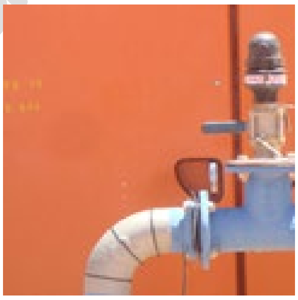
Appendix 4.
Fountain Head Gold Project Flood Assessment and Surface Water Management Strategy



ERIAS Group

Fountain Head Gold Project: Flood assessment and surface water management strategy

25 May 2021

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Section 1 Introduction

1.1 Background

CDM Smith Australia Pty Ltd (CDM Smith) has been engaged by PNX Metals Limited (PNX), through ERIAS Group, to undertake water-related assessments in support of environmental approvals for the proposed Fountain Head Gold Project (the Project). The Project is located approximately 170 km south of Darwin (Figure 1) within the Pine Creek region of the Northern Territory.

The Project involves brownfield development of the Fountain Head Mine pit, where gold mining and exploration dates back to the 1800's. Mining at Fountain Head was most recently undertaken from 2007 to 2009 by GBS Gold. PNX acquired the tenements in 2018 following further exploration and a mining scoping study completed in 2019.

Recent exploration drilling intersected notable gold mineralisation in the vicinity of the existing open pit, prompting a renewed focus on the Fountain Head site. As outlined in the Notice of Intent (ERIAS Group, 2019), PNX proposes to use open pit mining methods and a carbon in pulp plant (CIP) at the Project site with the following related activities:

- Dewatering of the existing Pit Lake and expansion of the existing open pit
- Expansion of the waste rock storage (WRS) as an integrated waste landform (IWL)
- Construction of processing related areas, crushing facility and gold processing plant
- Construction of supporting infrastructure and remediation and expansion of the existing evaporation dam (ED) into an evaporation pond (EP) for water storage

Surface water and groundwater management are critical to the success of this project, which has prompted the need for more detailed assessment and water balance modelling. The CDM Smith scope of works has a number of components that will contribute to the development of a Mine Management Plan (MMP) and Environmental Impact Statement (EIS) related to the Project – these components include:

- Two short technical reports describing 1) a proposed shallow groundwater monitoring network, and 2) the soil infiltration testing and assessment of potential solute fate from tailings stored within the IWL and temporary PAF stockpile (CDM Smith 2021a)
- A technical report documenting the model predicted water fluxes and quality changes related to Fountain Head Pit dewatering and Evaporation Pond storage through to the mine closure Stage, and other site water balance components (CDM Smith 2021b)
- A technical report related to other scoped components including catchment, surface water and flood modelling (this report).

1.2 Objective

The objectives of this report related to the development of the Fountain Head MMP and EIS are to:

- Identify contributing catchments and surface runoff that might affect the proposed mine infrastructure and quantity of surface water flows
- Explore the likelihood and extent of flooding in the vicinity of Fountain Head pit and proposed infrastructure to inform operational constraints and potential mitigation options
- Develop a site water management plan and propose water management options (e.g. drains and water storages) to minimise the volume of contact water and manage water on the site

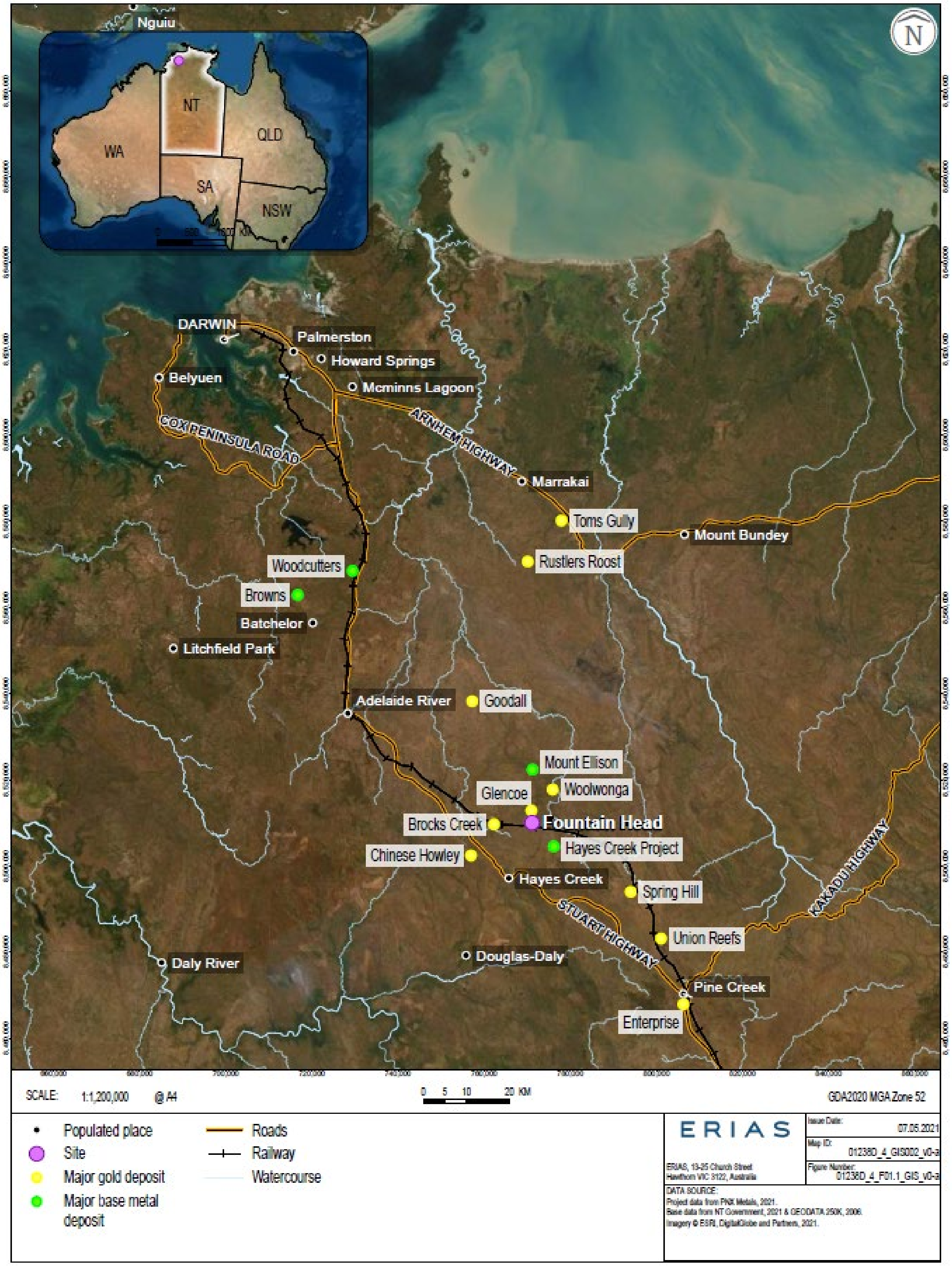


Figure 1 Project location map (source: ERIAS Group, 2021)

Section 2 Hydrology and flood modelling

2.1 Introduction

An analysis has been undertaken to investigate the behaviour of surface water for the Fountain Head site and local surrounds to evaluate potential flooding issues that may impact the mine infrastructure. Topographic data and aerial photography have been used with hydrological tools to generate surface water models of the Fountain Head site catchment so surface water behaviour can be investigated, described and better understood.

A XPRafts (Innovyze, 2018) runoff routing hydrological model and a two-dimensional TUFLOW hydraulic model (BMT, 2018) were used to generate design discharges for the Fountain Head site catchment and to estimate the design flood characteristics.

2.2 Hydrological model

2.2.1 Methodology

Design discharges from rainfall events for the catchment near Fountain Head Mine were estimated using the XPRafts runoff-routing model (Innovyze, 2018). The XPRafts model covers an area of 44.3 km² (including mine captured areas such as catchments of pits and dams). Design discharges were determined in accordance with the ensemble methodology recommended in Australian Rainfall and Runoff (ARR) 2019 (Ball et al., 2019).

There are no local stream gauges and recorded flow data for the hydrological model calibration. The XPRafts model predicted peak discharges were validated against the peak discharges estimated by the Rational Method (details provided in Section 2.2.7) for the sub-catchment upstream of the mine. Routing between sub-catchments near the mine site was incorporated into the TUFLOW hydraulic model (BMT, 2018). The TUFLOW model covers an area of 11.5 km².

The aim of the hydrologic assessment is to produce flood hydrographs for input to hydraulic model simulations that will assist in predicting flood characteristics such as inundation depth, flood extent, and flow velocities.

2.2.2 Topographic data

Figure 2 shows the extents of the available topographic data. Drone survey with ground control points was undertaken in July 2014 in the vicinity of Fountain Head Mine provided by PNX was adopted in the hydraulic model. 1:2500 topographical data from the Northern Territory Government was also provided by PNX and used to supplement the LiDAR data outside the area of coverage. The 1 second Shuttle Radar Topography Mission (SRTM) Digital Elevation Models (sourced from ELVIS - Elevation and Depth - Foundation Spatial Data) was used for areas outside the coverage of 1:2500 data.

2.2.3 Model configuration

Figure 3 shows the configuration of the XPRafts model and the locations of the sub-catchments. Table 1 shows the adopted XPRafts sub-catchment parameters. The following is of note:

- The average catchment slope was estimated from the drone survey, 1:2500 and 1s SRTM data
- A percentage impervious of 5% and a catchment Manning's 'n' value of 0.05 (considered reasonable for the type of catchment) were adopted for all sub-catchments
- A global storage 'Bx' factor of 1 (default value with no further multiplication) was adopted for the model.

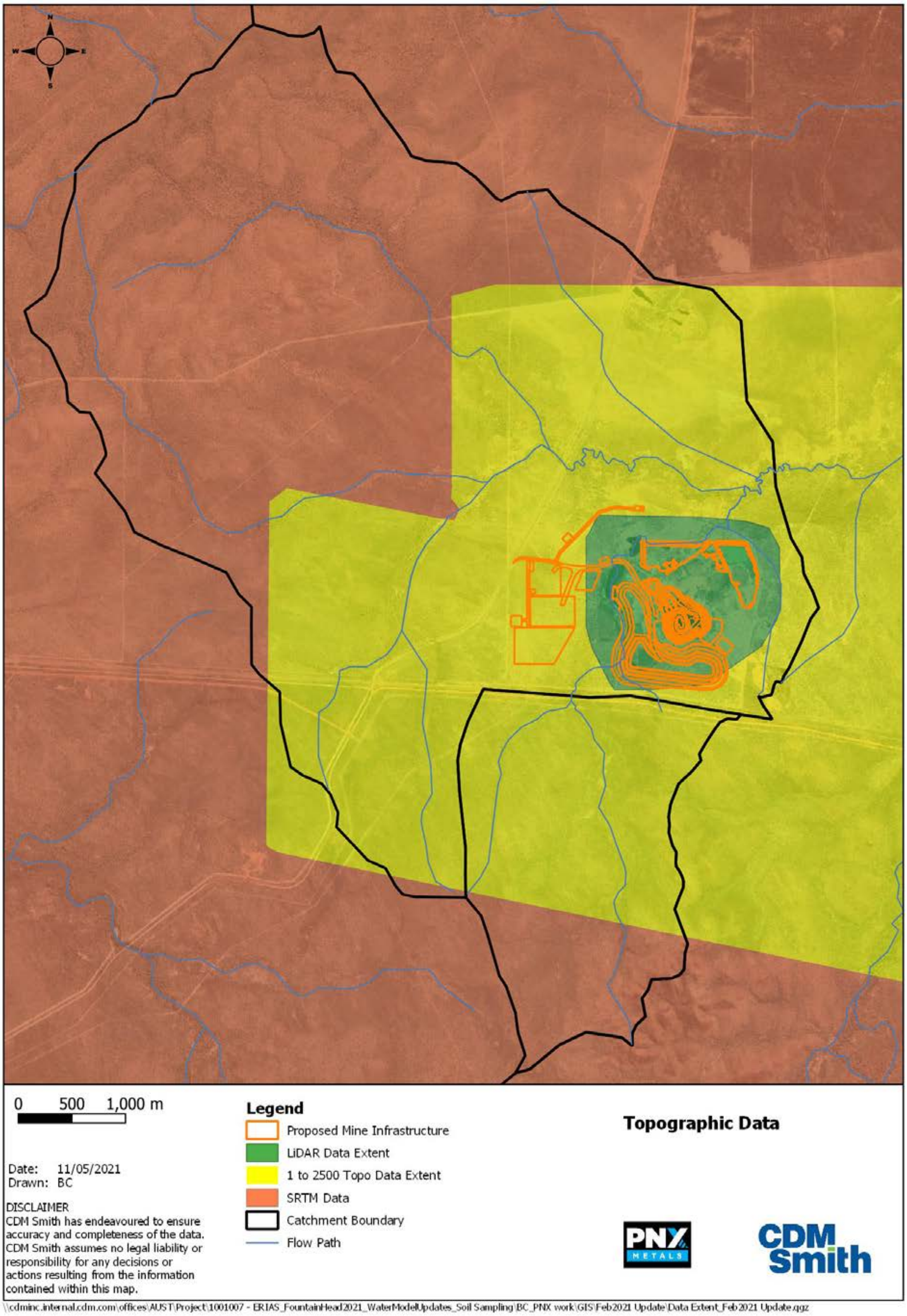


Figure 2 **Topographic data**

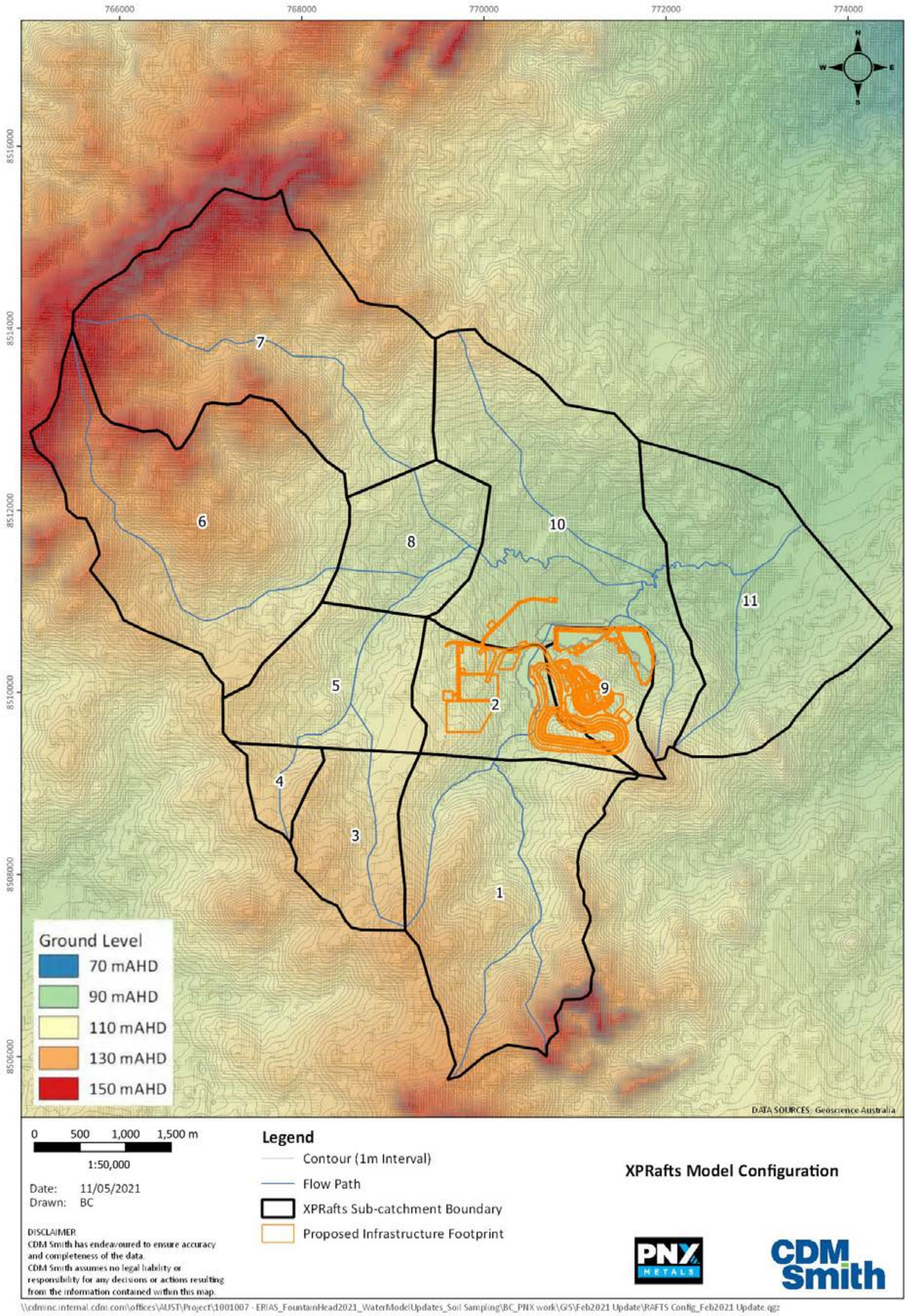


Figure 3 XPRafts model configuration

Table 1 Adopted XPRafts model parameters – sub-catchment ID, area and slope

Sub-catchment ID	Area (ha)	Slope (%)
1	603.3	0.8
2	216.1	0.9
3	202.9	0.7
4	60.3	1.1
5	273.7	0.8
6	722.4	0.9
7	782.2	1.1
8	219.0	0.4
9	136.8	1.4
10	678.3	0.5
11	531.5	0.4

2.2.4 Design rainfall intensity

Design rainfall depths at the mine (-13.46, 131.51) were obtained from the Bureau of Meteorology (BOM) (BOM, 2016) for the 10%, 5%, 2%, 1% and 0.1% annual exceedance probability (AEP) design events. The adopted design rainfall depths for a range of storm durations are shown in Table 2. To simulate the variability of storm events, ten temporal patterns, referred to as "an ensemble" were tested for each storm duration, following the ARR 2019 (Ball et al., 2019) methodology.

