



## Technical Memorandum

**DATE:** February 21, 2019

**TO:** James Bogusz and Stacey Lee, Victoria Airport Authority (VAA)

**FROM:** Chad Davey, Kerr Wood Leidal (KWL)

**RE: VICTORIA AIRPORT AUTHORITY  
2018 Reay Creek Hydrometric Monitoring Program – Summary Memorandum  
2083-035.300**

### 1. Introduction

Kerr Wood Leidal (KWL) was retained by the Victoria Airport Authority (VAA) to continue the hydrometric monitoring program that was initiated on Reay Creek in 2016. The goal of collecting water level and calculated discharge data is to better understand the hydrological response (i.e., water stage) of Reay Creek following precipitation events. This data could be used for future studies to validate the hydrological model developed for the Airport.

The following summary memorandum outlines the work that was conducted during the 2018 monitoring program and the data that was collected.

### 2. Hydrometric Program

#### 2.1 Station Installation

On January 29, 2016, KWL installed the Reay Creek hydrometric station to continuously monitor the water level in Reay Creek just upstream of Canora Road, immediately south of the Victoria International Airport (Figure 1).

A pressure transducer was installed at the hydrometric station to record water level every five minutes. Data is stored on a Solinst Edge datalogger (i.e. pressure transducer) and has the capacity to store ~4 months of data before it begins to overwrite previously collected data. The hydrometric monitoring station at Reay Creek consists of a 4" PVC pipe (i.e. stilling well) that houses the pressure transducer, benchmarks, and staff gauge (Photo 1). A Solinst barologger was also installed at the hydrometric station to measure barometric air pressure. Barometric data is needed for compensating barometric pressure changes when processing the information collected by the water level datalogger.



**Photo 1: Hydrometric Station at Reay Creek near Canora Road.**



On March 20 and November 9, 2018, KWL staff performed manual measurements of discharge and stage at the Reay Creek hydrometric station. Stacey Lee from the Victoria Airport Authority carried out the downloading of data from the hydrometric station for the remainder of the 2018 program.

## 2.2 Stage-Discharge Relationship

The hydrometric station at Reay Creek continuously records water level (i.e. stage). Discharge is not measured directly by the pressure transducer. To obtain discharge from the water level data record, a stage-discharge relationship (SDR) needs to be developed. Stage-discharge relationships are created by measuring instantaneous discharge at different water levels and relating them to a fixed staff gauge. Measured flows are graphed with the associated stages, and a curve relating manual measurements of stage and discharge is created. Manual measurements collected at the Reay Creek hydrometric station is provided in Table 1. The SDR for the Reay Creek hydrometric station is provided in Figure 2.

**Table 1: Manual measurements of Discharge and Stage Collected**

Date	Staff Gauge (m)	Discharge (m <sup>3</sup> /s)
January 29, 2016	0.455	0.3133
March 10, 2016	0.515	0.483
April 1, 2016	0.240	0.008
June 23, 2016	0.335	0.066
October 13, 2016	0.405	0.168
February 21, 2017	0.300	0.027
March 20, 2018	0.290	0.0057
November 9, 2018	0.403	0.1082

The Manual of BC Hydrometric Standards recommends that a minimum of 10 discharge measurements, well-distributed throughout the range of station water levels, be used to develop a Class 'A' SDR<sup>1</sup>. Consequently, the Reay Creek SDR (Figure 2) and the discharges calculated using them remain preliminary until a well distributed minimum number of manual discharge measurements are collected.

It is important to note that both 2018 manual measurements are plotting above the existing SDR (Figure 2). Consequently, this suggests that either the channel at the Reay Creek hydrometric station may have changed (e.g. debris accumulation, sediment deposition) or the staff gauge at the hydrometric station has shifted. In either scenario, the two most recent staff gauge readings are showing a higher water depth relative to discharge compared to previous measurements. A survey of the hydrometric station and channel cross-section should indicate the source of the error when compared with previous surveys.

