Memorandum

Refer to File No.: 1009-008 Hope Bay Belt

Date:	February 29, 2016
To:	John Roberts, VP Environmental Affairs Katsky Venter, Environmental Advisor
CC:	Erin Forster (B.Sc., R.P.Bio.), Project Manager Marc Wen (M.Sc., R.P.Bio), Partner in Charge
From:	Greg Langston (M.Sc.)
Subject:	Doris North Project 2015 Hydrology Compliance Monitoring Program

This memorandum was prepared at the request of TMAC Resources Inc. (TMAC). The purpose of the memorandum is to present annual hydrometric data that were collected as part of the 2015 Doris North Hydrology Compliance Monitoring Program (the Program), which addresses hydrometric monitoring requirements set out in the Doris North Gold Mine Project Certificate (Nunavut Impact Review Board (NIRB) No. 003, issued September 15, 2006; NIRB (2006)), the Type A and B Water Licence (Nunavut Water Board (NWB) Licence No. 2AM-DOH1323 Type A, renewed August 16, 2013, and NWB Licence No. 2BE-HOP1222 Type B, renewed June 30, 2012)and the Interim Water Management Plan (IWMP; SRK 2012).

1. INTRODUCTION

ERM Consultants Canada Ltd. (ERM) monitors and reports, on behalf of TMAC, the following elements of the Doris North Gold Mine Project Certificate (NIRB No. 003, issued September 15, 2006; NIRB (2006)), Type A Water Licence (NWB Licence No. 2AM-DOH1323 Type A renewed August 16, 2013 and No. 2BE-HOP1222 Type B, renewed June 30, 2012), and IWMP (SRK 2012), as part of the annual Program:

1. Open water season volumetric discharge from Doris Creek and Roberts Lake Outflow.
2. Water level variation at Doris Lake, the Tailing Impoundment Area (TIA), and Windy Lake.

These items correspond to the following elements of the Doris North Gold Mine Project Certificate, Water Licence, and IWMP:

1. Doris North Gold Mine Project Certificate
   - *Appendix C: Final Hearing Report Appendix B, Additional Comments, DFO, Item 2: [The Proponent] will monitor stage and discharge in Doris Outflow both upstream and downstream of the decant discharge point to provide information that can be used in assessing the accuracy of the impact predictions relating to fish habitat downstream.*
2. NWB Type A Water Licence No. 2AM-DOH1323
   - *Part G. Item 31. The Licensee shall, following the deposition of tailings, maintain water within the Tailings Impoundment Area at an elevation of least 28.3 metres above sea level such that a minimum of four (4) metres of water cover is maintained over the tailings at all times.*

- *Part J. Item 2: The Licensee shall install appropriate instrumentation in Doris Creek at Monitoring Station TL-2, to monitor flow when ice conditions allow for such measurements to be taken, on a real time and continuous basis for any year where discharges from the Tailings Impoundment Area are planned.*
- *Part J. Item 3. The Licensee shall undertake the Water Monitoring Program detailed in the Tables of Schedule J.*

  Note: This report contains discharge information from sites TL-2 and TL-3. All other requirements under this schedule are monitored by TMAC and presented in the 2AM-DOH1323 Monthly and Annual Reports.

3. NWB Type B Water Licence No. 2BE-HOP1222
   - *Part J. Item 9: The Licensee shall monitor water levels in Windy Lake during open water, in order to verify that additional water withdrawal for dust suppression activities does not result in drawdown beyond naturally occurring levels.*
4. IWMP (SRK 2012)
   - *Section 4.2: Continuous monitoring of Doris Lake water levels and outflows will continue under the hydrologic baseline characterization. These data will be used to calibrate the existing water balance and quality model.*

Hydrometric data collected to support habitat compensation projects and monitoring requirements for Fisheries Authorization NU-02-0117.3 are also reported here. Hydrometric baseline monitoring has been conducted in the Project area since 1996, with ERM conducting this work since 2009. The current Compliance Program has been in place since 2011.

All other aspects of water and waste water monitoring (e.g., water use and pumping volumes, etc.) are monitored by TMAC under the Surveillance Network Program (SNP) and reported monthly and annually to the NWB in accordance with the relevant clauses of Water Licences 2AM-DOH1323 and 2BE-HOP1222.

2. METHODS

The existing network of three streamflow and three water level monitoring stations for the Program were re-established at the beginning of the open water season in 2015 (Figure 1; Table 1). With the exception of the Windy Lake hydrometric monitoring station, the stations were established in the same locations as the 2014 monitoring network. The Windy Lake hydrometric station, which previously monitored lake level and streamflow, was relocated for 2015 and converted to a lake level monitoring station. Detailed site descriptions for each station can be found in Appendix A. Details regarding the standard methods used for installation of hydrometric stations, conducting stage-discharge measurements, and development of stage-discharge rating equations, and daily flow hydrographs for the Program are available in the Doris North Project 2013 Hydrology Compliance Monitoring Report (ERM Rescan 2014).

