Gemini Project

Surface Water Assessment

Magnetic South Pty Ltd

1238-01-G1, 26 September 2019

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1 Introduction

1.1 BACKGROUND

Magnetic South Pty Ltd proposes to develop the Gemini Project (the Project), a coal mine and associated infrastructure, located within the Fitzroy Basin. The proposed mine development site is located approximately 7.6 km west from the township of Dingo and 19.4 km southeast of Bluff (Figure 1.1).

WRM was commissioned by Magnetic South Pty Ltd to undertake a surface water impact assessment for the Project. This report presents the following:

- An overview of the regulatory framework which applies to the Project;
- A description of the existing surface water environment surrounding the Project, and the associated environmental values;
- A detailed description of the proposed water management strategy in and around the Project and details of the expected performance of the proposed water management system;
- A discussion of the potential impacts of the Project.

1.2 PROJECT DESCRIPTION

The Gemini Project is a greenfield open cut mine to produce Pulverised Coal Injection (PCI) coal and Coking Coal products for export for steel production. The Project term is anticipated to be 25 years from grant of the ML, with this term including initial construction, mine operation and rehabilitation activities. The main activities associated with the Project include:

- Exploration activities continuing in order to support mine planning;
- Development of a Mine Infrastructure Area (MIA) including mine offices, bathhouse, crib rooms, warehouse/stores, workshop, fuel storage, refuelling facilities, explosives magazine and sewage, effluent and liquid waste storage;
- Construction and operation of a Coal Handling Preparation Plant (CHPP) and coal handling facilities adjacent to the MIA (including Run-of-Mine (ROM) coal, product stockpiles and reject stockpiles [coarse and fine rejects]);
- Construction and operation of a surface conveyor from the product stockpiles to a Train Load Out (TLO) facility and rail loop connecting to the Blackwater-Gladstone Branch Rail to transport product coal to coal terminals at Gladstone for export;
- Construction of access roads from the Capricorn Highway to the MIA, and to the TLO facility;
- Installation of a raw water supply pipeline to connect to the Blackwater Pipeline network;
- Construction of a 66 kV transmission line and switching/substation to connect to the existing regional network;
- Other associated minor infrastructure, plant, equipment and activities;
- Development of mine areas (open cut pits) and out-of-pit waste rock emplacements;
- Drilling and blasting of competent waste material.
- Mine operations using conventional surface mining equipment (excavators, front end loaders, rear dump trucks, dozers);

- Mining up to 1.9 Mtpa ROM Coal - average 1.8 Mtpa for an operational mine life of approximately 20 years;
- Progressive placement of waste rock in:
  - Emplacements, adjacent to and near the open cut voids;
  - Mine voids, behind the advancing open cut mining operations.
- Progressive rehabilitation of waste rock emplacement areas and mined voids;
- Progressive establishment of soil stockpiles, laydown area and borrow pits (for road base and civil works). Material will be sourced from local quarries where required;
- Disposal of CHPP rejects (coarse and fine rejects) in out-of-pit spoil dumps, and in-pit behind the mining void;
- Progressive development of internal roads and haul roads including a causeway over Charlevue Creek to enable coal haulage and pit access;
- Development of water storage dams and sediment dams, and the installation of pumps, pipelines, and other water management equipment and structures including temporary levees, diversions and drains.

Figure 1.2 shows the layout of key project features, in particular the two proposed mine pits, associated out-of-pit spoil dumps, haul roads and CHPP, MIA and TLO.

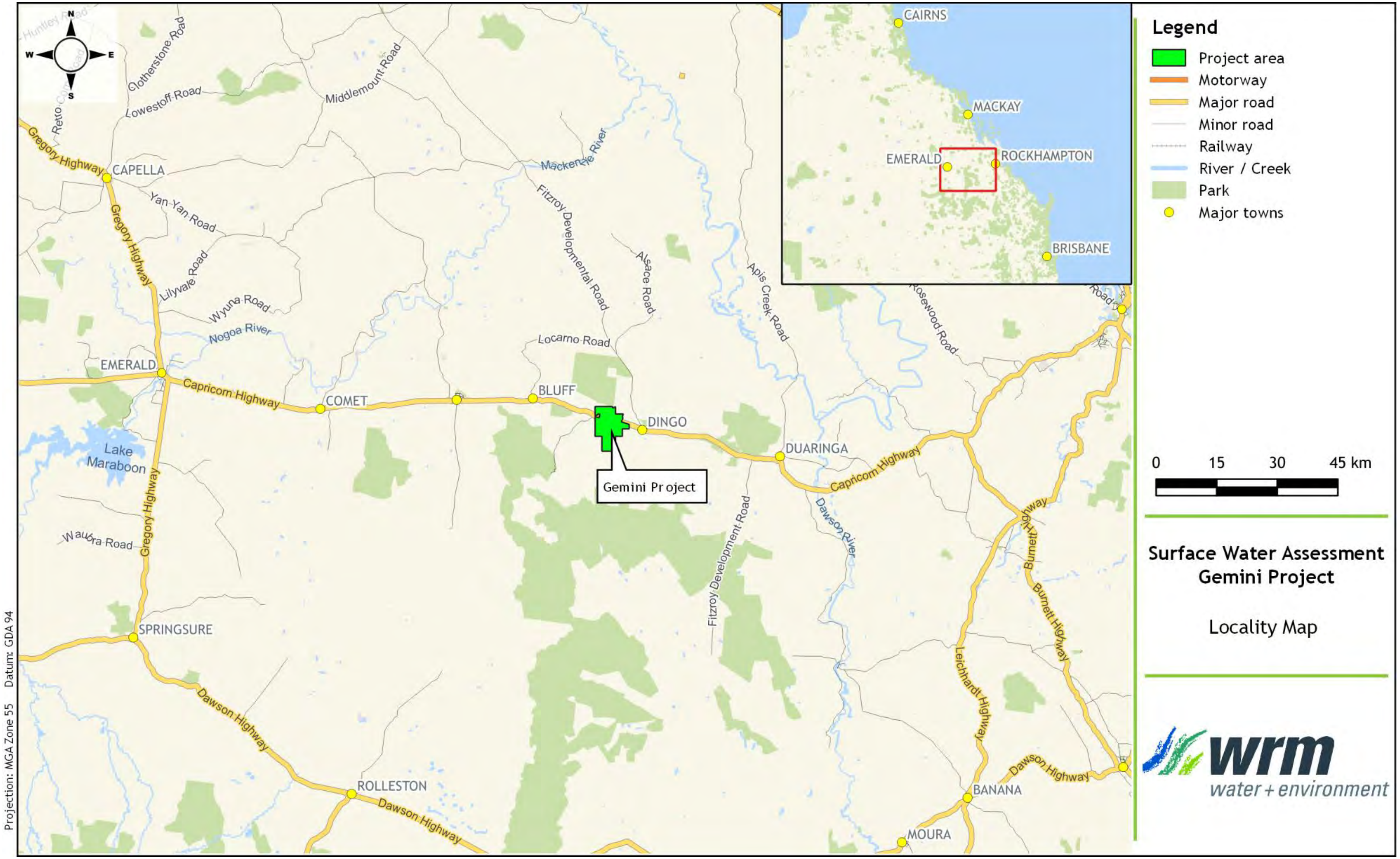


Figure 1.1 - Locality Plan

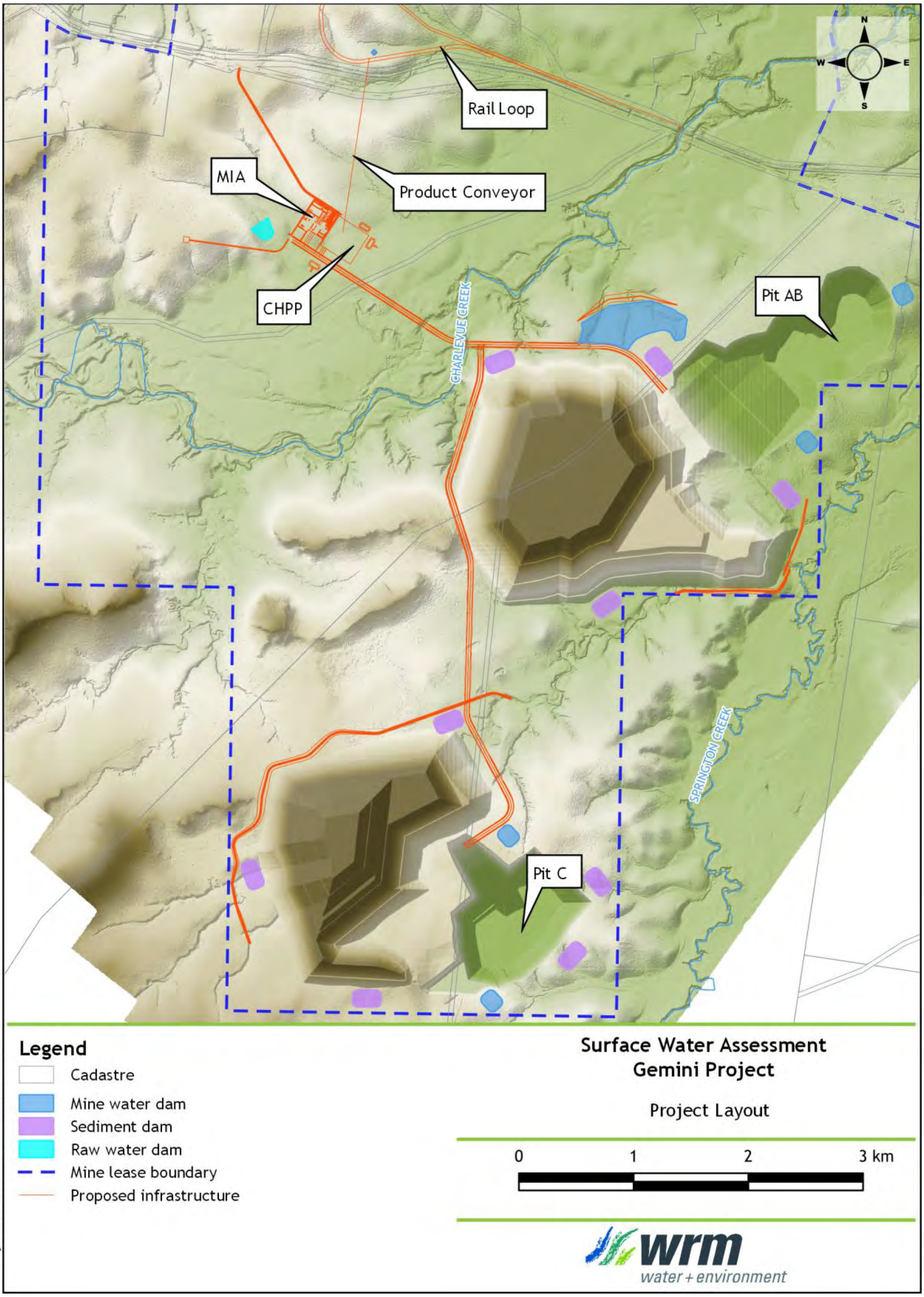


Figure 1.2 - Project layout

2 Regulatory framework

This section describes the regulatory framework (legislation, policies and standards) at Commonwealth and State level that would apply to surface water management for the Project.

2.1 COMMONWEALTH

2.1.1 EPBC Act

Under the Commonwealth Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act), an action requires approval from the Federal Environment Minister if the action has, will have, or is likely to have a significant impact on a Matter of National Environmental Significance (MNES).

An EPBC Referral (2010/5775) for the project lodged in 2010, was declared 'Not a Controlled Action if undertaken in a Particular Manner' in July 2011.

The Particular Manner Decision (EPBC 2010/5775) required the following measures to be taken to avoid significant impacts on the Fitzroy River turtle:

- To prevent downstream impacts to the Fitzroy River Turtle (Rheodytes leukops) the person taking the action must appropriately bund or locate pits in a manner that prevents surface water from entering the pit during a 1:1,000 year flood event.
- To prevent downstream impacts to the Fitzroy River Turtle (Rheodytes leukops) the person taking the action must appropriately bund or locate dams in a manner that prevents surface water from entering or damaging the dams during a during a 1:1,000 year flood event.

The currently proposed Gemini Project is consistent with the original EPBC referral in that:

- It is unlikely to have a significant impact on a MNES; and
- The same measures will be taken for the Gemini Project to avoid significant impacts on the Fitzroy River Turtle.

2.1.2 Independent Expert Scientific Committee

The Independent Expert Scientific Committee (IESC) on Coal Seam Gas and Large Coal Mining Developments provides scientific advice to decision makers on the impact that coal seam gas and large coal mining development may have on Australia's water resources.

The IESC provides independent, expert scientific advice on coal seam gas and large coal mining proposals as requested by the federal and state government regulators. The IESC assesses the proposals against the Information Guidelines for Independent Expert Scientific Committee and provides advice (IESC, 2018) on coal seam gas and large coal mining development proposals where there is a significant impact on water resources. The core purpose of the guideline is to determine whether a coal seam gas (CSG) or large coal mining development has or is likely to have a significant impact on a water resource. The requirements of the guideline have been considered in preparation of this surface water assessment.

2.2 QUEENSLAND

2.2.1 EP Act 1994

Resource activities are defined as environmentally relevant activities (ERAs) under the Queensland Environmental Protection Act 1994 (EP Act) and as such, the development and operation of the Project is regulated by the EP Act. The objective of the EP Act is to:

Protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends (ecologically sustainable development).

2.2.1.1 Environmental Authority

An environmental authority (EA) is granted in accordance with the EP Act and details the prescribed conditions that govern the ERA. In the context of surface water management, the EA sets out conditions that will be relevant to the Project, including:

- Management of contained water including release;
- Water management plan requirements;
- Regulation of water structures including dams and levees;
- Saline drainage management;
- Acid rock drainage management; and
- Storm water and sediment laden runoff management.

Model Mining Conditions

New mining project EA applications should apply the model mining conditions as outlined in Model Mining Conditions (DEHP, 2017). The purpose of the model mining conditions is to provide a consistent set of conditions to meet the general environmental protection commitments given for EAs for mining activities administered under the EP Act. The model conditions may be used as a basis for proposing environmental protection commitments in application documents (such as an EIS). Model conditions can be modified to suit the specific circumstances of a mining project, subject to the assessment criteria outlined in the EP Act.

Schedule F - Water (Fitzroy model conditions) form the basis of the requirements for the Project Water Management System design.

2.2.1.2 Environmental Protection (Water) Policy 2009

The Environmental Protection (Water) Policy 2009 (EPP Water) is the primary instrument for surface water management under the EP Act. The EPP Water governs discharge to land, surface water and groundwater, aims to protect environmental values (EVs) and sets water quality guidelines and objectives.

The processes to identify Environmental Values (EVs) and to determine Water Quality Guidelines (WQGs) and Water Quality Objectives (WQOs) in Queensland waters are based on the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ guidelines).

2.2.1.3 Mackenzie River Sub-basin Environmental Values and Water Quality Objectives 2011

The relevant document, pursuant to the EPP Water, for the Project is the Mackenzie River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Mackenzie River Sub-basin (DEHP, 2011). The document is made pursuant to the provisions of the EPP Water. It contains Environmental Values (EVs) and Water Quality Objectives (WQOs) for waters in the Mackenzie River Sub-basin, and they are listed under Schedule 1 of EPP Water. Refer to Section 3 for further details.

2.2.1.4 Manual for Assessing Consequence Categories and Hydraulic Performance of Structures

The Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (the Manual) (DES, 2016) defines the methodology and assessment criteria to determine if a structure associated with an ERA should be regulated under the EP Act. The Manual details the hydraulic design requirements for regulated structures and has been used as a reference in the preliminary design of the water management system and preliminary sizing of dams associated with the Project.

2.2.1.5 Guideline - Application Requirements for Activities with Impacts to Water

This guideline focuses on the types of impacts that environmentally relevant activities (ERAs) can have on water and outlines the information to be provided to the department as part of the ERA application process.

Section 4 of the guideline requires the applicant to provides details on a number of surface water-related issues, including:

- Discharges and releases;
- Unplanned and uncontrolled releases;
- Water infrastructure;
- Wetlands;
- Hydrology of receiving waters; and
- Mixing zones.

The guideline also refers to the department's technical guideline "Wastewater releases to Queensland waters", which is discussed in Section 2.2.1.6.

2.2.1.6 Technical Guideline - Wastewater Release to Queensland Waters

This guideline is provided to support a risk-based assessment approach to licensing releases of wastewater to surface water and applies the philosophy of the ANZECC & ARMCANZ (2000) Water Quality Guidelines and the intent of the Environmental Protection (Water) Policy 2009.

The information requirements identified in this guideline are as follows:

- Describe the proposed activity.
- Describe the receiving environment.
- Predict outcomes or impacts of the proposed wastewater release.
- Set circumstances, limits and monitoring conditions.

The Project's accommodation village will comprise a small sewage treatment plant. Waste sludge is expected to be removed for disposal by a regulated waste contractor. Treated effluent will be irrigated to a designated area in accordance with accepted conditions.

2.2.2 Water Act 2000

In Queensland, the Water Act 2000 (Water Act) is the primary statutory document that establishes a framework for the planning, allocation and use of non-tidal water. The Water Act is primarily administered by the Department of Natural Resources, Mines and Energy (DNRME) and the Department of Energy and Water Supply (DEWS).

The main purpose of the Water Act is to provide a framework for the following:

- The sustainable management of Queensland's water resources and quarry material by establishing a system for:
    - The planning, allocation and use of water; and
    - The allocation of quarry material and riverine protection.
- The sustainable and secure water supply for the south-east Queensland region and other designated regions;
- The management of impacts on underground water caused by the exercise of underground water rights by the resource sector; and

- The effective operation of water authorities.

A watercourse is defined by the Water Act as a river, creek or stream in which water flows permanently or intermittently and includes the bed and banks and any other element of a river, creek or stream confining or containing water.

The diversion of drainage features does not require authorisation under the Water Act.

2.2.2.1 Water Plan (Fitzroy Basin) 2011

The Water Plan (Fitzroy Basin) 2011, which replaces the Water Resource (Fitzroy Basin) Plan 2011, is subordinate legislation to the Water Act. The plan is developed and administered by DNRME. The purpose of the plan is:

- To define the availability of water in the Fitzroy Basin;
- To provide a framework for sustainably managing water and the taking of water;
- To identify priorities and mechanisms for dealing with future water requirements;
- To provide a framework for establishing water allocations;
- To provide a framework for reversing, where practicable, degradation in natural ecosystems;
- To regulate the taking of overland flow water; and
- To regulate the taking of groundwater.

The Project is located in the area managed by the Water Plan (Fitzroy Basin) 2011 that manages overland flow. Works on drainage features that capture overland flow must meet the requirements of the plan and may require authorisation under the Water Act.

2.2.2.2 Water Regulation 2016

Water Regulation 2016 is subordinate legislation to the Water Act and provides details, protocol and instruction for the following:

- Water rights and planning;
- Statutory authorisations to take or interfere with water;
- Matters relating to water licenses;
- Water allocations;
- Water supply and demand management;
- Declarations about watercourses.

2.2.3 Water Supply (Safety & Reliability) Act 2008

The Water Supply (Safety and Reliability) Act 2008 provides for the safety and reliability of water supply in Queensland. The purpose is achieved primarily by:

- Providing a regulatory framework for providing water and sewerage services in the State;
- Providing a regulatory framework for providing recycled water and drinking water quality, primarily for protecting public health;
- The regulation of referable dams; and
- Stating flood mitigation responsibilities.

3 Environmental Values

The Project is located within the Mackenzie Southern Tributaries (refer section 2.2.1.3) of the Mackenzie River sub-basin shown in Figure 3.1. The following EVs have been nominated broadly to the mapped areas for protection of zone:

- Aquatic ecosystems;
- Farm supply/use;
- Stock Water;
- Human consumption;
- Primary recreation;
- Secondary recreation;
- Visual recreation;
- Drinking water;
- Industrial use;
- Cultural and spiritual values.

The following WQOs for the above EVs are provided in Table 3.1. Where different EVs have different WQOs the lowest value has been adopted. WQOs are displayed for physio-chemical parameters only.

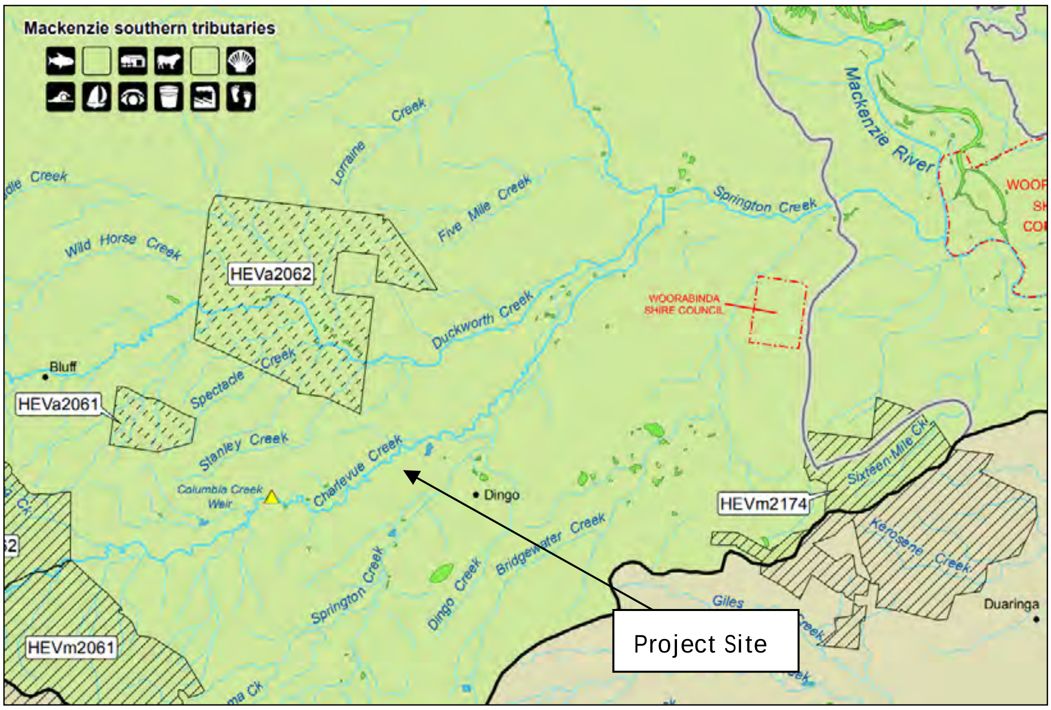


Figure 3.1 - Mackenzie River Sub-basin EVs

Table 3.1 - Water Quality Objectives for the Mackenzie River sub-basin

Parameter	WQO	Relevant EV
Ammonia N	< 20 µg/L	Aquatic ecosystem
Oxidised N	< 60 µg/L	Aquatic ecosystem
Organic N	< 420 µg/L	Aquatic ecosystem
Total nitrogen	< 500 µg/L	Aquatic ecosystem
Filterable Reactive Phosphorus (FRP)	< 20 µg/L	Aquatic ecosystem
Total Phosphorus	< 50 µg/L	Aquatic ecosystem
Chlorophyll a	< 5 µg/L	Aquatic ecosystem
Dissolved oxygen	85-110% saturation > 4 mg/L at surface	Aquatic ecosystem Drinking water
Turbidity	< 50 NTU	Aquatic ecosystem
Suspended solids	< 55 mg/L	Aquatic ecosystem
pH	pH 6.5-8.5	Aquatic ecosystem
Conductivity (EC) baseflow	720 µS/cm	Aquatic ecosystem
Conductivity (EC) high flow	250 µS/cm	Aquatic ecosystem
Sulphate	25 mg/L	Aquatic ecosystem
Total Dissolved Solids	< 2000 mg/L	Stock watering
Colour	50 Hazen Units	Drinking water
Total Hardness	150 mg/L as $CaCO_3$	Drinking water
Sodium	< 30 mg/L	Drinking water
Aluminium	< 5 mg/L < 0.055 mg/L	Stock watering Aquatic ecosystem
Arsenic	2.0 mg/L 0.5 mg/L up to 5 mg/L < 0.024 mg/L	Irrigation, Stock watering Aquatic ecosystem
Beryllium	< 0.5 mg/L	Irrigation
Boron	< 5 mg/L < 0.37 mg/L	Stock watering Aquatic ecosystem
Cadmium	< 0.01 mg/L < 0.0002 mg/L	Stock watering Aquatic ecosystem
Chromium	< 1 mg/L < 0.001 mg/L	Stock watering Aquatic ecosystem
Cobalt	< 0.1 mg/L	Irrigation
Copper	< 1 mg/L < 0.0014 mg/L	Stock watering (cattle) Aquatic ecosystem
Fluoride	< 2 mg/L	Irrigation
Fluoride	< 2 mg/L	Irrigation
Fluoride	< 2 mg/L	Irrigation
Iron	< 10 mg/L	Irrigation
Lead	< 0.1 mg/L < 0.0034 mg/L	Stock watering, Aquatic ecosystem
Lithium	< 2.5 mg/L	Irrigation
Manganese	< 10 mg/L < 1.9 mg/L	Irrigation Aquatic ecosystem
Mercury	< 0.002 mg/L < 0.00006 mg/L	Irrigation Aquatic ecosystem
Molybdenum	< 0.05 mg/L	Irrigation
Nickel	< 1 mg/L < 0.011 µg/L	Stock watering Aquatic ecosystem
Selenium	< 0.02 mg/L < 0.005 mg/L	Stock watering, Aquatic ecosystem
Uranium	< 0.1 mg/L	Irrigation
Vanadium	< 0.5 mg/L	Irrigation
Zinc	< 5 mg/L < 0.008 mg/L	Irrigation Aquatic ecosystem

3.1 AQUATIC ECOSYSTEM ENVIRONMENTAL VALUES

3.1.1 Fitzroy Basin Aquatic Ecosystem Health

The Fitzroy Partnership for River Health is a collaboration between Government, industry, research organisations and community to facilitate improved water quality monitoring, collate and assess data, and publicly report on waterway health and sustainable use.

The Partnership compiles water quality, biological and ecological health data for all waterways in the Fitzroy Basin and assigns them one of the following grades:

a. Excellent. All water quality and biological health indicators meet desired levels.
b. Good. Most water quality and biological health indicators meet desired levels.
c. Fair. There is a mix of good and poor levels of water quality and biological health indicators.
d. Poor. Some or few water quality and biological health indicators meet desired levels.
e. Fail. Very few or no water quality and biological health indicators meet desired levels.

In 2017-18 the Fitzroy Basin (including the Mackenzie River tributaries covering the Project area) received a C grade for aquatic ecosystem health. The Mackenzie Basin was graded C overall. It was graded B for physical/chemical and nutrients, C for toxicants and D for ecology. It was graded B for stock use and A for cropping use.

3.1.2 Aquatic ecology assessment of the Project area

Baseline aquatic ecology surveys for the Project were undertaken by AARC, and details of the results are provided in a separate report. The following extract from that report summarises the aquatic values of the Project area.

Extensive clearing for agricultural purposes has been undertaken across much of the study area including the removal of riparian vegetation. The removal of riparian vegetation and direct stock access to the waterways has resulted in bank instability, erosion and occurrence of weeds.

Stream sediments were found to contain a high proportion of sand particles with some sites containing a mixture of silt and clay. Metal concentrations in stream sediment were generally low, except for nickel levels at site DWR6.

Macroinvertebrate diversity, abundance and PET richness were generally low. SIGNAL scores were correspondingly low and consistent with the expected results for ephemeral streams in an agricultural setting. The AusRivAS predictive modelling assessed the aquatic environments at the sample sites as significantly impaired to highly degraded. While impaired habitats are common in ephemeral creeks, the extent and severity of the impairment indicates low waterway health.

The diversity and abundance of fish and crustaceans was found to be low.

4 Existing surface water environment

4.1 LOCAL CLIMATE - RAINFALL AND EVAPORATION DATA

Figure 4.3 shows locations of Bureau of Meteorology (BOM) and DNRME rainfall and evaporation recording stations with a significant period of record near the Project. Table 4.1 shows summary details of these stations.

Table 4.2 shows the variability in monthly rainfall at Dingo Post Office, which is the nearest rainfall station.

Table 4.1 - Rainfall stations in the vicinity of the Project

Station No.	Station Name	Data Obtained	Elevation (mAHD)	Distance from Project (km)	Opened	Lat	Long
035025	DINGO POST OFFICE	Rainfall	110	15	1896	-23.65	149.33
035172	MELMOTH	Rainfall	122	17	1914	-23.45	149.26
035186	BLACKDOWN TABLELAND AL	Rainfall	952	20	2010	-23.77	149.12
035132	NEW CALEDONIA	Rainfall	152	33	1968	-23.43	148.93
035134	BLACKWATER AIRPORT	Rainfall/Evap	193	40	2013	-23.60	148.81

Table 4.2 - Monthly Rainfall Statistics for Dingo Post Office (mm/month)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	111.6	110	74.8	37.1	33.4	35.4	26.8	22.5	25.3	46.2	64.5	101	685.4
Lowest	0	0	0	0	0	0	0	0	0	0	0	0	237.6
5th %ile	10.8	6.7	3.9	0	0	0	0	0	0	0	4.9	6.7	331.6
10th %ile	25.6	15	6.9	0	0	0	0	0	0	5.7	7.5	21.1	395.7
Median	90.9	84.4	53.3	19.8	16.1	26	11.5	16.4	10.1	30.6	52.8	94	659.6
90th %ile	222	245.4	167.1	92.4	76.3	87.3	69.2	54.4	75.6	98.5	140.9	185.2	993.1
95th %ile	264.1	281.5	197.9	135.4	118.2	106.8	100.3	76.4	92	130.5	165.9	226.5	1072.9
Highest	672.6	513.4	313.8	305.6	259.1	197.9	270	120.7	220.9	207.4	217.5	409.1	1351.1

Long term daily rainfall and evaporation data for the area from January 1889 to August 2019 (130 years) was obtained from the SILO (https://www.longpaddock.qld.gov.au/silo/). This data set is corrected for accumulated daily rainfall totals and missing data and is well suited to use in water balance modelling. Annual rainfall is presented in Figure 4.1. Monthly average rainfall and evaporation are shown in Figure 4.2. Average annual rainfall is 692 mm/a and average annual (pan) evaporation is 2,053 mm/a.

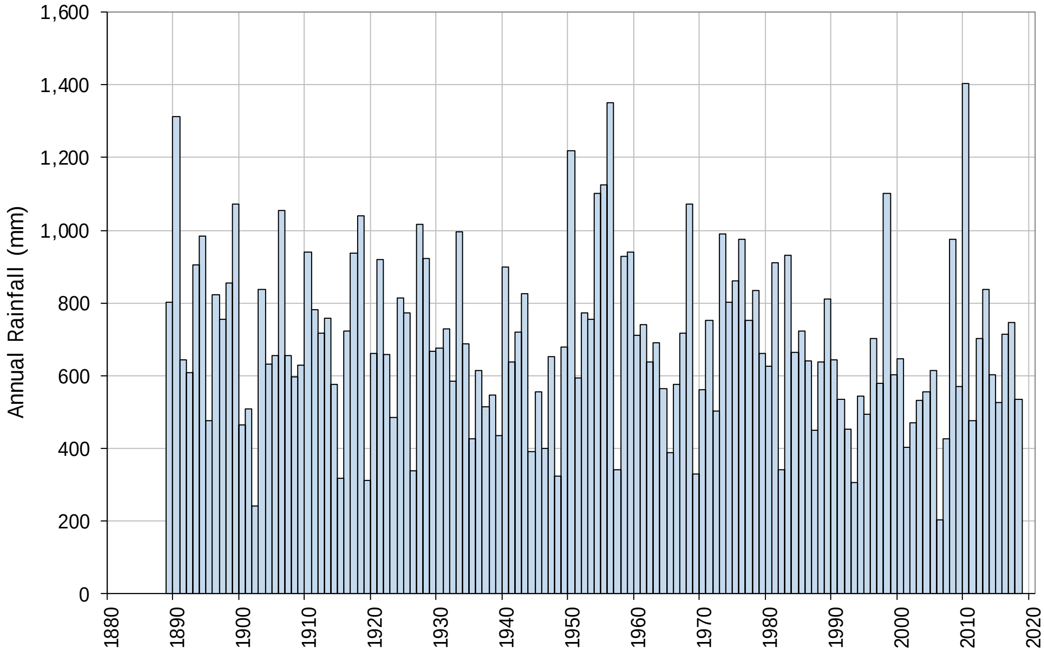


Figure 4.1 - Annual rainfall at Dingo Post Office - 1889 to 2019 (SILO)

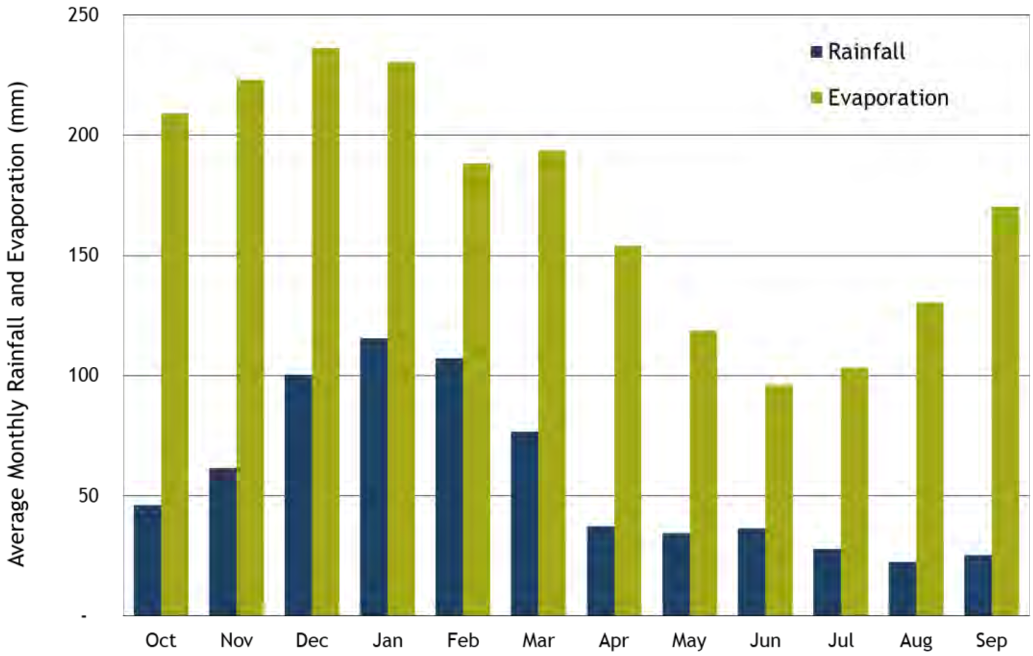


Figure 4.2 - Average monthly rainfall and pan evaporation at Dingo Post Office

4.2 CATCHMENT CONTEXT

As shown in Figure 4.3, the Project area is in the upper Mackenzie River catchment - part of the Fitzroy River Basin.

The Project area is in the catchment of Springton and Charlevue Creeks. Springton Creek joins the Mackenzie River approximately 47 km downstream of the Project. The upstream extent of the Fitzroy River is at the Dawson River/Mackenzie River. The Fitzroy River flows to the ocean east of the City of Rockhampton, approximately 400 km downstream of the Project area, and has a total catchment area of approximately 143,000 km^2. The total catchment area of the Mackenzie River sub-basin (including the catchments of the Nogoa and Comet Rivers) is 12,989 km^2.

As shown in Figure 4.4, the streams crossing the Project area (which include Charlevue Creek and Springton Creek) flow generally northeast, where Charlevue Creek joins Springton Creek approximately 3.6 km downstream of the Project, then later joins the Mackenzie River (Figure 4.4).

The Project mining lease application area is approximately 55.7 km^2. Charlevue Creek has a catchment area of approximately 343 km^2 to its confluence with the Springton Creek crossing the Project area and Springton Creek has a catchment area of 325 km^2 to the confluence with Charlevue Creek.

All waterways of the Project area are ephemeral and experience flow only after sustained or intense rainfall in the catchment. Stream flows are highly variable, with most channels drying out during winter to early spring when rainfall and runoff is historically low, although some pools hold water for extended periods. Therefore, physical attributes, water quality, and the composition of aquatic flora and fauna communities are also expected to be highly variable over time.

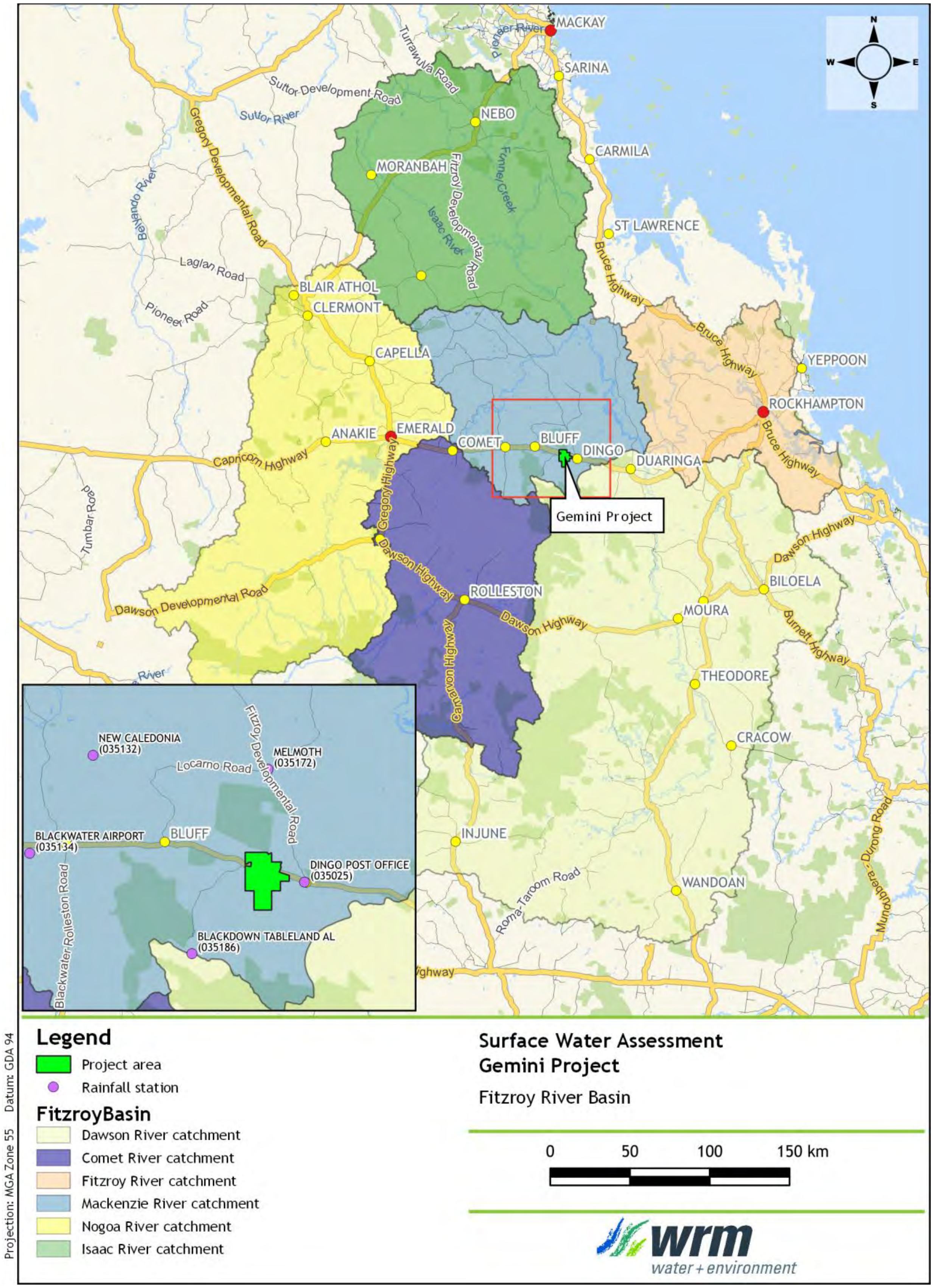


Figure 4.3 - Fitzroy River Basin

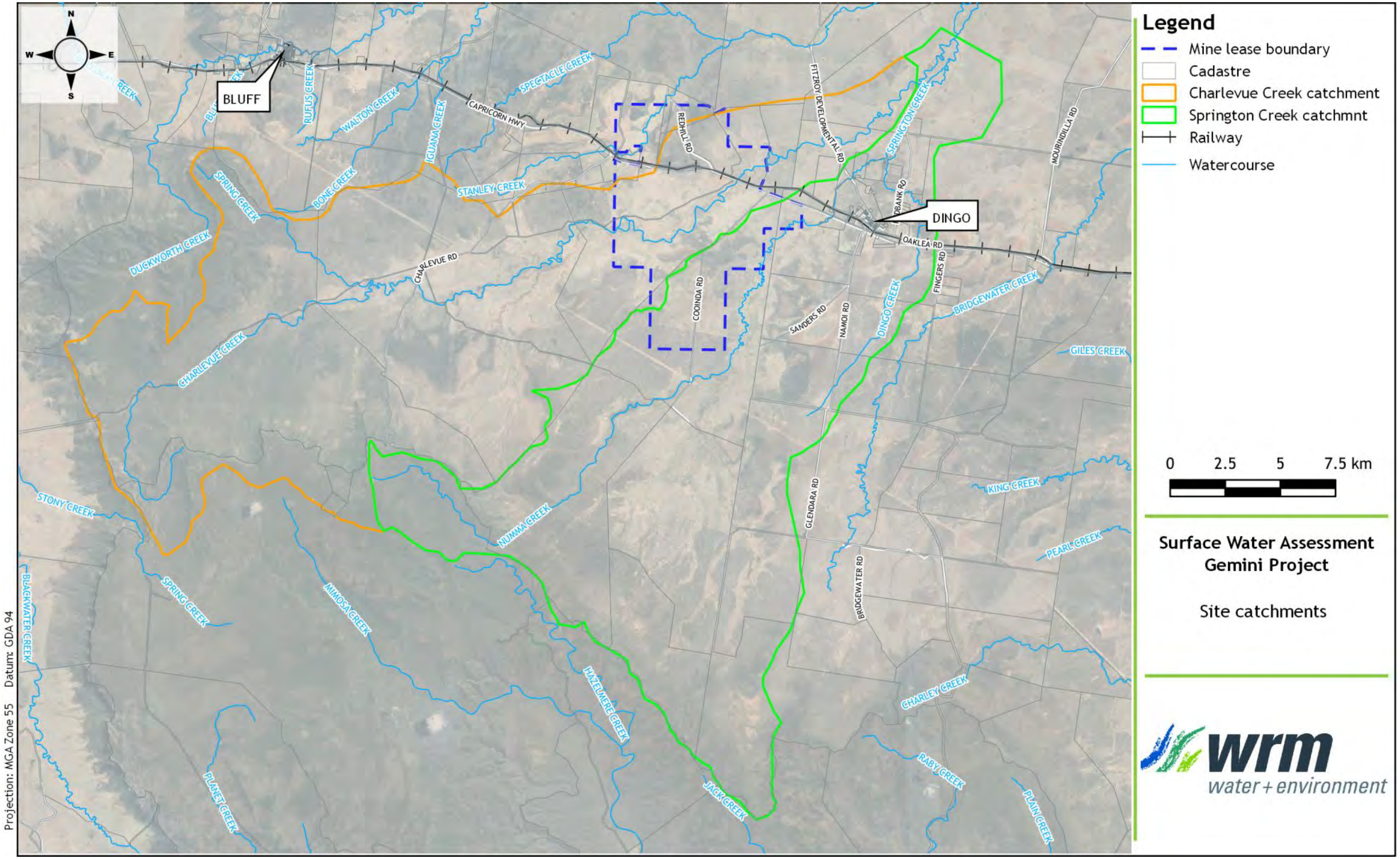


Figure 4.4 - Site catchments

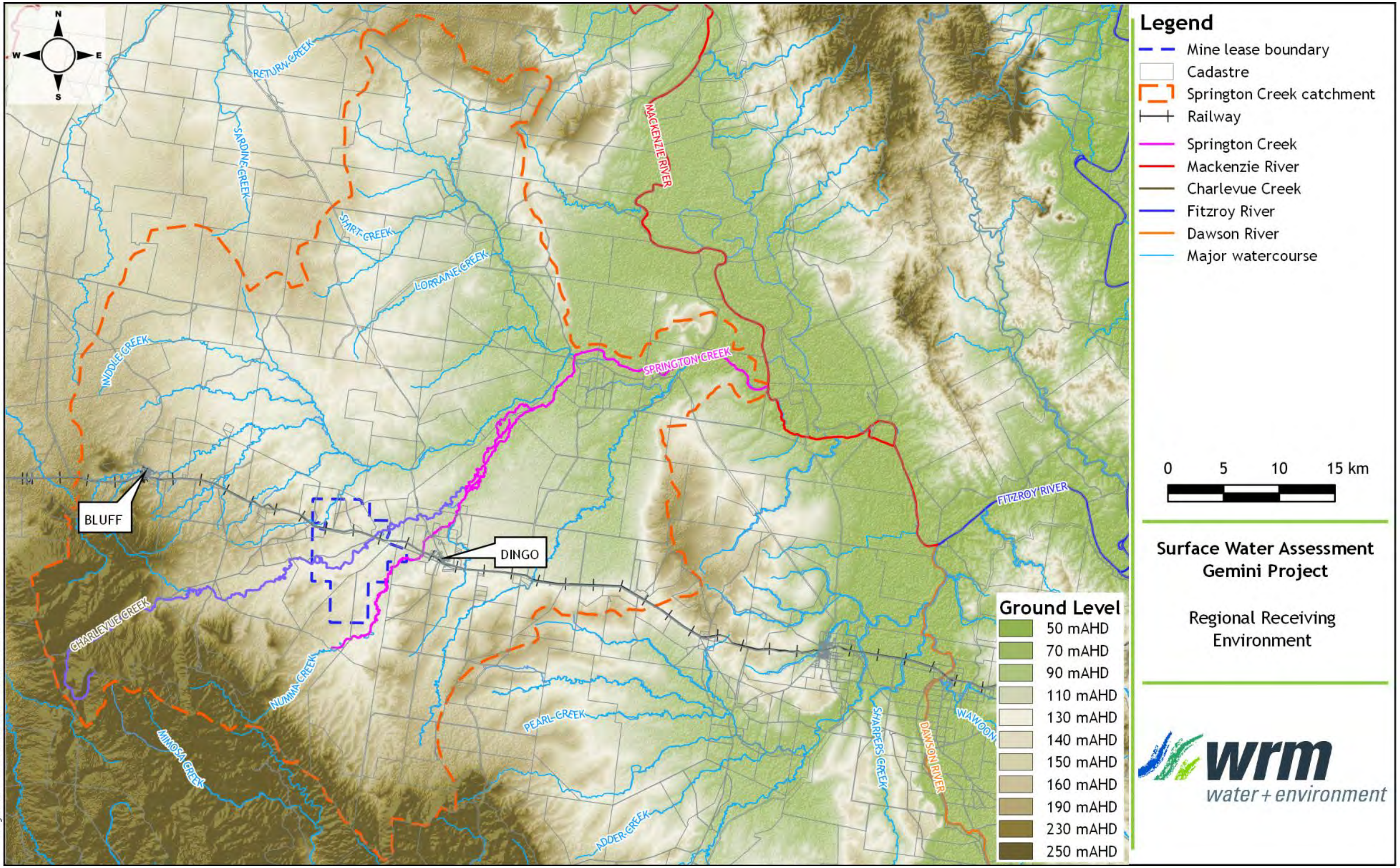


Figure 4.5 - Regional receiving environment

4.3 LOCAL STREAM MORPHOLOGY

The Project area is located within the Central Highlands region of the central Bowen Basin. The Bowen Basin is an early Permian to middle Triassic basin, extending through eastern Queensland from Collinsville in the north to Goondiwindi in the south.

The local stratigraphy typically comprises Permian coal measures overlain by Triassic and Tertiary sediments.

All nearby drainage features are ephemeral. In the Project area, Springton Creek and Charlevue Creek cross alluvial floodplains. The reaches of Springton Creek and Charlevue Creek in the proposed mining area have well-defined channels, typically with alluvial clay beds and well established in-channel vegetation.

Figure 4.6 - Drone photograph looking south across along Charlevue Creek across the Capricorn Highway to the Project area (source: Magnetic South Pty Ltd)

Figure 4.7 - Drone photograph looking southwest along Charlevue Creek at the site of the proposed haul road crossing (source: Magnetic South Pty Ltd)

Figure 4.8 - Photograph of Charlevue Creek channel upstream of the mine area (source: aarc)

Figure 4.9 - Photograph of Charlevue Creek channel upstream of the mine area (source: aarc)

Figure 4.10 - Drone photograph looking south along Springton Creek near the proposed location of AB Pit (source: Magnetic South Pty Ltd)

Figure 4.11 - Photograph of Springton Creek channel near proposed AB Pit location (source: aarc)

Figure 4.12 - Photograph of Springton Creek channel and floodplain near proposed AB Pit location (source: aarc)

Figure 4.13 - Drone photograph looking southeast to Springton Creek at confluence of unnamed tributary crossing proposed AB Pit (source: Magnetic South Pty Ltd)

Figure 4.14 - Drone photograph looking northeast along upper reach of the unnamed tributary of Springton Creek crossing proposed C Pit (source: Magnetic South Pty Ltd)

4.4 STREAMFLOW

There are no streamflow gauges located in the local catchments in the vicinity of the Project. The local streams are ephemeral, and based on the observed behaviour of other streams in the region, streamflow mostly occurs shortly after rainfall between September and April.

4.5 FLOODING

A flood study has been undertaken for this assessment. The extent, depth and velocity of flooding across the MDL in the 1% AEP flood are shown in Figure 4.15 and Figure 4.16. The full details of the flood study are provided in Appendix A.

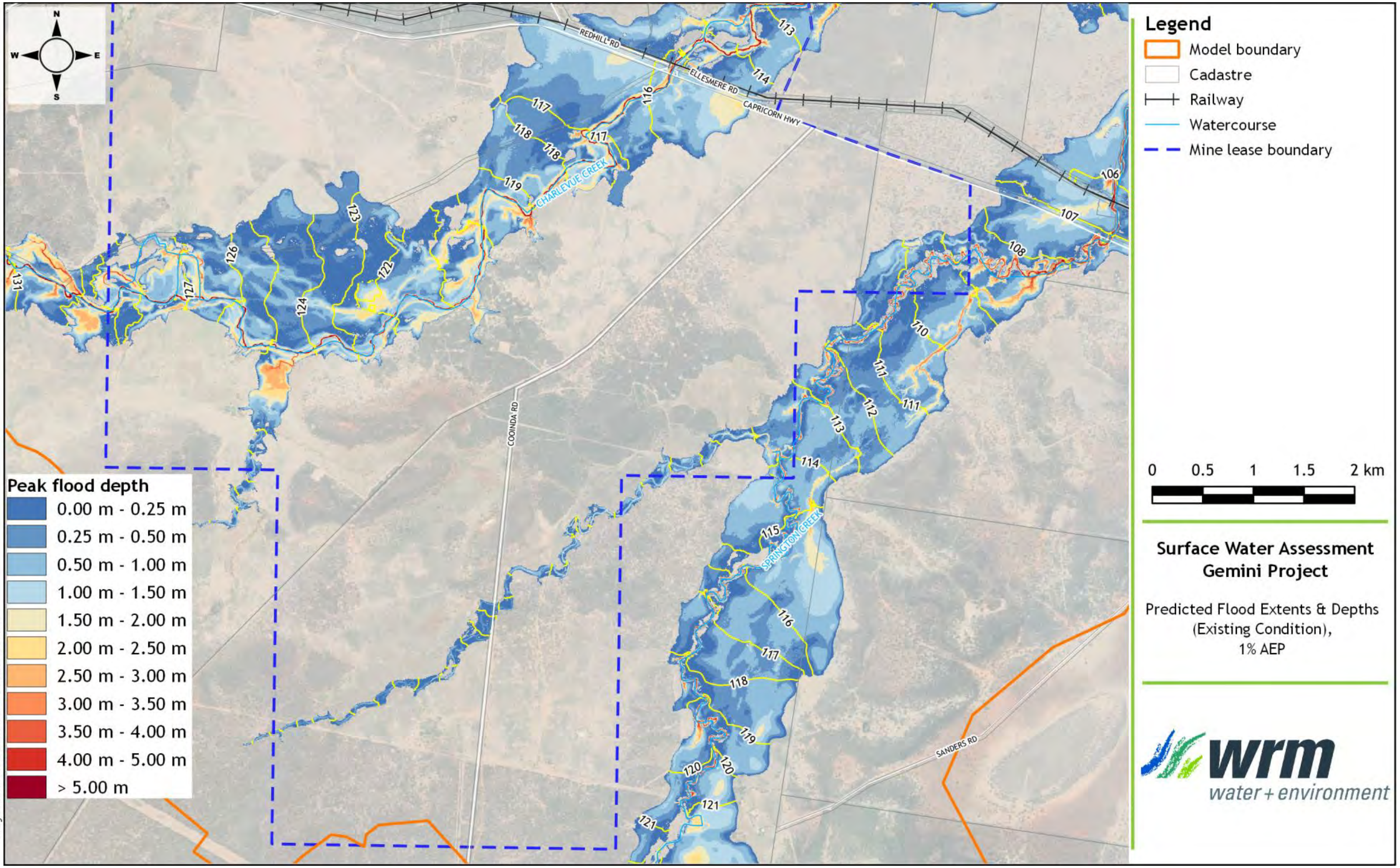


Figure 4.15 - Existing conditions 1% AEP flood depths and water level contours

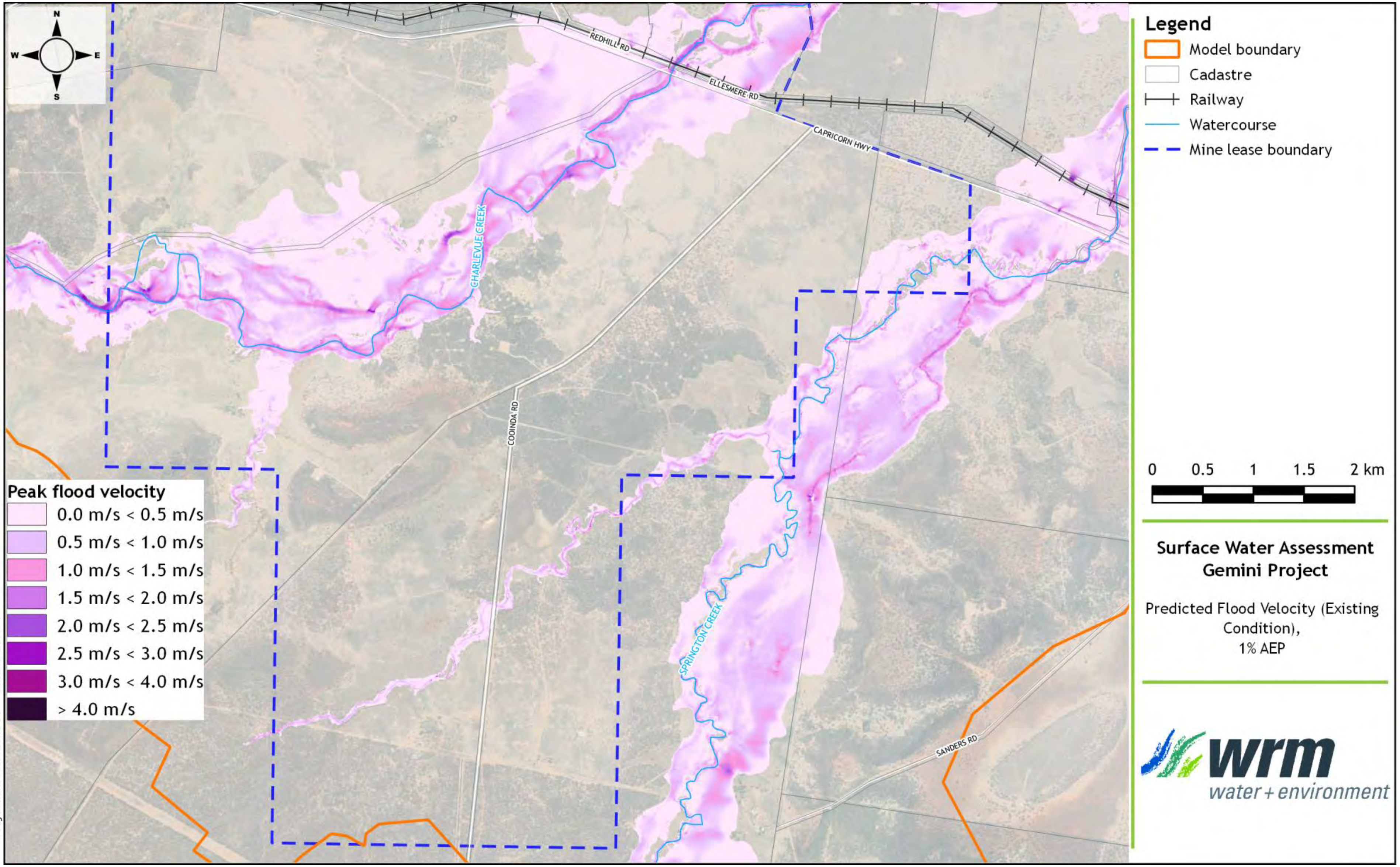


Figure 4.16 - Existing conditions 1% AEP flood velocities

4.6 WATER QUALITY

4.6.1 Baseline quality of receiving waters

Water quality of the region is variable and dependent on antecedent flow conditions and site-specific factors, such as adjacent land use and site disturbances.