Table 2 Adopted design rainfall depths (mm) [1]

Storm Duration	Design Event (AEP)				
	10%	5%	2%	1%	0.1%
1 hour	71.2	78.1	86.2	91.8	143
1.5 hour	80.9	88.9	98.5	105	163
2 hour	87.5	96.5	107	115	179
3 hour	96.7	107	121	131	204
4.5 hour	106	119	136	149	233
6 hour	114	129	149	165	259
9 hour	126	145	170	191	302
12 hour	137	158	189	214	338

Notes: 1. Source: BoM (2016)

2.2.5 Rainfall losses

The initial and continuing storm losses recommended in the ARR Data Hub (Geoscience Australia, 2019) are 41 mm and 4.4 mm/hr, respectively. During the validation to the Rational Method (discussed in Section 2.2.7), it was found that the ARR Data Hub recommended rainfall losses are excessive and have not been adopted for this study. The adopted initial and continuing rainfall losses, based on validation to the Rational Method, for all the design events are:

- For the 10% and 5% AEP design events, a 10 mm initial loss and a 0.5 mm/hr continuing loss were adopted.
- For the 2% and 1% AEP design events, a 5 mm initial loss and a 0.5 mm/hr continuing loss were adopted.

- For the 0.1% AEP design event, a conservative 0 mm initial loss was adopted. A continuing loss of 0.5 mm/h was adopted to be consistent with the more frequent events.

2.2.6 Temporal pattern and critical storm duration

The temporal patterns define the variability of rainfall during an event. The ensemble event approach described in ARR 2019 (Ball et al., 2019) has been adopted for this analysis. This approach uses an 'ensemble' of ten temporal patterns for each storm duration to derive a range of estimated peak flood discharges for each AEP up to the 1% AEP event. In accordance with ARR 2019 (Ball et al., 2019), point temporal patterns have been selected as the total catchment area assessed is 44 km² (point temporal patterns to be adopted for catchment area less than 75 km²) for the design events of 10%, 5%, 2% and 1% AEP.

The temporal patterns of relevance to the study area (Monsoonal North temporal patterns) were obtained from the ARR 2019 Data Hub (Ball et al., 2019). The discharge hydrograph that produces the peak design discharge closest to the average of the peak discharges estimated from the ensemble of ten temporal patterns was adopted.

For the 0.1% AEP design event, the temporal pattern in Generalised Short-Duration Method (GSDM) (BOM, 2003) was adopted for the short duration storms, in accordance with ARR 2019 (Ball et al., 2019).

2.2.7 Rational Method sub-catchment validation

The XPRafts model predicted peak discharge for sub-catchment 1, which drains through the Fountain Head site, was validated against the peak discharges estimated by the Rational Method. The Rational Method is a common method of estimating peak discharge from small catchments and is generally considered to provide a higher (conservative) discharge than measured. The Rational Method does not provide the time series or hydrograph of the flow and accordingly does not present the volume associated with the event.

Table 3 shows the 10%, 5%, 2% and 1% AEP XPRafts model design discharges and comparison to the Rational Method results for sub-catchment 1. The Rational Method calculations were determined in accordance with the methodology recommended in the Queensland Urban Drainage Manual (QUDM) (IPWEA, 2016) using:

- The 2016 Intensity–Frequency–Duration (IFD) design rainfalls (BOM)
- A runoff coefficient of 0.53 for the 10% AEP (C_{10}) design event.

The XPRafts model peak discharges correspond well to the Rational Method discharges and the XPRafts model predicted discharge hydrographs have been adopted for this study.

Table 3 Peak design discharges and validation to Rational Method, sub-catchment 1

Design Event (AEP)	Design Discharge (m³/s)		Difference	Critical Storm Duration (Hour)	Temporal Pattern	Rainfall Losses	
	Rational Method	XPRafts	XPRafts vs. Rational Method			Initial (mm)	Continuing (mm/hr)
10%	33.4	33.9	2%	3	10	10	0.5
5%	39.1	39.4	1%	3	10	10	0.5
2%	48.4	50.0	3%	3	2	5	0.5
1%	54.6	55.7	2%	3	2	5	0.5
0.1%	-	97.4	-	3	-	0	0.5

2.2.8 Design discharges

Figure 4 to Figure 7 show the distribution of the 10%, 5% 2% and 1% AEP peak discharges estimated from the ensemble of ten temporal patterns for a range of storm durations to sub-catchment 1. The distribution is represented as a box and whisker plot, which is a standardised way of presenting the distribution of data. For each duration, the rectangle box represents the 25%ile and 75%ile bound (the interquartile range (IQR) between the 1st and 3rd quartile) of the estimate. The blue horizontal line (whiskers) represents the upper and lower estimates. The horizontal line within the box is the median value and the cross mark is the average value (also shown above the plot). The discharge hydrograph that produces the peak design discharge closest to the average of the peak discharge estimated from the ensemble of ten temporal patterns was adopted.

Table 3 show the 10% AEP, 5% AEP, 2% AEP, 1% AEP and 0.1% AEP peak design discharges at sub-catchment 1 (see Figure 3). The critical storm duration is 3 hours to sub-catchment 1 for all design events. Accordingly, a design storm hydrograph was created for each AEP.

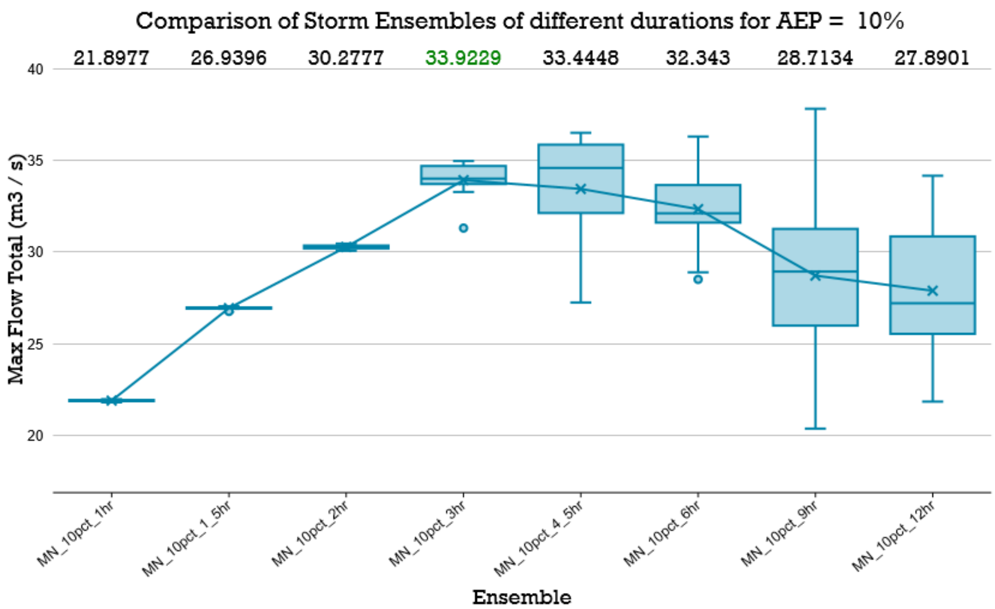


Figure 4 Box plots of 10% AEP design discharges at sub-catchment 1, XPRafts model

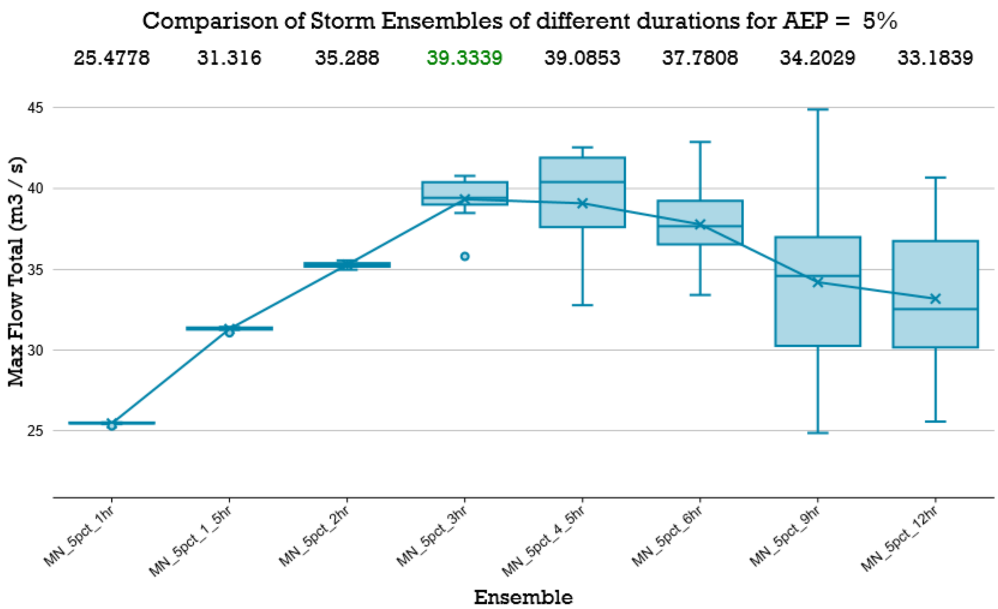


Figure 5 Box plots of 5% AEP design discharges at sub-catchment 1, XPRafts model

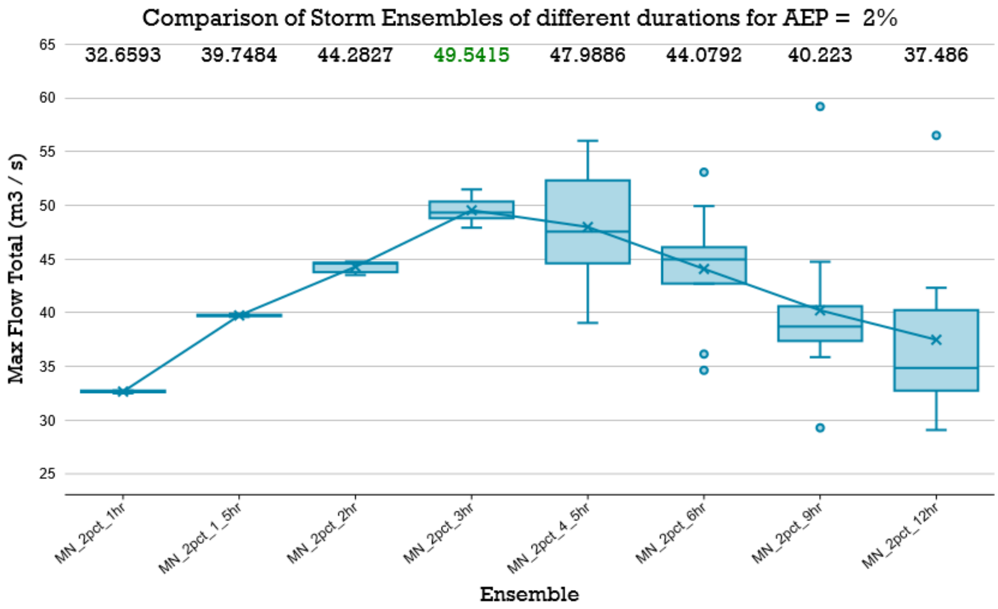


Figure 6 **Box plots of 2% AEP design discharges at sub-catchment 1, XPRafts model**

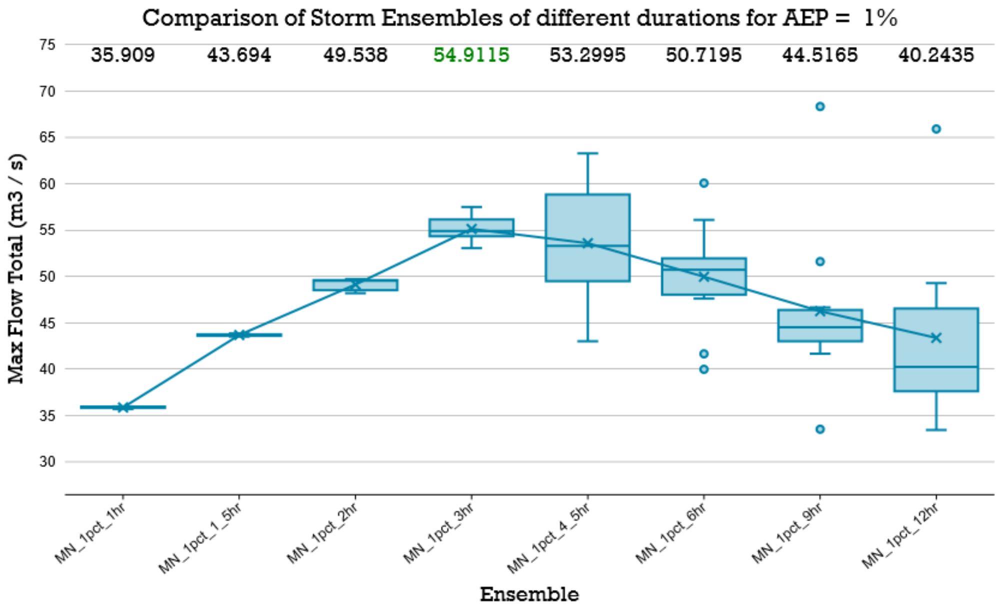


Figure 7 **Box plots of 1% AEP design discharges at sub-catchment 1, XPRafts model**

2.3 Hydraulic modelling

2.3.1 Overview

The TUFLOW hydraulic model (BMT, 2018) was used to simulate flood behaviour in the vicinity of Fountain Head Mine for the 10%, 5%, 2%, 1% and 0.1% AEP design events. Hydraulic modelling is used to characterise localised flood characteristics such as flood extent, depths and velocities, first for the existing conditions, and then to assess the potential flood impact from the proposed mine infrastructure of the Fountain Head Project.

Hydraulic modelling was undertaken using the TUFLOW Build 2020-01-AA HPC solver. TUFLOW is a computer program for simulating depth-averaged, one and two-dimensional free-surface flows such as occurs from floods and tides, with the 2D solution occurring over a regular grid of square elements. TUFLOW HPC is a 2D fixed grid hydrodynamic solver that uses an explicit finite volume solution that is 2nd order in space and 4th order in time. TUFLOW HPC uses adaptive time stepping with the ability to revert back in time should a numerical inconsistency occur, thereby providing extreme numerical stability. The solution solves the full 2D free-surface equations including the inertia and sub-grid turbulence (eddy viscosity) terms.

2.3.2 Model extent

Figure 8 shows the extent of the hydraulic (TUFLOW) model. The hydraulic model covers an area of approximately 11.5 km^2. The areas to the south-east are excluded due to higher elevation topography. A 4 m grid size was adopted in the hydraulic model.

2.3.3 Topographic data

Figure 8 shows the extents of the available topographic data for the hydraulic model. Drone survey in the vicinity of Fountain Head Mine provided by the client was adopted and supplemented by the 1:2500 data from the NT Government in areas outside the drone survey data coverage. Due to the lower accuracy of data beyond the drone survey data set, the model results should be used for relative assessment between the existing and developed scenarios, rather than as prediction of actual water levels.

2.3.4 Adopted Manning’s roughness

TUFLOW model uses Manning’s ‘n’ values to represent hydraulic resistance. Discrete regions of continuous vegetation types and land uses were mapped (as shown in Figure 8), and were assigned appropriate roughness values. Different vegetation and land use were mapped using aerial image. Table 4 shows the adopted Manning’s ‘n’ values for different land use types.