Figure 1
Hydrometric Monitoring Stations, Doris North Project, 2015

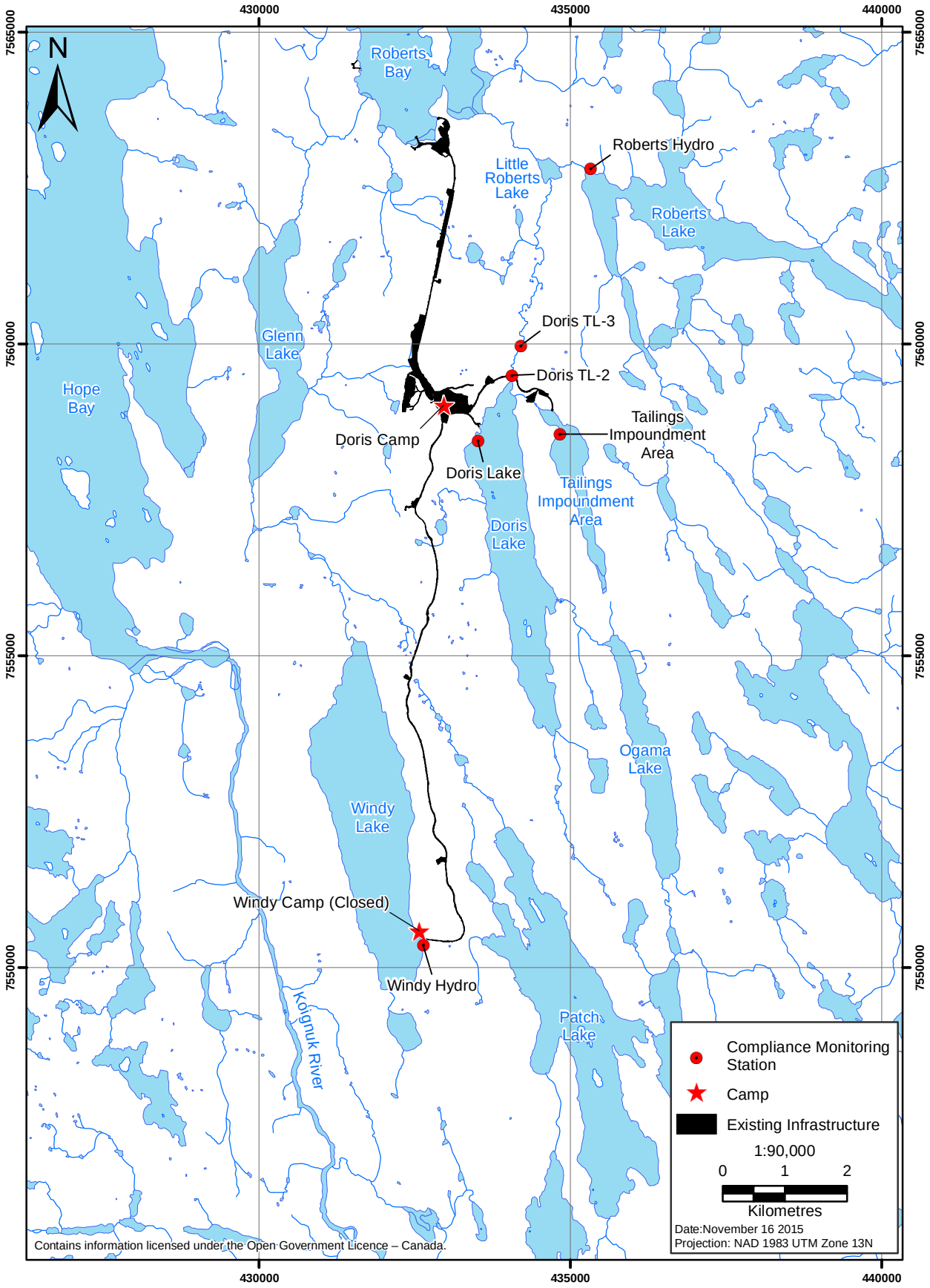


Table 1. 2015 Hydrometric Compliance Monitoring Stations, Doris North Project, 2015

Hydrometric Station	Location	UTM Coordinates[a] (Zone 13W, NAD83)		Drainage Area (km^2)	Drainage Area Covered by Lakes (%)	Monitoring Years	Period of Operation in 2015	Purpose
		Easting	Northing					
Streamflow Monitoring Stations								
Doris TL-2	Doris Lake outflow	434,059	7,559,504	94.6	20	1996-1998, 2000, 2003-2015	June 10 – September 21	Monitoring required for Project Certificate, Type A Water Licence, and IWMP
Doris TL-3	Doris Creek, downstream of waterfall	434,204	7,559,985	95.3	20	2011-2015	June 11 - September 20	Monitoring required for Project Certificate, Type A Water Licence and IWMP
Roberts Hydro	Roberts Lake outflow	435,325	7,562,815	97.9	17	2003-2015	June 11 - September 17	Supports requirements for Fisheries Authorization and No Net Loss Plan
Lake Monitoring Stations								
Doris Lake	Northwest shore of Doris Lake	433,512	7,558,452	n/a	n/a	2004-2015	July 15 - September 19	Monitoring required for Type A Water Licence and IWMP
Tailings Impoundment Area	Northwest shore of Tail Lake	434,832	7,558,560	n/a	n/a	2004-2015	July 15 - September 19	Monitoring required for Type A Water Licence
Windy Hydro	East shore of Windy Lake	432636	7550372	14.1	39	2006-2015	June 12 - September 19	Monitoring requirement for Type B Water Licence

[a] *Universal Transverse Mercator (UTM) Coordinates*

3. RESULTS AND DISCUSSION

Results from the 2015 Program are presented as follows: 1) manual stage-discharge measurements; 2) rating equations; 3) daily discharge hydrographs; 4) hydrologic indices; 5) lake water levels; 6) comparison with precipitation data; and 7) quality assurance and control (QA/QC). Results of the 2015 Program were compared to results from the 2009 to 2014 monitoring programs, which were previously reported in hydrology baseline and compliance reports (Rescan 2009, 2011a, 2011b, 2012a, 2012b, ERM Rescan 2014, ERM 2015).

3.1 Manual Stage-Discharge Measurements

In 2015, a minimum of six stage-discharge measurement visits were completed at each hydrometric station over a variety of flow conditions. These measurements were used to create new stage-discharge relationships or validate existing ones (Table 2).

Table 2. Summary of Manual Stage-Discharge Measurements, Doris North Project, 2015

Station and Drainage Area	Date	Stage (m)[a]	Discharge Measurement 1 (m^3/s)	Discharge Measurement 2 (m^3/s)	Measurement Precision as a % Difference	Equipment Used
Doris TL-2 94.6 km^2)	6/10/2015	99.175	2.338	2.334	0.2%	Flo-mate 2000
	6/12/2015	99.203	2.485	2.576	3.6%	Swoffer
	6/13/2015	99.213	2.55	2.618	2.6%	Flo-mate 2000
	6/14/2015	99.226	2.796	2.633	6.0%	Flo-mate 2000
	6/15/2015	99.222	2.744	2.697	1.7%	Flo-mate 2000
	7/15/2015	99.048	1.279	-	-	FH950
	7/16/2015	99.037	1.236	1.243	0%	FH950
	7/17/2015	99.029	1.214	-	-	FH950
	7/19/2015	99.014	1.215	-	-	FH950
	8/14/2015	99.052	1.329	1.328	0.1%	FlowTracker
	8/15/2015	99.044	1.328	1.323	0.4%	FlowTracker
	8/17/2015	99.023	1.26	1.25	0.8%	FlowTracker
	9/1/2015	98.944	1.014	0.987	2.7%	FH950
	9/3/2015	98.942	0.982	0.961	2.2%	FH950
	9/19/2015	98.868	0.743	0.709	4.7%	FH950
	9/20/2015	98.86	0.70	0.685	2.5%	FH950
Doris TL-3 (95.3 km^2)	6/11/2015	97.72	2.547	-	-	Flo-mate 2000
	6/12/2015	97.748	2.74	2.804	2.3%	Swoffer
	6/13/2015	97.763	2.617	2.566	2.0%	Flo-mate 2000
	6/14/2015	97.771	2.619	2.671	2.0%	Flo-mate 2000
	6/15/2015	97.776	2.576	2.646	2.7%	Flo-mate 2000
	7/16/2015	97.456	1.247	1.269	2.4%	FH950
	7/20/2015	97.466	1.184	1.164	0.8%	FH950

(continued)

Table 2. Summary of Manual Stage-Discharge Measurements, Doris North Project, 2015 (completed)

Station and Drainage Area	Date	Stage (m)[a]	Discharge Measurement 1 (m^3/s)	Discharge Measurement 2 (m^3/s)	Measurement Precision as a % Difference	Equipment Used
Doris TL-3 (95.3 km^2) *(cont'd)*	8/15/2015	97.523	1.406	1.463	4.0%	FlowTracker
	8/16/2015	97.508	1.388	1.41	1.6%	FlowTracker
	9/20/2015	97.317	0.707	0.688	2.7%	FH950
Roberts Hydro (97.9 km^2)	6/11/2015	99.432	1.97	2.028	2.9%	Flo-mate 2000
	6/13/2015	99.559	3.91	4.167	6.4%	Flo-mate 2000
	6/14/2015	99.595	4.696	4.709	0.3%	Flo-mate 2000
	7/16/2015	99.300	1.186	1.191	0.4%	FH950
	8/17/2015	99.244	1.054	1.022	3.1%	FlowTracker
	9/17/2015	99.110	0.365	0.385	5.3%	FH950

[a] *Water levels referenced to site-specific arbitrary local datum.*

3.2 Stage-Discharge Rating Equations

Stage-discharge relationships (i.e. rating curves) were developed for all stream hydrometric stations in the monitoring network. Rating equations are summarized in Table 3.

