TETRA TECH EBA

June 6, 2016

ISSUED FOR USE
FILE: ENVMIN03009-01
Via Email: david@canadianzinc.com

Canadian Zinc Corporation
Suite 1710 - 650 West Georgia Street
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Attention: Mr. David Harpley

Subject: Stream Crossing Design Water Levels for Prairie Creek Mine Access Road
Northwest Territories

1.0 INTRODUCTION

Tetra Tech EBA Inc, (Tetra Tech EBA) was retained by Canadian Zinc Corporation (CZN) to determine design open water levels for Sundog Creek and a tributary channel along a re-aligned segment of access road for the CZN Prairie Creek Mine. Design water levels were requested for Sundog Creek from road Kilometer Post (KP) 33.6 to 38.0 where the road alignment follows the channel south bank, and for a tributary channel crossing at KP 28.7. This letter confirms the results which were initially provided by email communications.

This work generally follows the methods used in prior studies conducted by Tetra Tech in 2012 and 2014 to determine design water levels at 25 watercourse crossings along the access road. Note that KP distances are referenced to KP 0 at the mine site and are dependent on the alignment, which is subject to revision during the process of detailed design.

2.0 DESIGN APPROACH

Design water levels at bridge crossing locations were predicted by using HEC-RAS modelling of open water 100-year peak flows for a cross section at the approximate crossing centreline location. Flows were estimated using the same regional analysis approach developed for the 2012 study. The design water levels are the model results for existing conditions, without hydraulic effects of road embankments, abutments, or piers which may be proposed at a future stage of design.

Design water levels for the road from KP 33.6 to 38.0, located along the south bank of Sundog Creek, were based on a HEC-RAS model of the existing channel adjacent to the road, without consideration of possible encroachments which may be proposed for final design. The water levels for road KP positions reflect the water level at the cross section that most closely extends to the original KP stations. Because the road KP positions are subject to change, our results also reference the corresponding UTM coordinates for the current alignment.

Channel geometry and gradient are derived from high-resolution LiDAR elevation data obtained (flown) in June 2012 with 15 cm vertical accuracy and an approximate horizontal point density of one point per square metre. The LiDAR-derived sections for the tributary channel crossing and for the Sundog Creek profile were used as-is, without adjustment for bathymetry (depth below the LiDAR surface elevation), which is a conservative approach for estimation of high water levels.

Estimates of Manning “n” hydraulic roughness values for the channel and floodplain were made by examining photographs provided by CZN, which showed the site conditions. These included aerial reconnaissance images taken on various dates and ground photographs taken by Hatfield Consultants during site surveys in late September 2014. For the Sundog Creek profile and the tributary channel at KP 28.7, a Manning’s “n” of 0.055 was assumed for the channel and associated overbank areas which consist of exposed alluvial materials.

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As indicated, the water levels provided herein are for open water flow conditions. There is a possibility of ice-influenced high water levels which should be investigated by field observations at breakup when ice influences will be at their greatest. While it is unknown whether ice effects will control any of the crossing designs, field observations are needed to rule out this possibility. The design high water level for the bridge crossings based on open water will need to be amended if field observations at breakup identify significant ice effects.

3.0 100-YEAR DESIGN DISCHARGES

Tributary basin areas for each of the crossing locations were determined from digital analysis of GeoBase 1:50,000 scale Canadian Digital Elevation Data derived from the National Topographic Data Base. The watershed analysis was done using Global Mapper software, with a visual inspection of the delineation results against 1:50,000 scale Toporama mapping to confirm that the results were reasonable.

Design discharges were estimated on the basis of a regional hydrologic analysis completed for the 2012 design assessment using Water Survey of Canada peak flow data for Prairie Creek at Cadillac Mine (495 km^2), Flat River near the Mouth (8560 km^2), and South Nahanni River above Virginia Falls (14500 km^2). A best fit trend line of drainage area to 100-year discharge was determined on the basis of these three stations and used to estimate 100-year discharges at the crossing locations. The trend line equation is given below, with discharge (Q) in m^3/s and basin area (A) in km^2.

$$Q_{100} = 1.888\ A^{0.751}$$

The Sundog Creek tributary channel at KP 28.7 has a basin area of 4.15 km^2 and a design 100-year discharge of 5.5 m^3/s.

The hydrology of the main channel of Sundog Creek was assessed in our March 17, 2016 letter report, “Sundog Creek Realignment Reach, KP 35-38, Hydrotechnical Assessment.” The design flows from KP 33.6 to 38.0 vary as a result of two major tributaries that enter in the vicinity of road KPs 35.5 and 37.0. The design 100-year discharges assumed for the present assessment are as follows:

Upstream of KP 35.5: 29.0 m^3/s

Between KP 35.5 and 37.0: 59.3 m^3/s

Downstream of KP 37.0: 85.6 m^3/s

4.0 DESIGN 100-YEAR WATER LEVELS

Figures 1 and 2 below shows the location of the tributary crossing at road KP 28.7 and the channel cross section together with the computed100-year water level. The channel slope at the crossing location is 0.05, and the minimum bed elevation, determined from the LiDAR data, is 980.0 m.