The recommended upper limit of applicability for a SDR is a measure of how far the curve can be confidently extrapolated beyond the highest discharge measurement. An industry standard is to extrapolate to two times the highest discharge measurement. The Reay Creek SDR (Figure 2) shows the SDR upper limit of 0.96 m<sup>3</sup>/s, equivalent to a staff gauge reading of approximately 0.61 m, which is two times the highest flow measurement which was collected on March 10, 2016 (see Table 1).

<sup>1</sup> Ministry of Environment. 2009. *Manual of British Columbia Hydrometric Standards*, Version 1.0 (Resources Information Standards Committee), 204p.



## 2.3 Reay Creek Hydrograph

Data was collected at the Reay Creek hydrometric station from November 2017 to November 2018 and is presented in Figures 3 and 4. Figure 3 presents the hydrometric data collected at 5-minute intervals, whereas Figure 4 presents the Reay Creek hydrometric data as a daily mean discharge. The blue line on both Figures 3 and 4 represent the SDR upper limit, the flow values above the SDR upper limit are associated with a high uncertainty and should not be relied upon.

There is one data gap in the hydrograph record: June 15 to June 23, 2018. This was due to the datalogger at the hydrometric station having exceeded its memory capacity and overwriting previously collected data.

The shape of the hydrograph for Reay Creek illustrates how reactive the discharge response is to precipitation events. The discharge and stage in Reay Creek rises and falls in a very short amount of time. The largest discharge event occurred on January 30, 2018. Table 2 shows the relationship between mean monthly discharge total monthly precipitation for 2017 and 2018. The higher precipitation during the fall and winter periods between November to January result in the highest discharges in Reay Creek (Table 2). In contrast, the drier spring and summer period between May and October results in Reay Creek having the lowest flows of the year.

**Table 2: Total precipitation (mm) and mean monthly discharge (Litres/s) for 2017 and 2018 at the Reay Creek Hydrometric Station.**

Month	2017		2018	
	Total Precipitation* (mm)	Mean Discharge (L/s)	Total Precipitation* (mm)	Mean Discharge (L/s)
Jan	52	18.3	223.7	252
Feb	130	113.7	43.5	81
Mar	138	126.7	30.7	54
Apr	75	68.2	97.8	94
May	48	18.2	3.4	21
Jun	28	8.9	23.6	21
Jul	0	0.5	2.2	2
Aug	3	0.6	1.6	1
Sep	20	2.9	63.2	15
Oct	92	34.6	78.9	40
Nov	193	144.2	137.7	92 <sup>1</sup>
Dec	131	130.7	153.3	-

\* Precipitation data is from the weather station at the Victoria Airport (ID#1018621)  
<sup>1</sup> Mean discharge data for month of November is based on 10 days of data only



### 3. Summary

The 2018 manual measurements of discharge and stage indicate that the current SDR for the Reay Creek hydrometric station may no longer be valid. It is recommended that the hydrometric program be continued into 2019. In addition, a cross-section survey and further manual measurements of discharge and stage should be collected to develop a new preliminary SDR for the Reay Creek hydrometric station.

KWL is available to provide assistance in continuing Reay Creek hydrometric program for 2019.

We trust that this letter memorandum meets your current needs. If you have any questions or concerns please do not hesitate to contact me.

Yours truly,

**KERR WOOD LEIDAL ASSOCIATES LTD.**

Chad Davey, M.Sc., R.P. Bio  
Fluvial Geomorphologist

- Encl: Figure 1: Location of Reay Creek Hydrometric Station  
Figure 2: SDR for Reay Creek Hydrometric Station  
Figure 3: Reay Creek Hydrograph (5 min Instantaneous)  
Figure 4: Reay Creek Hydrograph (Daily Mean Flow)