Table 3. Summary of Stage-Discharge Rating Equations, Doris North Project, 2015

Hydrometric Station	Rating Equation[a]	Number of Flow Measurements Used in Curve	Root Mean Square Error (%)	Monitoring Period Used to Develop Curve (Years)[b]
Doris TL-2	$h<99.06 : Q = 2.19(h-98.260)^{2.170}$ $h>99.06 : Q = 8.96(h-98.670)^{2.010}$	16	2.5	2015
Doris TL-3	$h<97.48 : Q = 3.08(h-96.810)^{2.191}$ $h>97.48 : Q = 3.00(h-96.810)^{2.121}$	18	5.6	2014-2015
Roberts Hydro	$h<99.42 : Q = 5.843(h-98.869)^{1.876}$ $h>99.42 : Q = 18.983(h-99.002)^{2.633}$	12	7.1	2014-2015

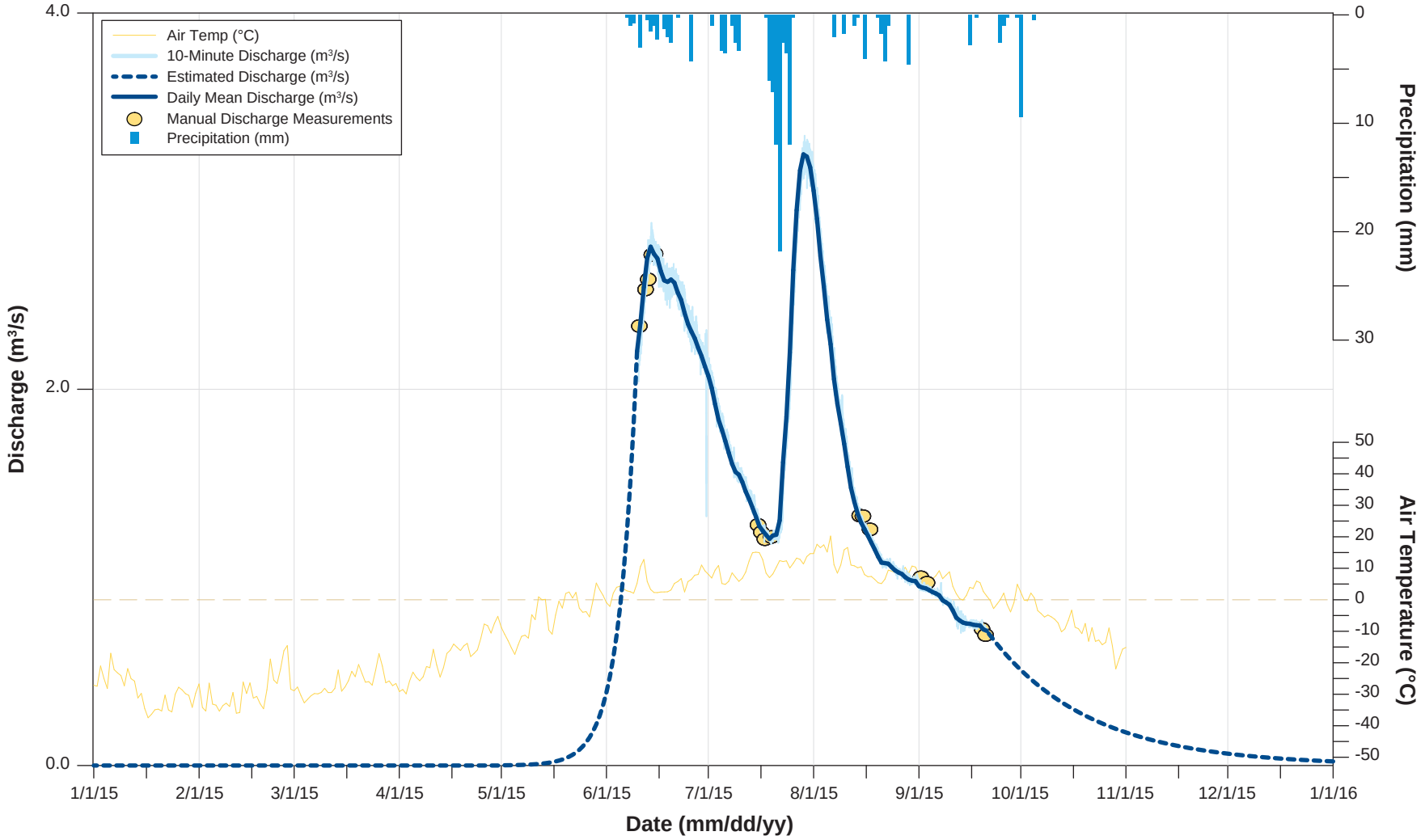
[a] *Q = discharge (m^3/s); h = stage (m)*

[b] *In some cases not all of the data collected during the year(s) listed were used in the development of the rating curve (e.g., stage measurements affected by ice were excluded).*

3.3 Hydrographs

Discharge hydrographs were generated at each active streamflow monitoring station by applying the rating equation to the collected stage record (Figures 2 to 4). Each hydrograph includes the 10-minute discharge showing the variance in daily measured discharge, daily mean discharge, and estimated discharge when mean daily discharge could not be calculated based on stage records. Estimation methods follow those detailed in previous reports (e.g., ERM Rescan 2014). Hydrographs also include manual flow measurements to show the goodness of fit for discharge measurements collected in 2015. Daily mean air temperature and daily precipitation collected at the Doris Climate Station were included to provide context for the hydrologic response of the stream monitored at each station. A complete summary of Doris North meteorological conditions for 2015 can be found it the Doris North Project 2015 Meteorological Compliance Monitoring Program Memorandum (ERM 2016).

Figure 2
Hydrometric Station TL-2: 2015 Hydrograph



Notes: Precipitation and air temperature based on Doris Climate Station.
Station installed June 10; demobilized September 21, 2015.
Mean daily discharge values between May 1 and June 9 are estimated using a logarithmic growth function.
Mean daily discharge values between September 22 and December 31 are estimated using a logarithmic growth function.
The channel was assumed to be frozen to the bed from January 1 to May 1, 2015.

