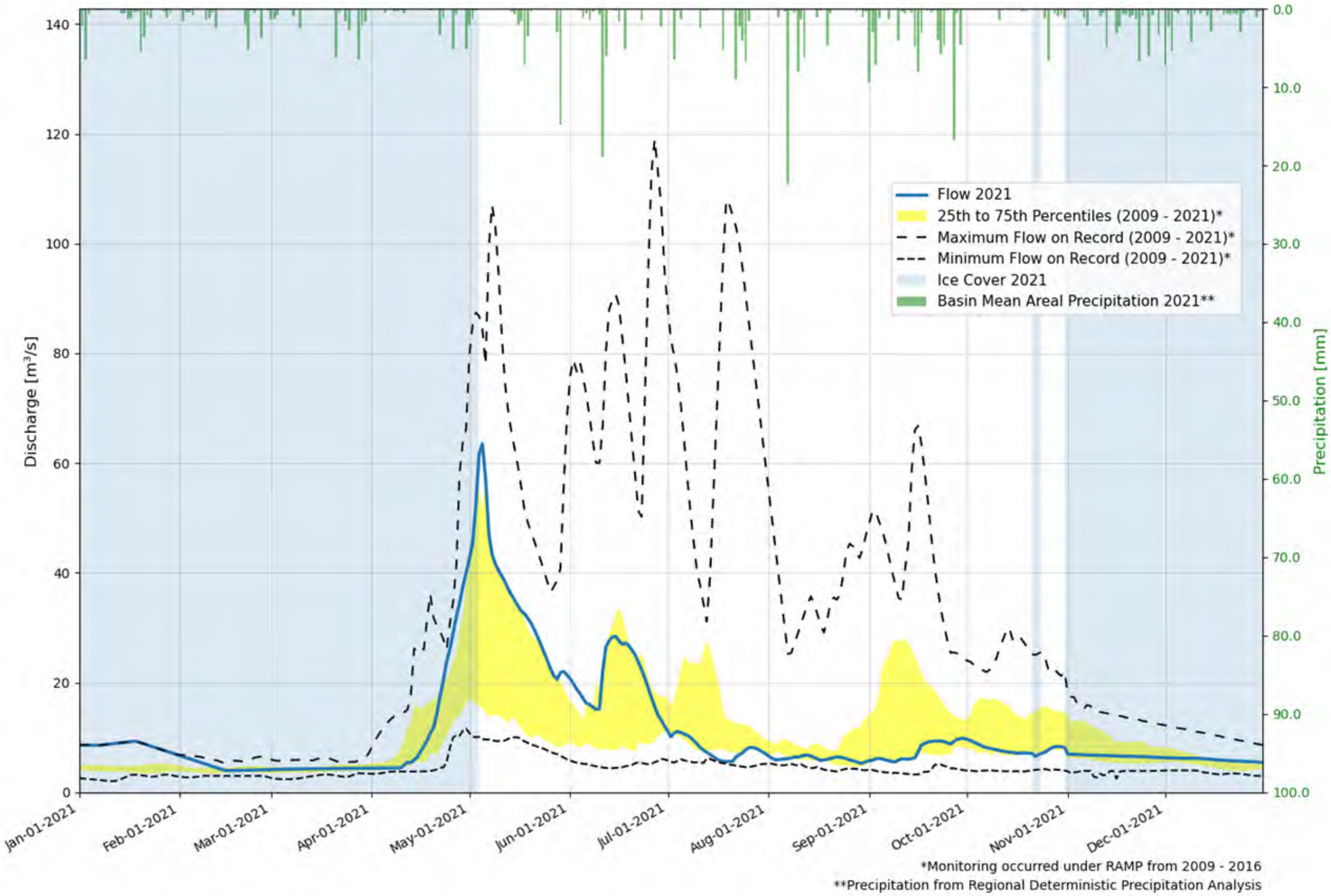


Figure C15: Firebag River upstream of Suncor Firebag (07DC003)

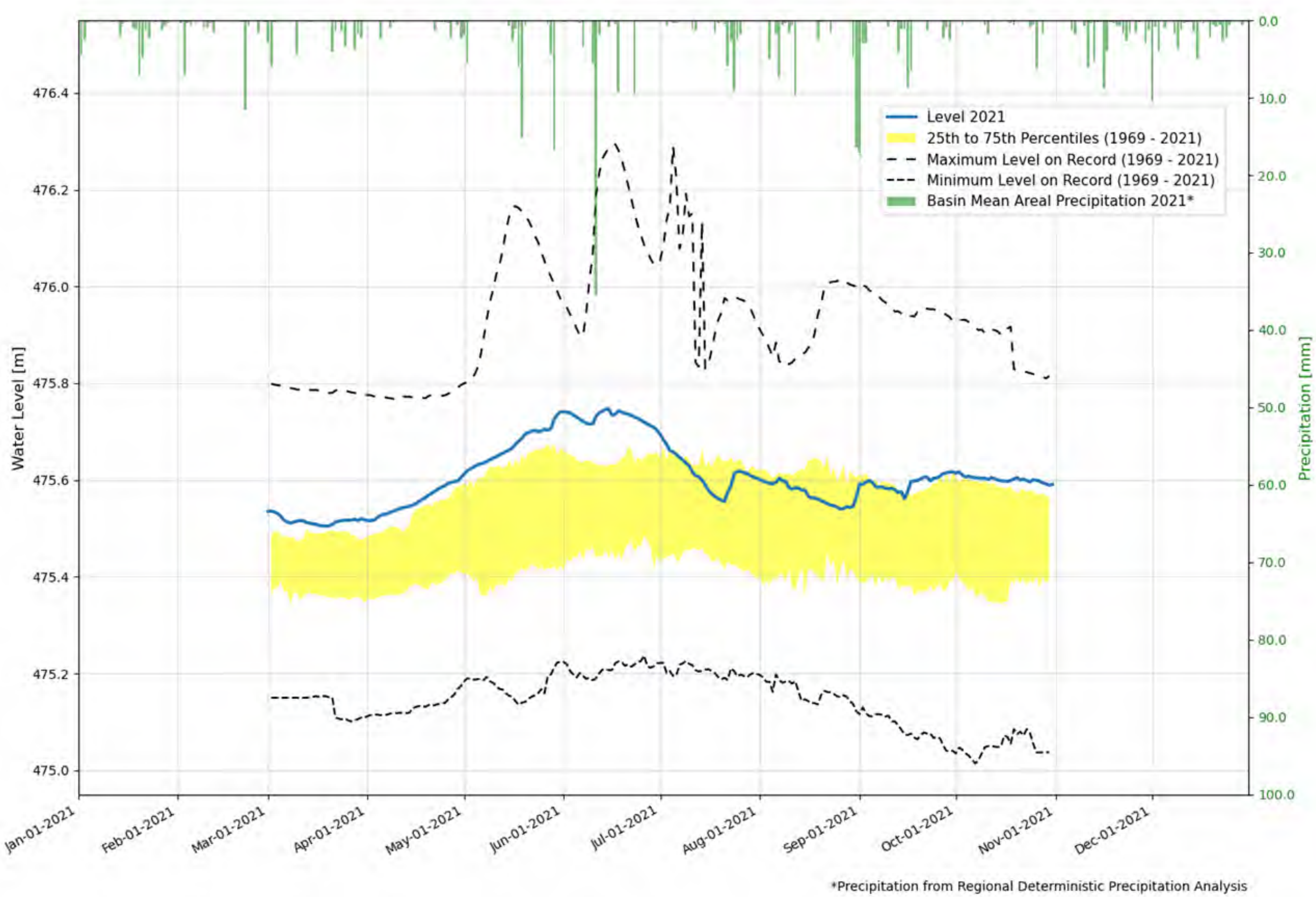


Figure C16: Gregoire Lake near Fort McMurray (07CE001)

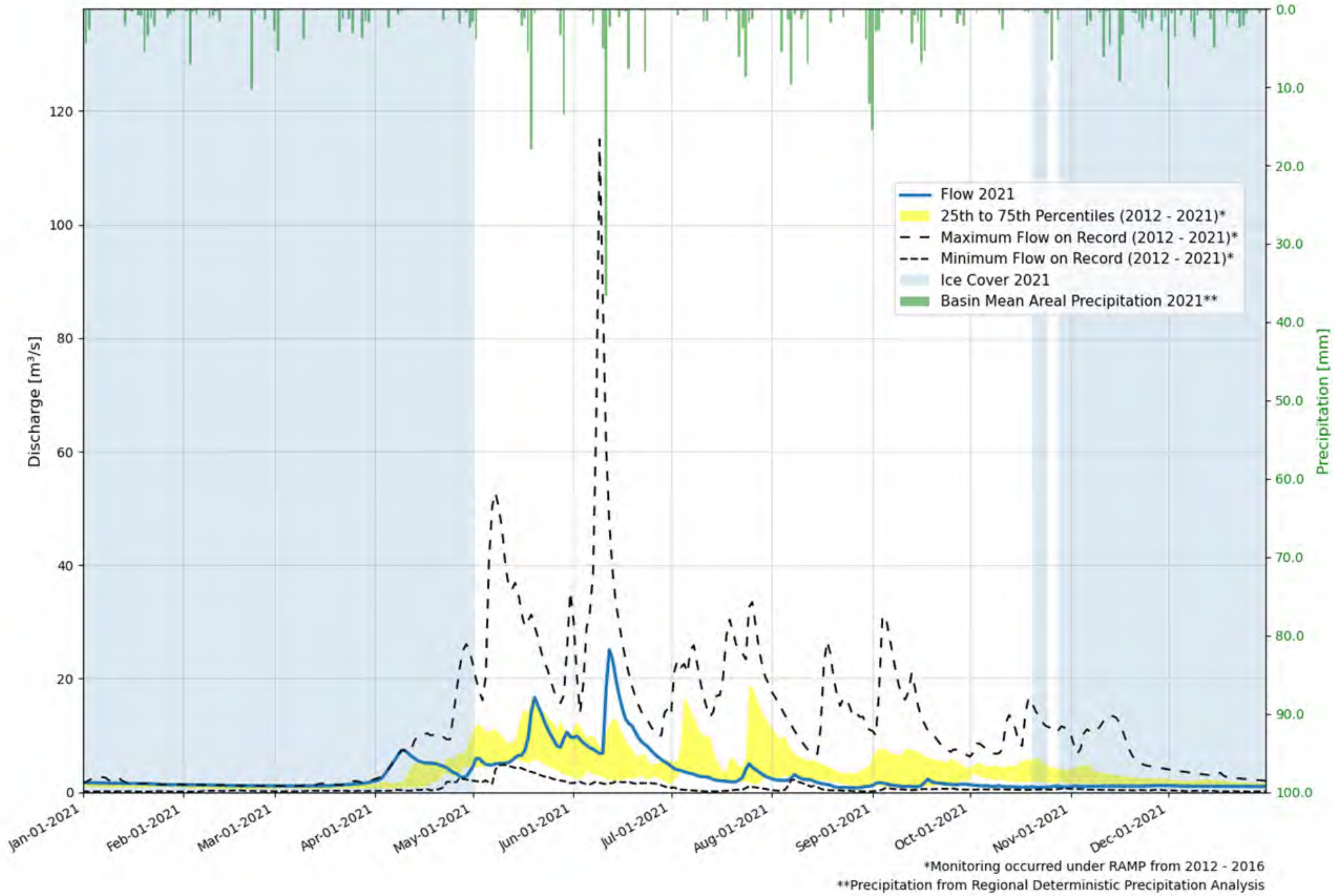


Figure C17: Gregoire River near the Mouth (07CE008)

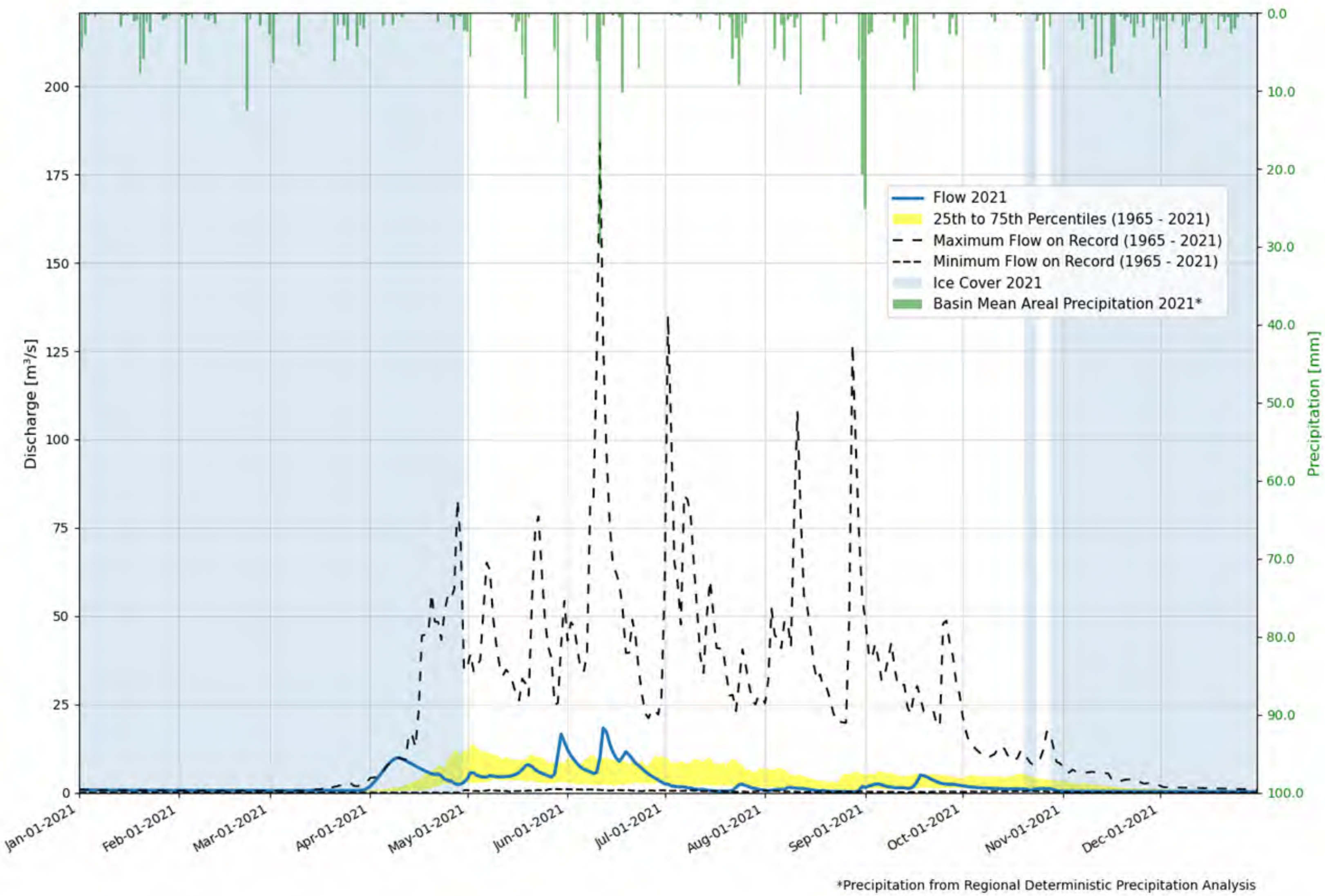


Figure C18: Hangingstone River at Fort McMurray (07CD004)