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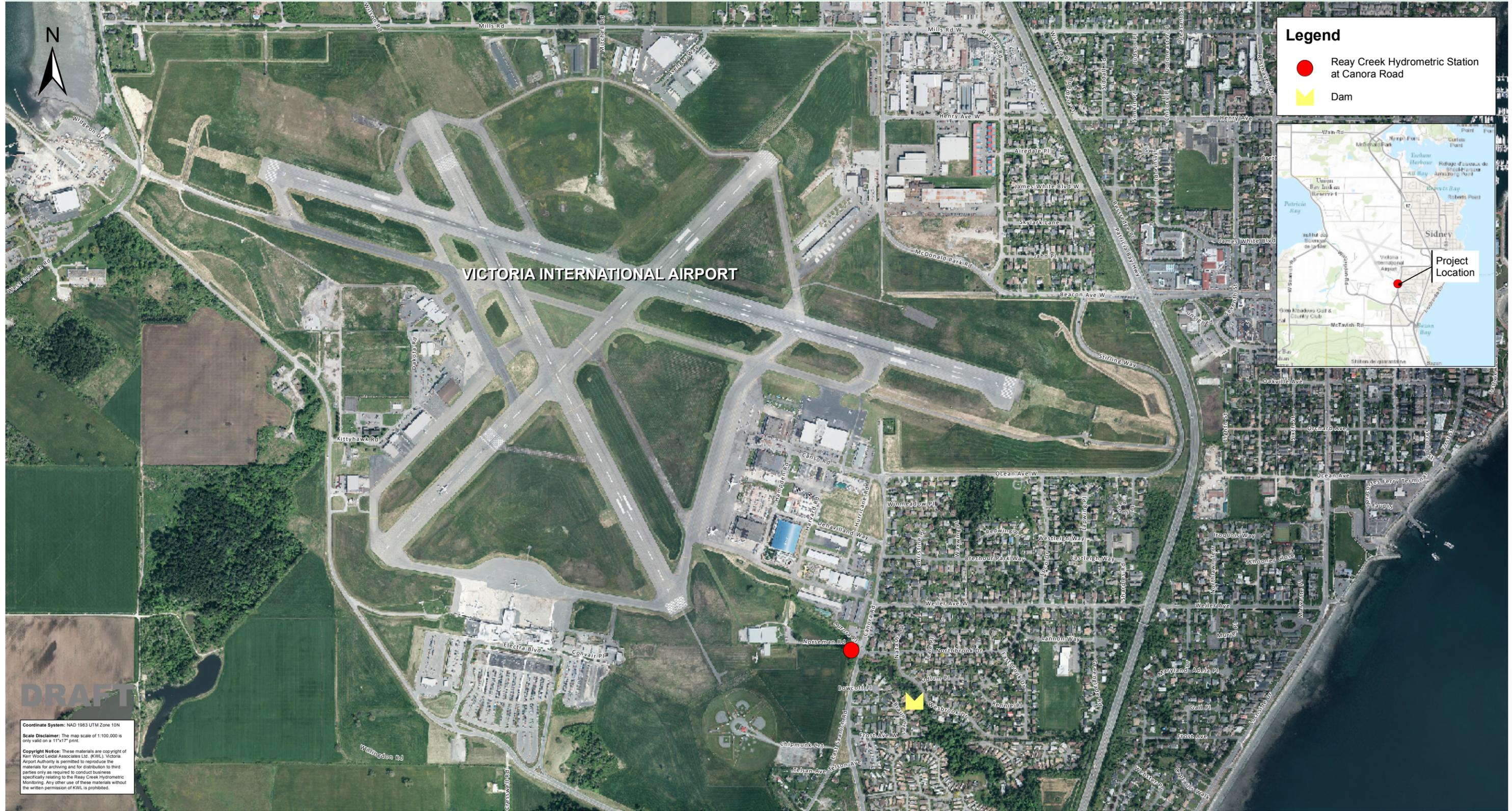
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### Revision History

Revision #	Date	Status	Revision Description	Author
0	February 14, 2019	Internal Review		CD
1	February 21, 2019	FINAL		CD