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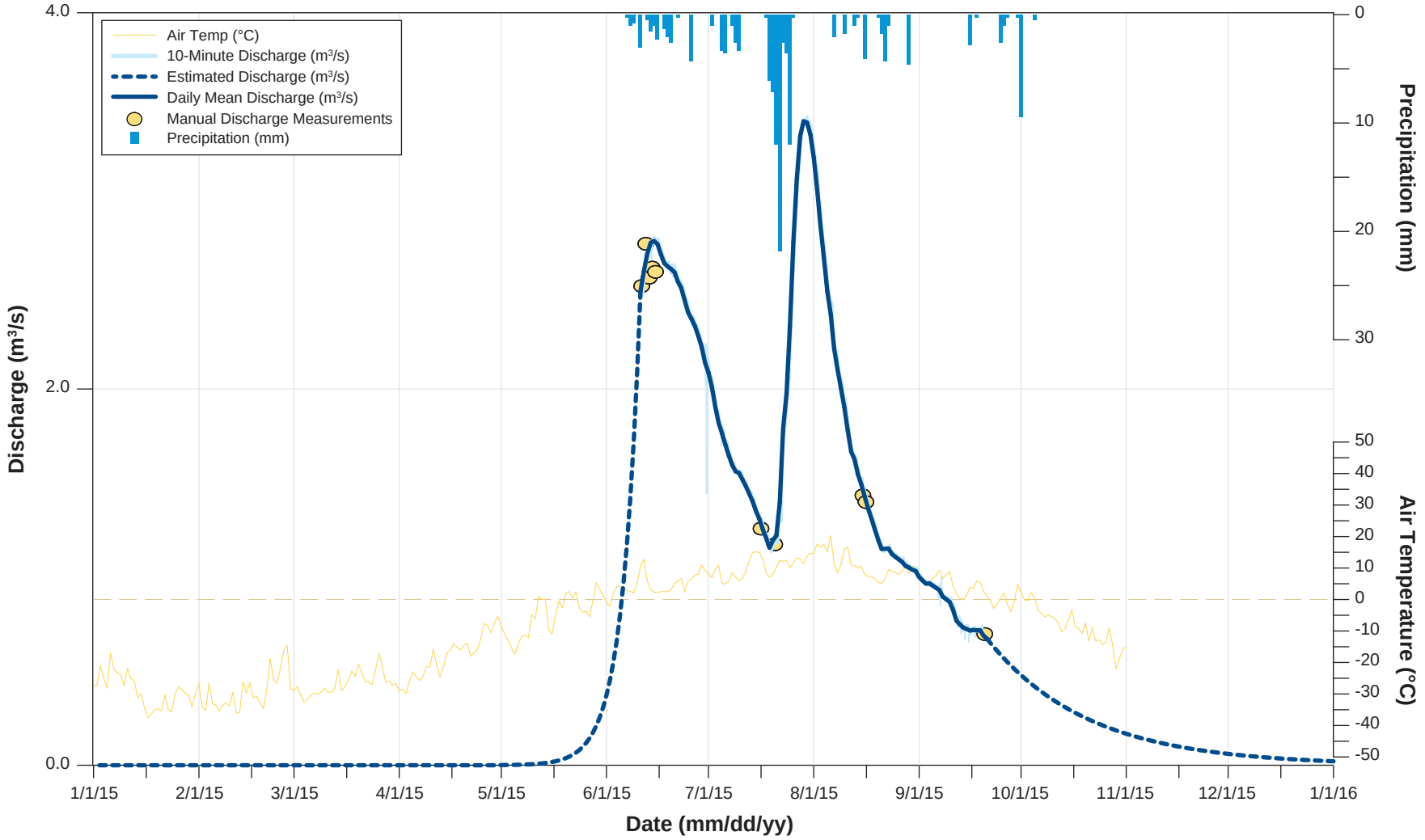
Figure 3
Hydrometric Station TL-3: 2015 Hydrograph



Notes: Precipitation and air temperature based on Doris Climate Station.
Station installed June 11; demobilized September 21, 2015.
Mean daily discharge values between May 1 and June 10 are estimated using a logarithmic growth function.
Mean daily discharge values between September 22 and December 31 are estimated using a logarithmic growth function.
The channel was assumed to be frozen to the bed from January 1 to May 1, 2015.

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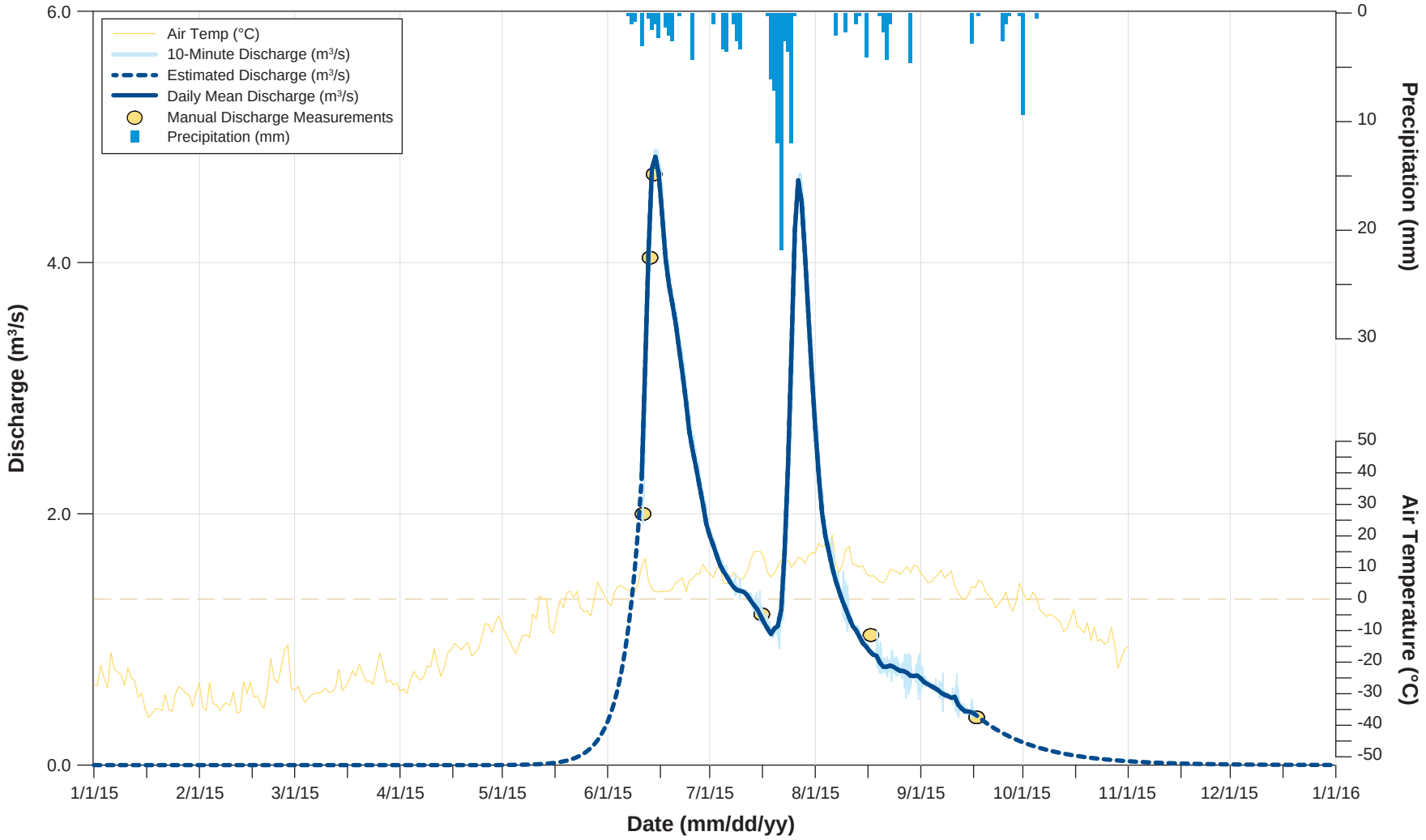
Figure 4
Hydrometric Station Roberts Hydro: 2015 Hydrograph



Notes: Precipitation and air temperature based on Doris Climate Station.
Station installed June 11; demobilized September 17, 2015.
Mean daily discharge values between May 1 and June 10 are estimated using a logarithmic growth function.
Mean daily discharge values between September 18 and December 31 are estimated using a logarithmic growth function.
The channel was assumed to be frozen to the bed from January 1 to May 1, 2015.

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3.4 Hydrologic Indices

Discharge and runoff (discharge normalised to drainage area) results for 2015 are presented in Tables 4 and 5, respectively. Annual peak flow and peak unit yield (an expression of discharge normalized to drainage area) for 2015 are presented in Tables 6 and 7, respectively. Data from 2009-2014 are provided for comparison. Peak discharge normally occurs in early June coinciding with spring snow melt. However, 2015 peak flows for Doris Creek were generated by a large precipitation event that occurred at the end of July. Roberts Lake Outflow also experienced high flows related to the precipitation event, but the flows were slightly lower than those related to the June snow melt.