Figure 1: KP 28.7, Sundog tributary. 2016 road alignment shown on 2012 orthophoto image. Flow is left to right. Channel cross section view taken at yellow dashed line viewing downstream.

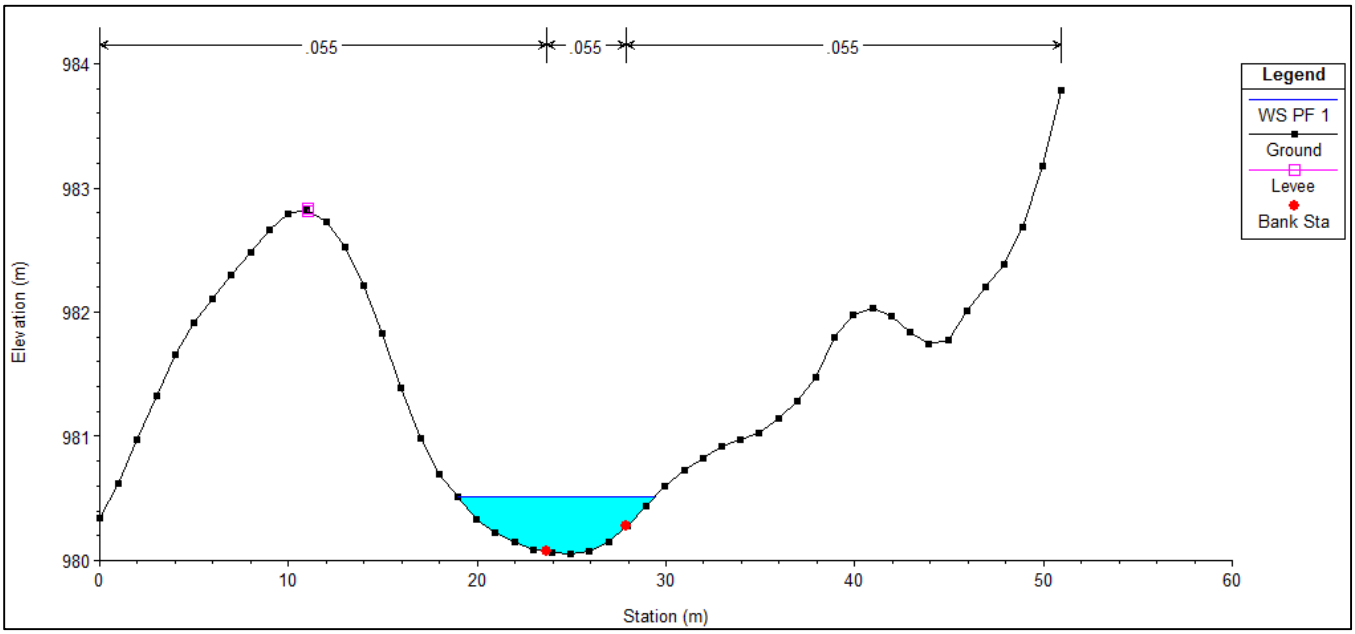

Figure 2: Sundog tributary, HEC-RAS model result for 100-year flood. The 100-year discharge of 5.5 m3/s has a water depth of 0.5 m, water surface elevation of 980.5 m, and velocity of 1.7 m/s.

Figure 3 shows the Sundog Creek channel for the reach for which a water surface profile was determined. This figure is from our March 17, 2016 letter report which presented a hydrotechnical assessment of a proposed re-alignment of Sundog Creek. Computed 100-year water levels for the reach from KP 33.6 to 38.0 are shown on Figure 4 and are listed in Table 1.

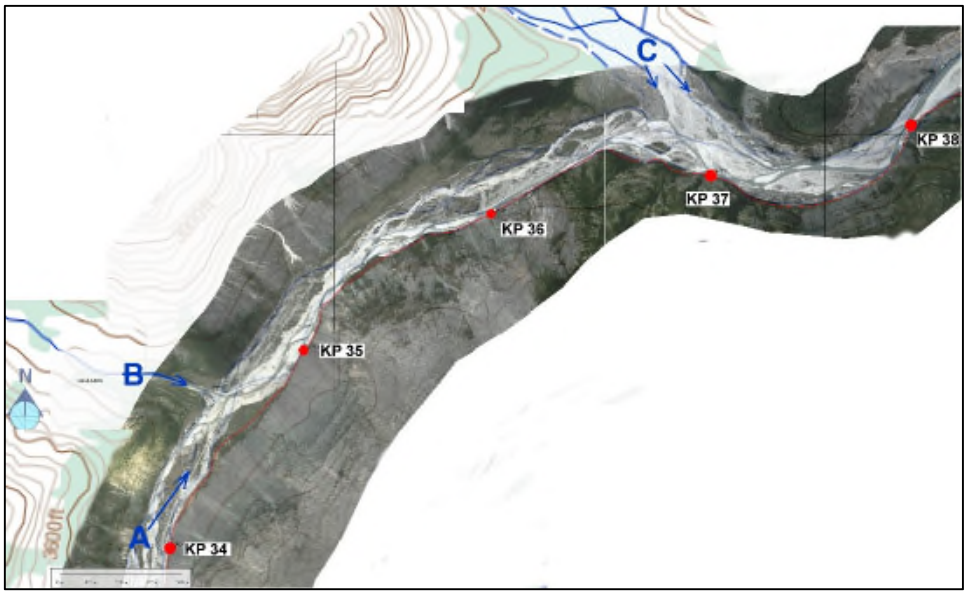

Figure 3: Sundog Creek at water level profile reach.

