Technical Memorandum

03 March 2023

To	Ron Scheckenberger	**Project No.**	010978-MEM-303
Copy to	JART, Kevin Mitchell (CRH), Brian Zeman (MHBC), Ellen Ferris (MHBC), Anthony Goodban (GEC)		
From	Kyle Fritz, Sarah Irwin, Andrew Betts, Richard Murphy		
Project Name	Dufferin Aggregates Milton Quarry East Extension (MQEE)		
Subject	Supplemental Assessment of Wetland U1 Hydrology		

1. Introduction

GHD has undertaken additional analysis of the proposed Milton Quarry East Extension (MQEE) in further response to Joint Agency Review Team (JART) comments and subsequent discussion on February 3, 2023. The related JART comment on the GWRA is 79. This memorandum provides the supplemental assessment of the influence of the proposed MQEE on the hydrology of the catchment of Wetland U1 as requested on February 3, 2023, and as further discussed with you on February 13, 2023.

Wetland U1 is located wholly within the proposed MQEE licence area and is east of the Extraction Limit. Under both current and proposed conditions, runoff from surrounding grassland (agricultural/fallow field) areas concentrates in this wetland prior to overflowing to the south through a farmer's ditch. The dimensions of the ditch are approximately 1 m in width and 0.3 m in depth and it is reasonably well defined and identifiable. The ditch extends from the wetland overflow at the south limit of the wetland to the southern end of the field and woodland boundary, approximately 150 m. At the south end of the field no defined flow path is identifiable and overland sheet flow is anticipated to occur to the west into hummocky terrain before turning south at the woodland boundary (recall no flow has been observed in the available monitoring years: 2019 through 2022). From the woodland boundary, no defined flow path is identifiable; however, topography dictates that any overland flow would report to Wetland W36. In general, channelized flow would be expected to occur over a limited distance before dispersing into sheet flow. To date, no observations of flow in this channel have been recorded by GHD or GEC and these conclusions are based on review of surrounding topography.

Total storage in the wetland is approximately 600 m^3 and is limited by the shallow depth of the feature (0.6 m). Additional evaluation has been undertaken to determine if an impact could occur as a result of wetland mitigation (enhancement) via diffuse discharge and an associated reduction in runoff storage capacity. Under the conditions proposed, wetland storage may be reduced during the spring period when the Water Management System (WMS) will maintain the water level as high as elevation 338 m AMSL. Total storage for this scenario is reduced by approximately 400 m^3 relative to pre-development conditions that conservatively assume the wetland is dry (empty). It is worth noting that the proposed WMS will actively regulate the wetland water level via a programmable logic controller (PLC) and real-time water level feedback. Upon commencement of precipitation, the WMS discharge rate to the wetland will be reduced automatically without operator intervention. For all of the scenarios evaluated, the WMS flow is zero, as this would automatically result any time the water level is above the assigned target elevation.

2. Wetland U1 Runoff Evaluation

Both hydrologic and hydraulic models were developed using the PCSWMM software to simulate inflow hydrographs to Wetland U1, perform storage routing, and calculate wetland outflow rates for a range of design storms and scenarios. Due to the naturally dispersed flow paths identified above, concentration of runoff and peak runoff rates have been conservatively assessed immediately downstream of the Wetland U1 outlet where a defined channel is present. The catchment delineation was previously presented in the Geology and Water Resources Assessment Report (GWRA) and presented on Figure 5.2, which has been updated based on JART feedback and attached herein.

The 3-, 6-, and 12-hour duration 100-year storm events were assessed with rainfall depths obtained from the MTO IDF Curve Look-up Tool (**http://www.eng.uwaterloo.ca/~dprincz/mto_site/terms.shtml.shtml**). The 3-hour 100-year rainfall depth was temporally disaggregated using the Chicago distribution and the 6- and 12-hour 100-year rainfall depths were disaggregated using the SCS Type II distribution to create design storm hyetographs for input to the model.

The wetland drainage area and flow length were modified in the model to reflect the changes between pre-and post-development conditions. Wetland storage was represented in the model by a stage-surface area relationship determined from the site survey data and the containing elevation of the wetland was set to the overflow elevation of 338.09 m AMSL. Model catchment parameters are summarized below in Table 1.

Table 1 Summary of Catchment Parameters

Catchment	Area	Flow Length	Slope	Manning's n	Depression Storage	Soil Type
	(ha)	(m)	(%)	(-)	(mm)	(-)
Pre-development	10.5	350	3.5	0.05	5	Sandy Loam
Post-development	6.3	252	3.5	0.05	5	Sandy Loam

The proposed MQEE excavation will result in an approximate 40% reduction in drainage area for Wetland U1 and no change in land cover classification is anticipated within the catchment. The scenarios and resultant peak outflow rates are summarized in Table 2 below. Outflow rates from Wetland U1 are presented for pre- and post-development scenarios on Figure 1.