Table 4. Total Runoff, Doris North Project, 2009 to 2015[a]

Hydrometric Station	Total Runoff (mm)										
	2009 to 2014 Annual[b]									2015 Observed[a]	2015 Annual[b]
	2009	2010	2011	2012	2013	2014	Min	Mean	Max		
Doris TL-2	*99*	*129*	*191*	*106*	*41*	*113*	*41*	*113*	*191*	159	*187*
Doris TL-3[c]	*n/a*	*n/a*	*190*	*108*	*47*	*120*	*47*	*116*	*190*	162	*190*
Roberts Hydro[d]	*98*	*146*	*162*	*99*	*61*	*138*	*61*	*117*	*162*	152	*168*

Notes:
[a] Calculated from recorded values during the open water season. Site-specific periods of record for historic data are presented in baseline and compliance reports (Rescan 2009, 2011a, 2011b, 2012a, and 2012b, ERM Rescan 2014, ERM 2015), and site-specific periods of record for 2015 data are provided in Table 1.
[b] Annual values include estimated data for periods when stations were demobilized, typically at the star of thaw and near freeze-up.
[c] Station established in July 2011 approximately 500 m downstream of TL-2: Values were estimated for June 2011.
[d] Roberts Hydro values from 2009 include estimated values for the period when the station was damaged (July 30 to Oct. 31).

Table 5. Mean Discharge, Doris North Project, 2009 to 2015[a]

Hydrometric Station	Mean Discharge (m^3/s)										
	2009 to 2014 Annual[b]									2015 Observed[a]	2015 Annual[b]
	2009	2010	2011	2012	2013	2014	Min	Mean	Max		
Doris TL-2	*0.29*	*0.39*	*0.57*	*0.32*	*0.12*	*0.34*	*0.12*	*0.34*	*0.57*	1.68	*0.56*
Doris TL-3[c]	*n/a*	*n/a*	*0.58*	*0.33*	*0.14*	*0.36*	*0.14*	*0.35*	*0.58*	1.74	*0.57*
Roberts Hydro[d]	*0.31*	*0.45*	*0.50*	*0.31*	*0.19*	*0.41*	*0.19*	*0.36*	*0.50*	1.74	*0.52*

Notes:
[a] Calculated from recorded values during the open water season. Site-specific periods of record for historic data are presented in baseline and compliance reports (Rescan 2009, 2011a, 2011b, 2012a, and 2012b, ERM Rescan 2014, ERM 2015), and site-specific periods of record for 2015 data are provided in Table 1.
[b] Annual values include estimated data for periods of when stations were demobilized.
[c] Station established in July 2011: Values were estimated for June 2011.
[d] Roberts Hydro values from 2009 include estimated values for the period when the station was damaged.

Table 6. Peak Flow, Doris North Project, 2009 to 2015

Hydrometric Station	Peak Flow (m^3/s)									
	2009 to 2014									2015 (Date)
	2009	2010	2011	2012	2013	2014	Min	Mean	Max	
Doris TL-2										
Instantaneous	2.39	4.61	5.88	3.62	1.00	2.45	1.00	3.50	5.88	3.35 (July 29)
Daily	2.29	4.44	5.77	3.56	0.98	2.41	0.98	3.41	5.77	3.25 (July 29)
Doris TL-3[a]										
Instantaneous	n/a	n/a	5.96	3.83	1.29	2.97	1.29	3.69	5.96	3.45 (July 30)
Daily	n/a	n/a	5.86	3.78	1.25	2.94	1.25	3.63	5.86	3.42 (July 29)
Roberts Hydro										
Instantaneous	2.55	5.84	7.47	3.63	2.01	6.54	2.01	4.30	7.47	4.90 (June 15)
Daily	2.49	5.78	7.34	3.60	1.97	6.31	1.97	4.24	7.34	4.84 (June 15)

Notes:
[a] Station established in July 2011. Peak flow values for 2011 were estimated with the incorporation of modelled data for June.

Table 7. Peak Unit Yield, Doris North Project, 2009 to 2015

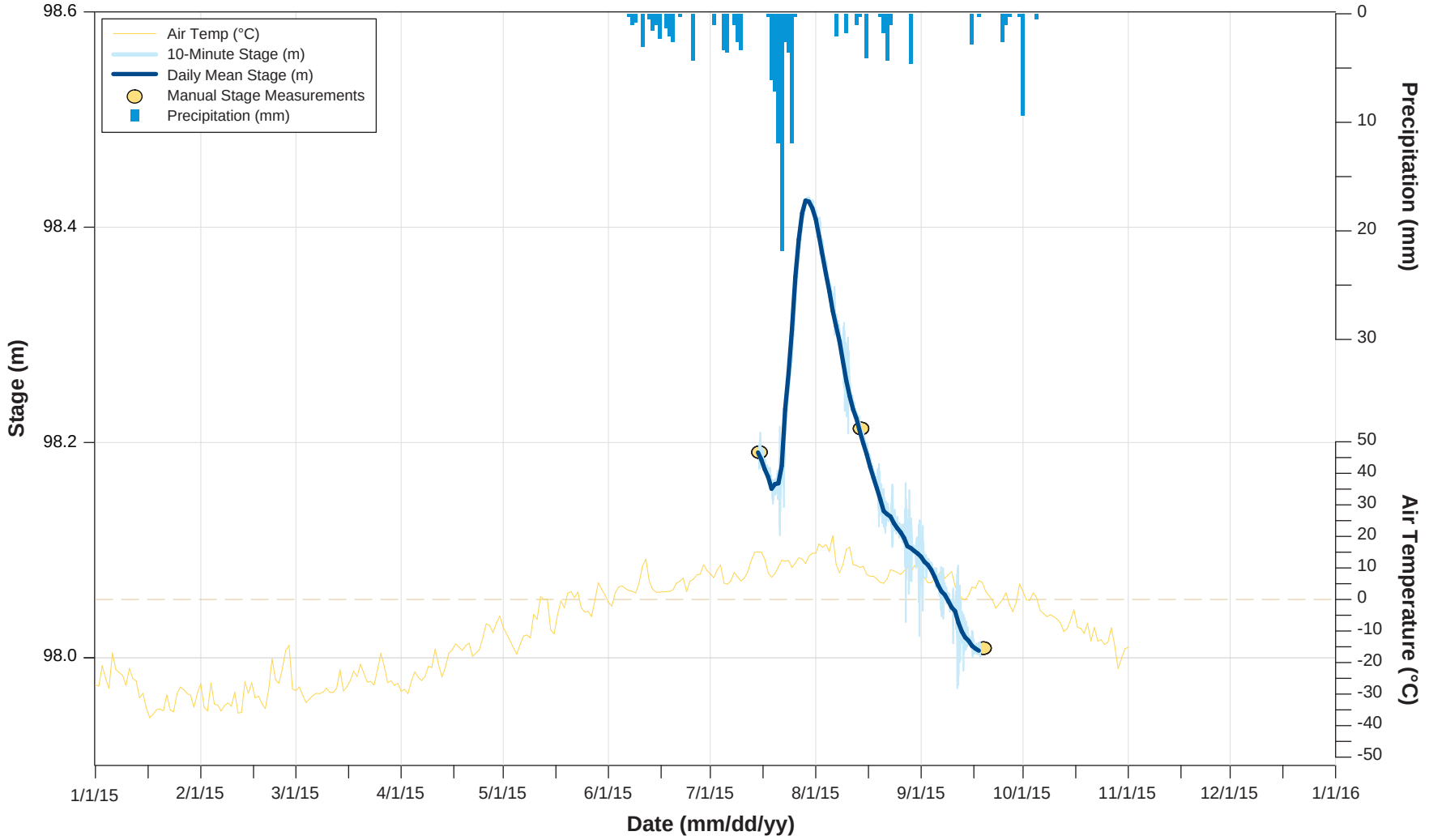
Hydrometric Station	Peak Unit Yield ($L/s/km^2$)									
	2009 to 2014									2015 (Date)
	2009	2010	2011	2012	2013	2014	Min	Mean	Max	
Doris TL-2										
Instantaneous	25.24	48.57	62.19	38.29	10.55	25.94	10.55	36.97	62.19	35.39 (July 29)
Daily	24.17	46.73	60.97	37.65	10.37	25.50	10.37	35.98	60.97	34.34 (July 29)
Doris TL-3[a]										
Instantaneous	n/a	n/a	62.51	40.14	13.50	31.13	13.50	38.72	62.51	36.24 (July 30)
Daily	n/a	n/a	61.50	39.66	13.15	30.85	13.15	38.10	61.51	35.92 (July 29)
Roberts Hydro										
Instantaneous	26.03	59.59	76.35	37.09	20.58	69.13	20.58	43.93	76.35	50.07 (June 15)
Daily	25.47	58.97	75.00	36.82	20.10	66.74	20.10	43.27	75.00	49.46 (June 15)

Notes:
[a] Station established in July 2011. Peak unit yield values for 2011 were estimated from modelled data.