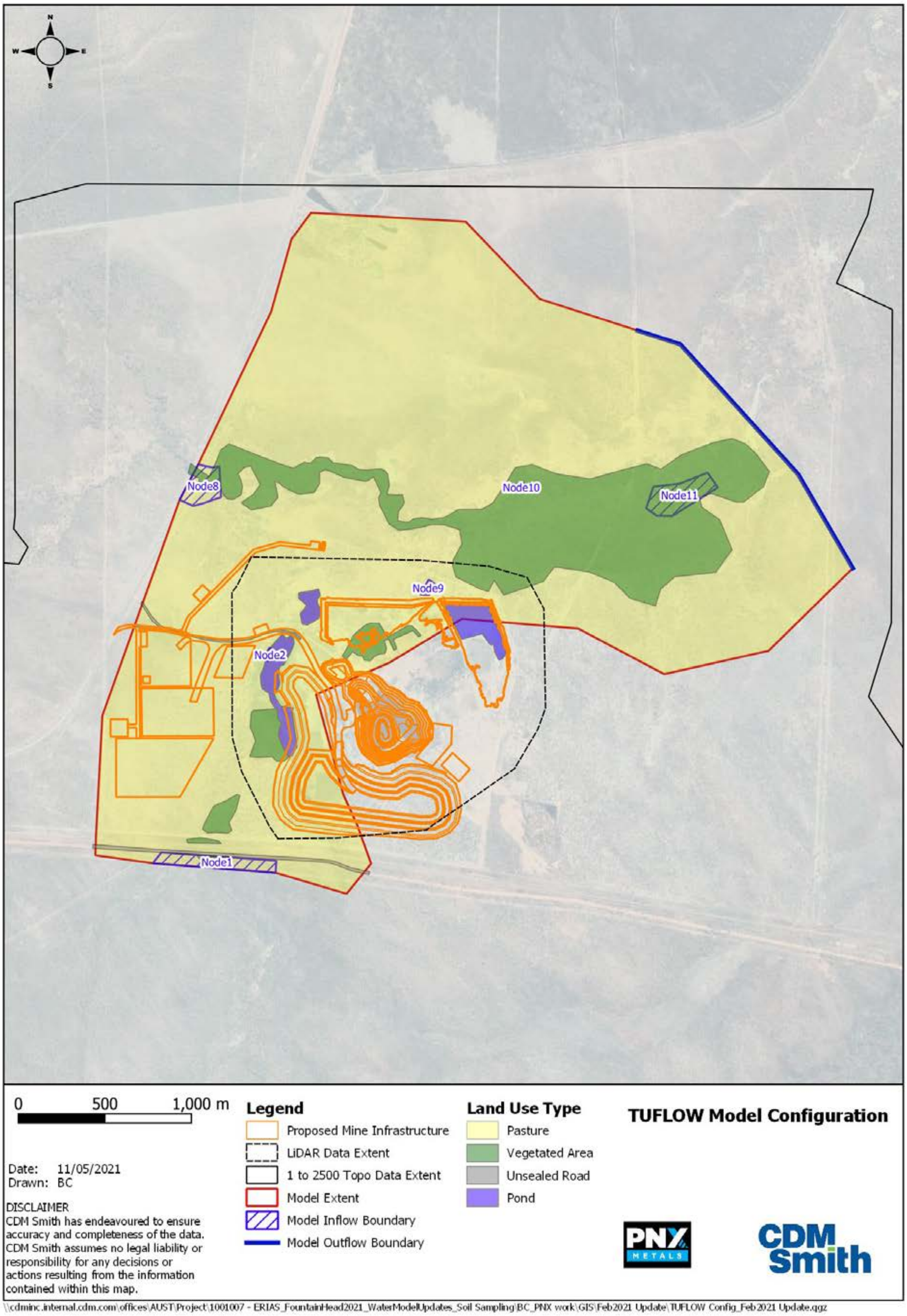


Figure 8 **TUFLOW model configuration**

Table 4 Adopted Manning's roughness values

Land Use Type	Adopted Manning's 'n' Value
Pasture	0.05
Vegetated	0.07
Unsealed Road	0.04
Ponds	0.03

2.3.5 Inflow and outflow boundaries

Figure 8 shows the locations of the inflow boundaries used in the TUFLOW model. Inflow boundaries have been extracted from the XPRafts model with names corresponding to the XPRafts node numbers (See Figure 3). Inflows have been delineated into 'total' and 'local' inflows, with total inflows including runoff from the entire catchment draining to that point and local inflows representing runoff from the single sub-area only.

A flood slope of 0.1% was adopted as the model outflow boundary, which is consistent with the ground level slope.

2.3.6 Hydraulic model results

Figure A.1 to Figure A.10 in Appendix A show the simulated peak flood levels, depths and velocities in the vicinity of the Fountain Head Mine for the 10%, 5%, 2%, 1% and 0.1% AEP design events. The 1% AEP peak flood depths and velocities are shown in Figure 9 and Figure 10. The peak flood levels and velocities at key reporting locations are shown in Table 5 (locations shown in Figure 9). The model results show that:

- Floodwater drains through the culverts under the railway and exceeds the railway elevations (during flood events rarer than 10% AEP) in a northerly direction towards the mine site. Floodwater will pond at the Fountain Head Lake (west of the WRS) before overtopping the existing haul road to flow northward for all design events assessed.
- The overtopping depths of the existing haul road are up to 0.7 m for the 10% AEP and up to 1.2 m for the 0.1% AEP.
- The western part of the proposed IWL and the western part of the proposed EP will be inundated by all design flood events assessed equal to or rarer than 10% AEP.
- Flood protection and stormwater management is required for the proposed Fountain Head site to protect the proposed mine infrastructure, prevent localised ponding and to reduce the potential erosion from overtopping at the existing haul road.

Table 5 Modelled peak flood levels and velocities at key reporting locations, Existing Case

Reporting Location	Peak Flood Level (m AHD)					Peak Flood Velocity (m/s)				
	10% AEP	5% AEP	2% AEP	1% AEP	0.1% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.1% AEP
1	99.62	99.65	99.71	99.73	99.86	0.6	0.6	0.7	0.7	0.8
2	98.24	98.31	98.42	98.47	98.80	0.4	0.4	0.5	0.5	0.4
3	98.24	98.31	98.42	98.47	98.80	0.01	0.02	0.02	0.03	0.04
4	98.24	98.31	98.42	98.47	98.80	0.1	0.1	0.1	0.1	0.2
5	94.79	94.83	94.91	94.95	95.66	1.1	1.2	1.4	1.5	1.9
6	94.13	94.29	94.58	94.71	95.62	0.7	0.8	0.8	0.8	0.9
7	94.07	94.17	94.34	94.41	94.80	1.4	1.5	1.6	1.7	1.8

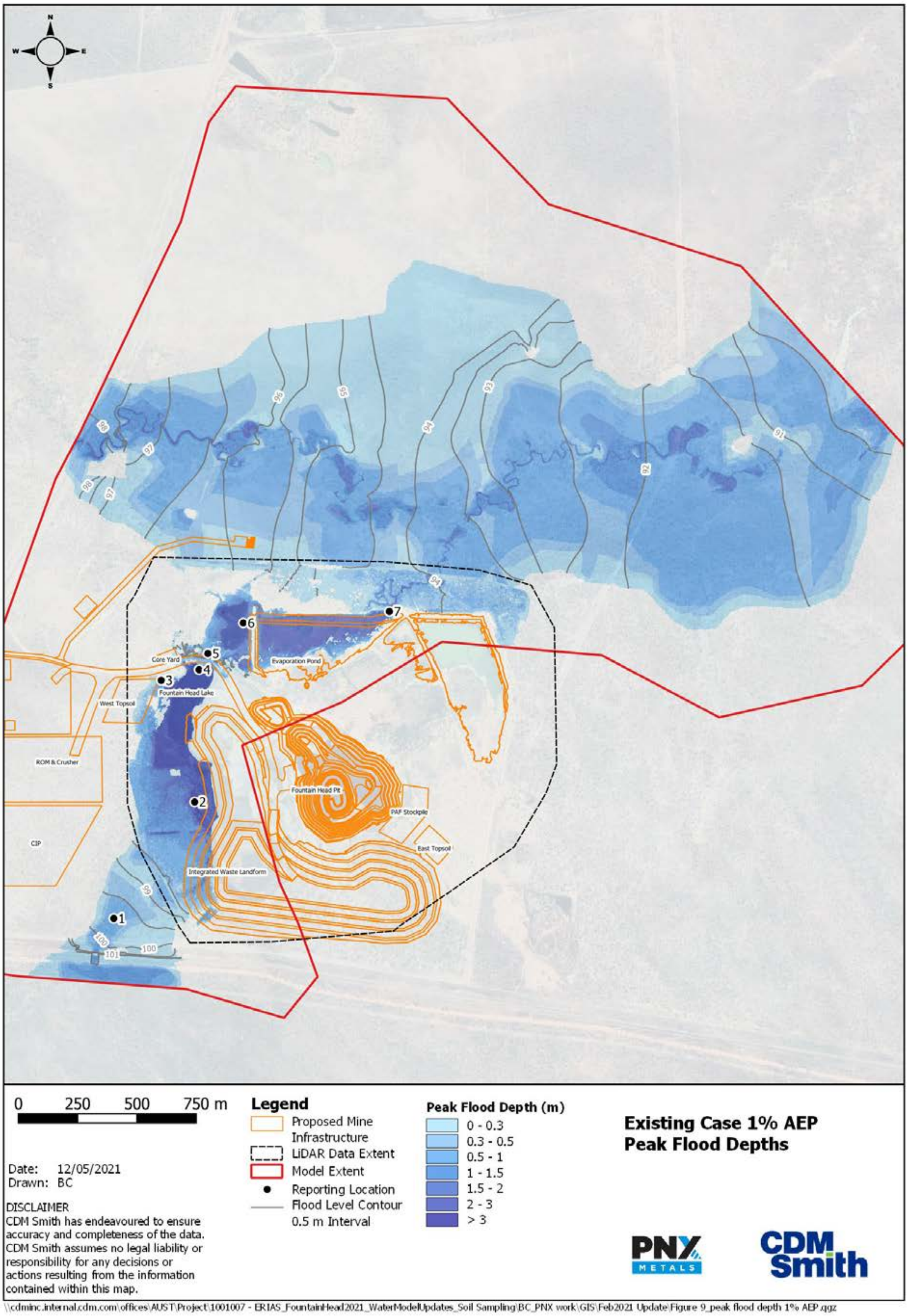
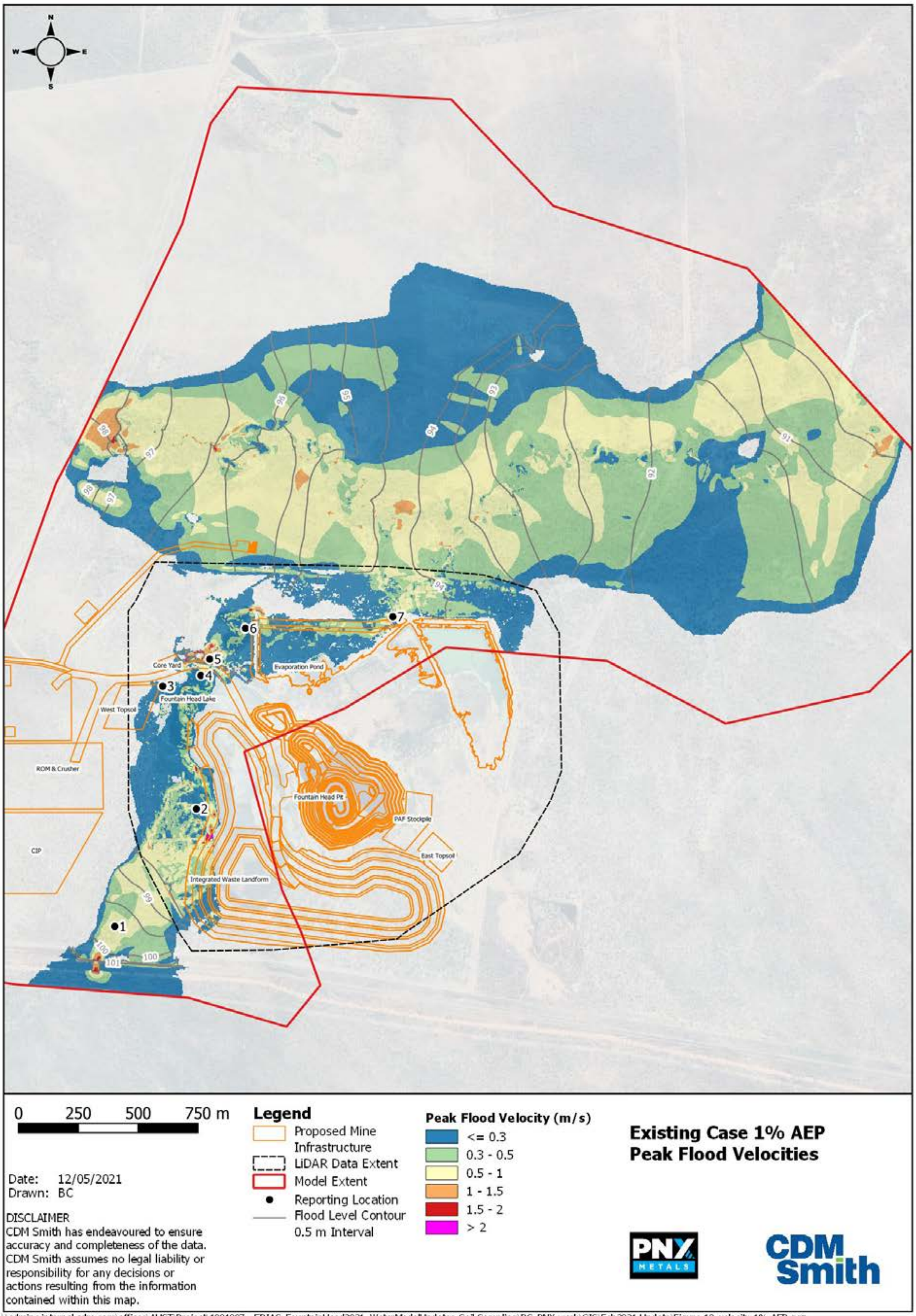


Figure 9 **Modelled peak flood depths, 1% AEP Existing Case (Infrastructure not modelled)**



\\cdminc.internal.cdm.com\offices\AUST\Project\1001007 - ERIAS_FountainHead2021_WaterModelUpdates_Soil Sampling\BC_PNX work\GIS\Feb2021 Update\Figure 10_velocity 1% AEP.qgz

Figure 10 Modelled peak flood velocities, 1% AEP Existing Case (Infrastructure not modelled)

2.4 Potential mitigation strategies

Figure 11 shows a series of potential mitigation options to achieve adequate flood immunity, reduce flood impacts and erosion risks. Details of the potential mitigation options are discussed below.

Most of the proposed mining infrastructure is located outside the 0.1% AEP flood extent. To reduce the flood risk, a few components of proposed infrastructure (such as the core yard) are also proposed to be raised or protected by bunds to achieve the required flood immunity and reduce erosion potential.

To avoid local water ponding and reduce potential flood impacts, it is proposed to construct a diversion channel along the western side of the IWL to reinstate the natural flow path and to divert the natural catchment runoff into the existing Fountain Head Lake. A diversion is also proposed along the northern side of the proposed EP as its western portion is located on the existing flow path. Figure 11 shows the location of the proposed conceptual diversion channels. Further discussion on the conceptual diversions is provided in Section 3.3.5.

Erosion protection, such as rock armour protection, is recommended along the outer toe of the proposed IWL and, western and northern toe of the proposed EP, as shown in Figure 11. It is understood that the existing haul road is subject to erosion issues during overtopping events and hence erosion protection is also recommended at the haul road in addition to consideration of alternative designs that may include a series of culverts.

2.5 Flood impact assessment

The potential flood impacts of the proposed mining infrastructure are assessed using the hydraulic model discussed in Section 2.3. The potential mitigation measures discussed in Section 2.4 are also included. The following is of note:

- The proposed raised areas or bunded areas were excluded in the model or modelled as ‘glass-wall’ (with infinite height in the model to prevent floodwater entering) to set design flood levels.
- The proposed diversions are conceptually modelled as an 8 m wide channel in the hydraulic model to avoid localised ponding and reduce potential impact. Initial assessment found that the flood impacts may not be overly sensitive to the size of the modelled diversion, which were based on the nearby channel characteristics. Further assessment related to the diversion characteristics needed to manage expected inflows is recommended and required during detailed design.
- The existing haul road is unchanged in the hydraulic model. Further assessment will be required at the detailed design stage or if alternative haul road design (such as adding culvert crossings or different crest levels) is proposed.

Figure 12 and Figure 13 show the modelled 1% AEP peak flood level and velocity difference for the proposed and existing cases. Table 6 shows the 1% AEP peak flood levels and level differences compared to the Existing Case at the at key reporting locations. The model results show that:

- The modelled 1% AEP peak flood level west of the proposed IWL is up to 0.1 m. There is no adverse flood impact on the existing railway.
- The 1% AEP peak flood levels at Fountain Head lake and west of the proposed EP would increase by up to 0.1 m and 0.9 m, respectively. This is mainly due to the western portion of the proposed EP (which is located on the existing flow path) restricting the flow conveyance.
- The flood impacts extend to the north of the EP with very minor flood levels increasing up to 0.05 m (mostly less than 0.03 m). The 1% AEP flood extent for the Proposed Case is similar to the Existing Case.
- The 1% AEP peak flood velocities increase along the toe of the proposed IWL and north of the EP, where erosion protection measures are proposed. There are some localised increases of flood velocities at the proposed diversions. Erosion protection measures are required for the diversions where high flood velocities are predicted, such as the channel bends and outlets.