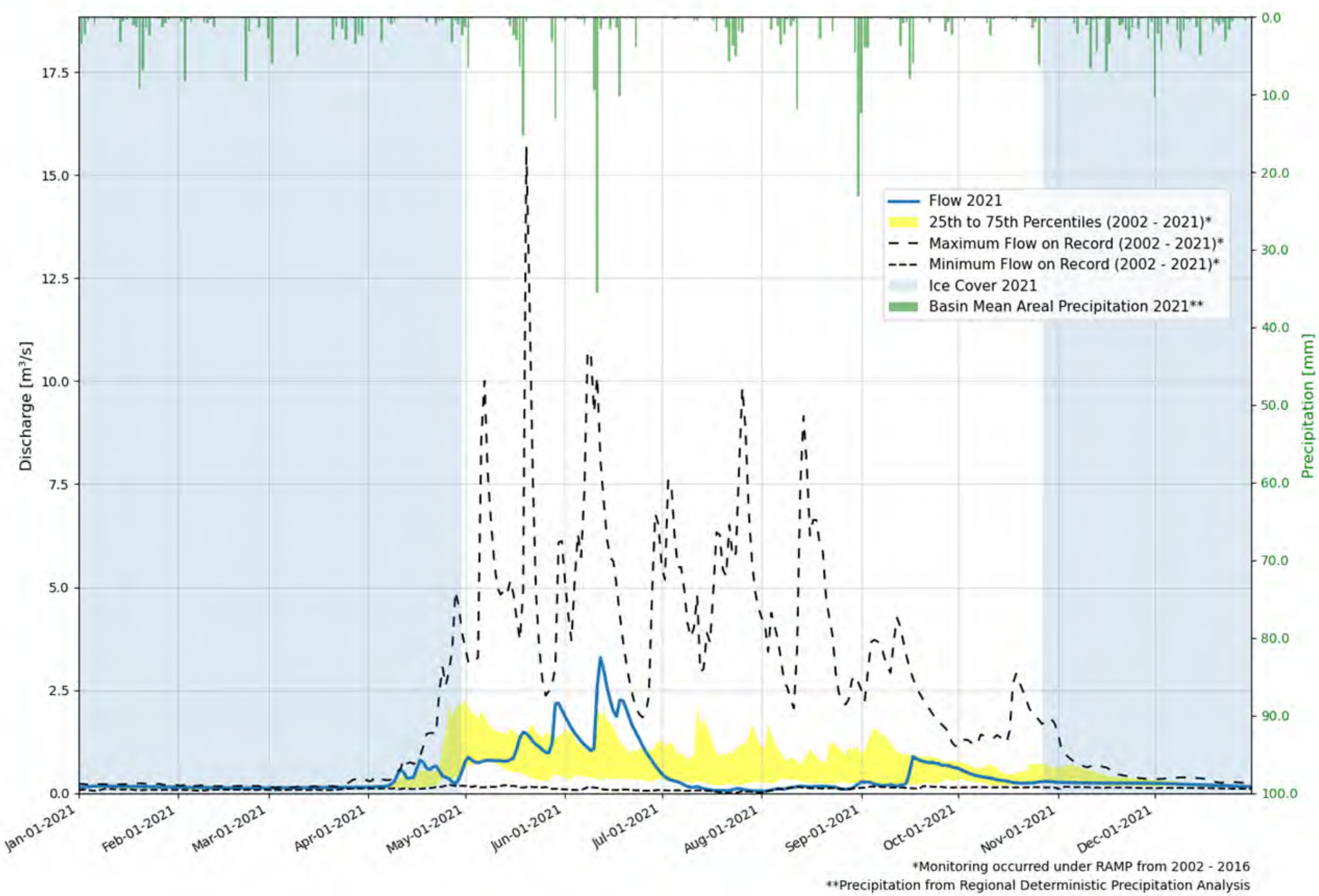


Figure C19: Hangingstone River at North Star Road (07CD008)

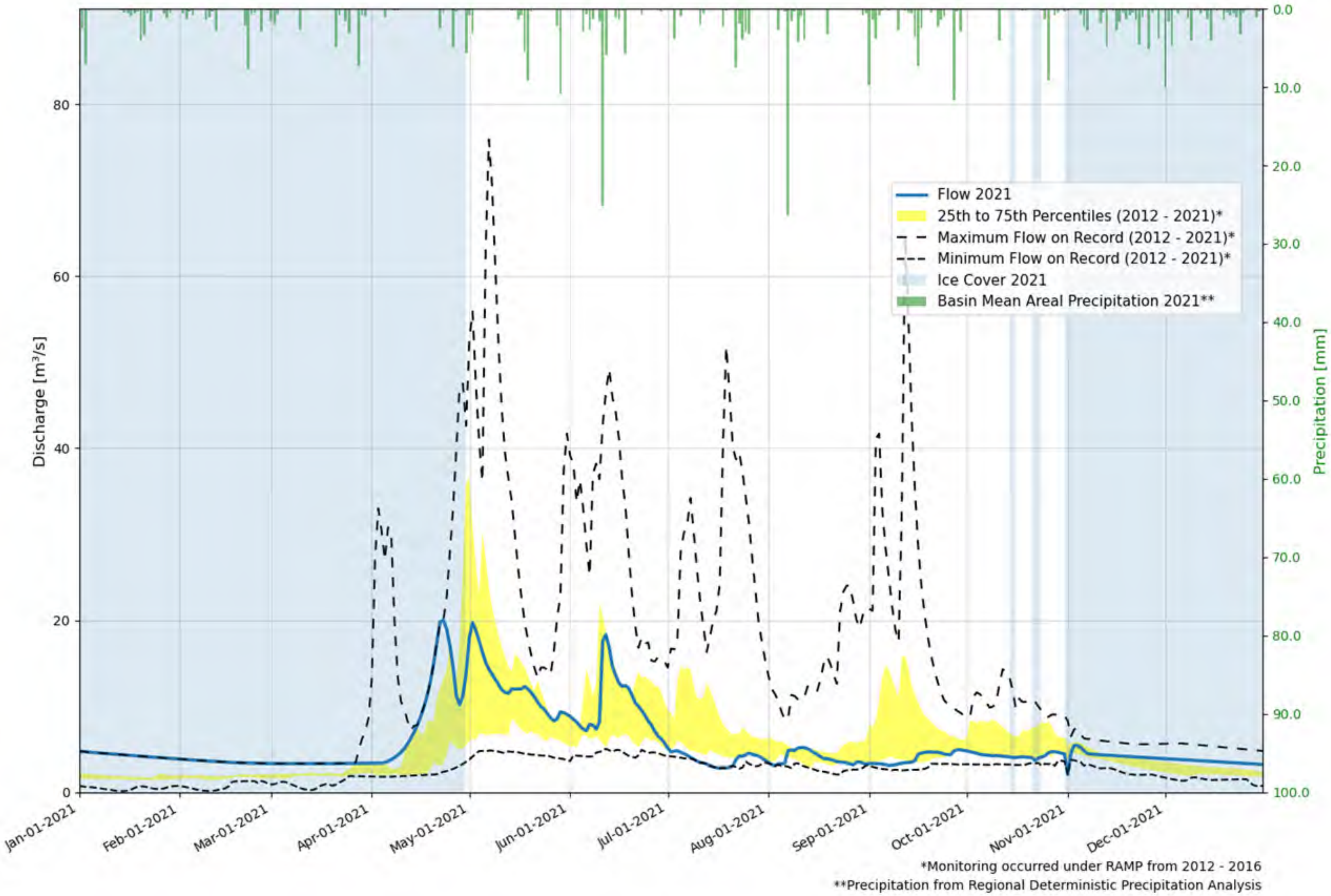
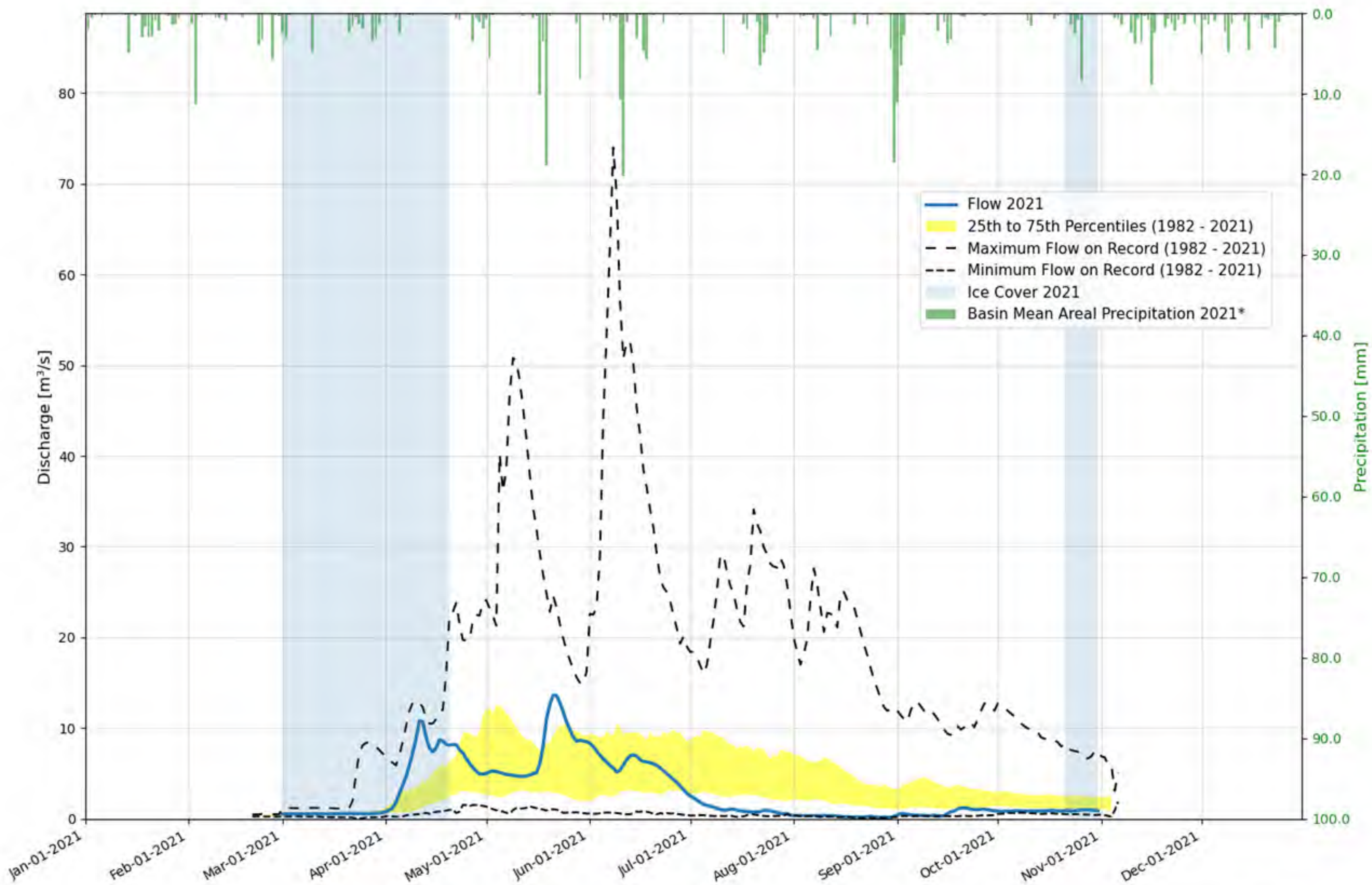


Figure C20: High Hill River near the Mouth (07CD009)