3.5 Lake Water Levels

Water level monitoring was conducted at Doris Lake, the TIA, and Windy Lake (Table 8). Water level records for the 2015 season are shown in Figures 5 to 7. Pressure transducers at Doris Lake and the TIA were installed on the first ice-free site visit (July 15, 2015) to replace older malfunctioning sensors. The Doris Lake and TIA sensors were installed at a depth of > 5 m to avoid ice damage and allow water level to be continuously recorded throughout the winter season. Data from January 1 to July 15, 2015 for the TIA were not available due to sensor failure. Data from January 1 to July 15, 2015 for Doris Lake are available, but of poor quality and not considered valid due to sensor malfunction. The Windy Lake hydrometric station, which previously monitored lake level and streamflow, was relocated and converted to an open water season lake level monitoring station in 2015. The relatively large variance observed in the 10-minute water level at Windy Hydro is likely the result relatively high wave action due to windy conditions.

Figure 5
Annual Stage Record at Doris Lake Station, Doris North Project, 2015



Notes: Precipitation and air temperature based on Doris Climate Station.
Sensor was replaced on July 15 and will record continuously throughout the winter.
Data is presented from the beginning of the valid record to the last day of data collected during the final site visit (September 19).

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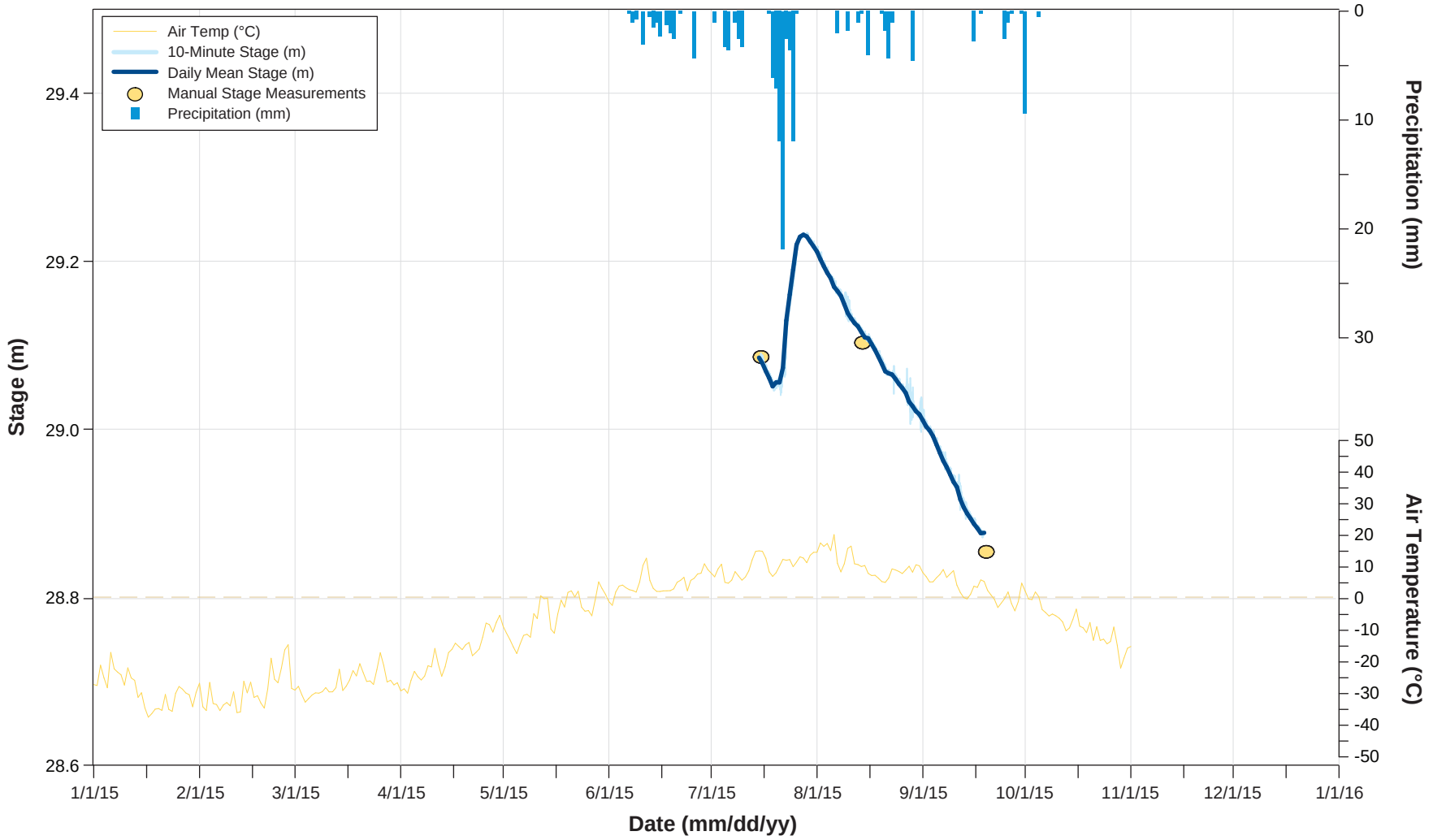
Figure 6
Stage Record at the TIA Station, Doris North Project, 2015



Notes: Precipitation and air temperature based on Doris Climate Station.
Station installed July 15 and will record continuously throughout the winter.
Data presented is from the beginning of the record to the last day of data collected during the final site visit (September 19).