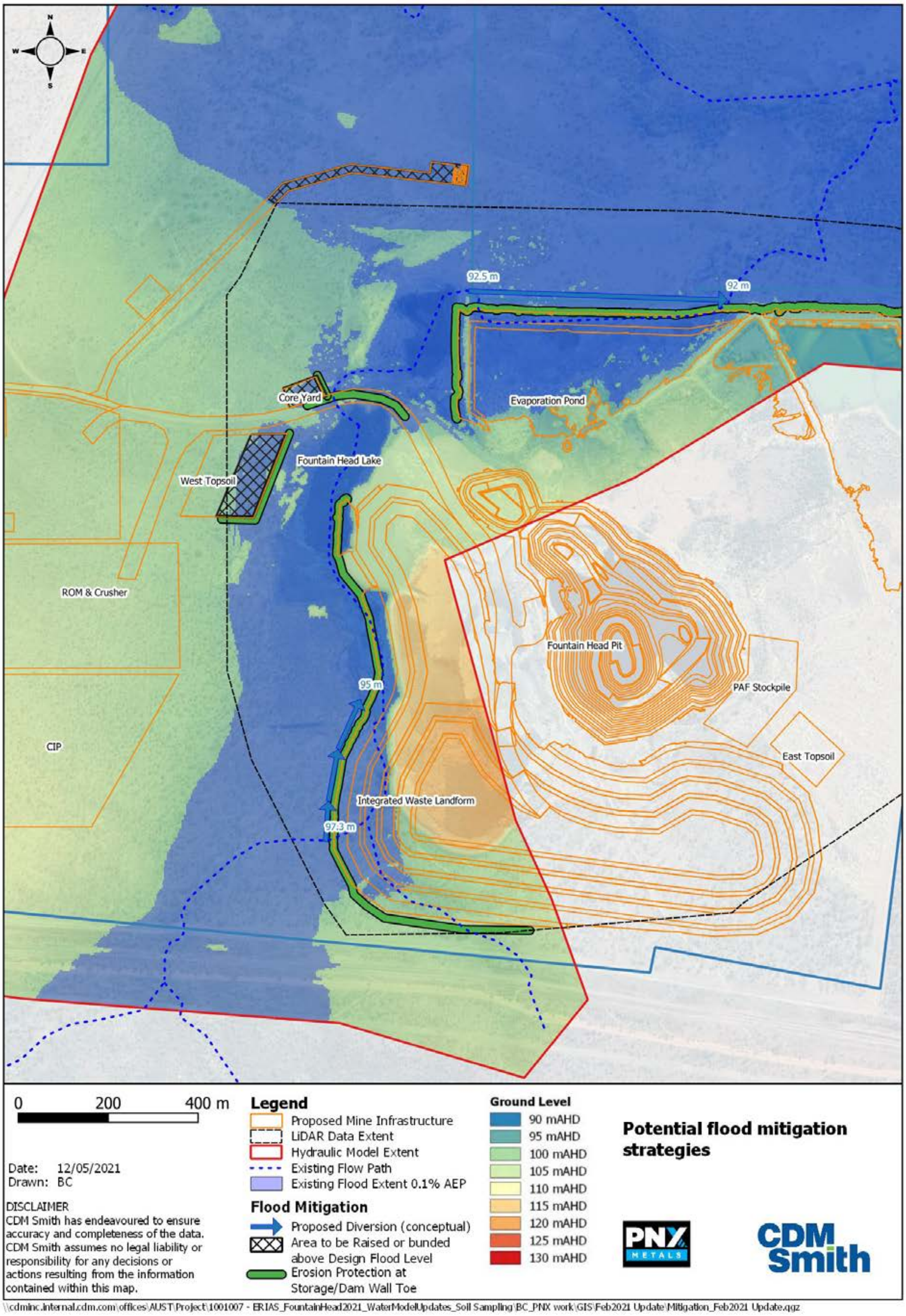


Figure 11 Potential flood mitigation strategies

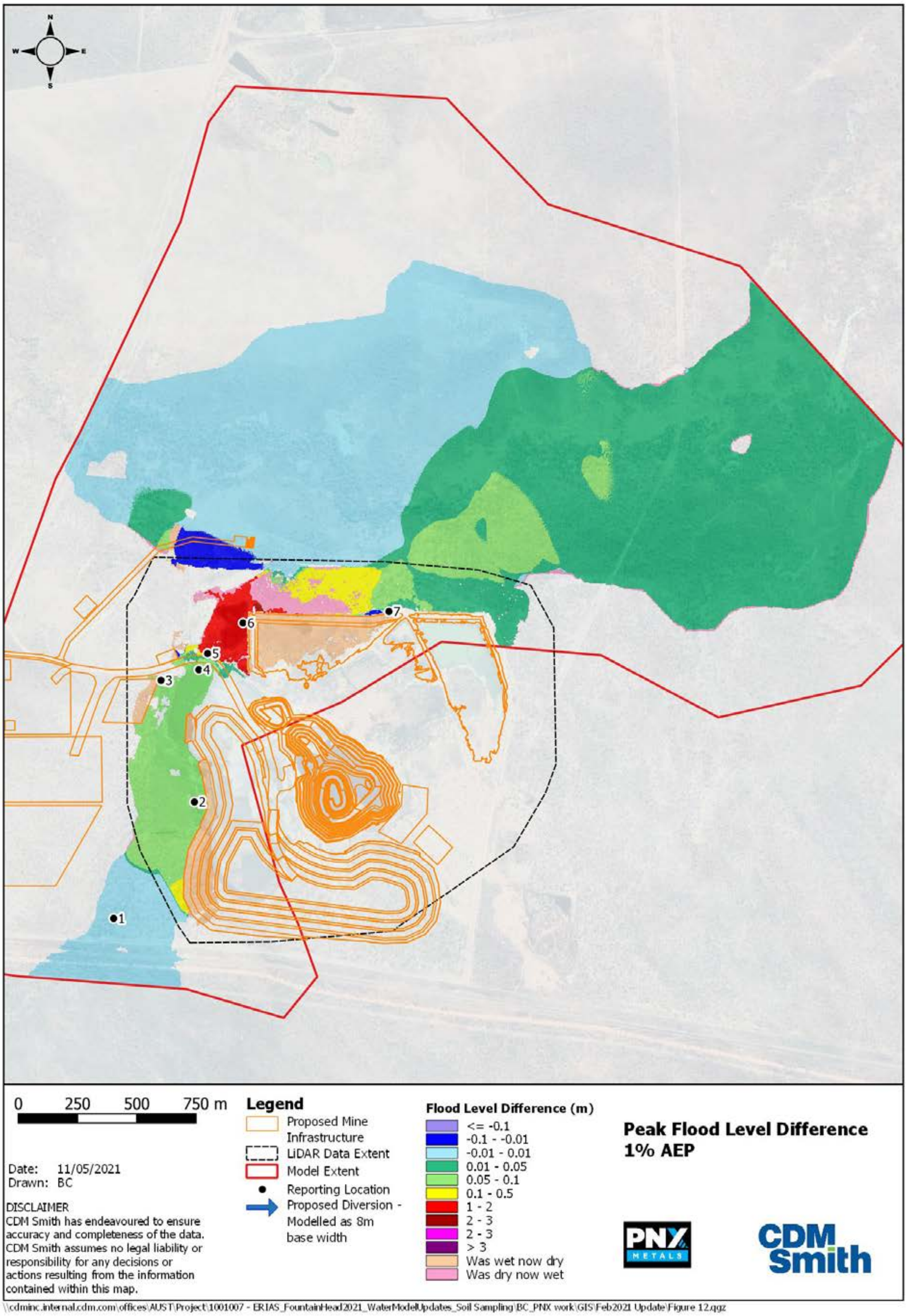


Figure 12 **Modelled peak flood level differences, proposed case minus existing case, 1% AEP**

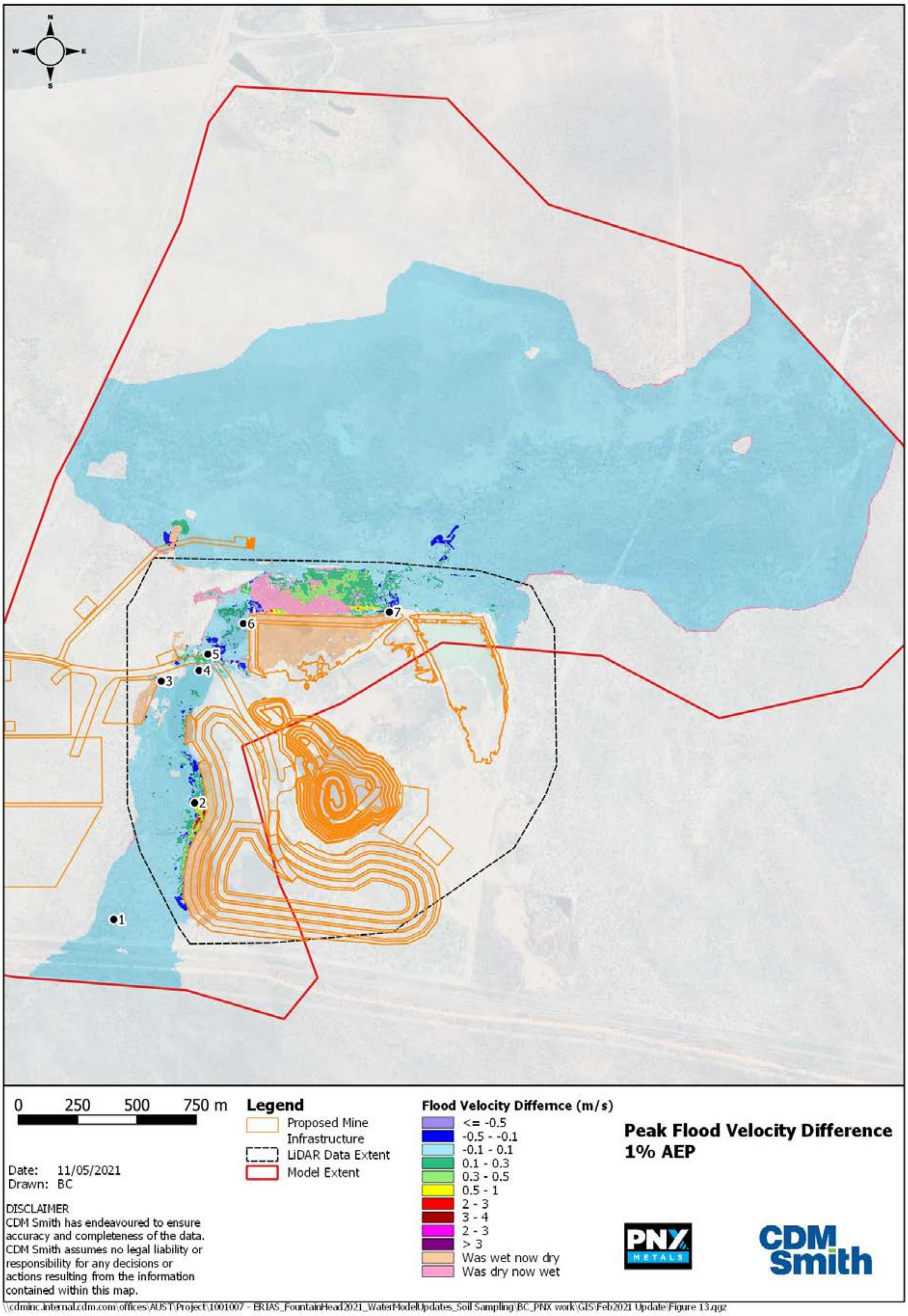


Figure 13 Modelled peak flood velocity differences, proposed case minus existing case, 1% AEP

- The 1% AEP peak flood velocities increase along the toe of the proposed IWL and north of the EP, where erosion protection measures are proposed. There are some localised increases of flood velocities at the proposed diversions. Erosion protection measures are required for the diversions where high flood velocities are predicted, such as the channel bends and outlets.

Table 6 Proposed Case peak flood levels and differences compared to Existing Case at reporting locations

Reporting Location	Proposed Case Peak Flood Level (mAHD)					Differences compared to Existing Case (m)				
	10% AEP	5% AEP	2% AEP	1% AEP	0.1% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.1% AEP
1	99.62	99.65	99.71	99.73	99.86	0.0	0.0	0.0	0.0	0.0
2	98.32	98.39	98.50	98.55	98.86	0.1	0.1	0.1	0.1	0.1
3	98.32	98.38	98.50	98.55	98.85	0.1	0.1	0.1	0.1	0.1
4	98.32	98.38	98.50	98.55	98.85	0.1	0.1	0.1	0.1	0.1
5	95.05	95.30	95.55	95.63	96.05	0.3	0.5	0.6	0.7	0.4
6	95.04	95.30	95.55	95.62	96.03	0.9	1.0	1.0	0.9	0.4
7	94.16	94.23	94.37	94.43	94.75	0.1	0.1	0.0	0.0	-0.1

Section 3 Proposed water management strategy

3.1 Long term climate data – rainfall and evaporation

Long term daily rainfall and evaporation data for the project area have been sourced from the SILO database (https://www.longpaddock.qld.gov.au/silo/) from January 1889 to December 2019 (131 years). This database is corrected for missing data and is suitable to be used in water balance modelling.

Figure 14 shows the annual rainfall from 1889 to 2019, and average annual rainfall. Monthly average rainfall and evaporation are shown in Figure 15. Table 7 shows the variability in monthly rainfall at the project site based on the SILO database. The climate data shows that:

- Average annual rainfall is 1,282 mm/a and average annual (pan) evaporation is 2,250 mm/a.
- The rainfall at the project site has a distinct wet season (October to March) dominance. The highest monthly average rainfall is 309 mm in January, whilst the lowest monthly average rainfall is 2 mm in June, July and August.
- The monthly average evaporation is between 143 mm (February) to 240 mm (October).

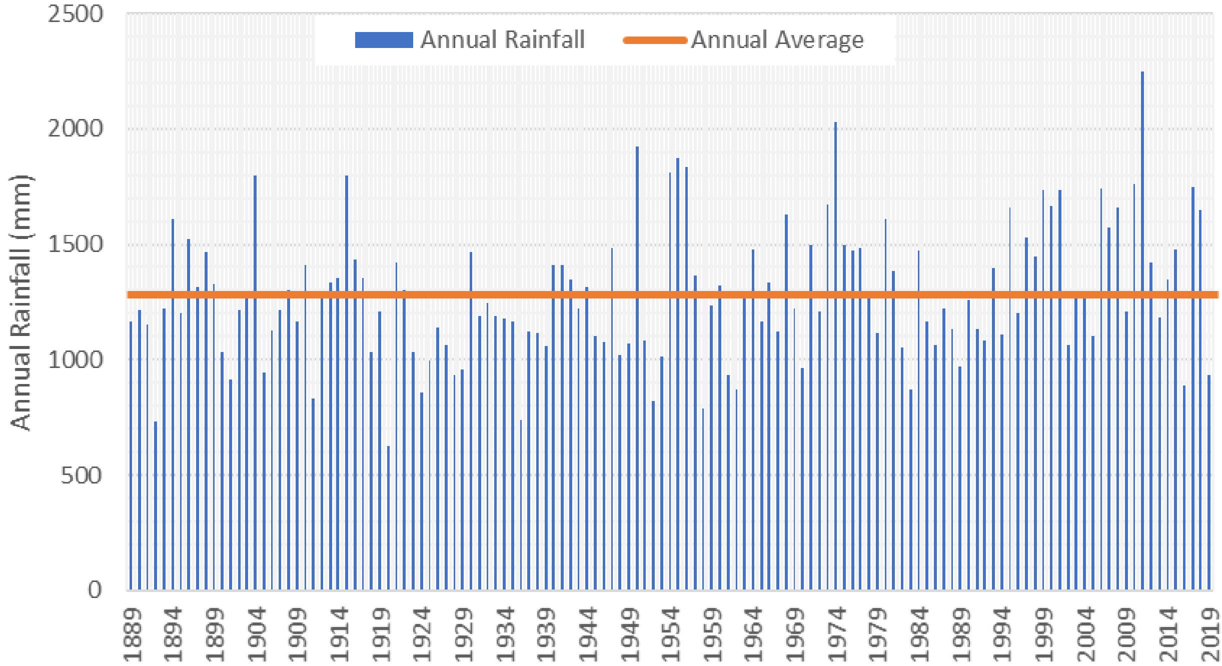


Figure 14 Annual rainfall and average annual rainfall

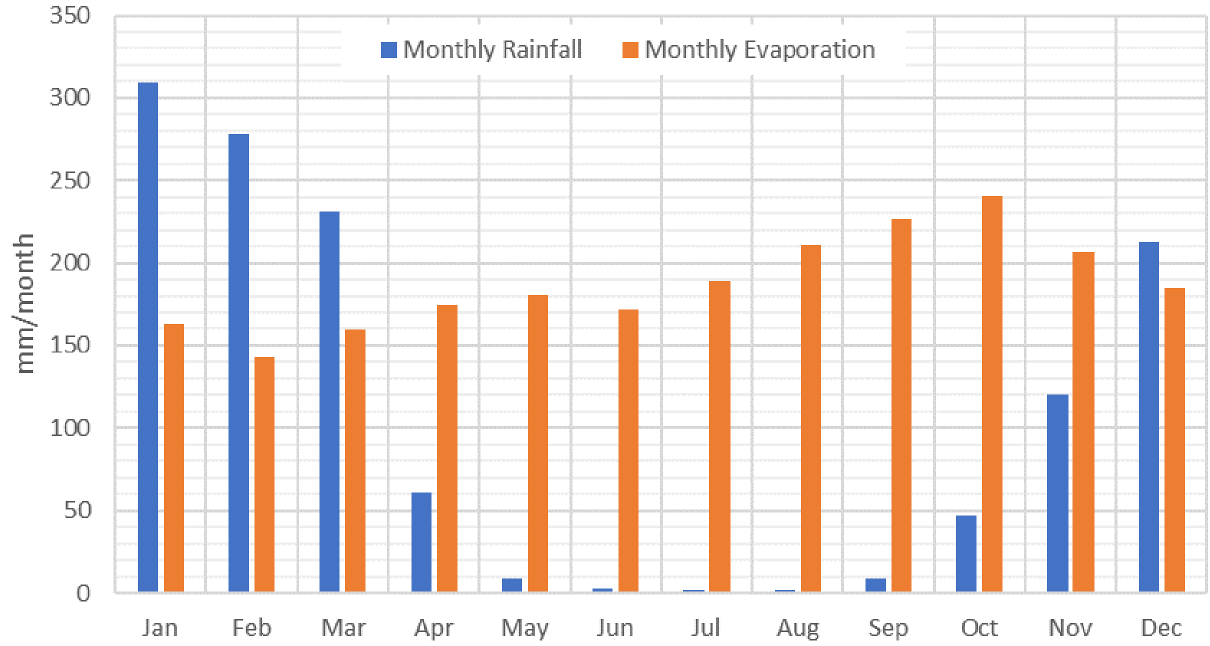


Figure 15 Average monthly rainfall and pan evaporation

Table 7 Monthly rainfall statistics for the project site (mm/month)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	309	278	231	61	9	2	2	2	9	47	120	212	1,282
Lowest	96	41	4	0	0	0	0	0	0	0	33	66	625
10th %ile	170	139	76	0	0	0	0	0	0	4	55	106	936
Median	287	255	208	34	0	0	0	1	1	34	112	192	1,222
90th %ile	464	427	434	144	19	3	0	3	34	119	186	322	1,673
Highest	812	662	659	526	175	52	81	33	63	195	244	678	2,248

3.2 Catchment characteristics

As shown in Figure 16, the Fountain Head Project area is located in the upper Margaret River catchment. The Project area is mostly within the catchment of a Southern Flow Path which drains into Fountain Head Lake before overflowing into the Unnamed Creek. The Unnamed Creek drains in an easterly direction on the northern side of the Project area into the Margaret River. The catchment area of the Southern Flow Path to the south of the railway is approximately 6 km^2 and the catchment area of the Unnamed Creek north of the Project site is approximately 33 km^2. The total catchment of the Margaret River to the confluence of Unnamed Creek is approximately 374 km^2 (including Unnamed Creek).