*Precipitation from Regional Deterministic Precipitation Analysis

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

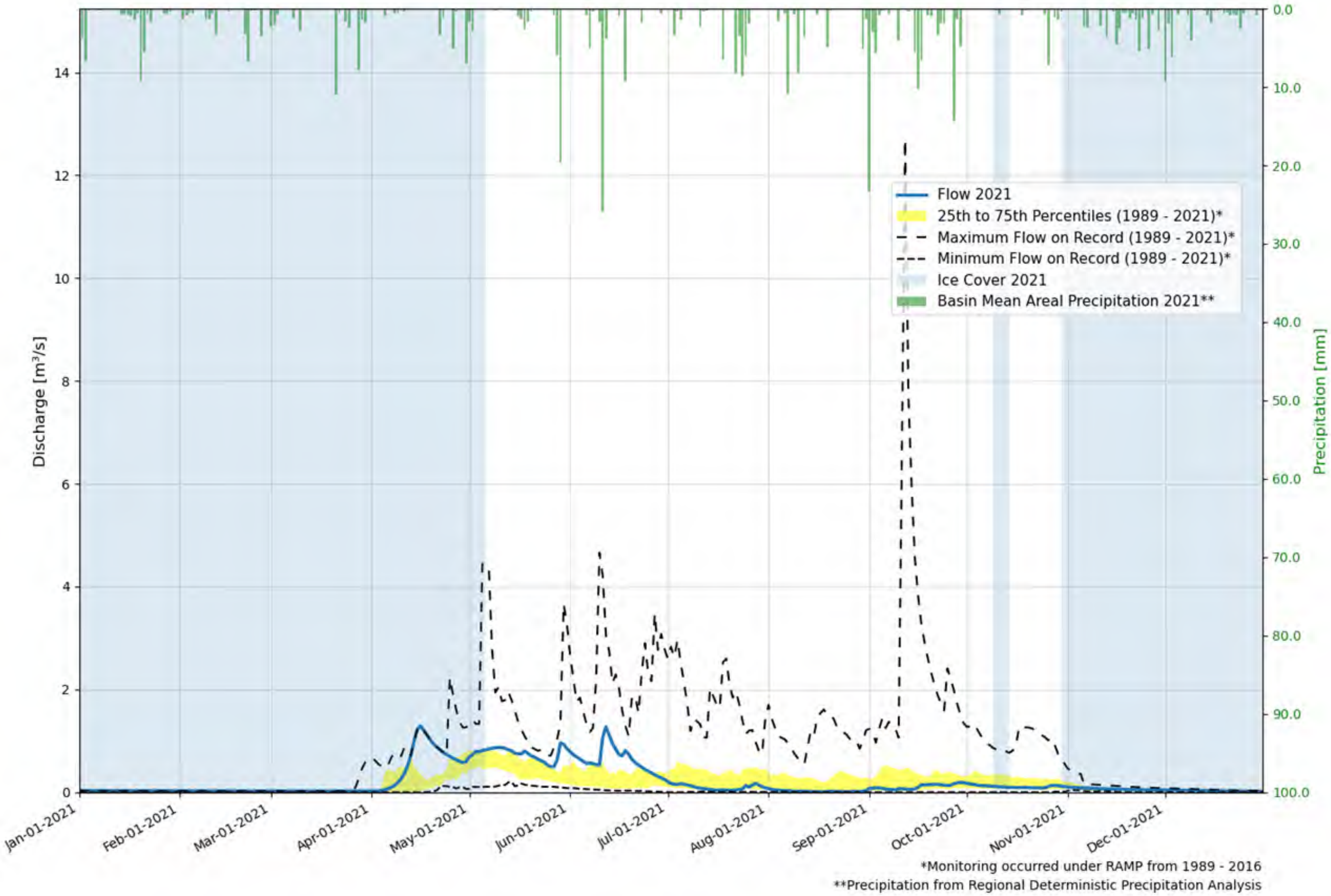


Figure C22: Iyinimin Creek above Kearl Lake (07DA027)

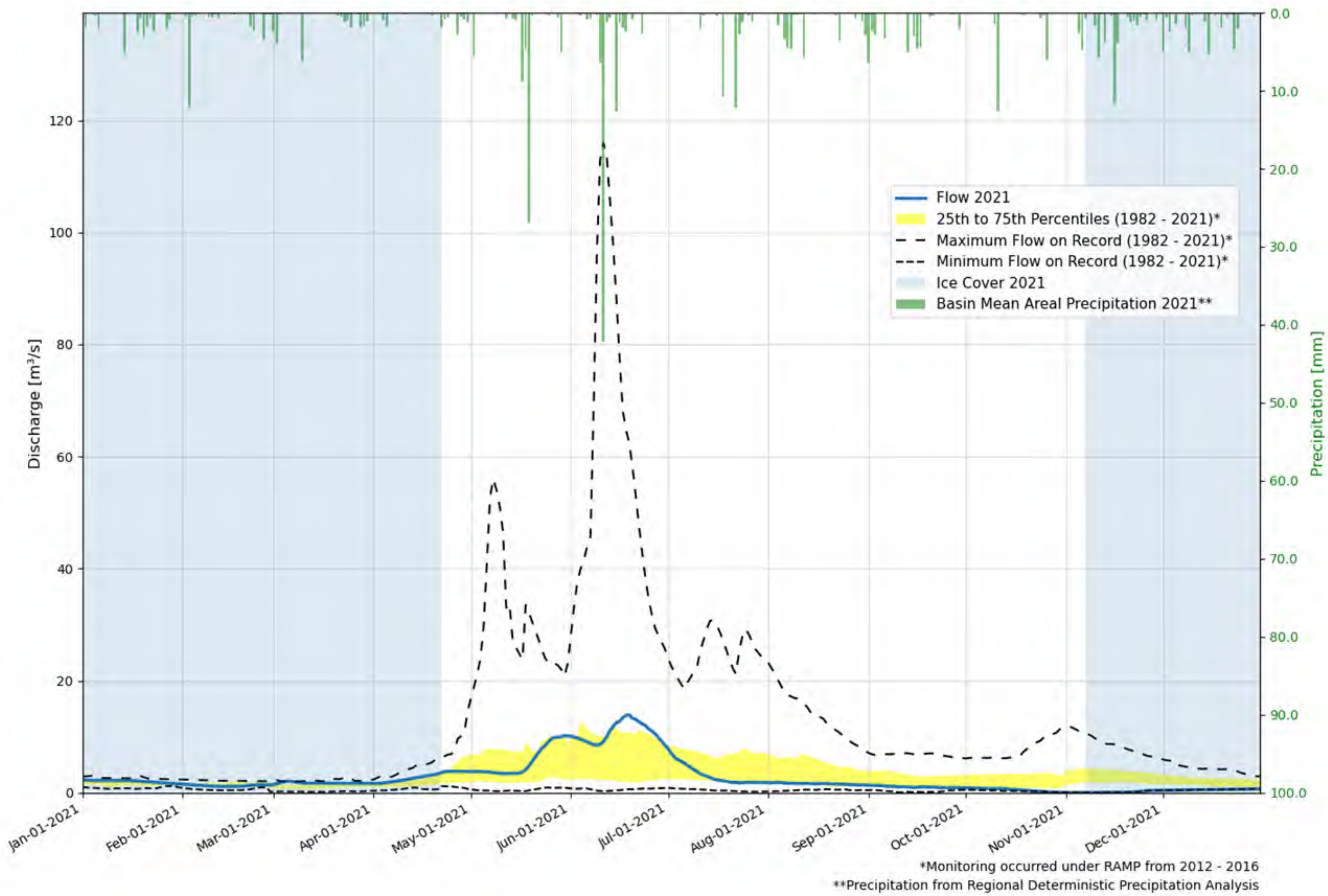


Figure C23: Jackfish River below Christina Lake (07CE005)

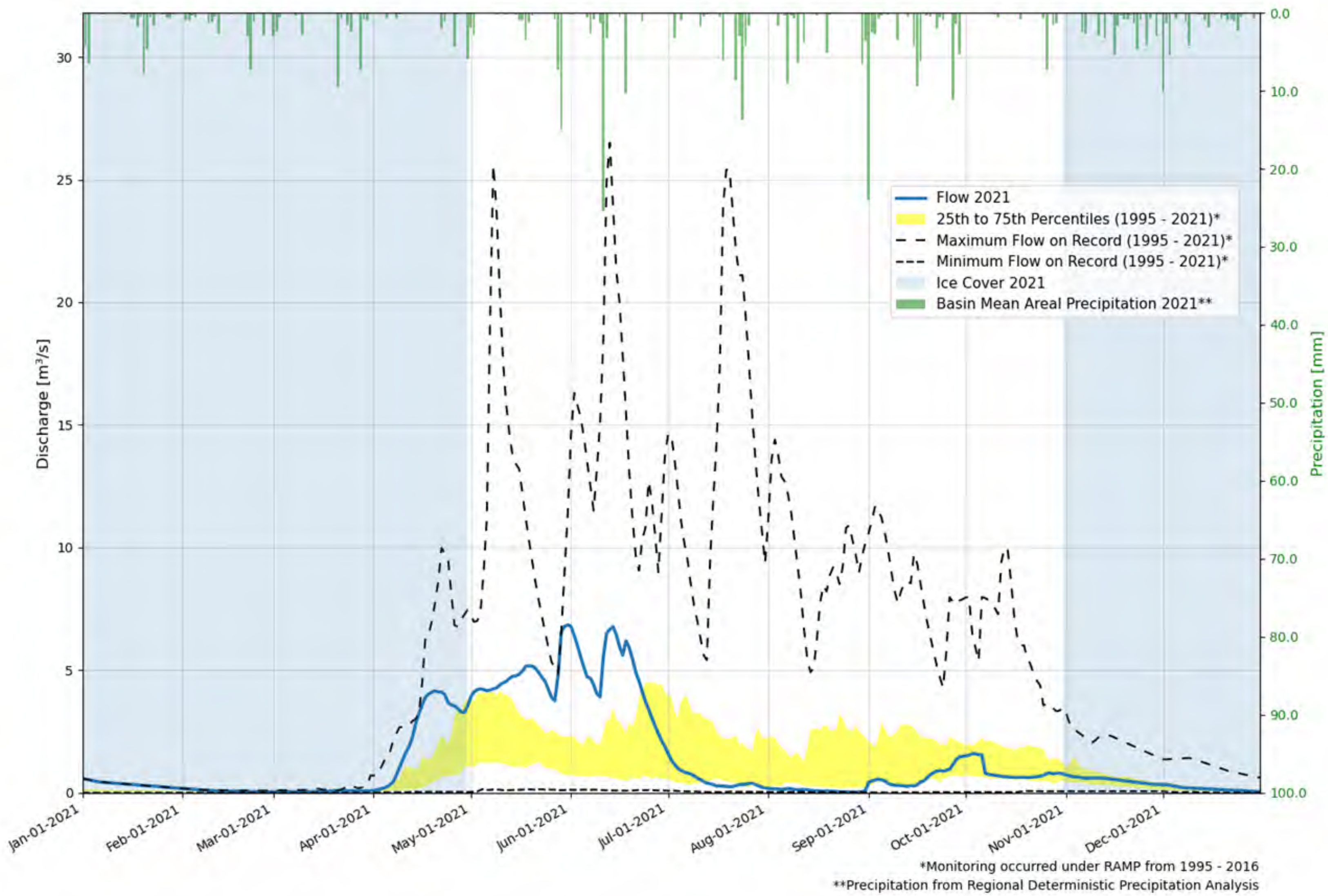


Figure C24: Jackpine Creek at Canterra Road (07DA026)

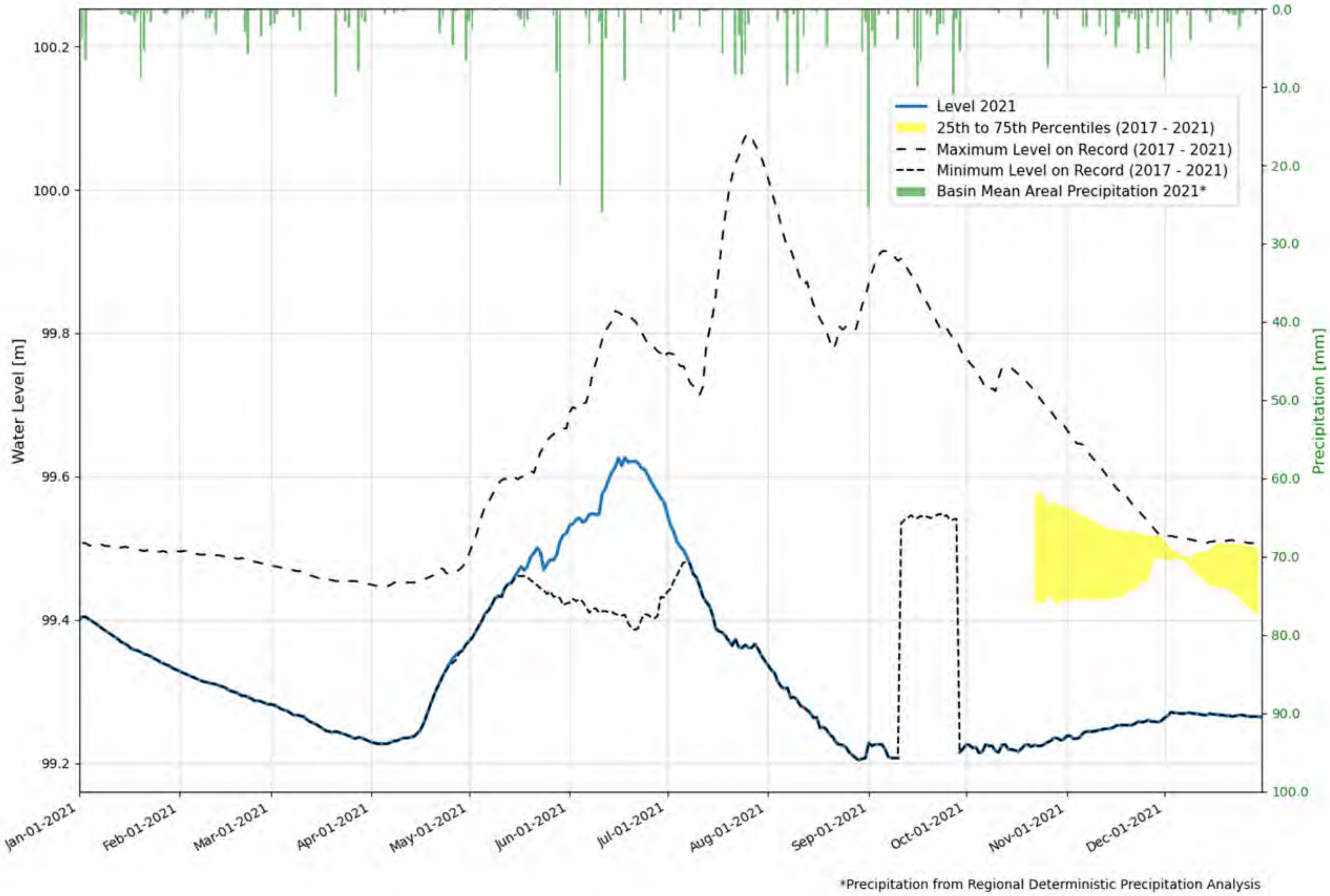


Figure C25: Kearl Lake at Canterra Road (07DA024)

Note: The strange shape of the minimum level of record is not in error. 2021 experienced the lowest level on record for this lake, however there was a period of missing data during October, during which time the minimum level reverts to the previous lowest recorded values.

