Appendix J

Short Term Erosion Monitoring Memos – Water Level and Discharge Monitoring Memo

Report

22 January 2024

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From	Jeff Doucette	**Project No.**	11209954
Project Name	City of Toronto-Yellow Creek MP		
Subject	Water Level and Discharge Monitoring		

Dear Mr. McCreery

1. Introduction

1.1 Purpose of this report

As part of the Yellow Creek Geomorphic Systems Master Plan (YCGSMP) process, short-term water level and discharge monitoring of Yellow Creek was a required component to provide additional characterization of the system. The following technical memo presents the results of the water level and flow measurements implemented by GHD within the Study Area between May 2020 and October 2021, as well as any implications of these results on the YCGSMP. The purpose of the monitoring was to observe relative magnitudes of flow and responses to rain events to compliment the short-term erosion monitoring completed during the same period.

1.2 Limitations

This report: has been prepared by GHD for City of Toronto and may only be used and relied on by City of Toronto for the purpose agreed between GHD and City of Toronto as set out in section 1.1 of this report.

GHD otherwise disclaims responsibility to any person other than City of Toronto arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

Accessibility of documents

If this report is required to be accessible in any other format, this can be provided by GHD upon request and at an additional cost if necessary.

2. Water Level Measurements

Deployment of a level logger occurred on 1 May, 2020, located immediately upstream of the pedestrian bridge within Reach 3. This location was chosen due to the fixed bed and banks at the narrowing of the creek at the pedestrian crossing. The level logger was removed for winter to avoid damage to the sensor by ice. The logger was displaced on 8 July, 2020, due to high flows and reinstalled on 1 September, 2020, after it was located downstream.

Photo 1 – View of level logger installation taken during site visit for data download (8 May, 2020)

3. Flow Measurements

Periodic measurements of discharge were completed to develop a rough stage-discharge curve. Area-velocity measurements were conducted on the following dates as summarized in **Table 1** below, using a Flow Tracker Acoustic Velocity Meter.

Table 1 Stage and Discharge Measurements

Date/Time	Stage (m)	Discharge (m^3/s)
21 October, 2020	0.460	0.05
23 November, 2020	0.480	0.07
26 November, 2020	0.446	0.03
30 November, 2020	0.650	0.70
18 December, 2020	0.450	0.03
26 March, 2021	0.531	0.14

Due to high velocities at the site, it was not possible to measure discharge during high flow events. High flow events were also of very short duration making them difficult to predict and capture. Discharge estimates larger than the highest measured discharge in the field will not be very accurate and should only be considered as orders of magnitude values. Figure 1 shows the stage-discharge curve with R^2 = 0.998.