The proposed mine infrastructure components are located on both sides of the existing Fountain Head Lake and to the south of the Unnamed Creek. The land use type within the catchment is mostly natural and undisturbed.

All flow paths at the Project site are ephemeral and experience surface runoff only after significant rainfall events in the catchment. Surface runoff discharges are highly variable and most flow paths are likely to dry out during dry seasons when rainfall is low, although some ponds or lakes hold water for extended periods. Therefore, surface flows and water quality are expected to be highly variable over time.

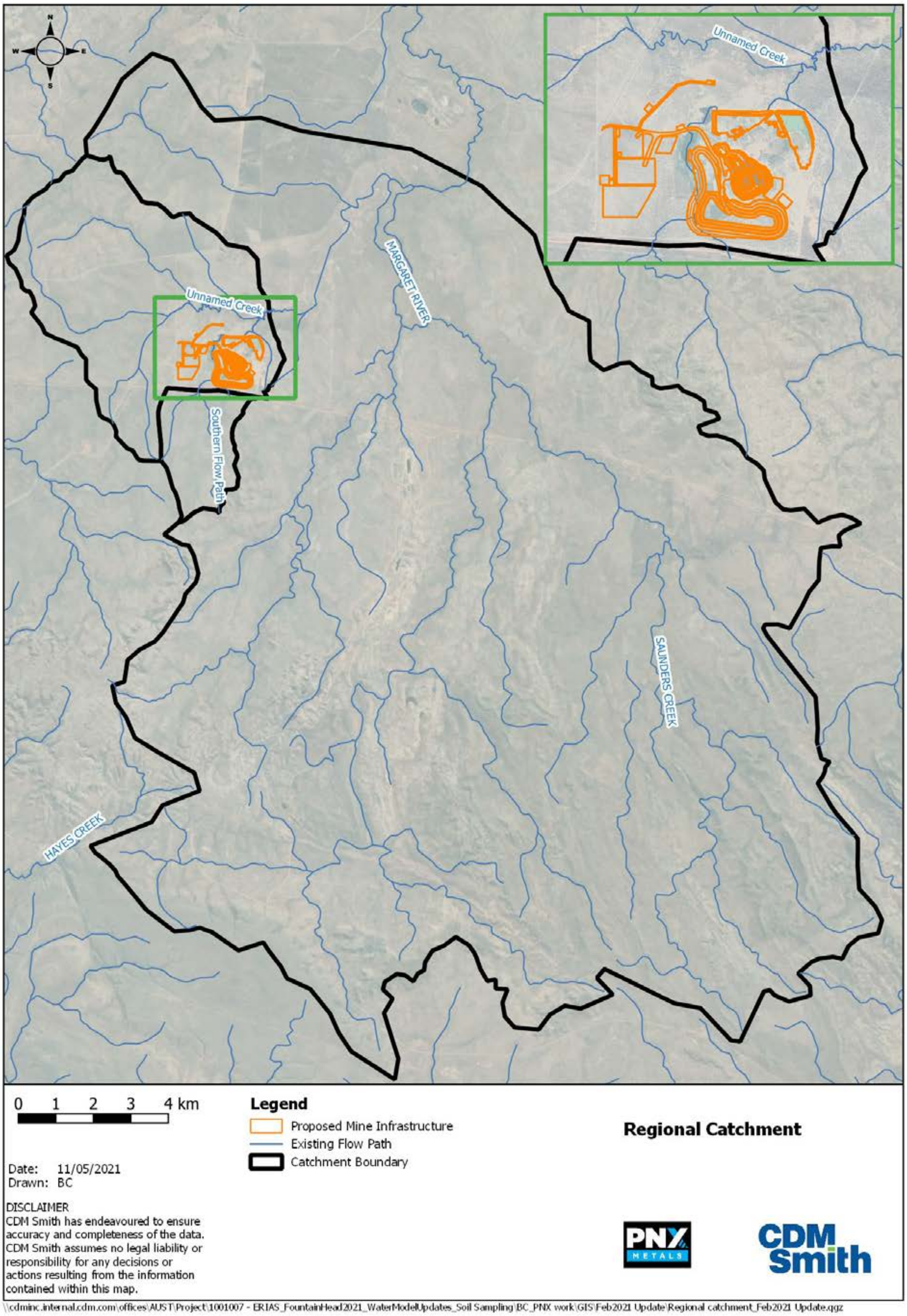


Figure 16 Catchment characteristics of the Fountain Head Project

3.3 Proposed water management strategy

The proposed infrastructure and land disturbance from the Project may lead to potential impacts on surface water quality to the downstream receiving waters, such as increased sediment loads, concentrations of salts or other pollutants, if not mitigated. The proposed strategy for management of surface water of the Project is based on the separation of water from different sources considering the anticipated water quality, followed by the appropriate management of each source. Based on the expected water quality, the site water management system includes two segregated systems:

- Mine affected water system – runoff from the proposed PAF stockpile is proposed to be captured and to allow an assessment of water quality prior to release to the environment. A storage dam is proposed to the north side of the PAF stockpile to capture the runoff from the PAF stockpile. The PAF stockpile runoff dam is designed with sufficient capacity to contain a 1:100 year 72 hour duration storm.
- Sediment water system – Sediments generated from the surface runoff from hardstand, IWL and ROM areas will be settled in the proposed sediment dams (refer to Figure 17). The sediment dams will operate with decanted overflow into the environment after the settlement of suspended sediments.
- CDM Smith (2021b) present the results of conservative arsenic concentration modelling using representative runoff concentrations derived from water extraction test results from existing WRS and ore (after EGI 2020). The modelling predicts there would be no exceedances of the two ANZECC guidelines discussed within the existing model assumptions. Water quality of runoff from IWL and hardstand/industrial areas should still be monitored and tested however to reduce the uncertainty of representative solute concentrations and assess the need for any additional water management strategies.
- Water in the sediment dams is not proposed to be pumped back to the site water balance system for reuse for the Project. However, the water in the sediment dams can potentially be pumped to the EP if the water quality is found to be of concern.

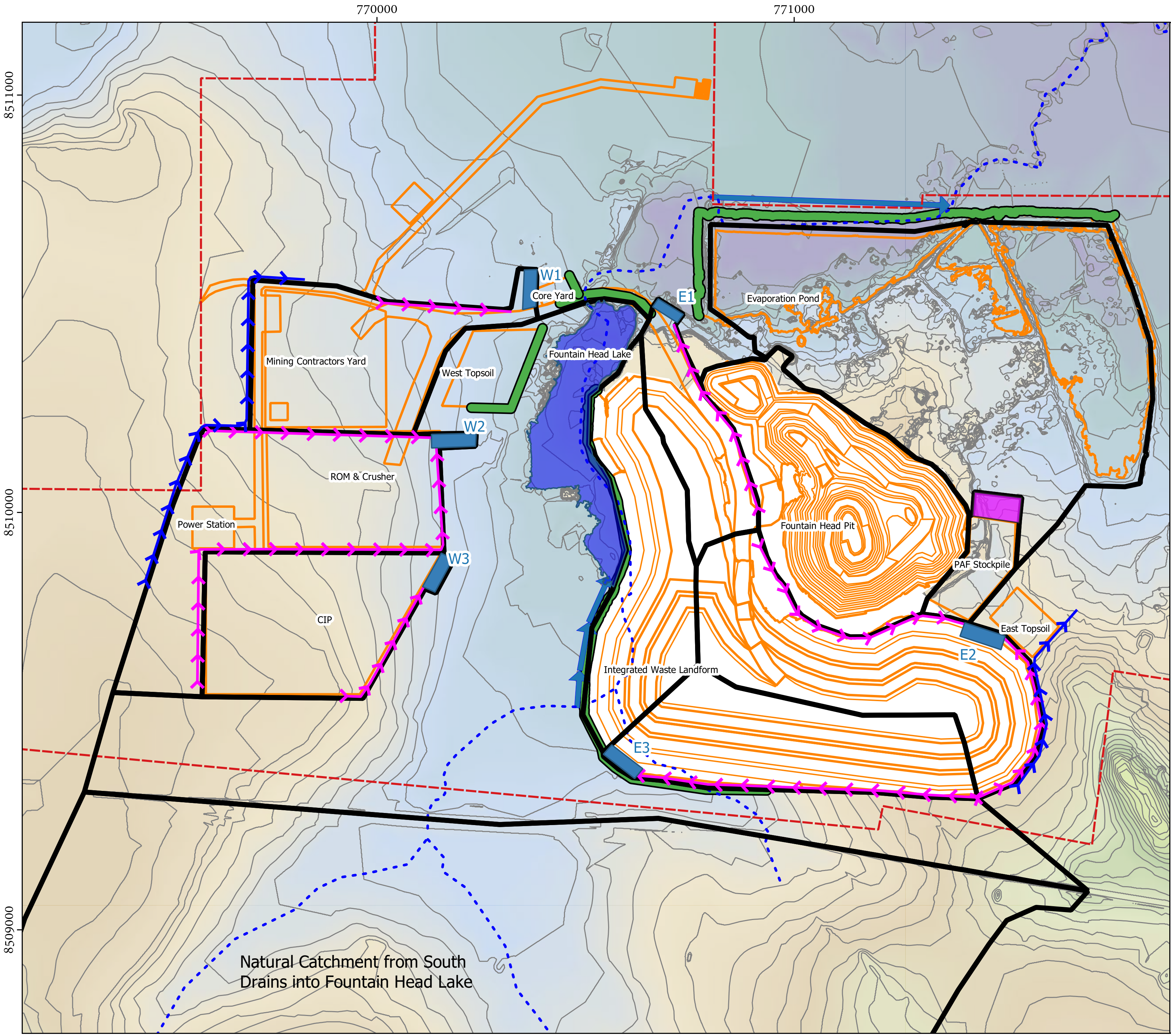
The internal runoff from the CIP is assumed to be contained and managed within the CIP footprint through drainage or bunding with sumps and will be returned to the process, as advised by PNX Metals. A sediment dam (W3) has also been sized for the sediment runoff from the CIP area.

The majority of clean water from natural or undisturbed areas is generally diverted to flow directly to the Unnamed Creek, bypassing mine infrastructure. The natural catchment south of the Project site will flow past the proposed mine infrastructure into the Fountain Head Lake before overflowing north, similar to the current situation.

The proposed mine life is relatively short at less than 5 years. Figure 17 shows the proposed mine infrastructure and final mining stage (most disturbed stage), as well as the proposed water management strategy. The proposed water management system includes the following components:

- Evaporation Pond
- Sediment dams (W1, W2, W3, E1, E2 and E3)
- Runoff drains
- Diversion channels
- Erosion protection

Figure 17 - Proposed water management system layout, operational phase



Legend

- Project Area
- Proposed Mine Infastructure
- Contour 1m Interval
- Existing Flow Path
- Proposed Sediment Dam
- PAF Stockpile Runoff Dam
- Fountain Head Lake
- Catchment Boundary
- Proposed 'Contact' Runoff Drain
- Proposed 'Non-contact' Runoff Drain
- Erosion Protection at Storage/Pond Wall Toe
- Proposed Diversion (conceptual)

Ground Level

- 90 mAHD
- 95 mAHD
- 100 mAHD
- 105 mAHD
- 110 mAHD
- 115 mAHD
- 120 mAHD
- 110 mAHD
- 130 mAHD

Date Published: 25 May 2021
Project Number: 1000667
Client: PNX Metals Ltd
Drawn: BC
Map Projection: GDA94 / MGA Zone 52

N

0 250 500 m

1:12,500

PNX METALS

CDM Smith

3.3.1 Evaporation Pond

The existing water storage dams are located immediately to the northeast of the Fountain Head pit. To increase the existing on-site storage capacity, proposed works plan to increase the height and extend the northern dam walls further to the west (ERIAS Group, 2019). This will create a relatively large and connected surface water storage, referred to here as the EP. Figure 18 shows the stage-volume-area relation curve of the proposed EP and other relevant elevations.

The proposed design provided by PNX Metals has the wall crest at 98.8 m AHD (approximately 1,050 ML capacity) with a proposed operational water level at 97.4 m AHD to account for a 1% AEP rainfall event and freeboard. The EP is effectively dry (less than around 0.1 ML) at a level of 91.5 m AHD.

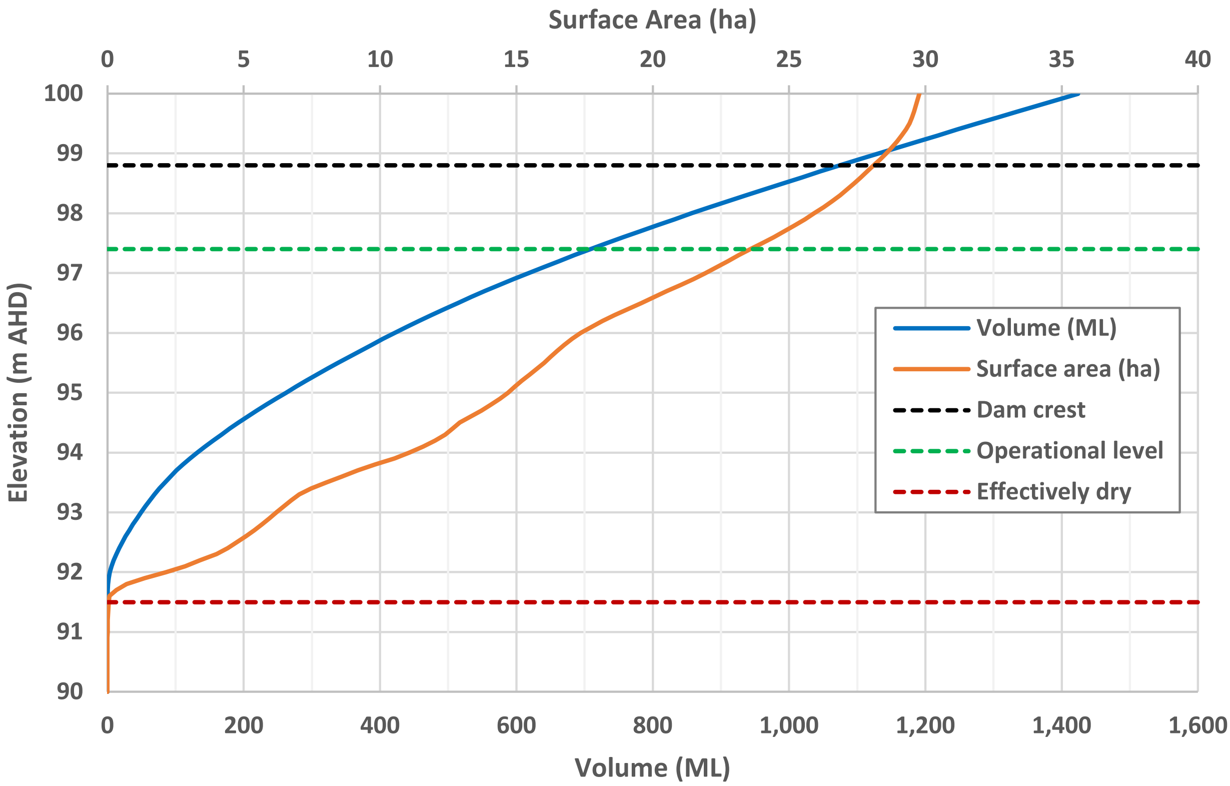


Figure 18 Stage-volume-area relation curve of the proposed Evaporation Pond

3.3.2 Sediment dams

Figure 17 shows the locations and configuration of the five proposed sediment dams for IWL and mine infrastructure areas, sized based on available site data. Table 8 shows the catchment areas along with preliminary required storage volumes and surface areas for the proposed sediment dams in accordance with the Best Practice Erosion and Sediment Control guidelines (IECA 2008). The outflow areas for each sediment dam can be seen in Figure 17 and Table 8 and are discussed in more detail within CDM Smith (2021b). The following is of note for the sediment dams:

- A 'Type F' sediment dam as defined by IECA (2008) (capture-treat-release approach) is to be used for the project site. The 'Type F' basins are generally suitable for fine grained soils that can readily settle without the need for flocculating agents. Type 'F' basins can only be operated as wet basins and the critical design parameter is the volume of the settling pond.
- A 1:3 side batter slope and width to length ratio has been adopted for the sizing of sediment dams
- A 3 m depth is adopted to size the surface area of the sediment dams

- The volume of the sediment storage zone will be 50% of the settling zone. Note that the adopted sediment dam volumes mean that the capacity of the sediment dams will be exceeded regularly and water will spill to the receiving areas at least once in most years (as discussed in more detail within CDM Smith 2021b).
- The minimum volume of settling zone was estimated using the following equation:

  $Vs = 10 \times R_{(85\%,5day)} \times Cv \times A$

  where: Vs = volume of the settling volume (m^3);

  $R_{(85\%,5day)}$ = 85%, 5-day rainfall depth (36.0mm);

  Cv = Volumetric runoff co-efficient (0.6); and

  A = Catchment area connected to the sediment dam in hectares (ha).
- Figure 19 shows the typical cross-section of sediment dam Type 'F'.
- Regular inspection and maintenance will be required on all established sediment dams to ensure they are operated in line with the Best Practice Erosion and Sediment Control guidelines, including water quality testing, pumping out following rainfall events and de-silting of sediment.