A baseline water quality monitoring program has been implemented for the Project, and limited water quality data is available to characterise site water quality

AARC (2019) provided the results of laboratory testing of field samples taken in Charlevue Creek and Springton Creek in late February 2018 and mid April 2019. The results for some key physico-chemical parameters can be summarised as follows:

- electrical conductivity (EC) within the WQO (i.e. 72 - 138 µS/cm);
- turbidity and suspended solids higher than the WQO (i.e. 422 - 5,630 NTU and 58 - 6,170 mg/L respectively);
- pH generally within but occasionally lower than the WQO (i.e. 6.1 - 7.3).

Surface water quality was found to be generally poor. Exceedances of the turbidity WQO were observed across all sites. Low DO levels were also recorded in stagnant pools along ephemeral the waterways. However, at the time of sampling there was no surface flow, and as such, these exceedances are not reliable indicators of long-term system health.

Petroleum hydrocarbon concentrations in Charlevue Creek and Springton Creek exceeded WQO values at downstream locations. These results may indicate an existing local source of petroleum hydrocarbons. Possible sources include crude oil, heavy fuel oils, lubricating oils, asphalt. The Capricorn Highway is a possible point source for the petroleum hydrocarbons observed at nearby locations.

4.6.2 Geochemical characterisation of overburden

RGS undertook a geochemical assessment (RGS, 2018) of representative samples of mining waste materials for the project. The samples represented the main overburden, interburden and potential coal reject materials likely to be encountered. The main findings of the assessment are as follows:

- Initial and ongoing surface runoff and seepage from mining waste materials is expected to be moderately alkaline and have a moderate level of salinity.
- Kinetic leach column (KLC) test results indicate that mining waste materials are unlikely to generate acid conditions and are more likely to generate pH neutral to alkaline conditions.
- Metal/metalloid enrichment was limited to cobalt in a single carbonaceous siltstone sample. However, the nature of a coal deposit means some metals/metalloids are expected to be slightly elevated in some materials.
- Most metals/metalloids are sparingly soluble at the neutral to alkaline pH of leachate expected from bulk mining waste materials. Dissolved metal/metalloid concentrations in surface runoff and leachate from bulk mining waste materials are therefore expected to be low and unlikely to pose a significant risk to the quality of surface and groundwater resources at relevant storage facilities.
- Most mining materials appear susceptible to dispersion and erosion, and appropriate management processes will need to be developed based on field trials for progressive rehabilitation of these materials during operations and at mine closure.
- Mining waste materials should be amenable to revegetation as part of rehabilitation activities, although, gypsum and fertiliser addition may need to be considered for sodic materials to limit dispersion and erosion and to provide a reasonable growth medium for revegetation and rehabilitation.

5 Proposed water management strategy

5.1 SITE WATER TYPES

Land disturbance associated with mining has the potential to adversely affect the quality of surface runoff in downstream receiving waters through increased sediment loads. In addition, runoff from active mining areas (including coal stockpiles, etc.) may have increased concentrations of salts and other pollutants when compared to natural runoff.

For the purpose of site water management, site water has been classified into the types shown in Table 5.1 on the basis of the likely water quality characteristics.

Table 5.1 - Site water types

Water Type	Definition
Mine affected water	In accordance with the DEHP Guideline Model Mining Conditions, mine affected water means the following types of water: i) pit water, tailings dam water, processing plant water; ii) water contaminated by a mining activity which would have been an environmentally relevant activity under Schedule 2 of the Environmental Protection Regulation 2008 if it had not formed part of the mining activity; iii) rainfall runoff which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated, excluding rainfall runoff discharging through release points associated with erosion and sediment control structures that have been installed in accordance with the standards and requirements of an Erosion and Sediment Control Plan to manage such runoff, provided that this water has not been mixed with pit water, tailings dam water, processing plant water or workshop water; iv) groundwater which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated; v) groundwater from the mine dewatering activities; vi) a mix of mine affected water (under any of paragraphs i to v) and other water.
Sediment water	Surface water runoff from areas that are disturbed by mining operations (including out-of-pit waste rock emplacements). This runoff does not come into contact with coal or other carbonaceous material and may contain high sediment loads but does not contain elevated level of other water quality parameters (e.g. electrical conductivity, pH, metals, metalloids, non-metals). This runoff must be managed to ensure adequate sediment removal prior to release to receiving waters.
Clean catchment water	Surface runoff from areas unaffected by mining operations. Clean catchment water includes runoff from undisturbed areas and fully rehabilitated areas.
Raw water	Untreated water, generally from an external water supply, that has not been contaminated by mining activities.
Potable water	Treated water suitable for human consumption.

The proposed strategy for the management of surface water at the Project is based on the separation of water from different sources based on anticipated water quality.

On the basis of the expected runoff and groundwater inflow quality, the site water management system separates water into two segregated management systems:

- Mine affected water system - which will manage runoff and seepage from the mine pits, CHPP, coal stockpiles, and MIA. This is a closed system designed to prevent releases of mine affected water to the environment.
- Sediment water system - runoff from overburden dumps will be managed under an erosion and sediment control plan which is to be implemented throughout the Project, such that sediment generated and transported by runoff will be settled in a sediment dam. As overburden runoff quality is expected to be relatively benign, the sediment dams will potentially discharge directly into the environment (after the settlement of suspended sediment), and as such, will not affect the mine water balance. However, the water balance assessment has also assumed sediment dams will be pumped back to the CHPP for reuse.

Clean water from undisturbed areas is generally diverted around the areas of disturbance. A raw water supply pipeline is proposed to supplement site water supplies, and will be delivered to a dedicated raw water dam, which will also intercept clean water from its local upstream catchment.

5.2 MINE DEVELOPMENT AND STAGING

Over the 18-year operating life of the Project, the operation will be staged as indicated in the following series of figures, which show the catchment areas to each mine water storage and the land use types comprising each catchment. These "snapshots" of mine operations have been adopted for the purpose of the site water balance modelling.

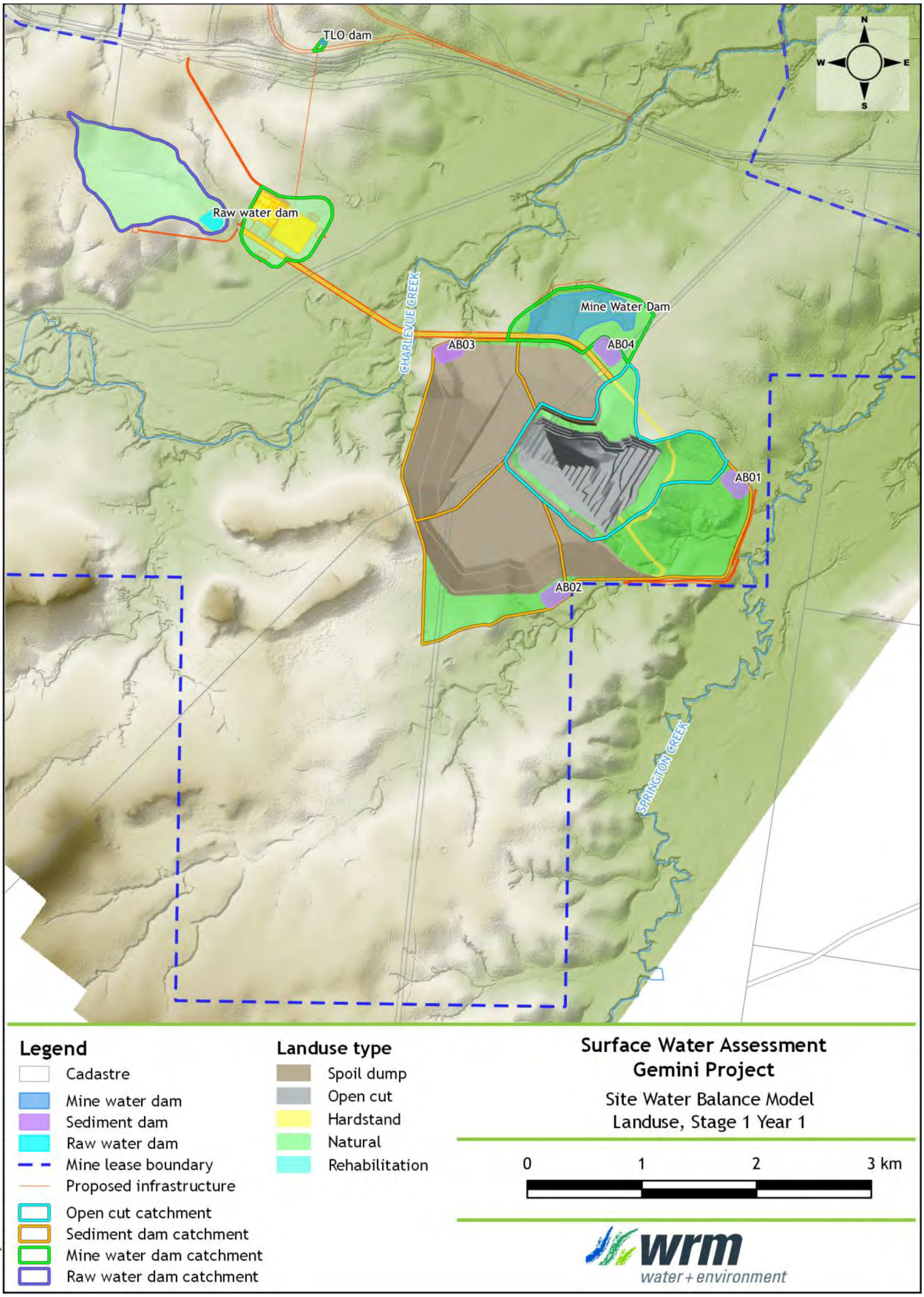


Figure 5.1 - Proposed water management system layout - Stage 1 (Year 1)

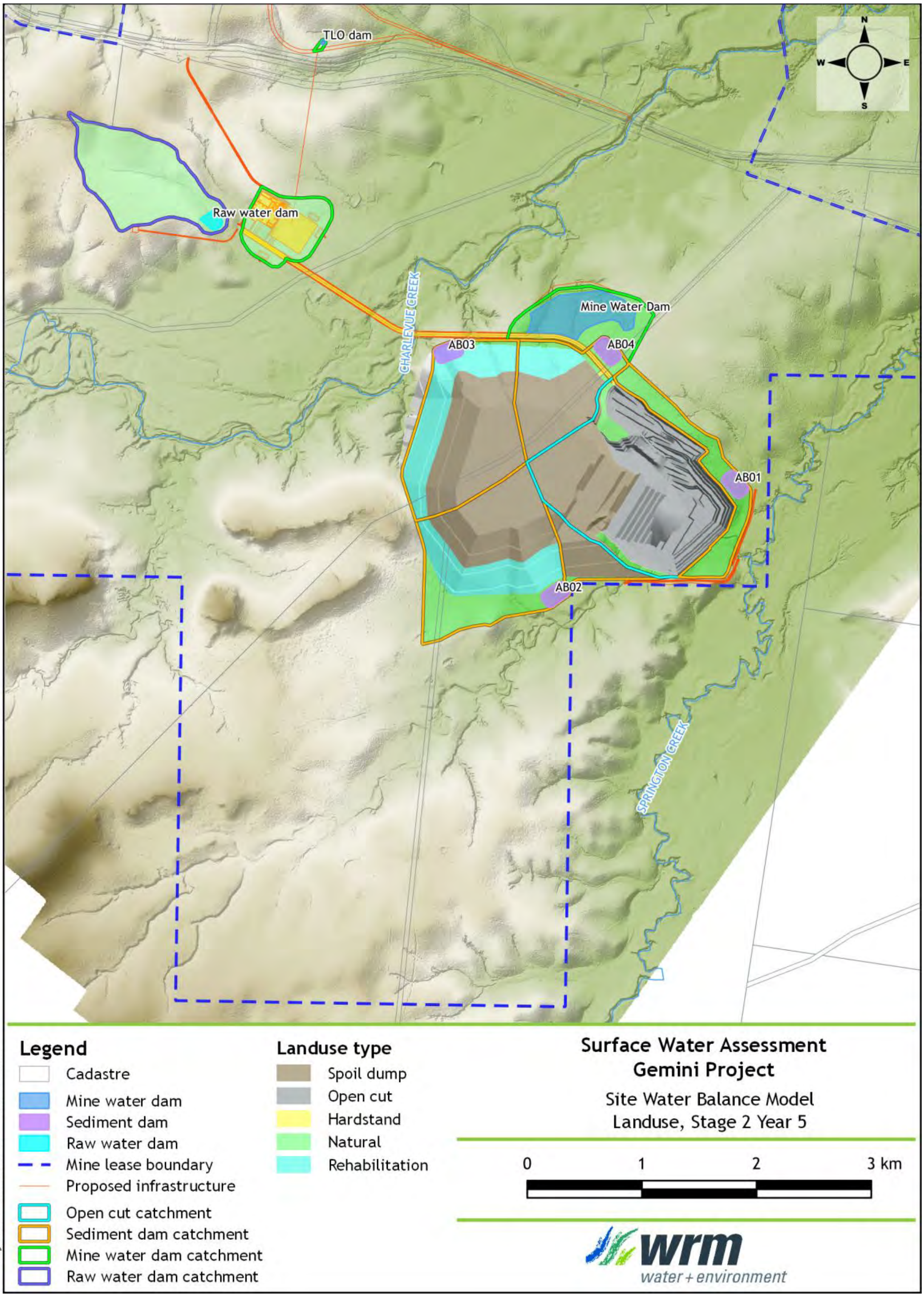


Figure 5.2 - Proposed water management system layout - Stage 2 (Year 5)

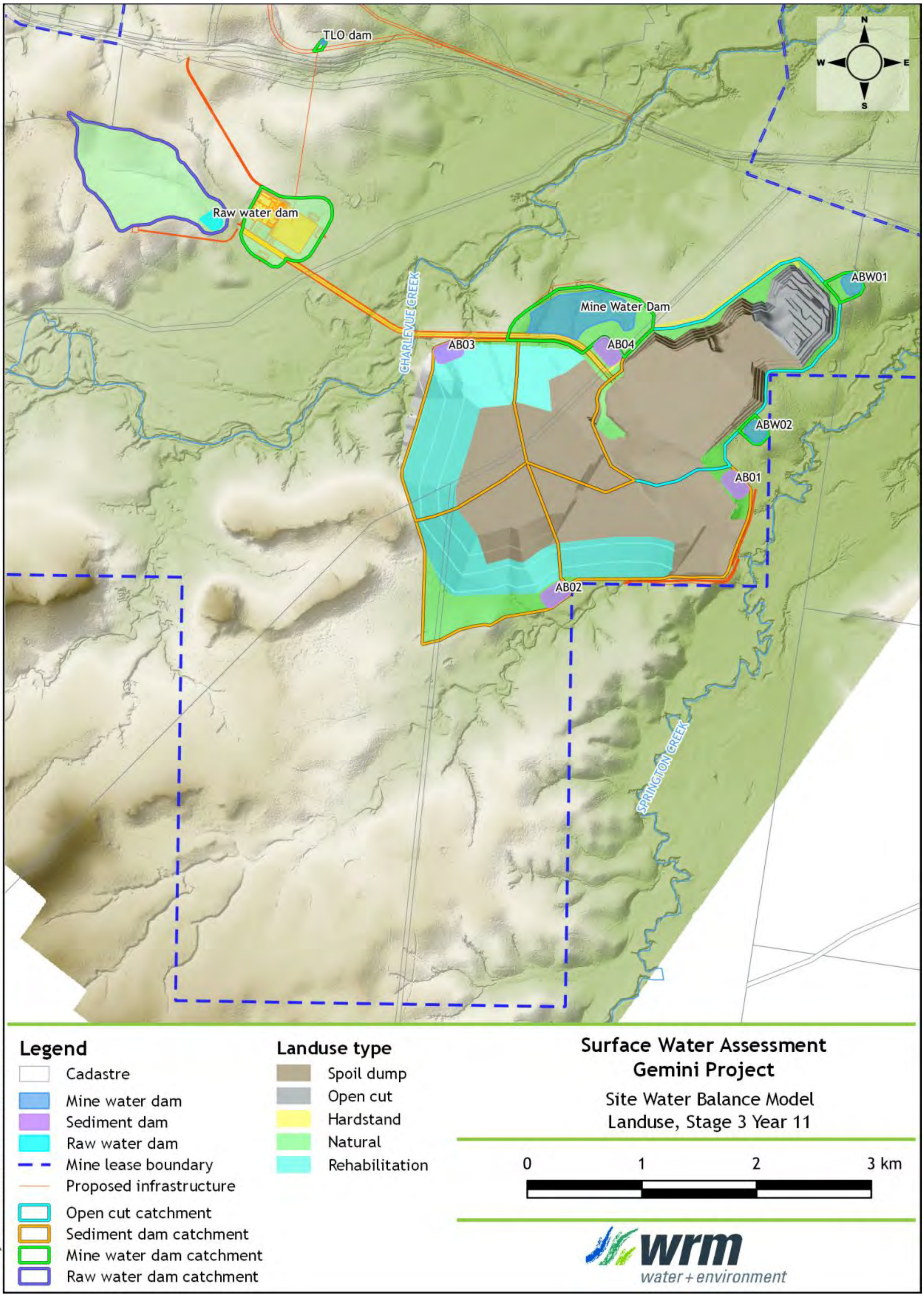


Figure 5.3 - Proposed water management system layout - Stage 3 (Year 11)

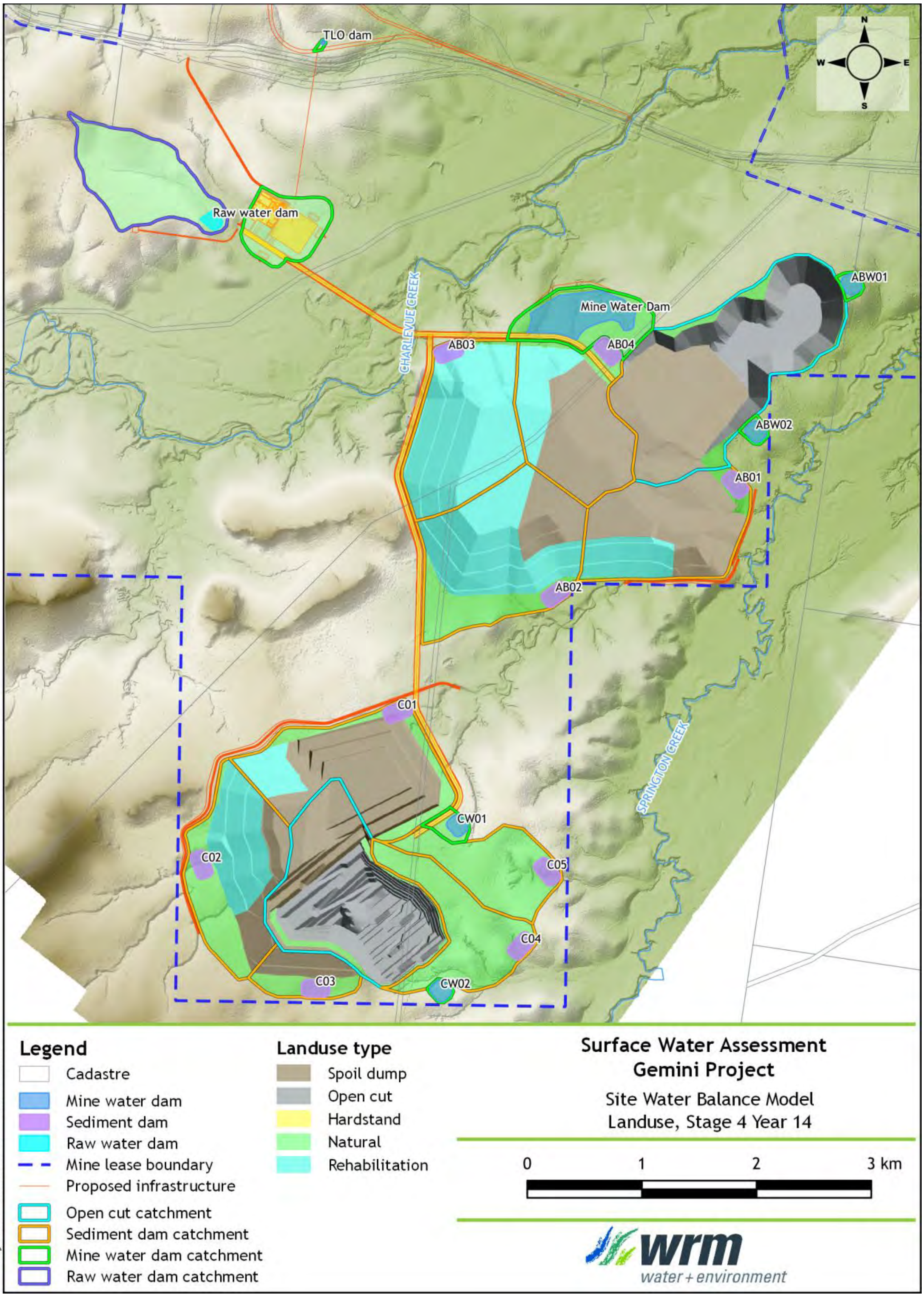


Figure 5.4 - Proposed water management system layout - Stage 4 (Year 14)

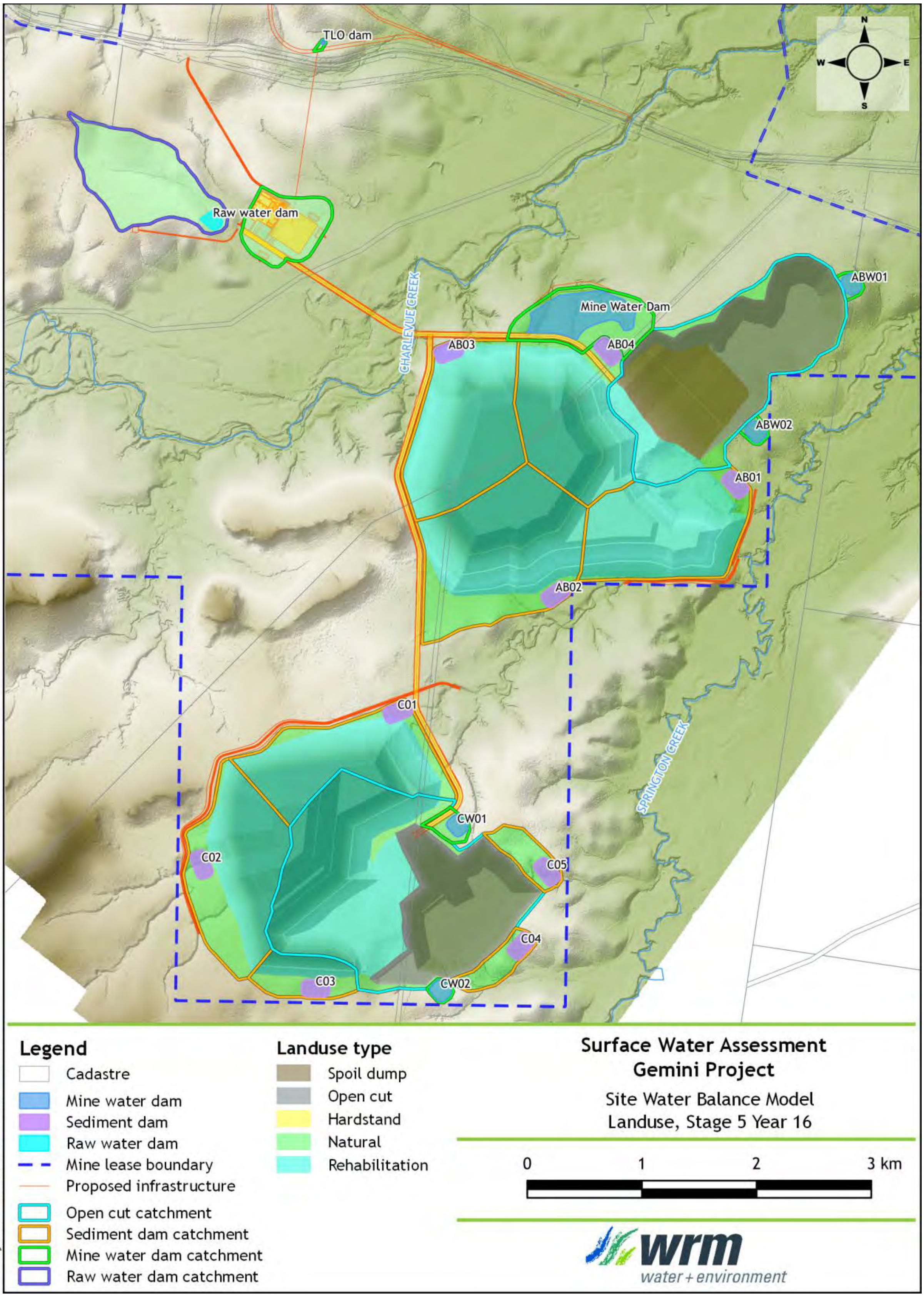


Figure 5.5 - Proposed water management system layout - Stage 5 (Year 16)

5.3 WATER MANAGEMENT SYSTEM COMPONENTS

5.3.1 Mine affected water dams

Several types of dams are proposed to hold mine affected runoff, including:

Raw Water Dam - Receives raw water imported via the offsite water supply pipeline. This dam will also capture clean surface runoff from its local undisturbed upslope catchment.

Mine Water Dam - receives pumped groundwater and surface runoff dewatered from AB Pit and C Pit. Water will be transferred from the Mine Water Dam for reuse at the CHPP and for other uses as required. Offsite discharge of mine water will be avoided by operating below a maximum operating level and directing emergency overflows from the Mine Water Dam via a spillway to the mine pit. If stored water quality allows, controlled mine water releases may be made to Charlevue Creek in accordance with the Environmental Authority (these releases have been conservatively excluded from the site water balance model to ensure water can be contained on site without release under historical climate conditions).

AB Pit - will be used as a supplementary mine water storage after commencement of mining in C Pit.

Out-of-pit mine water dams - a number of small staging dams may be used to collect water pumped from the mine pits before transferring to the Mine Water Dam. These dams are small and have not been included in the site water balance model. Offsite discharge of mine water from these dams will be avoided by directing emergency overflows via spillways to the mine pit.

MIA Dams - will capture and contain runoff from the MIA and coal stockpiles. Oil/water separators are proposed for vehicle wash and workshop areas to treat hydrocarbon contaminated runoff prior to capture. These dams will be sized and operated such that the risk of off-site release is very low.

TLO Dam - A series of sediment traps and small drainage dams will be used to capture washdown and overflow from trains and sumps before it is directed to the TLO Dam. Water collected in this small dam will pumped to the Mine Water Dam. The dams will be sized and operated such that the risk of off-site release is very low.

Table 5.2 - Gemini Project mine affected water dam details

Storage	Catchment area (ha)	Storage capacity (ML)
Mine Water Dam	50.3	1,000
MIA Dams	38.0	90
Raw Water Dam	78.1	56.6
TLO Dam	0.5	0.5

5.3.2 Sediment dams

Catchment runoff from overburden dumps at AB Pit and C Pit will be captured in sediment dams. Sediment dams will be designed and operated in accordance with the Department of Environment and Heritage Protection Guideline - *Stormwater and environmentally relevant activities (DEHP, 2017).*

This guideline states that"

"*For events up to and including a 24 hour storm event with an ARI of 1 in 10 years, the following must be achieved:*

i. a sediment basin must be designed, constructed and operated to retain the runoff at the site(s) approved as part of the ERA application;

ii. *the release stormwater from these sediment basins must achieve a total suspended solids (TSS) concentration of no more than 50mg/L for events up to and including those mentioned above. For events larger than those stated above, all reasonable and practical measures must be taken to minimise the release of prescribed contaminants."*

The sediment dams have therefore been sized as follows:

- Water storage capacity 1 in 10 AEP 24 hour storm event with and adopted volumetric event runoff coefficient for disturbed catchments of 0.5; and;
- total sediment basin volume = settling zone capacity + sediment storage volume. The sediment storage volume is the portion of the basin storage volume that progressively fills with sediment until the basin is de-silted;
- solids storage volume = 25% of water storage volume.

If required, water captured in sediment dams will be pumped back into the mine water system. Table 5.3 shows the required sediment dam volumes using this method.

Table 5.3 - Gemini Project sediment dam details

Storage	Catchment area (ha)	10year 24 hour water storage capacity (ML)	Solids storage volume (ML)	Total Storage capacity (ML)
AB01	146.1	105.9	26.5	132
AB02	155.5	112.7	28.2	141
AB03	121.8	88.3	22.1	110
AB04	114.9	83.3	20.8	104
C01	132.7	96.2	24.1	120
C02	106.8	77.4	19.4	97
C03	32.4	23.5	5.9	29
C04	76.0	55.1	13.8	69
C05	64.8	47.0	11.7	59

5.4 CATCHMENT AREAS AND LAND USE

A summary of adopted catchment areas and land use types for each stage are provided in Table 5.4 to Table 5.8. The proposed disturbance footprints are shown in Figure 5.1, Figure 5.2, Figure 5.3, Figure 5.4, and Figure 5.5.

Table 5.4 - Catchment areas and land use breakdown summary - Stage 1 - Year 1

Dam	Contributing catchment (ha)					
	Spoil dump	Open Cut	Road/ Hardstand	Natural	Rehabilitation	Total
AB01	21.8	-	3.4	79.1	-	104.3
AB02	98.0	-	-	37.2	-	135.2
AB03	117.6	-	-	2.5	-	120.1
AB04	34.9	-	1.3	10.5	-	46.7
C01	-	-	-	-	-	-
C02	-	-	-	-	-	-
C03	-	-	-	-	-	-
C04	-	-	-	-	-	-
C05	-	-	-	-	-	-
AB PIT	12.1	71.8	2.8	52.8	-	139.5
C PIT	-	-	-	-	-	-
ABW01	-	-	-	-	-	-
ABW02	-	-	-	-	-	-
CW01	-	-	-	-	-	-
CW02	-	-	-	-	-	-
Mine Water Dam	-	-	2.4	47.9	-	50.3
MIA Dam	-	-	17.1	21.0	-	38.1
TLO Dam	-	-	-	0.5	-	0.5
Raw Water Dam	-	-	-	78.1	-	78.1

Table 5.5 - Catchment areas and land use breakdown summary - Stage 2 - Year 5

Dam	Contributing catchment (ha)					
	Spoil dump	Open Cut	Road/ Hardstand	Natural	Rehabilitation	Total
AB01	20.8	-	-	1.7	-	22.5
AB02	58.3	-	-	37.2	38.7	134.2
AB03	73.1	-	-	2.5	46.2	121.8
AB04	42.0	-	1.3	10.3	12.6	66.2
C01	-	-	-	-	-	-
C02	-	-	-	-	-	-
C03	-	-	-	-	-	-
C04	-	-	-	-	-	-
C05	-	-	-	-	-	-
AB PIT	58.1	111.9	0.2	9.0	-	179.2
C PIT	-	-	-	-	-	-
ABW01	-	-	-	-	-	-
ABW02	-	-	-	-	-	-
CW01	-	-	-	-	-	-
CW02	-	-	-	-	-	-
Mine Water Dam	-	-	2.4	47.9	-	50.3
MIA Dam	-	-	17.1	21.0	-	38.1
TLO Dam	-	-	-	0.5	-	0.5
Raw Water Dam	-	-	-	78.1	-	78.1

Table 5.6 - Catchment areas and land use breakdown summary - Stage 3 - Year 11

Dam	Contributing catchment (ha)					
	Spoil dump	Open Cut	Road/ Hardstand	Natural	Rehabilitation	Total
AB01	102.4	-	-	10.6	33.2	146.2
AB02	44.0	-	-	37.2	51.5	132.7
AB03	32.7	-	-	2.5	86.6	121.8
AB04	59.6	-	1.4	9.7	20.6	91.3
C01	-	-	-	-	-	-
C02	-	-	-	-	-	-
C03	-	-	-	-	-	-
C04	-	-	-	-	-	-
C05	-	-	-	-	-	-
AB PIT	157.3	38.5	0.7	27.6	-	224.1
C PIT	-	-	-	-	-	-
ABW01	-	-	-	5.7	-	5.7
ABW02	-	-	-	3.9	-	3.9
CW01	-	-	-	-	-	-
CW02	-	-	-	-	-	-
Mine Water Dam	-	-	2.4	47.9	-	50.3
MIA Dam	-	-	17.1	21.0	-	38.1
TLO Dam	-	-	-	0.5	-	0.5
Raw Water Dam	-	-	-	78.1	-	78.1

Table 5.7 - Catchment areas and land use breakdown summary - Stage 4 - Year 14

Dam	Contributing catchment (ha)					
	Spoil dump	Open Cut	Road/ Hardstand	Natural	Rehabilitation	Total
AB01	79.6	-	-	9.7	27.0	116.3
AB02	29.4	-	-	37.2	88.9	155.5
AB03	-	-	-	2.5	119.3	121.8
AB04	71.9	-	1.2	10.5	31.1	114.7
C01	91.9	-	-	23.0	17.8	132.7
C02	26.3	-	-	37.8	48.6	112.7
C03	16.9	-	-	15.5	-	32.4
C04	-	-	-	76.0	-	76.0
C05	-	-	0.5	64.3	-	64.8
AB PIT	98.0	104.6	-	15.1	-	217.7
C PIT	49.2	98.6	-	11.3	-	159.1
ABW01	-	-	-	3.9	-	3.9
ABW02	-	-	-	3.9	-	3.9
CW01	-	-	0.9	6.4	-	7.3
CW02	-	-	-	3.2	-	3.2
Mine Water Dam	-	-	2.4	47.9	-	50.3
MIA Dam	-	-	17.1	21.0	-	38.1
TLO Dam	-	-	-	0.5	-	0.5
Raw Water Dam	-	-	-	78.1	-	78.1

Table 5.8 - Catchment areas and land use breakdown summary - Stage 5 - Year 16

Dam	Contributing catchment (ha)					
	Spoil dump	Open Cut	Road/ Hardstand	Natural	Rehabilitation	Total
AB01	-	-	-	9.7	106.7	116.4
AB02	-	-	-	37.2	118.3	155.4
AB03	-	-	-	2.5	119.3	121.8
AB04	-	-	1.3	10.5	103.2	115.0
C01	-	-	-	15.6	86.9	102.5
C02	-	-	-	37.8	74.9	112.7
C03	-	-	-	15.2	14.7	29.9
C04	-	-	-	15.7	-	15.7
C05	-	-	-	17.6	-	17.6
AB PIT	71.0	104.6	-	15.1	27.0	217.8
C PIT	-	115.7	0.1	15.8	165.2	296.8
ABW01	-	-	-	3.9	-	3.9
ABW02	-	-	-	3.9	-	3.9
CW01	-	-	0.9	6.4	-	7.3
CW02	-	-	-	3.2	-	3.2
Mine Water Dam	-	-	2.4	47.9	-	50.3
MIA Dam	-	-	17.1	21.0	-	38.1
TLO Dam	-	-	-	0.5	-	0.5
Raw Water Dam	-	-	-	78.1	-	78.1

6 Site water balance

6.1 WATER DEMANDS

6.1.1 Coal handling and preparation plant

The CHPP will comprise a dense medium cyclone / spirals / flotation plant. Flotation tailings, screen bowl effluent and concentrate, fines reject thickening cyclone overflow, fines reject screen undersize and belt press filter filtrate will be fed to a tailings thickener to separate solids. Solids from the tailings thickener will be processed with belt press filters to remove rejects from the flocculants.

The use of the belt press filters reduces the total water demand compared to traditional tailings disposal methods due to the low losses to waste moisture. The project description provides the following CHPP demand estimates throughout the project life, which includes allowance for coal crushing and conveyor dust suppression. Table 6.1 shows the details of forecast CHPP demands.

Table 6.1 - Forecast CHPP and TLO demands

Year	CHPP Demand (ML/a)	TLO Demand (ML/a)
1	162.0	0.72
2	162.0	0.73
3	162.0	0.73
4	162.0	0.73
5	162.0	0.73
6	162.0	0.72
7	162.0	0.72
8	162.0	0.71
9	162.0	0.72
10	162.0	0.72
11	162.0	0.70
12	162.0	0.74
13	162.0	0.74
14	162.0	0.74
15	162.0	0.74
16	162.0	0.72
17	162.0	0.74
18	143.4	0.65

6.1.2 Train loading operation (TLO)

TLO water demands for controlling dust generation for the TLO, rail loading and freight would be managed by:

- Shrouding and sprays on delivery/transfer to the loadout bin;
- During wagon loading;
- Telescopic chutes;
- Use of water sprays and surfactants;
- During freight - application of a veneer prior to departure;
- Removal of any wagon overload situations.

A 40L/wagon water demand is adopted, where a wagon contains 80 tonne of product coal. Table 6.1 shows the details of forecast CHPP demands.

6.1.3 Haul road dust suppression

The proposed mining schedule for the project includes starting mining at AB Pit and progressing to C Pit.

Mine affected water will be used as a priority for haul road dust suppression. Water for haul road dust suppression will be sourced from the Mine Water Dam which will be supplied with water from the operational pits and supplemented with sediment dam or raw water when required.

Haul Road water demand will be increasing throughout the project life where. Haul road dust suppression water demand is expected to commence at around 315 ML/a, and increases to approximately 512 ML/a at Stage 5.

6.1.4 Potable water demands

Potable water will be delivered to site by truck and stored in potable water tanks before distribution around the site using pressure pumps and small-bore poly pipes.

6.2 GROUNDWATER INFLOWS TO MINING PITS

Groundwater inflows were estimated by JBT Consulting Australia Pty Ltd (JBT, 2019). The estimates provided by JBT Consulting are net inflows to the pit after evaporation losses from the pit faces and the entrained moisture losses due to mining. The adopted net inflow rates are provided in Table 6.2.

Table 6.2 - Estimated net annual groundwater inflow to pits after losses

Year	AB Pit Net GW Inflow ML/a	C Pit Net GW Inflow ML/a
1	31.5	-
2	31.5	-
3	31.5	-
4	31.5	-
5	31.5	-
6	31.5	-
7	31.5	-
8	31.5	-
9	31.5	-
10	31.5	-
11	220.8	-
12	220.8	-
13	189.2	-
14	189.2	15.8
15	15.8	15.8
16	15.8	15.8
17	15.8	15.8
18	15.8	31.5

6.3 WATER BALANCE MODEL

A computer-based operational simulation model (OPSIM) was used to assess the dynamics of the mine water balance under conditions of varying rainfall and catchment conditions throughout the development of the Project. The OPSIM model dynamically simulates the operation of the water management system and keeps complete account of all site water volumes and representative water quality on a daily time step.

The model has been configured to simulate the operations of all major components of the water management system. The simulated inflows and outflows included in the model are given in Table 6.3.

Table 6.3 - Simulated inflows and outflows to the water management system

Inflows	Outflows
Direct rainfall on water surface of storages	Evaporation from water surface of storages
Catchment runoff	CHPP demand
Raw water supply	Haul road dust suppression demand
Groundwater inflows	TLO water demands
	Dam overflows

6.4 SIMULATION METHODOLOGY

6.4.1 Modelled staging of mine plans

The water balance model was run on a daily time step for an 18 year period, corresponding with the proposed mine life between Year 1 and Year 18. The model assumes that operations commence in January.

Catchment land use changes were assessed through the discrete stages, described in the previous section. These stages have been selected using the mining progression information, and provide a representative disturbance footprint for each stage.

6.5 CATCHMENT RUNOFF

6.5.1 Catchment runoff salinity

The OPSIM model includes a conservative salt balance with each catchment type assigned a fixed salinity.

Water samples taken from Springton and Charlevue Creeks had a median EC of 114 µS/cm (74 mg/L). For the purpose of the site salt balance, runoff from undisturbed (natural) catchments was assumed to have a salinity (EC) of 150 µS/cm.

Kinetic leach column (KLC) testing of the local overburden material (RGS, 2019) showed that leachate from all KLC samples (apart from the carbonaceous siltstone and coal) had initial EC values less than 800 µS/cm, and at the end of six months less than 203 µs/cm. Based on these results, for the purpose of the site salt balance, runoff from spoil was assumed to have a salinity of 600 µS/cm. Runoff from highwalls was assigned an EC of 8,000 µS/cm to account for potential contact with the coal seams, which would result in increased salinity, and hardstand areas were conservatively assigned an EC of 900 µS/cm.

6.5.2 Catchment runoff rates

The OPSIM model uses the Australian Water Balance Model (AWBM) (Boughton, 2003) to estimate runoff from rainfall. The AWBM is a saturated overland flow model which allows for variable source areas of surface runoff. The AWBM uses a group of connected conceptual storages (three surface water storages and one ground water storage) to represent a catchment. Water in the conceptual storages is replenished by rainfall and is reduced by evaporation (surface stores only). Simulated surface runoff occurs when the conceptual storages fill and overflow.

The model uses daily rainfalls and estimates of catchment evapotranspiration to calculate daily values of runoff using a daily water balance of soil moisture. The model has a baseflow component which simulates the recharge and discharge of a shallow subsurface store. Runoff depth calculated by the AWBM model is converted into runoff volume by multiplying the contributing catchment area.

The model parameters define the storage depths (C1, C2 and C3), the proportion of the catchment draining to each of the storages (A1, A2 and A3), and the rate of flux between them (Kb, Ks and BFI).

Catchments across the site water management system have been characterised into the following land use types:

- Natural/undisturbed, representing areas in their natural state;
- Roads, hardstand and mining pit floor areas;
- Spoil dump, representing uncompacted dumped overburden material;
- Open cut, representing pit area; and
- Rehabilitated, representing established rehabilitated spoil areas.

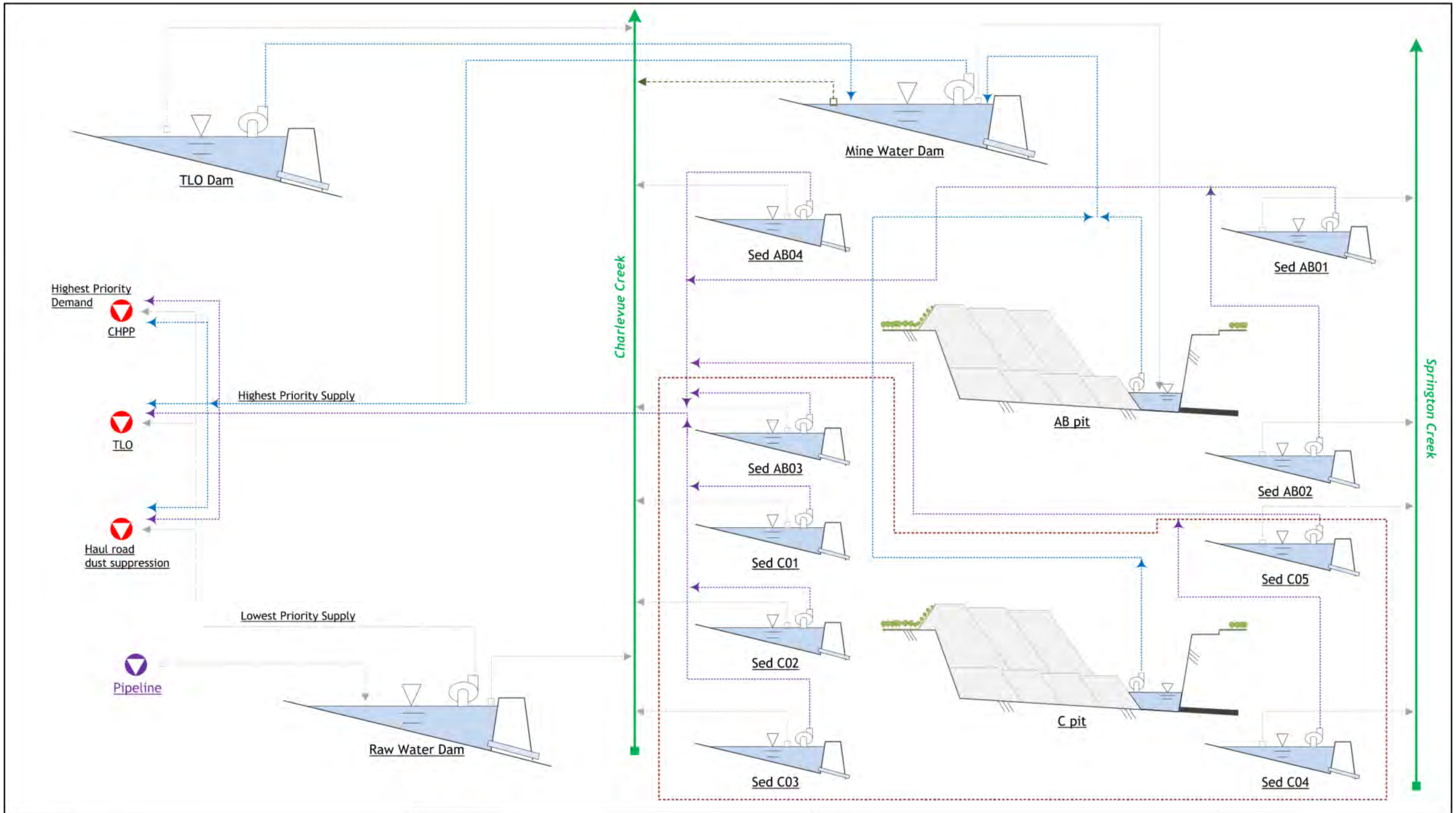
Adopted rainfall runoff parameters are summarised in Table 6.4. In the absence of site-specific parameters, parameters typical for coal mines in the Bowen Basin were adopted.

Table 6.4 - Adopted AWBM parameters

Parameter	Spoil Dump	Hardstand	Natural	Established Rehab	Open Cut
A1	0.134	0.134	0.134	0.134	0.134
A2	0.433	0.433	0.433	0.433	0.433
A3	0.433	0.433	0.433	0.433	0.433
C1	10	5	25	11	5
C2	50	20	100	60	20
C3	120	40	180	130	40
C_{avg}	74.9	26.7	124.6	83.7	26.7
BFI	0.35	0	0.2	0.35	0
K_{base}	0.6	0	0.82	0.6	0
K_{surf}	0.1	0.1	0.17	0.1	0.1
Rehab runoff/rainfall	9.8%	20.9%	5.1%	8.6%	20.9%
Runoff salinity (EC) µS/cm	600	900	150	150	8,000

Figure 5.1 to Figure 5.5 show how catchment landuse will change as the project develops.

A schematic of the integrated Gemini Project water management system configuration is shown in Figure 6.1. A summary of the proposed storages within the integrated WMS and their operating strategies are summarised in the following sections.



Dingo West

Figure	Proposed integrated water management system schematic
Job	1238-01
Date	30/07/2019

Legend

- Sediment water
- Mine water
- Natural watercourse
- Intermittent flow
- Spillway/overflow
- To be added post Stage 4
- Controlled release

Notes

Spill Flow Directions:
Good engineering practice is to include a stabilised spillway as a contingency for dam safety. This arrow does not indicate that these discharges (spills/overflows) are a part of the water management system or that spills will occur. The arrow is to show the direction of water flow (by gravity) should the dam water level exceed the dam spillway level.

wrm water + environment

Figure 6.1 - Proposed integrated water management system schematic

6.6 MODELLING OF WATER DEMAND

6.6.1 Haul road dust suppression

Haul road dust suppression watering rates were applied to haul road areas that vary as mining progresses. The following rules were used to determine the applied dust suppression rate on any given day of the historical rainfall record:

- The assessment used daily evaporation rates sourced from the SILO evaporation dataset;
- For a dry day (zero rainfall), the haul road watering rate is equal to the daily evaporation rate;
- For a rain day when rainfall is less than the daily evaporation rate, the watering rate is reduced and is only required to make up the remaining depth to the daily evaporation rate;
- For a rain day when rainfall exceeds the daily evaporation rate, no haul road watering is required; and
- It was assumed that 29 metres of the haul road width would be watered.

The estimated consumption rates for each phase are summarised in Table 6.5 (but note that the totals will vary with climate in the model).

Table 6.5 - Forecast haul road dust suppression demand

Year	Stage	Haul road length (km)	Average daily application rate (mm/d)	Maximum daily application rate (mm/d)	Average annual demand (ML/a)	Average daily demand (ML/d)
1	1	6.7	4.4	9.7	314.6	0.86
2	1	6.7	4.4	9.7	314.6	0.86
3	1	6.7	4.4	9.7	314.6	0.86
4	1	6.7	4.4	9.7	314.6	0.86
5	2	7.1	4.4	9.7	333.4	0.91
6	2	7.1	4.4	9.7	333.4	0.91
7	2	7.1	4.4	9.7	333.4	0.91
8	2	7.1	4.4	9.7	333.4	0.91
9	2	7.1	4.4	9.7	333.4	0.91
10	2	7.1	4.4	9.7	333.4	0.91
11	3	8.7	4.4	9.7	401.5	1.10
12	3	8.7	4.4	9.7	401.5	1.10
13	3	8.7	4.4	9.7	401.5	1.10
14	4	9.9	4.4	9.7	464.9	1.27
15	4	9.9	4.4	9.7	464.9	1.27
16	5	10.9	4.4	9.7	511.8	1.40
17	5	10.9	4.4	9.7	511.8	1.40
18	5	10.9	4.4	9.7	511.8	1.40

6.7 SUMMARY OF DEMANDS

The estimated annual demands and groundwater inflows to the mine are summarised in Table 6.6 below. Potable water demands have not been modelled.

Table 6.6 - Summary of adopted demands and expected groundwater inflows

Year	Demand (ML/a)				Net GW Inflow (ML/a)
	CHPP	Haul Road	TLO	Total	
1	162.0	314.6	0.72	477.3	31.5
2	162.0	314.6	0.73	477.3	31.5
3	162.0	314.6	0.73	477.3	31.5
4	162.0	314.6	0.73	477.3	31.5
5	162.0	333.4	0.73	496.1	31.5
6	162.0	333.4	0.72	496.1	31.5
7	162.0	333.4	0.72	496.1	31.5
8	162.0	333.4	0.71	496.1	31.5
9	162.0	333.4	0.72	496.1	31.5
10	162.0	333.4	0.72	496.1	31.5
11	162.0	401.5	0.70	564.2	220.8
12	162.0	401.5	0.74	564.2	220.8
13	162.0	401.5	0.74	564.2	189.2
14	162.0	464.9	0.74	627.6	205.0
15	162.0	464.9	0.74	627.6	31.5
16	162.0	511.8	0.72	674.5	31.5
17	162.0	511.8	0.74	674.5	31.5
18	143.4	511.8	0.65	655.9	47.3

6.8 OPERATING RULES

The operating rules to be applied to the links joining the various elements in the water balance model are summarised in Table 6.7 below.

Table 6.7 - Gemini Project water management system operating rules

Item	Node Name	Operating Rules
1.0	*External Water Supply*	
1.1	Pipeline	• Supplies the Raw Water Dam - which in turn supplies the haul road dust suppression, CHPP and TLO; • Yearly allocation assumed unlimited; • Capacity limited to 200L/s.
2.0	*Supply to Demands*	
2.1	CHPP	• Demands in priority, from the Mine Water Dam, Sediment Dams and Raw Water Dam respectively.
2.2	Haul road dust suppression	• Demands from the Mine Water Dam, Sediment Dam and Raw Water Dam; • Demands vary daily according to the loss model detailed in this report.
2.3	TLO	• Demands from the Mine Water Dam, Sediment Dams and Raw Water Dam; • Demands according to the coal production rate and usage rate (L/t ROM).
3.0	*Transfer of pit water*	
3.1	Mine Pit	• Pit dewatering directed to Mine Water Dam, at a nominal rate of 200 L/s. Pumping to cease when the maximum operating level reached.
4.0	*Operation of site dams*	
4.1	Mine Water Dam	• Receives pumped transfers from the Mine Pit up to the maximum operating level; • Storage overflows to Pit; • Controlled releases in accordance with the EA conditions may be made to Charelevue Creek if required, but this has been conservatively excluded from the model.
4.4	Raw water Dam	• Receives pumped transfers from pipeline to a maximum operating level (to be determined); • Overflows to Charlevue Creek.
4.5	TLO Dam	• Pumping to Mine Water Dam; • Overflows to Charlevue Creek.
4.6	AB01	• Sediment dam, active from Year 1 onwards; • Overflows to Springton Creek.
4.7	AB02	• Sediment dam, active from Year 1 onwards; • Overflows to Springton Creek.
4.8	AB03	• Sediment dam, active from Year 1 onwards; • Overflows to Charlevue Creek.
4.9	AB04	• Sediment dam, active from Year 1 onwards; • Overflows to Charlevue Creek.

Item	Node Name	Operating Rules
4.10	C01	• Sediment dam, active from Year 14 onwards; • Overflows to Charlevue Creek.
4.11	C02	• Sediment dam, active from Year 14 onwards; • Overflows to Charlevue Creek.
4.12	C03	• Sediment dam, active from Year 14 onwards; • Overflows to Charlevue Creek.
4.13	C04	• Sediment dam, active from Year 14 onwards; • Overflows to Springton Creek.
4.14	C05	• Sediment dam, active from Year 14 onwards; • Overflows to Springton Creek.
5.0	*Receiving water*	
5.1	Springton Creek	• Receives uncontrolled overflows from the following sediment dams: o AB01; o AB02; o C04; o C05.
5.2	Charlevue Creek	• Receives uncontrolled overflows from the following sediment dams: o AB03; o AB04; o C01; o C02; o C03.
6.0		• All storages and pits receive local catchment runoff and lose water through evaporation

6.9 WATER BALANCE MODEL RESULTS

The results of the site water balance model are summarised in the following sections.

6.9.1 Mine water dam behaviour

The results of the water balance model presented in Figure 6.2 show that as pit catchments and groundwater inflows increase, the likelihood of needing to store large volumes of water in the mine water dam increases. By the end of Year 7, the median stored volume is at the Mine Water Dam's maximum operating volume.