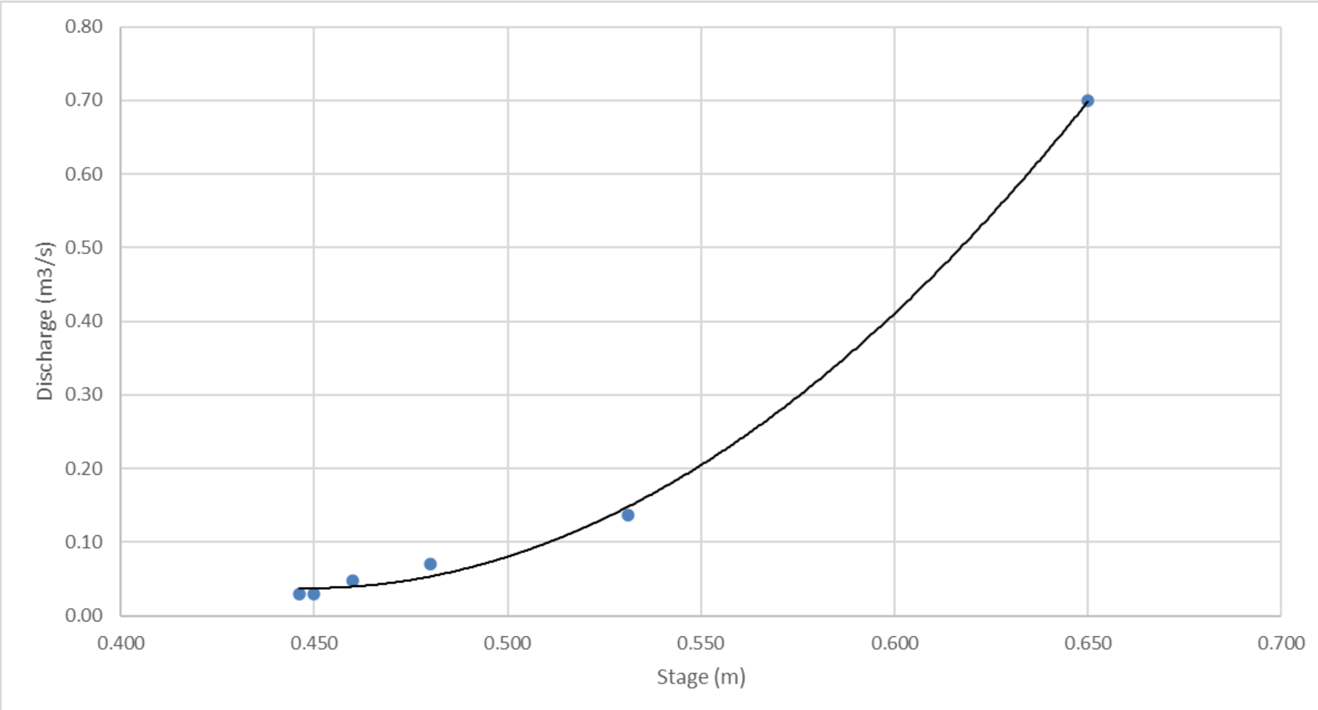

Figure 1 *Stage-Discharge Curve*

4. Results

Water level and precipitation for 2020 and 2021 are shown in Figure 2 and Figure 3, respectively. Precipitation data was obtained from the station 'TORONTO INTL A', Climate ID# 6158731 (Environment and Natural Resources, Canada). For 2020, the lowest flow water level measured was 0.365 m and the maximum water level recorded was 1.559 m. Since the level logger became dislodged, likely washed out during a large storm, there was a data gap from mid-June, 2020, to 1 September, 2020, when it was re-installed. For 2021, the lowest flow water level measured was 0.350 m and the maximum water level recorded was 1.407 m. There was some data loss since the level logger was again partially dislodged at the end of June, 2021, and was re-installed on 15 July, 2021.