Table 2 Summary of Peak Outflow Rates from Wetland U1

Development Scenario	100-year, 3-hour Peak Flow	100-year, 6-hour Peak Flow	100-year, 12-hour Peak Flow
	(m^3/s)	(m^3/s)	(m^3/s)
Pre-development Empty	0.369	0.743	1.182
Post-development Empty	0.177	0.419	0.712
Post-development Full at 338 m	0.378	0.663	0.974

In general, longer duration storm events result in higher peak outflow rates. This is because longer duration storm events produce higher runoff volumes, therefore higher water levels above the wetland outlet, and reduce the mitigating effect of wetland storage. Under all scenarios the post-development outflow rate from Wetland U1 is substantially equivalent to, or less than, the pre-development condition. Therefore, the development will not make worse or increase the erosion potential downstream of Wetland U1. For context, velocity and shear stress have been assessed below in Section 3.

3. Evaluation of Erosion Potential

An erosion assessment was completed to evaluate the erosion potential of the grass-lined farmer's ditch located immediately downstream of Wetland U1 using velocity and shear stress as indicators for erosion. The location of cross-section XS-1 relative to Wetland U1 is presented on revised GWRA Figure 5.4 Rev1 attached. The evaluation of erosion potential has been completed for all 3 durations of the 100-year storm event for post-development conditions.

The Manning's equation was used to calculate the velocity and hydraulic radius at a surveyed cross-section approximately 25 m downstream from the Wetland U1 overflow. The slope of the channel was determined using survey data and was found to be 0.2%. Shear stress was then calculated as the product of the unit weight of water, hydraulic radius, and longitudinal slope of the ditch at the cross-section. The Manning's equation used the following inputs:

– Cross-sectional geometry obtained from a survey
– Longitudinal slope calculated between the surveyed channel centreline points
– Manning's roughness coefficient of 0.030 for a straight grassy channel
– Post-development flow rates obtained from the PCSWMM model assuming the initial water surface elevation of the wetland was 338 m AMSL

The calculated velocities and shear stress values were compared against permissible velocity and shear stress values for erosion protection for the vegetation most representative of the site conditions as shown in Table 3.

Table 3 Results of Erosion Potential Evaluation

Storm Event	Slope	Calculated Velocity	Hydraulic Radius	Depth	Shear Stress	Permissible Velocity(1)	Permissible Shear Stress(1)
	(m/m)	(m/s)	(m)	(m)	(Pa)	(m/s)	(Pa)
100-year, 3-hour duration	0.002	0.33	0.11	0.22	2.06	1.1	47.9
100-year, 6-hour duration	0.002	0.36	0.12	0.40	2.36		
100-year, 12-hour duration	0.002	0.39	0.14	0.42	2.67		
Note 1) Permissible velocity and shear stress are for Class C Turf from HEC-15 (FWHA, 2005).							

The results show that the calculated velocities and shear stress values are less than the permissible values for all durations of the 100-year storm event and the potential for significant erosion is low.

4. Conclusion

Based on the above evaluation of runoff generation and erosion potential downstream of Wetland U1, it is concluded that the proposed MQEE development will not increase the potential for downstream erosion. It is further concluded that the erosion potential is acceptable under the worst-case conditions evaluated.