The mine water dam's maximum operating level has been chosen to manage the risk of overflows. The spillway directs overflows to AB Pit, so the likelihood of uncontrolled offsite discharge from the Mine Water Dam is negligible.

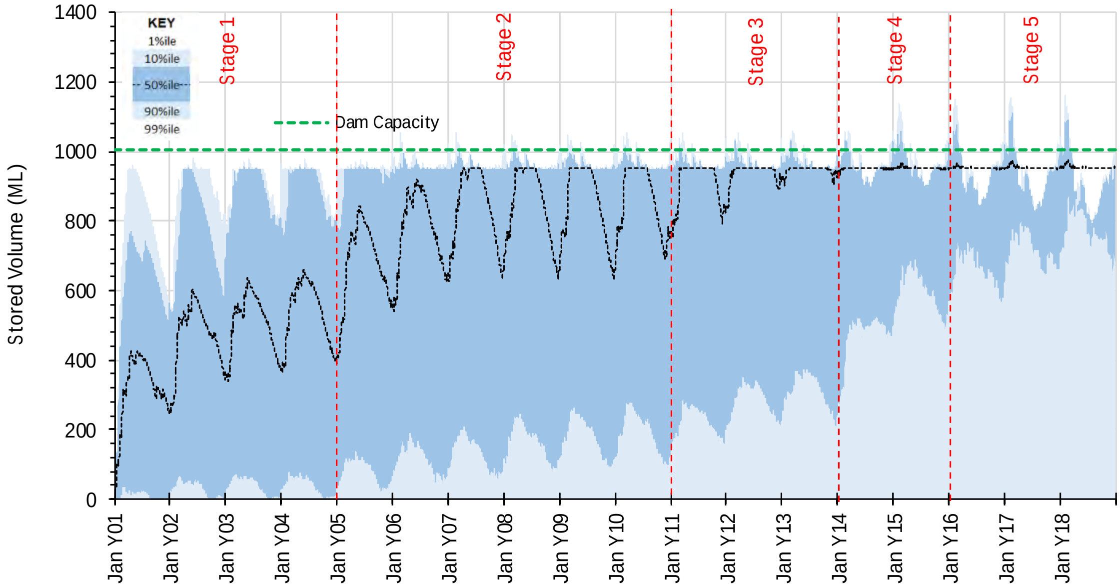


Figure 6.2 - Mine Water Dam - stored water volume behaviour

6.9.2 Likelihood of pit inundation

Figure 6.3 shows a plot of water volumes accumulating in AB pit and C pit over the project life. The plot shows the median stored volume is minimal on all days.

At AB Pit, stored water volumes can be maintained at relatively low volumes which would not interrupt mining operations. The 10th percentile In pit inventory is negligible prior to each wet season, prior to the end of AB Pit mining at the end of Year 13.

After Year 13, AB Pit can be used to stored excess water from C Pit in very wet periods. While the median stored water volume is negligible, up to 3,250ML of water could be stored in AB Pit at the 1% confidence level, which corresponds to a level just below the expected equilibrium final void lake water level.

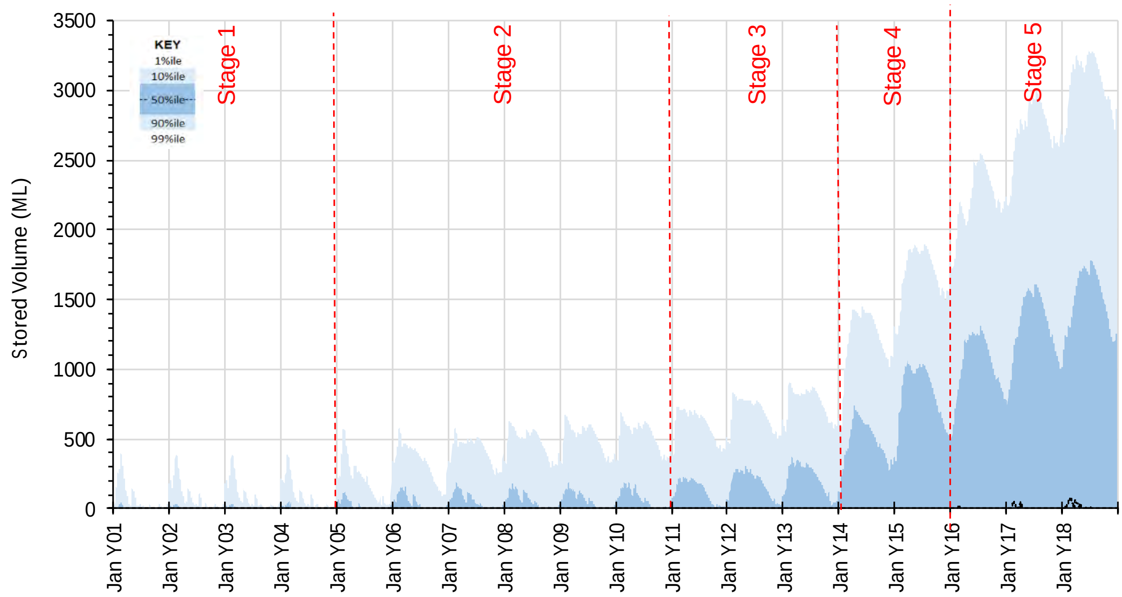


Figure 6.3 - AB pit - stored volume behaviour

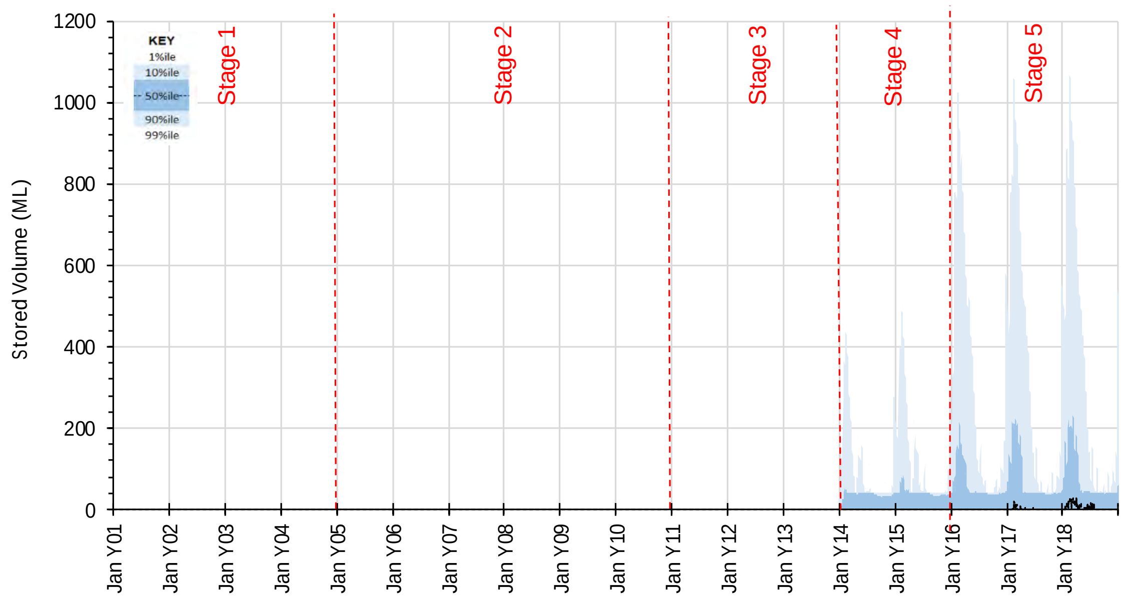


Figure 6.4 - C pit - stored volume behaviour

6.9.3 Water supply reliability

Figure 6.5 shows imported water requirements from the external pipeline are highest in the early project stages. Under very dry conditions, the demand could reach 500 ML/a, but median Year 1 demand is less than 100 ML/a. During later years, accumulated stored pit and sediment dam water is sufficient to supply demands in all but the driest years.

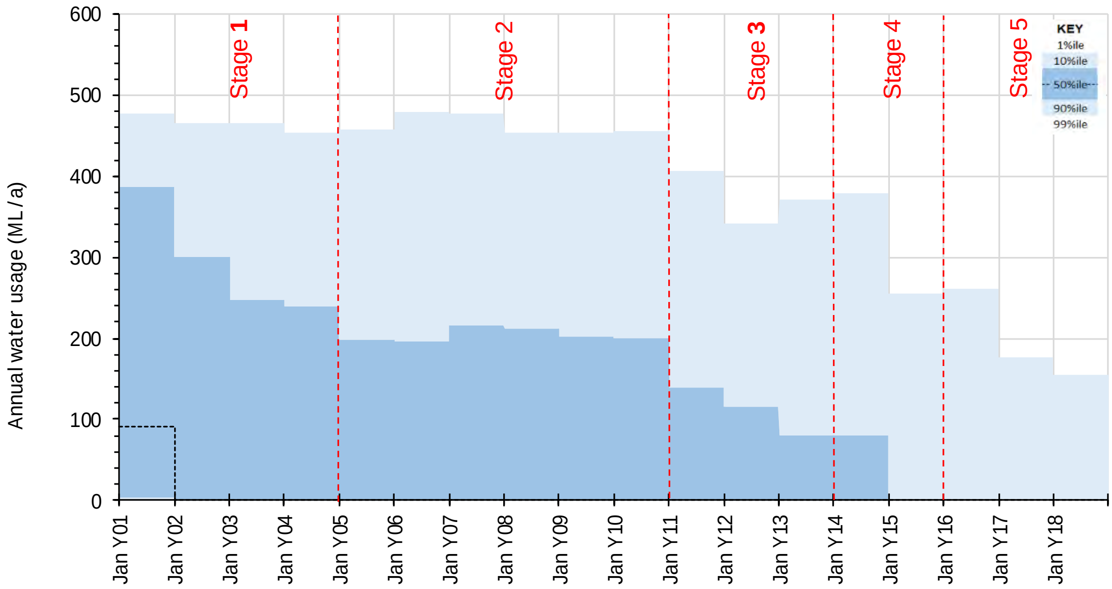


Figure 6.5 - Raw water pipeline usage

6.9.4 Sediment dam releases

Figure 6.6 and Figure 6.7 show that the likelihood of sediment dam discharges to Charlevue and Springton Creeks increases over the mine life. In the early years, the likelihood of discharge is low, as contributing catchments are relatively small, and captured water may be used to supplement site water demands. However, in later years the likelihood of discharges increases. Water captured in sediment dams is expected to have low salinity and coarse sediments will settle out, such that any impacts to downstream water quality are expected to be minor.

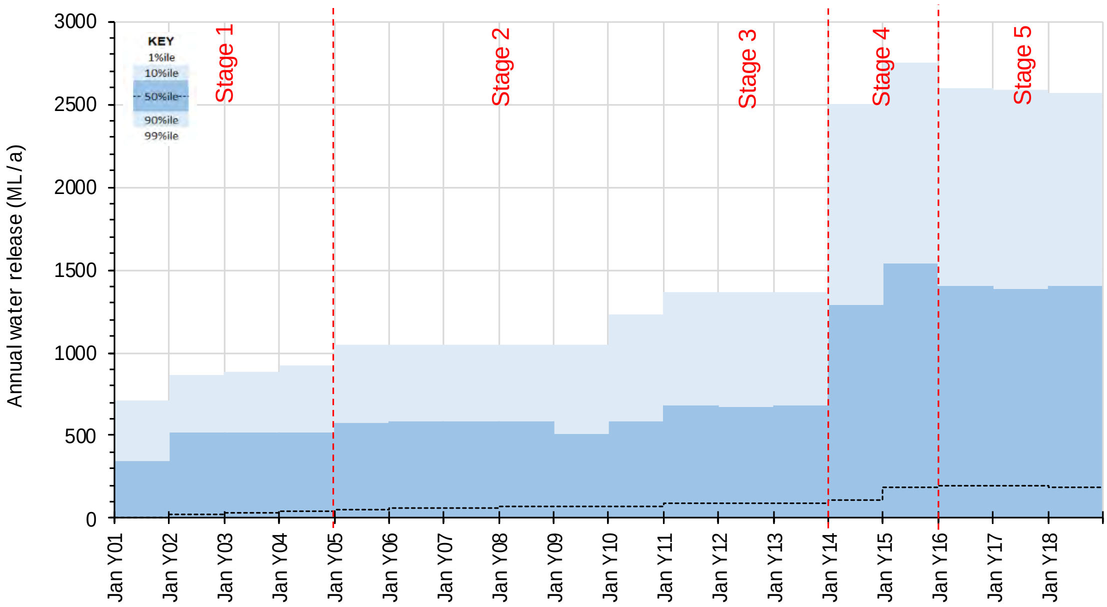


Figure 6.6 - Sediment dam spills to Charlevue Creek

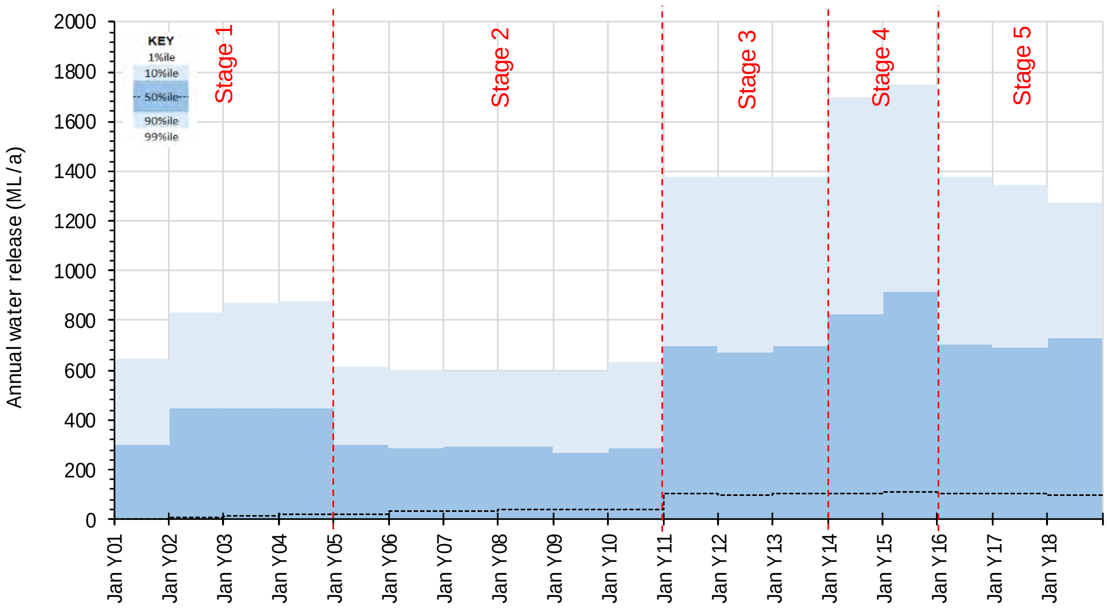


Figure 6.7 - Sediment dam spills to Springton Creek

6.9.5 Overall site water balance

The overall average annual site water balance is summarised in Table 6.8.

Table 6.8 - Average annual site water balance

Component	Process	Volume (ML/a)					
		Stage 1 Y1 - Y4 (4 years)	Stage 2 Y5 - Y10 (6 years)	Stage 3 Y11 - Y13 (3 years)	Stage 4 Y14 - Y15 (2 years)	Stage 5 Y16 - Y18 (3 years)	Total (18 years)
Inflows	Rainfall and runoff	973	1,052	1,215	2,148	2,214	7,602
	Net groundwater inflow	32	32	210	118	37	428
	External supply pipeline	89	51	29	17	11	196
	Total	1,093	1,135	1,454	2,283	2,261	8,226
Outflows	Evaporation	250	317	386	629	762	2,344
	Haul road dust suppression	315	336	405	469	515	2,040
	CHPP Usage	162	162	162	162	162	810
	Spill from Raw Water Dam	37	41	41	43	44	206
	Spill from Sediment Dams	223	245	398	669	652	2,187
	Spill from Mine Affected Water Dams	0	0	0	0	0	0
	Total	988	1,102	1,392	1,972	2,135	7,587
Change in Site Water Inventory		102	29	59	308	122	619

7 Flood mitigation and impacts

The proposed mine operations and associated infrastructure are largely located outside of the Charlevue Creek and Springton Creek flood inundation areas identified in section 4.5. However, the potential for the following project features to interact with floodwater has been investigated as part of this assessment:

- The rail loop, which is located near the northern margin of the Charlevue Creek floodplain, in close proximity to the existing Capricorn Highway and Aurizon's Blackwater rail corridor.
- The CHPP/MIA fill pad which is located to the north of the Charlevue Creek floodplain.
- The haul road between AB Pit and the CHPP, which crosses Charlevue Creek;
- The AB Pit spoil dump, which encroaches towards the Charlevue Creek floodplain
- The AB Pit levee, which is required to prevent inundation of the AB Pit mine area from flooding at the downstream end of an unnamed second order tributary of Springton Creek, which is to be diverted around the proposed mine area.
- The C Pit overburden dump which will necessitate the construction of a drain to divert clean runoff in the upper reaches of the unnamed second order tributary of Springton Creek around the workings.

The locations of the mine infrastructure horizontal alignments of the drainage channels and associated levees are shown in Figure 7.1. The flood models were used to:

- Assess the impact of the Project on peak flood levels.
- Assess peak water levels and velocities along the levees and channels proposed to protect the proposed mine areas from flooding;

Figure 7.1 shows the Project will temporarily increase Charlevue flood levels immediately upstream of the proposed haul road crossing. In the 1% AEP flood, these impacts are contained within the mine lease area.

There will be no impact on flood levels in the Charlevue Creek or Springton Creek at the existing Capricorn Highway, Blackwater Rail corridor, or downstream of the Project area.

While the unnamed tributary of Springton Creek is not a watercourse as defined under the Water Act, the diversion channel will be designed taking into consideration the principles set out in the Guideline: "Works that interfere with water in a watercourse - watercourse diversions" (DNRM, September 2014). This document sets out key design principles and requirements for the functional designs of permanent diversions. It includes guidance on watercourse diversion design and operation including maintenance, monitoring and revegetation. Preliminary designs are shown in Figure 7.3 to Figure 7.8 which also show the post development flood conditions with diversions and levees in place.

The works at AB Pit will locally increase flood levels in Springton Creek by up to 0.22 m in the 1% AEP flood. These impacts would extend off the lease area onto land owned by Magnetic South Pty Ltd, and reduce with distance downstream of the boundary.

The full details of the methodology and results of flood modelling for a range of flood events are presented in Appendix A.

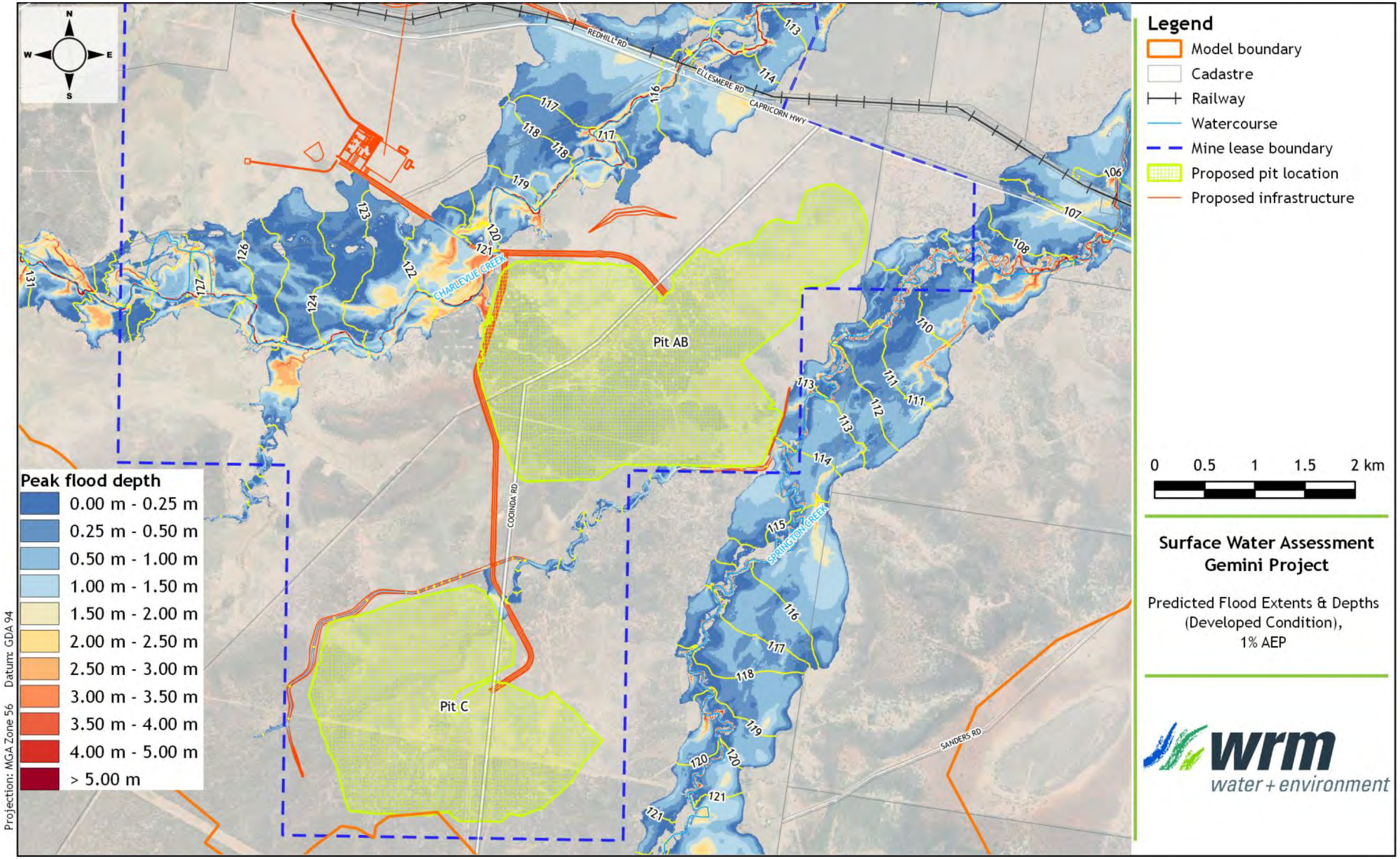


Figure 7.1 - Developed conditions 1% AEP flood depths and water levels

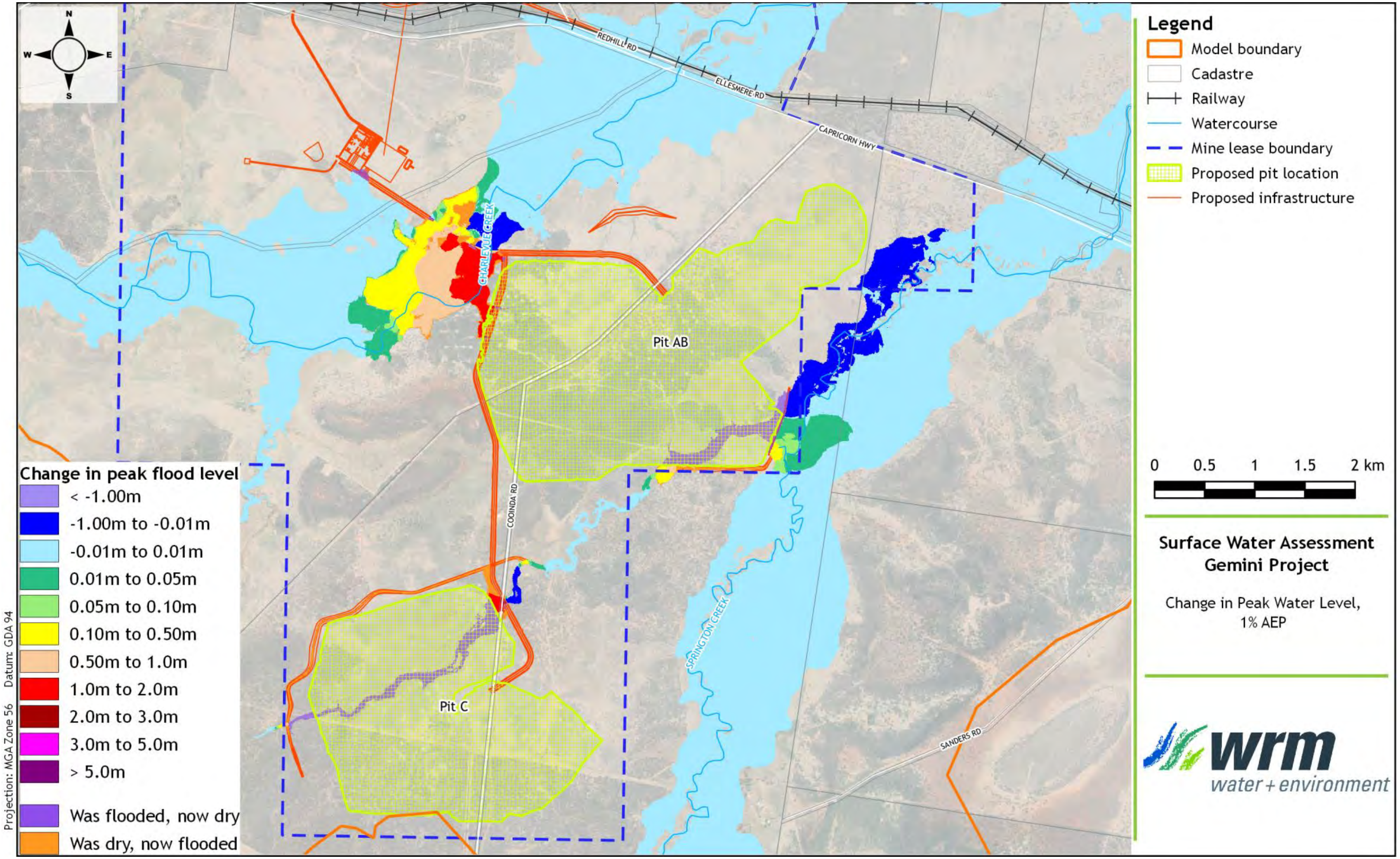


Figure 7.2 - Impacts of the Project on 1% AEP flood levels

Figure 7.3 - Upper reach of unnamed Springton Creek tributary - existing 1% AEP flood depths

Figure 7.4 - Upper reach of unnamed Springton Creek tributary - proposed 1% AEP flood depths

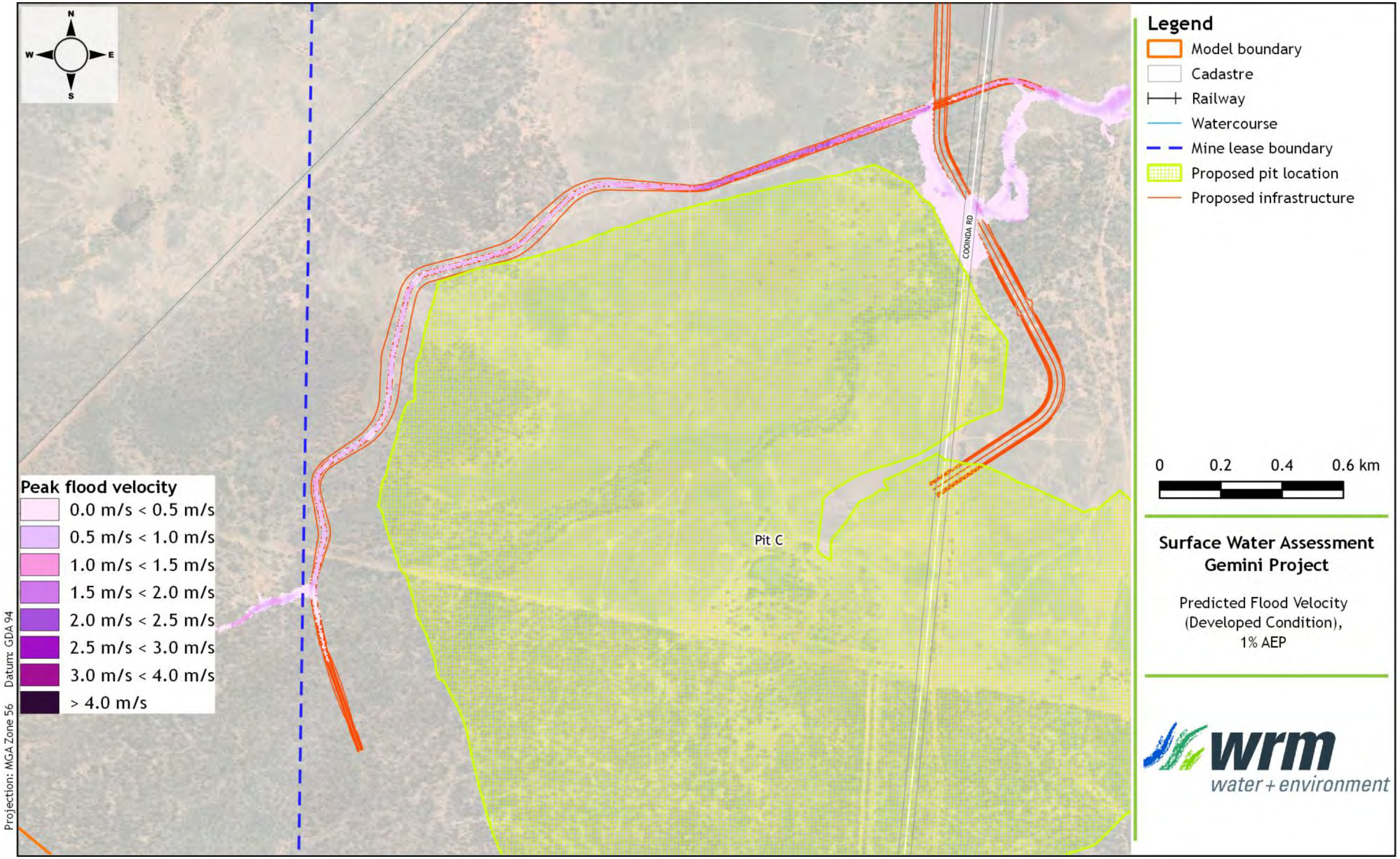


Figure 7.5 - Upper reach of unnamed Springton Creek tributary - proposed 1% AEP flood velocities

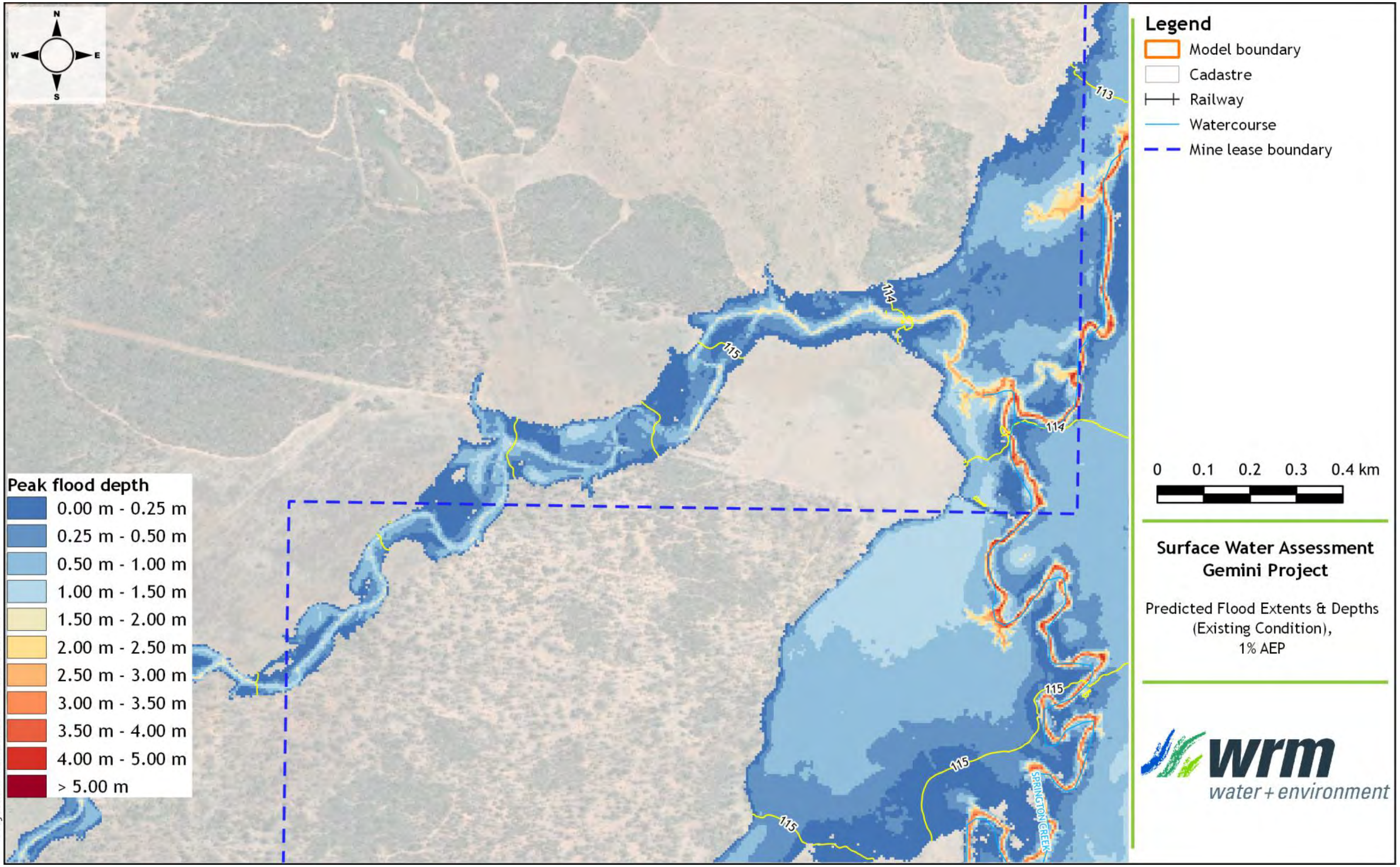


Figure 7.6 - Lower reach of unnamed Springton Creek tributary at AB Pit - existing 1% AEP flood depths

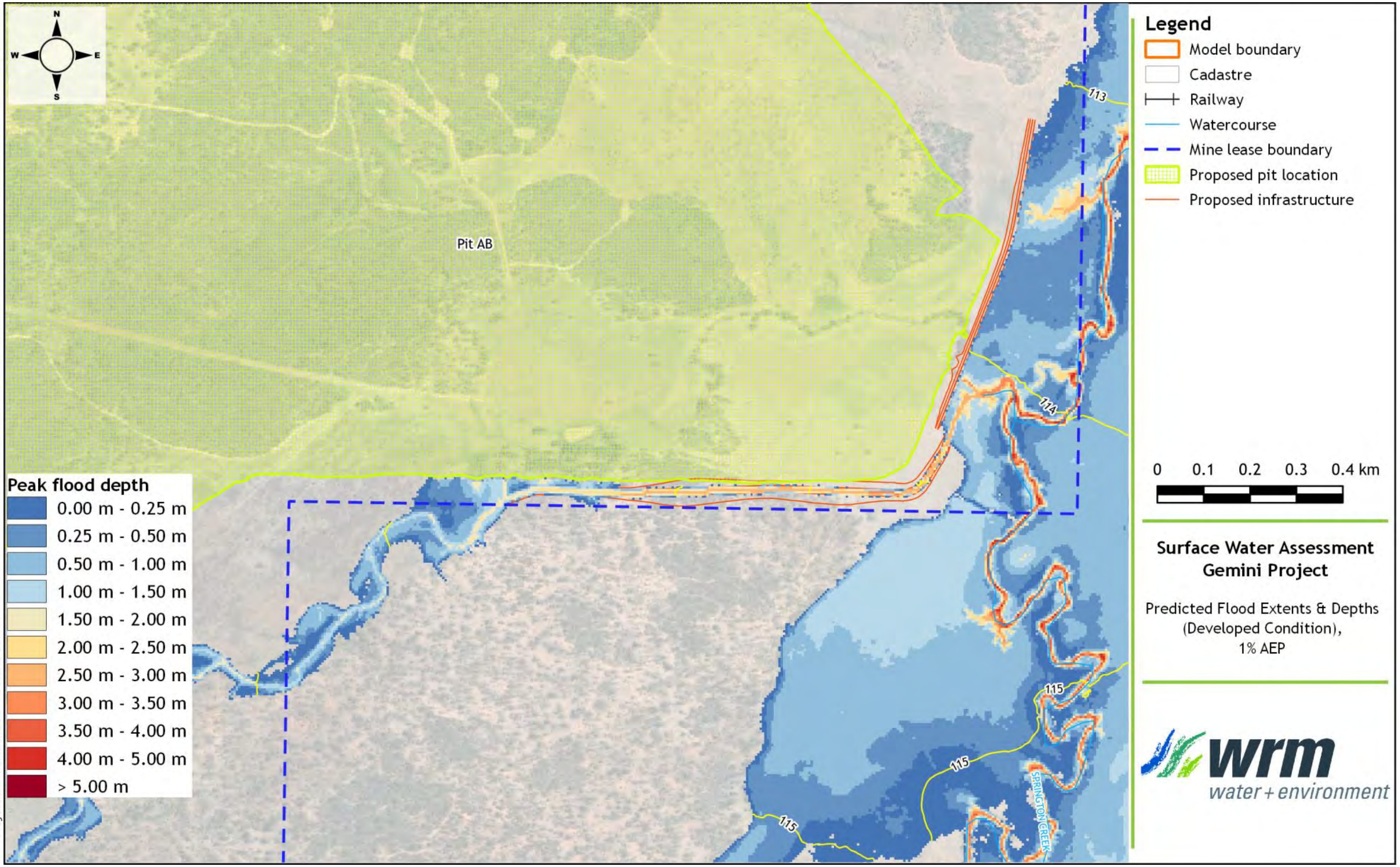


Figure 7.7 - Lower reach of unnamed Springton Creek tributary at AB Pit - proposed 1% AEP flood depths

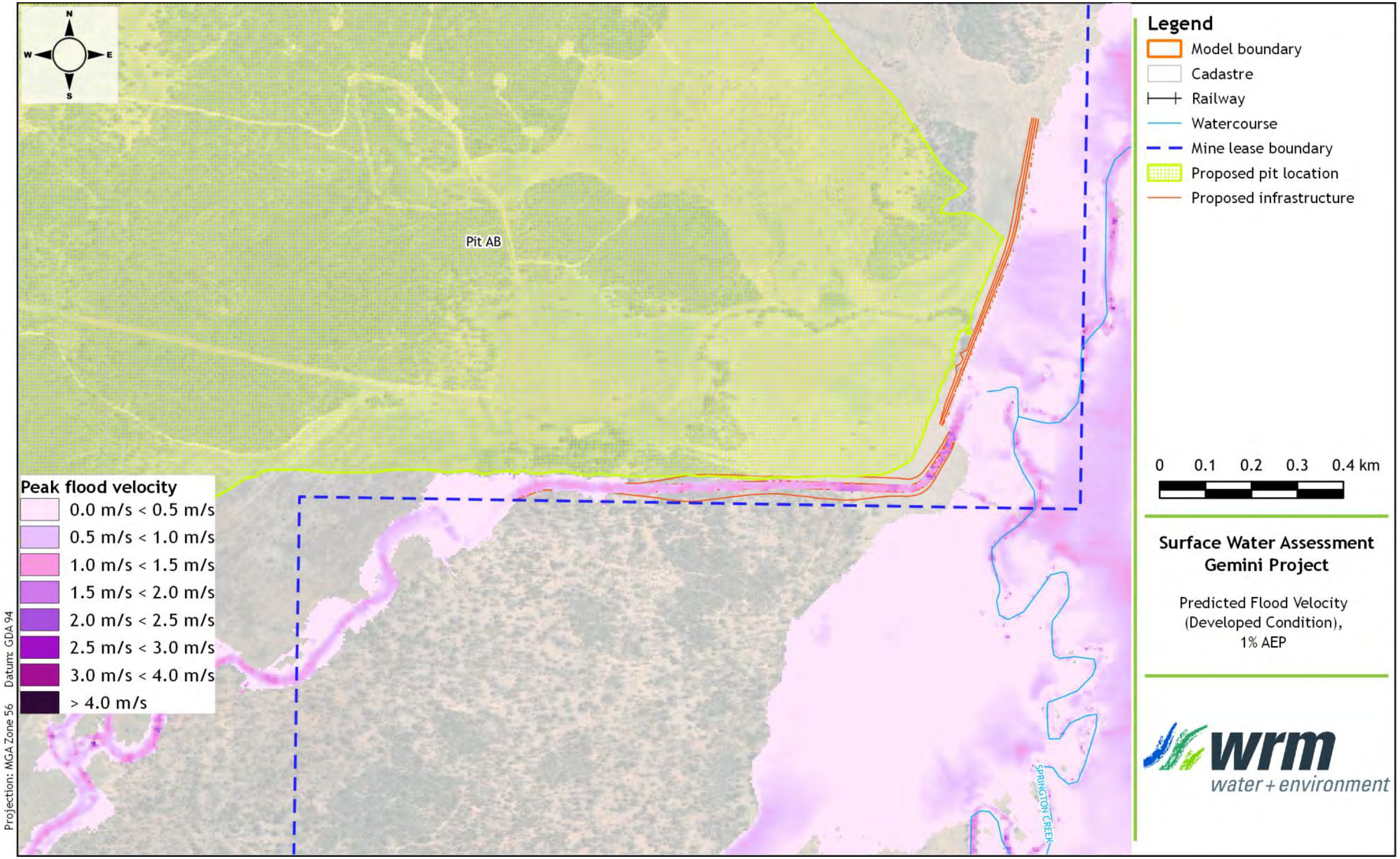


Figure 7.8 - Lower reach of unnamed Springton Creek tributary at AB Pit - proposed 1% AEP flood velocities

8 Final void behaviour

8.1 OVERVIEW

Water levels in the final voids will vary over time, depending on the prevailing climatic conditions, and the balance between evaporation losses and inflows from rainfall, surface runoff, and groundwater.

A GOLDSIM model (separate to the OPSIM model used for the operational modelling) was used to assess the likely long-term behaviour of the final void pit lakes. The historical rainfall and evaporation sequences were repeated 5 times to create a long-term climate record for use in the model.

The potential effects of climate change were assessed using climate-change adjusted SILO climate data developed as part of the Consistent Climate Scenarios (CCS) project by the Queensland Government's Department of Environment and Science (DES).

8.2 FINAL VOID CONFIGURATION

The final void configurations and contributing catchment areas are shown in Figure 8.1. The proposed final void catchments include the pits' plan areas, and immediate upslope catchments. Key details of the final voids are as follows:

- AB Pit final void will be approximately 72 m deep, with a floor level of 40 mAHD and an overflow level of approximately 112 mAHD.
- C Pit final void will be approximately 70 m deep, with a floor level of 58 mAHD and an overflow level of approximately 128 mAHD.

The final void will be located and designed such that it is not inundated by flooding in the probable maximum flood (refer Figure 8.2).

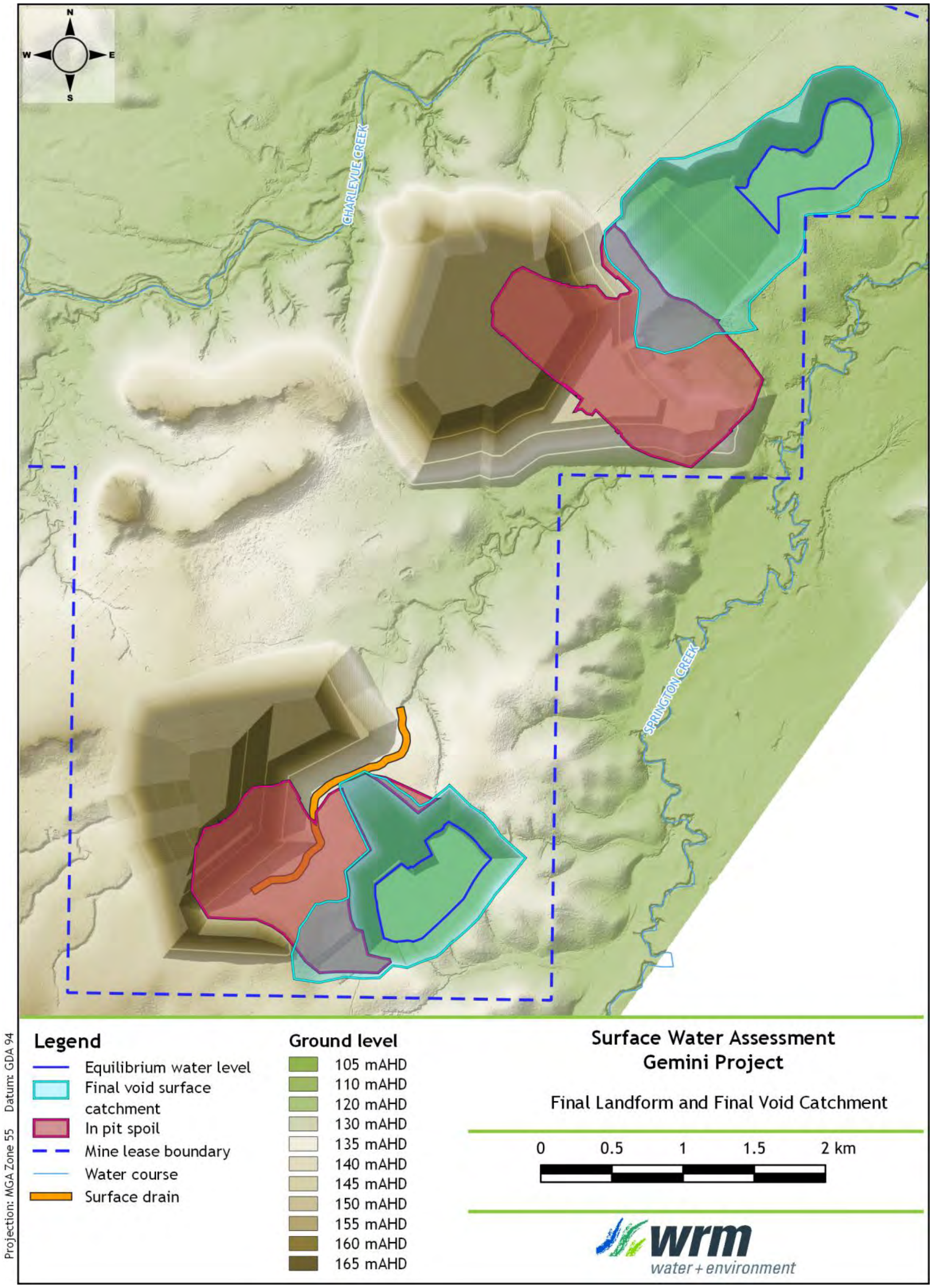


Figure 8.1 - Final landform and final void catchments

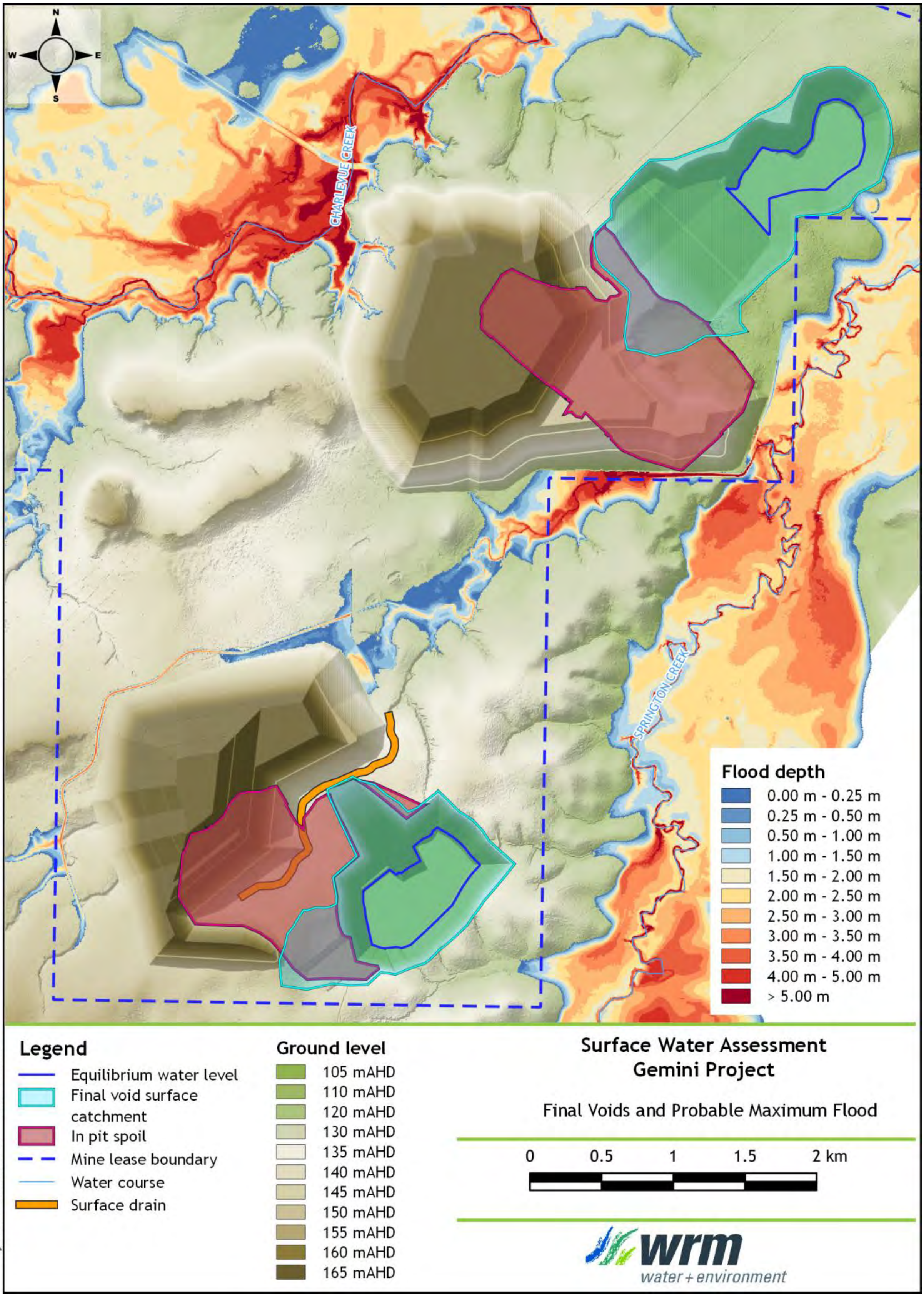


Figure 8.2 - Final landform and flood levels in Probable Maximum Flood

8.3 CONCEPTUAL MODEL

A representative schematisation of a conceptual final void water balance is presented in Figure 8.3.

The figure shows that key water inputs include rainfall on pit lake water surfaces, runoff from pit faces and rehabilitated upstream catchment areas, and groundwater interception. Depending on the configuration of the spoil dump, rainfall may also infiltrate through in-pit spoil.

Outflows are generally limited to evaporation. Under certain circumstances (i.e. if the final void water level exceeds the level of a neighbouring aquifer), outflows may also include seepage losses to surrounding aquifers. Water accumulating in the pit lake may also infiltrate into the adjacent overburden, creating additional water storage in this 'spoil aquifer'.

Sources of salt include salts dissolved in groundwater and catchment runoff. In the absence of any seepage or surface outflows to the environment, there is generally no removal of salt from the system, and thus, salts are expected to accumulate over time.

In principle, for an initially empty void, water is expected to accumulate until evaporative losses from the wetted surface area balance the combined influence of catchment runoff, rainfall and groundwater interception. Where catchment inflows are limited, over a sufficiently long time-scale, water levels are expected to reach a nominal steady state, with some variation about the steady state level during prolonged periods of wet or dry climate bias. This principle works in reverse for any voids that are filled (e.g. by pumping) above their steady state level prior to relinquishment; water levels will reduce due to evaporation until the wetted surface contracts to a point where evaporative losses balance inflows.

The Gemini Project voids are to be partially backfilled to prevent the interchange of water between the coal seams and the lakes - resulting in lower water levels and salinities than would otherwise be the case.

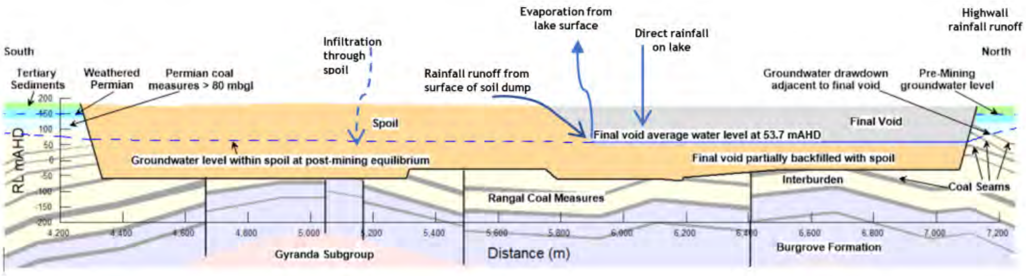


Figure 8.3 - Final landform and pit lake catchment

8.4 NUMERICAL MODELLING APPROACH

The GOLDSIM model simulates the generation, movement and loss of water on a daily time-step within each final void, over a 515-year period. The volume of water in the void is calculated at each time step as the sum of direct rainfall to the void surface, catchment runoff, and groundwater inflows, less evaporation losses.

The model tracks the quantity salt captured and stored within the system. Key components of the model are summarised in the following sub-sections, including descriptions of key model inputs, assumptions and sensitivity parameters.

8.5 STAGE-STORAGE CHARACTERISTICS

The stage-storage and stage-area curves for the voids were estimated from the final landform terrain model. The adopted relationships are shown in Figure 8.6.

8.6 CATCHMENT RUNOFF

Surface runoff catchment areas draining to the final voids were determined based on the adopted final landform. The following land use assumptions were adopted:

- All overburden dumps and cleared areas within the final void catchments will be rehabilitated and revegetated after cessation of mining;
- All rehabilitated catchment will naturally revert toward pre-disturbed conditions over time (as vegetation matures and top soil weathering and consolidation takes place). The long-term runoff properties will be somewhere between rehab and natural catchment.

The AWBM was used to model surface water runoff. The AWBM parameters adopted for rehabilitated areas in the operational water balance were also used for the final void analysis. The modelled surface catchments to each void are summarised in Table 8.1.

Table 8.1 - Final void surface catchments (ha)

Catchment type	AB Pit	C Pit
Natural	15.1	2.0
Pit	104.6	115.7
Rehab	98.0	20.3
Total	217.7	138.0

8.7 PIT SURFACE EVAPORATION

Evaporation from the void lake water surface was modelled using estimates of Morton's Lake evaporation. The reduced evaporation resulting from shading and wind shielding provided by the pit walls was modelled using an adjustment factor referred to herein as the 'pit factor'. A linearly varying depth-dependent storage evaporation factor has been applied to each void to simulate the change in evaporation as void water levels increase. The storage evaporation factors are as follows:

- Bottom of void - 0.5;
- Top of void - 0.8.

Pit factors are supported by the findings of ACARP Project No. C7007 (2001) which entailed development of a practical methodology for predicting the hydrology and water quality of final spoil-void systems. The study proposed adopting typical pit factors of 0.56 for near-empty pits and 0.78 for near-full pits based on modelling undertaken at several mines in Queensland and NSW.

8.8 GROUNDWATER

Ground water investigations by JBT Consulting indicate that due to partial backfilling of the voids, groundwater inflows to the final voids are expected to be negligible.