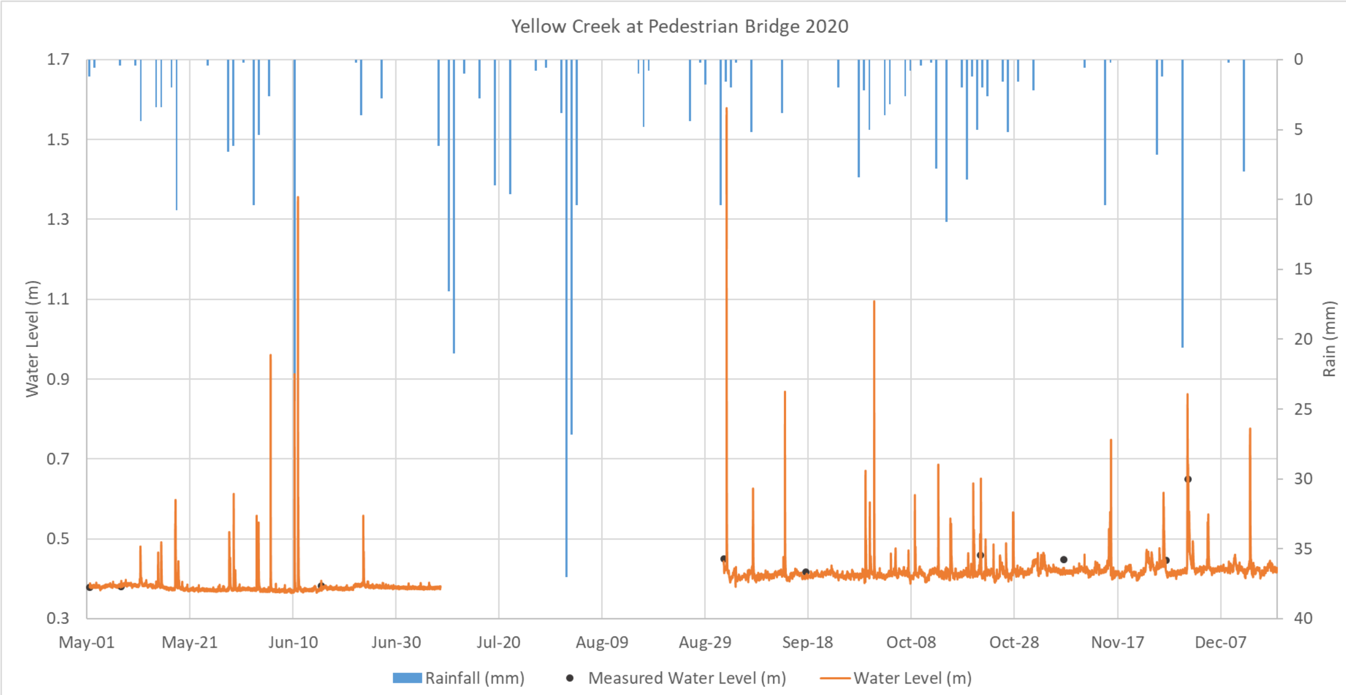

Figure 2 ***2020 Water Level and Precipitation***

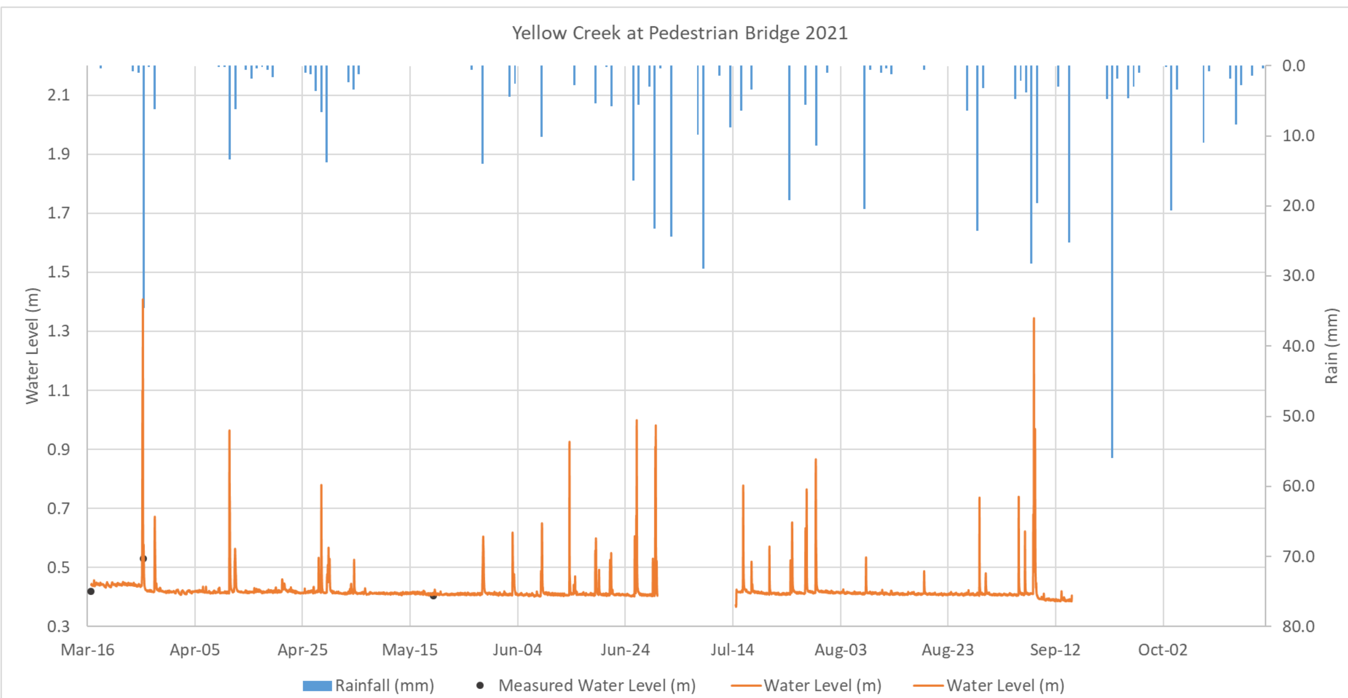

Figure 3 ***2021 Water Level and Precipitation***

The discharge estimate is shown for 2020 and 2021 in Figure 4 and Figure 5, respectively. For both years, lowest calculated discharge was 0.04 m^3/s. For 2020, the average calculated discharge was 0.09 m^3/s and largest flow was 20.16 m^3/s. The largest flow falls between the estimated 5-yr return period flow (17.16 m^3/s) and the 10-yr return period flow (22.91 m^3/s) as provided by TRCA. It is important to understand that the calculated high flows are not accurately estimated due to the limitations of the stage-discharge curve. For 2021, average calculated discharge was

0.08 m³/s with largest flow calculated of 15.03 m³/s. The largest flow for 2021 falls between the estimated 2-yr return period flow (7.99 m³/s) and the 5-yr return period flow (17.16 m³/s) as provided by TRCA.