Regards,

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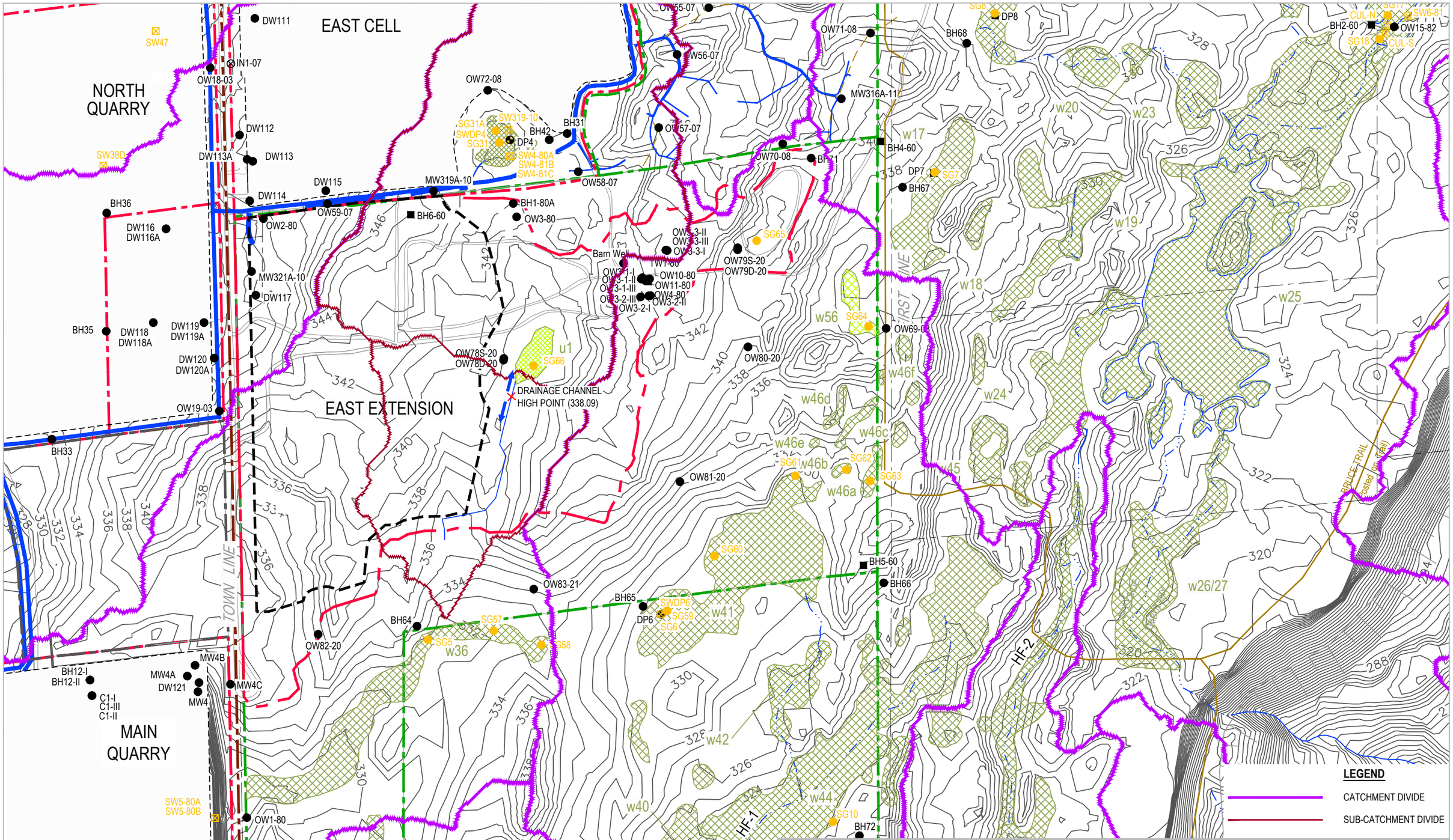
Attachments: GWRA Figure 5.2 Rev1
Figure 1 – Wetland U1 Topography
GWRA Figure 5.4 Rev1

Attachments

GWRA Figure 5.2 Rev1

Figure 1 – Wetland U1 Runoff Hydrographs

GWRA Figure 5.4 Rev1



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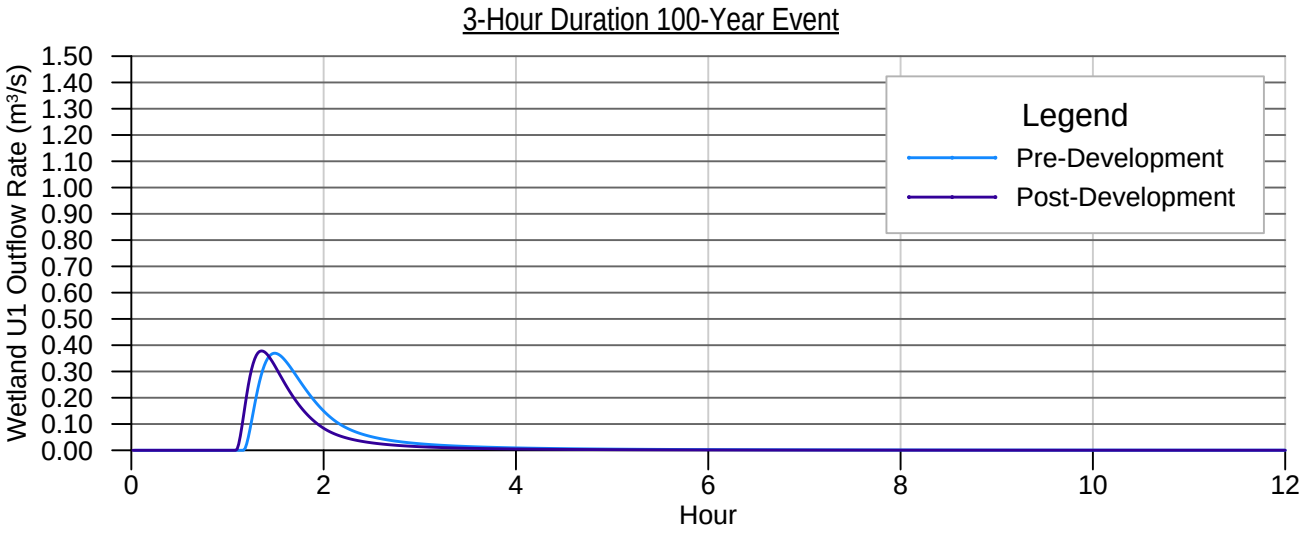