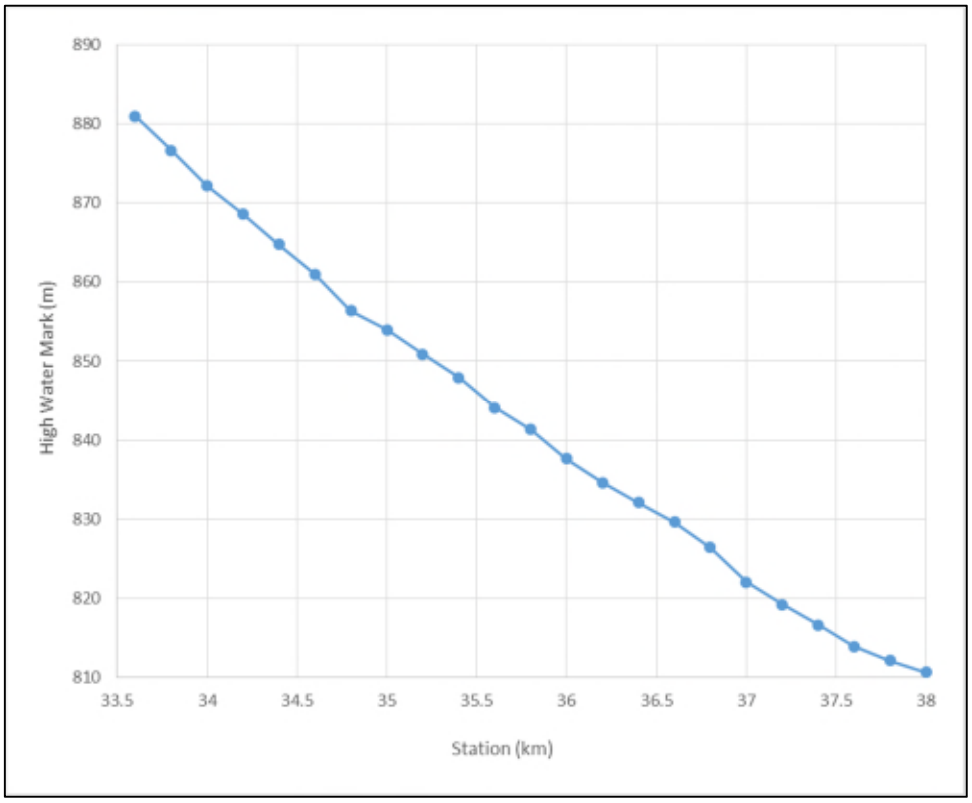

Figure 4: Sundog Creek 100-year water level profile.

Table 1: Sundog Creek 100-Year Water Levels

Road KP	LATITUDE, m (UTM WGS84 Z 10)	LONGITUDE , m (UTM WGS84 Z 10)	100-year Water Level, m
33.6	6827371.1	424070.9	881
33.8	6827569.3	424097.7	876.7
34	6827766.6	424126.9	872.2
34.2	6827950.6	424196.9	868.6
34.4	6828118.2	424301.1	864.8
34.6	6828260.5	424430.5	861
34.8	6828404.2	424569.3	856.4
35	6828573.0	424674.2	854
35.2	6828753.8	424751.8	850.9
35.4	6828882.3	424904.1	847.9
35.6	6828984.6	425073.0	844.1
35.8	6829050.7	425256.6	841.3
36	6829129.1	425439.9	837.6
36.2	6829231.0	425611.9	834.6
36.4	6829329.4	425786.0	832.1
36.6	6829368.2	425962.7	829.6
36.8	6829333.1	426149.9	826.4
37	6829284.8	426336.9	822
37.2	6829191.1	426510.5	819.2
37.4	6829157.9	426705.5	816.6
37.6	6829207.5	426897.9	813.9
37.8	6829314.9	427064.0	812.1
38	6829489.7	427154.6	810.6

As stated above, the design water levels presented in this report are preliminary values for open water flow conditions only. Further consideration of ice effects which may affect hydraulic performance is recommended, as is additional modelling to assess effects of road embankments, abutments, or piers which may be proposed at a future stage of design.

5.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Canadian Zinc Corporation and their agents. Tetra Tech EBA Inc. (Tetra Tech EBA) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Canadian Zinc Corporation, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in Tetra Tech EBA's Services Agreement.

6.0 CLOSURE

We trust this report meets your present requirements. If you have any questions or comments, please contact the undersigned.

Sincerely,
Tetra Tech EBA Inc.

REGISTERED PROFESSIONAL ENGINEER
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June 6, 2016

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