**KERR WOOD LEIDAL ASSOCIATES LTD.**  
consulting engineers



Project No. 2083.024  
Date January 2018  
Scale 1:10,000

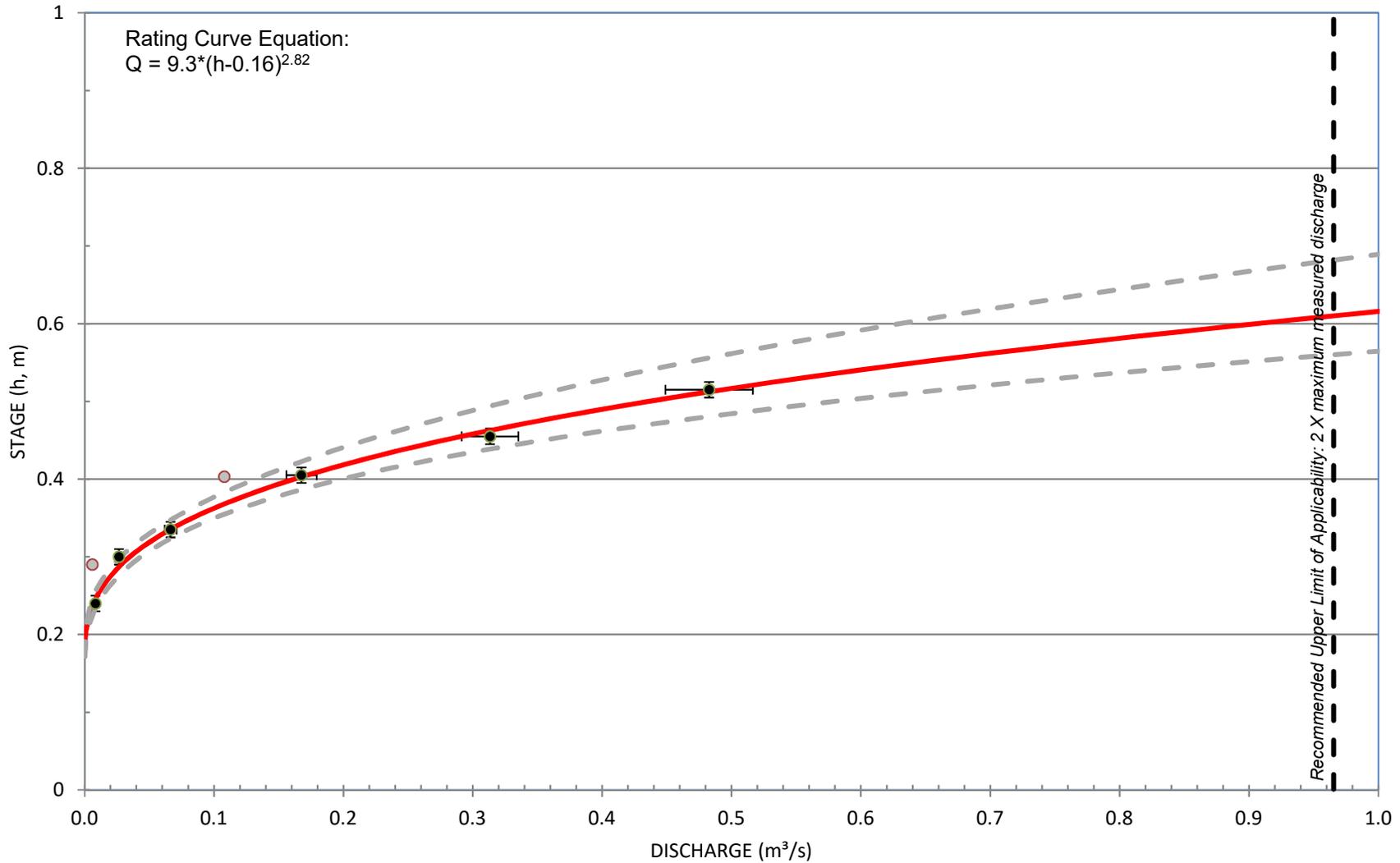
### Reay Creek Hydrometric Station - Site Map

Figure 1

**2018 Preliminary Stage Discharge Relationship**  
**Reay Creek Hydrometric Station**  
 (Estimated by Method of Maximum Likelihood)

— Rating Curve    
 ○ 2018 points    
 ● Points Used for Rating Curve    
 - - - Confidence Limits