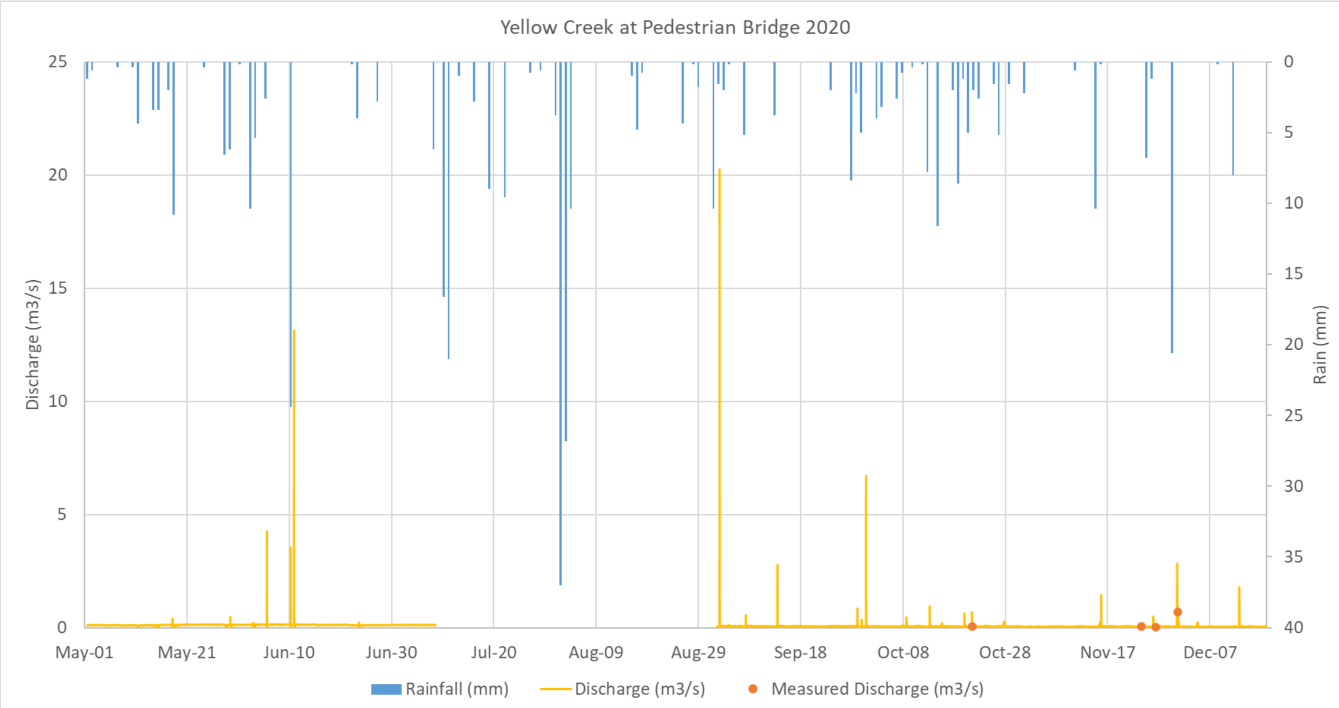

Figure 4 2020 Discharge Estimate and Precipitation

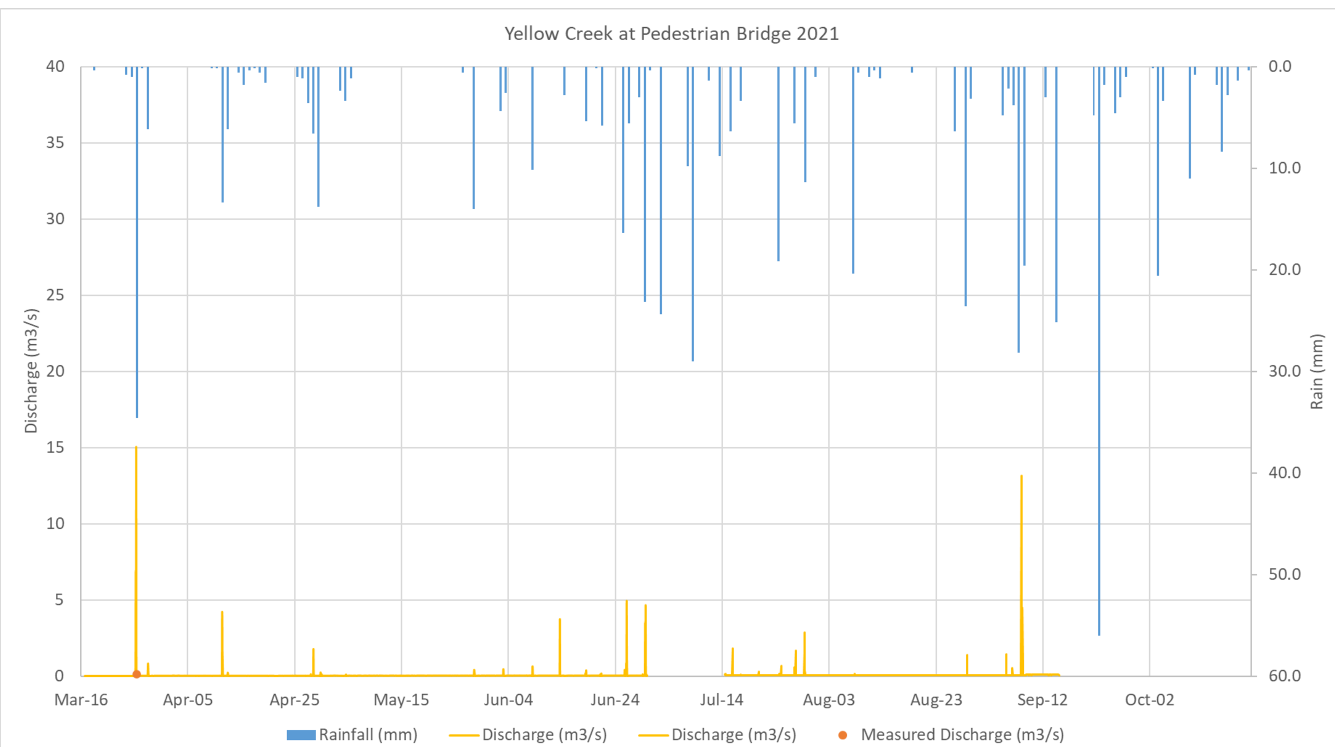

Figure 5 2021 Discharge Estimate and Precipitation

The recorded water levels and estimated discharge are shown for a large 34.6 mm total rainfall event on 26 March, 2021, to illustrate the peakedness of the flow and rapid response of the system to rainfall. Figure 6 shows that a rise in water level of approximately 1m resulted in an estimated peak discharge of 15.0 m^3/s during the 26 March, 2021, storm.