8.9 CLIMATE CHANGE IMPACTS

Climate-change adjusted SILO climate data are available from the Queensland Government Department of Environment and Science (DES), and were developed as part of the Consistent Climate Scenarios (CCS) project. The CCS project hosts data from 19 separate global climate models (GCMs), which explore four emissions scenarios, three timing horizons and three climate warming sensitivities. The nineteen separate models can be split into four Representative Future Climate (RFC) partitions, defined below:

- HI: a high level of global warming, where the Eastern Indian Ocean (EIO) warms faster than the Western Pacific Ocean (WPO);
- HP: a high level of global warming, where the WPO warms faster than the EIO;
- WI: a low level of global warming, where the EIO warms faster than the WPO; and
- WP: a low level of global warming, where the WPO warms faster than the EIO.

Figure 8.4 is an excerpt from the CCS project user guide (DSITIA, 2015) showing the four RFC quadrants, component models and indicative rainfall trends. The caption associated with the original version of this figure has been reproduced as a footnote[1].

Data based on the mean result of all models within each RFC quadrant is offered by the CCS for applications where considering the output of all 19 models is not feasible/practical. This approach has been followed for the purposes of assessing climate change sensitivity as part of current investigations. Table 8.2 and Table 8.3 list the percentage change in evaporation and rainfall respectively, based on mean output for the four RFC quadrants. Data is based on the most conservative carbon emission rate (RCP8.5) available in the CCS dataset, and expected climate as at 2070. Data has been listed for the low, medium and high sensitivities. Information is for the Gemini Project location.

The adjustments listed in Table 8.2 and Table 8.3 have been applied to the long-term SILO daily climate time-series, and passed through the AWBM rainfall runoff sub-model to produce daily estimates of runoff (rehabilitated land use AWBM parameter set used). Annual average runoff depths have been plotted against average annual net evaporation depths (evaporation minus rainfall) in Figure 8.5 to illustrate the potential to impact on long-term water levels in the Gemini Project pit lakes. Note the naming convention used in the figure, and henceforth in this document, is XX.Y where XX is the scenario (e.g. HI) and Y is the sensitivity (medium).

Figure 8.5 shows that all scenarios predict increases in net evaporation, and that all scenarios predict reductions in runoff. It is evident that all scenarios will result in lower final void water levels than the base case scenario. The sensitivity of final void water levels to changes in future climate change have been assessed by modelling all the above scenarios.

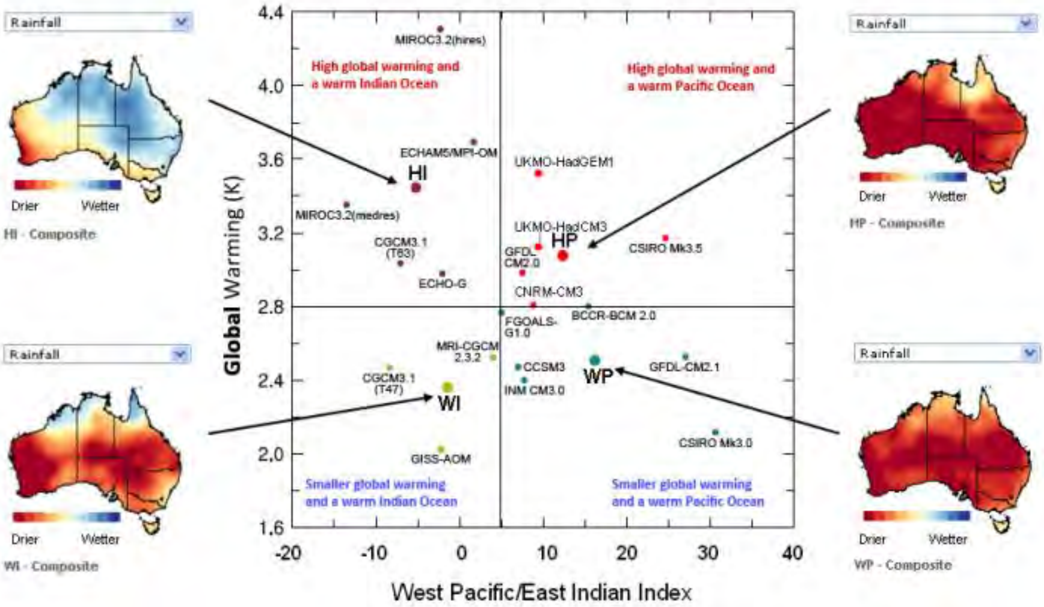


Figure 8.4 - A partition of Global Climate Models for future climate using global warming sensitivity and ocean warming indices (source: DSITIA, 2015)

[1] From DSITIA, 2015 - Figure 8.1 (verbatim): A partition of CMIP3 Global Climate Models (GCMs) for future climate using global warming sensitivity and ocean warming indices (adapted from Watterson, 2011). Values for nineteen individual GCMs (forced by the SRES A1B emissions scenario) are represented by the small dots and labelled by their GCM model code (Table 8.2). The central horizontal and vertical lines separate the four Representative Future Climate (RFC) partitions. The larger dots indicate the CCS composite means for GCMs within each of the four RFC responses: (HI) high global warming and a warmer Indian Ocean; (HP) high global warming and a warmer Pacific Ocean; (WP) lower global warming and a warmer Indian Ocean and (WP) lower global warming and a warmer Pacific Ocean. The maps show projected 21st Century changes in rainfall for the GCMs clustered in each of the four (HI, HP, WI and WP) RFC partitions.

Table 8.2 - Percentage change in evaporation by model and sensitivity

Model*	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
HI (high)	16.2	18.6	21.5	15.8	12.8	10.2	8.2	9.2	14.1	14.0	20.1	11.2	13.1
HI (med)	10.0	11.5	13.3	9.8	7.8	6.0	5.0	5.6	8.8	8.8	12.6	7.0	7.5
HI (low)	5.4	6.2	7.2	5.3	4.2	3.1	2.6	2.9	4.8	4.8	6.9	3.8	3.3
HP (high)	16.9	19.2	19.3	16.6	15.8	17.2	13.8	17.1	17.2	18.1	18.4	14.9	15.3
HP (med)	10.7	12.1	12.1	10.4	9.9	10.8	8.6	10.8	10.9	11.5	11.7	9.5	9.0
HP (low)	5.9	6.6	6.6	5.7	5.4	5.9	4.7	5.9	6.0	6.3	6.5	5.3	4.2
WI (high)	15.8	18.1	14.0	10.9	8.6	11.3	12.0	10.5	13.4	9.1	11.6	11.8	10.7
WI (med)	10.0	11.3	8.7	6.7	5.2	6.9	7.4	6.4	8.4	5.6	7.2	7.4	6.0
WI (low)	5.5	6.2	4.7	3.6	2.7	3.7	4.0	3.4	4.6	3.0	4.0	4.1	2.5
WP (high)	27.7	17.9	24.4	24.0	26.2	19.2	15.6	14.1	14.5	16.7	23.4	12.7	17.8
WP (med)	17.5	11.1	15.3	15.2	16.4	11.8	9.6	8.7	9.0	10.5	14.8	7.9	10.5
WP (low)	9.6	6.0	8.4	8.4	9.0	6.3	5.2	4.7	4.9	5.8	8.1	4.3	5.0

Note: * model is RFC partition, text in brackets is the sensitivity

Table 8.3 - Percentage change in rainfall by model and sensitivity

Model*	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
HI (high)	-7.3	37.8	-14.3	-55.3	66.7	-48.1	3.3	-10.7	-9.1	-9.0	-46.0	4.1	-3.6
HI (med)	-4.9	25.3	-9.6	-37.0	44.7	-32.3	2.2	-7.2	-6.1	-6.0	-30.8	2.7	-2.4
HI (low)	-2.8	14.7	-5.6	-21.5	26.0	-18.7	1.3	-4.2	-3.5	-3.5	-17.9	1.6	-1.4
HP (high)	-12.2	-6.2	4.8	-20.3	-32.2	-37.4	-14.6	-39.6	-45.5	-60.0	-46.4	-27.8	-23.9
HP (med)	-8.2	-4.1	3.2	-13.6	-21.6	-25.0	-9.8	-26.5	-30.5	-40.2	-31.1	-18.6	-16.0
HP (low)	-4.8	-2.4	1.9	-7.9	-12.5	-14.5	-5.7	-15.4	-17.7	-23.3	-18.0	-10.8	-9.3
WI (high)	-15.7	5.4	9.1	-11.5	2.7	-18.1	-3.6	-14.2	-17.2	-3.3	-21.5	-17.9	-8.4
WI (med)	-10.6	3.6	6.1	-7.7	1.8	-12.2	-2.4	-9.5	-11.6	-2.2	-14.4	-12.0	-5.6
WI (low)	-6.1	2.1	3.5	-4.5	1.0	-7.1	-1.4	-5.5	-6.7	-1.3	-8.4	-7.0	-3.3
WP (high)	-11.1	11.0	7.6	-9.3	-65.5	20.0	-6.6	21.5	-12.5	-29.5	-42.6	12.9	-6.9
WP (med)	-7.5	7.4	5.1	-6.2	-43.9	13.4	-4.4	14.4	-8.4	-19.7	-28.6	8.7	-4.6
WP (low)	-4.3	4.3	2.9	-3.6	-25.5	7.8	-2.6	8.4	-4.9	-11.5	-16.6	5.0	-2.7

Note: * model is RFC partition, text in brackets is the sensitivity

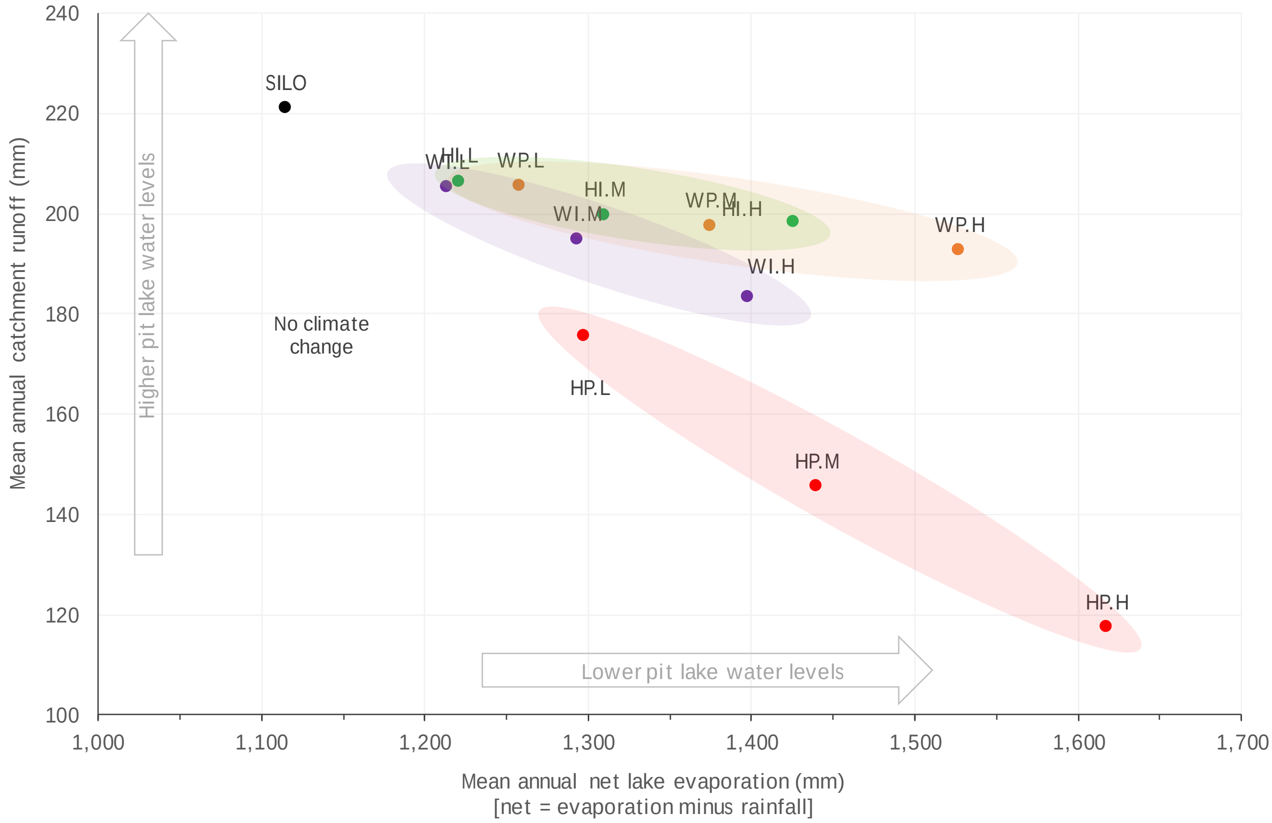


Figure 8.5 - Plot of net evaporation versus AB Pit runoff for HI, HP, WI and WP GCM groupings

8.10 LAKE SALINITY

As the void lake will not spill, and seepage into the local Permian material is expected to be minimal, salinity will rise over time as salts are transported from the local surface catchment and contained in the void. A simple conservative solute model was coupled with the lake water balance to estimate the potential lake salinity.

Water samples taken from Springton and Charlevue Creek had a median EC of 114 µS/cm, while kinetic leach column (KLC) testing of the local overburden material (RGS, 2019) showed that leachate from all KLC samples (apart from the carbonaceous siltstone and coal) had initial EC values less than 800 µS/cm, and at the end of six months less than 203 µs/cm.

While runoff salinity is therefore likely to gradually decline over time as salts are leached from the adjacent ground into runoff and seepage, for this final void assessment, runoff was conservatively assumed to have the following fixed salinities:

- Natural Runoff - 100 mg/L (equivalent to EC of approximately 150 µS/cm);
- Rehabilitation - 200 mg/L (equivalent to EC of approximately 308 µS/cm);
- Pit Runoff - 390 mg/L (equivalent to EC of approximately 600 µS/cm).

These assumptions will tend to result in the model overestimating long-term contribution of runoff to void lake salinity.

8.11 MODEL RESULTS

Figure 8.6 shows the simulated long-term water levels in the final voids. The results show the following:

For AB Pit:

- Under the existing (SILO) climate scenario - the modelled water level reaches equilibrium at around 52.9 mAHD within 50 years and generally remains at this level throughout the remainder of the simulation (fluctuating between 47.4 and 57.6 mAHD).
- The maximum modelled water level (57.6 mAHD) is around 54 m below the void overflow level of approximately 112 mAHD, and well below the potential level of groundwater seepage to the tertiary aquifer.
- Under the climate change scenarios, the equilibrium water level is lower than the existing climate scenario.

For C Pit:

- Under the existing (SILO) climate scenario - the water level reaches equilibrium at around 70.3 mAHD within 50 years and generally remains at this level throughout the remainder of the simulation (fluctuating between 66.0 and 73.5 mAHD).
- The maximum modelled water level is around 54.4 m below the void surface overflow level of approximately 128 mAHD, and well below the potential level of groundwater seepage to the tertiary aquifer.
- Under all climate change scenarios, the equilibrium water level is lower than the existing climate scenario.

Table 8.4 summarises the simulated long-term water balance for the base case scenario and the WP.M scenario, which is closest to the average of all modelled climate scenarios.

Figure 8.8 and Figure 8.9 show the results of the salt balance. Salt accumulates within both voids over time. Under the existing climate conditions scenario, the void lake salinity exceeds a TDS of 30,000 mg/L after approximately 500 years of simulation. During the first 200 years, apart from short periods when inflows are very low, and salt concentrations temporarily increase rapidly due to evaporation, lake salinities are predicted to be less than 10,000 mg/L.

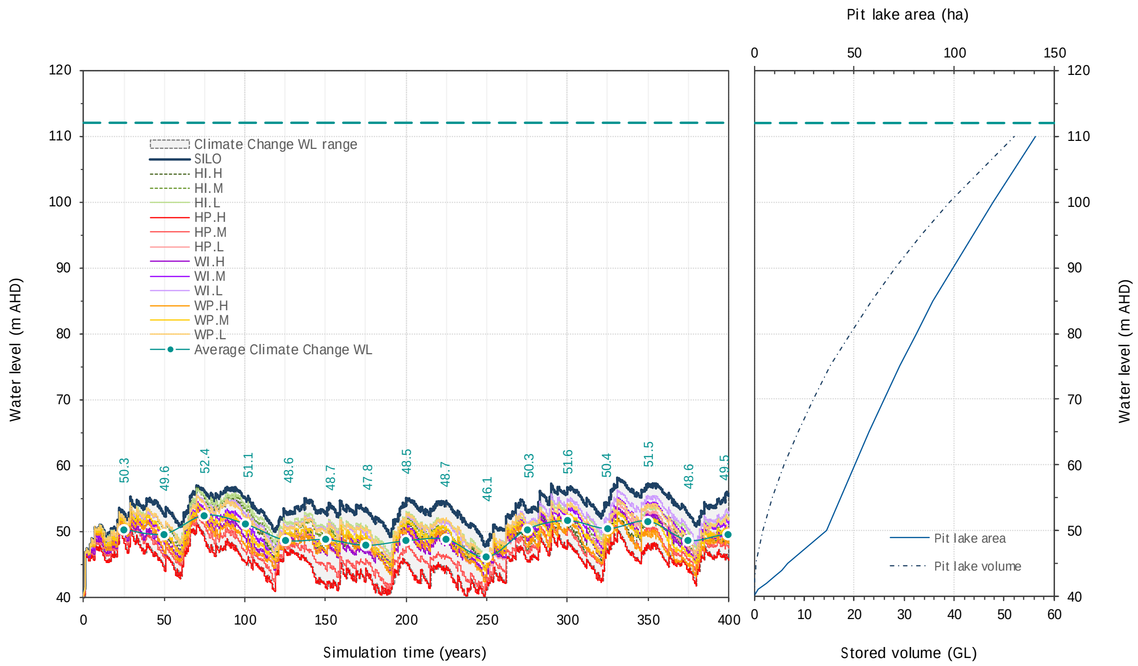


Figure 8.6 - Results of final void modelling AB Pit

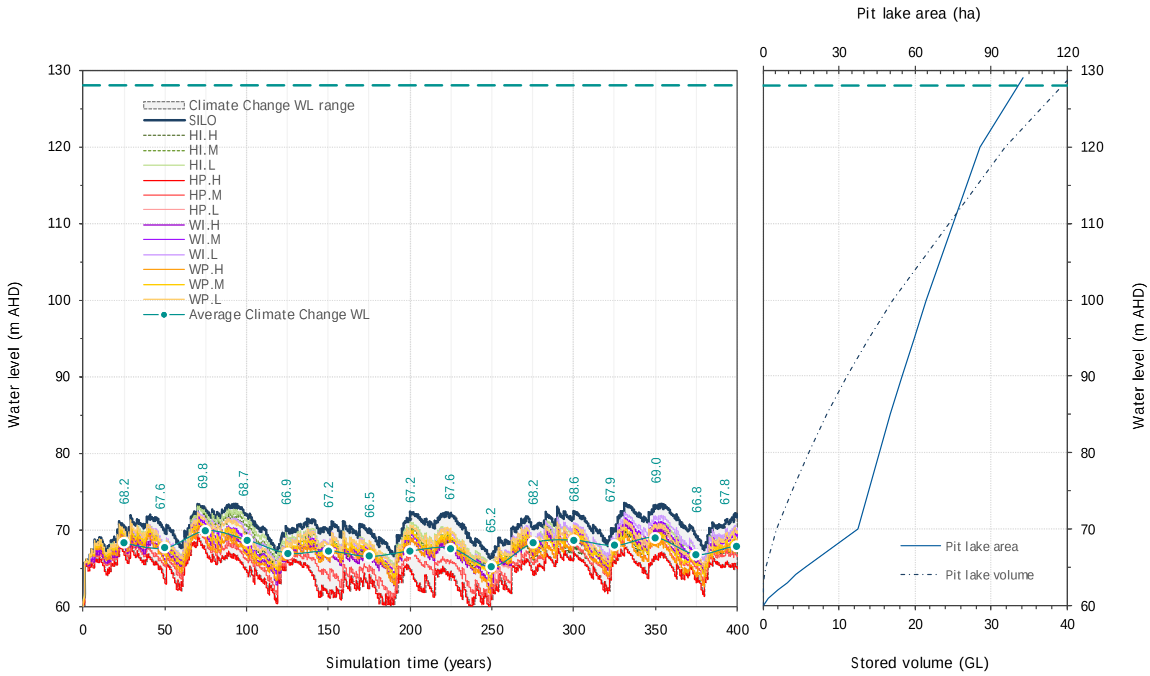


Figure 8.7 - Results of final void modelling C Pit

Table 8.4 - Average annual final void water balance - at equilibrium

		AB Pit		C Pit	
		Climate Scenario		Climate Scenario	
		EXISTING (SILO)	WP.M	EXISTING (SILO)	WP.M
Climate Averages					
Evaporation	mm/a	1,811	2,033	1,811	2,033
Rainfall	mm/a	694	656	694	656
Runoff characteristics					
Rehab runoff	mm/a	*59.9*	*52.6*	*59.9*	*52.6*
Rehab runoff/rainfall		8.6%	8.0%	8.6%	8.0%
Natural runoff	mm/a	*35.6*	*30.7*	*35.6*	*30.7*
Natural runoff/rainfall		5.1%	4.6%	5.1%	4.6%
Pit runoff	mm/a	*145.0*	*129.9*	*145.0*	*129.9*
Pit runoff/rainfall		20.9%	14.3%	20.9%	14.3%
Inflows					
Direct Rainfall	ML/a	283	202	253	176
Runoff	ML/a	156	150	127	125
GW inflow	ML/a	0	0	0	0
Outflows					
Pit evaporation	ML/a	439	352	380	301

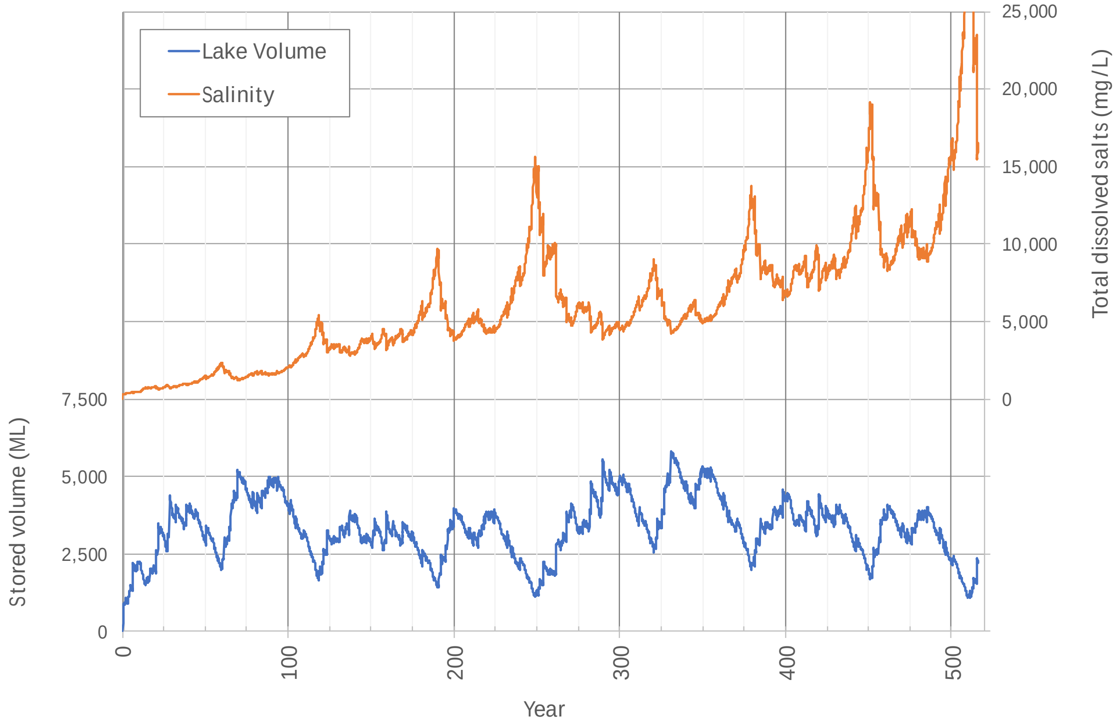


Figure 8.8 - Modelled void lake salinity - AB Pit

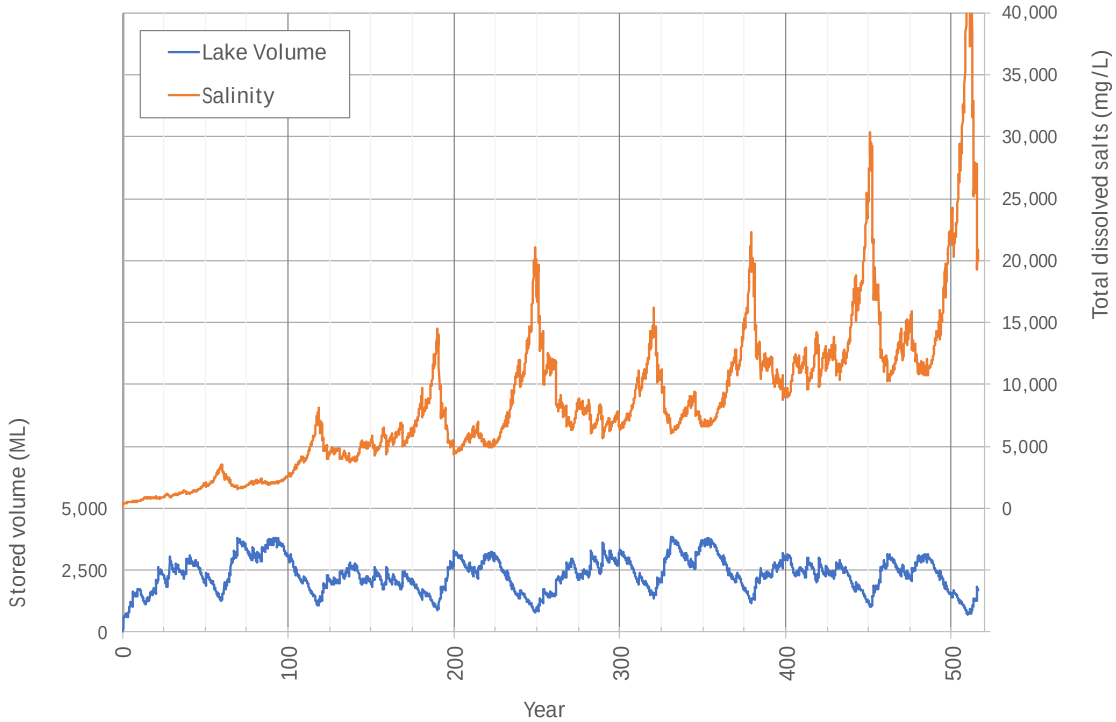


Figure 8.9 - Modelled void lake salinity - C Pit

8.12 SENSITIVITY ANALYSIS

The sensitivity of the equilibrium water level to uncertainty in the key input parameters was tested by reducing the AWBM USC values to half their original values - to increase runoff to the void.

Under these conditions, the equilibrium water level remained below:

- 63.9 mAHD at AB Pit, and
- 80.0 mAHD at C Pit.

Table 8.5 shows that under the high runoff scenario, total average inflows at equilibrium increase by approximately 26% compared to the base case, and the increase in lake water surface area results in a corresponding increase in evaporation.

Table 8.5 - Sensitivity analysis - high runoff - average annual final void water balance - at equilibrium

		C Pit	
		Sensitivity analysis	
		Base Case	High Runoff
Climate Averages			
Evaporation	mm/a	1,811	1,811
Rainfall	mm/a	694	694
Runoff characteristics			
Rehab runoff	mm/a	*59.9*	*111*
Rehab runoff/rainfall		8.6%	16.0%
Natural runoff	mm/a	*35.6*	*35.6*
Natural runoff/rainfall		5.1%	5.1%
Pit runoff	mm/a	*145.0*	*218.8*
Pit runoff/rainfall		20.9%	31.4%
Inflows			
Direct Rainfall	ML/a	253	297
Runoff	ML/a	127	183
GW inflow	ML/a	0	0
Outflows			
Pit evaporation	ML/a	380	480

9 Vulnerability to climate change during operations

The long-term effects of climate change on final void behaviour have been assessed in Section 8.

A number of potential adaptive measures have been considered to assist with resilience to climate change effects, most of which will be implemented in any case to cater for the high climatic variability experienced in the region:

- Contingency measures for directing excess inflows to the mine pit;
- Off-site water supplies of sufficient capacity to deliver the entire site water demand;
- Water efficient plant design;
- Overdesign of drainage and containment systems to cater for increased duration, frequency and intensity of rainfall due to climate change effects.

10 Potential surface water impacts and mitigation measures

10.1 OVERVIEW

The potential impacts of the Project on water resources identified in the preceding sections of the report, and proposed mitigation measures, are summarised in the following sections:

- the diversion of an unnamed tributary of Springton Creek, including changes to the channel and floodplain geometry - and resultant potential changes to stream morphology;
- impacts on the flooding regime in Charlevue Creek and Springton Creek;
- impacts on flood levels at the Capricorn Highway and the Blackwater Rail Corridor upstream of the proposed rail loop and train loadout;
- the creation of a final void lake at the completion of mining;
- short-term loss of catchment area - and subsequent reduction in streamflow in local streams due to the capture of runoff within on-site storages and the open cut pit;
- long-term reduction in streamflow in local streams due to residual loss of catchment to the final void;
- impacts on regional water availability due to the potential need to obtain water from external sources to meet construction and operational water requirements for the Project;
- adverse impacts on the quality of surface runoff draining from the disturbance areas to the various receiving waters surrounding the Project, during both construction and operation of the Project;
- adverse impacts on environmental values in the Mackenzie River catchment associated with releases from the sediment management system.

10.2 FLOODING IMPACTS

The outcomes of the flood impact assessment are as follows:

- The proposed rail loop will not impact Charlevue Creek or Springton Creek flooding.
- The Project will temporarily increase Charlevue Creek flood levels immediately upstream of the proposed haul road crossing. These impacts are contained within the mine lease area.
- There will be no impact on flood levels in the Springton Creek or Charlevue Creek at the existing Capricorn Highway, Blackwater Rail corridor, or downstream of the Project area.
- The works at AB Pit will locally increase flood levels in Springton Creek by up to 0.22 m in the 1% AEP flood. These impacts would extend off the lease area onto land owned by Magnetic South Pty Ltd, and reduce with distance downstream of the boundary.
- There will be localised off-lease impacts on flood levels in the unnamed tributary of Springton Creek immediately upstream of AB Pit and C Pit.

10.3 FINAL VOID LAKES

At mine closure, final voids will remain at each mine pit.

The floor of the AB pit will be at an elevation of approximately 40 mAHD or 72 m below the natural surface elevation (112 mAHD). The floor of the C pit will be at an elevation of approximately 60 mAHD or approximately 68 m below the natural surface elevation (128 mAHD).

Over time, the voids will fill with surface water runoff to form a lake. Based on water balance modelling:

For AB Pit:

- Under the existing (SILO) climate scenario - the modelled water level reaches equilibrium at around 52.9 mAHD within 50 years and generally remains at this level throughout the remainder of the simulation (fluctuating between 47.4 and 57.6 mAHD).
- The maximum modelled water level (57.6 mAHD) is around 54 m below the void overflow level of approximately 112 mAHD, and well below the potential level of groundwater seepage to the tertiary aquifer.
- Under the climate change scenarios, the equilibrium water level is lower than the existing climate scenario.

For C Pit:

- Under the existing (SILO) climate scenario - the water level reaches equilibrium at around 70.3 mAHD within 50 years and generally remains at this level throughout the remainder of the simulation (fluctuating between 66.0 and 73.5 mAHD).
- The maximum modelled water level is around 54.4 m below the void surface overflow level of approximately 128 mAHD, and well below the potential level of groundwater seepage to the tertiary aquifer.
- Under all climate change scenarios, the equilibrium water level is lower than the existing climate scenario.

Salt will accumulate within both voids over time. The void lake salinity is expected to exceed a TDS of 30,000 mg/L after approximately 500 years. Final void modelling suggests that during the first 200 years after closure, apart from short periods when inflows are very low, and salt concentrations temporarily increase rapidly due to evaporation, lake salinities will be less than 10,000 mg/L.

10.4 GEOMORPHOLOGICAL IMPACTS

An unnamed tributary of Springton Creek will be diverted to allow mining of the resource at both pits. This stream is not defined as a watercourse under the Water Act. Nonetheless, it is proposed that where practicable, the diversion works will be constructed to comply with the design principles set out in the Guideline: “Works that interfere with water in a watercourse - watercourse diversions”.

The proposed diversion channel would be designed to accommodate flood flows at velocities which would be non-erosive in the 1 in 100 AEP flood with appropriate channel lining.

10.5 IMPACTS ON DOWNSTREAM FLOW REGIME

During operations, the Project’s water management system will intercept runoff from disturbed areas of the mine site.

The water management system has been designed to achieve a high level of containment of mine affected water, with any overflows from the Main Water Dam directed to the mine pit. As controlled releases are not part of the proposed water management strategy for the mine affected water management system, runoff currently flowing from these parts of the catchment to Charlevue Creek and Springton Creek will be temporarily stopped during project operations.

As overburden runoff quality is expected to be relatively benign, sediment dams will potentially discharge directly into the environment (after the settlement of suspended sediment), and as such, will not reduce downstream flows. However, sediment dams will be pumped back to the mine affected water system if water quality monitoring shows the water is unsuitable for release. As shown in Table 10.1, the maximum captured catchment areas represent:

- 1.0% of Charlevue Creek catchment upstream of the Springton Creek confluence;
- 3.6% of Springton Creek catchment upstream of the Charlevue Creek confluenc; and
- 2.3% of Springton Creek catchment downstream of the Charlevue Creek confluence.

Table 10.1 - Catchment excised by site water management system at Year 18

Description	Charlevue Creek	Springton Creek	Total
Total Intercepted in MW System (ha)	336.9	1,174.9	
To confluence (U/S) (ha)	32,243	32,497	
	1.0%	3.6%	
Downstream of confluence (ha)		2.3%	64,740

After mine closure, the water management system will be decommissioned but there will be some residual impact on streamflow due to drainage to the final voids. As shown in Table 10.2, the maximum captured catchment areas represent:

- 0.03% of Charlevue Creek catchment upstream of the Springton Creek confluence;
- 1.1% of Springton Creek catchment upstream of the Charlevue Creek confluence; and
- 0.6% of Springton Creek catchment downstream of the Charlevue Creek confluence.

Table 10.2 - Catchment excised by site water management system at mine closure

Description	Charlevue Creek	Springton Creek	Total
Total Intercepted in Final Void (ha)	10.0	345.0	
To confluence (U/S) (ha)	32,243	32,497	
	0.03%	1.1%	
Downstream of confluence (ha)		0.6%	64,740

10.6 IMPACTS ON RECEIVING WATER QUALITY

The potential impacts on receiving water quality will be managed by the site water management system.

To avoid significant downstream impacts, the system has been designed to achieve a high level of containment without the need for controlled releases, as the opportunities to release mine water are likely to be very limited. However, should water quality allow, water may be released to Charlevue Creek in accordance with Environmental Authority conditions consistent with the "*Model water conditions for coal mines in the Fitzroy basin*".

Any unplanned overflows from the Mine Water Dam, would overflow to the mine pit. The only potential mine water release points are the MIA Dam spillways. However, these dams will be operated in such a way that the risk of release is small.

Runoff from overburden dumps will be managed under an erosion and sediment control plan to reduce sediment loads to background levels before release. Water would be discharged either via sediment dam spillways or perforated riser pipes.

10.6.1 Seepage

There is some potential for seepage of water from the Mine Water Dam to Charlevue Creek. The dam will be designed with a floor and sides of material that will limit seepage to avoid environmental harm.

10.7 CUMULATIVE IMPACTS

The only known existing coal mine within the Springton Creek catchment is the recently commenced Bluff Coal Mine. The Walton Coal Project is also proposed within the catchment. These two projects are of relatively small scale and short life. The potential cumulative impacts of the two projects are discussed in the following sections.

10.7.1 Regional water availability

The water balance model shows that (due to the relatively low water requirements of the coal preparation plant) the mine site water requirements of the Gemini Project can largely be sourced from water collected within the site water management system.

Shortfalls in water supply for both the Walton Coal Mine and the Bluff Coal Mine are to be supplied with mine water from the Jellinbah Mine. As a result, the potential cumulative impacts of mine projects on water availability in the catchment of Springton Creek is limited to the effect of cumulative catchment excision by the two projects.

Based on catchment information presented in the Bluff Coal Mine EIS, the cumulative impact of the projects on flows in Springton Creek will be minimal.

10.7.2 Controlled releases

Mine affected water from the Project will be managed through a mine water management system which is designed to achieve full containment of mine water under historical conditions. The water management plans for the other project are similarly designed for the complete containment of mine water. Releases would only occur in accordance with Environmental Authority conditions consistent with the "*Model water conditions for coal mines in the Fitzroy basin*".

Releases from sediment dams are authorised under the EA if an ESCP is appropriately implemented. Water releases from both projects would only be allowed from the sediment water system if water quality meets the sediment dam release criteria to be set in the Environmental Authority.

If operated in accordance with the EA, the impact of releases from the projects on water quality in the regional catchment systems would be minimal.

11 Water monitoring

11.1 RECEVING WATER MONITORING

A Receiving Environment Monitoring Plan (REMP) will be developed for the Project in accordance with the model mining conditions. The REMP would be implemented to monitor, identify and describe any adverse impacts to surface water environmental values, quality and flows due to the authorised mining activity.

Water quality monitoring will be undertaken upstream and downstream of the project to detect downstream water quality impacts and to demonstrate compliance with the Environmental Authority release conditions. The proposed receiving water monitoring points are listed in Table 11.1 and shown in Figure 11.1. Locations have been chosen so that the sites are unaffected by the project operations but are accessible during wet weather.

Water quality will be monitored for the 'standard' suite water quality parameters included in the Model Water Conditions for coal mines in the Fitzroy basin - but not limited to, pH, EC, major anions (sulfate, chloride and alkalinity), major cations (sodium, calcium, magnesium and potassium), TDS and a broad suite of soluble metals/ metalloids.

Water quality monitoring will be compliant with the National Water Quality Management Strategy. Samples will be collected monthly or during each flow event, where possible. Continuous water level, salinity, turbidity and pH monitoring equipment will be installed at the downstream stations.

Table 11.1 - Receiving water monitoring points

Description	Latitude (deg)	Longitude (deg)
Springton Creek US	-23.6976	149.2738
Springton Creek DS	-23.6434	149.3145
Charlevue Creek US	-23.6305	149.2715
Charlevue Creek DS	-23.6469	149.2104

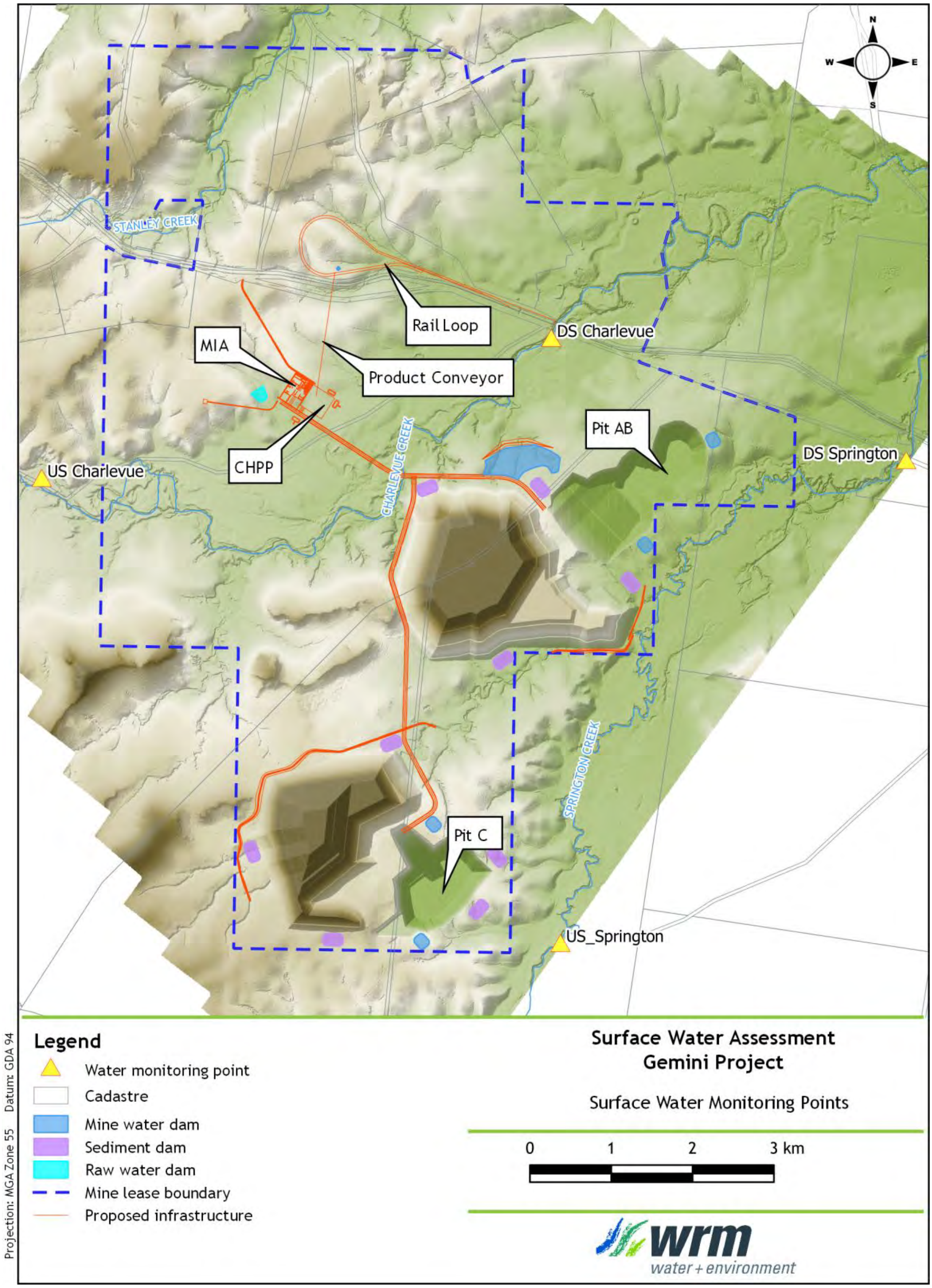


Figure 11.1 - Proposed upstream and downstream receiving water monitoring points

11.2 MINE WATER SYSTEM MONITORING

An onsite water monitoring system will also be used to validate system performance against the design assumptions in terms of water quality and water quantity, so that an adaptive management can be implemented to protect the surface water environment.

11.2.1 Mine affected water dam monitoring

Surface runoff and seepage water collected in the Mine Water Dam and Process Water Dam will be monitored for 'standard' water quality parameters including, but not limited to, pH, EC, major anions (sulphate, chloride and alkalinity), major cations (sodium, calcium, magnesium and potassium), TDS and a broad suite of soluble metals/metalloids.

11.2.2 Spoil and sediment dam monitoring

Validation testwork will be undertaken on potential spoil materials as the Project develops to enable appropriate spoil management measures to be planned and implemented as required.

Some spoil materials may be sodic with potential for dispersion and erosion. Where highly sodic and/or dispersive spoil is identified, this material would not be placed in final landform surfaces and would not be used in construction activities. Regardless of the spoil type, especially where engineering or geotechnical stability is required, testing would be undertaken during construction to determine the propensity of such materials to erode.

Surface runoff and seepage from spoil piles, including any rehabilitated areas, would be monitored for 'standard' water quality parameters including, but not limited to, pH, EC, major anions (sulfate, chloride and alkalinity), major cations (sodium, calcium, magnesium and potassium), TDS and a broad suite of soluble metals/ metalloids.

The sediment dam monitoring would be used to validate the anticipated quality of water runoff reporting to sediment dams and haul road runoff dams. Initially, the sediment dam monitoring would occur on a regular (e.g. monthly) basis to demonstrate the water quality of stored waters is consistent with the relevant operating parameters to allow releases from sediment dams to occur when required. Subject to demonstrating the water quality objectives can be met, the frequency of monitoring and suite of parameters for the sediment dam monitoring would be reviewed and updated accordingly (e.g. to occur only when releases occur).

12 References

AARC, 2019	*Gemini Project Aquatic Ecology Report* prepared for Magnetic South by aarc environmental solutions, September 2019
DEHP, 2017	*Guideline Stormwater and environmentally relevant activities Department of Environment and Heritage Protection ESR/2015/1653* • Version 1.02 • Effective: 17 FEB 2014 1.02 3-Jul-17 https://environment.des.qld.gov.au/assets/documents/regulation/pr-gl-stormwater-guideline-era.pdf
JBT, 2019	*Gemini Project- Groundwater Assessment* - JBT Consulting Pty Ltd, September 2019
RGS, 2018	*Dingo West Coal Project Geochemical Assessment of Mining Waste Materials* - Report prepared for Magnetic South Pty Ltd, 19 March 2018

Appendix A Flood impact assessment

A1 Introduction

A1.1 PROJECT OVERVIEW

The Gemini Project is a proposed open cut coal mine in the Fitzroy Basin. The proposed mine development site is located approximately 7.6 km west from the town of Dingo and 19.4 km southeast of Bluff. The two main regional centres are Emerald, 110 km west of the site and Rockhampton, 134 km east of the Project area.

The mine development schedules are expected to include two open cut pits, AB Pit and C Pit (Figure A.3). AB Pit will disturb an area of 694 ha within the mining lease application areas and C Pit will have a 465 ha disturbance area. Additional disturbance areas include sediment and mine water dams, a mine industrial area (MIA), a coal handling processing plant (CHPP), a conveyor, a dedicated rail loop, train load out (TLO) and mine roads interconnecting this infrastructure.

The proposed mine lease area is crossed by two main drainage paths flowing in a northeasterly direction. The northern stream is Charlevue Creek and the southern stream is Springton Creek, where Charlevue Creek joins the Springton Creek 5.2 km northeast of Dingo.

A1.2 SCOPE OF THIS STUDY

A1.2.1 Study objectives

This report presents the methodology and results of hydrologic and hydraulic modelling undertaken to assess the impacts of the Gemini Project on flood behaviour in the reaches of Charlevue Creek and Springton Creek crossing the Project area. The modelling results define the existing flood conditions, as well as conditions during operation of the Project. The key outcomes of the study are to:

- Define existing flood conditions across the Project area for a range of design flood events, in terms of peak water levels and peak velocities;
- Assess peak water levels and velocities along the levees proposed to protect the proposed mine areas from flooding;
- Determine the impacts of the proposed Project during project operations;
- Assess the long-term flood conditions in events up to the probable maximum floodi and the residual impacts of the Project following mine closure.

As the flood investigations detailed in this report have been specifically undertaken for the purpose of impact assessment, the results presented herein should not be used for any other purpose without seeking advice from WRM regarding their applicability.

A2 Estimation of design discharges

A2.1 METHODOLOGY

The XP-RAFTS runoff-routing model (XP Software, Version 2018.1.2) was used to estimate design discharges for the Charlevue Creek and Springton Creek catchments. In the absence of suitable stream gauge data, the peak discharges estimated by the XP-RAFTS model were validated against the Rational Method and Regional Flood Frequency Estimation (RFFE) estimates.

The validated XP-RAFTS model was used to estimate design discharges based on design rainfall and temporal pattern data developed using AR&R 2016 methodology (Ball et al, 2016). Design discharge hydrographs were estimated for the 50%, 10%, 2%, 1% and 0.1% annual exceedance probability (AEP) design discharges as well as the probable maximum flood (PMF) design discharge.

A2.2 XP-RAFTS MODEL CONFIGURATION

A2.2.1 Spatial configuration

Figure A.1 shows the XP-RAFTS model configuration adopted in the vicinity of the Project area. The hydrologic model includes both Charlevue Creek catchment and Springton Creek catchment to 4 km downstream of the confluence of Charlevue Creek and Springton Creek. The combined catchment has a total area of 680.5 km^2, consisting of 43 sub-catchments.

A2.2.2 Sub-catchment parameters

The XP-RAFTS model uses a single sub-catchment approach to determine runoff hydrographs, based on the overall sub-catchment parameters (fraction impervious, roughness and slope). Sub-catchment fraction impervious and roughness (Manning's 'n') parameters were weighted based on the various land use types in each sub-catchment based on available topographic data and aerial photographs.

Table A.9 presents the adopted sub-catchment parameters including catchment area, percentage impervious, catchment slope and PERN 'n' catchment roughness coefficients.

Model parameters for each sub-catchment were determined as follows:

- A percentage impervious of zero was adopted for all sub-catchments;
- Catchment slopes were determined based on the available topographic data;
- A sub-catchment storage coefficient multiplication factor 'Bx' of 1.0 was adopted for all events;
- Sub-catchment PERN 'n' values were determined based on the density of vegetation in each sub-catchment. The adopted sub-catchment PERN 'n' value was 0.05 for sub-catchments with largely bushland areas; and
- Initial (IL) and continuing (CL) losses for the validation events were determined based on the recommended AR&R 2016 data hub parameter. The selection of initial and continuing losses for design events is described in Section A2.6.

A2.2.3 Routing parameters

Channel routing in the XP-RAFTS model was configured based on specifying a 'K' and 'X' value for each routing link. An 'X' value of 0.25 was adopted for all routing links. The 'K' values represent estimated flow travel times (in hours) and were calculated based on the flow path lengths and an assumed conservative flow velocity of 1 m/s.

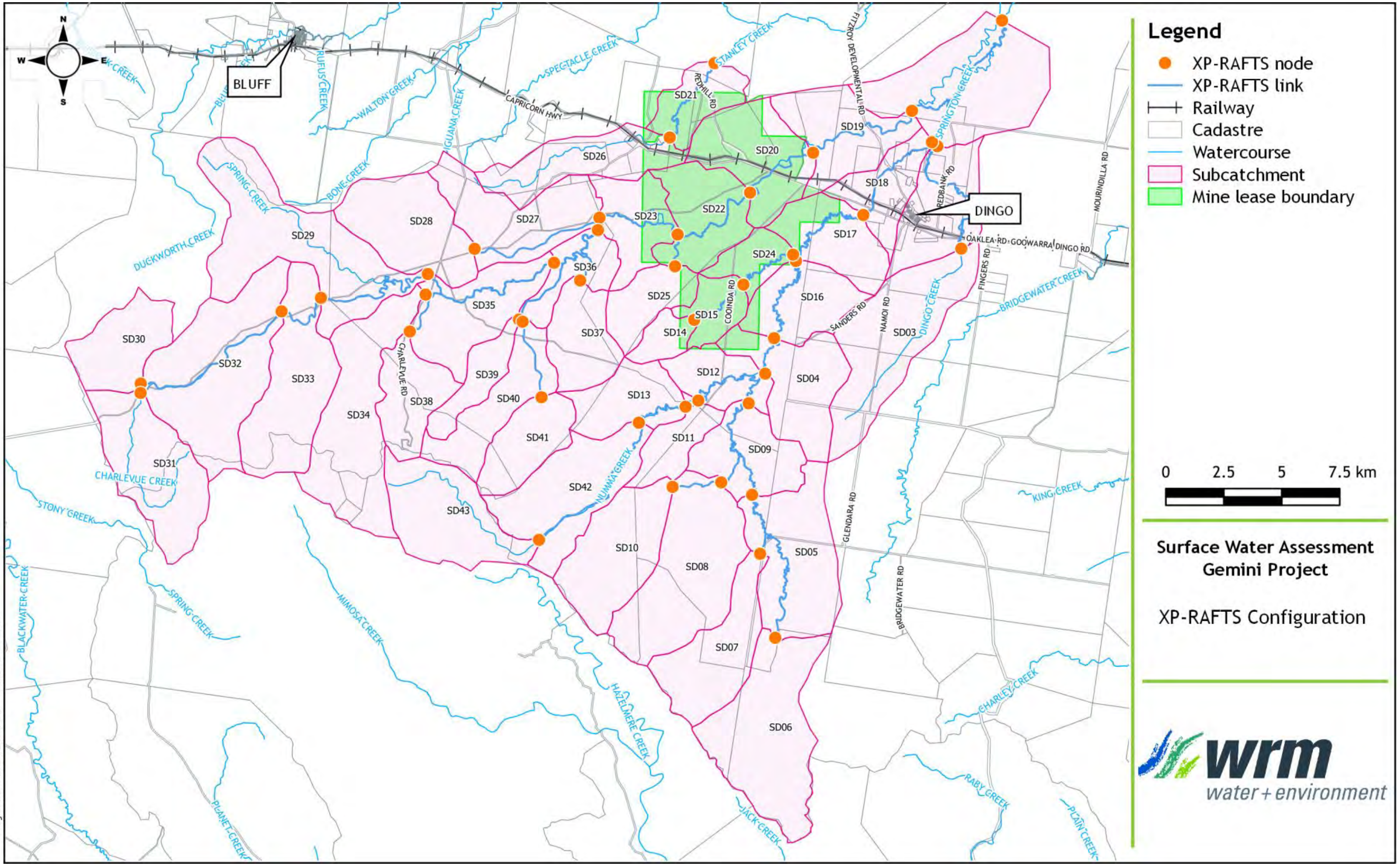


Figure A.1 - XP-RAFTS model configuration

A2.3 DESIGN RAINFALL DEPTH

A2.3.1 50% to 0.1% AEP design events

Design rainfall depths and intensities were derived using intensity-frequency duration (IFD) data obtained from the Bureau of Meteorology's (BoM's) 2016 Rainfall IFD Data System. Design rainfall IFDs were obtained based on the centroid point location at the combined Charlevue Creek and Springton Creek catchment.

A2.3.2 Probable maximum flood design event

PMP rainfall depths for durations up to 6 hours were estimated using the methodology given in *The Estimation of Probable Maximum Precipitation in Australia: Generalised Short Duration Method (GSDM)* (BoM, 2003).

PMF rainfall depths for durations longer than 6 hours were estimated using the standard methodology given in *The Estimation of Probable Maximum Precipitation: Generalised Tropical Storm Method Revised (GTSMR)* (BoM, 2006).

The followings parameters were adopted:

- For GSDM:
  - The terrain was assumed to be 100% rough, S = 0;
  - Elevation Adjustment Factor, EAF = 1;
  - Moisture Adjustment Factor, MAF = 0.85.
- For GTSMR:
  - Located in the coastal zone;
  - Annual Moisture Adjustment Factor, AMAF = 0.75;
  - Winter Moisture Adjustment Factor, WMAF = 0.78;
  - Decay Amplitude Factor, DAF = 1.0;
  - Topographical Adjustment Factor, TAF = 1.13.

Note that aerial reduction factors are already applied to the PMP rainfalls due to the catchment area being incorporated into the PMP rainfall estimation methodology.

A2.4 AREAL REDUCTION FACTORS

The areal reduction factor was obtained from the ARR data hub and has been applied based on the combined catchment size in the model for design events up to 0.1% AEP.

A2.5 TEMPORAL PATTERNS

A2.5.1 50% to 0.1% AEP design events

Temporal patterns were obtained from the AR&R 2016 data hub based on the centroid of the combined Charlevue Creek and Springton Creek catchment. The AR&R 2016 temporal pattern methodology involves the use of an 'ensemble' of 10 temporal patterns, which produces 10 design hydrographs (and peak discharges) for each duration for each AEP. For each location and AEP, the storm duration with the highest median peak design discharge of the ensemble is selected and the temporal pattern that produces the peak design discharge just above the ensemble median is adopted.

A2.5.2 Probable maximum flood design event

The temporal patterns for storm durations up to and including 12 hours were obtained from the GSDM methodology (BoM, 2003). Temporal patterns for durations longer than 12 hours were obtained for Coastal Zone storms from the GTSMR methodology (BoM, 2006).

A2.6 DESIGN RAINFALL LOSSES

For design events up to 0.1% AEP, an initial loss (IL) of 42 mm and continuing losses (CL) of 2.0 mm/hr were adopted for this assessment based on the AR&R 2016 data hub report. An IL of 0 mm and CL of 1 mm/hr were used for PMP design event.