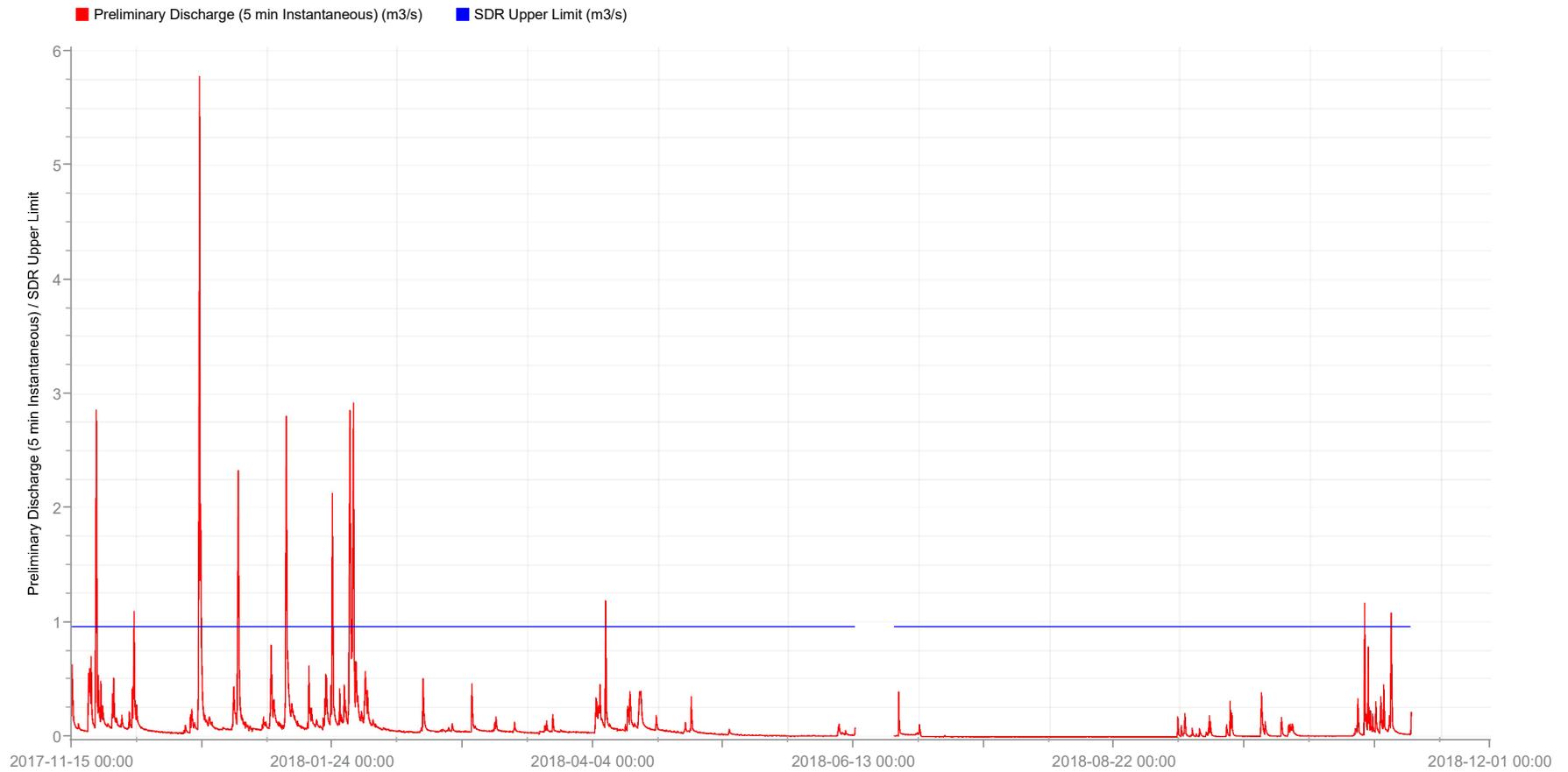
Rating Curve Equation:  
 $Q = 9.3 \cdot (h - 0.16)^{2.82}$