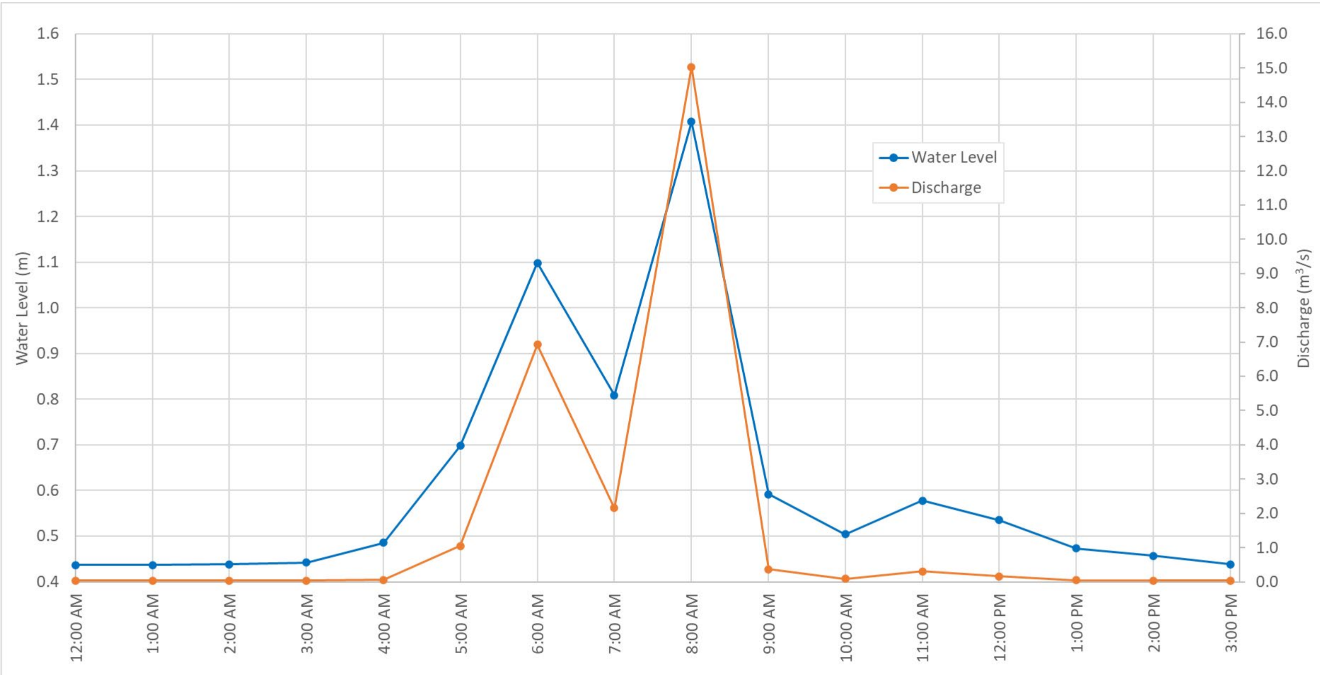

Figure 6 Representative Large Rain Event with Estimated Discharge (26 March, 2021)

Rainfall measured at the nearby City of Toronto rain gauge station, RG 039, recorded total rainfall of 33.3 mm for 26 March, 2021 (City of Toronto, Open Data). Precipitation data was available at 5-minute intervals and used to review discharge responsiveness. Figure 7 shows that estimated discharge peaks approximately 1.5 h from peak rainfall as shown by the lag in discharge behind both the distinct peaks in rainfall. Flows returned to near base flow within approximately 1 hr after the peak.