The incorporation of pre-burst depths specified in AR&R 2016 data hub is achieved by applying median depth values (ratio multiplied by initial loss) at an initial timestep for each event duration. Table A.1 shows the adopted median pre-burst and depth ratio values used in calculating design rainfall continuing losses.

Table A.1 - Median pre-burst depths (mm) and ratios

Duration min (hours)	50% AEP	2% AEP	1% AEP
60 (1.0)	0.4 (0.012)	5.5 (0.070)	6.5 (0.074)
90 (1.5)	0.1 (0.003)	4.1 (0.046)	6.1 (0.061)
120 (2.0)	0.0 (0.001)	5.3 (0.054)	7.7 (0.069)
180 (3.0)	0.5 (0.011)	6.8 (0.062)	9.4 (0.076)
360 (6.0)	0.0 (0.000)	14.5 (0.108)	23.4 (0.153)
720 (12.0)	0.0 (0.000)	17.4 (0.104)	27.5 (0.143)
1080 (18.0)	0.0 (0.000)	17.6 (0.092)	27.8 (0.126)
1440 (24.0)	0.0 (0.000)	12.2 (0.058)	20.8 (0.085)
2160 (36.0)	0.0 (0.000)	10.6 (0.043)	18.5 (0.065)
2880 (48.0)	0.0 (0.000)	3.1 (0.011)	5.4 (0.017)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)

A2.7 MODEL VALIDATION

The peak design discharges produced by the XP-RAFTS model were validated against the Rational Method and Regional Flood Frequency Estimation (RFFE) estimates.

A2.7.1 Rational method

The Rational Method was applied to a number of sub-catchments with areas less than 25 km^2.

Table A.2 compares the Rational Method results and XP-RAFTS peak discharges estimates at 4 sub-catchment outflow locations. The time of concentration was calculated using the Modified Friend's equation with no overland flow component.

The outflow locations used in the Rational Method calculation correspond to the XP-RAFTS nodes of SD02, SD15, SD21 and SD24. The Rational Method 1% AEP peak design discharges at these nodes are ranged between 13.8 m^3/s and 34.8 m^3/s. The estimated XP-RAFTS model discharges match the estimated Rational Method discharges well (within 10%) for sub-catchment SD15 and SD24, while the XP-RAFTS model gives a larger discharge compared to the RM estimates at sub-catchments SD02 and SD21.

Table A.2 - Comparison of Rational Method and XP-RAFTS model design discharges

Design event	Sub-catchment	Rational Method	XP-RAFTS	Difference
1% AEP	SD02	23.0	34.8	34%
	SD15	13.7	14.5	6%
	SD21	16.0	20.4	21%
	SD24	12.8	13.8	7 %

A2.7.2 RFFE estimates

The RFFE method was applied to the combined Charlevue Creek & Springton Creek catchment. Figure A.2 and Table A.3 show comparisons between RFFE estimates and XP-RAFTS model results. Design discharges obtained using XP-RAFTS match the RFFE estimates well (within +/-30%) for all design events.

The calibrated XP-RAFTS model was used to derive flood discharge hydrographs for use in the hydraulic model.

Table A.3 - Comparison of RFFE and XP-RAFTS model design discharges

AEP	Adopted XP-RAFTS design discharge (m^3/s)	RFFE discharge (m^3/s)			Difference
		Lower 5% confidence limit	Expected parameter quantile	Upper 95% confidence limit	
50%	180	57	149	391	17.1%
20%	-	137	345	877	
10%	604	199	544	1,480	10.0%
5%	-	262	798	2,420	
2%	1,061	345	1,240	4,410	-16.8%
1%	1,316	411	1,680	6,740	-27.6%

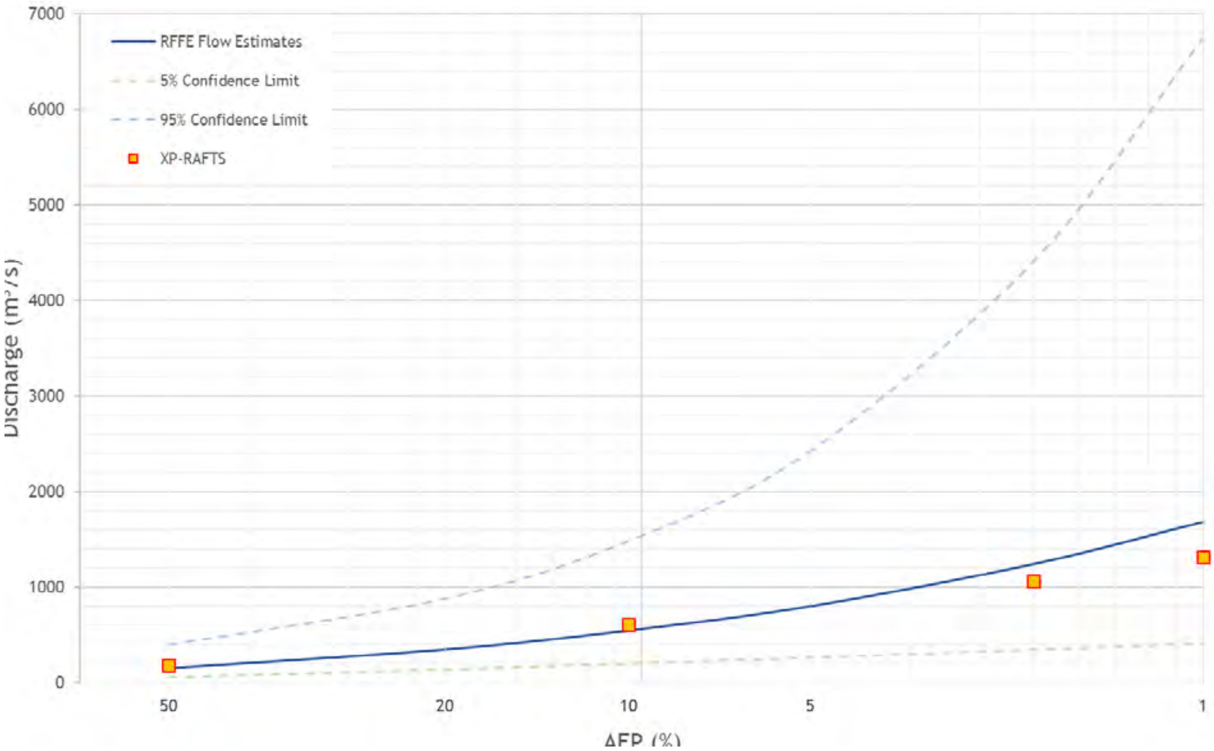


Figure A.2 - Comparison of RFFE and XP-RAFTS design discharges

A2.8 ADOPTED DESIGN DISCHARGES

Design discharges were estimated in accordance with AR&R 2016 guidelines for the 50% (1 in 2), 2% (1 in 50), 1% (1 in 100) and 0.1% (1 in 1,000) AEP events as well as the probable maximum flood (PMF) event.

Table A.4 shows XP-RAFTS predicted design peak discharges and relevant critical storm durations and temporal patterns for all modelled design events at the outlet (SD01) of the combined Charlevue Creek & Springton Creek catchment.

The design discharge hydrographs from the XP-RAFTS model were adopted as inflows to the TUFLOW hydraulic model.

Table A.4 - XP-RAFTS design discharges and critical durations at the outlet (SD01) of the combined Charlevue Creek & Springton Creek catchment

AEP	Combined Charlevue Creek & Springton Creek catchment		
	XP-RAFTS discharge (m^3/s)	Critical duration (hours)	Corresponding Temporal Pattern
50%	180	24	10
10%	604	24	10
2%	1,061	24	6
1%	1,316	24	2
0.1%	2,384	24	9
PMF	12,952	24	-

A3 Hydraulic modelling

A3.1 OVERVIEW

The TUFLOW hydrodynamic model (BMT WBM, 2016) was used to estimate flood extents and depths along the channel and floodplain of Charlevue Creek and Springton Creek and their tributaries for a range of design events. TUFLOW represents hydraulic conditions on a fixed grid by solving the full two-dimensional depth averaged momentum and continuity equations for free surface flow. The model automatically identifies breakout points and flow directions within the study area. All hydraulic modelling was undertaken using the TUFLOW Build 2018-03-AD HPC solver.

Figure A.3 shows the TUFLOW model boundary. The model covers an area of approximately 139.4 km^2 where the Project area is bounded by Charlevue Creek to the north and Springton Creek to the south.

The TUFLOW model was configured using a grid cell size of 5 metres. This provides a reasonable compromise between a coarse grid cell size sufficient for Charlevue Creek and Springton Creek, and a fine enough grid cell size required for the tributaries crossing the Project area.

A3.2 EXISTING CONDITIONS TUFLOW MODEL CONFIGURATION

A3.2.1 Topography

Topographic LiDAR survey data covering the majority of TUFLOW model area (purple region in Figure A.3) was provided by Magnetic South Pty Ltd.

Additional LiDAR data covering the area to the northeast near Dingo (green region in Figure A.3), was obtained from the Foundation Spatial Data Framework - Elevation and Depth portal (http://elevation.fsdf.org.au/) (referred to as ELVIS). The ELVIS LiDAR data is available on a 1 m grid and was acquired in 2012.

Hydrologically-enforced SRTM (Shuttle Radar Topography Mission) lidar data was used to cover an upstream portion of the Springton Creek floodplain (red region in Figure A.3). This data is available on a 30m grid, with a vertical accuracy of +/- 9.8 m. The SRTM was modified to better match the LiDAR at the boundary by lowering it by 1.8 m and applying a z-shape to smooth the transition between (geometry reinforcement in Figure A.4).

The combined data was converted into a digital elevation model (DEM) for use as the base TUFLOW model topography.

A3.2.2 Hydraulic roughness

Hydraulic roughness in the TUFLOW model is represented by Manning's 'n' roughness coefficients. Manning's 'n' values for the various land use types were selected based on typical published values. Land use types within the existing conditions model were identified using aerial photography.

Table A.5 shows the adopted Manning's 'n' values used in the model and Figure A.5 shows the locations of the Manning's 'n regions.

Table A.5 - **Adopted hydraulic roughness Manning's 'n' values**

Area	Manning's 'n'
Dense riparian vegetation	0.060
Creek / river channel	0.050
Pasture	0.035

A3.2.3 Inflow and outflow boundaries

Figure A.4 shows the locations of inflow and outflow boundaries in the TUFLOW model. The model includes a total of 16 inflow boundaries. The model inflow boundaries were applied within the 2D model domain using surface-area “SA” polygons. Using this approach, flows are initially applied to the lowest point within each SA polygon. Design discharge hydrographs for these inflow boundaries were obtained from the XP-RAFTS hydrologic model.

A3.2.4 Tailwater conditions

The downstream boundary was set to minimise its influence on predicted flood behaviour. Flood slopes between 0.1% and 0.15% were adopted for the Springton Creek outlet in northeast of the Project area. A 0.4% bed slope was applied for the model outlet at Stanley Creek north of the Project area.

A3.2.5 Hydraulic structures

Bridges and culverts within the Project area have been surveyed and modelled in the TUFLOW hydraulic model. Culverts are treated as 1D networks and bridges are modelled as 2D layered flow constrictions, with points snapped onto the lines to represent the road/rail elevation.

Under existing conditions, a total number of 4 culverts were modelled, two located on the east of Charlevue Creek and two located on the west of Charlevue Creek. Two bridges were modelled (Figure A.4). Both bridges are located on the Capricorn Highway, one across Springton Creek and one across Charlevue Creek. An 800 mm thick slab and 500 mm height guard rails were adopted for both bridges.

Table A.6 and Table A.7 provide summary information on the existing culverts and bridges located under Capricorn Highway and Blackwater railway line embankments included in the model.

Table A.6 - Culvert details

Name	Road/ Rail Crossing	Dimension	IL U\S (mAHD)	IL D\S (mAHD)
SM02_a	Capricorn Hwy	3 x 0.75h*1.2w RCBC	114.06	113.53
SM02_b	Blackwater Rly	12 x 1.65m RCPs	113.90	113.63
SM04_a	Capricorn Hwy	9 x 0.75h*1.2w RCBC	113.66	113.31
SM04_b	Blackwater Rly	10 x 1.38m RCPs	113.77	113.68

[a] - RCP = reinforced concrete pipe, RCBC = concrete box culvert

Table A.7 - Bridge details

Name	Road/Rail Crossing	U/S Invert (mAHD)	D/S invert (mAHD)
BRD01	Capricorn Hwy/ Springton Creek	106.85	106.90
BRD03	Capricorn Hwy/ Charlevue Creek	114.90	114.90

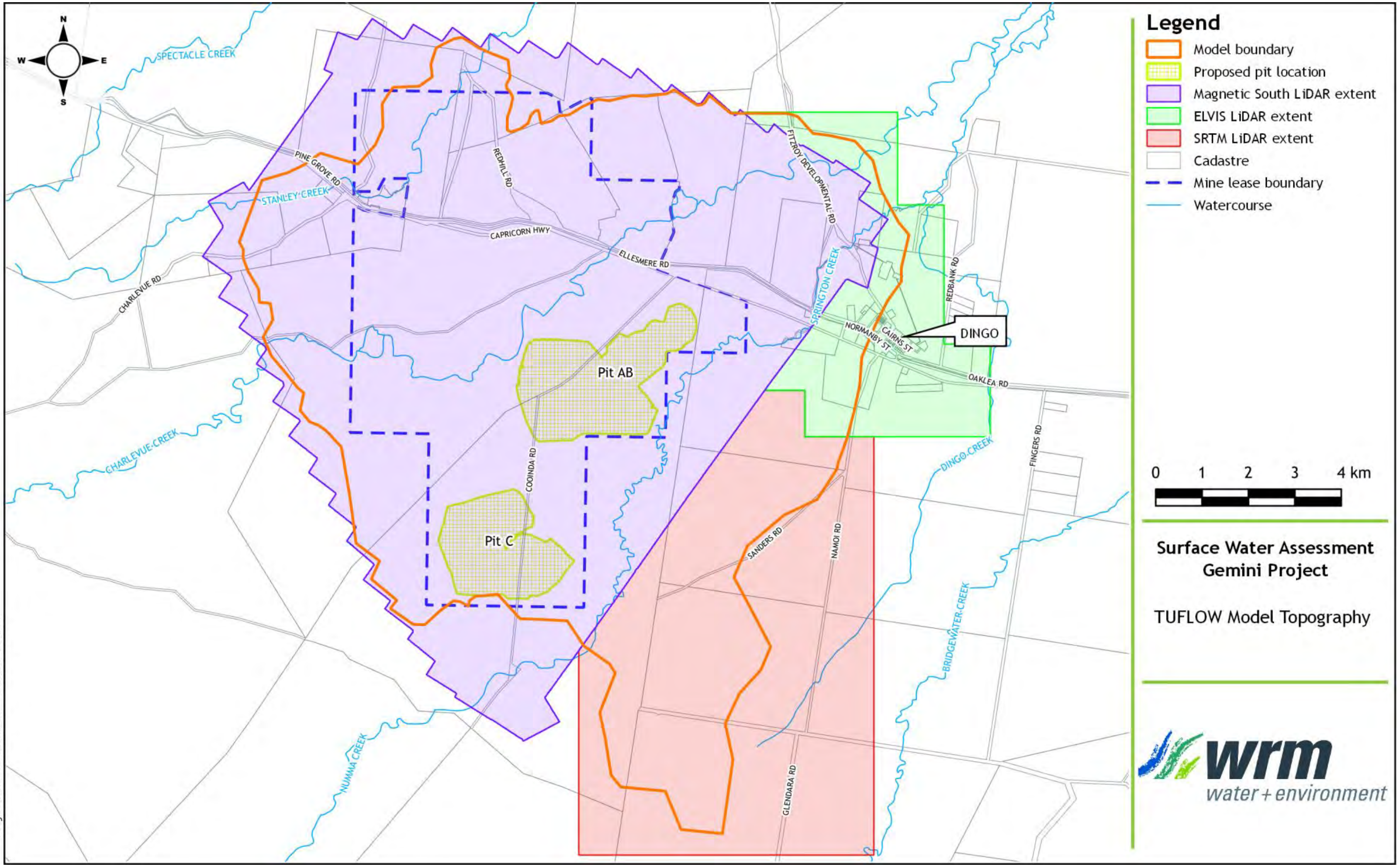


Figure A.3 - TUFLOW model topography

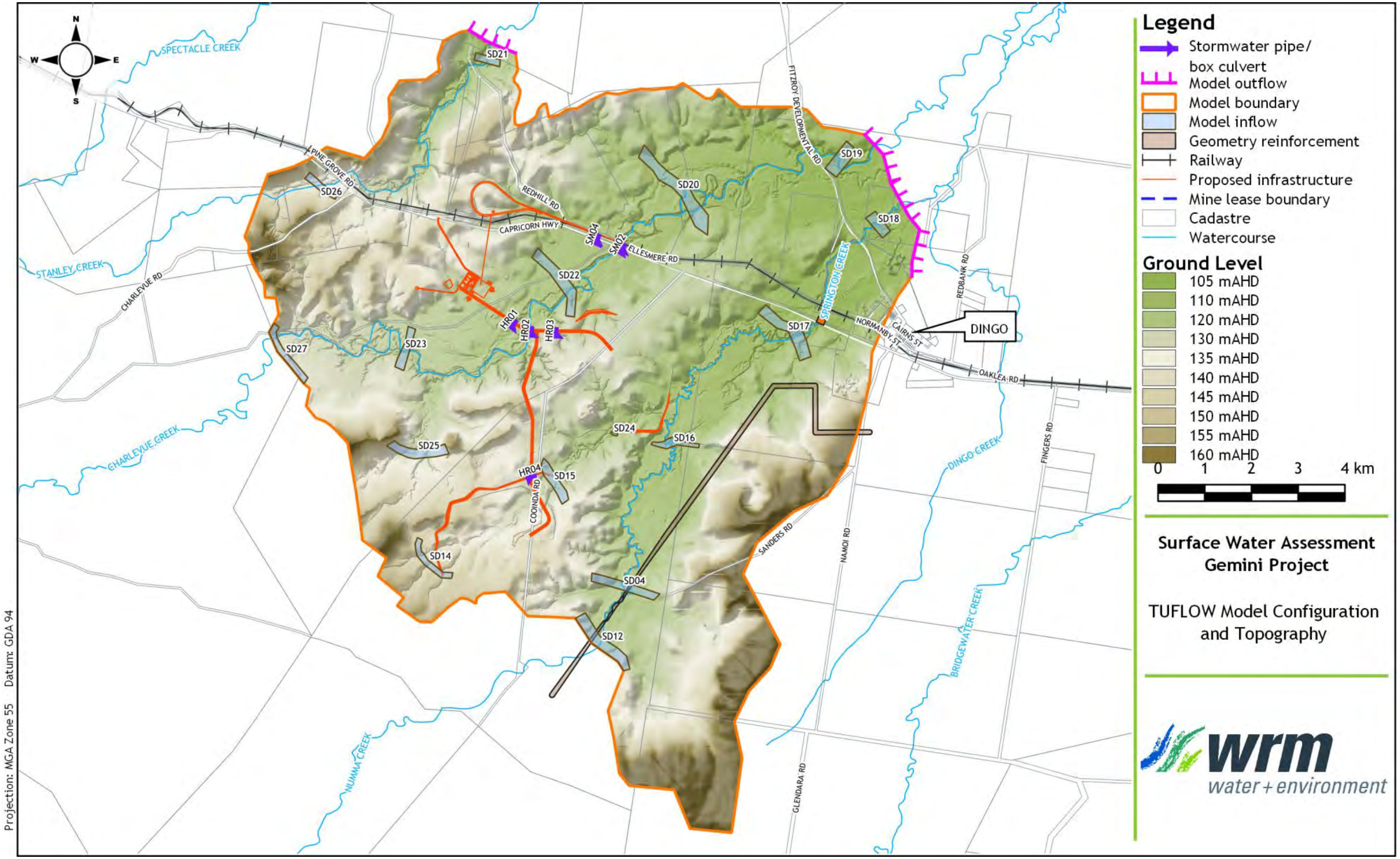


Figure A.4 - TUFLOW model configuration

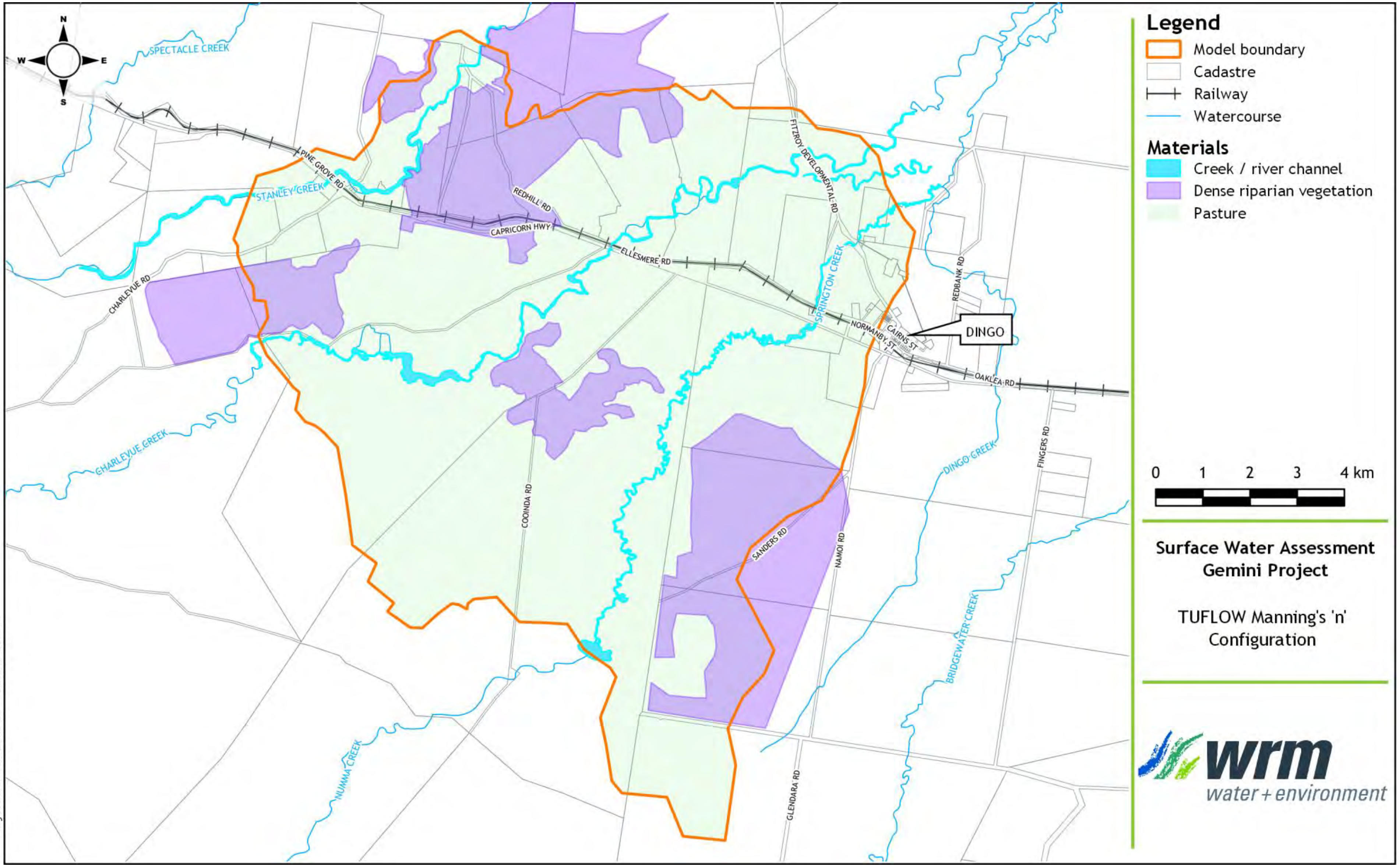


Figure A.5 **- Manning's 'n' configuration**

A3.3 DEVELOPED CONDITIONS TUFLOW MODEL

A3.3.1 Topography

A number of changes were made to the model DEM to reflect changes associated with:

- proposed overburden dumps and pit protection levees;
- haul roads connecting the two mining pits to the MIA and CHPP;
- diversion channels for the minor tributary of Springton Creek crossing the mine area.

The locations of these proposed structures are shown in Figure A.4.

A3.3.2 Hydraulic roughness

Land use types within the developed conditions model were identical to those defined for the existing conditions model.

A3.3.3 Inflow and outflow conditions

No changes to the existing conditions inflow and outflow locations were made.

A3.3.4 Hydraulic structures

Additional culverts under the proposed haul roads were added in the developed conditions. Details of the proposed Project culvert configurations are provided in Table A.8.

Table A.8 - Proposed new culverts in Project area

Name	Road/ Rail Crossing	Dimension	IL U\S (mAHD)	IL D\S (mAHD)
HR01	Haul Road (North)	3 x 0.9m RCPs	118.34	117.84
HR02	Haul Road (North)	3 x 2.1m RCPs	114.97	114.60
HR03	Haul Road (North)	2 x 0.9m RCPs	122.69	122.20
HR04	Haul Road (South)	3 x 0.9m RCPs	126.70	126.28

A3.3.5 Diversion channels

Earthworks models of the preliminary diversion channel designs were provided by TMM group and included in the model. The transitions between the diversion channels and the adjacent landforms were modified slightly to improve hydraulic performance.

A3.4 TUFLOW MODELLING RESULTS

Flood maps showing design peak flood depths and water level contours for the 1% AEP event under existing conditions and developed conditions are shown in Section A8.

Flood maps showing design peak flood velocities for the 1% AEP under existing and developed conditions are shown in Figure A.13 to Figure A.16 and Figure A.17 to Figure A.19 respectively.

Maps showing the water level difference between developed and existing conditions are shown in Figure A.20 to Figure A.21.

Flood mapping for a range of other design events (50% AEP,2% AEP, 0.1% AEP, and PMF) are provided in Section A8.

A4 Summary of findings

The purpose of this flood study was to:

- Define existing flood conditions across the Project area for a range of design events, in terms of peak water level, peak velocity, and water depth;
- Assess peak water levels and velocities along the levees proposed to protect the proposed works from flooding;
- Determine design flood conditions at the proposed haul road crossing, to assist in the preliminary design of cross-drainage infrastructure;
- Determine design flood conditions at the proposed railway crossing and to determine the potential for impacts on flood conditions;
- Assess the hydraulic conditions in the channels proposed to divert runoff in the unnamed Springton Creek tributary around both mining areas;
- Determine the residual impacts of the proposed Project during project operations.

An XP-RAFTS hydrologic model was developed to estimate design discharge hydrographs for the catchments of Charlevue Creek and Springton Creek which cross the Project area. In the absence of gauged streamflow data, the resulting peak discharges were validated against peak discharges estimated using the Rational Method and RFFE.

The model was used to estimate design discharges for the 50%, 10%, 2%, 1%, and 0.1% AEP events as well as the PMF design event in accordance with the AR&R 2016 approach using an ensemble of design temporal patterns.

- The 0.1% AEP design flood event was used in the design of flood levees;
- The 2% AEP and 1% AEP design events are of interest when assessing the impacts on road, rail and other off-site infrastructure;
- The PMF event was used in the risk analysis for the proposed final void location.

A TUFLOW hydraulic model was also developed to determine existing and developed conditions flood behaviour in Charlevue Creek, Springton Creek, and its unnamed tributary crossing the mine area. The adopted grid cell size was five metres, and the inflow boundaries were represented using design discharge hydrographs estimated using the XP-RAFTS runoff-routing model. The model incorporated the proposed works, including the haul roads, levees and diversion channels.

The outcomes of the study are as follows:

- The Project will temporarily increase Charlevue Creek flood levels in the immediate vicinity of the proposed haul road crossing. These impacts are contained within the mine lease area.
- There will be no impact on flood levels in Charlevue Creek or Springton Creek at the existing Capricorn Highway, Blackwater Rail corridor, or downstream of the Project area.
- While the unnamed tributary of Springton Creek is not a watercourse as defined under the Water Act, the diversion channel will be designed taking into consideration the principles set out in the Guideline: "Works that interfere with water in a watercourse - watercourse diversions" (DNRM, September 2014). This document sets out key design principles and requirements for the functional designs of permanent diversions. It includes guidance on watercourse diversion design and operation including maintenance, monitoring and revegetation. Preliminary designs are shown in Figure 7.3 to Figure 7.8 which also show the post development flood conditions with diversions and levees in place.

- The works at AB Pit will locally increase flood levels in Springton Creek by up to 0.22 m in the 1% AEP flood. These impacts would extend off the lease area onto land owned by Magnetic South Pty Ltd, and reduce with distance downstream of the boundary.
- There will be localised off-lease impacts on flood levels in the unnamed tributary of Springton Creek immediately upstream of AB Pit and C Pit.

A5 References

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A6 Model parameters

A6.1 XP-RAFTS SUB-CATCHMENT PARAMETERS

Table A.9 - Adopted XP-RAFTS sub-catchment parameters

Sub-catchment ID	Area (km^2)	Percentage impervious (%)	Catchment slope (%)	Catchment PERN 'n'
SD01	0.29	0	0.11	0.05
SD02	0.15	0	0.34	0.05
SD03	0.26	0	0.29	0.05
SD04	0.17	0	0.07	0.05
SD05	0.23	0	0.23	0.05
SD06	0.28	0	1.12	0.05
SD07	0.17	0	0.98	0.05
SD08	0.28	0	0.54	0.05
SD09	0.14	0	0.18	0.05
SD10	0.19	0	0.82	0.05
SD11	0.07	0	0.40	0.05
SD12	0.09	0	0.17	0.05
SD13	0.11	0	0.37	0.05
SD14	0.04	0	0.49	0.05
SD15	0.06	0	0.32	0.05
SD16	0.13	0	0.09	0.05
SD17	0.13	0	0.01	0.05
SD18	0.10	0	0.15	0.05
SD19	0.16	0	0.14	0.05
SD20	0.17	0	0.16	0.05
SD21	0.09	0	0.31	0.05
SD22	0.14	0	0.15	0.05
SD23	0.11	0	0.18	0.05
SD24	0.06	0	0.29	0.05
SD25	0.09	0	0.31	0.05
SD26	0.15	0	0.40	0.05
SD27	0.19	0	0.33	0.05
SD28	0.19	0	0.39	0.05
SD29	0.24	0	0.82	0.05
SD30	0.12	0	2.22	0.05
SD31	0.21	0	3.91	0.05
SD32	0.32	0	0.92	0.05
SD33	0.22	0	1.93	0.05
SD34	0.27	0	2.78	0.05
SD35	0.17	0	0.30	0.05
SD36	0.08	0	0.16	0.05
SD37	0.11	0	0.47	0.05
SD38	0.11	0	3.51	0.05
SD39	0.07	0	1.01	0.05
SD40	0.13	0	1.21	0.05
SD41	0.11	0	1.21	0.05
SD42	0.21	0	0.78	0.05
SD42	0.20	0	7.33	0.05

A7 Rational Method calculations

Table A.10 - Springton Creek estimated discharges SD15

Catchment:	SD15

Catchment area and coefficient of runoff	
Catchment Area (ha)	612.63
C_{10}	0.40

Channel Characteristics	
Channel length (m)	4009
Channel slope (m/m)	0.003
Manning's 'n'	0.050
Channel bottom width (m)	10.00
Channel side slope (m/m)	0.250

Design Discharges						
ARI (years)	AEP (%)	Frequency Factor F_y	C_y	t_c[a] (mins)	Rainfall Intensity (mm/h)	Peak Discharge (m^3/s)
1	63	0.80	0.32	154.0	16.4	8.93
1.44	50	0.85	0.34	153.3	16.5	9.53
4.48	20	0.95	0.38	151.9	16.6	10.7
10	10	1.00	0.40	151.2	16.6	11.3
20	5	1.05	0.42	150.6	16.7	11.9
50	2	1.15	0.46	149.5	16.8	13.1
100	1	1.20	0.48	149.0	16.8	13.7

a - Time of Concentration (t_c) is calculated using Modified Friend's equation

Table A.11 - Springton Creek estimated discharges SD02

Catchment:	SD02

Catchment area and coefficient of runoff	
Catchment Area (ha)	1513.00
C_{10}	0.40

Channel Characteristics	
Channel length (m)	7564
Channel slope (m/m)	0.003
Manning's 'n'	0.050
Channel bottom width (m)	10.00
Channel side slope (m/m)	0.250

Design Discharges

ARI (years)	AEP (%)	Frequency Factor F_y	C_y	t_c[a] (mins)	Rainfall Intensity (mm/h)	Peak Discharge (m^3/s)
1	63	0.80	0.32	255.3	11.1	15.0
1.44	50	0.85	0.34	254.0	11.2	16.0
4.48	20	0.95	0.38	251.8	11.3	18.0
10	10	1.00	0.40	250.8	11.3	19.0
20	5	1.05	0.42	249.9	11.3	20.0
50	2	1.15	0.46	248.2	11.4	22.0
100	1	1.20	0.48	247.3	11.4	23.0

a - Time of Concentration (t_c) is calculated using Modified Friend's equation

Table A.12 - Springton Creek estimated discharges SD21

Catchment:	SD21

Catchment area and coefficient of runoff	
Catchment Area (ha)	869.00
C_{10}	0.40

Channel Characteristics	
Channel length (m)	5434
Channel slope (m/m)	0.003
Manning's 'n'	0.050
Channel bottom width (m)	10.00
Channel side slope (m/m)	0.250

Design Discharges

ARI (years)	AEP (%)	Frequency Factor F_y	C_y	t_c[a] (mins)	Rainfall Intensity (mm/h)	Peak Discharge (m^3/s)
1	63	0.80	0.32	199.3	13.5	10.4
1.44	50	0.85	0.34	198.3	13.5	11.1
4.48	20	0.95	0.38	196.5	13.6	12.5
10	10	1.00	0.40	195.7	13.7	13.2
20	5	1.05	0.42	194.9	13.7	13.9
50	2	1.15	0.46	193.5	13.8	15.3
100	1	1.20	0.48	192.9	13.8	16.0

a - Time of Concentration (t_c) is calculated using Modified Friend's equation

Table A.13 - Springton Creek estimated discharges SD24

Catchment:	SD24

Catchment area and coefficient of runoff	
Catchment Area (ha)	584.76
C_{10}	0.40

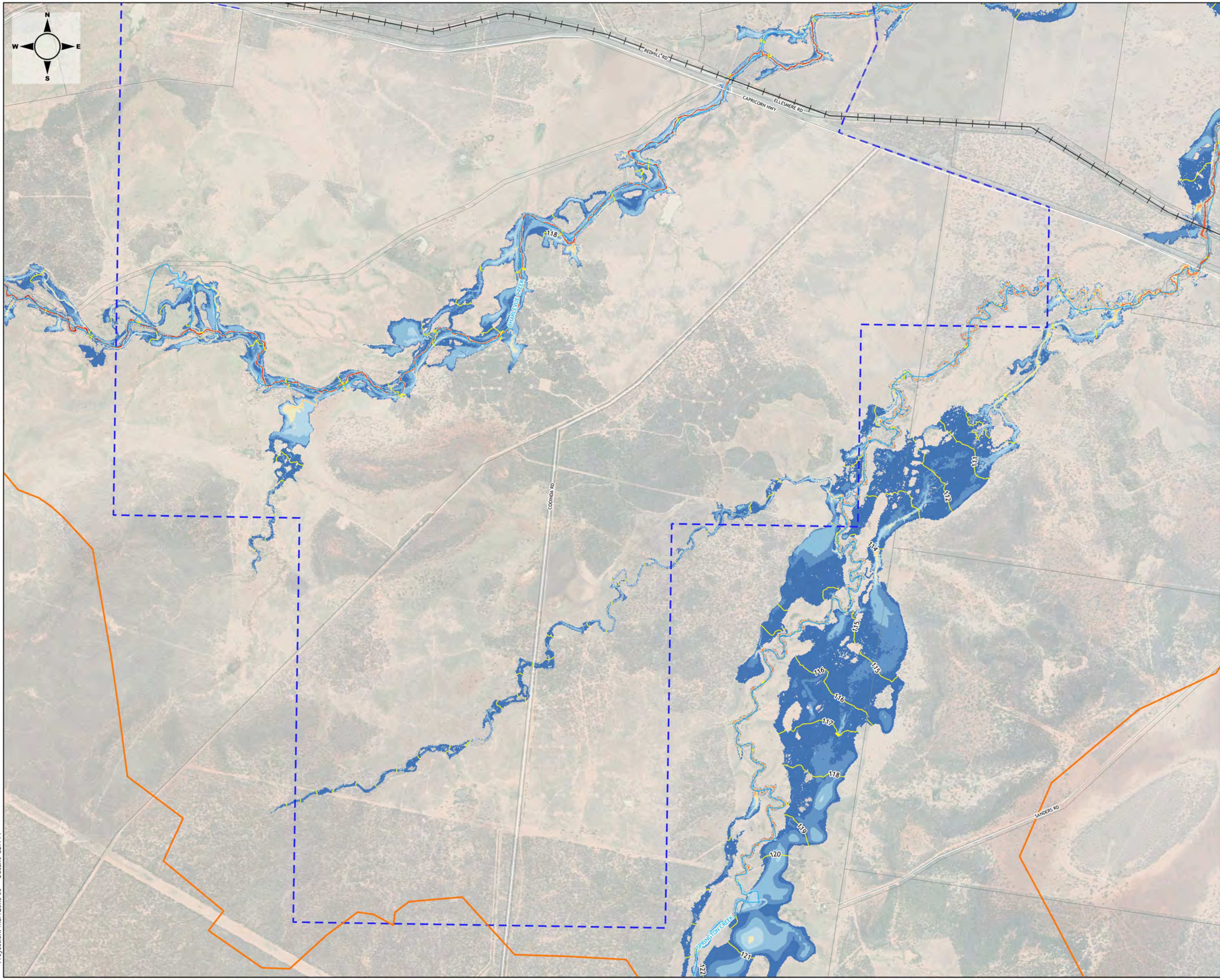
Channel Characteristics	
Channel length (m)	4092
Channel slope (m/m)	0.003
Manning's 'n'	0.050
Channel bottom width (m)	10.00
Channel side slope (m/m)	0.250

Design Discharges

ARI (years)	AEP (%)	Frequency Factor F_y	C_y	t_c[a] (mins)	Rainfall Intensity (mm/h)	Peak Discharge (m^3/s)
1	63	0.80	0.32	158.8	16.0	8.33
1.44	50	0.85	0.34	158.0	16.1	8.89
4.48	20	0.95	0.38	156.6	16.2	10.0
10	10	1.00	0.40	155.9	16.3	10.6
20	5	1.05	0.42	155.3	16.3	11.1
50	2	1.15	0.46	154.2	16.4	12.2
100	1	1.20	0.48	153.7	16.4	12.8

a - Time of Concentration (t_c) is calculated using Modified Friend's equation

A8 Flood maps



Legend

- Model boundary
- Cadastre
- Railway
- Watercourse
- Mine lease boundary

Peak flood depth

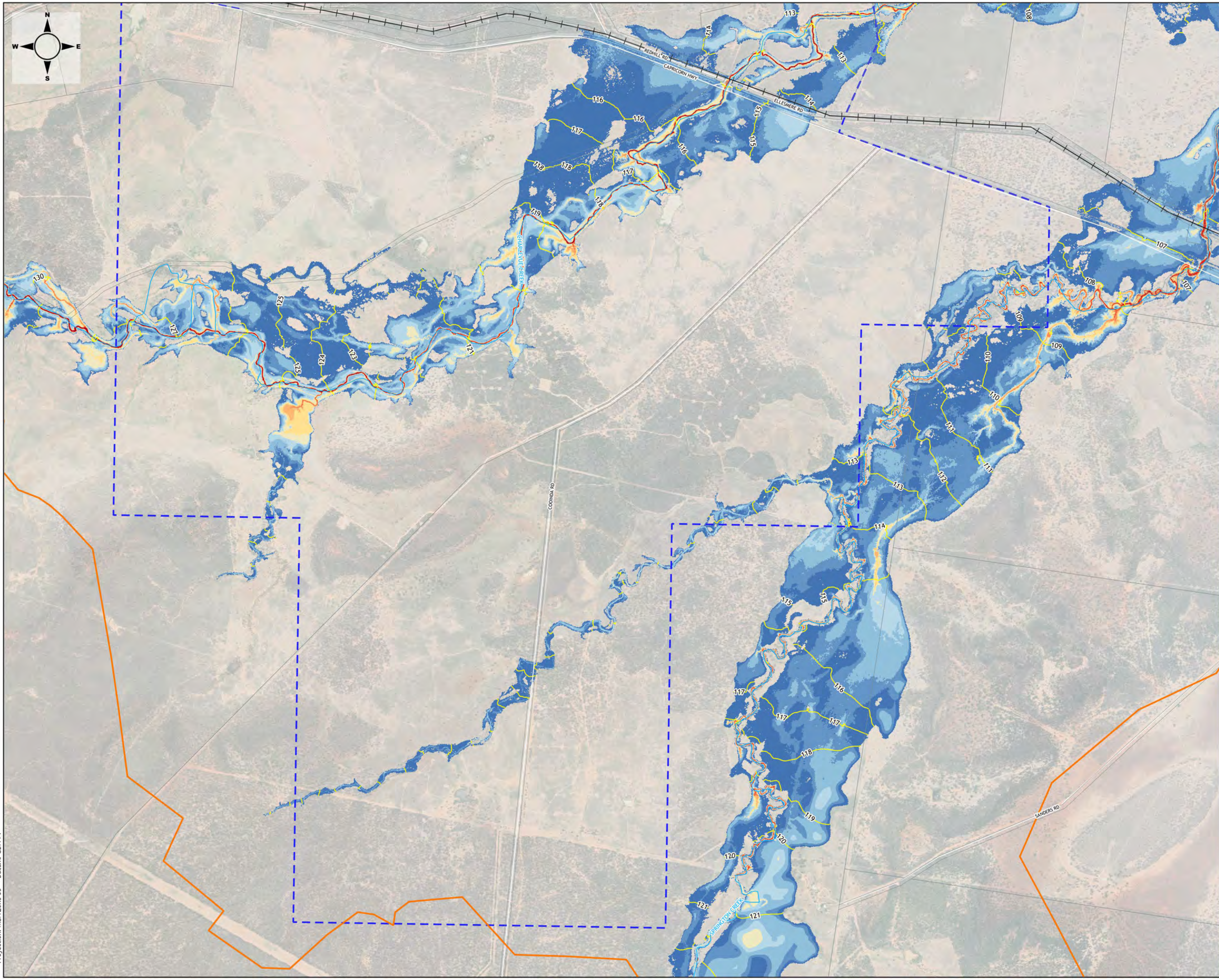
- 0.00 m - 0.25 m
- 0.25 m - 0.50 m
- 0.50 m - 1.00 m
- 1.00 m - 1.50 m
- 1.50 m - 2.00 m
- 2.00 m - 2.50 m
- 2.50 m - 3.00 m
- 3.00 m - 3.50 m
- 3.50 m - 4.00 m
- 4.00 m - 5.00 m
- > 5.00 m

0 0.25 0.5 0.75 1 km

Surface Water Assessment
Gemini Project

Predicted Flood Extents & Depths (Existing Condition), 50% AEP

wrm water + environment



Legend

- Model boundary
- Cadastre
- Railway
- Watercourse
- Mine lease boundary

Peak flood depth

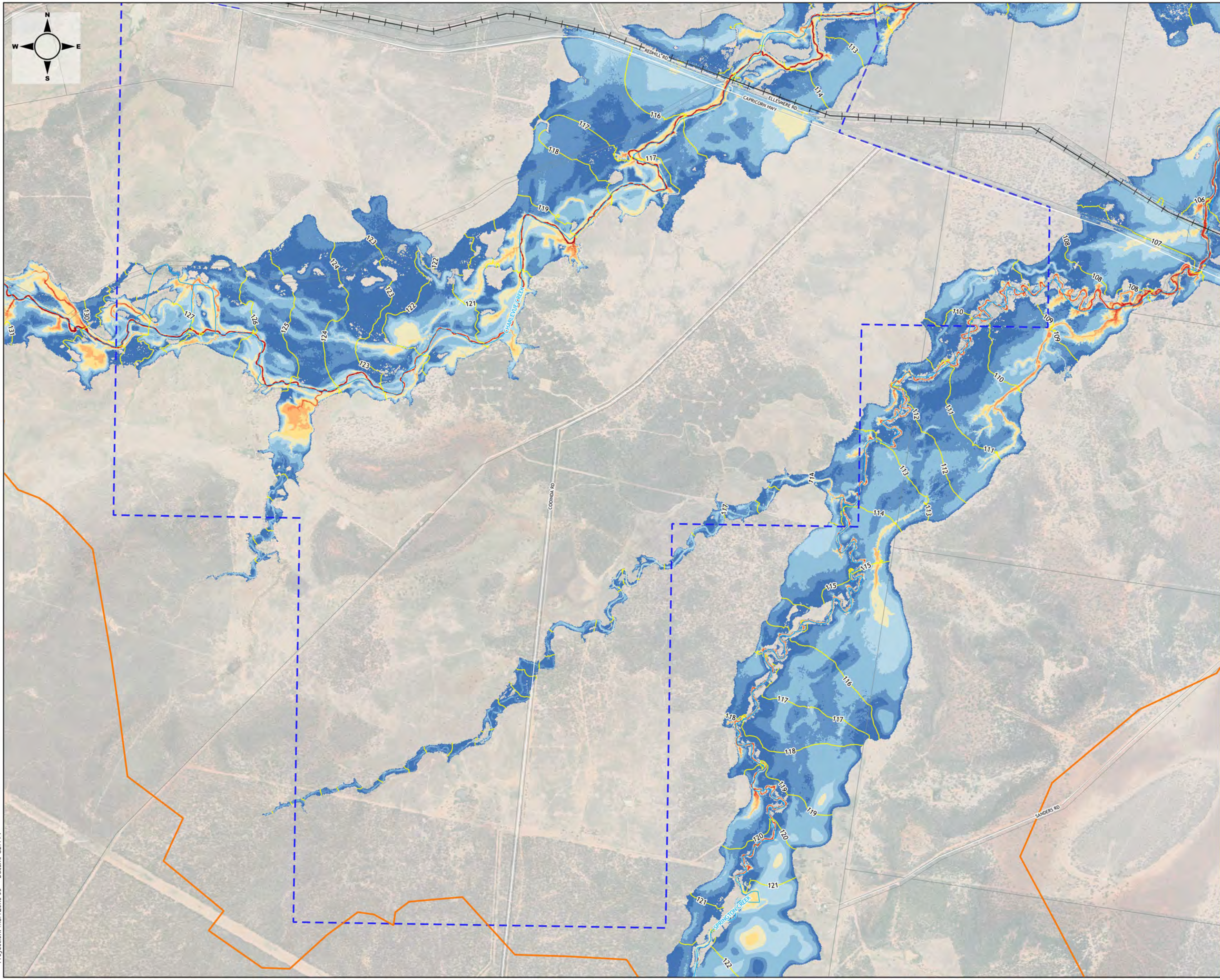
- 0.00 m - 0.25 m
- 0.25 m - 0.50 m
- 0.50 m - 1.00 m
- 1.00 m - 1.50 m
- 1.50 m - 2.00 m
- 2.00 m - 2.50 m
- 2.50 m - 3.00 m
- 3.00 m - 3.50 m
- 3.50 m - 4.00 m
- 4.00 m - 5.00 m
- > 5.00 m

0 0.25 0.5 0.75 1 km

Surface Water Assessment
Gemini Project

Predicted Flood Extents & Depths
(Existing Condition),
10% AEP

wrm
water + environment



Legend

- Model boundary
- Cadastre
- Railway
- Watercourse
- Mine lease boundary

Peak flood depth

- 0.00 m - 0.25 m
- 0.25 m - 0.50 m
- 0.50 m - 1.00 m
- 1.00 m - 1.50 m
- 1.50 m - 2.00 m
- 2.00 m - 2.50 m
- 2.50 m - 3.00 m
- 3.00 m - 3.50 m
- 3.50 m - 4.00 m
- 4.00 m - 5.00 m
- > 5.00 m

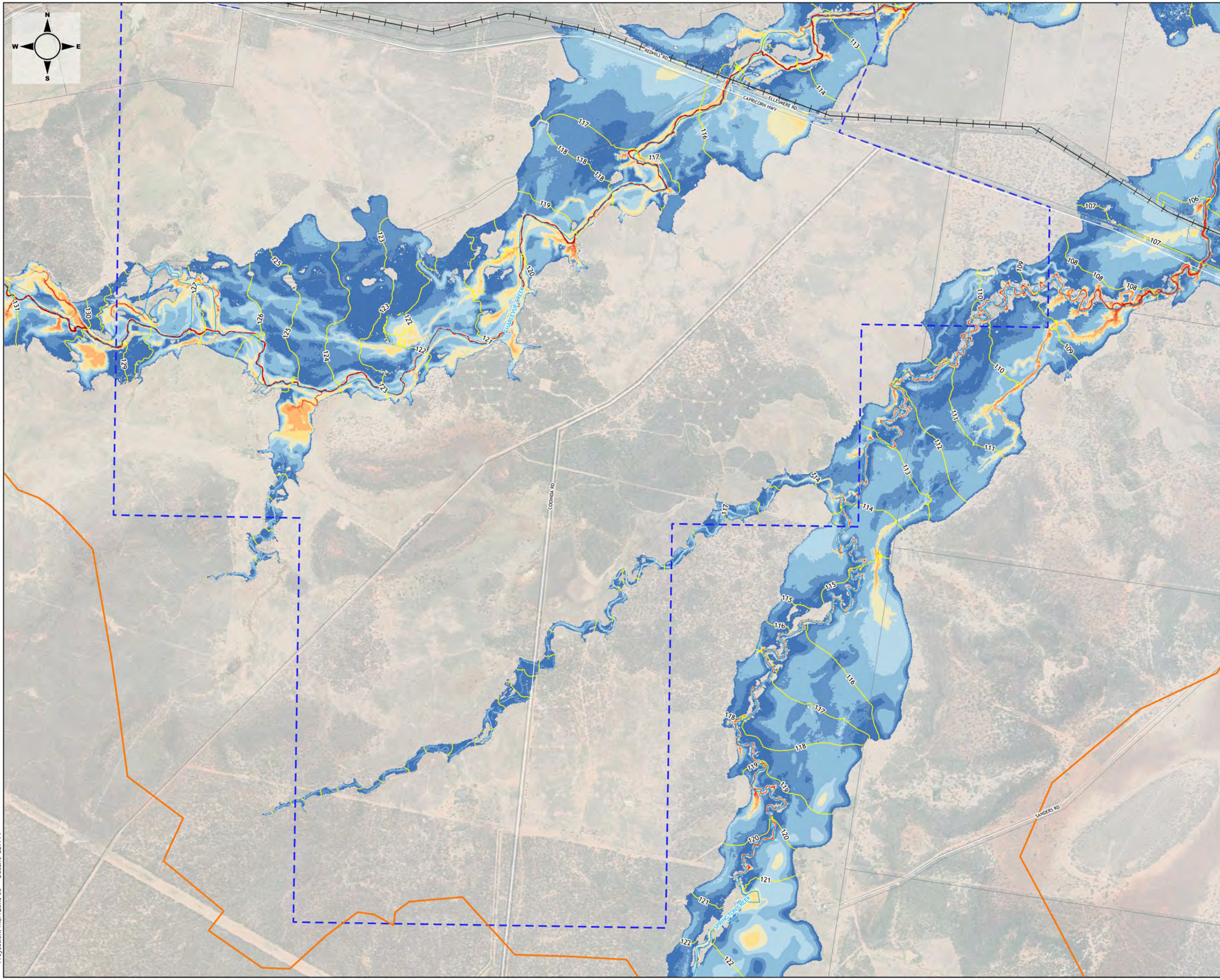
0 0.25 0.5 0.75 1 km

Surface Water Assessment
Gemini Project

Predicted Flood Extents & Depths (Existing Condition), 2% AEP

wrm water + environment

Projection: MGA Zone 55 Datum: GDA 94



Legend

- Model boundary
- Cadastre
- Railway
- Watercourse
- Mine lease boundary

Peak flood depth

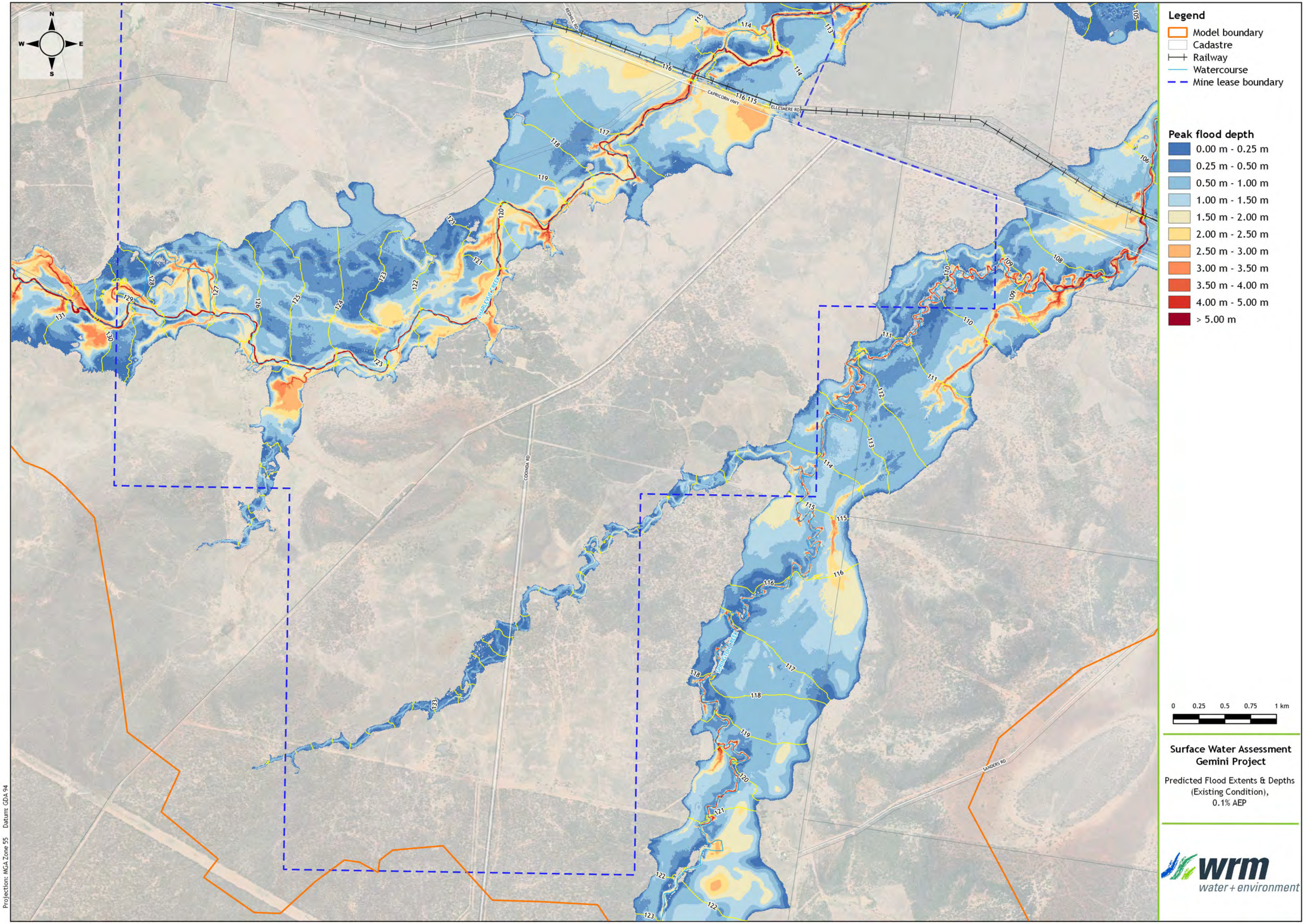
- 0.00 m - 0.25 m
- 0.25 m - 0.50 m
- 0.50 m - 1.00 m
- 1.00 m - 1.50 m
- 1.50 m - 2.00 m
- 2.00 m - 2.50 m
- 2.50 m - 3.00 m
- 3.00 m - 3.50 m
- 3.50 m - 4.00 m
- 4.00 m - 5.00 m
- > 5.00 m