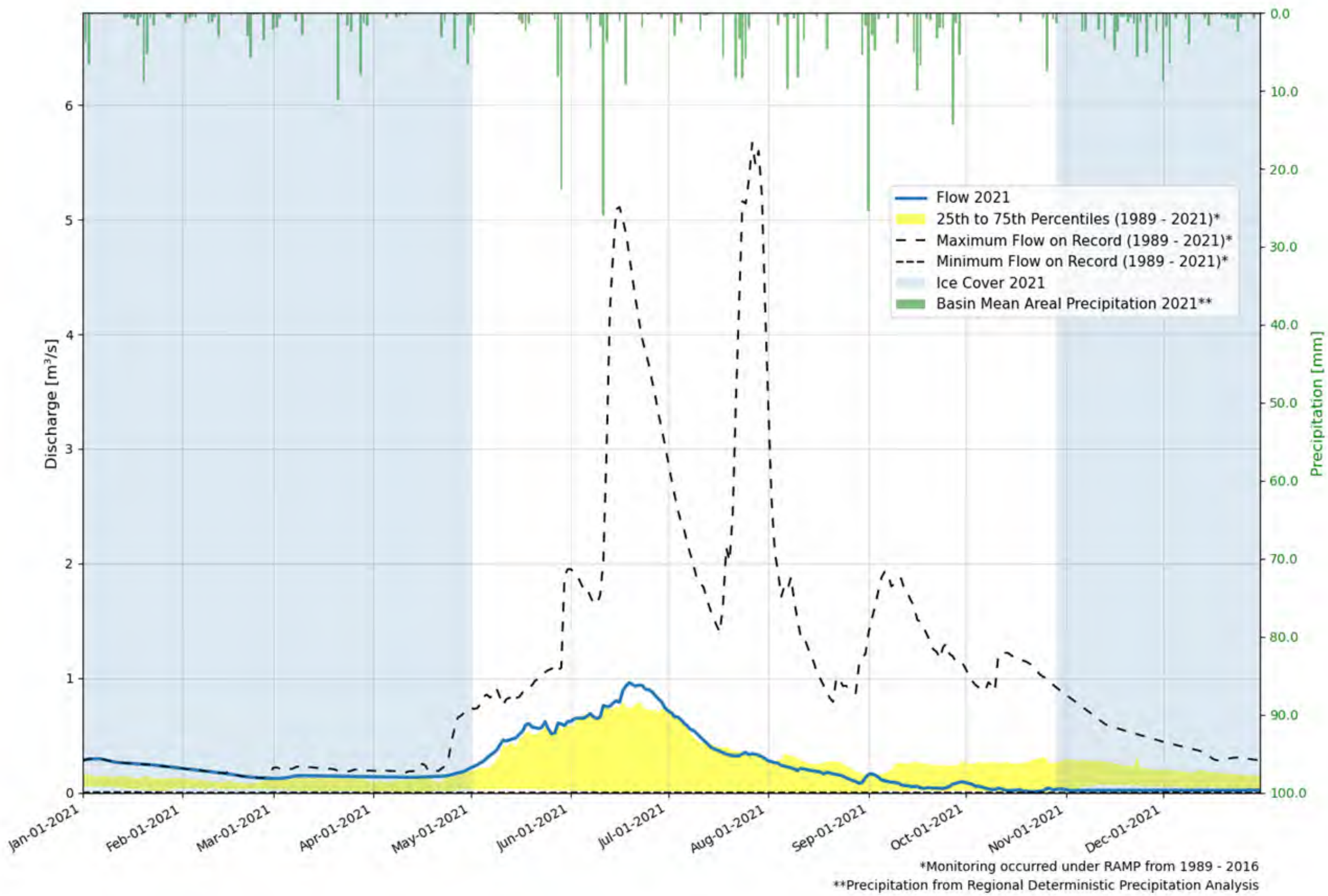


Figure C26: Kearl Lake Outlet (07DA030)

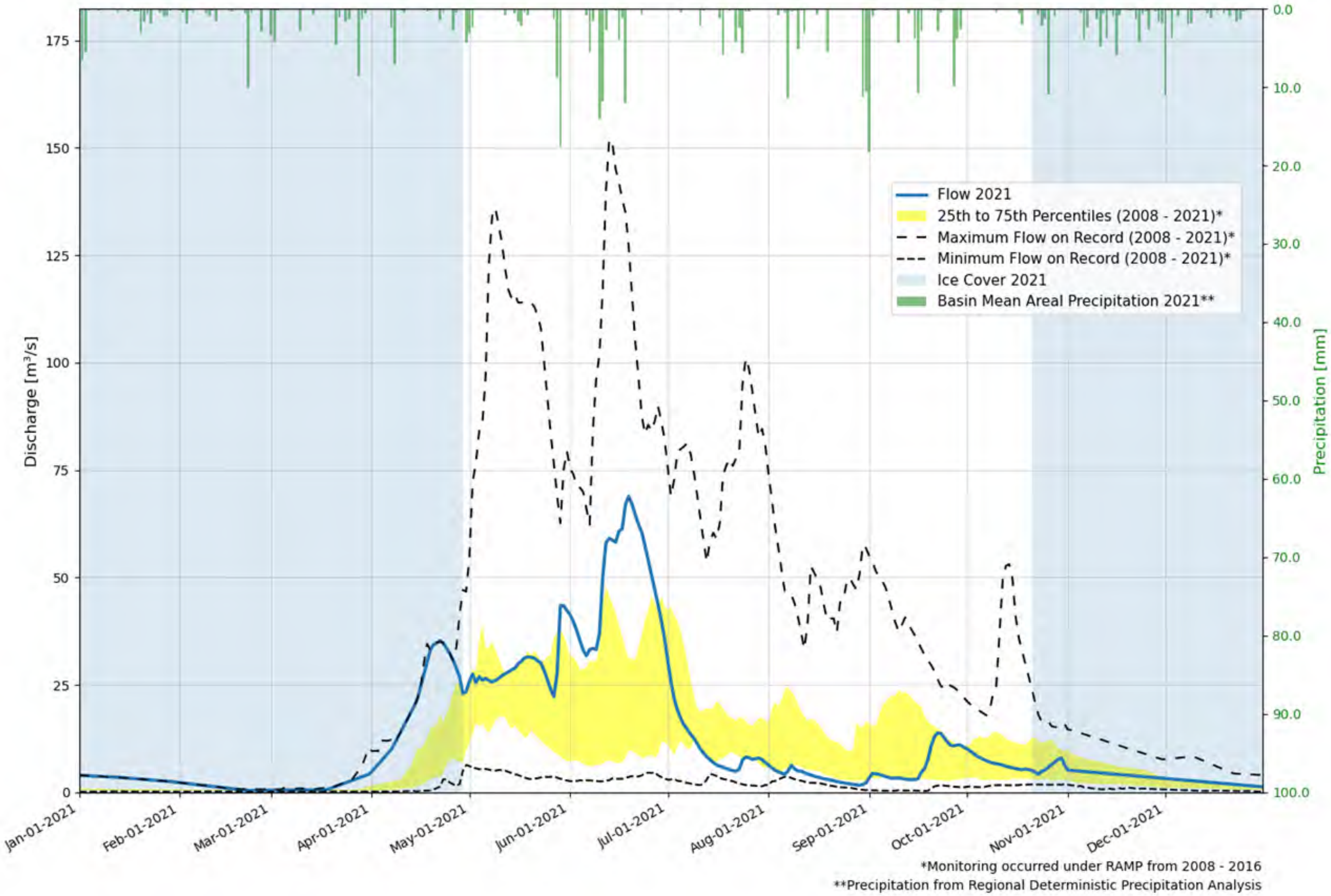


Figure C27: MacKay River at Petro-Canada Bridge (07DB006)

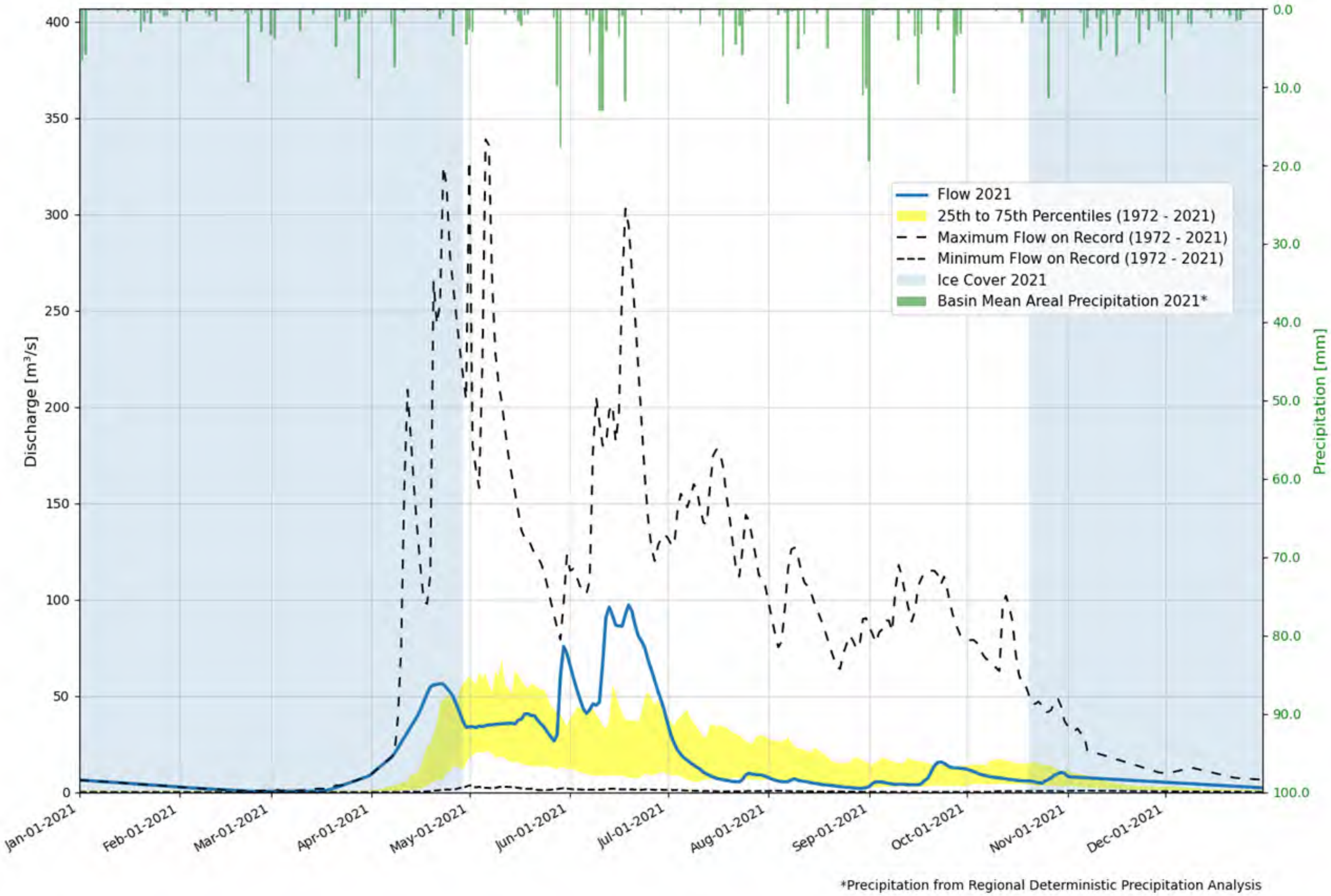


Figure C28: MacKay River near Fort MacKay (07DB001)

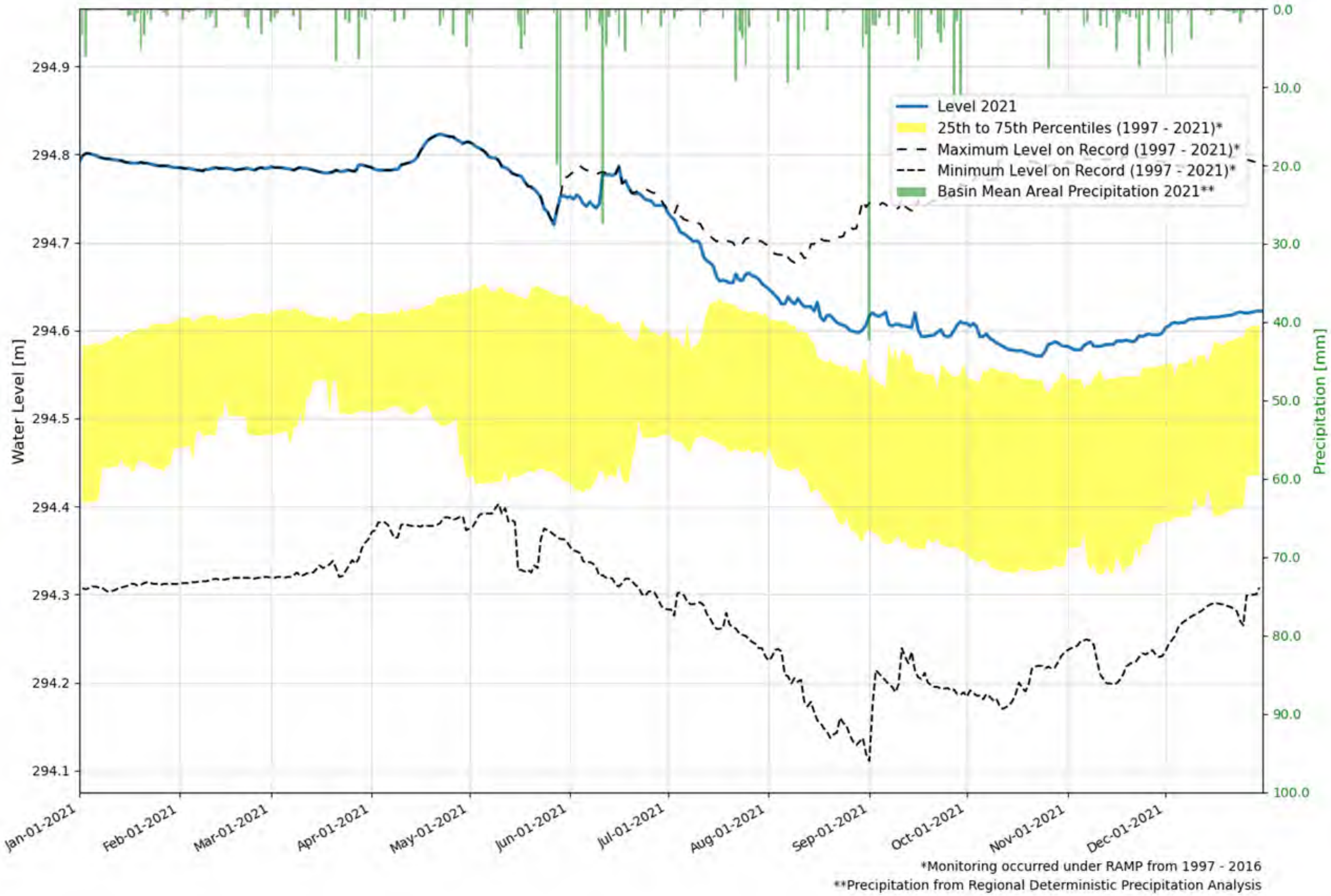


Figure C29: McClelland Lake at East End (07DA023)