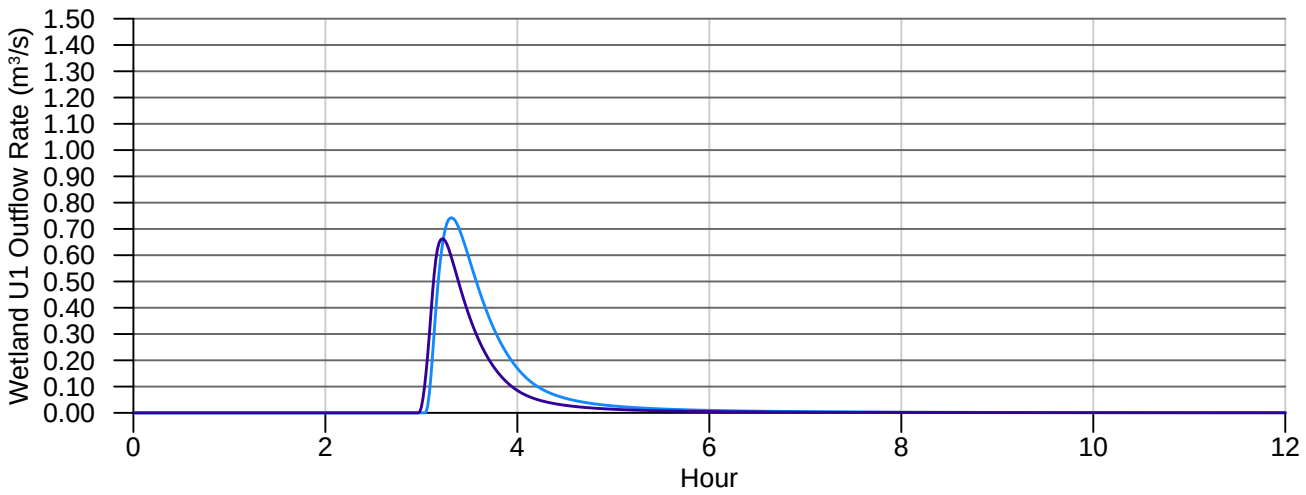

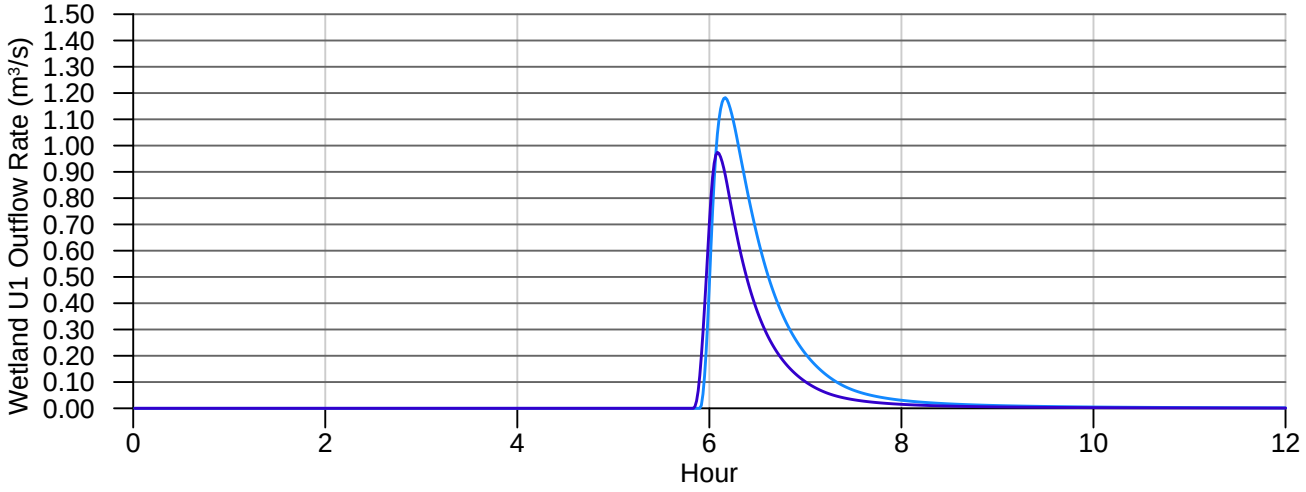

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Project No. **10978**
Date **February 2023**