0 0.25 0.5 0.75 1 km

Surface Water Assessment
Gemini Project

Predicted Flood Extents & Depths (Existing Condition), 1% AEP

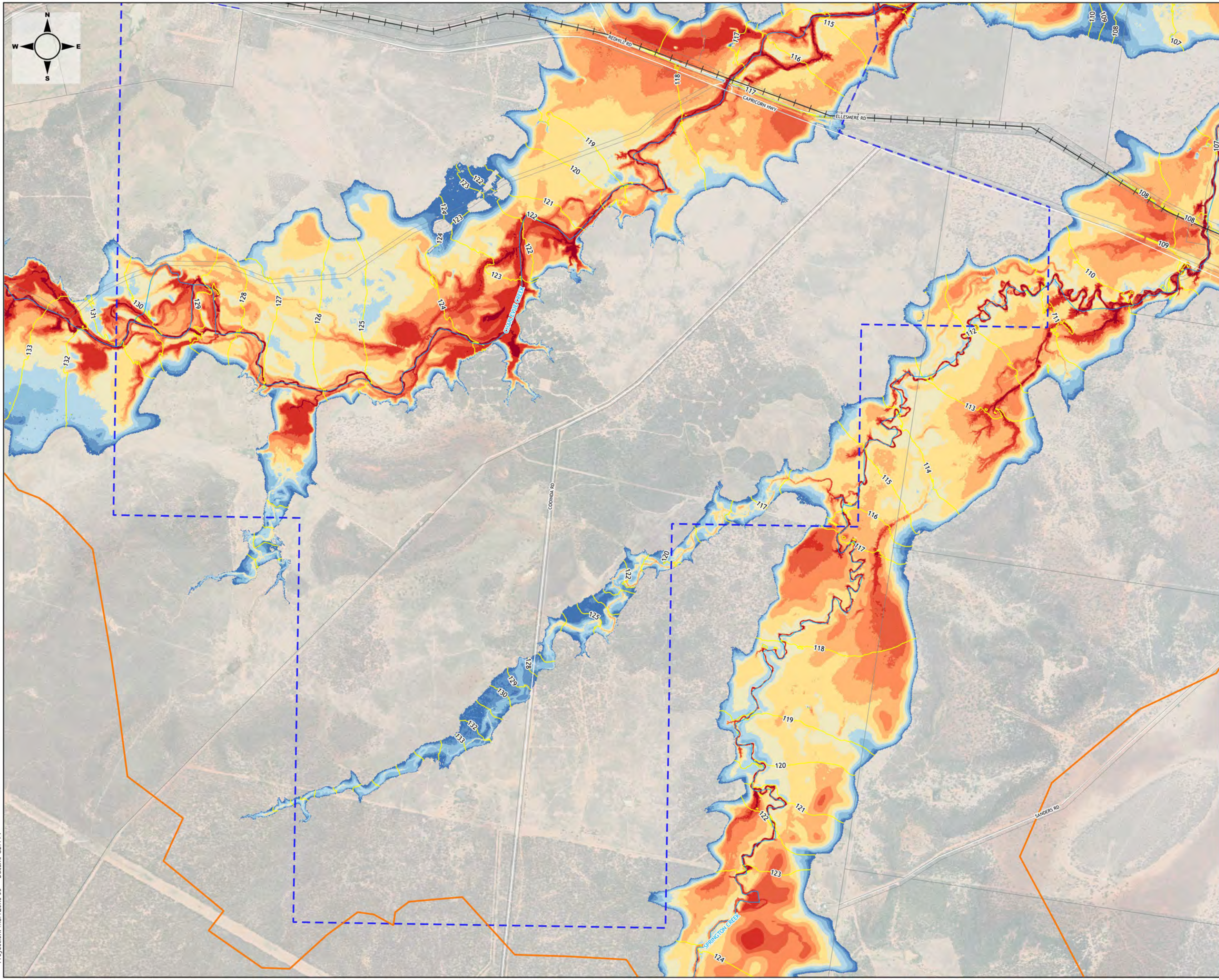
wrm water + environment



Surface Water Assessment
Gemini Project

Predicted Flood Extents & Depths (Existing Condition), 0.1% AEP

wrm water + environment



Legend

- Model boundary
- Cadastre
- Railway
- Watercourse
- Mine lease boundary

Peak flood depth

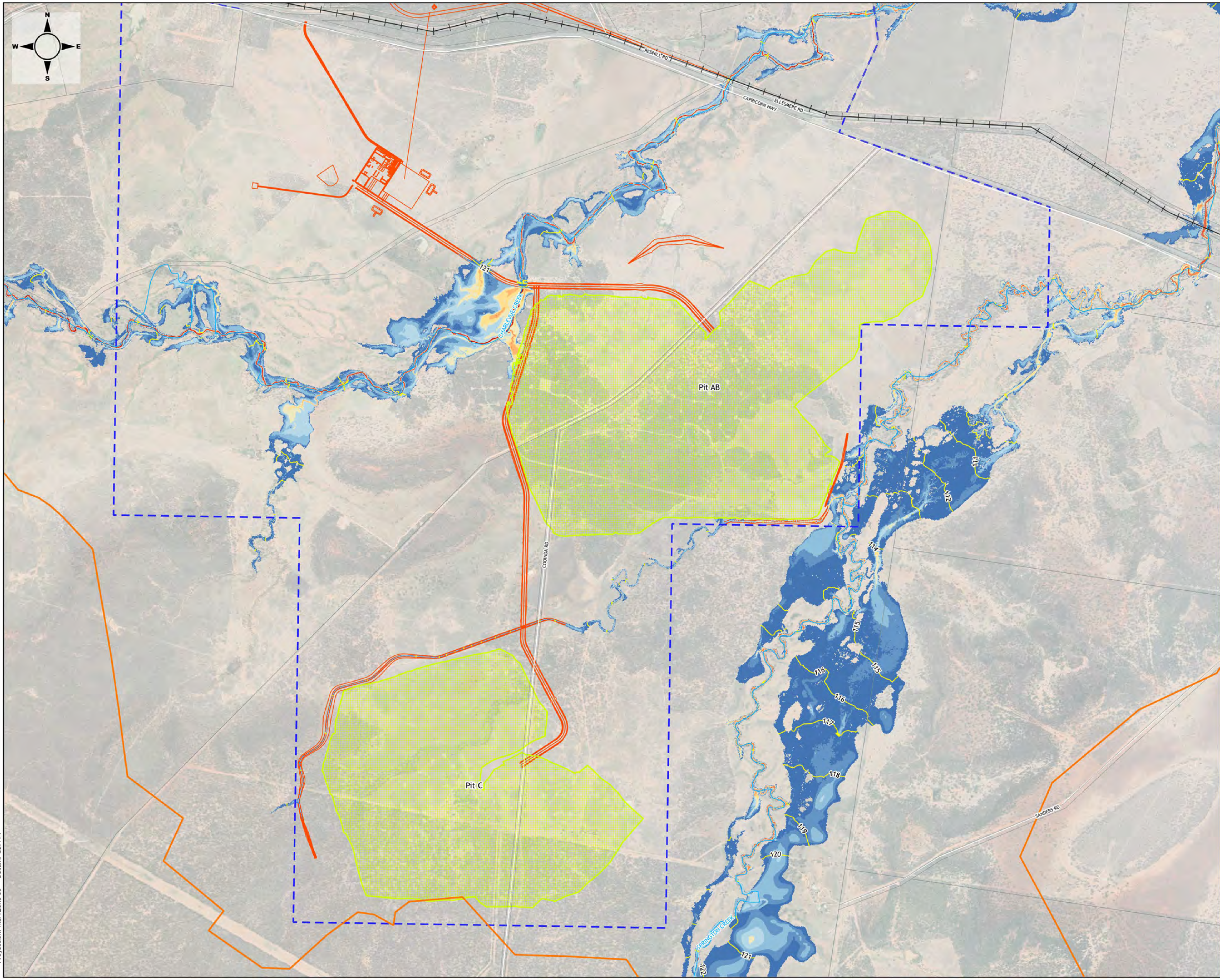
- 0.00 m - 0.25 m
- 0.25 m - 0.50 m
- 0.50 m - 1.00 m
- 1.00 m - 1.50 m
- 1.50 m - 2.00 m
- 2.00 m - 2.50 m
- 2.50 m - 3.00 m
- 3.00 m - 3.50 m
- 3.50 m - 4.00 m
- 4.00 m - 5.00 m
- > 5.00 m

0 0.25 0.5 0.75 1 km

Surface Water Assessment
Gemini Project

Predicted Flood Extents & Depths (Existing Condition), PMF

wrm water + environment



Legend

- Model boundary
- Cadastre
- Railway
- Watercourse
- Mine lease boundary
- Proposed pit location
- Proposed infrastructure

Peak flood depth

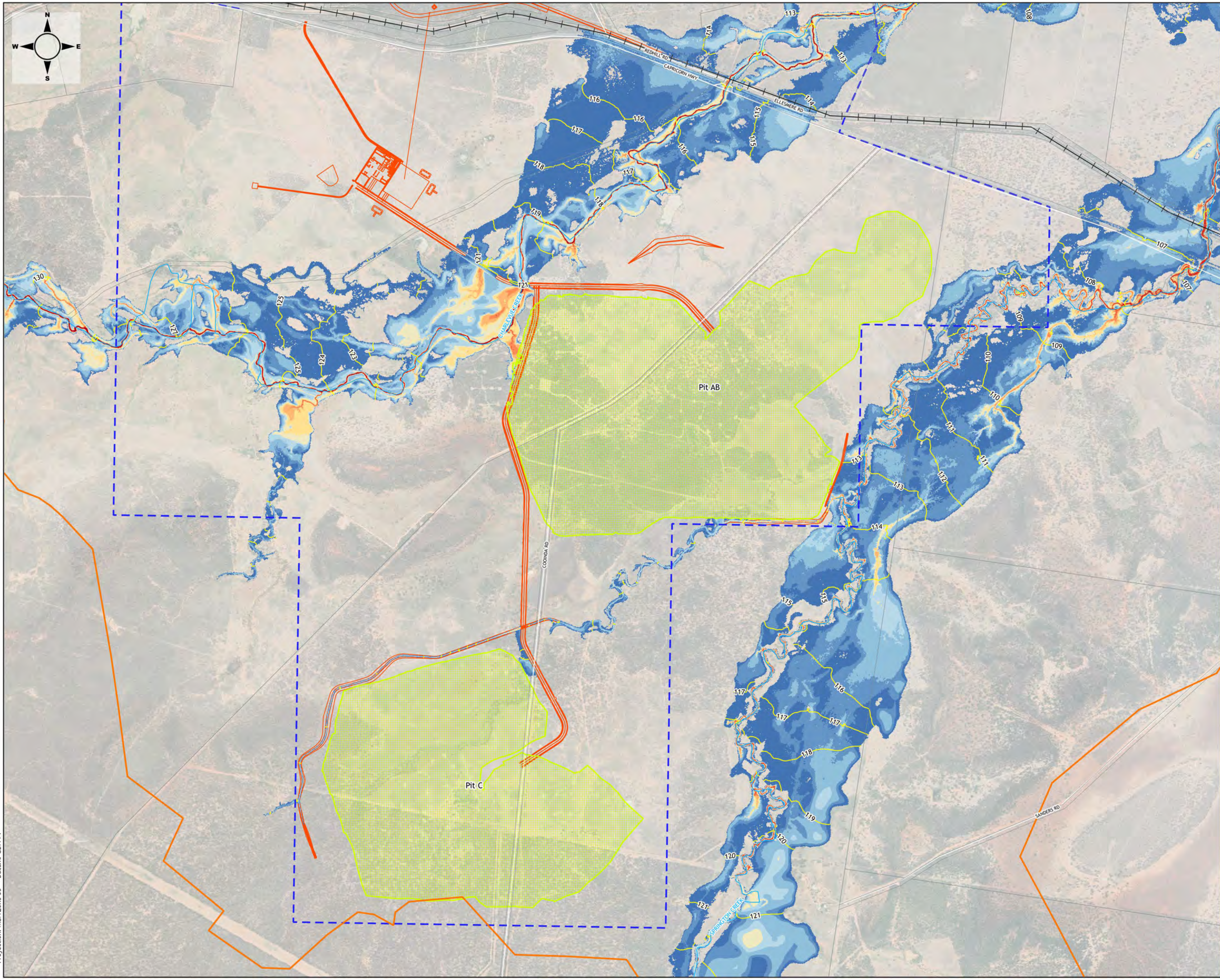
- 0.00 m - 0.25 m
- 0.25 m - 0.50 m
- 0.50 m - 1.00 m
- 1.00 m - 1.50 m
- 1.50 m - 2.00 m
- 2.00 m - 2.50 m
- 2.50 m - 3.00 m
- 3.00 m - 3.50 m
- 3.50 m - 4.00 m
- 4.00 m - 5.00 m
- > 5.00 m

0 0.25 0.5 0.75 1 km

Surface Water Assessment Gemini Project

Predicted Flood Extents & Depths (Developed Condition), 50% AEP

wrm water + environment



Legend

- Model boundary
- Cadastre
- Railway
- Watercourse
- Mine lease boundary
- Proposed pit location
- Proposed infrastructure

Peak flood depth

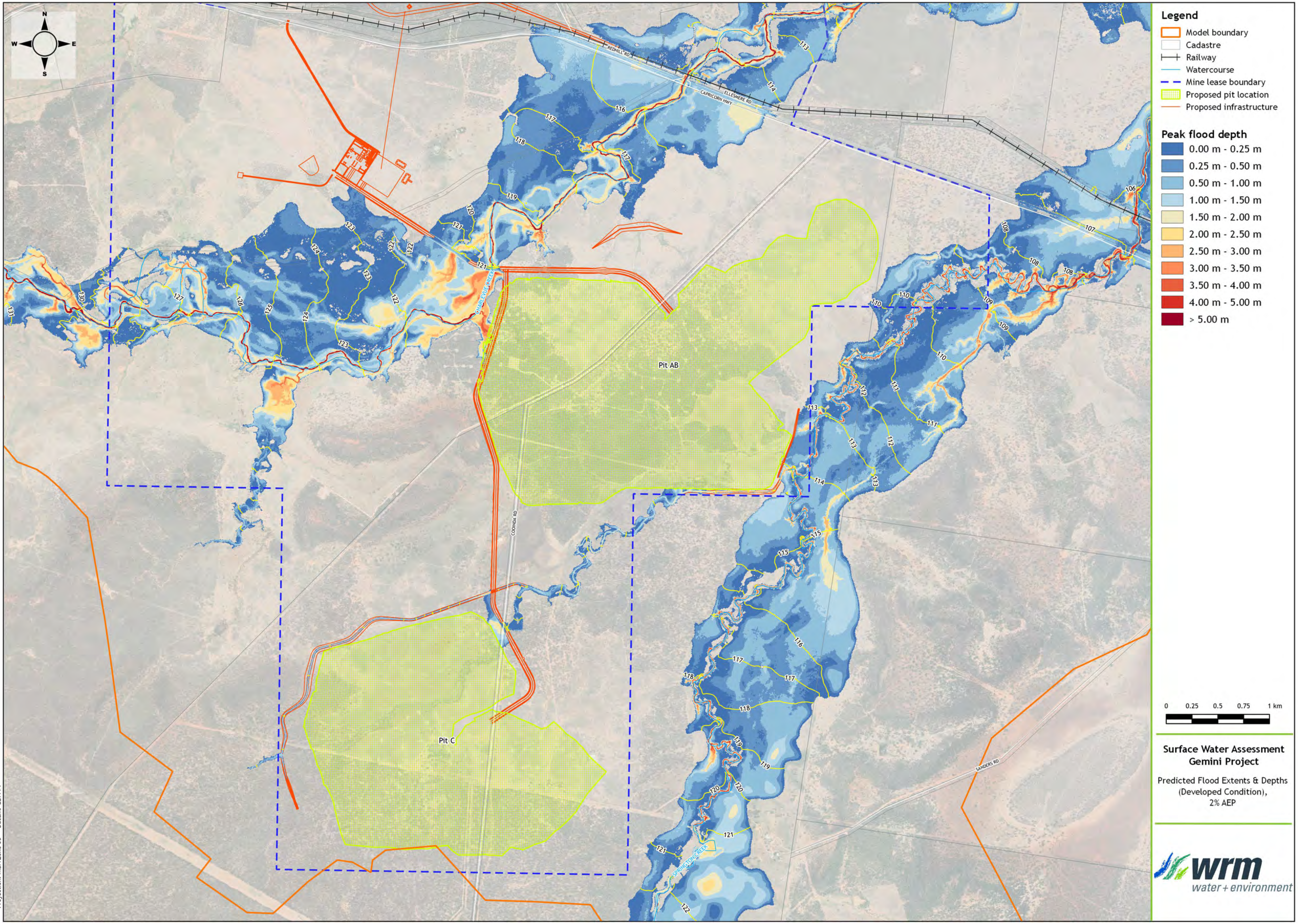
- 0.00 m - 0.25 m
- 0.25 m - 0.50 m
- 0.50 m - 1.00 m
- 1.00 m - 1.50 m
- 1.50 m - 2.00 m
- 2.00 m - 2.50 m
- 2.50 m - 3.00 m
- 3.00 m - 3.50 m
- 3.50 m - 4.00 m
- 4.00 m - 5.00 m
- > 5.00 m

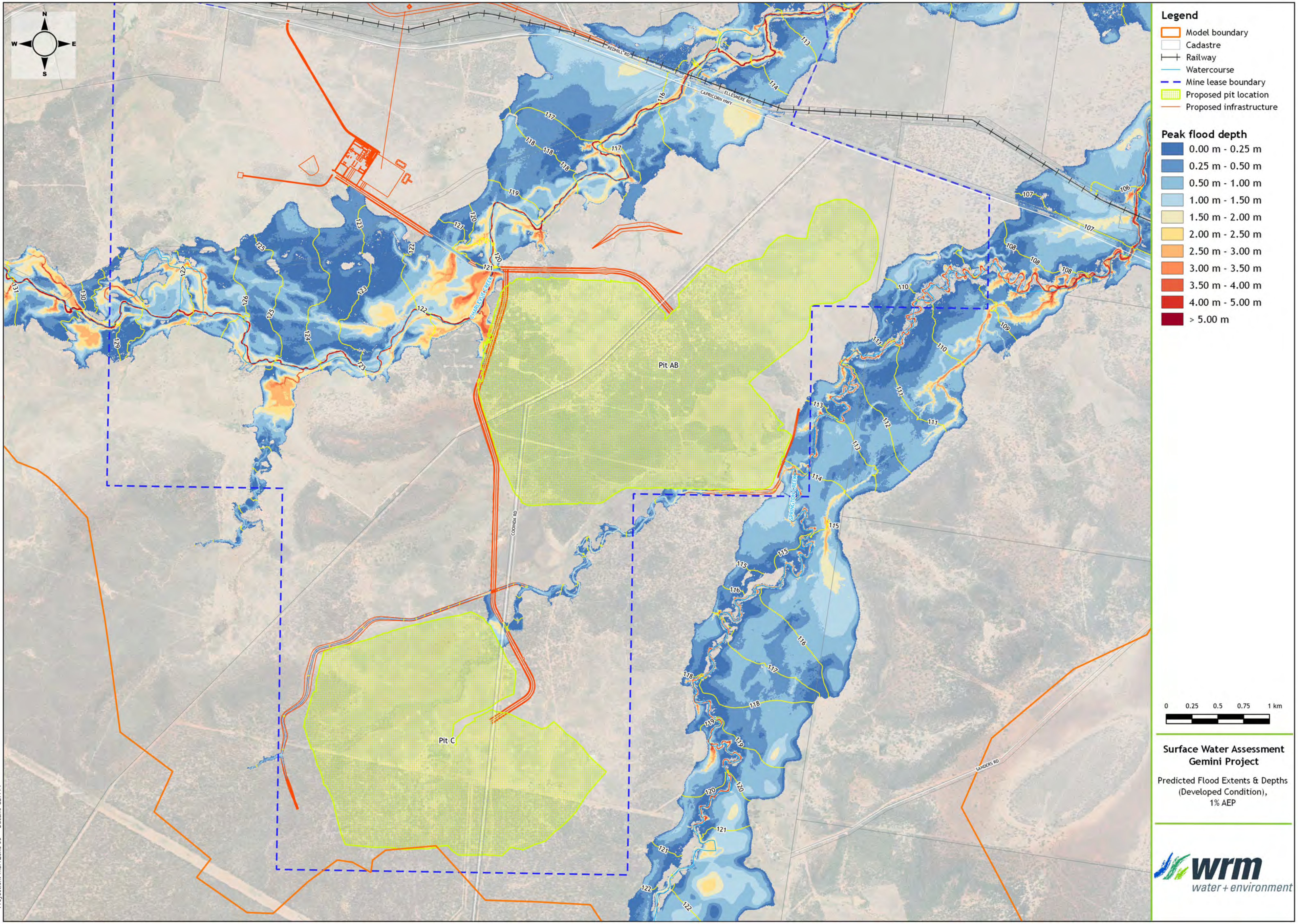
0 0.25 0.5 0.75 1 km

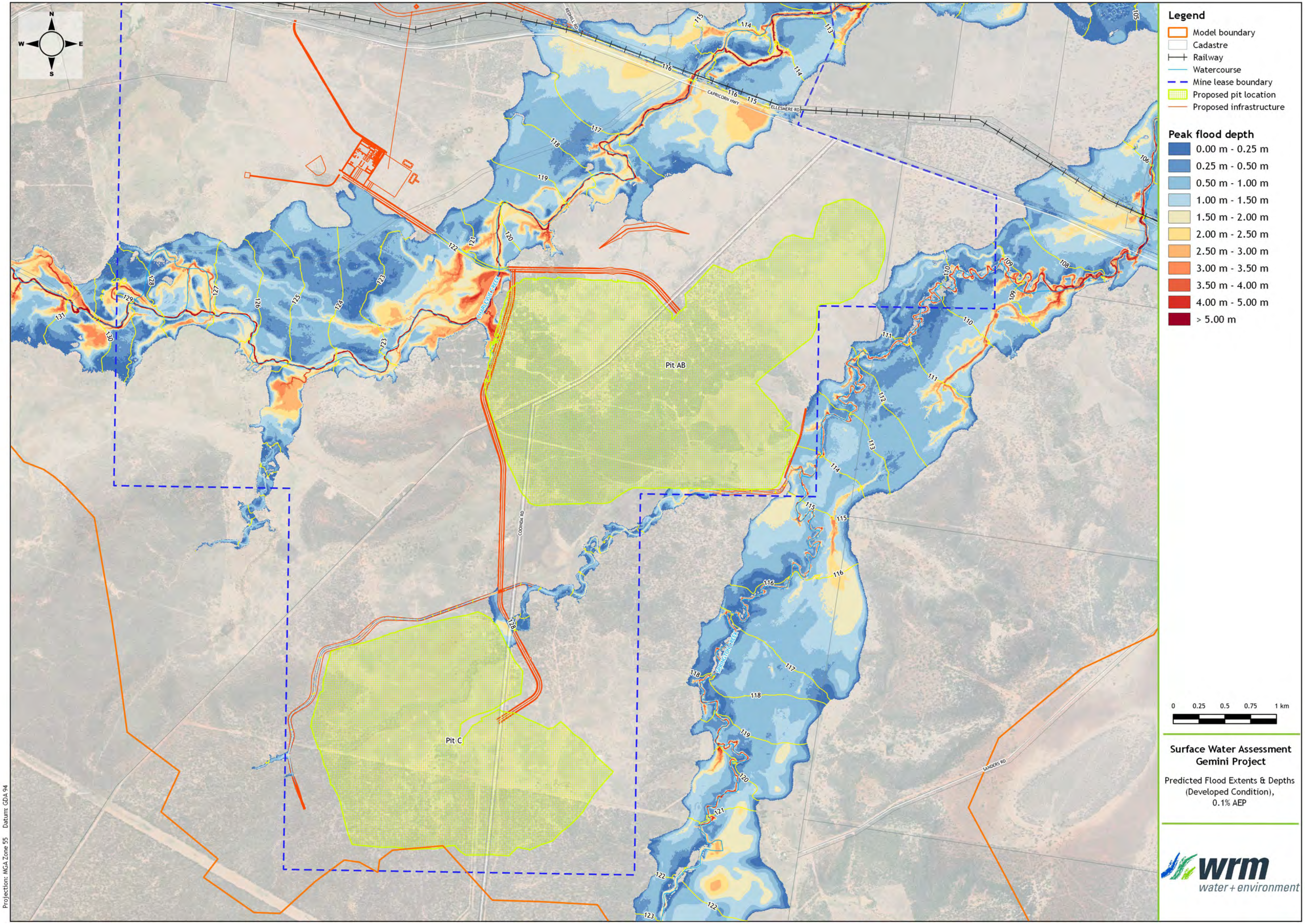
Surface Water Assessment
Gemini Project

Predicted Flood Extents & Depths (Developed Condition), 10% AEP

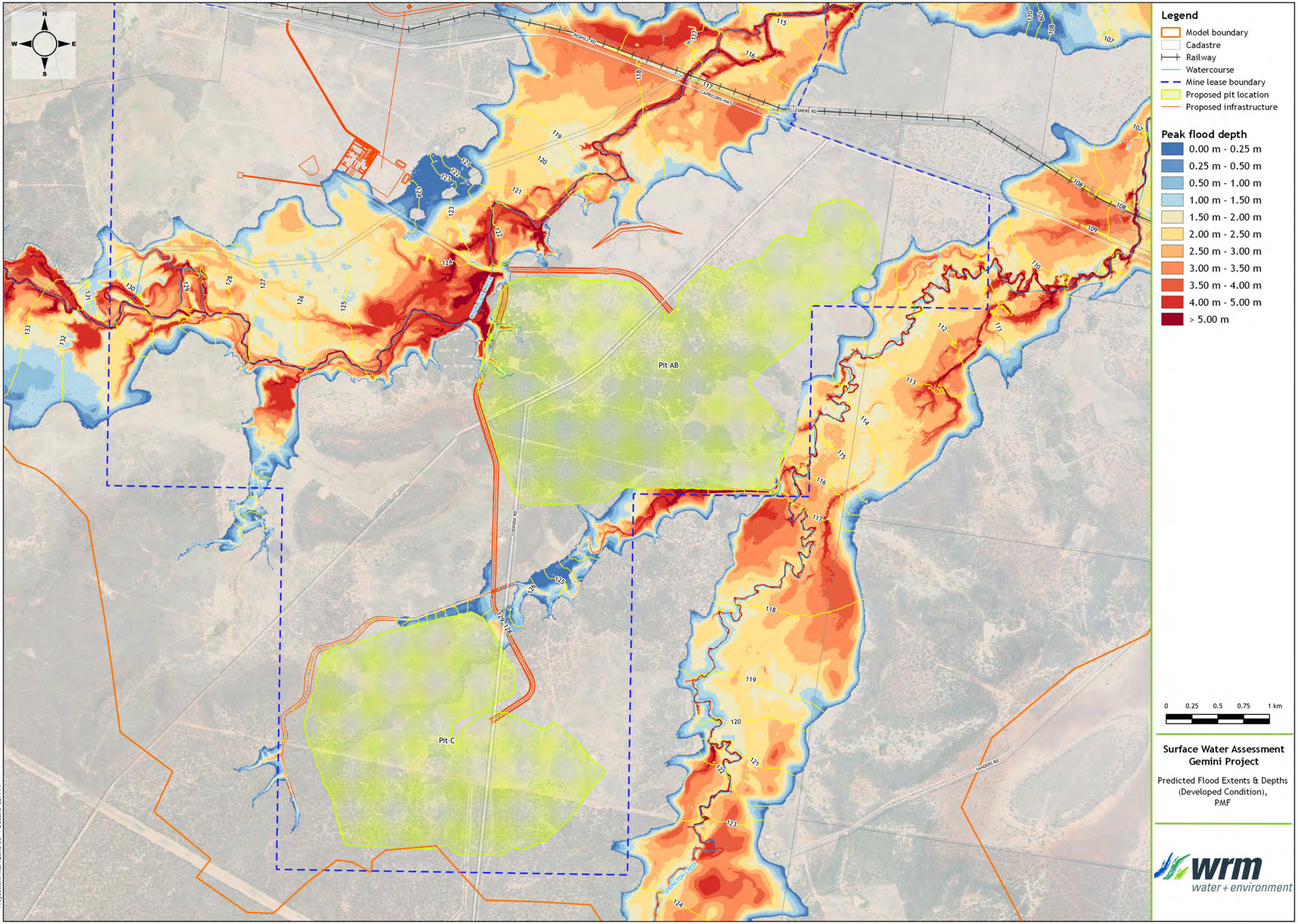
wrm water + environment

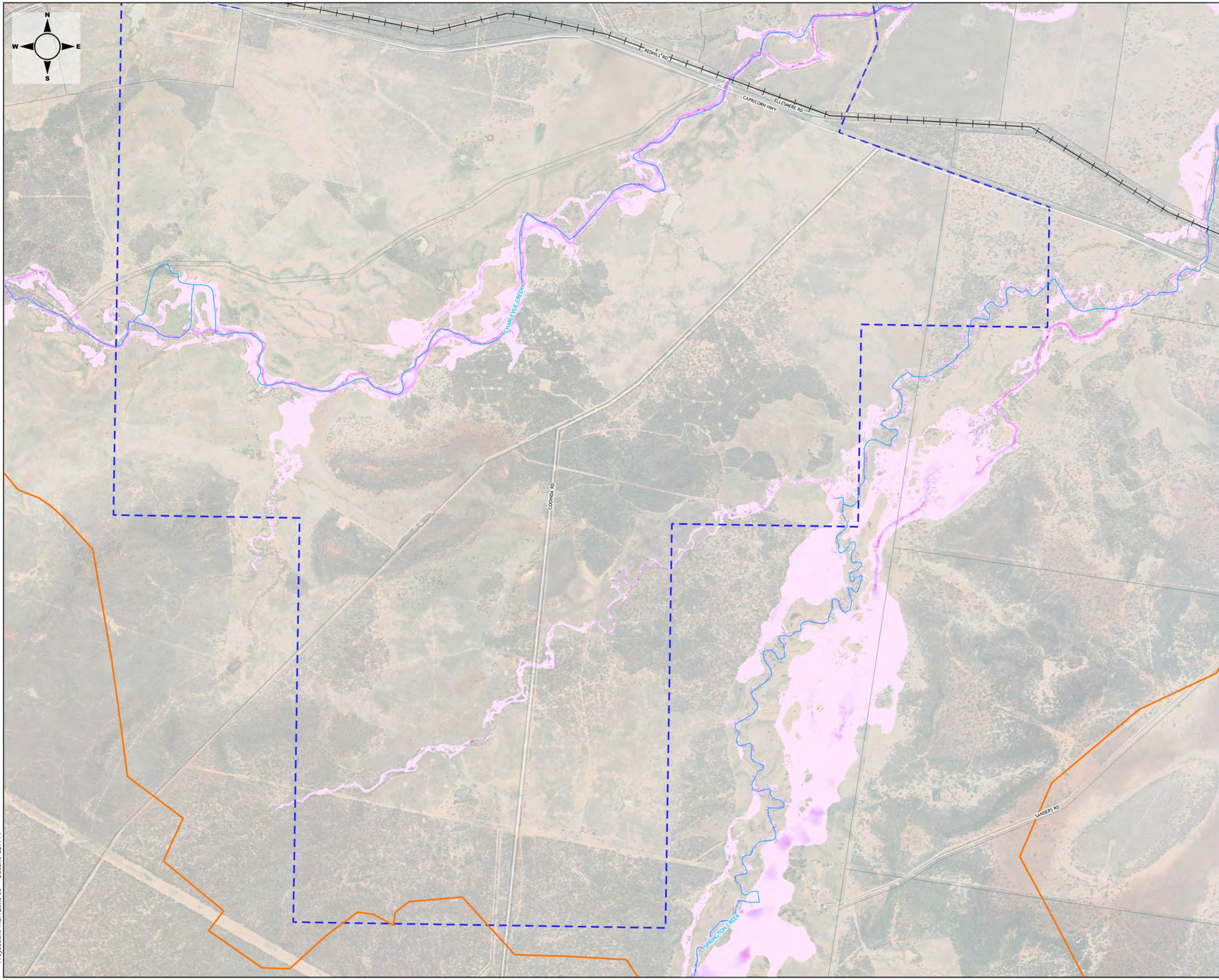

Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
Peak flood depth
0.00 m - 0.25 m
0.25 m - 0.50 m
0.50 m - 1.00 m
1.00 m - 1.50 m
1.50 m - 2.00 m
2.00 m - 2.50 m
2.50 m - 3.00 m
3.00 m - 3.50 m
3.50 m - 4.00 m
4.00 m - 5.00 m
> 5.00 m
0 0.25 0.5 0.75 1 km
Pit AB
Pit C
Surface Water Assessment
Gemini Project
Predicted Flood Extents & Depths
(Developed Condition),
2% AEP
wrm water + environment
Projection: MGA Zone 55 Datum: GDA 94


Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
Peak flood depth
0.00 m - 0.25 m
0.25 m - 0.50 m
0.50 m - 1.00 m
1.00 m - 1.50 m
1.50 m - 2.00 m
2.00 m - 2.50 m
2.50 m - 3.00 m
3.00 m - 3.50 m
3.50 m - 4.00 m
4.00 m - 5.00 m
> 5.00 m
0 0.25 0.5 0.75 1 km
Surface Water Assessment
Gemini Project
Predicted Flood Extents & Depths (Developed Condition), 1% AEP
wrm water + environment
Projection: MGA Zone 55 Datum: GDA 94
N
S
E
W
Pit AB
Pit C
REDHILL RD
CAPRICORN HWY
ELLESMERE RD
COONDA RD
SANDERS RD
CHARLEVUE CREEK
SPRINGTON CREEK



Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
Peak flood depth
0.00 m - 0.25 m
0.25 m - 0.50 m
0.50 m - 1.00 m
1.00 m - 1.50 m
1.50 m - 2.00 m
2.00 m - 2.50 m
2.50 m - 3.00 m
3.00 m - 3.50 m
3.50 m - 4.00 m
4.00 m - 5.00 m
> 5.00 m
0 0.25 0.5 0.75 1 km
Surface Water Assessment
Gemini Project
Predicted Flood Extents & Depths (Developed Condition), 0.1% AEP
wrm
water + environment
Pit AB
Pit C
CAPRICORN HWY
ELLESMERE RD
REDHILL RD
COONDA RD
SANDERS RD
Projection: MGA Zone 55 Datum: GDA 94


N
S
E
W
REDHILL RD
CAPRICORN HWY
ELLESMERE RD
COONDA RD
SANDERS RD
CHARLEVUE CREEK
SPRINGTON CREEK
Pit AB
Pit C
Projection: MGA Zone 55 Datum: GDA 94
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
Peak flood depth
0.00 m - 0.25 m
0.25 m - 0.50 m
0.50 m - 1.00 m
1.00 m - 1.50 m
1.50 m - 2.00 m
2.00 m - 2.50 m
2.50 m - 3.00 m
3.00 m - 3.50 m
3.50 m - 4.00 m
4.00 m - 5.00 m
> 5.00 m
0 0.25 0.5 0.75 1 km
Surface Water Assessment
Gemini Project
Predicted Flood Extents & Depths (Developed Condition), PMF
wrm
water + environment



Legend

- Model boundary
- Cadastre
- Railway
- Watercourse
- Mine lease boundary

Peak flood velocity

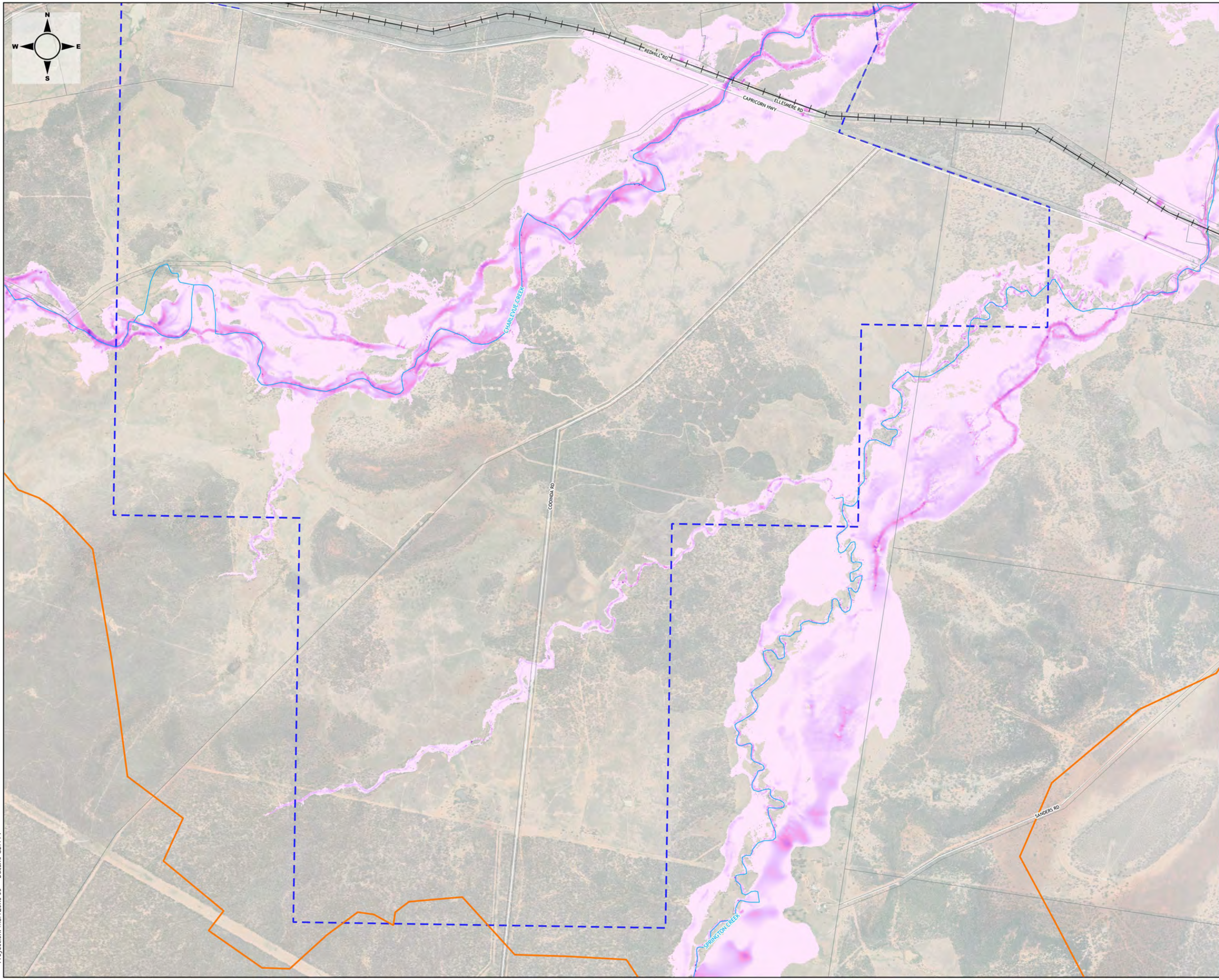
- 0.0 m/s < 0.5 m/s
- 0.5 m/s < 1.0 m/s
- 1.0 m/s < 1.5 m/s
- 1.5 m/s < 2.0 m/s
- 2.0 m/s < 2.5 m/s
- 2.5 m/s < 3.0 m/s
- 3.0 m/s < 4.0 m/s
- > 4.0 m/s

0 0.25 0.5 0.75 1 km

Surface Water Assessment
Gemini Project

Predicted Flood Velocity (Existing Condition),
50% AEP

wrm
water + environment



Projection: MGA Zone 55 Datum: GDA 94

Legend

- Model boundary
- Cadastre
- Railway
- Watercourse
- Mine lease boundary

Peak flood velocity

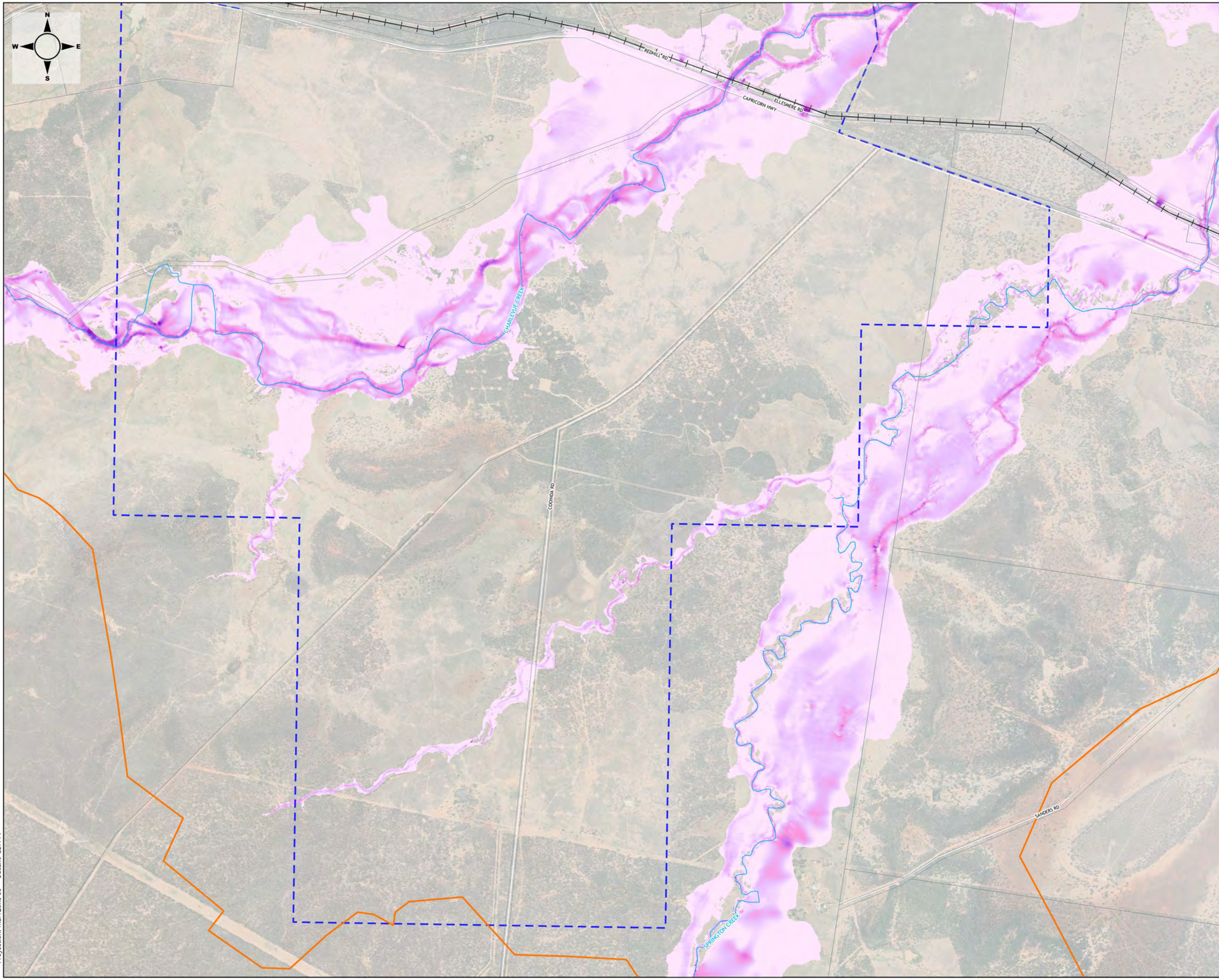
- 0.0 m/s < 0.5 m/s
- 0.5 m/s < 1.0 m/s
- 1.0 m/s < 1.5 m/s
- 1.5 m/s < 2.0 m/s
- 2.0 m/s < 2.5 m/s
- 2.5 m/s < 3.0 m/s
- 3.0 m/s < 4.0 m/s
- > 4.0 m/s

0 0.25 0.5 0.75 1 km

Surface Water Assessment
Gemini Project

Predicted Flood Velocity (Existing Condition),
10% AEP

wrm water + environment



Legend

- Model boundary
- Cadastre
- Railway
- Watercourse
- Mine lease boundary

Peak flood velocity

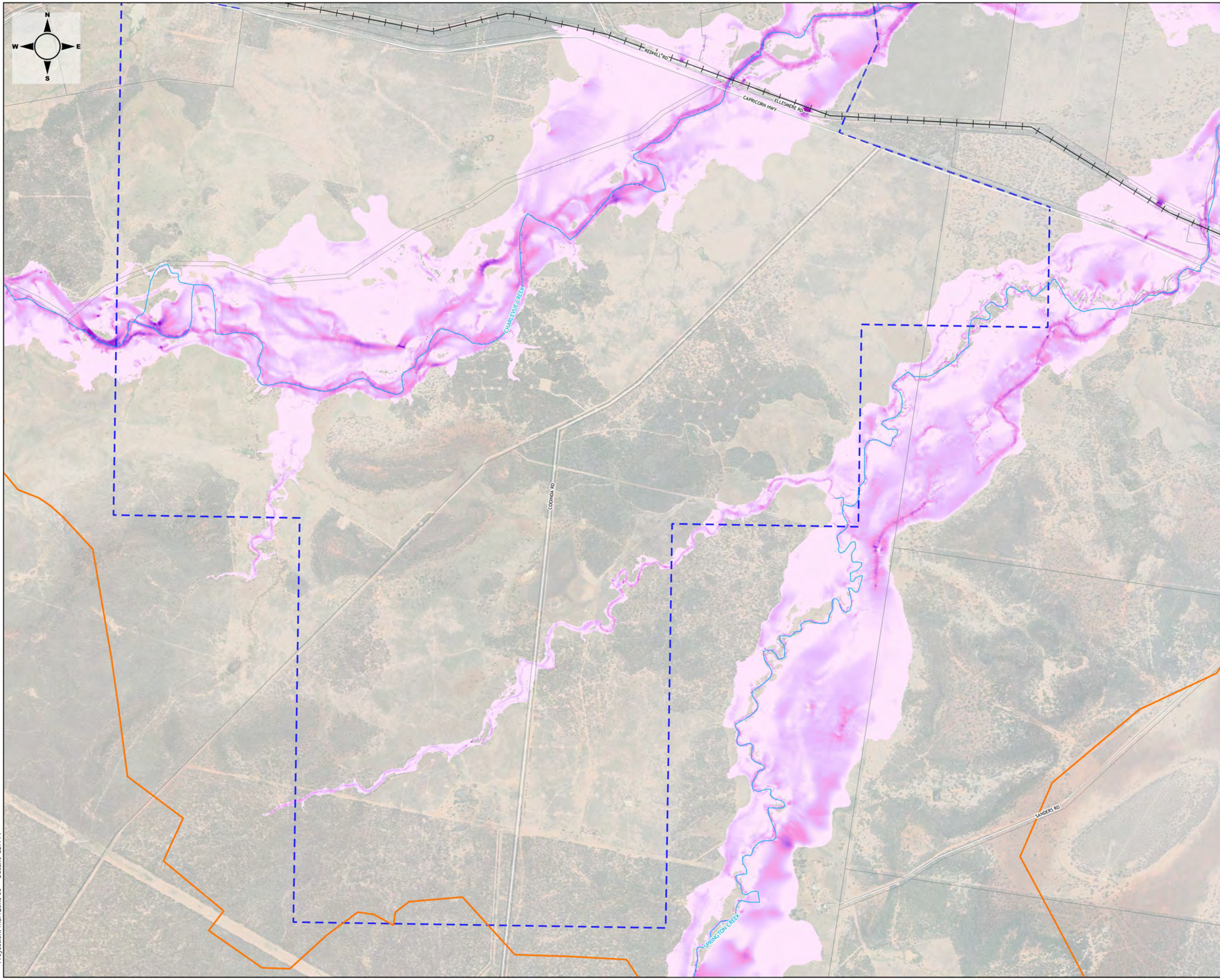
- 0.0 m/s < 0.5 m/s
- 0.5 m/s < 1.0 m/s
- 1.0 m/s < 1.5 m/s
- 1.5 m/s < 2.0 m/s
- 2.0 m/s < 2.5 m/s
- 2.5 m/s < 3.0 m/s
- 3.0 m/s < 4.0 m/s
- > 4.0 m/s

0 0.25 0.5 0.75 1 km

Surface Water Assessment
Gemini Project

Predicted Flood Velocity (Existing Condition),
2% AEP

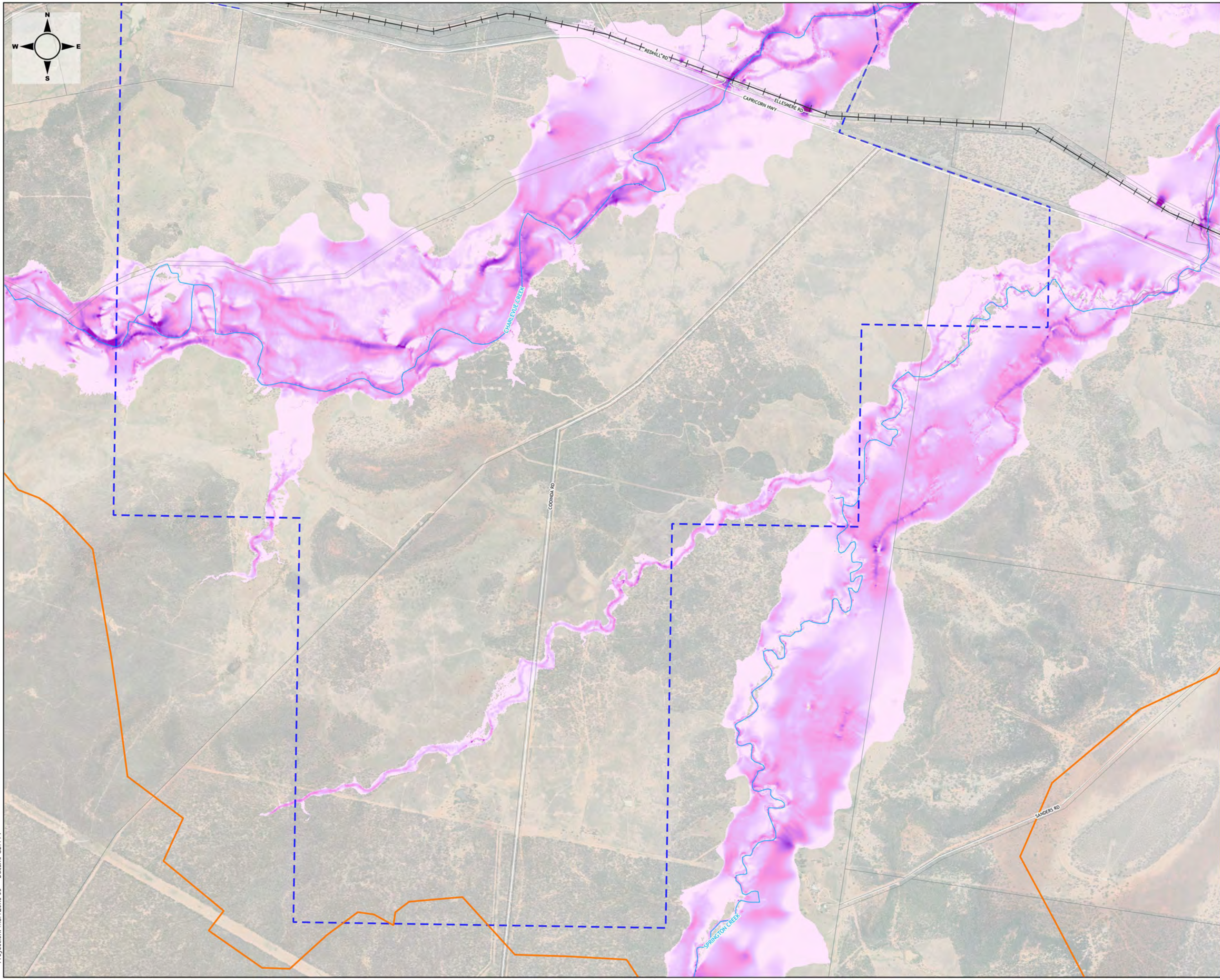
wrm water + environment



Surface Water Assessment
Gemini Project

Predicted Flood Velocity (Existing Condition), 1% AEP

wrm water + environment



Legend
- Model boundary
- Cadastre
- Railway
- Watercourse
- Mine lease boundary

Peak flood velocity
- 0.0 m/s < 0.5 m/s
- 0.5 m/s < 1.0 m/s
- 1.0 m/s < 1.5 m/s
- 1.5 m/s < 2.0 m/s
- 2.0 m/s < 2.5 m/s
- 2.5 m/s < 3.0 m/s
- 3.0 m/s < 4.0 m/s
- > 4.0 m/s