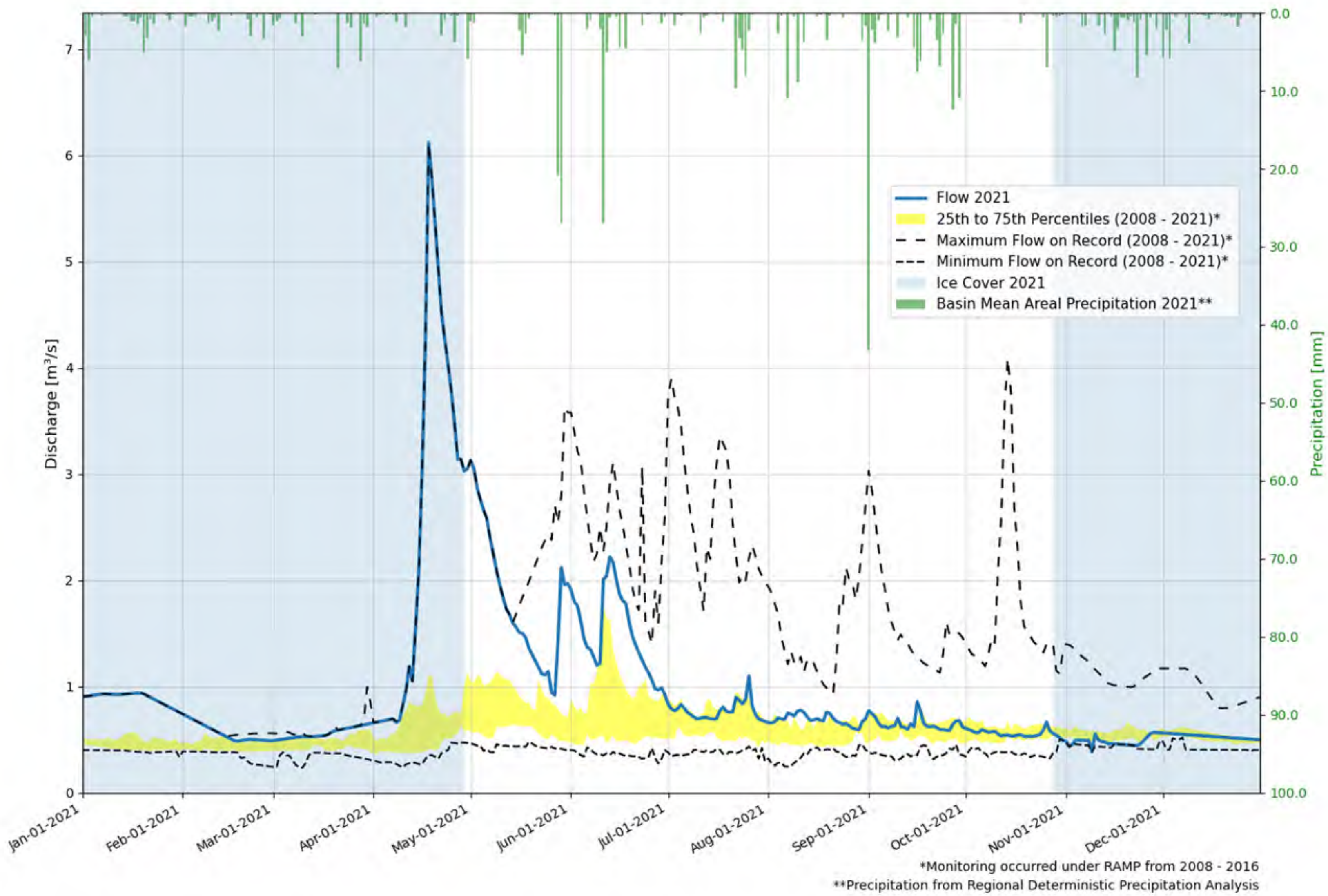


Figure C30: McClelland Lake Outlet above Firebag River (07DC004)

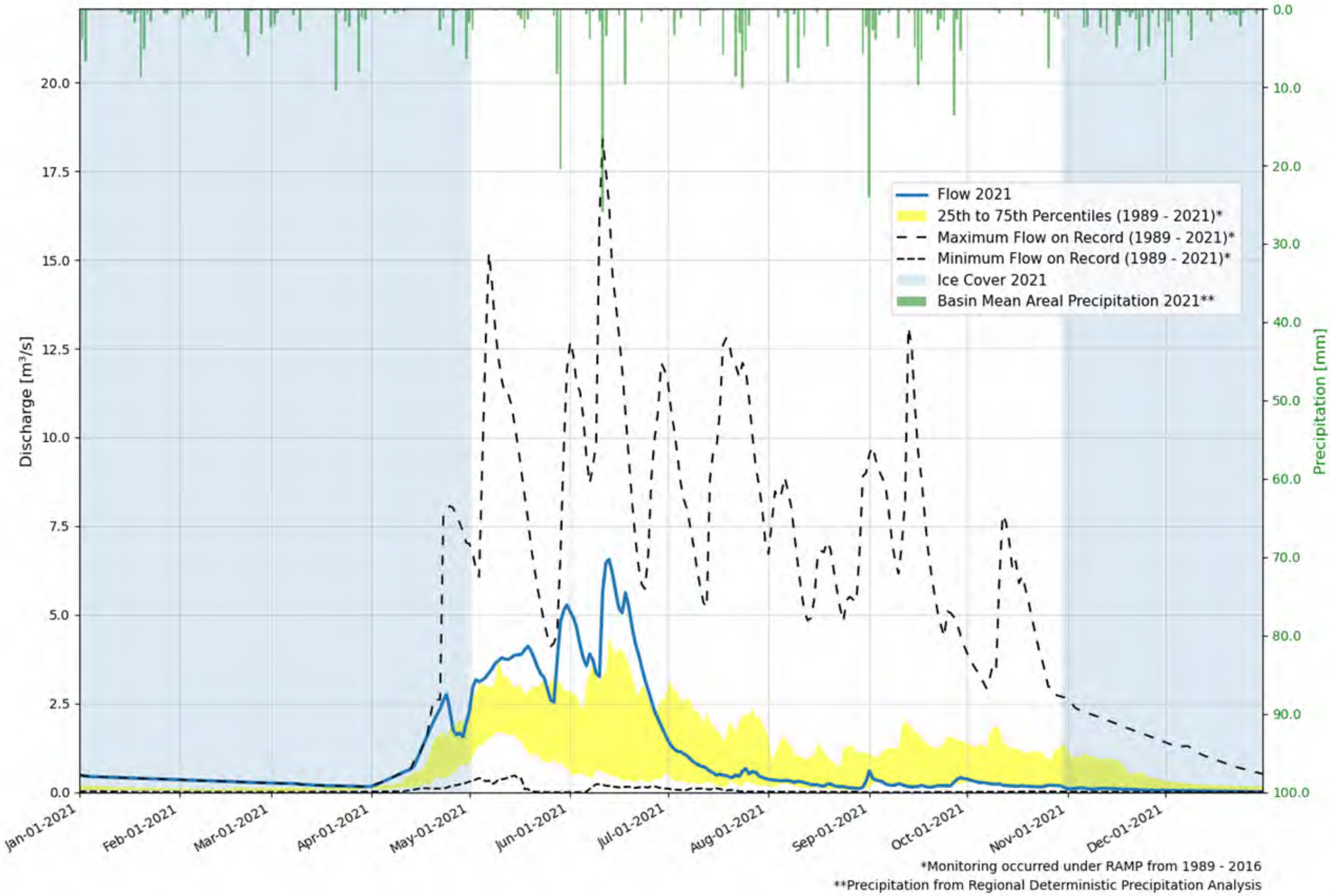


Figure C31: Muskeg Creek near the Mouth (07DA035)

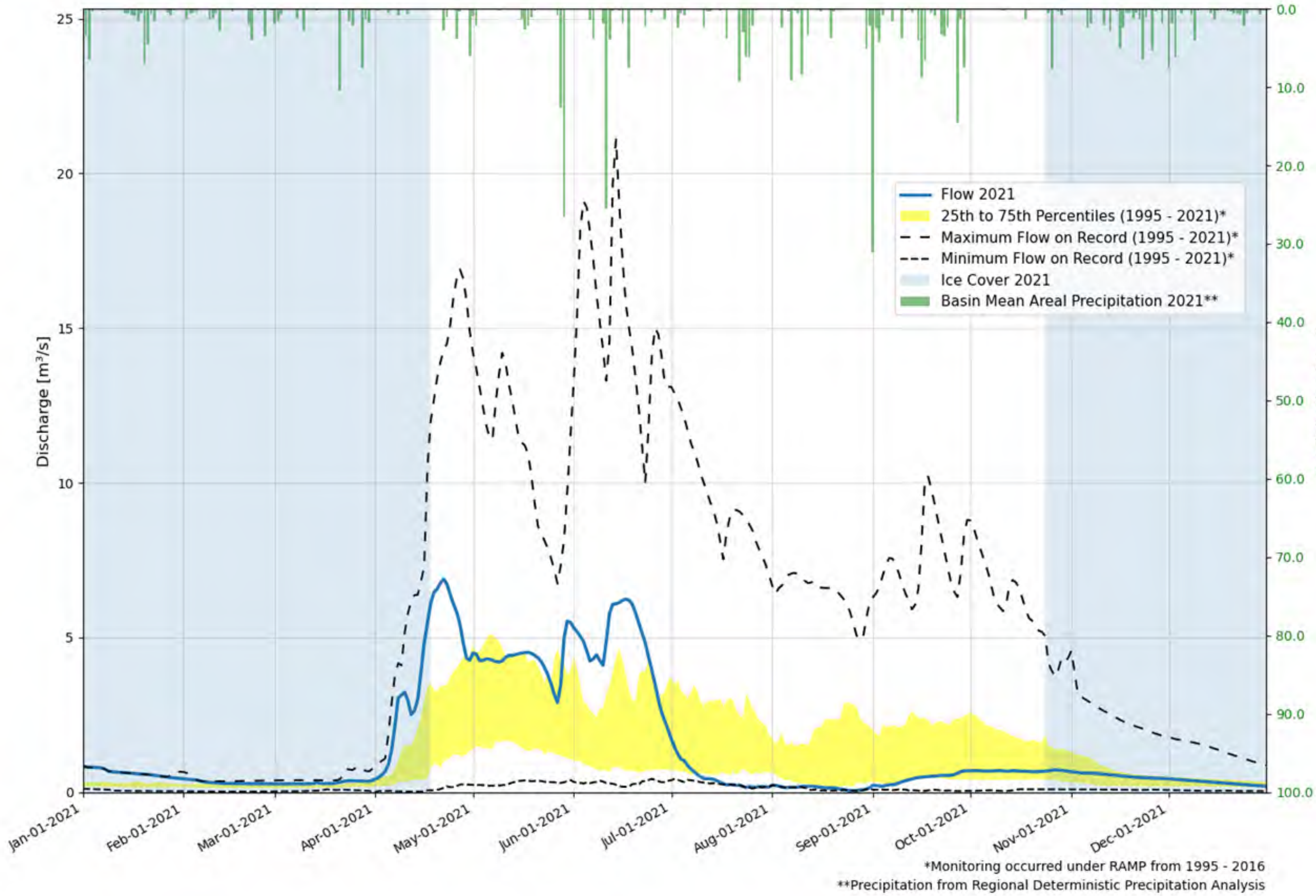


Figure C32: Muskeg River above Muskeg Creek (07DA029)

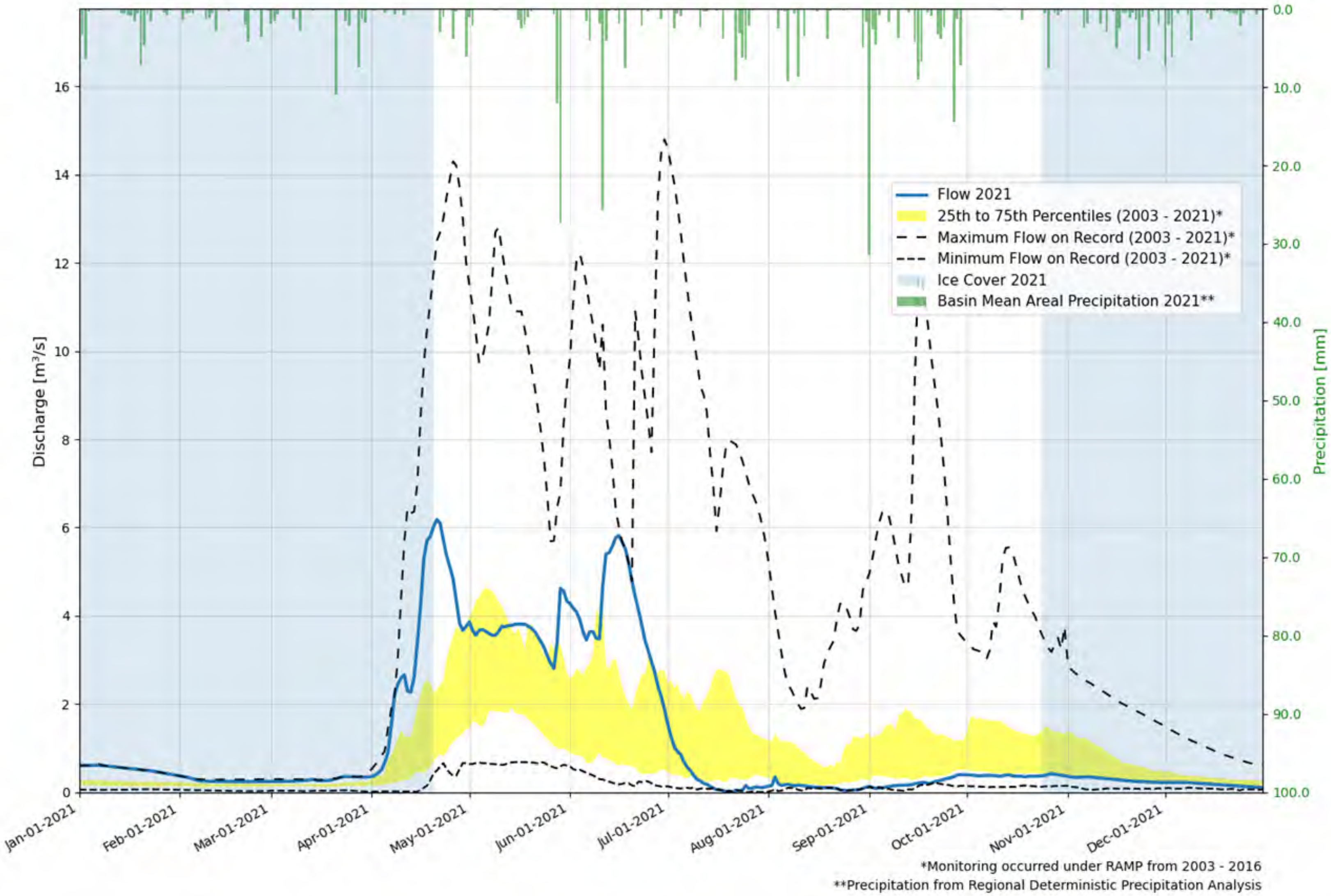


Figure C33: Muskeg River above Stanley Creek (07DA028)