WETLAND U1 RUNOFF HYDROGRAPH

FIGURE 1

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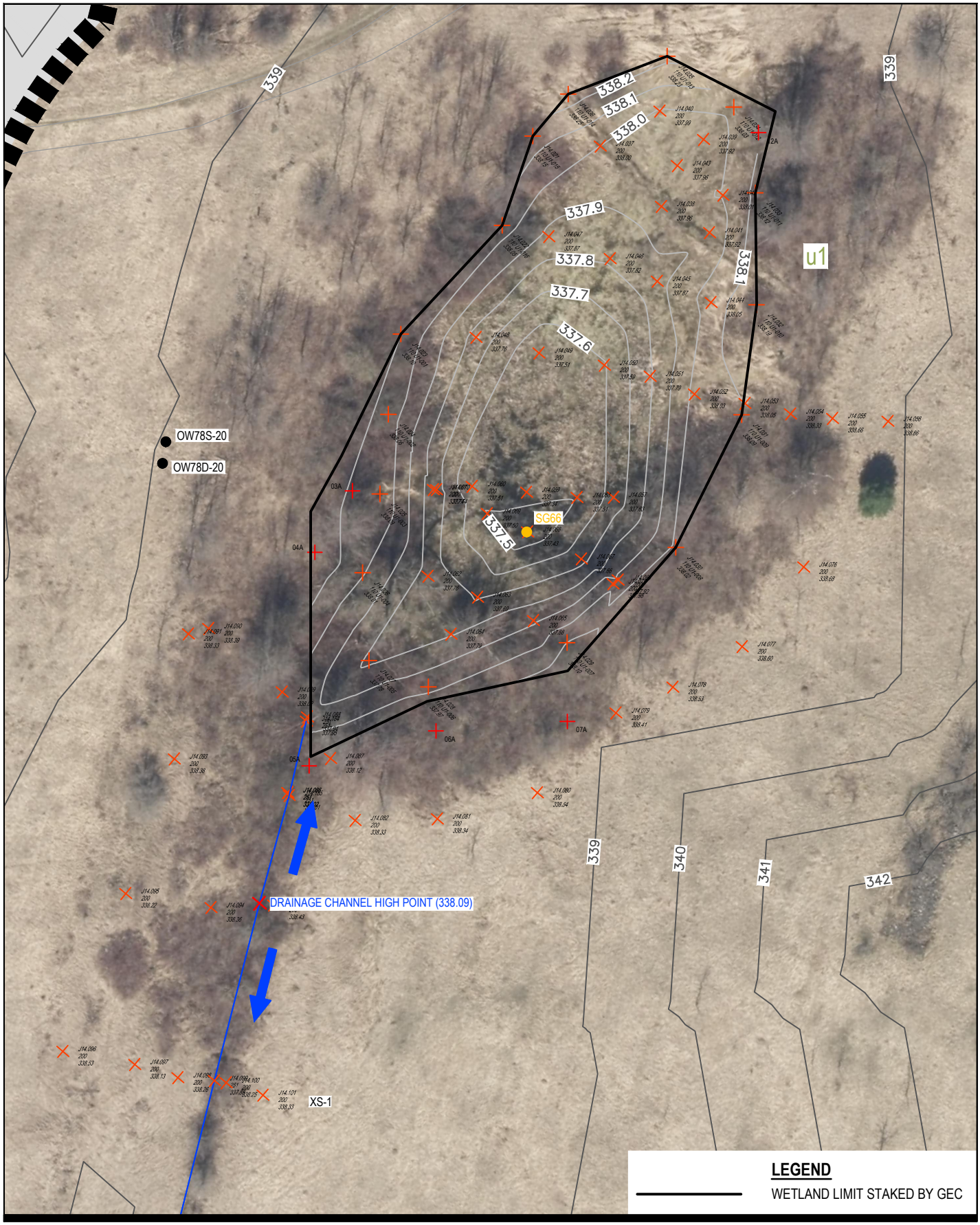

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Coordinate System:
UTM17m NAD27

GHD

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WETLAND U1 DETAILS

FIGURE 5.4 Rev1

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