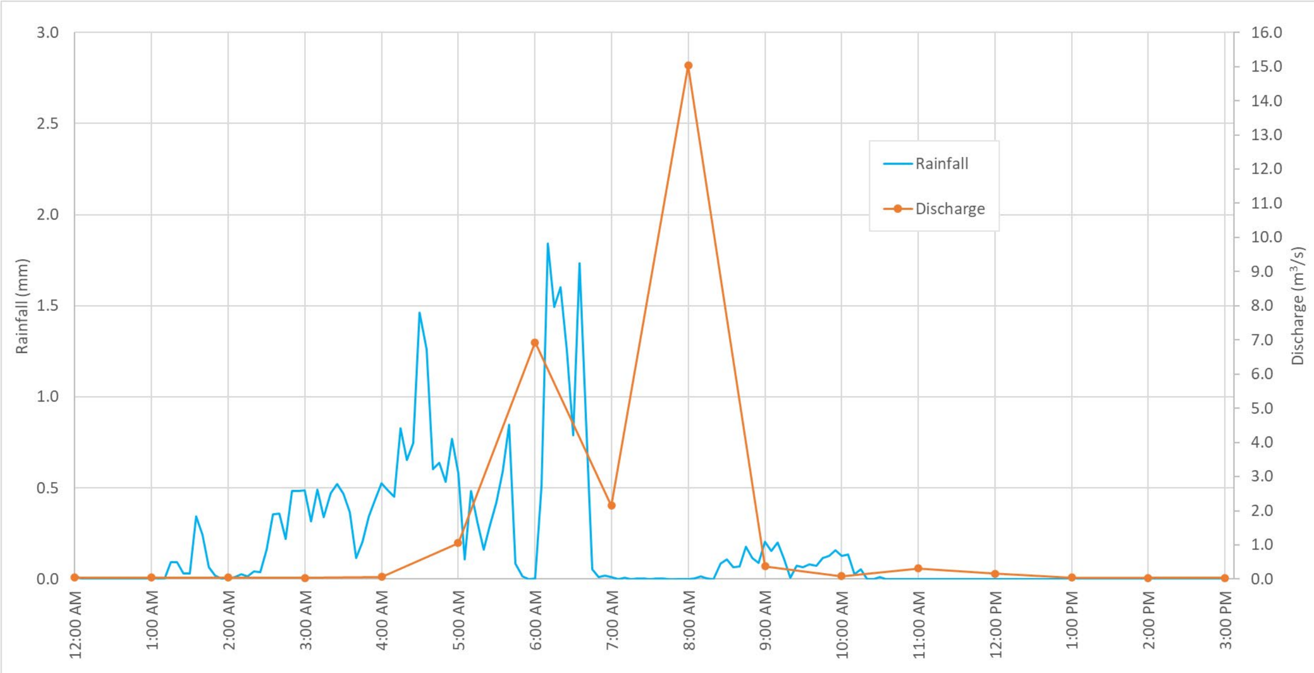

Figure 7 ***Rainfall and Estimated Discharge (26 March, 2021)***

5. Summary

Water level and discharge monitoring was completed as part of the YCGSMP process. For both 2020 and 2021, lowest calculated discharge was 0.04 m^3/s. For 2020 and 2021, respectively, average calculated discharge was 0.09 m^3/s and 0.08 m^3/s. Largest estimated discharge was 20.16 m^3/s in 2020 and 15.03 m^3/s in 2021; however, it is critical to note that the calculated high flows should only be used as a representation of the order of magnitude of the flow since the stage-discharge curve did not extend to high flow rates.

The flow rate was very responsive to rain events as shown by an example large rainfall event. Flows peaked approximately 1.5 hrs after the rainfall peaked and flows decreased to baseflow approximately 2.5 hrs after rain fall ceased. This indicates that flows have a very high peakedness, meaning that the flow rate quickly increases and decreases in response to rainfall events. The flows are not spread out over a long period of time. The geomorphic implications for this are that intense rainfall events will lead to corresponding intense flow events that will reach high velocities and shear stresses for a short period of time. This will result in exceedance of thresholds for movement of large stones, erosion of cohesive banks, or damage to the quarried block wall. This is in contrast to more natural systems where more runoff will infiltrate into the ground, be lost through evapotranspiration or attenuated by longer or rougher flow paths to the watercourse resulting in low peak velocities and shear stresses in the watercourse.

<table>
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<tr><td colspan="2">Project number</td><td colspan="6">11209954</td></tr>
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<tr><td rowspan="2">Status Code</td><td rowspan="2">Revision</td><td rowspan="2">Author</td><td colspan="2">Reviewer</td><td colspan="3">Approved for issue</td></tr>
<tr><td>Name</td><td>Signature</td><td>Name</td><td>Signature</td><td>Date</td></tr>
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