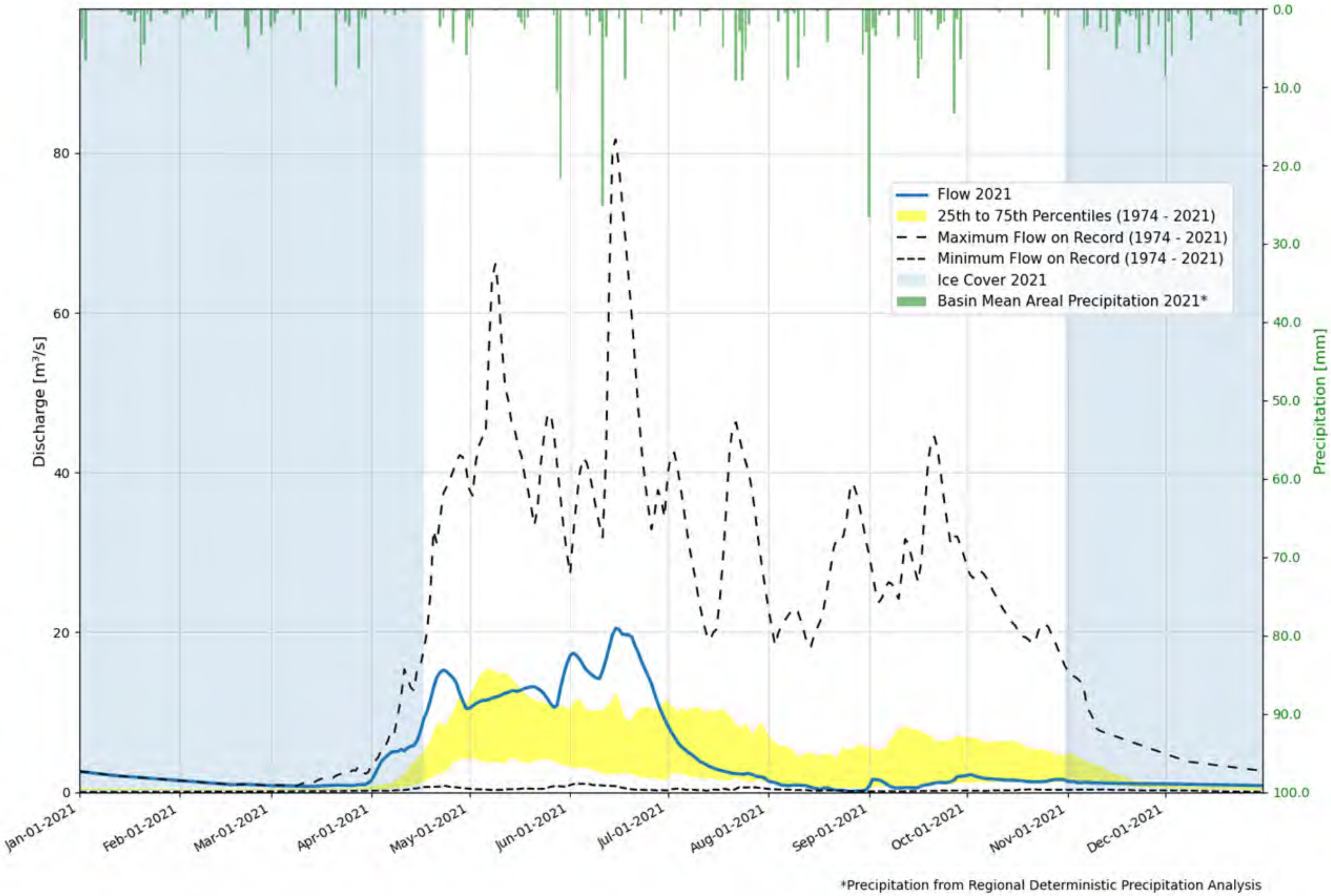


Figure C34: Muskeg River near Fort MacKay (07DA008)

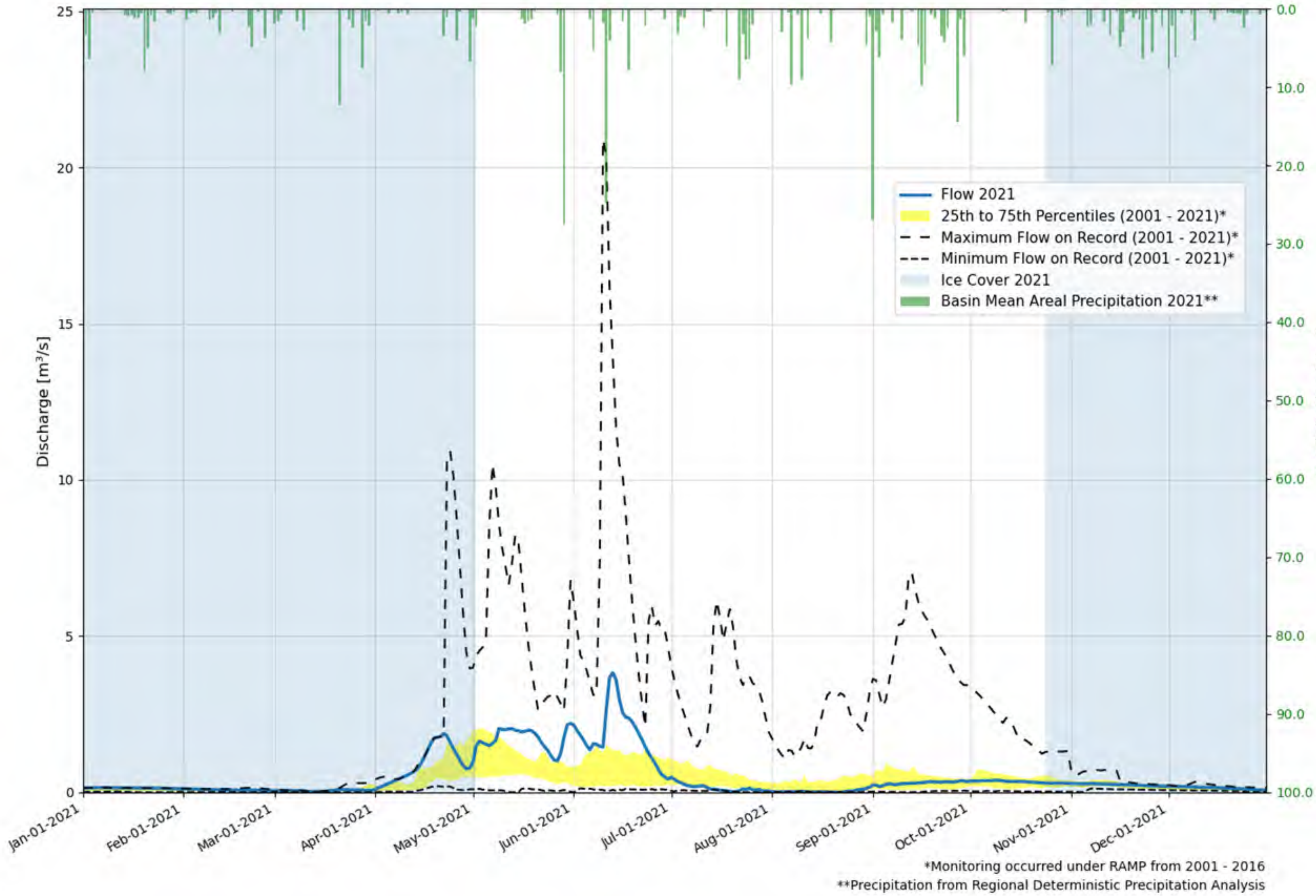


Figure C35: Muskeg River Upland (07DA034)

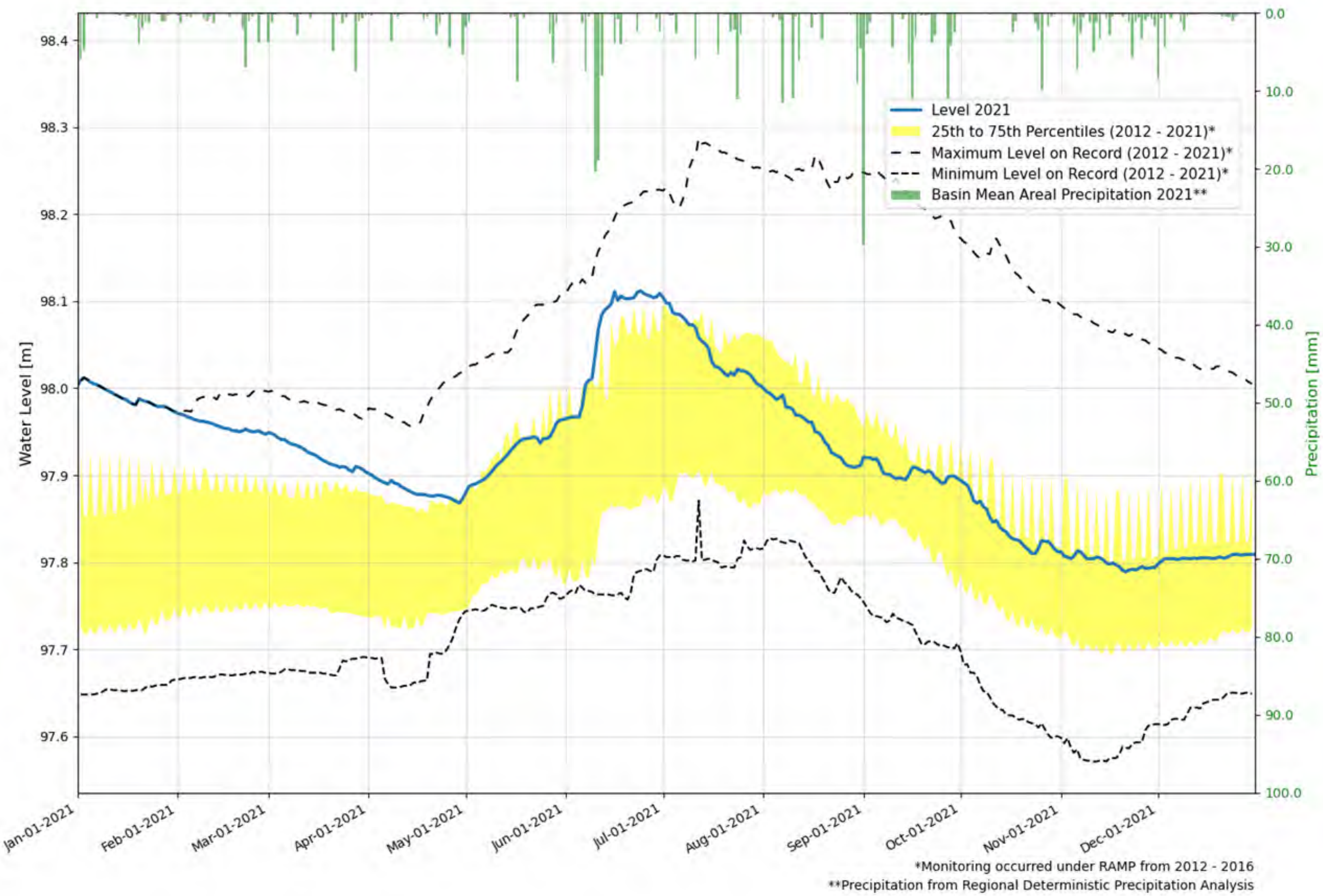


Figure C36: Namur Lake near the Outlet (07DA025)