Table 8 Proposed sediment dams (preliminary sizing)

Sediment Dam	Catchment Area (ha)	Volume of Settling Zone (ML)	Volume of Sediment Storage Zone (ML)	Total Volume (ML)	Surface Area (ha)	Overflow area
W1	16.5	3.6	1.8	5.4	0.28	Downstream of FH Lake
W2	24.1	5.2	2.6	7.8	0.38	FH Lake
W3	17.0	3.7	1.8	5.5	0.29	FH Lake
E1	8.1	1.8	0.9	2.6	0.16	Downstream of FH Lake
E2	22.2	4.8	2.4	7.2	0.35	West of EP sub-catchment
E3	17.5	3.8	1.9	5.7	0.29	FH Lake

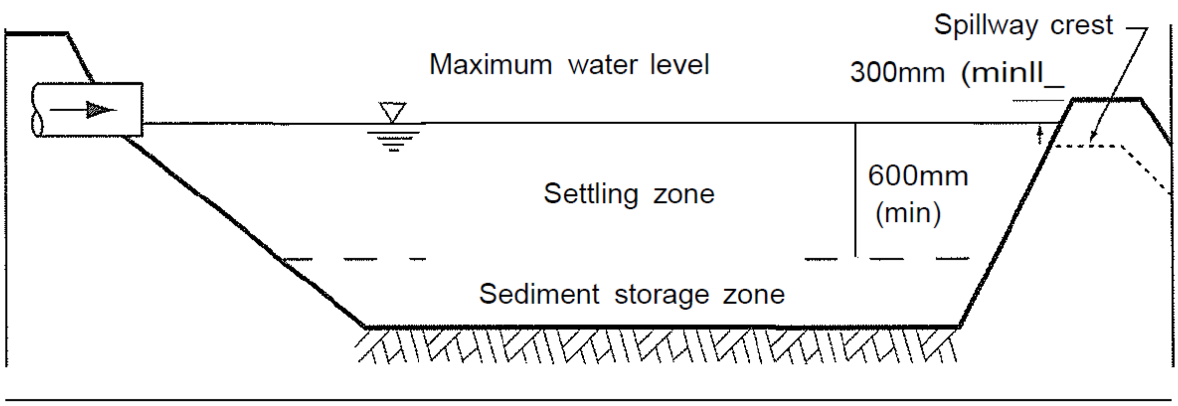


Figure 19 Typical sediment dam cross-section

3.3.3 PAF stockpile runoff dam

A PAF stockpile is proposed to the east of the Fountain Head Pit with a catchment area of approximately 3.3 ha based on an indicative footprint provided by PNX. A storage dam is proposed to the north side of the PAF stockpile to capture the localised runoff. The PAF stockpile runoff dam is preliminarily sized with a capacity to contain a 1:100 year 72 hour duration storm. The estimated storage volume of the PAF stockpile runoff dam is approximately 16.7 ML, noting the capacity may be revised once the PAF stockpile footprint is refined. Figure 17 shows the locations and approximate footprint of the PAF stockpile runoff dam, with assumption of 3 m depth for the dam. The PAF stockpile dam overflows to the proposed EP where it can provide additional water storage.

3.3.4 Proposed runoff drains

Figure 17 shows the locations of the proposed runoff drains, including:

- 'Contact' runoff drain to divert surface runoff from disturbed areas (such as IWL and mine infrastructure areas) to sediment management structures to capture and settle sediment.
- 'Clean' runoff drain to divert clean/natural catchment runoff from undisturbed areas away from disturbed areas.

'Contact' runoff drains are proposed around the perimeter of the IWL and proposed mine infrastructure areas to divert the 'contact' runoff to the sediment dams.

'Non-contact' runoff drains are proposed to the west of the mine infrastructure area and east of the IWL to divert the natural catchment runoff away from the site to minimise the volume of contact water.

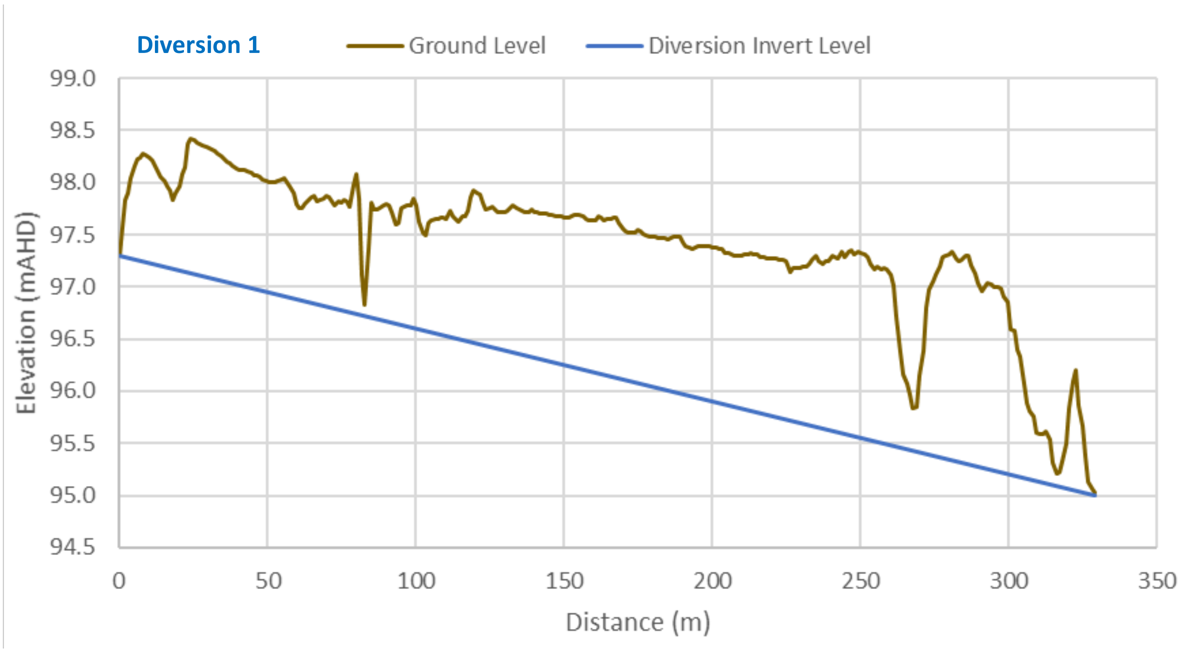
3.3.5 Proposed diversions

To avoid local water ponding and reduce potential flood impacts, it is proposed to reinstate the natural flow path and to divert the natural catchment runoff into the existing Fountain Head Lake. A diversion is also proposed along the northern side of the proposed EP, which is located on the existing flow path. Figure 17 shows the locations of these two proposed diversions.

Figure 20 shows the longitudinal sections of the two conceptual diversion channels. The proposed diversions are conceptually modelled as an 8 m wide channel in the hydraulic model (discussed in Section 2) to avoid localised ponding and reduce potential flood impacts. Initial assessment found that the flood impacts may not be overly sensitive to the size of the modelled diversion and the modelled size was based on the nearby channel characteristic. Further assessment is recommended and required during detailed design stage.

3.3.6 Erosion protection

Erosion protection, such as rock armour protection, is recommended along the outer toe of the proposed IWL, EP and other mine infrastructure, as shown in Figure 17. It is understood that the existing haul road is subject to erosion issues during overtopping events from the Fountain Head Lake and hence rock armour erosion protection is also recommended at the haul road. If the haul road remains a low level causeway for flow from south to north, the erosion protection may also need to consider energy dissipation to reduce the energy from peak discharges flowing over the haul road. Appropriately sized rocks should provide sufficient energy dissipation.



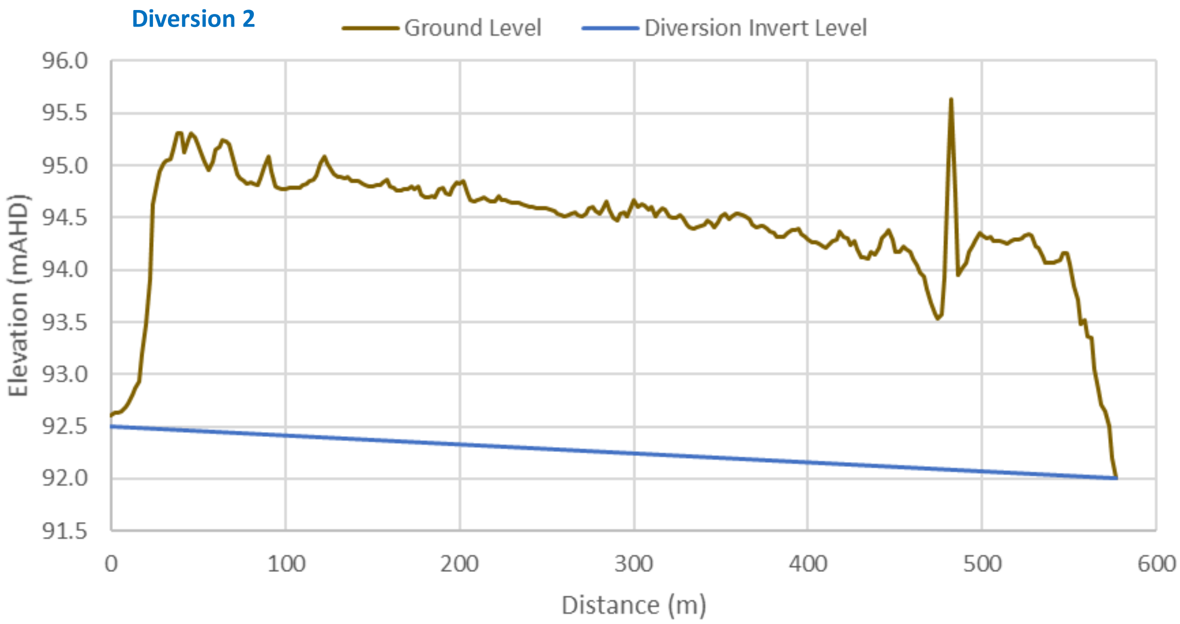


Figure 20 Longitudinal sections of the proposed conceptual diversions

Section 4 Conclusions

4.1 Hydrology and flood modelling

Hydrologic and hydraulic models were developed to investigate the behaviour of surface water for the Fountain Head Mine site and local surrounds to evaluate potential flooding issues that may impact the mine infrastructure. The design discharges for the Fountain Head site catchment and the flood characteristics were generated for design flood events from 10% AEP to 0.1% AEP in accordance with the 2019 Australia Rainfall and Runoff guidelines (Ball et al., 2019). The likelihood and extent of flooding in the vicinity of Fountain Head Pit Lake and infrastructure were identified to inform operational constraints and potential flood and adverse water quality mitigation options.

Based on the modelling results, potential mitigations options such as diversions, areas to be raised or flood protected and erosion protection measures are conceptually proposed and assessed.

4.2 Site water management strategy

A site water management plan was developed to manage the site water quantity and quality to minimise contact water generation and reduce sediment loads. The proposed water management system includes the following components:

- Evaporation Pond
- Sediment dams
- PAF stockpile runoff dam
- Runoff drains
- Diversion channels
- Erosion protection.

The water and solute balance of the proposed EP was assessed in the technical site water balance report (CDM Smith, 2021b). The six proposed sediment dams were sized in accordance with the Best Practice Erosion and Sediment Control guidelines (IECA, 2008) to reduce sediment loads offsite. The PAF stockpile runoff dam is designed with sufficient capacity to contain a 1:100 year 72 hour duration storm. A number of runoff drains, diversions and erosion protections are proposed as part of the site water management strategy.

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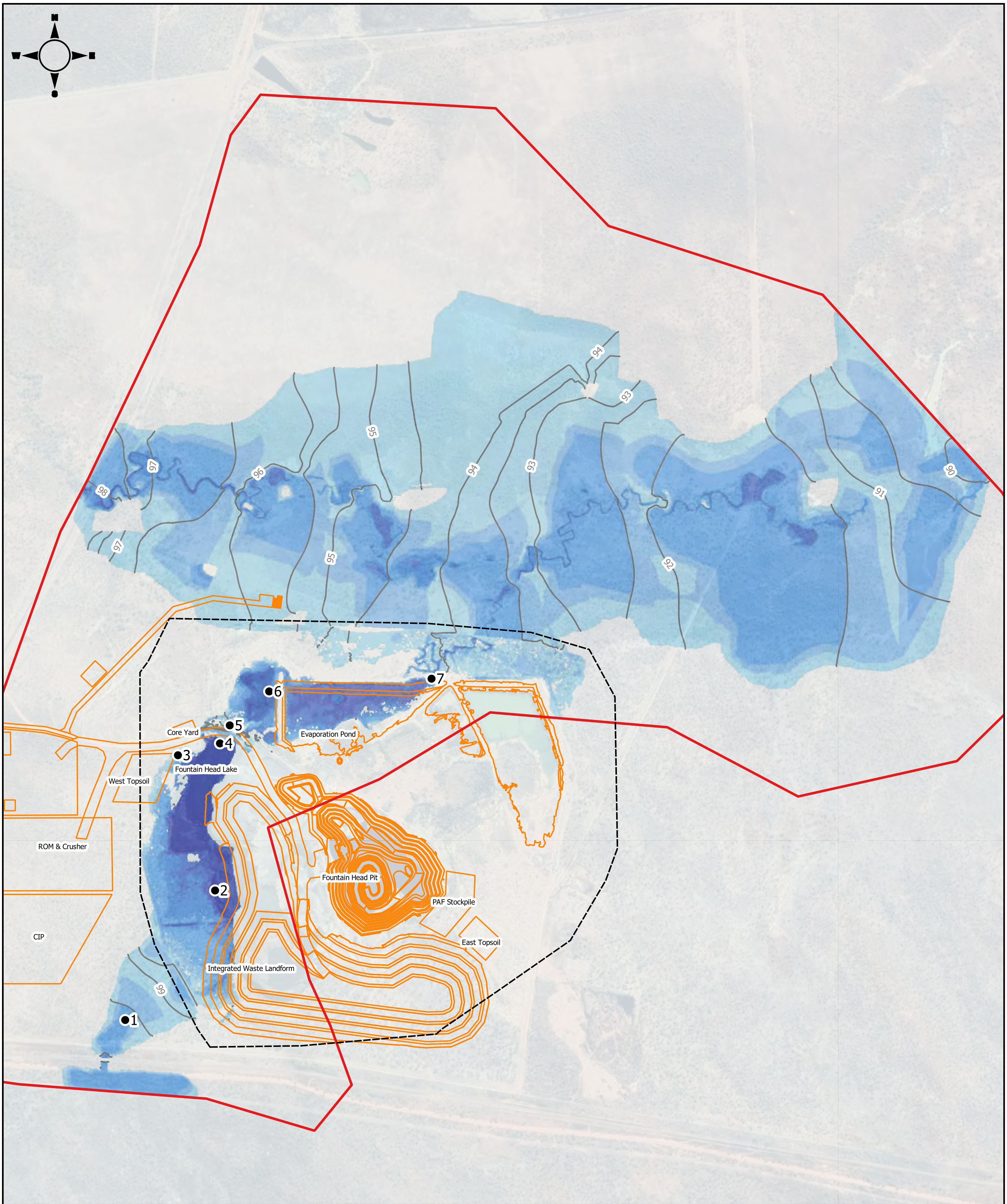
Appendix A Flood Maps Existing Conditions



0 250 500 750 m

Legend

- Proposed Mine Infastructure
- LiDAR Data Extent
- Model Extent
- Reporting Location
- Flood Level Contour 0.5 m Interval

Peak Flood Depth (m)

- 0 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 3
- > 3

Figure A.1
Existing Case 10% AEP Peak Flood Depths

Date: 12/05/2021
Drawn: BC

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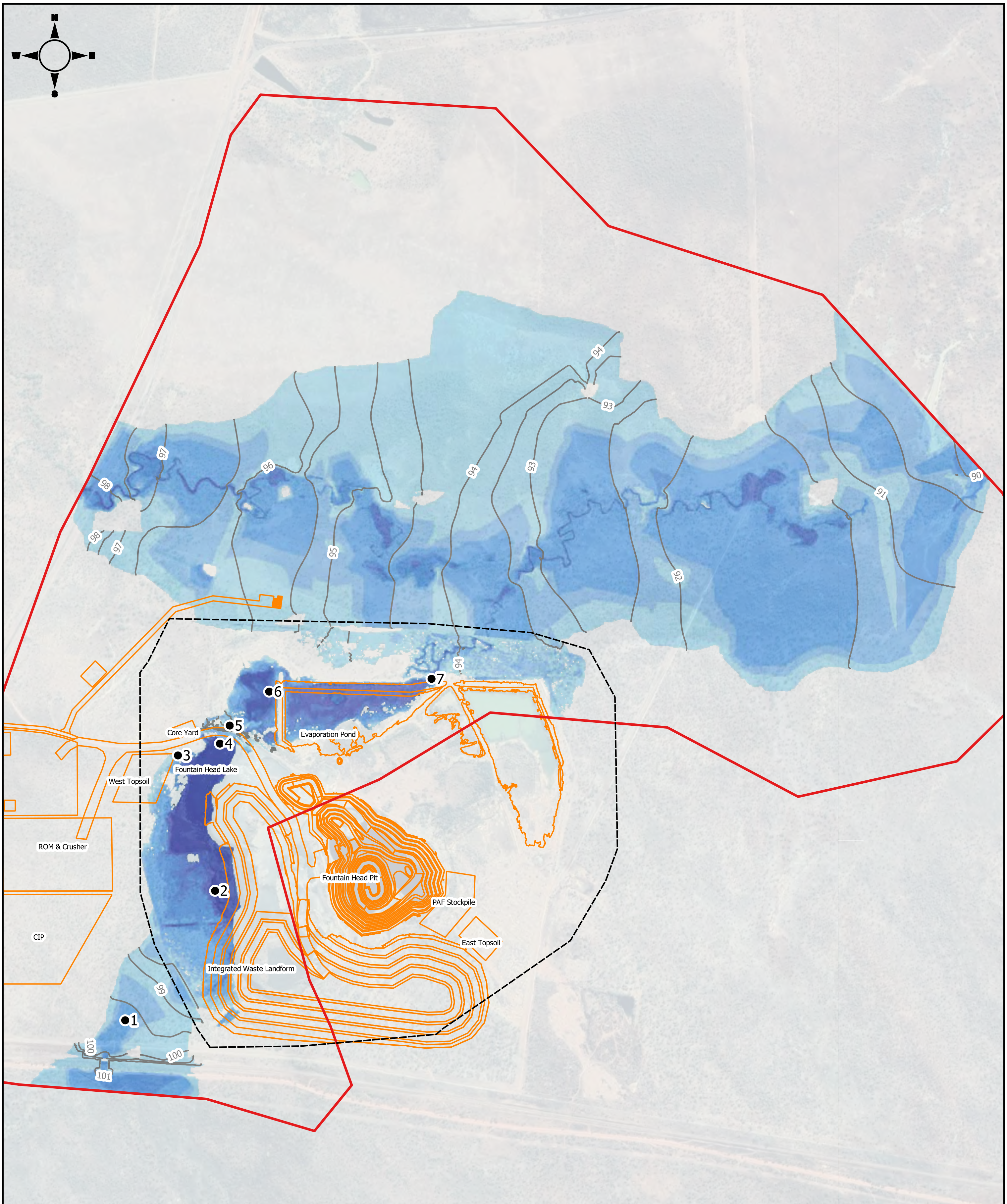