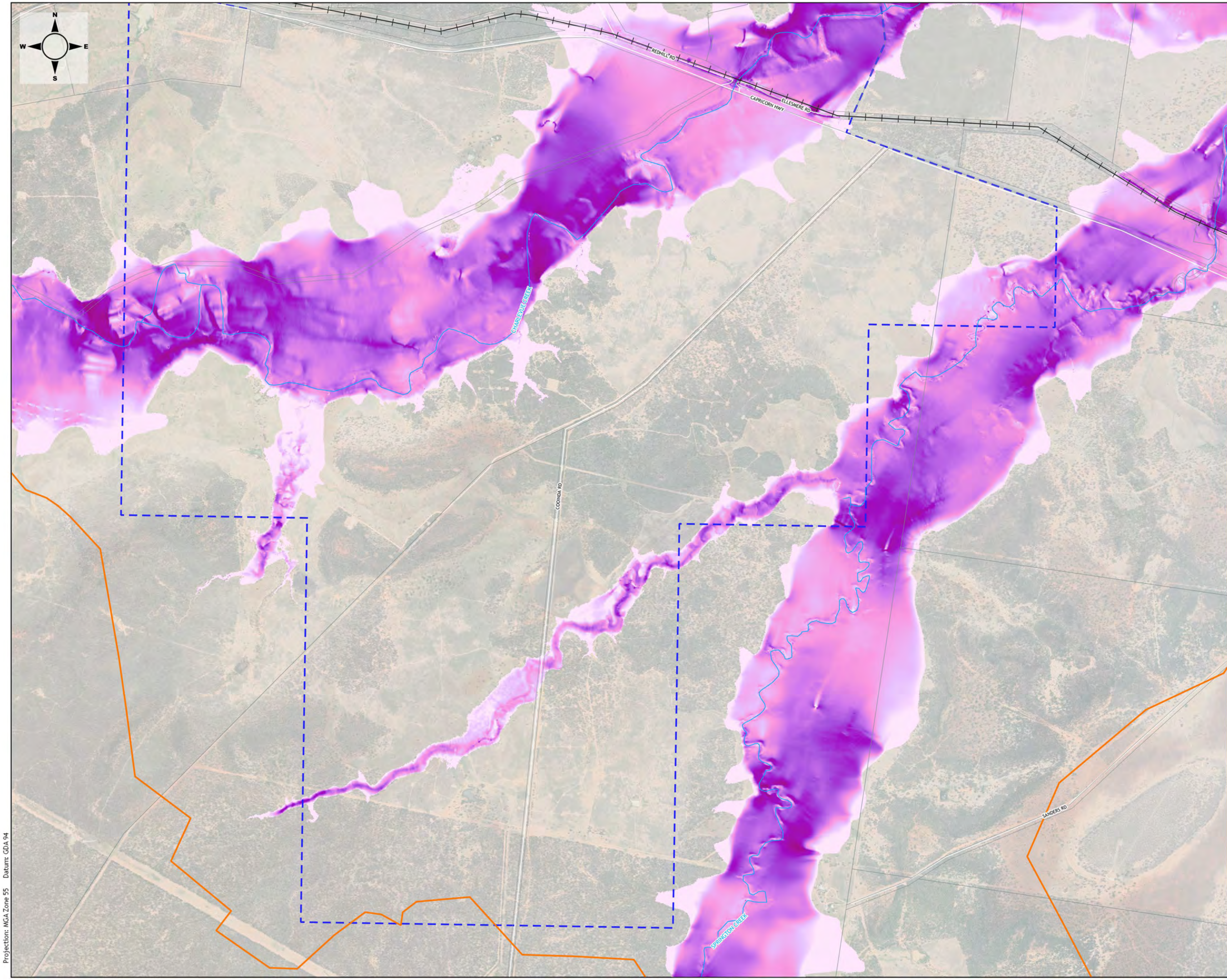
0 0.25 0.5 0.75 1 km

Surface Water Assessment
Gemini Project

Predicted Flood Velocity (Existing Condition), 0.1% AEP

wrm water + environment

Projection: MGA Zone 55 Datum: GDA 94



Legend

- Model boundary
- Cadastre
- Railway
- Watercourse
- Mine lease boundary

Peak flood velocity

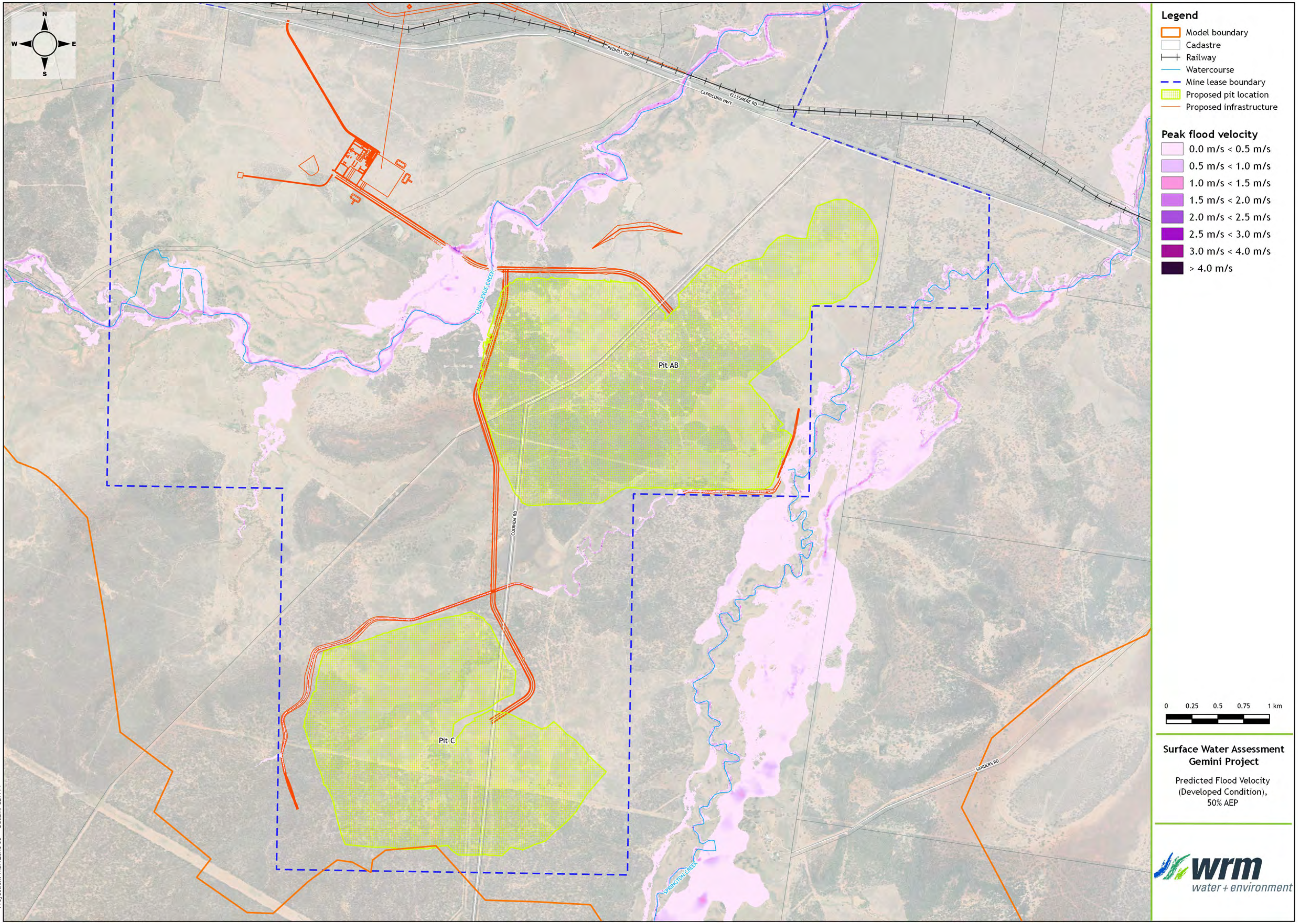
- 0.0 m/s < 0.5 m/s
- 0.5 m/s < 1.0 m/s
- 1.0 m/s < 1.5 m/s
- 1.5 m/s < 2.0 m/s
- 2.0 m/s < 2.5 m/s
- 2.5 m/s < 3.0 m/s
- 3.0 m/s < 4.0 m/s
- > 4.0 m/s

0 0.25 0.5 0.75 1 km

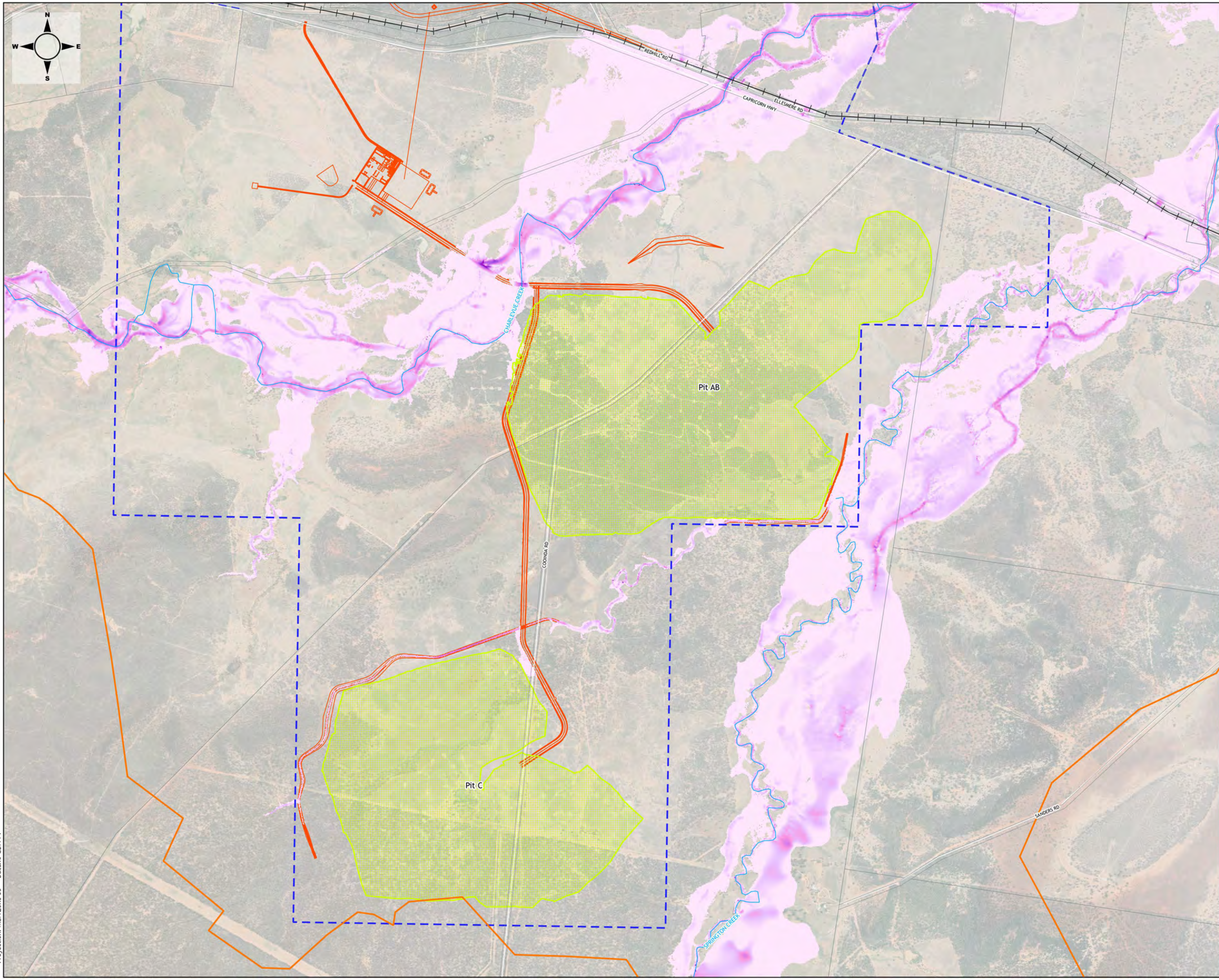
Surface Water Assessment
Gemini Project

Predicted Flood Velocity (Existing Condition), PMF

wrm water + environment



N
S
E
W
REDHILL RD
CAPRICORN HWY
ELLESMERE RD
CHARLEVILLE CREEK
Pit AB
COONDA RD
Pit C
SPRINGTON CREEK
SANDERS RD
Projection: MGA Zone 55 Datum: GDA 94
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
Peak flood velocity
0.0 m/s < 0.5 m/s
0.5 m/s < 1.0 m/s
1.0 m/s < 1.5 m/s
1.5 m/s < 2.0 m/s
2.0 m/s < 2.5 m/s
2.5 m/s < 3.0 m/s
3.0 m/s < 4.0 m/s
> 4.0 m/s
0 0.25 0.5 0.75 1 km
Surface Water Assessment
Gemini Project
Predicted Flood Velocity
(Developed Condition),
50% AEP
wrm
water + environment



Legend

- Model boundary
- Cadastre
- Railway
- Watercourse
- Mine lease boundary
- Proposed pit location
- Proposed infrastructure

Peak flood velocity

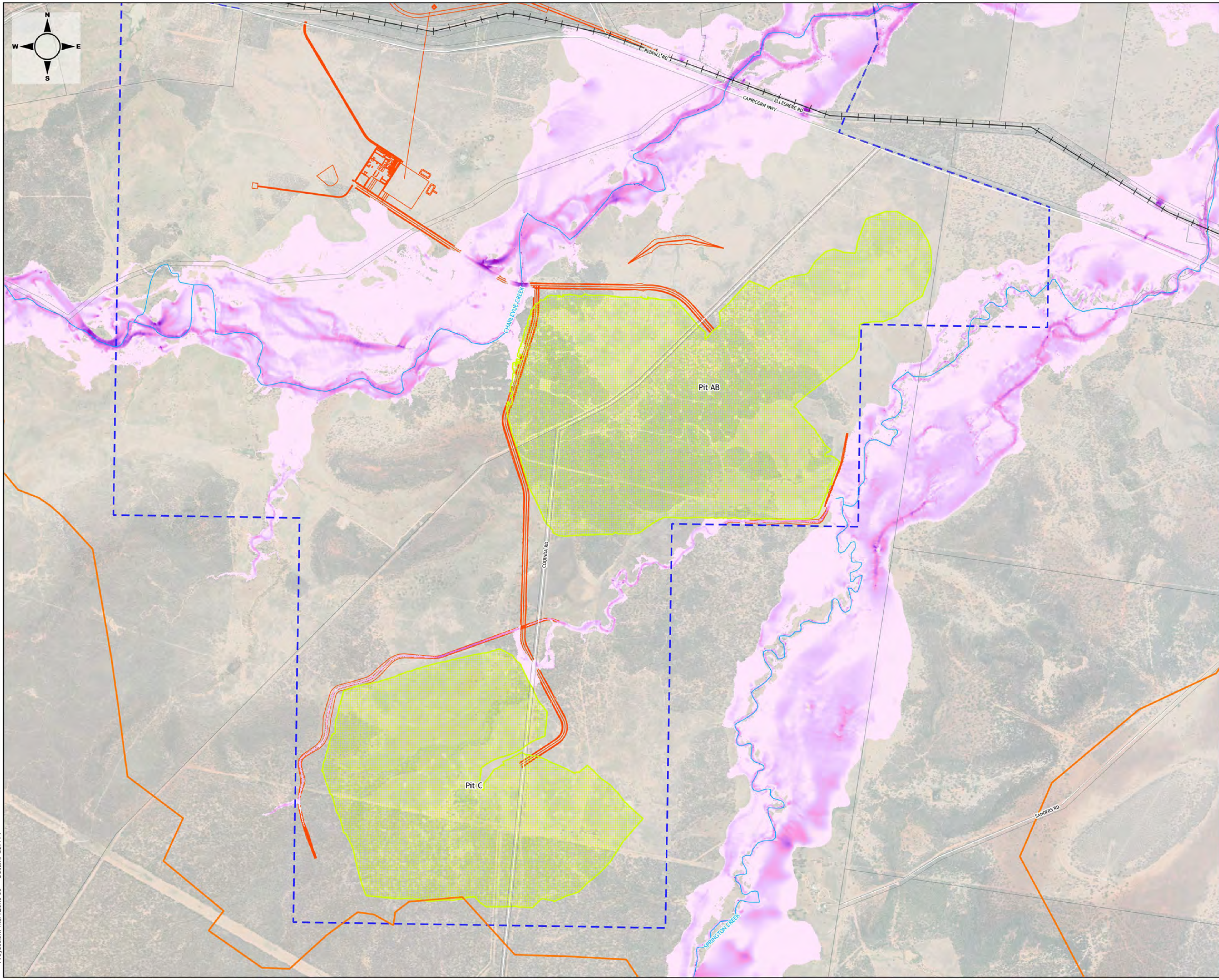
- 0.0 m/s < 0.5 m/s
- 0.5 m/s < 1.0 m/s
- 1.0 m/s < 1.5 m/s
- 1.5 m/s < 2.0 m/s
- 2.0 m/s < 2.5 m/s
- 2.5 m/s < 3.0 m/s
- 3.0 m/s < 4.0 m/s
- > 4.0 m/s

0 0.25 0.5 0.75 1 km

Surface Water Assessment
Gemini Project

Predicted Flood Velocity (Developed Condition), 10% AEP

wrm water + environment



Legend

- Model boundary
- Cadastre
- Railway
- Watercourse
- Mine lease boundary
- Proposed pit location
- Proposed infrastructure

Peak flood velocity

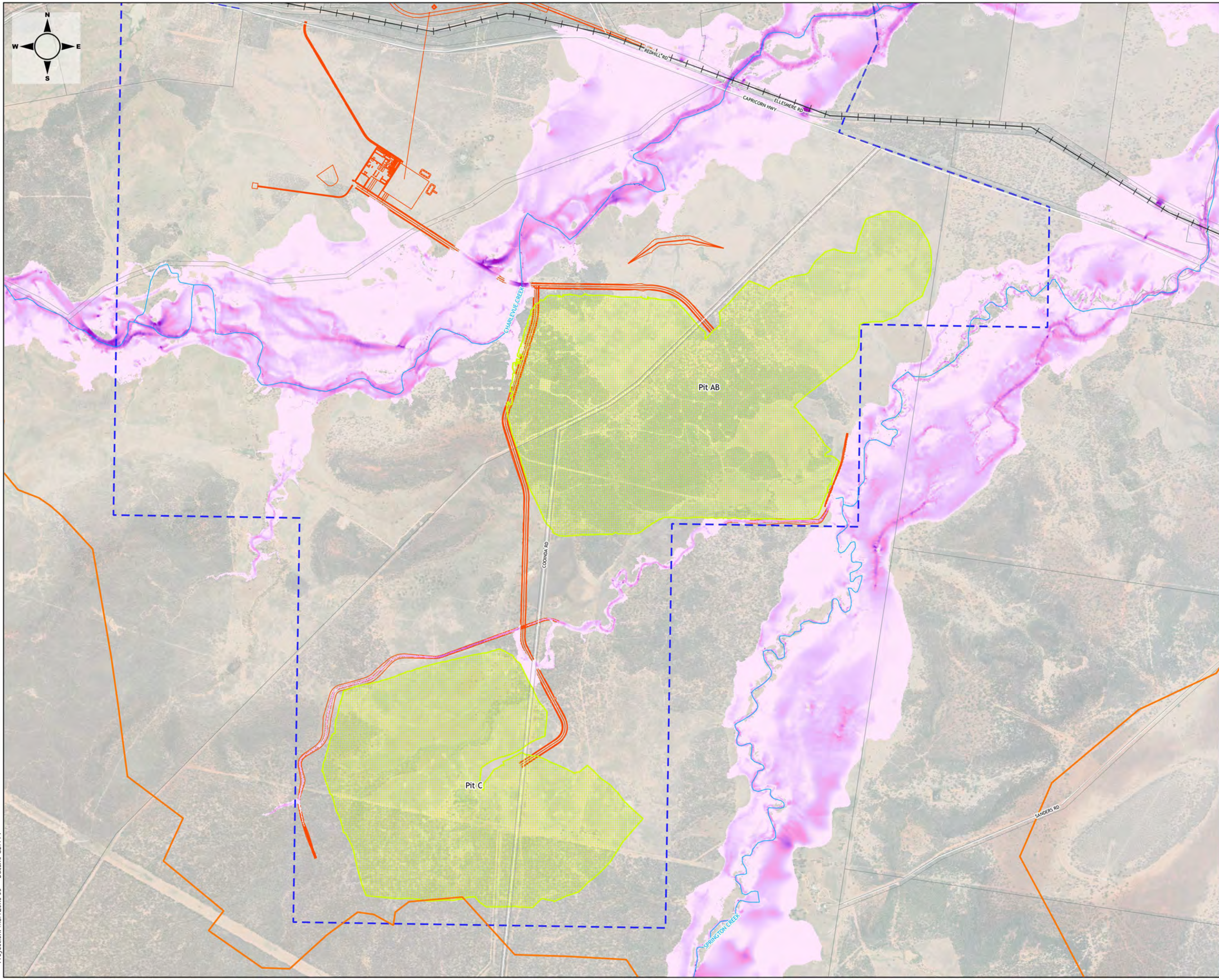
- 0.0 m/s < 0.5 m/s
- 0.5 m/s < 1.0 m/s
- 1.0 m/s < 1.5 m/s
- 1.5 m/s < 2.0 m/s
- 2.0 m/s < 2.5 m/s
- 2.5 m/s < 3.0 m/s
- 3.0 m/s < 4.0 m/s
- > 4.0 m/s

0 0.25 0.5 0.75 1 km

Surface Water Assessment
Gemini Project

Predicted Flood Velocity
(Developed Condition),
2% AEP

wrm
water + environment



Legend

- Model boundary
- Cadastre
- Railway
- Watercourse
- Mine lease boundary
- Proposed pit location
- Proposed infrastructure

Peak flood velocity

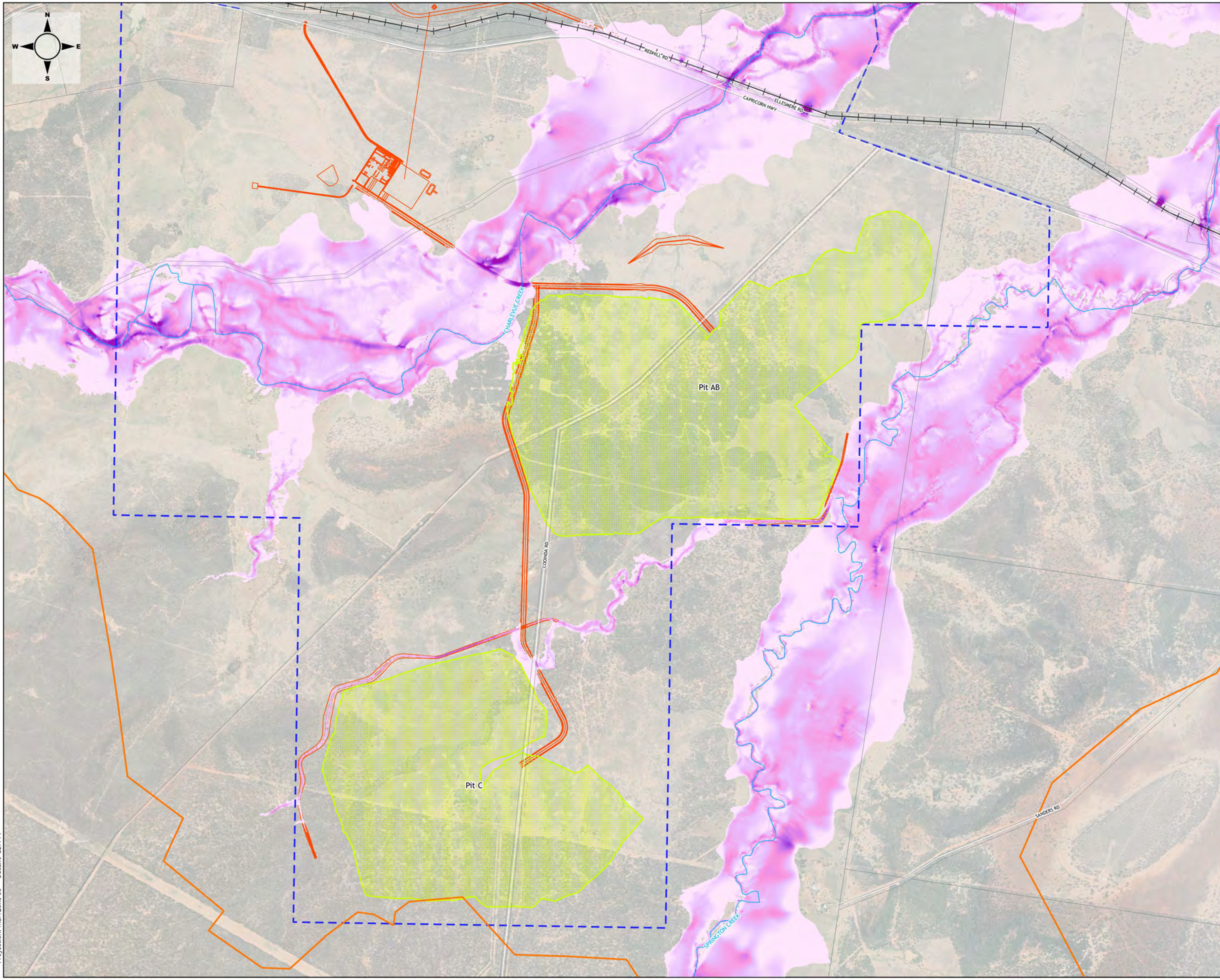
- 0.0 m/s < 0.5 m/s
- 0.5 m/s < 1.0 m/s
- 1.0 m/s < 1.5 m/s
- 1.5 m/s < 2.0 m/s
- 2.0 m/s < 2.5 m/s
- 2.5 m/s < 3.0 m/s
- 3.0 m/s < 4.0 m/s
- > 4.0 m/s

0 0.25 0.5 0.75 1 km

Surface Water Assessment
Gemini Project

Predicted Flood Velocity (Developed Condition), 1% AEP

wrm water + environment



Projection: MGA Zone 55 Datum: GDA 94

Legend

- Model boundary
- Cadastre
- Railway
- Watercourse
- Mine lease boundary
- Proposed pit location
- Proposed infrastructure

Peak flood velocity

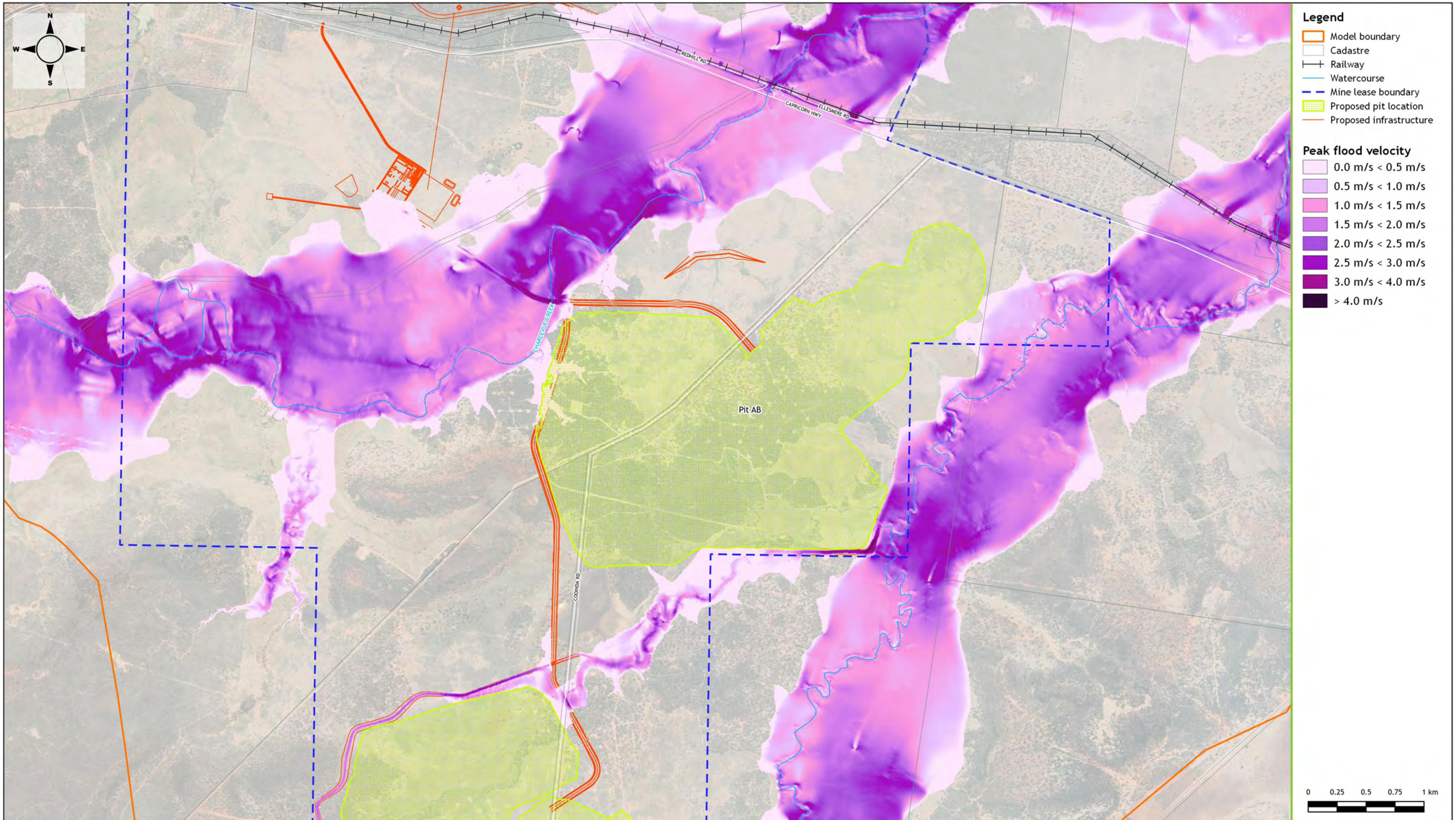
- 0.0 m/s < 0.5 m/s
- 0.5 m/s < 1.0 m/s
- 1.0 m/s < 1.5 m/s
- 1.5 m/s < 2.0 m/s
- 2.0 m/s < 2.5 m/s
- 2.5 m/s < 3.0 m/s
- 3.0 m/s < 4.0 m/s
- > 4.0 m/s

0 0.25 0.5 0.75 1 km

Surface Water Assessment
Gemini Project

Predicted Flood Velocity (Developed Condition), 0.1% AEP

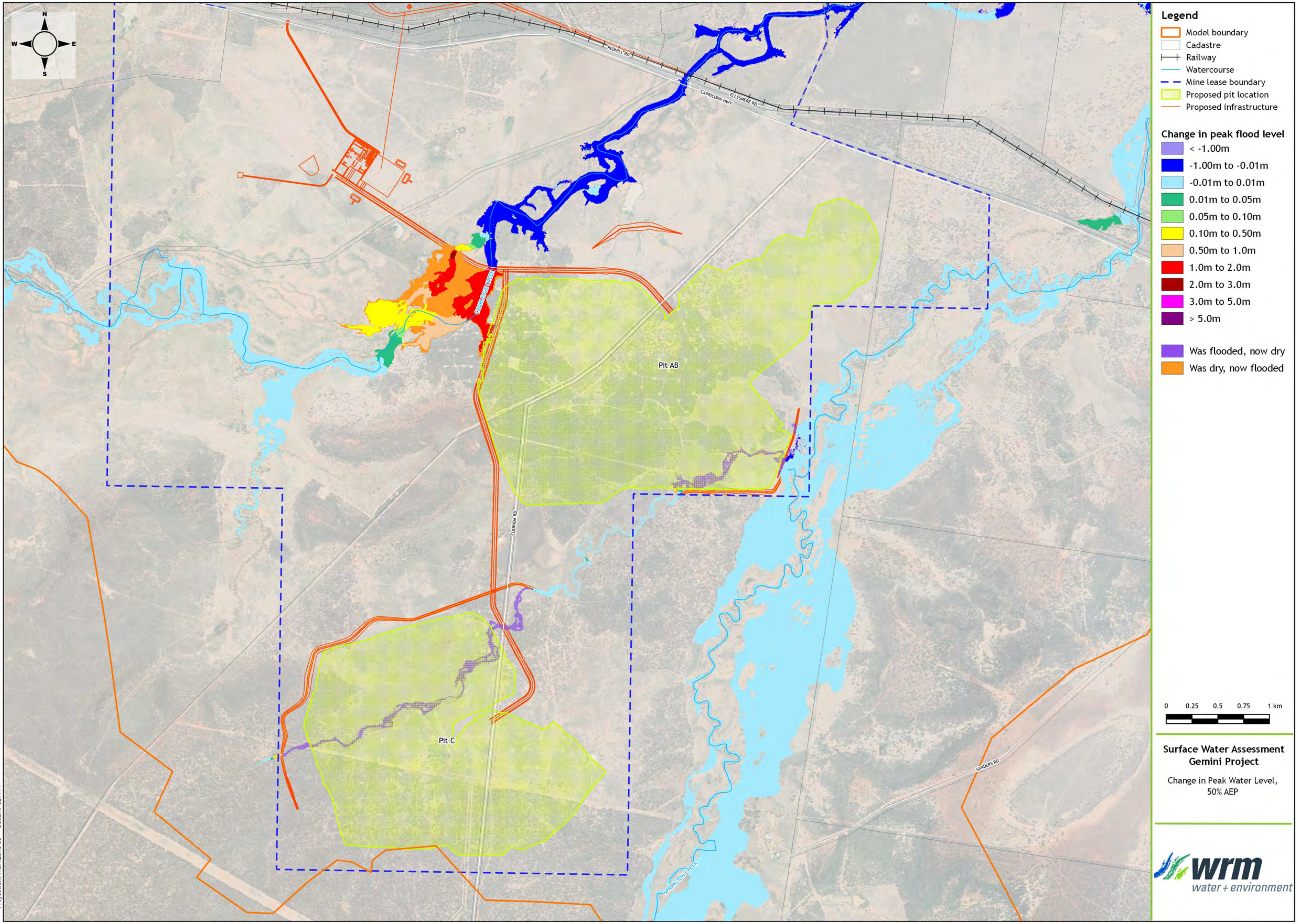
wrm water + environment



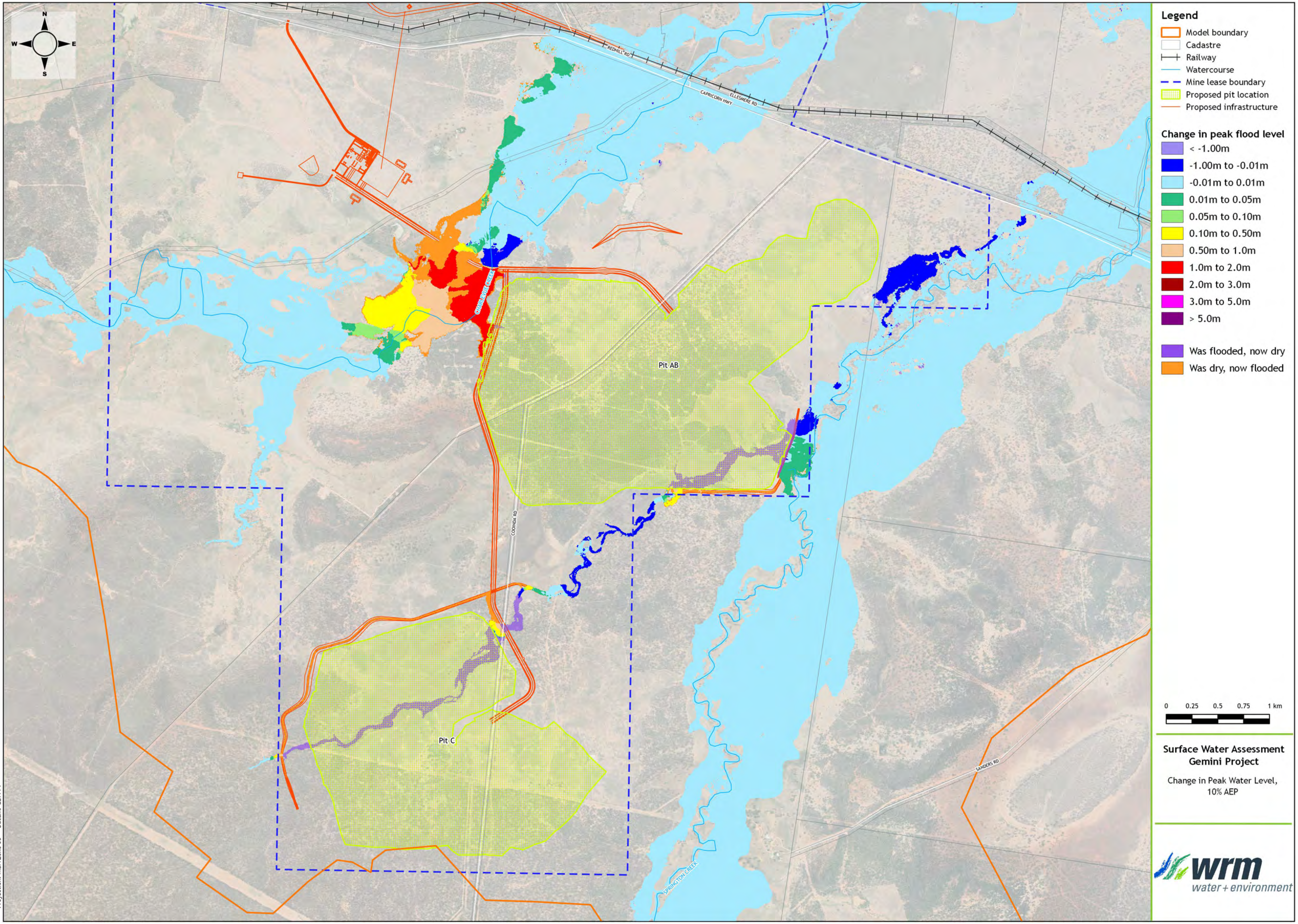
Surface Water Assessment
Gemini Project

Predicted Flood Velocity
(Developed Condition),
PMF

wrm water + environment

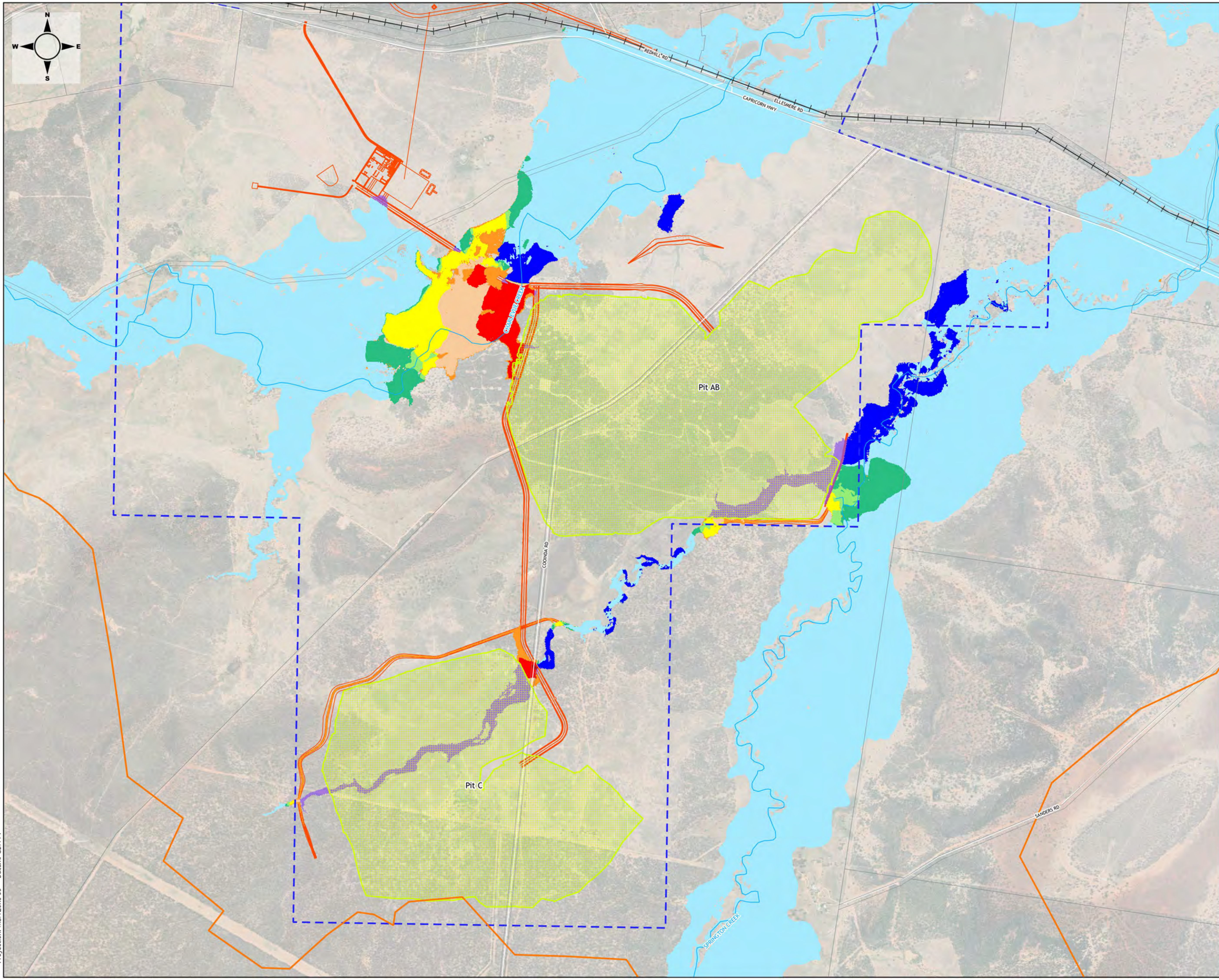


N
S
E
W
REDHILL RD
CAPRICORN HWY
ELLESMERE RD
COONDA RD
SPRINGTON CREEK
SANDERS RD
Pit AB
Pit C
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
Change in peak flood level
< -1.00m
-1.00m to -0.01m
-0.01m to 0.01m
0.01m to 0.05m
0.05m to 0.10m
0.10m to 0.50m
0.50m to 1.0m
1.0m to 2.0m
2.0m to 3.0m
3.0m to 5.0m
> 5.0m
Was flooded, now dry
Was dry, now flooded
0
0.25
0.5
0.75
1 km
Surface Water Assessment
Gemini Project
Change in Peak Water Level, 50% AEP
wrm water + environment
Projection: MGA Zone 55 Datum: GDA 94



Surface Water Assessment
Gemini Project

Change in Peak Water Level, 10% AEP



Legend

- Model boundary
- Cadastre
- Railway
- Watercourse
- Mine lease boundary
- Proposed pit location
- Proposed infrastructure

Change in peak flood level

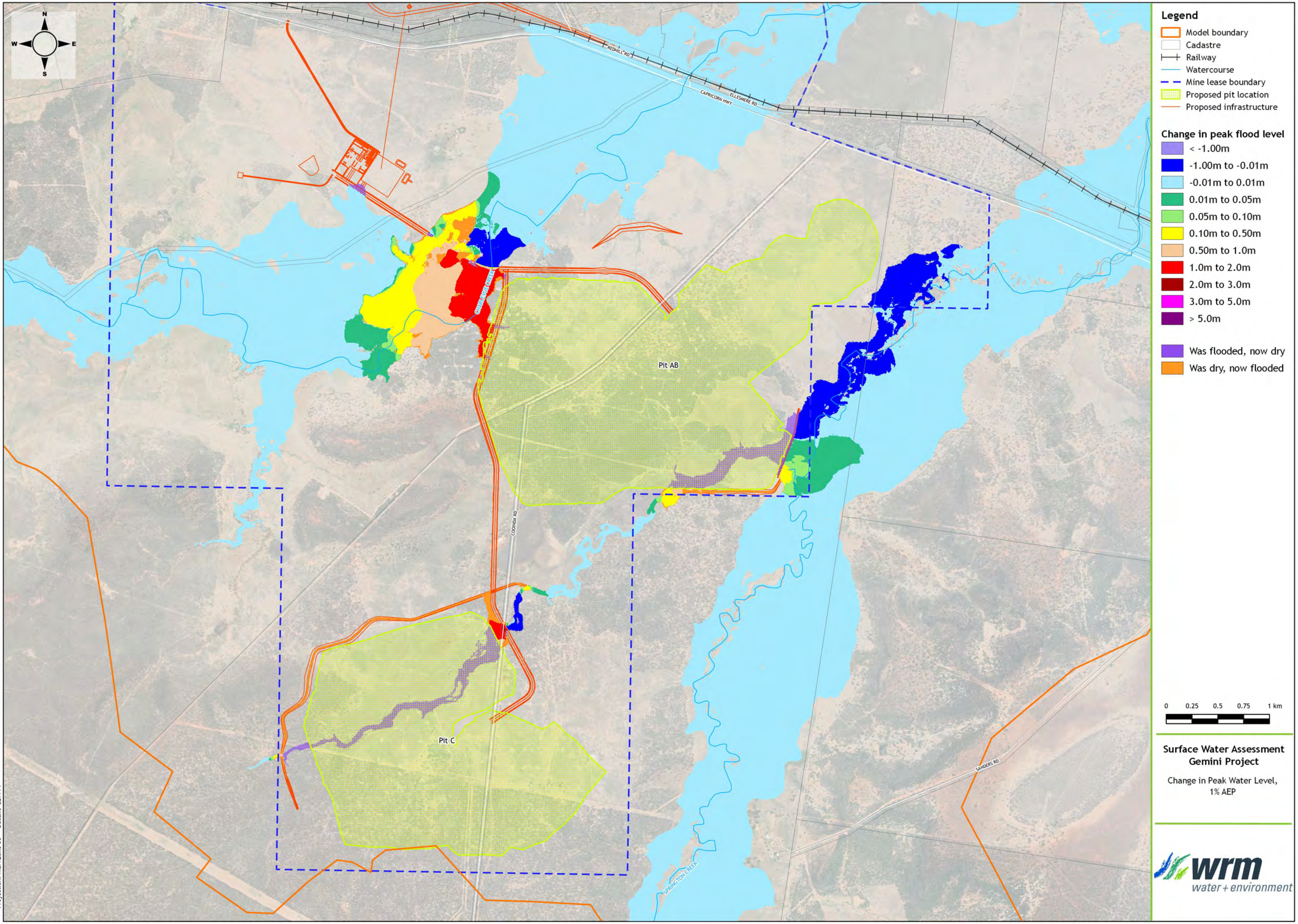
- < -1.00m
- -1.00m to -0.01m
- -0.01m to 0.01m
- 0.01m to 0.05m
- 0.05m to 0.10m
- 0.10m to 0.50m
- 0.50m to 1.0m
- 1.0m to 2.0m
- 2.0m to 3.0m
- 3.0m to 5.0m
- > 5.0m
- Was flooded, now dry
- Was dry, now flooded

0 0.25 0.5 0.75 1 km

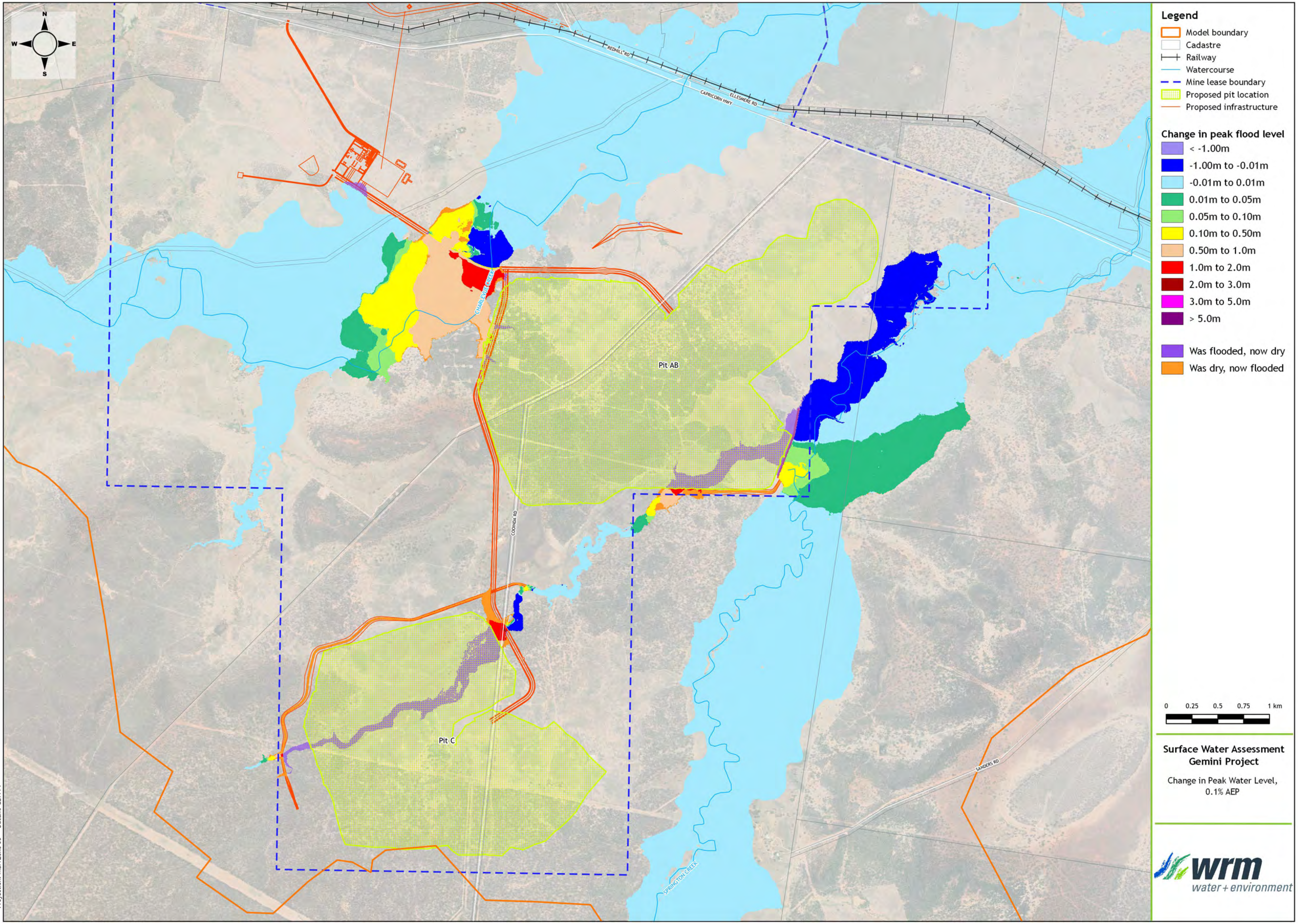
Surface Water Assessment Gemini Project

Change in Peak Water Level, 2% AEP

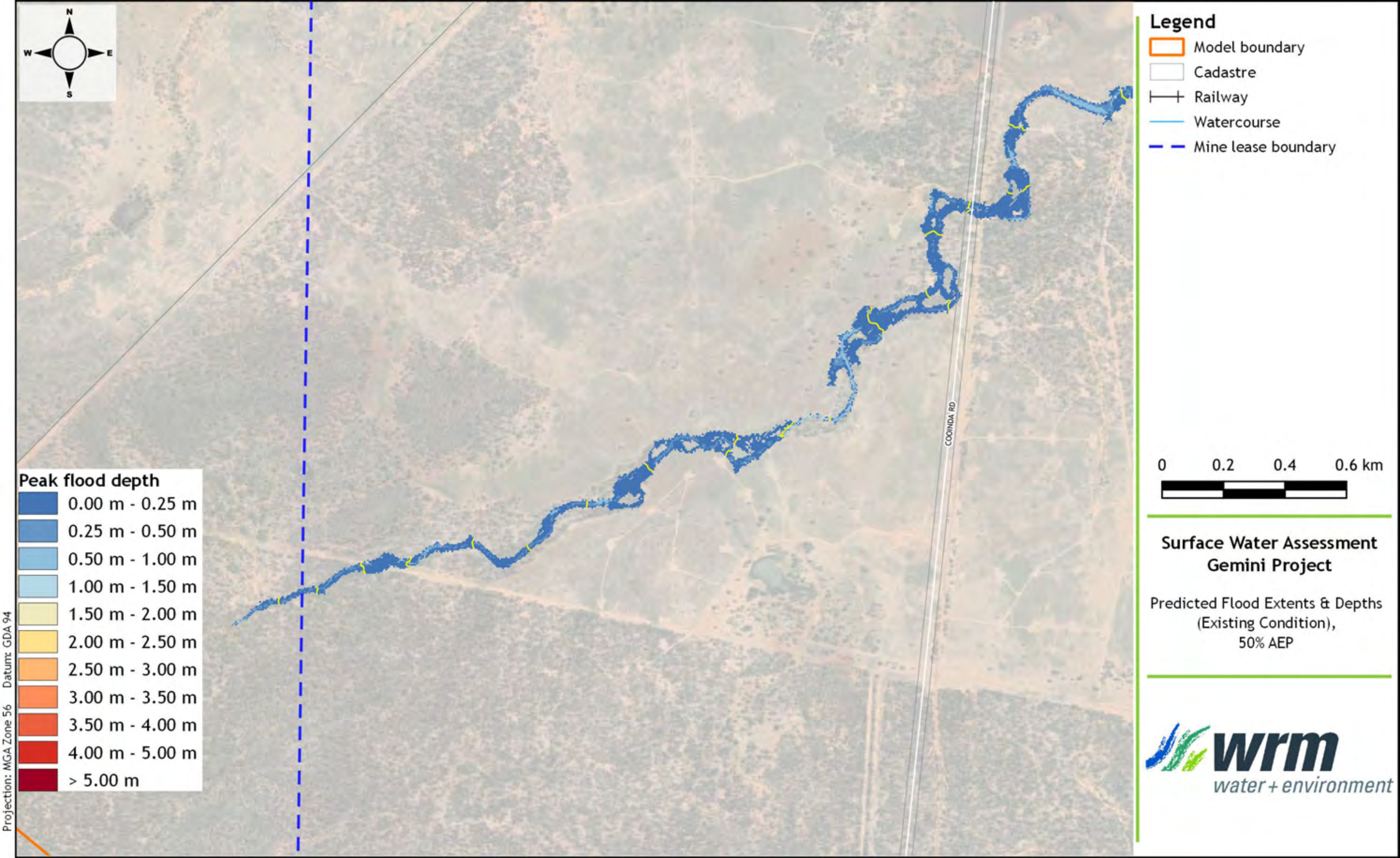
wrm water + environment



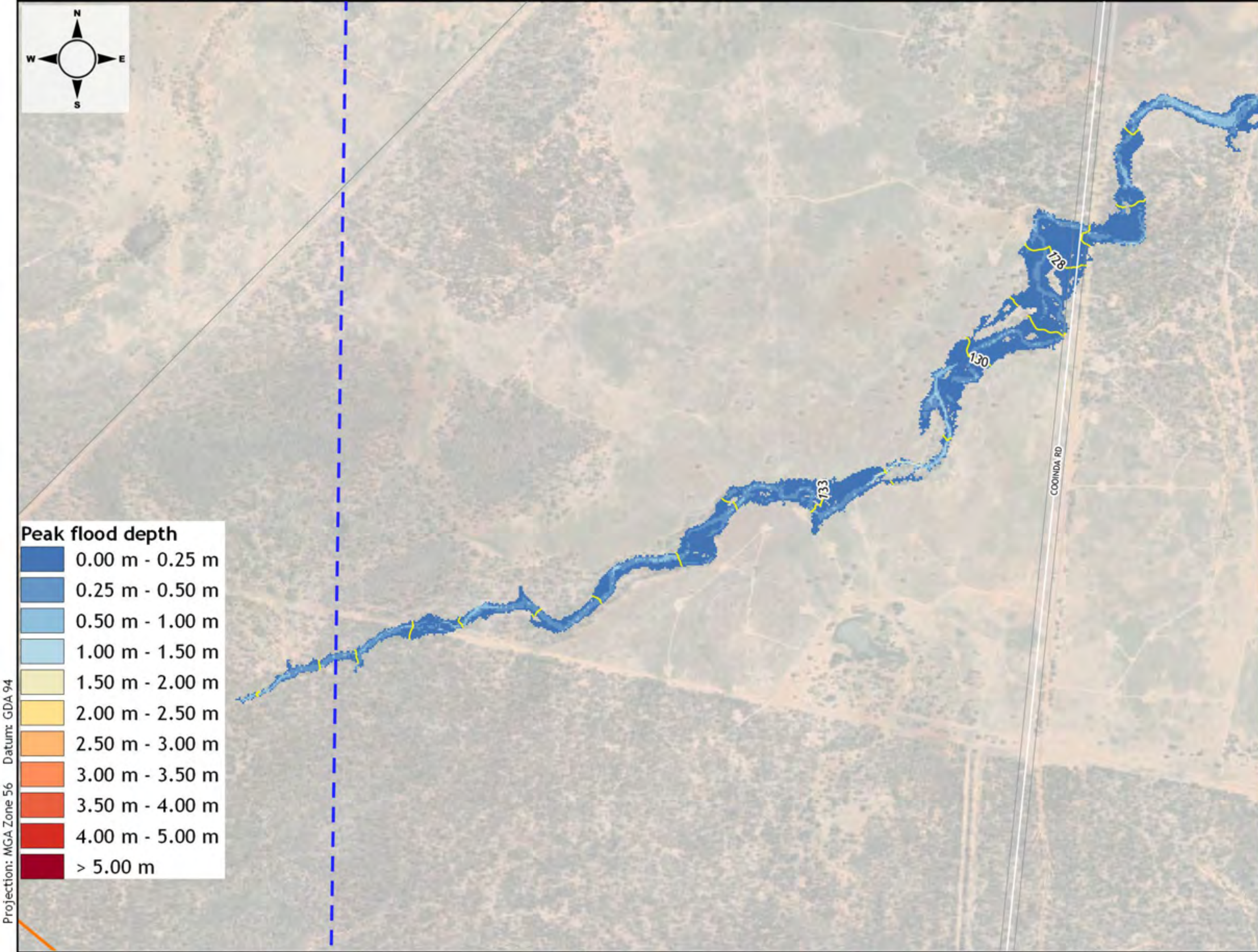
N
S
E
W
REDHILL RD
CAPRICORN HWY
ELLESMERE RD
Pit AB
Pit C
COONDA RD
SPRINGTON CREEK
SANDERS RD
Projection: MGA Zone 55 Datum: GDA 94
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
Change in peak flood level
< -1.00m
-1.00m to -0.01m
-0.01m to 0.01m
0.01m to 0.05m
0.05m to 0.10m
0.10m to 0.50m
0.50m to 1.0m
1.0m to 2.0m
2.0m to 3.0m
3.0m to 5.0m
> 5.0m
Was flooded, now dry
Was dry, now flooded
0 0.25 0.5 0.75 1 km
Surface Water Assessment
Gemini Project
Change in Peak Water Level, 1% AEP
wrm
water + environment