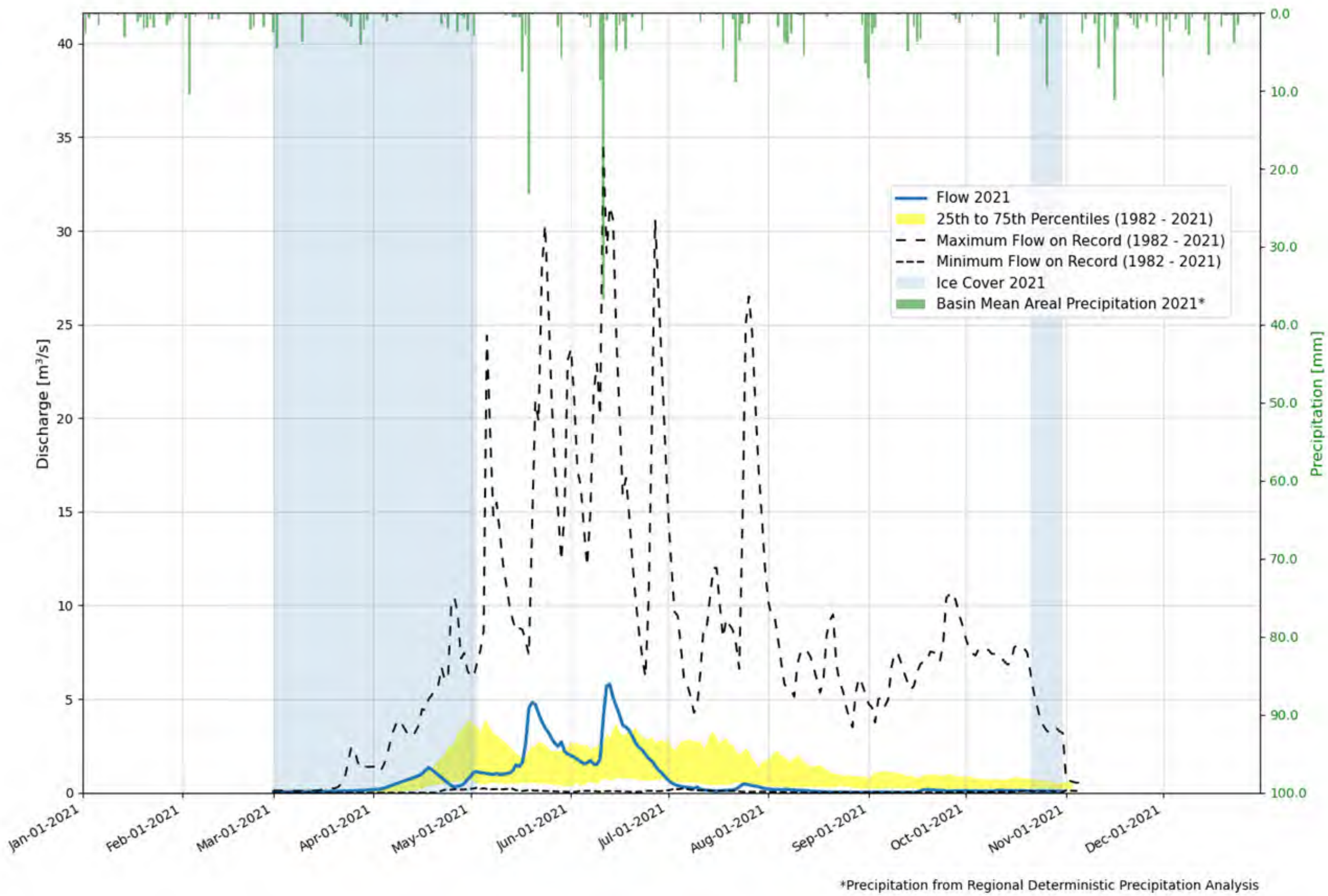


Figure C37: Pony Creek near Chard (07CE003)

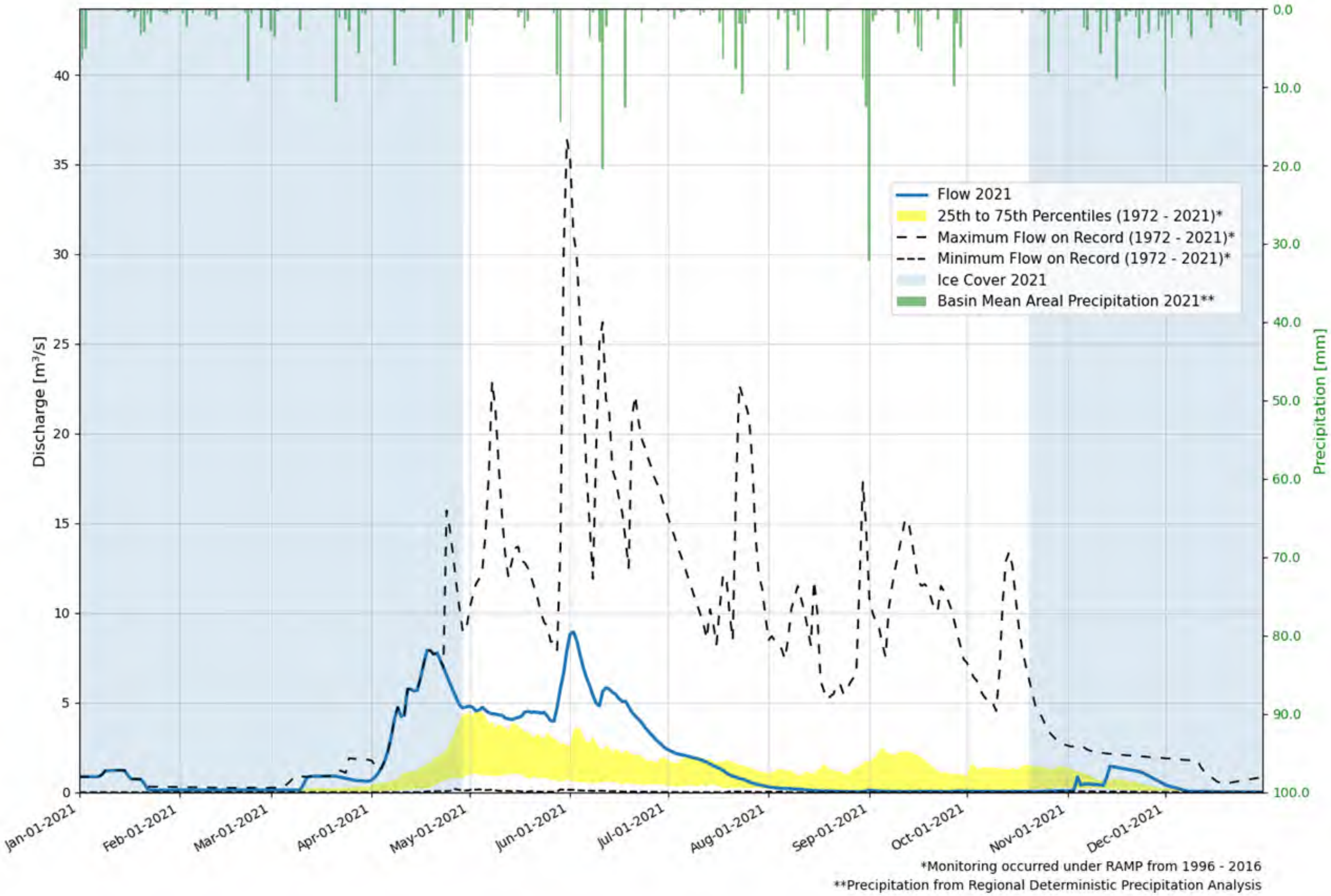


Figure C38: Poplar Creek near Fort McMurray (07DA007)

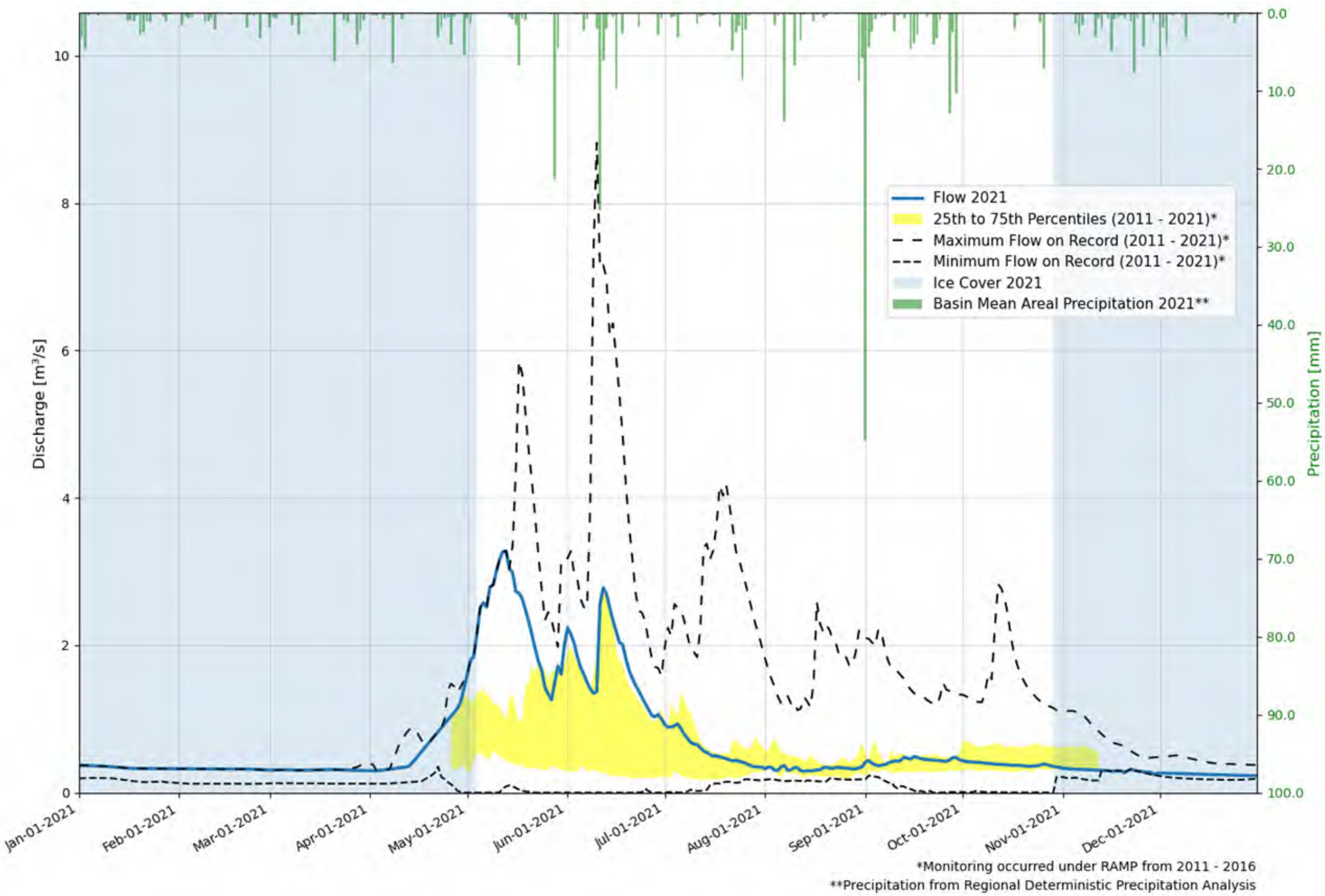


Figure C39: Red Clay Creek near the Mouth (07DA042)

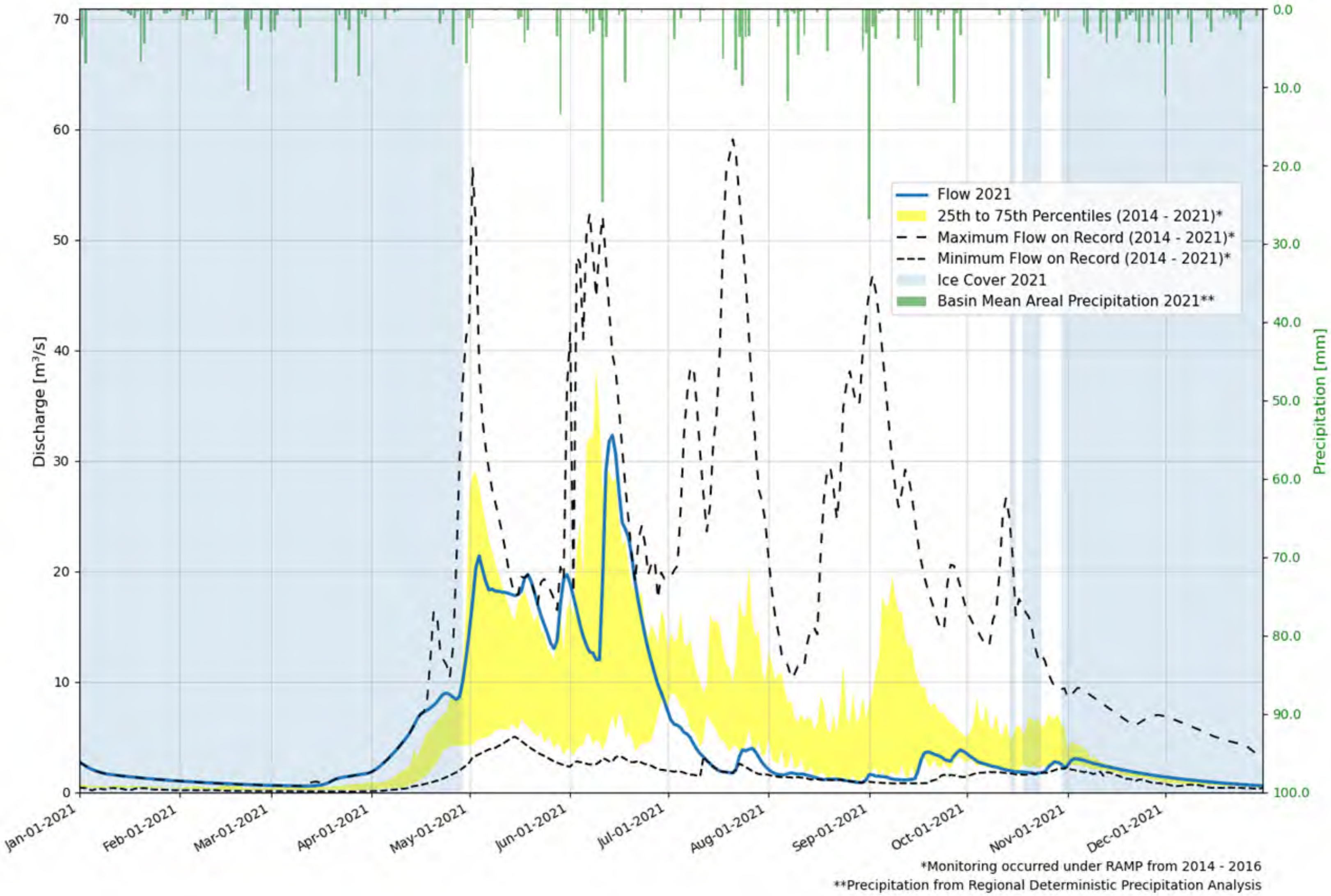


Figure C40: Steepbank River below North Steepbank River (07DA044)