**Reay Creek at Canora Road**

Start Date: 2017-11-15 00:00

End Date: 2018-11-30 23:59

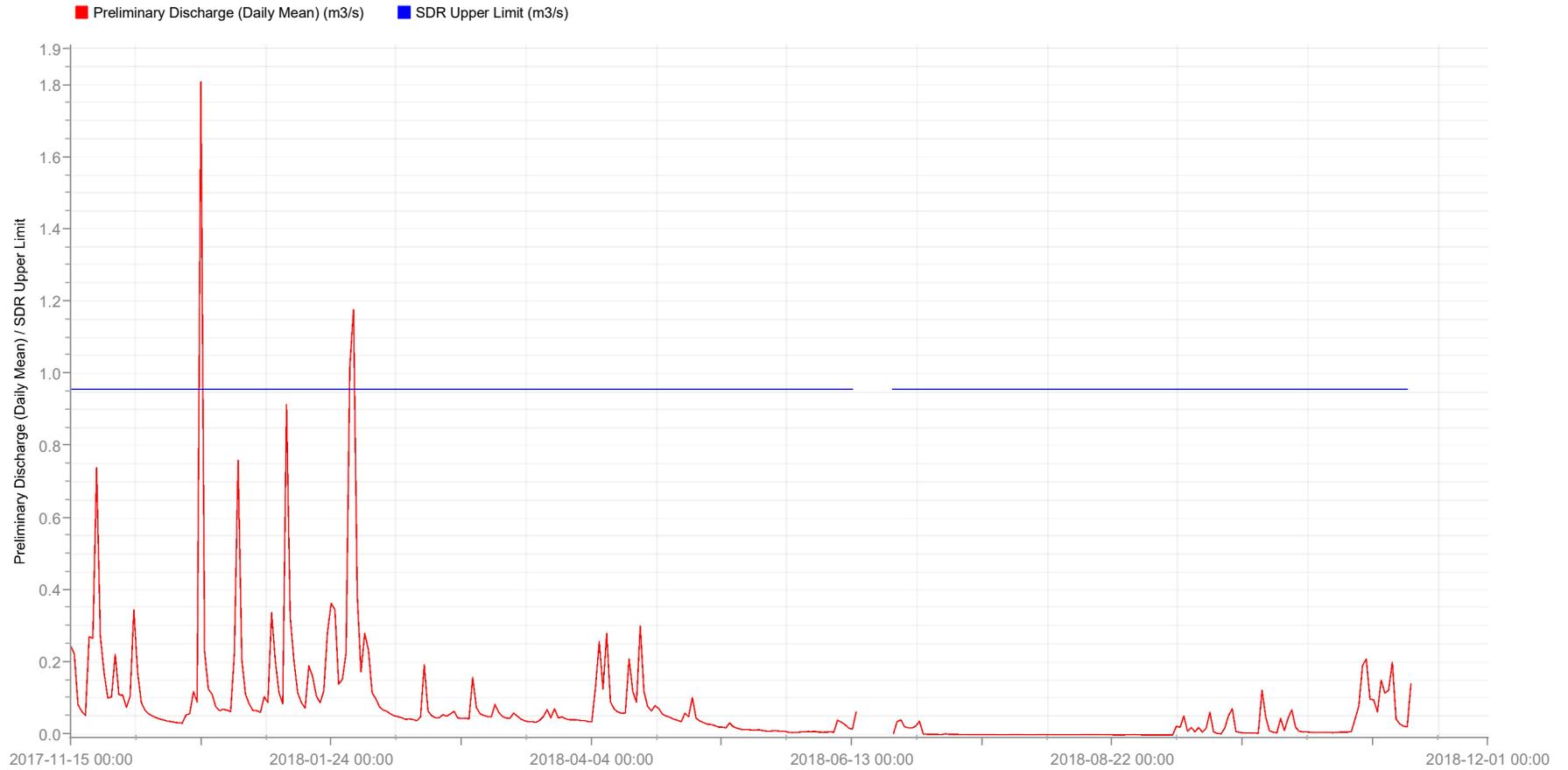


**Reay Creek Hydrograph - 5 Min Instantaneous**

**Figure 3**

**Reay Creek at Canora Road**

Start Date: 2017-11-15 00:00  
End Date: 2018-11-30 23:59



Reay Creek Hydrograph - Daily Mean Flow

Figure 4