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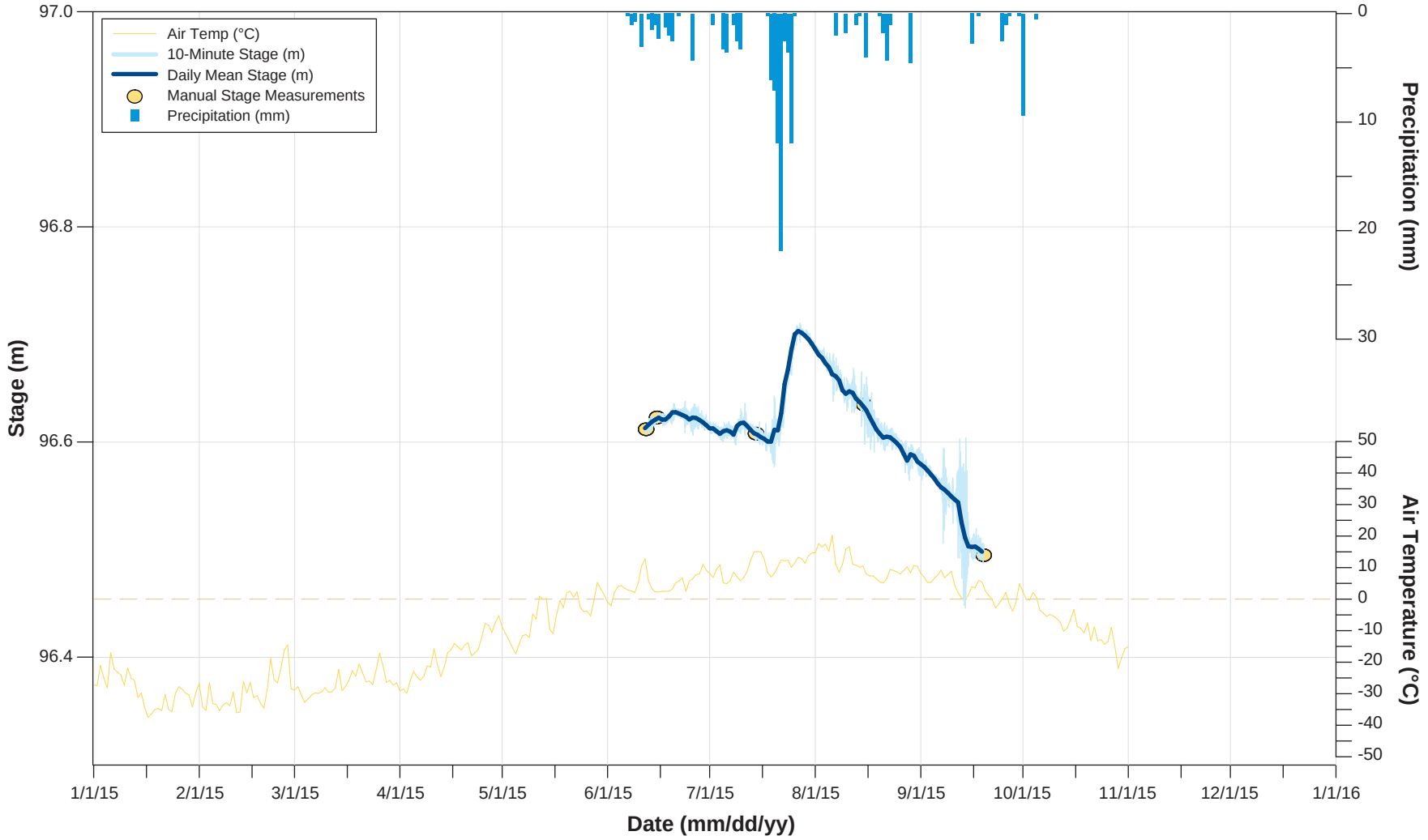
Figure 7
Stage Record at Windy Lake Station, Doris North Project, 2015



Notes: Precipitation and air temperature based on Doris Climate Station.
Station installed June 12 and demobilized for winter.
Data presented is from the beginning of the record to the last day of data collected during the final site visit (September 19).

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Table 8. Lake Water Level Variations in Doris Lake and the TIA, Doris North Project, 2015

Lake	Lake Area (km^2)	Drainage Area at Lake Outlet (km^2)	Period of Operation in 2015	Min Water Level (m)	Max Water Level (m)	Mean Water Level (m)	Water Level Change (m)
Doris[ab]	3.4	94.6	July 15 - September 19	98.006	98.424	98.182	0.418
TIA[abc]	0.8	4.2	July 15 - September 19	93.862 (28.876)	94.218 (29.232)	94.054 (29.068)	0.356
Windy[b]	5.3	14.1	June 12 - September 19	96.498	96.703	96.612	0.205

Notes:
[a] Data is monitored continuously. The end date in the Period of Operation column notes the last day of data collected during the final site visit. Dataloggers will collect data through winter 2015/16.
[b] Water level is referenced to the local station datum.
[c] Water level in masl in parenthesis.

3.6 Comparison with Precipitation Data

The winter of 2014/2015 was an average precipitation year in the Arctic Tundra region according to Environment Canada's Climate Tends and Variations Bulletin (CTVB, EC 2015). The CTVB ranked the winter of 2014/2015 as the 30th wettest winter out of 68 years of record (10.9% above normal) for this region (EC 2015). This is consistent with the discharge record which shows peak flows during freshet within 15% of the average peak flows observed between 2009 and 2014.

The summer of 2015 was a wetter than average year (11th wettest out of a 68 year record, 12.6% above normal) in Arctic Tundra climatic region according to Environment Canada's CTVB. Precipitation recorded at the Doris Climate Station for the 2015 open water monitoring period (June to September) is compared with data from 2009 to 2014 in Table 9. This comparison shows the significance of the July precipitation, the majority of which occurred between July 20th and 26th (65.0 mm). The maximum daily rainfall during July 2015 was 21.8 mm and occurred on July 23rd.

Table 9. 2009 to 2015 Monthly Precipitation Recorded at the Doris Climate Station for the Open Water Season (June to September)

Month	Doris Climate Station Precipitation (mm)									
	2009 to 2014									
	2009	2010	2011	2012	2013	2014	Min	Mean	Max	2015
June	4.8	1.3	32.0	5.8	56.4	18.0	1.3	19.7	56.4	20.8
July	22.4	34.0	21.1	23.4	46.6	21.7	21.1	28.2	46.6	80.3
August	28.7	23.9	12.7	12.7	38.7	31.7	12.7	24.2	38.7	21.1
September	19.3	16.0	32.0	5.8	36.3	48.8	5.8	29.4	48.8	6.9

The effects of the July precipitation are clearly observed in the 2015 hydrographs and hydrologic indices. The July peak in the hydrographs suggests that similar streamflow was generated by the July rains as typically would result from freshet.

3.7 Data Quality Assurance and Control

The dynamic permafrost of the Canadian Arctic creates a challenging environment in which to collect hydrological data. Although great care is taken to minimize the uncertainty in the measurements and computed data presented in this report, it is not possible to eliminate it. Furthermore, the dynamic permafrost environment of the Project area provides a number of distinct challenges affecting data uncertainty. These challenges relate primarily to the following:

1. the stability of station infrastructure such as bench marks and water level sensors; and
2. the stability of channel banks and morphology.

A number of procedures were used, both in the field and in the office, to assess and assure data quality for each hydrometric station. Field QA/QC procedures include conducting two discharge measurements per site visit, following accepted water level surveying procedures, and conducting monthly bench mark surveys to assess bench mark stability (bench mark stability being critical to maximising stage measurement quality). Details regarding the standard methods used for installing hydrometric stations, conducting stage-discharge measurements, and developing stage-discharge relationships for the Program are provided in the Doris North Project 2013 Hydrology Compliance Monitoring Report (ERM Rescan 2014).

Monthly bench mark surveys indicated that movement has occurred in the bench marks at stations TL-2, TL-3, and Windy Hydro. These bench marks are installed in large boulders, and the instability is likely the result of changes in the underlying permafrost and active layer caused by melting and/or frost heaving. Unstable bench marks result in increased uncertainty in surveyed water levels and stage-discharge relationships, and are a common challenge for hydrological studies in permafrost environments. Similarly, the stability of channel banks and channel morphology can also result in changes to the stage-discharge relationship. This is particularly true for small streams such as those measured in the Project area, where even small channel changes have the ability to alter the stage-discharge relationship. Any increase in uncertainty in the measurement of stage, discharge and the stage-discharge relationship propagates through the computations of discharge.