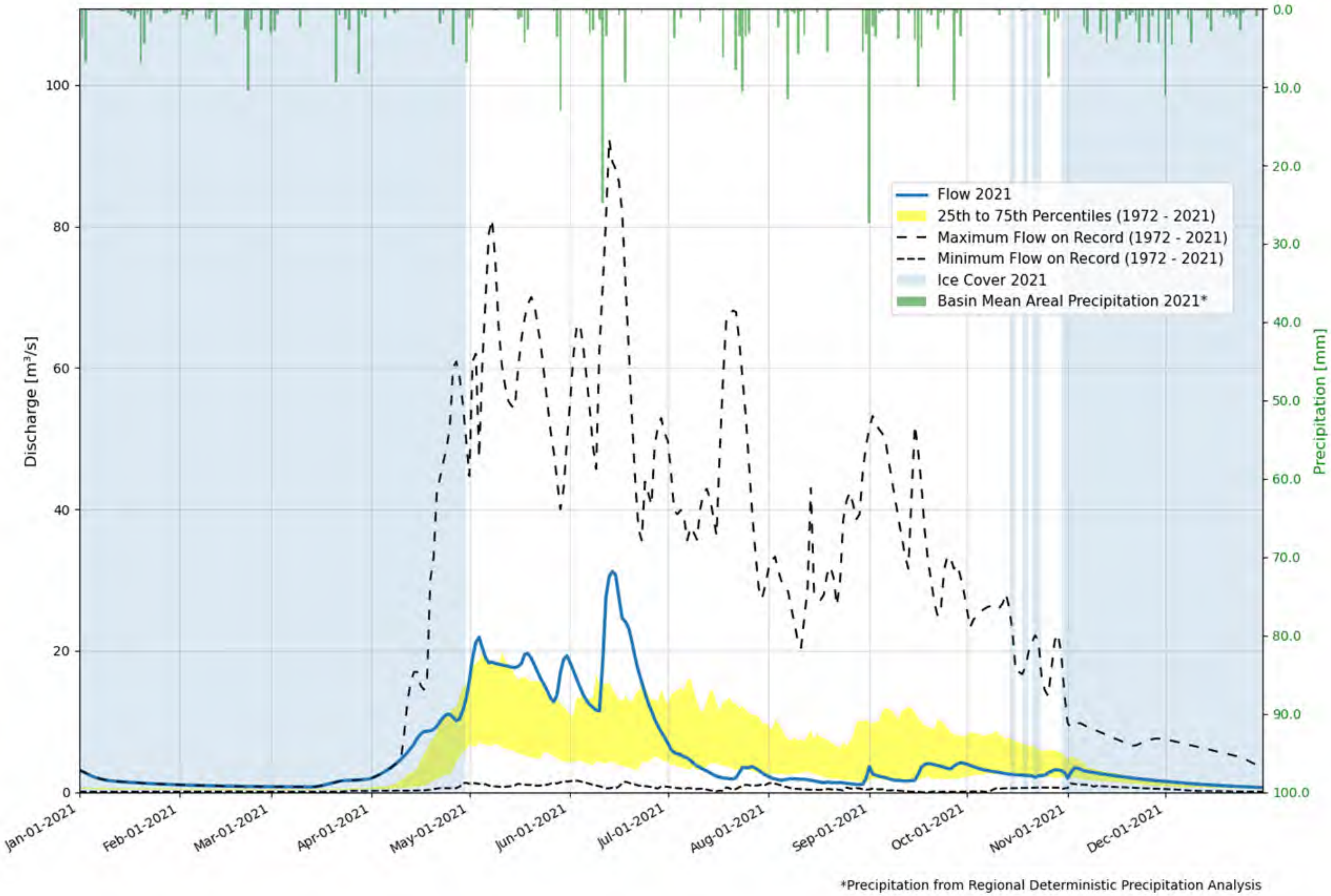


Figure C41: Steepbank River near Fort McMurray (07DA006)

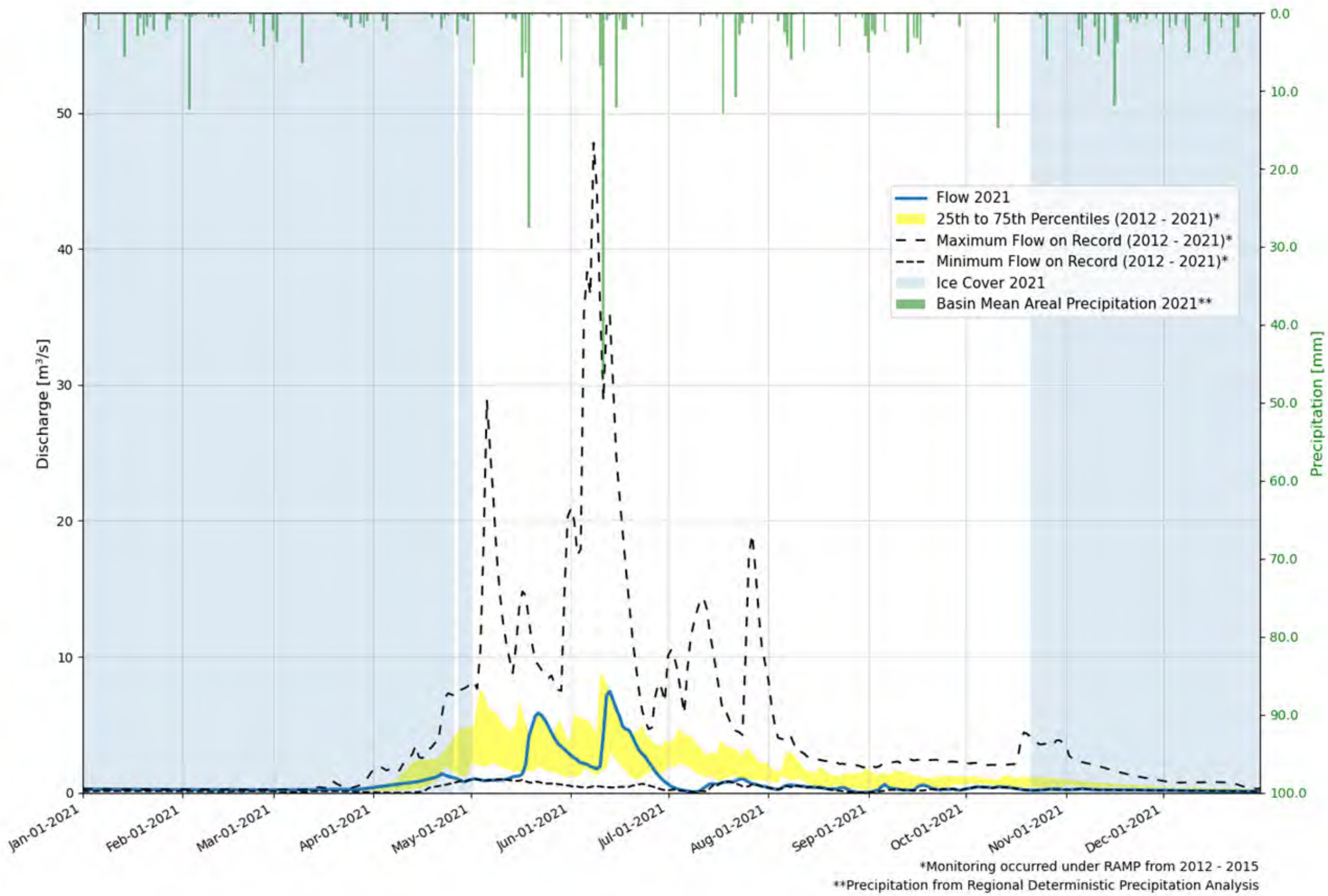


Figure C42: Sunday Creek above Christina Lake (07CE010)

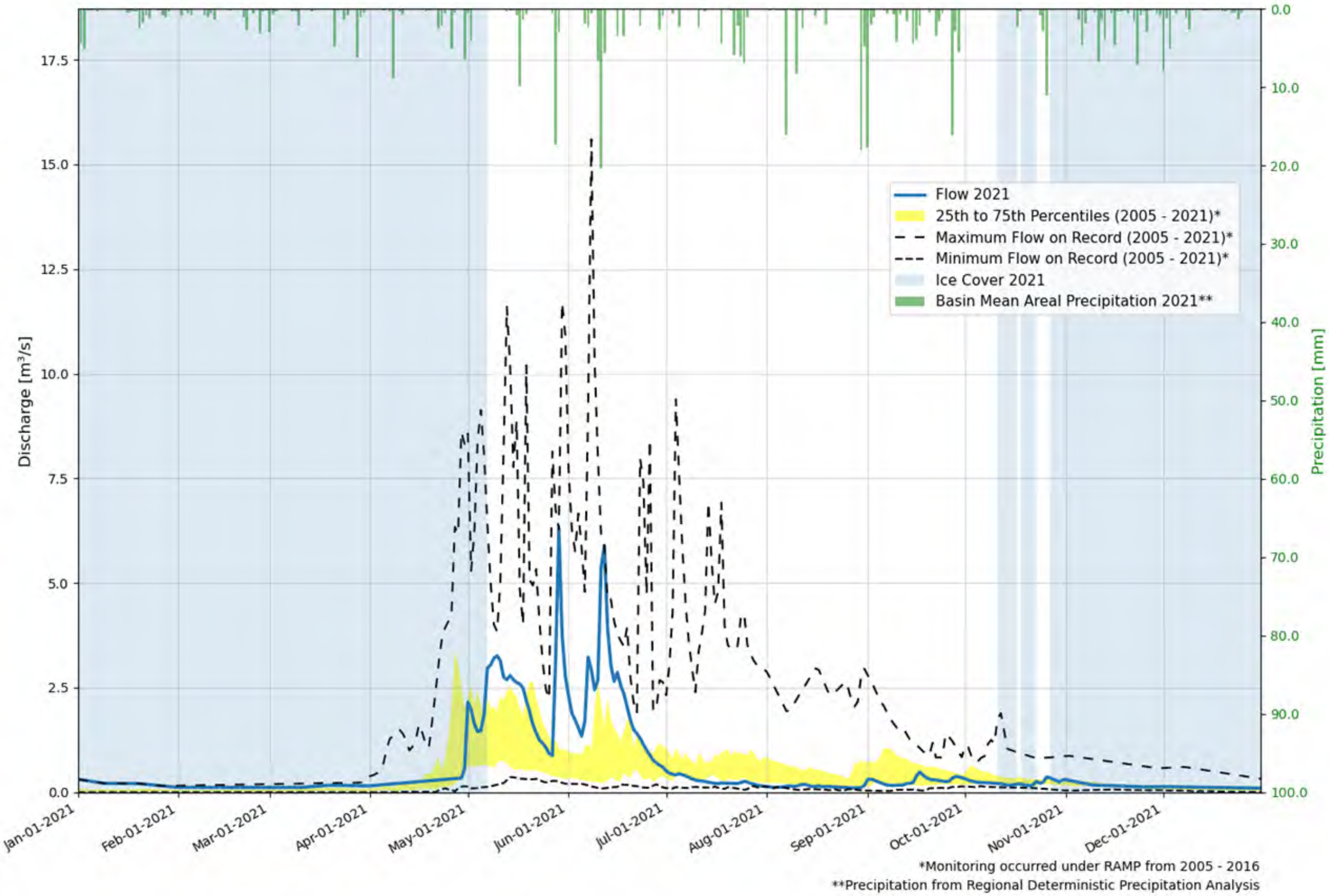


Figure C43: Tar River above Canadian Natural Resources Limited Lake (07DA037)

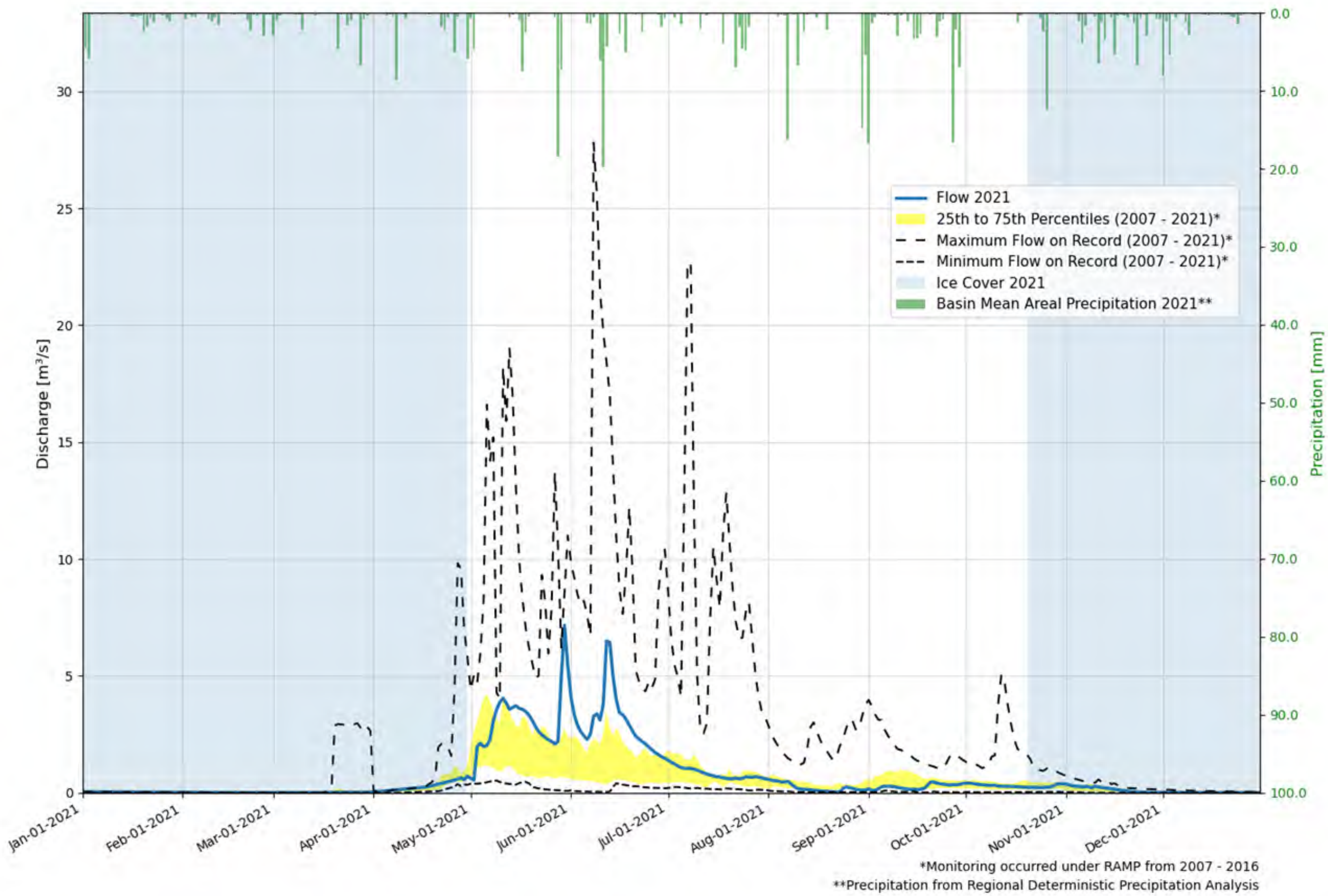


Figure C44: Tar River near the Mouth (07DA045)