Legend

- Proposed Mine Infastructure
- LiDAR Data Extent
- Model Extent
- Reporting Location
- Flood Level Contour 0.5 m Interval

Peak Flood Depth (m)

- 0 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 3
- > 3

Figure A.2
Existing Case 5% AEP Peak Flood Depths

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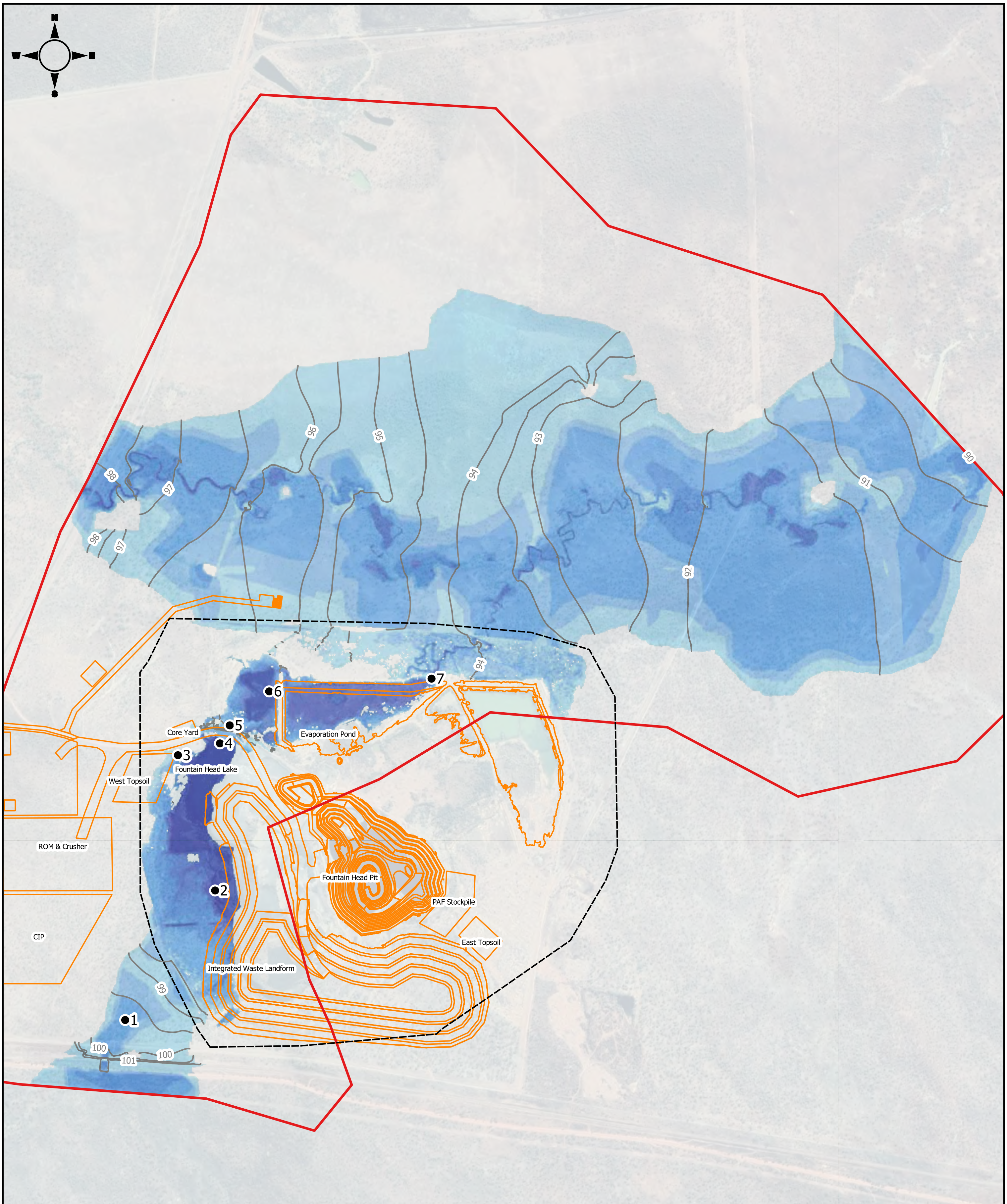

0 250 500 750 m

Legend

- Proposed Mine Infrastructure
- LiDAR Data Extent
- Model Extent
- Reporting Location
- Flood Level Contour 0.5 m Interval

Peak Flood Depth (m)

- 0 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 3
- > 3

Figure A.3
Existing Case 2% AEP Peak Flood Depths

Date: 12/05/2021
Drawn: BC

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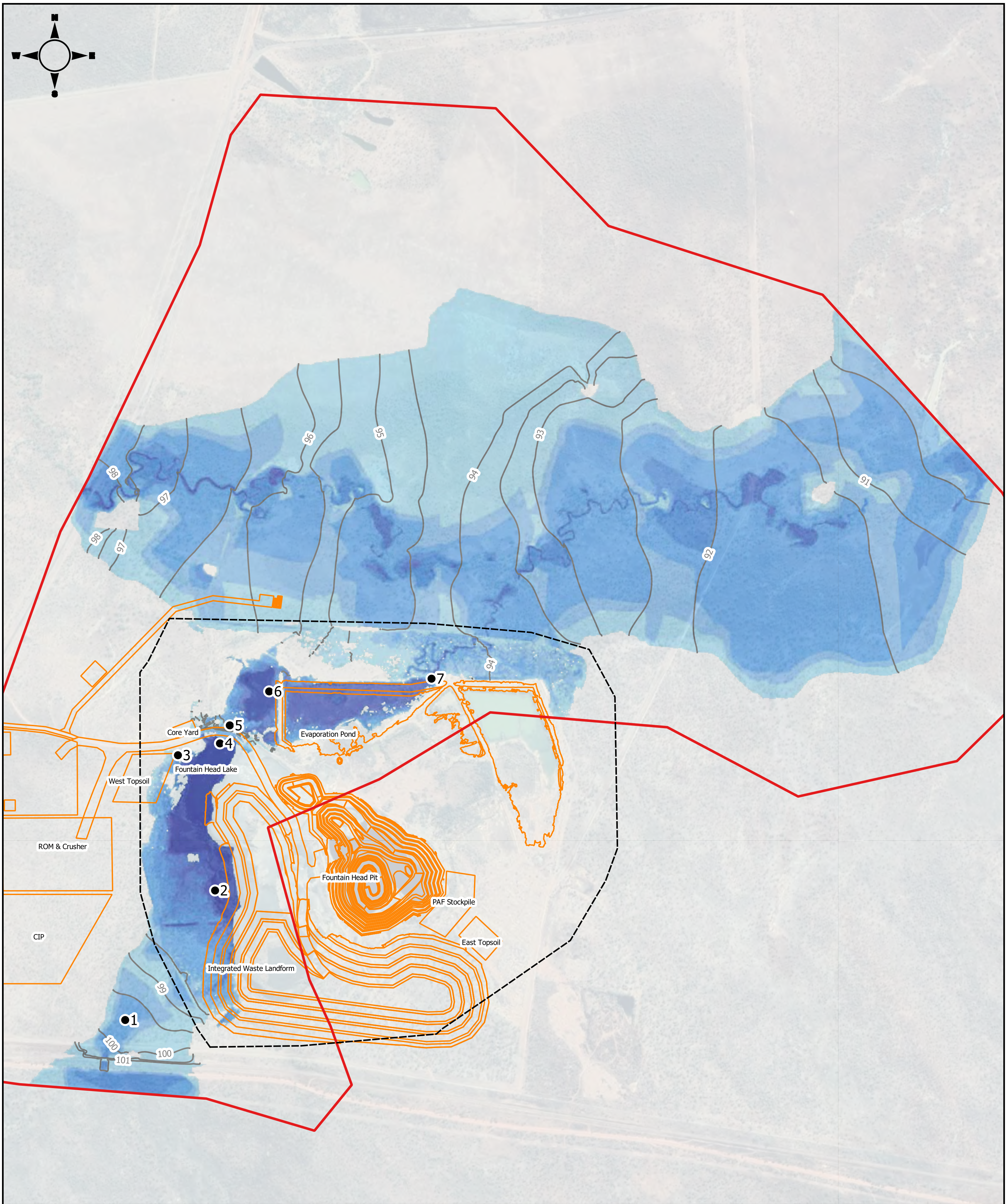

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Date: 12/05/2021
Drawn: BC

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Legend

- Proposed Mine Infastructure
- LiDAR Data Extent
- Model Extent
- Reporting Location
- Flood Level Contour 0.5 m Interval

Peak Flood Depth (m)

- 0 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 3
- > 3

Figure A.4
Existing Case 1% AEP Peak Flood Depths

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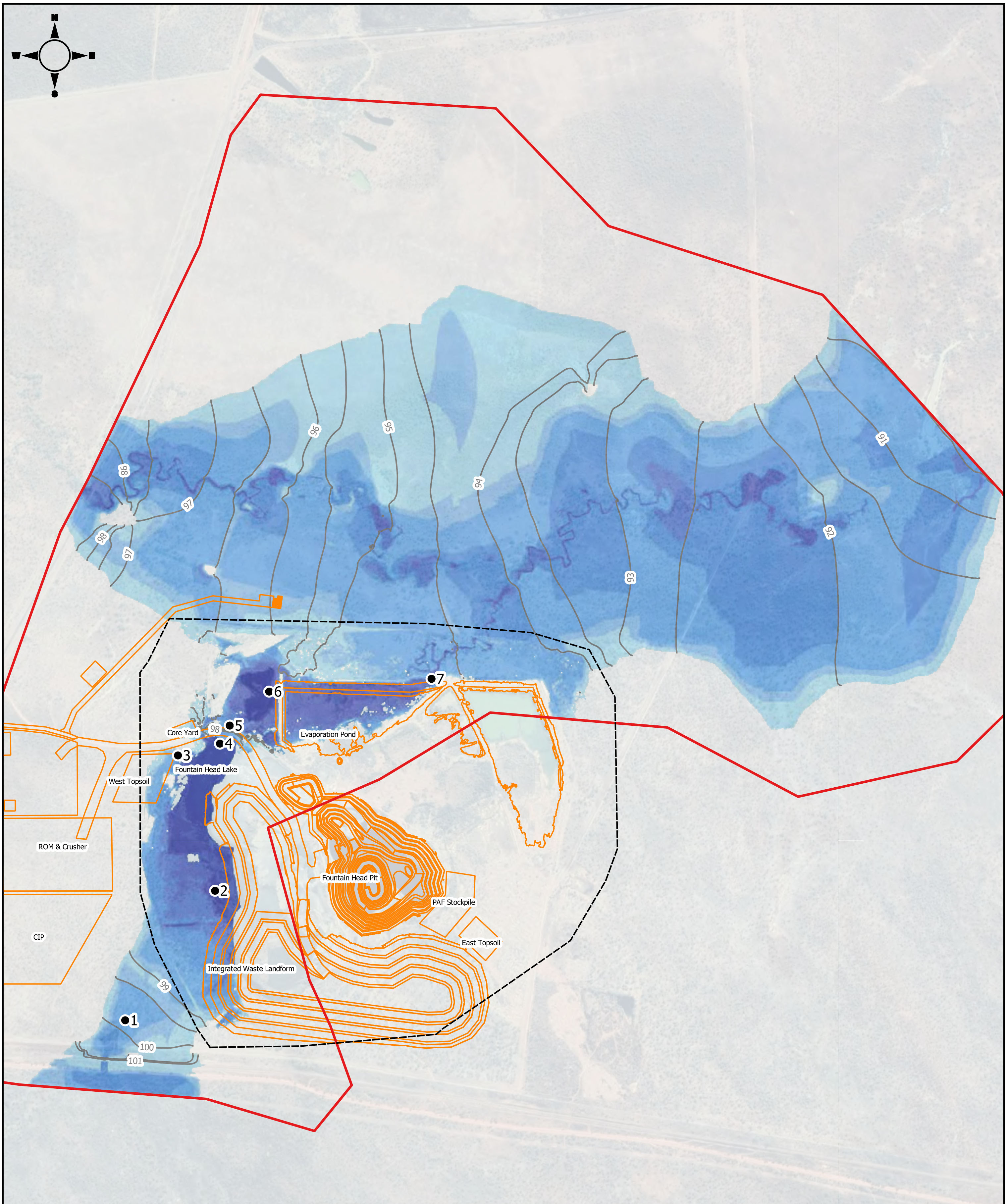

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Date: 12/05/2021
Drawn: BC

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Legend

- Proposed Mine Infrastructure
- LiDAR Data Extent
- Model Extent
- Reporting Location
- Flood Level Contour 0.5 m Interval

Peak Flood Depth (m)

- 0 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 3
- > 3

Figure A.5
Existing Case 0.1% AEP Peak Flood Depths

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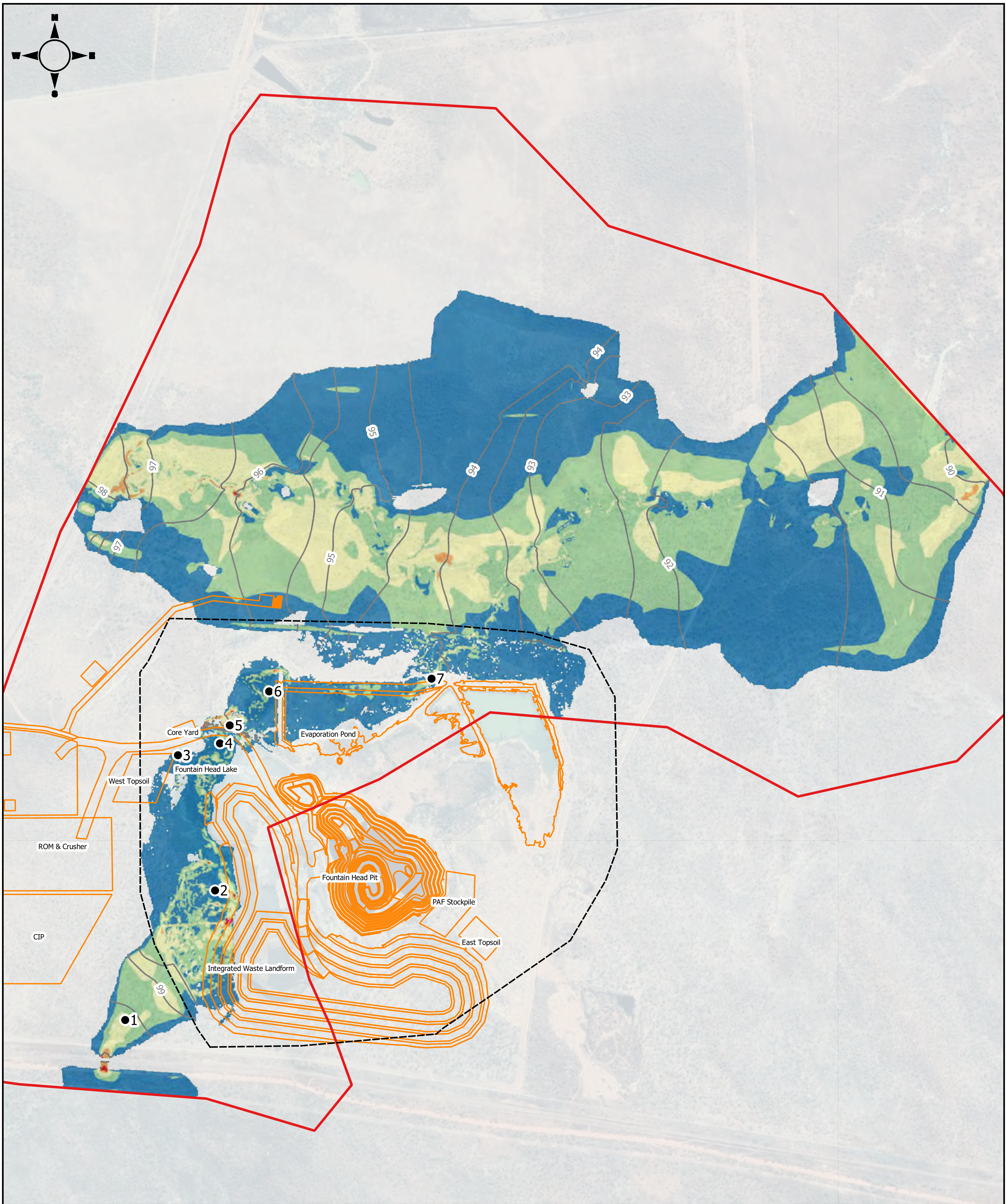