To further assess data quality, stage-discharge measurements were compared to existing stage-discharge relationships to evaluate the stability the existing relationships and identify potential erroneous measurements and/or outliers. For site TL-2, this comparison indicated that the 2015 measured data varied from the rating curve, although no individual outliers were identified in the 2015 data. It is hypothesized that minor channel instability may be the cause of the instability of the TL-2 stage-discharge relationship. Consequently, a new stage-discharge relationship was developed using only 2015 data. Sensor movements and drift were identified by instantaneous shifts in the water level record and by comparing the recorded and surveyed water levels, respectively. Minor corrections were made to the stage record to account for sensor movement and drift.

Similarly, no outliers within the 2015 measurements collected at station TL-3 were identified, however some variation between the 2015 data and the existing rating curve was observed. In this case, the stage-discharge relationship was updated by incorporating both the 2014 and 2015 data. A rating shift (a temporary change to the rating curve) was introduced for the 2015 July high-flow period to account for a change in flow condition related the decrease in snow-melt runoff between

the TL-3 discharge measurement site and the monitoring station. Minor corrections were made to the stage record to account for sensor movement and drift.

At the Roberts Hydro station, all data collected in 2015 fell within 12% of the existing rating curve and the majority of the data (5 of 6 measurements) fell within 6% of the existing rating curve. Consequently, no changes were made to the relationship. Corrections were applied to the stage record to account for sensor movement/drift.

The uncertainty due to the movement of bench marks and changes in stream morphology is identified and minimized through the QA/QC procedures outlined above. Station TL-2 is also equipped with a satellite telemetry system which transmits recorded data hourly for daily review by ERM hydrologists. This data transmission allows near real-time plotting of hydrograph trends to screen for potential significant flow alterations, which can then be verified with site weather conditions. This desk-based screening of TL-2 data is then supplemented with monthly field flow measurements which include the QA/QC measures described above.

Recorded discharge at station TL-2 was used to determine the allowable pumping rate from the TIA to ensure that discharge from the TIA remained less than 10% of background flow levels. Changes to the TL-2 stage-discharge relationship for 2015 resulted in increased uncertainty in forecasting allowable pumping rates. A comparison of daily pumping rates for the season with computed discharge for site TL-2 is presented monthly and annually by TMAC as part of the NWB Monthly and Annual reports for 2AM-DOH1323.

4. SUMMARY

The 2015 open-water season was characterized by two distinct high flow periods. High flows generated by spring snow-melt (i.e. freshet) were observed in early June, with peak freshet occurring on June 15th. A second peak in flows of equal or greater magnitude was generated by heavy rains in late July with peak flows for this period occurring on July 29th. The winter of 2015 was a normal year in terms of precipitation (30th wettest out of 68 years), while the summer of 2015 was the 11th wettest in the past 68 years. Flows declined steadily from the end of July through the low-flow period of late August and September.

The observed runoff for the monitored watersheds ranged from 152 to 162 mm, and annual runoff ranged from 168 to 190 mm (Table 4). The annual runoff values for 2015 ranged from 43 to 65% higher than the 2009 to 2014 site-specific averages. Peak daily flows for the monitored stations ranged from 3.2 to 6.3 m^3/s. These flows were approximately 4 to 7% below the 2009 to 2014 average at stations TL-2 and TL-3, respectively, and 12% above the 2009 to 2014 average at the Roberts Hydro station. These results suggest that the higher runoff values are due to the July rainfall event generating a second peak in flow and elevating flows for the remainder of the monitoring season, rather than abnormally high peak flows.

A summary of compliance target achievements is provided in Table 10. New sensors were installed at both Doris Lake and the TIA to allow for continuous water level monitoring at these stations. No equipment failures or technical problems occurred during the 2015 summer monitoring period resulting in zero missing data.

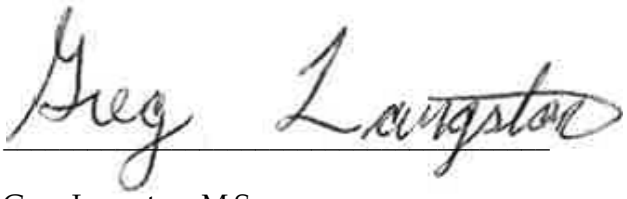
Table 10. Summary of Compliance Points

Compliance Requirement	Results
Doris North Project Certificate	
Appendix C. Proponent will monitor stage and discharge in Doris Outflow both upstream and downstream of the decant discharge point to provide information that can be used in assessing the accuracy of the impact predictions relating to fish habitat downstream.	Hydrometric station TL-2 is located upstream of the discharge location. Station TL-3 is located downstream of the discharge location. Each station collects and records stage at 10-minute intervals during the open water season. A minimum of eight discharge measurements were completed at each location and were used to convert recorded stage to discharge using a stage-discharge relationship.
Type A Water Licence 2AM-DOH1323	
Part G. Item 31. The Licensee shall, following the deposition of tailings, maintain water within the Tailings Impoundment Area at an elevation of least 28.3 metres above sea level such that a minimum of four (4) metres of water cover is maintained over the tailings at all times.	Though tailings have not yet been deposited in the TIA, water levels have been monitored almost continuously, with a data gap from September 8, 2013 to July, 2014 due to a datalogger malfunction and from September 18, 2014 to July 15, 2015 between when the temporary datalogger and pressure transducer were removed and the new sensor and datalogger were installed
Part J. Item 2: The Licensee shall install appropriate instrumentation in Doris Creek at Monitoring Station TL-2, to monitor flow when ice conditions allow for such measurements to be taken, on a real time and continuous basis for any year where discharges from the Tailings Impoundment Area are planned.	Real time continuous monitoring was conducted at station TL-2 when ice conditions allowed, to provide flow predictions for TIA dewatering operations.
Part J. Item 3. The Licensee shall undertake the Water Monitoring Program detailed in the Tables of Schedule J[a]	Automated hydrometric stations TL-2 and TL-3 were operated throughout the open-water season in 2015. Stage-discharge measurements were collected at each site and annual discharge hydrographs were generated.
Type B Water Licence 2BB-HOP1222	
Part J. Item 9. The Licensee shall monitor water levels in Windy Lake during open water, in order to verify that additional water withdrawal for dust suppression activities does not result in drawdown beyond naturally occurring levels.	Automated hydrometric station Windy Hydro was operated throughout the open-water season in 2015. Stage measurements were collected at each site and the stage record for the monitoring season was generated.
Interim Water Management Plan	
Section 4.2: Continuous monitoring of Doris Lake water levels and outflows will continue under the hydrologic baseline characterization. These data will be used to calibrate the existing water balance and quality model.	Though mining has not yet commenced, water levels are continuously monitored in Doris Lake, although data from September 18 2015 to July 15, 2015 was discarded during the QA/QC review due to a sensor malfunction. A new sensor was installed on July 15, 2015. Doris Lake outflows were monitored at the automated TL-2 and TL-3 hydrometric stations throughout the open-water season in 2015. Stage discharge measurements were collected and annual discharge hydrographs were generated.

Note:

[a] ERM monitors discharge at sites TL-2 and TL-3. All other requirements under this element are monitored by TMAC and presented elsewhere.

Prepared By:



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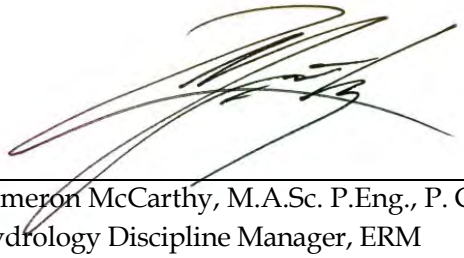

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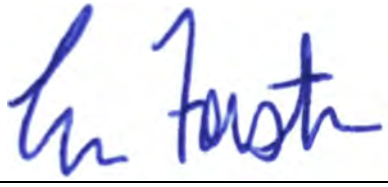

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