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Date: 12/05/2021
Drawn: BC

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Legend

- Proposed Mine Infastructure
- LiDAR Data Extent
- Model Extent
- Reporting Location
- Flood Level Contour 0.5 m Interval

Peak Flood Velocity (m/s)

- <= 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Figure A.6
Existing Case 10% AEP Peak Flood Velocities

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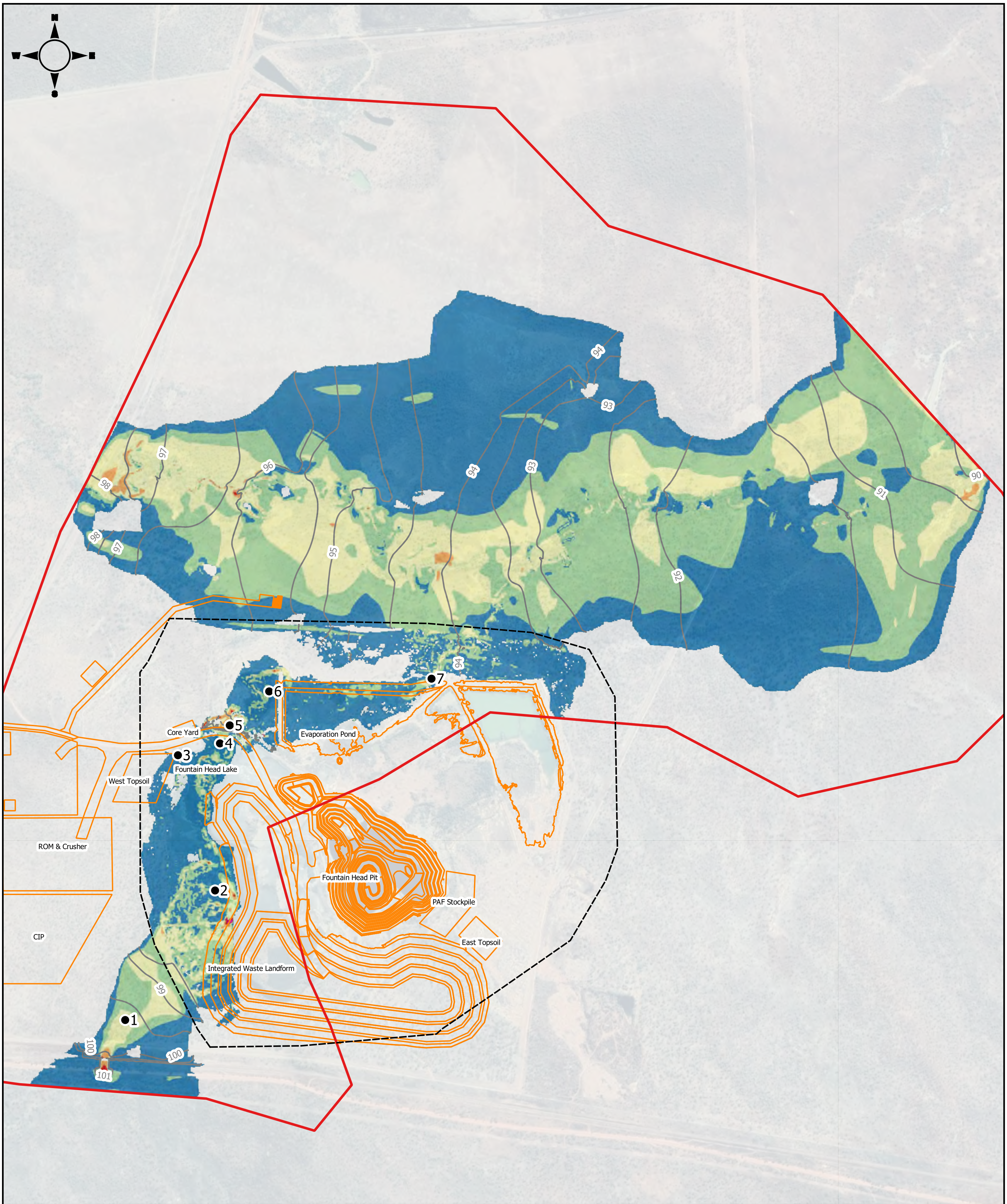

0 250 500 750 m

Date: 12/05/2021
Drawn: BC

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Legend

- Proposed Mine Infastructure
- LiDAR Data Extent
- Model Extent
- Reporting Location
- Flood Level Contour 0.5 m Interval

Peak Flood Velocity (m/s)

- <= 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Figure A.7 Existing Case 5% AEP Peak Flood Velocities

PNX METALS

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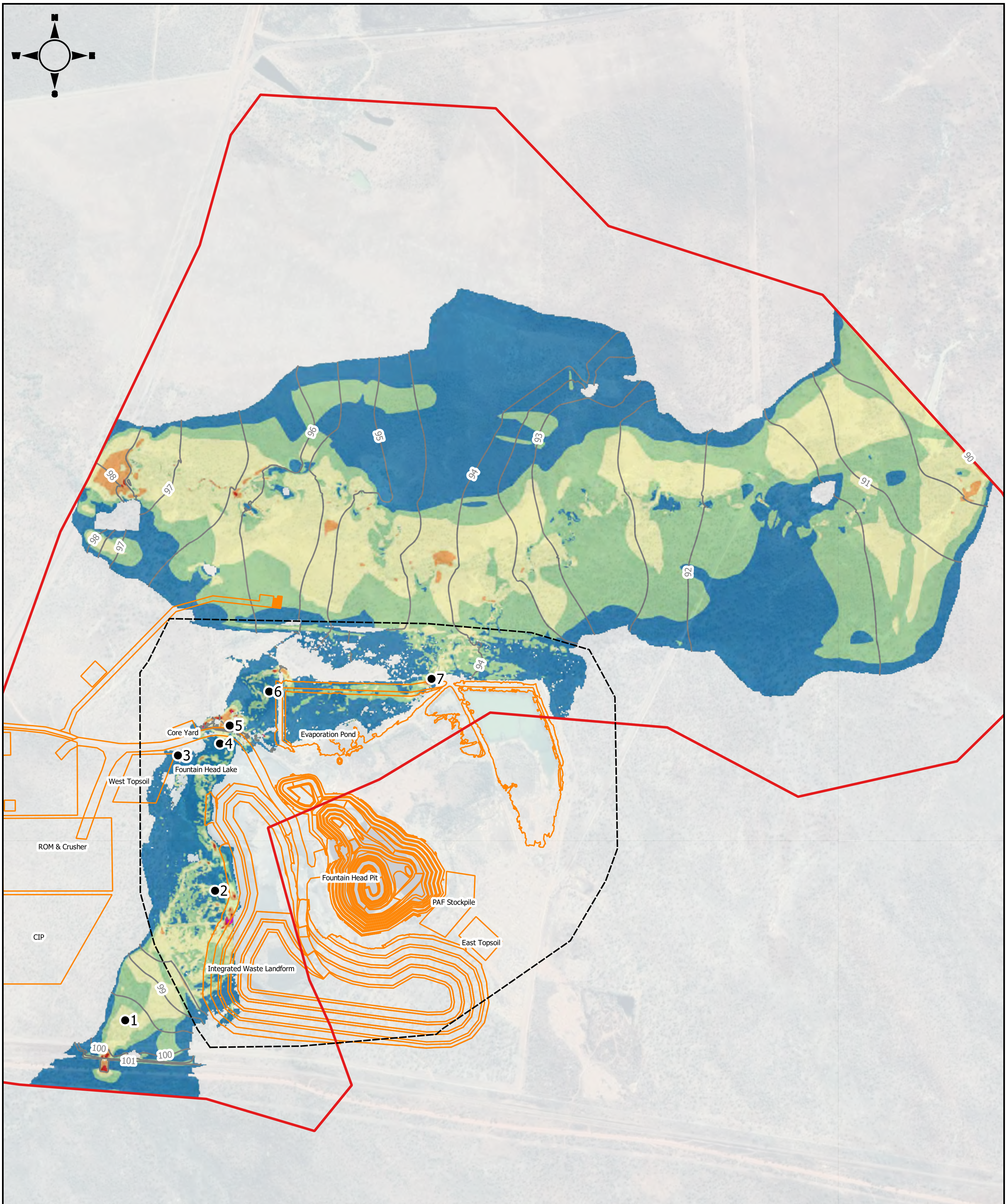

Legend

- Proposed Mine Infastructure
- LiDAR Data Extent
- Model Extent
- Reporting Location
- Flood Level Contour 0.5 m Interval

Peak Flood Velocity (m/s)

- <= 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Figure A.8
Existing Case 2% AEP Peak Flood Velocities

Date: 12/05/2021
Drawn: BC

PNX METALS

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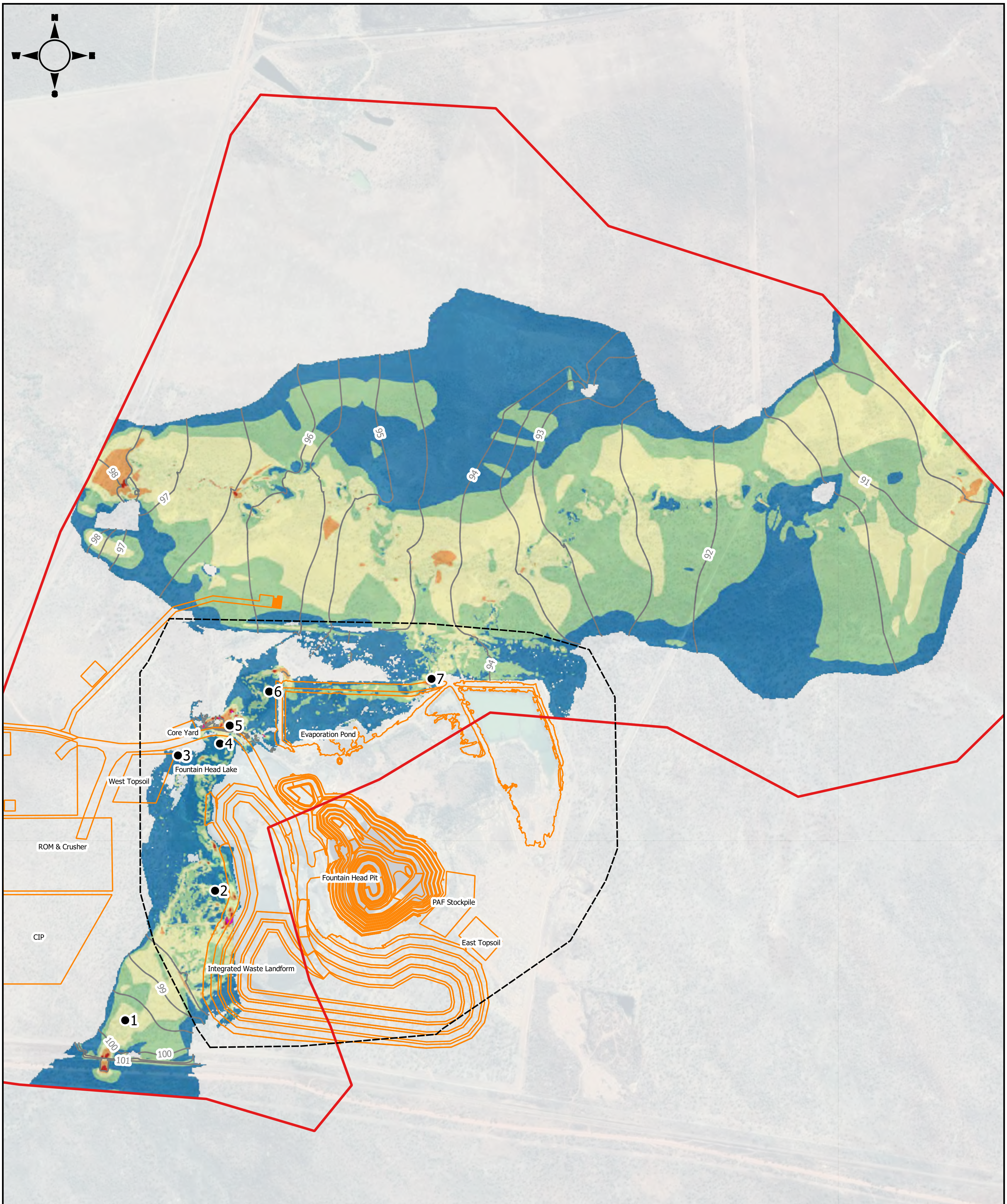


Legend

- Proposed Mine Infrastructure
- LiDAR Data Extent
- Model Extent
- Reporting Location
- Flood Level Contour 0.5 m Interval

Peak Flood Velocity (m/s)

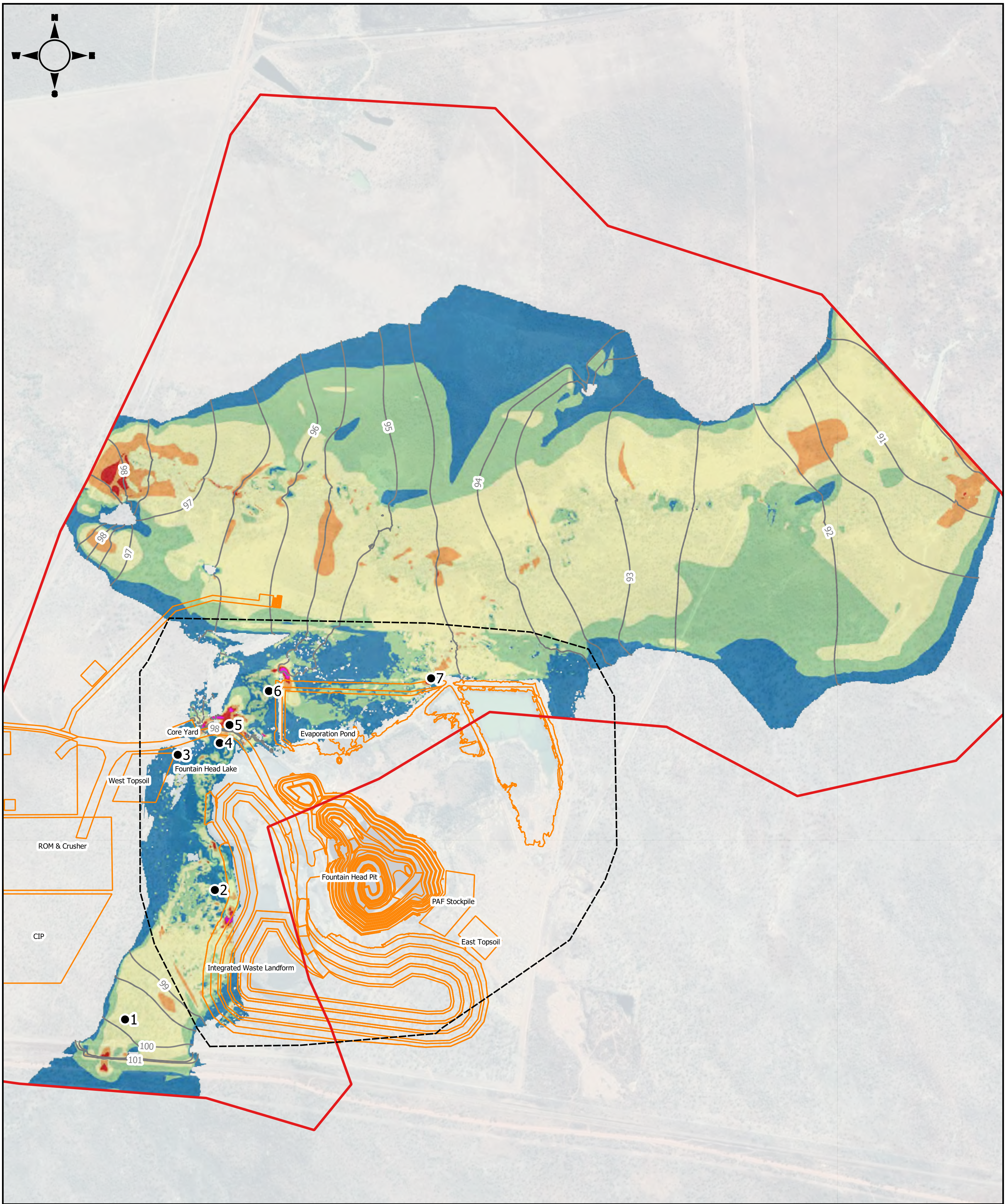
- <= 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Figure A.9 Existing Case 1% AEP Peak Flood Velocities

Date: 12/05/2021
Drawn: BC

PNX METALS

CDM Smith



0 250 500 750 m

Date: 12/05/2021
Drawn: BC

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CDM Smith has endeavoured to ensure accuracy and completeness of the data. CDM Smith assumes no legal liability or responsibility for any decisions or actions resulting from the information contained within this map.

Legend

- Proposed Mine Infastructure
- LiDAR Data Extent
- Model Extent
- Reporting Location
- Flood Level Contour 0.5 m Interval

Peak Flood Velocity (m/s)

- <= 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Figure A.10
Existing Case 0.1% AEP Peak Flood Velocities

PNX METALS

CDM Smith

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