N
W
E
S
Pit AB
Pit C
REDHILL RD
CAPRICORN HWY
ELLESMERE RD
COONDA RD
SANDERS RD
SPRINGTON CREEK
Projection: MGA Zone 55 Datum: GDA 94
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
Change in peak flood level
< -1.00m
-1.00m to -0.01m
-0.01m to 0.01m
0.01m to 0.05m
0.05m to 0.10m
0.10m to 0.50m
0.50m to 1.0m
1.0m to 2.0m
2.0m to 3.0m
3.0m to 5.0m
> 5.0m
Was flooded, now dry
Was dry, now flooded
0 0.25 0.5 0.75 1 km
Surface Water Assessment
Gemini Project
Change in Peak Water Level, 0.1% AEP
wrm
water + environment



N
W
E
S
COOINDA RD
Peak flood depth
0.00 m - 0.25 m
0.25 m - 0.50 m
0.50 m - 1.00 m
1.00 m - 1.50 m
1.50 m - 2.00 m
2.00 m - 2.50 m
2.50 m - 3.00 m
3.00 m - 3.50 m
3.50 m - 4.00 m
4.00 m - 5.00 m
> 5.00 m
Projection: MGA Zone 56 Datum: GDA 94
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
0 0.2 0.4 0.6 km
Surface Water Assessment
Gemini Project
Predicted Flood Extents & Depths
(Existing Condition),
50% AEP
wrm
water + environment



Legend

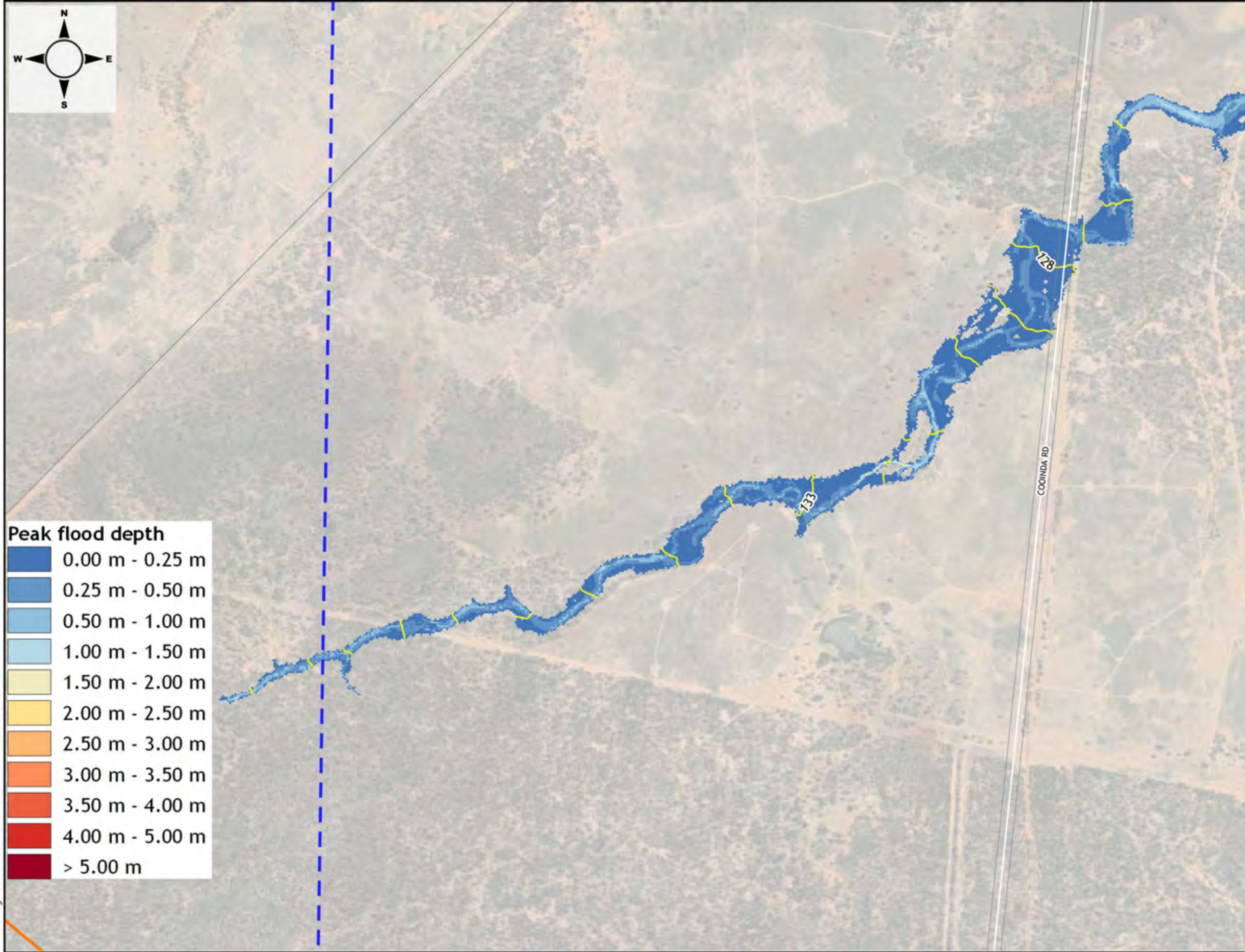
- Model boundary
- Cadastre
- Railway
- Watercourse
- Mine lease boundary

0 0.2 0.4 0.6 km

Surface Water Assessment
Gemini Project

Predicted Flood Extents & Depths (Existing Condition), 10% AEP

wrm water + environment



Legend

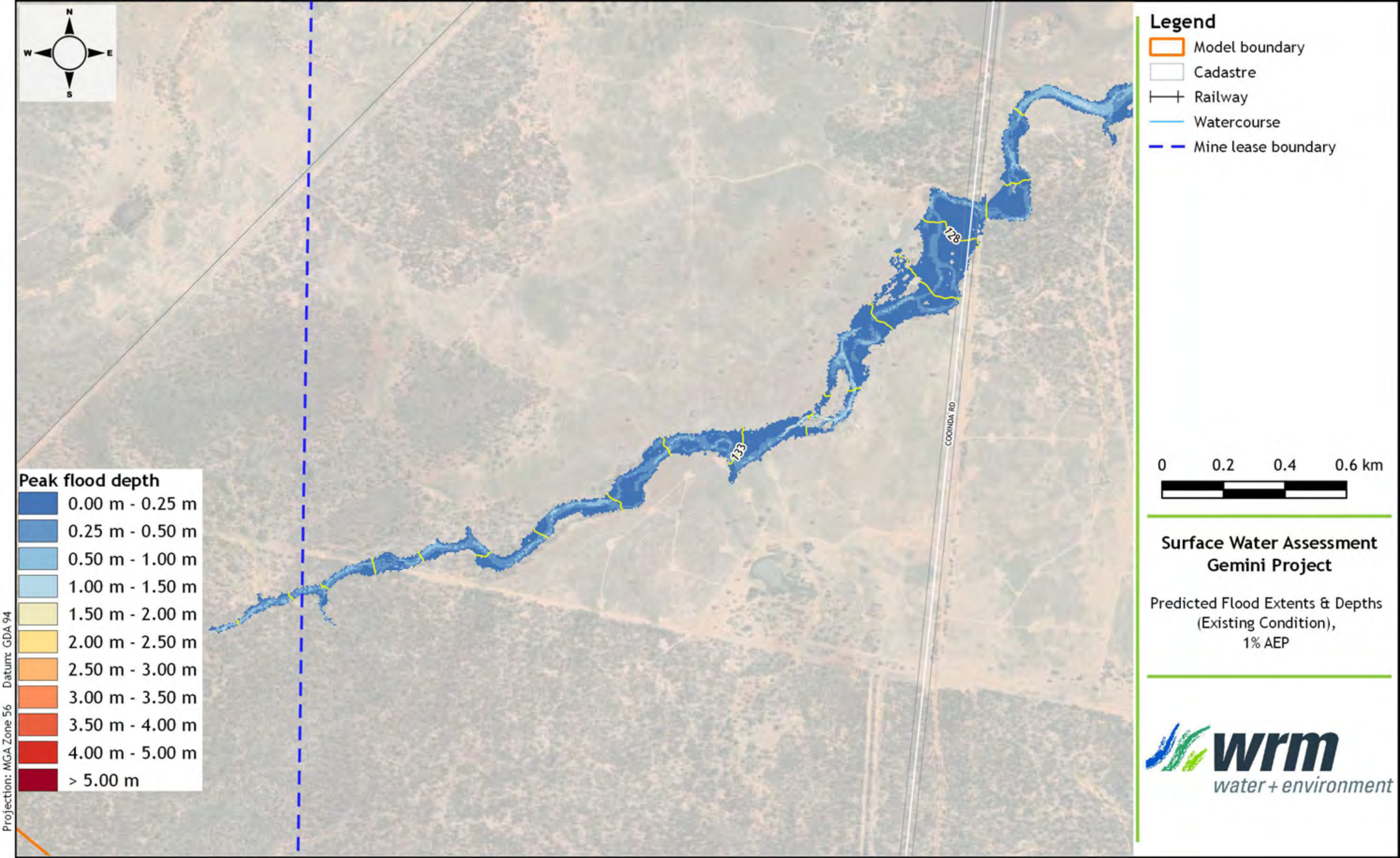
- Model boundary
- Cadastre
- Railway
- Watercourse
- Mine lease boundary

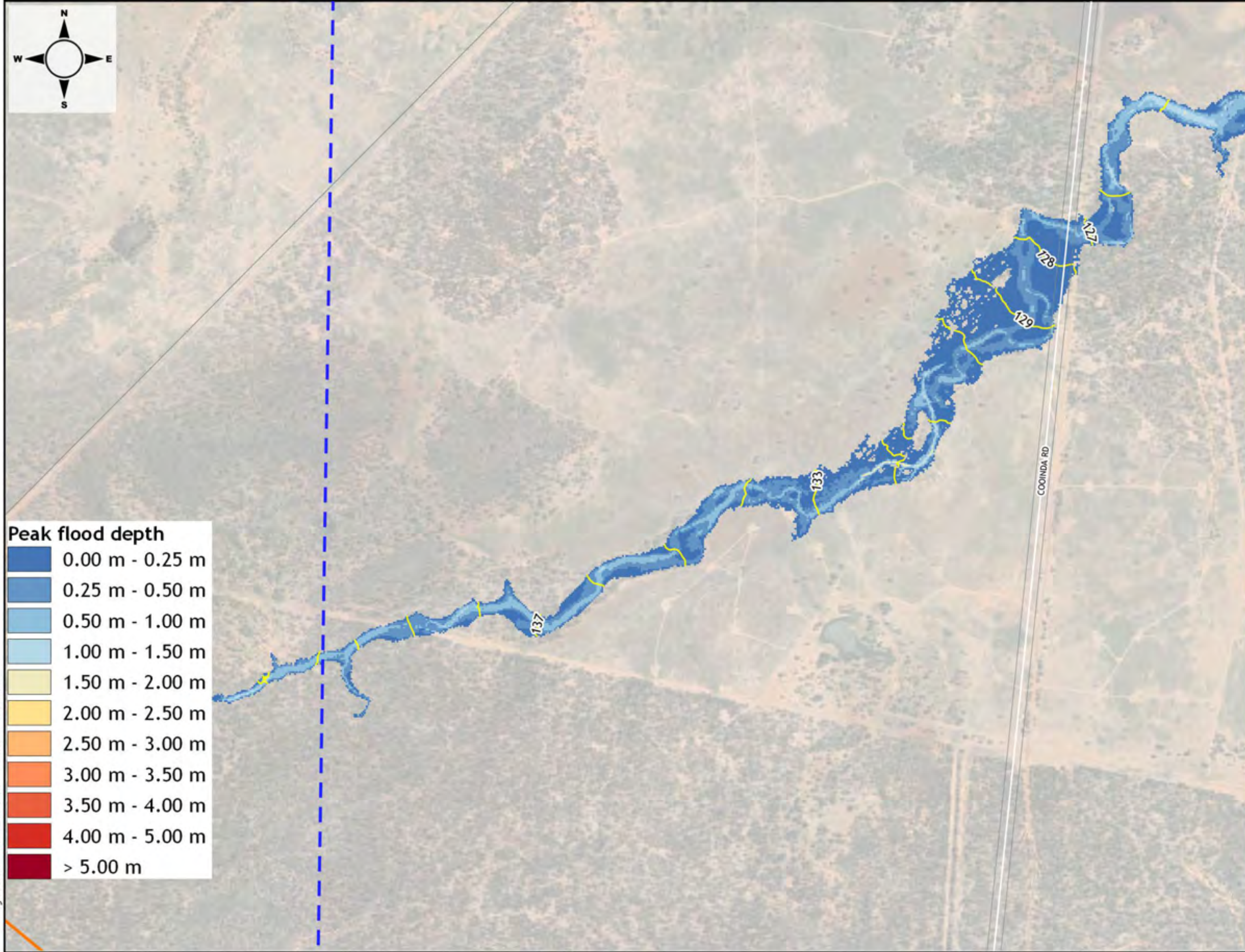
0 0.2 0.4 0.6 km

Surface Water Assessment
Gemini Project

Predicted Flood Extents & Depths
(Existing Condition),
2% AEP

wrm
water + environment


N
W
E
S
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
128
133
COOINDA RD
0
0.2
0.4
0.6 km
Peak flood depth
0.00 m - 0.25 m
0.25 m - 0.50 m
0.50 m - 1.00 m
1.00 m - 1.50 m
1.50 m - 2.00 m
2.00 m - 2.50 m
2.50 m - 3.00 m
3.00 m - 3.50 m
3.50 m - 4.00 m
4.00 m - 5.00 m
> 5.00 m
Projection: MGA Zone 56 Datum: GDA 94
Surface Water Assessment
Gemini Project
Predicted Flood Extents & Depths
(Existing Condition),
1% AEP
wrm
water + environment



Legend

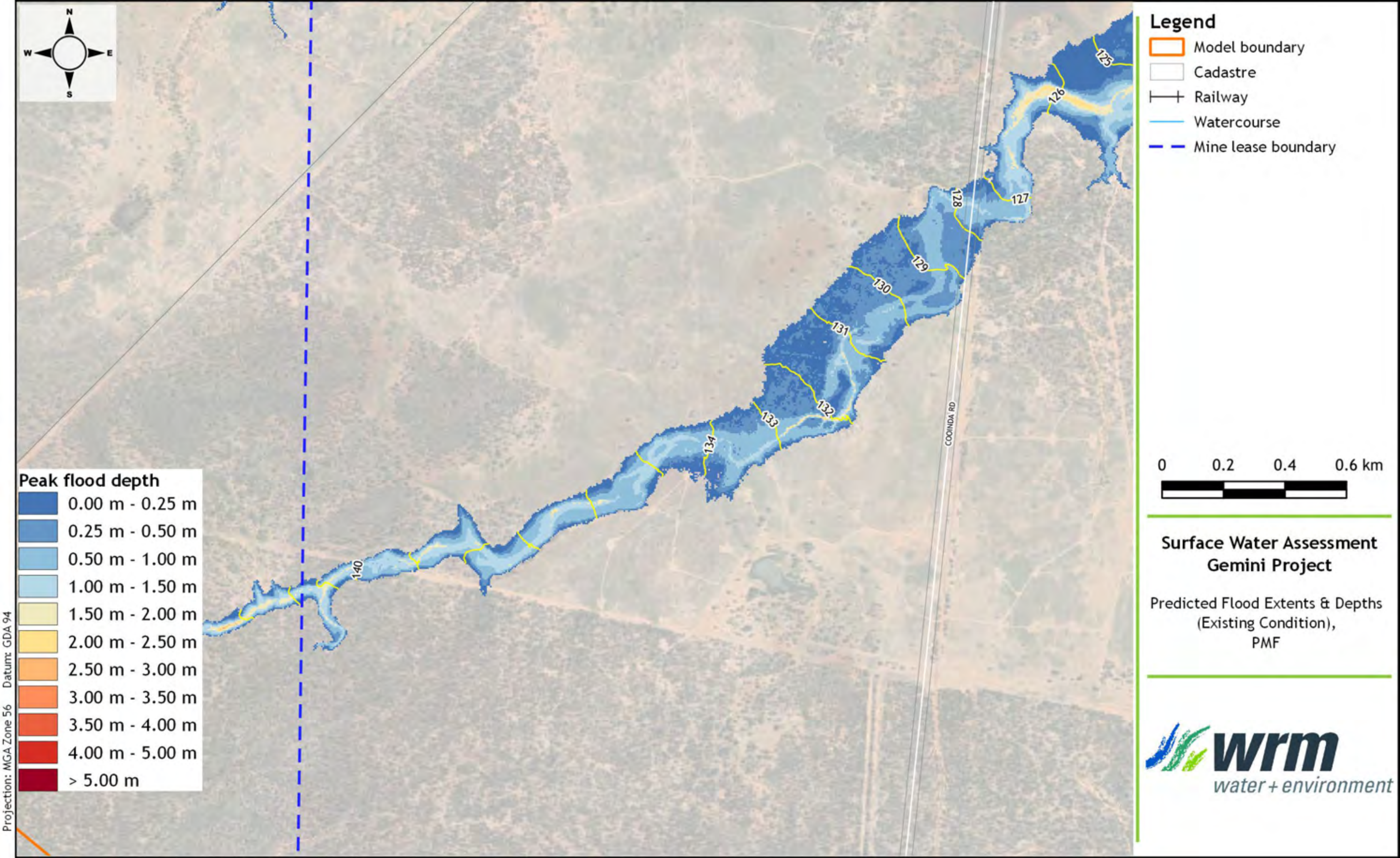
- Model boundary
- Cadastre
- Railway
- Watercourse
- Mine lease boundary

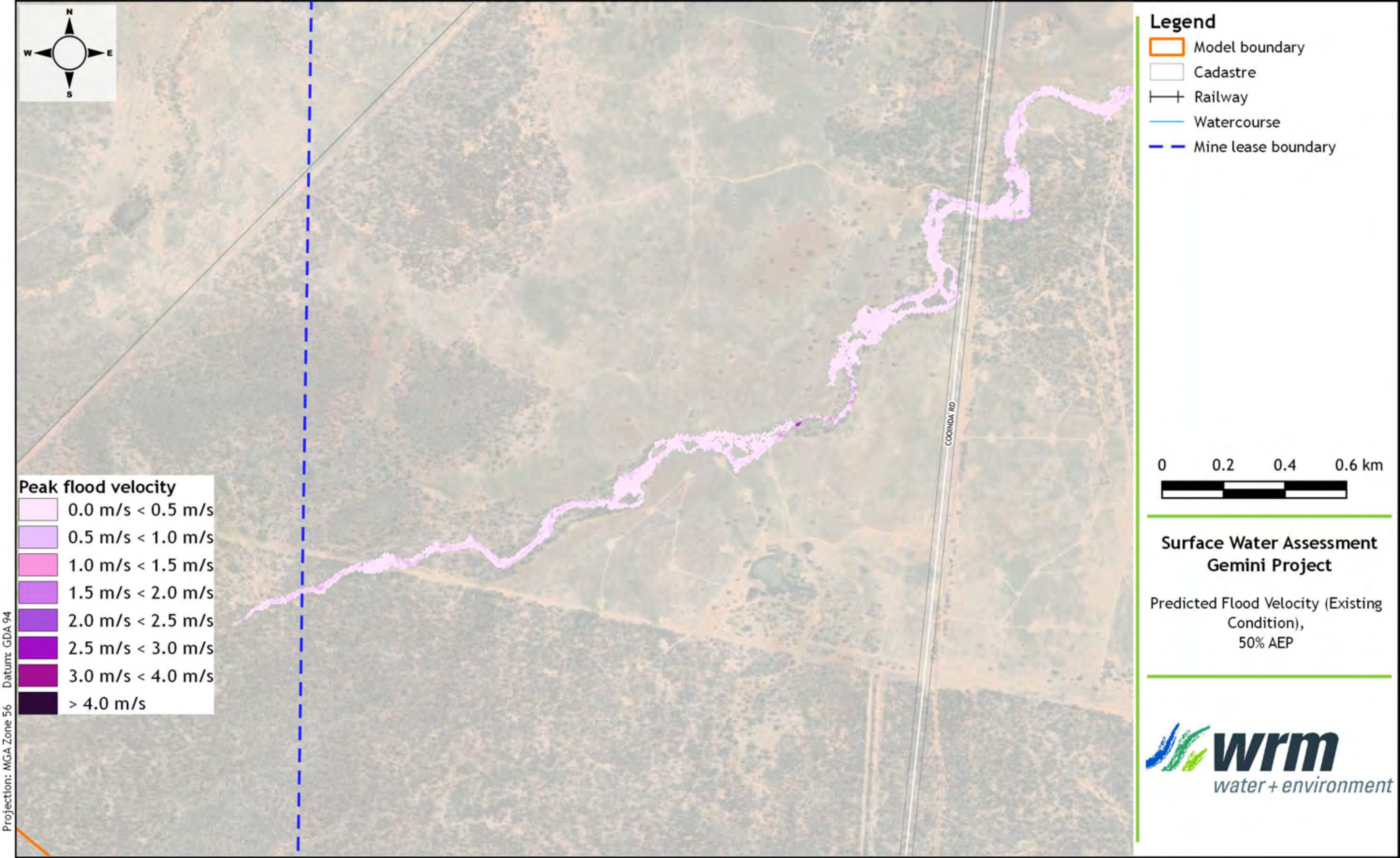
0 0.2 0.4 0.6 km

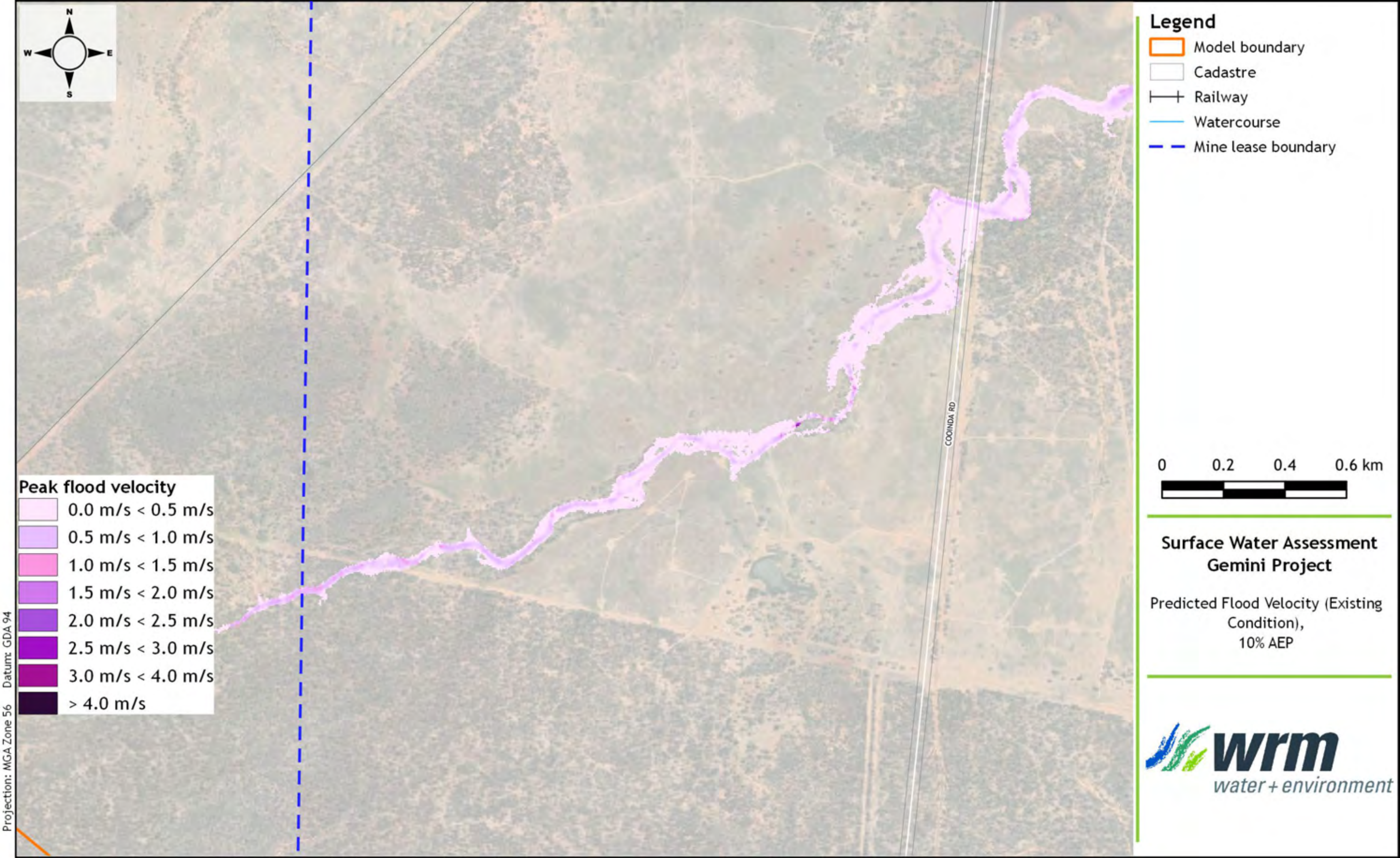
Surface Water Assessment
Gemini Project

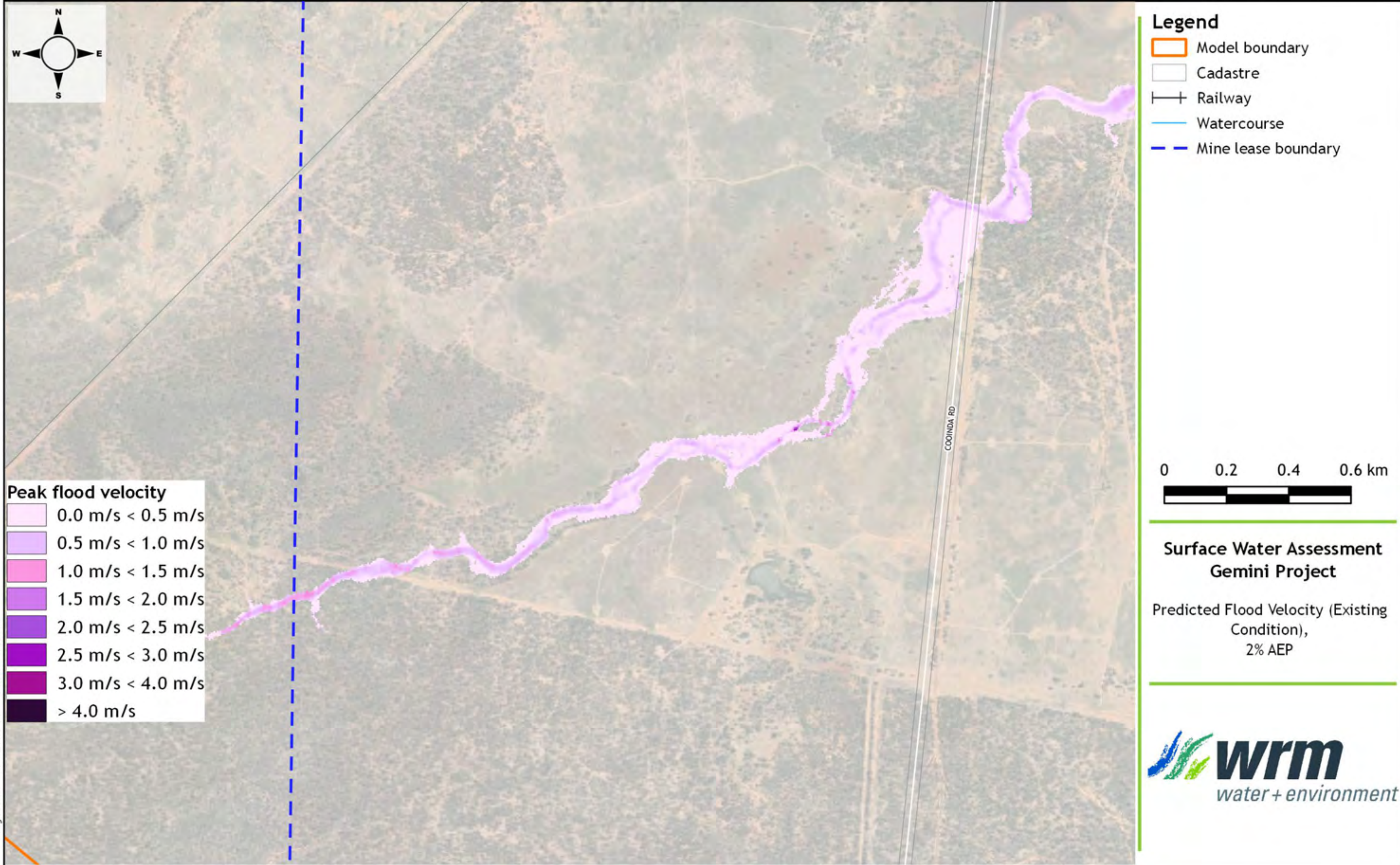
Predicted Flood Extents & Depths (Existing Condition), 0.1% AEP

wrm water + environment


N
W
E
S
125
126
127
128
129
130
131
132
133
134
140
COOINDA RD
Peak flood depth
0.00 m - 0.25 m
0.25 m - 0.50 m
0.50 m - 1.00 m
1.00 m - 1.50 m
1.50 m - 2.00 m
2.00 m - 2.50 m
2.50 m - 3.00 m
3.00 m - 3.50 m
3.50 m - 4.00 m
4.00 m - 5.00 m
> 5.00 m
Projection: MGA Zone 56 Datum: GDA 94
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
0
0.2
0.4
0.6 km
Surface Water Assessment
Gemini Project
Predicted Flood Extents & Depths
(Existing Condition),
PMF
wrm
water+environment


N
W
E
S
COOINDA RD
Peak flood velocity
0.0 m/s < 0.5 m/s
0.5 m/s < 1.0 m/s
1.0 m/s < 1.5 m/s
1.5 m/s < 2.0 m/s
2.0 m/s < 2.5 m/s
2.5 m/s < 3.0 m/s
3.0 m/s < 4.0 m/s
> 4.0 m/s
Projection: MGA Zone 56 Datum: GDA 94
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
0 0.2 0.4 0.6 km
Surface Water Assessment
Gemini Project
Predicted Flood Velocity (Existing Condition),
50% AEP
wrm
water+environment


N
W
E
S
Peak flood velocity
0.0 m/s < 0.5 m/s
0.5 m/s < 1.0 m/s
1.0 m/s < 1.5 m/s
1.5 m/s < 2.0 m/s
2.0 m/s < 2.5 m/s
2.5 m/s < 3.0 m/s
3.0 m/s < 4.0 m/s
> 4.0 m/s
COOINDA RD
Projection: MGA Zone 56 Datum: GDA 94
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
0 0.2 0.4 0.6 km
Surface Water Assessment
Gemini Project
Predicted Flood Velocity (Existing Condition),
10% AEP
wrm
water + environment

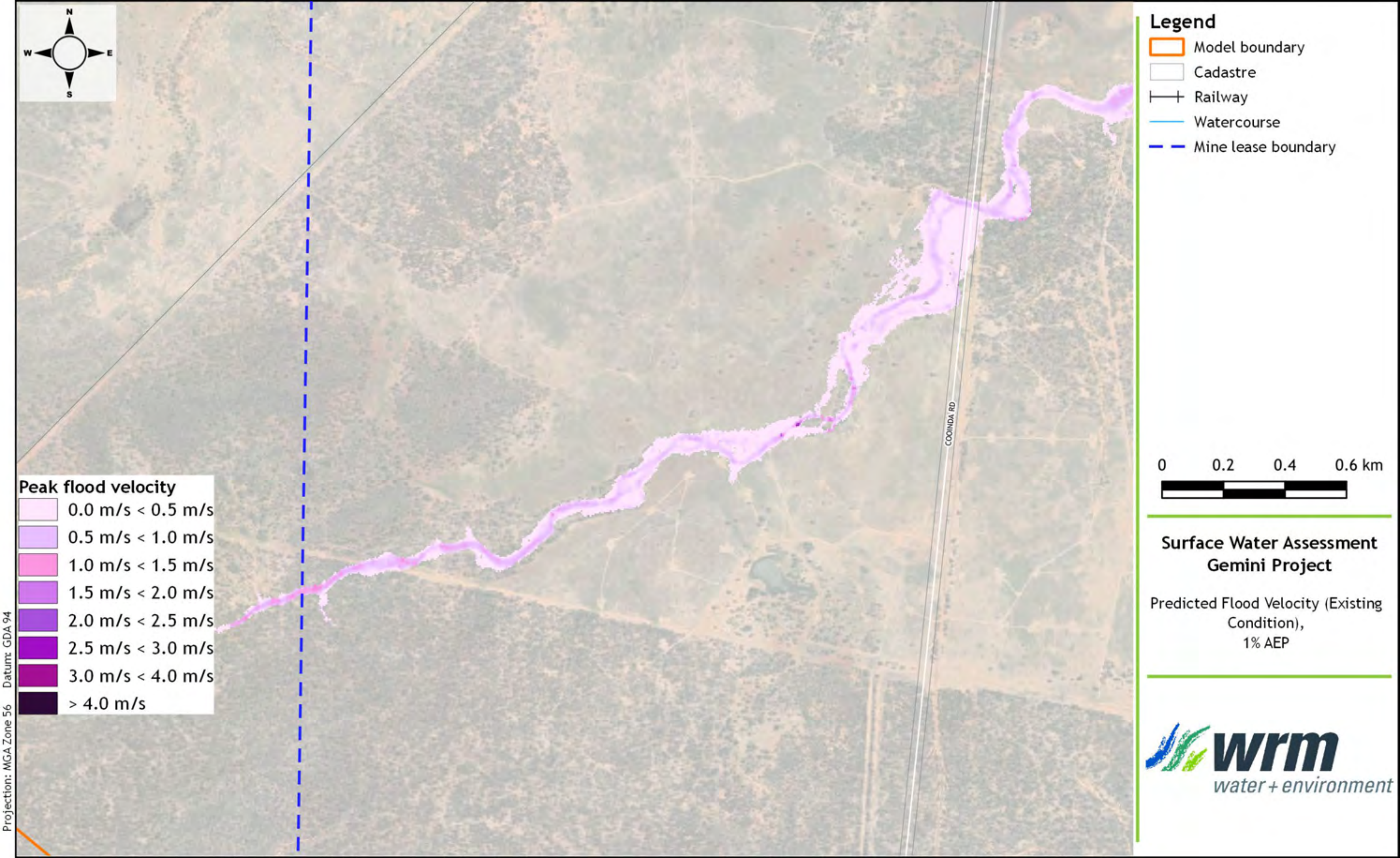


Projection: MGA Zone 56 Datum: GDA 94

Surface Water Assessment
Gemini Project

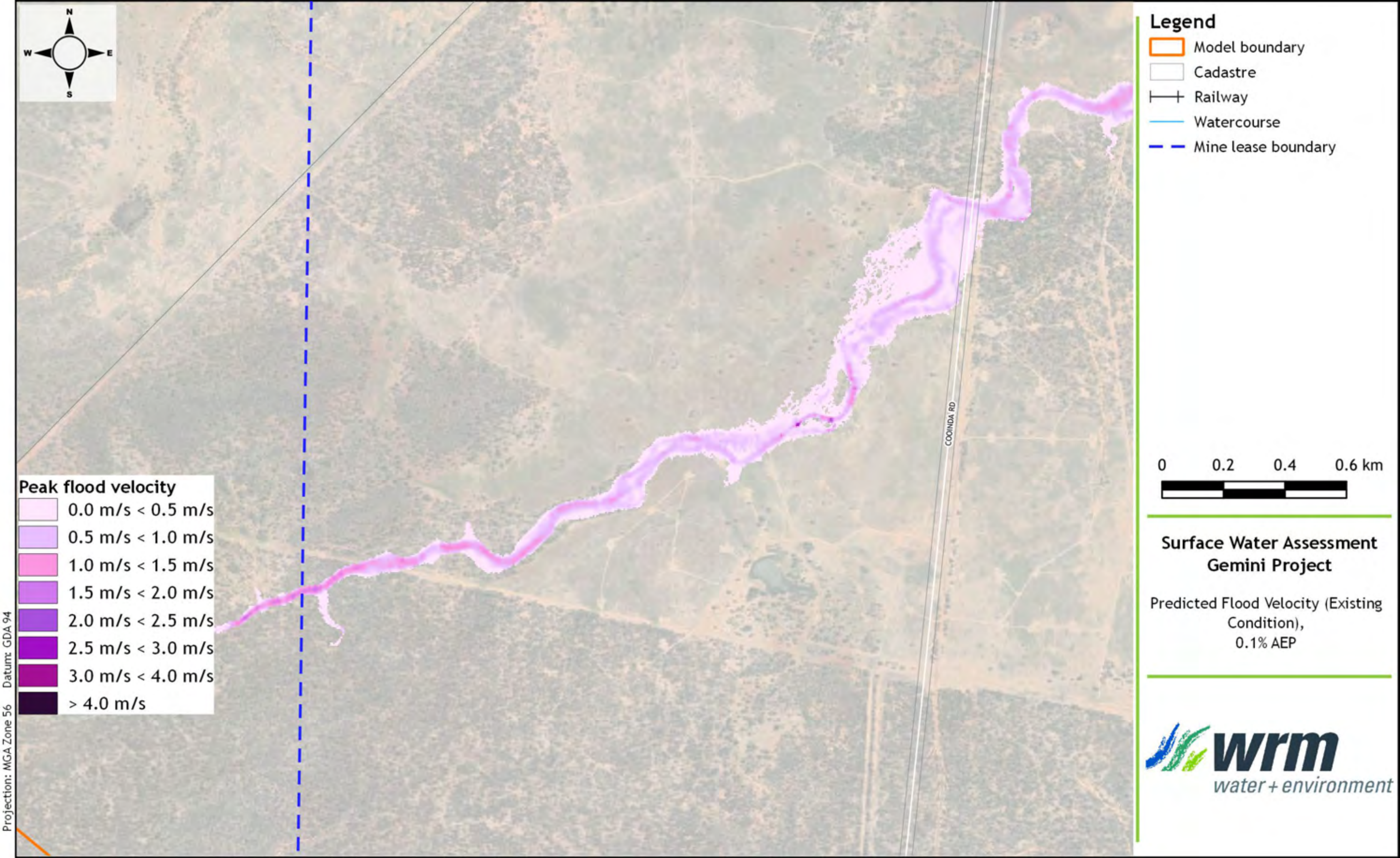
Predicted Flood Velocity (Existing Condition),
2% AEP

wrm water + environment

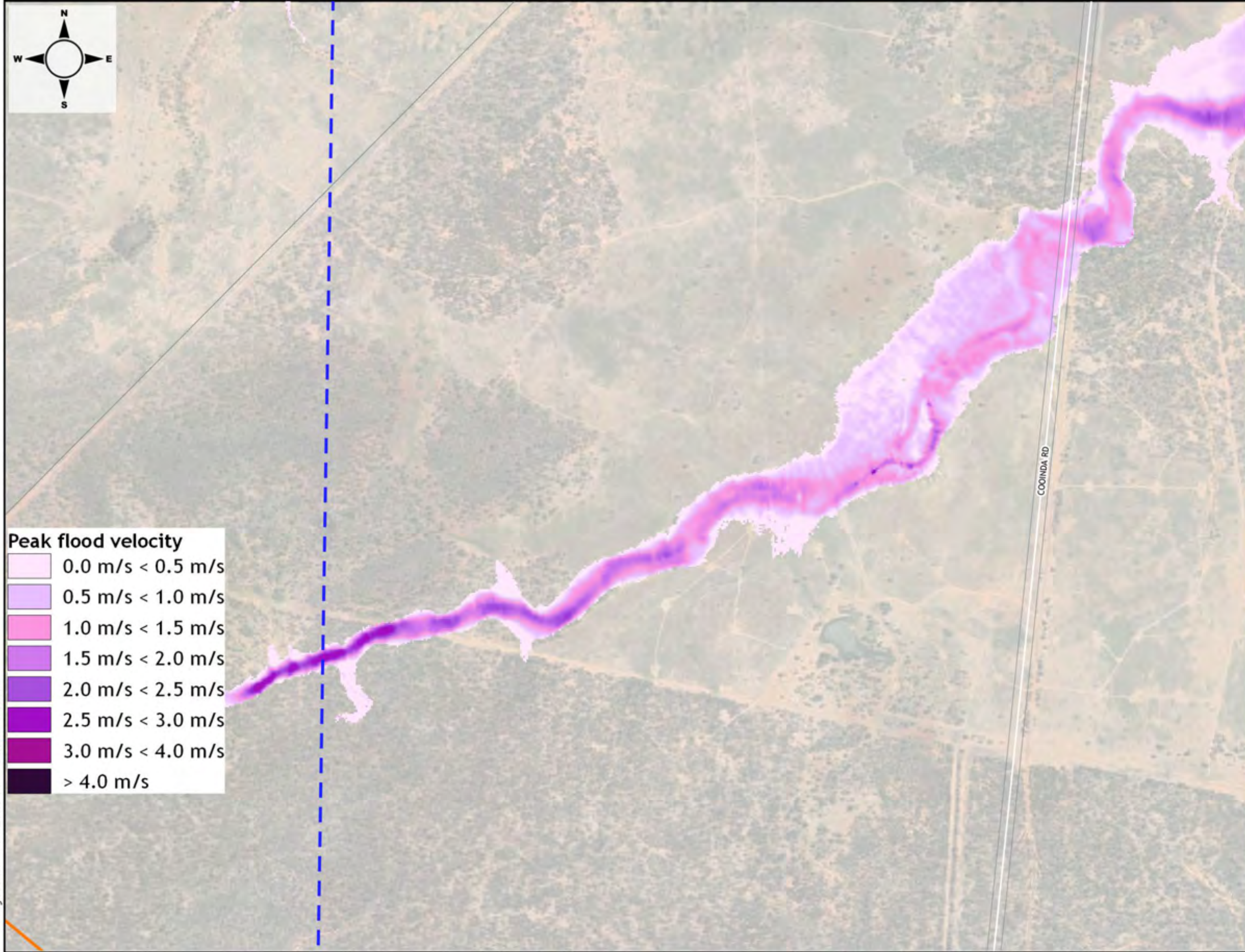


Surface Water Assessment
Gemini Project

Predicted Flood Velocity (Existing Condition), 1% AEP



N
E
S
W
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Peak flood velocity
0.0 m/s < 0.5 m/s
0.5 m/s < 1.0 m/s
1.0 m/s < 1.5 m/s
1.5 m/s < 2.0 m/s
2.0 m/s < 2.5 m/s
2.5 m/s < 3.0 m/s
3.0 m/s < 4.0 m/s
> 4.0 m/s
COOINDA RD
0
0.2
0.4
0.6 km
Surface Water Assessment
Gemini Project
Predicted Flood Velocity (Existing Condition),
0.1% AEP
wrm
water + environment
Projection: MGA Zone 56
Datum: GDA 94



Legend

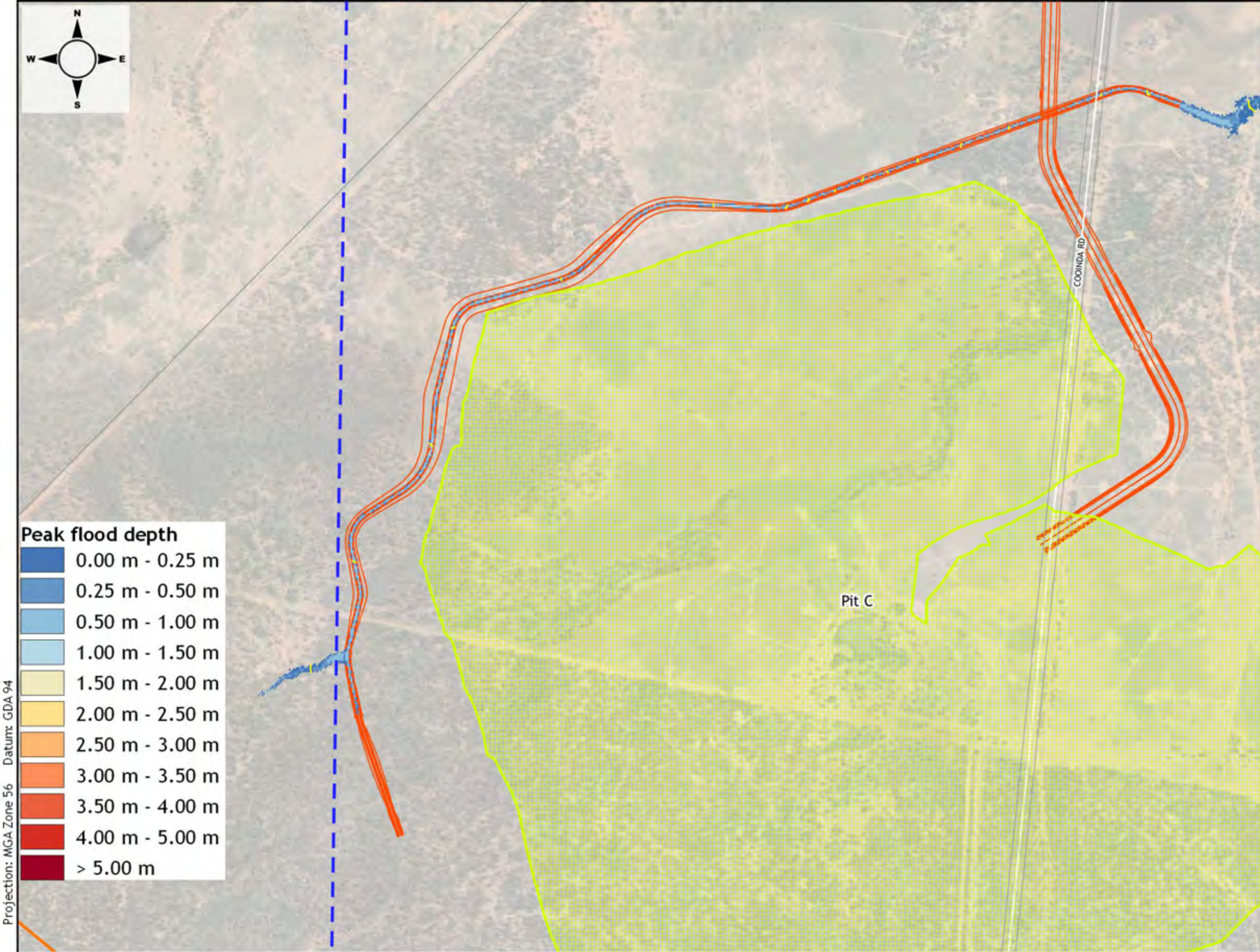
- Model boundary
- Cadastre
- Railway
- Watercourse
- Mine lease boundary

0 0.2 0.4 0.6 km

Surface Water Assessment
Gemini Project

Predicted Flood Velocity (Existing Condition),
PMF

wrm water + environment



Legend

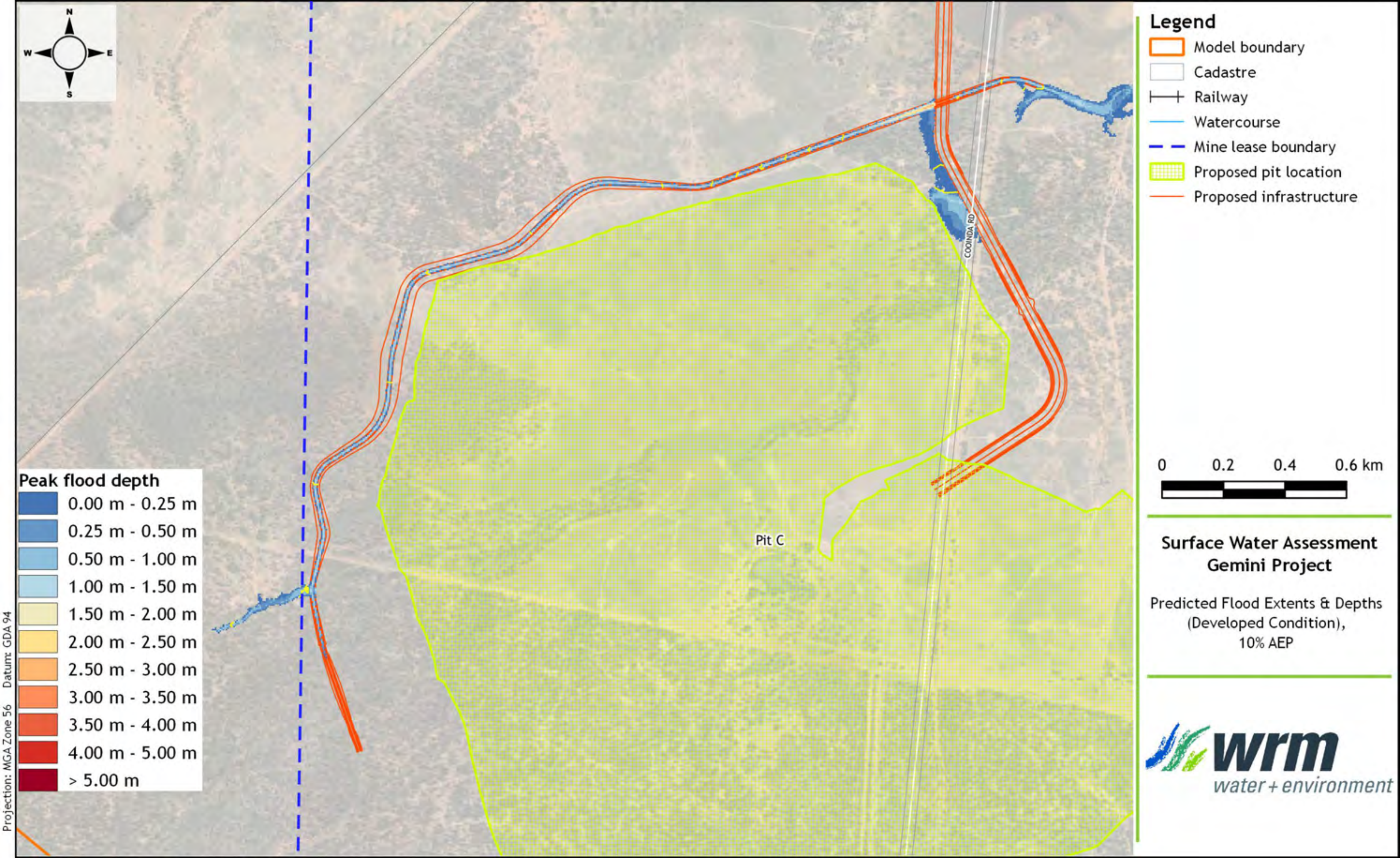
- Model boundary
- Cadastre
- Railway
- Watercourse
- Mine lease boundary
- Proposed pit location
- Proposed infrastructure

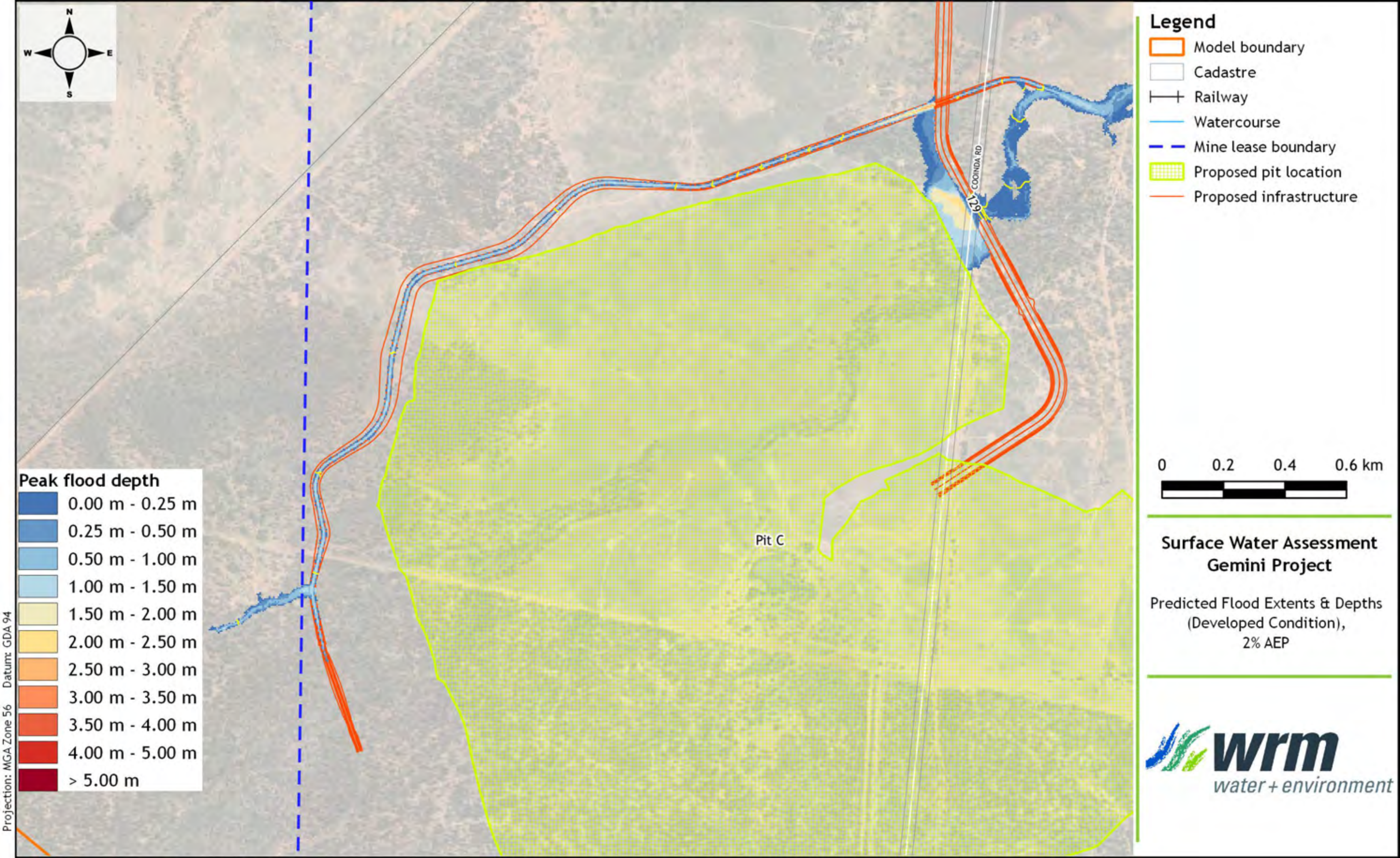
0 0.2 0.4 0.6 km

Surface Water Assessment
Gemini Project

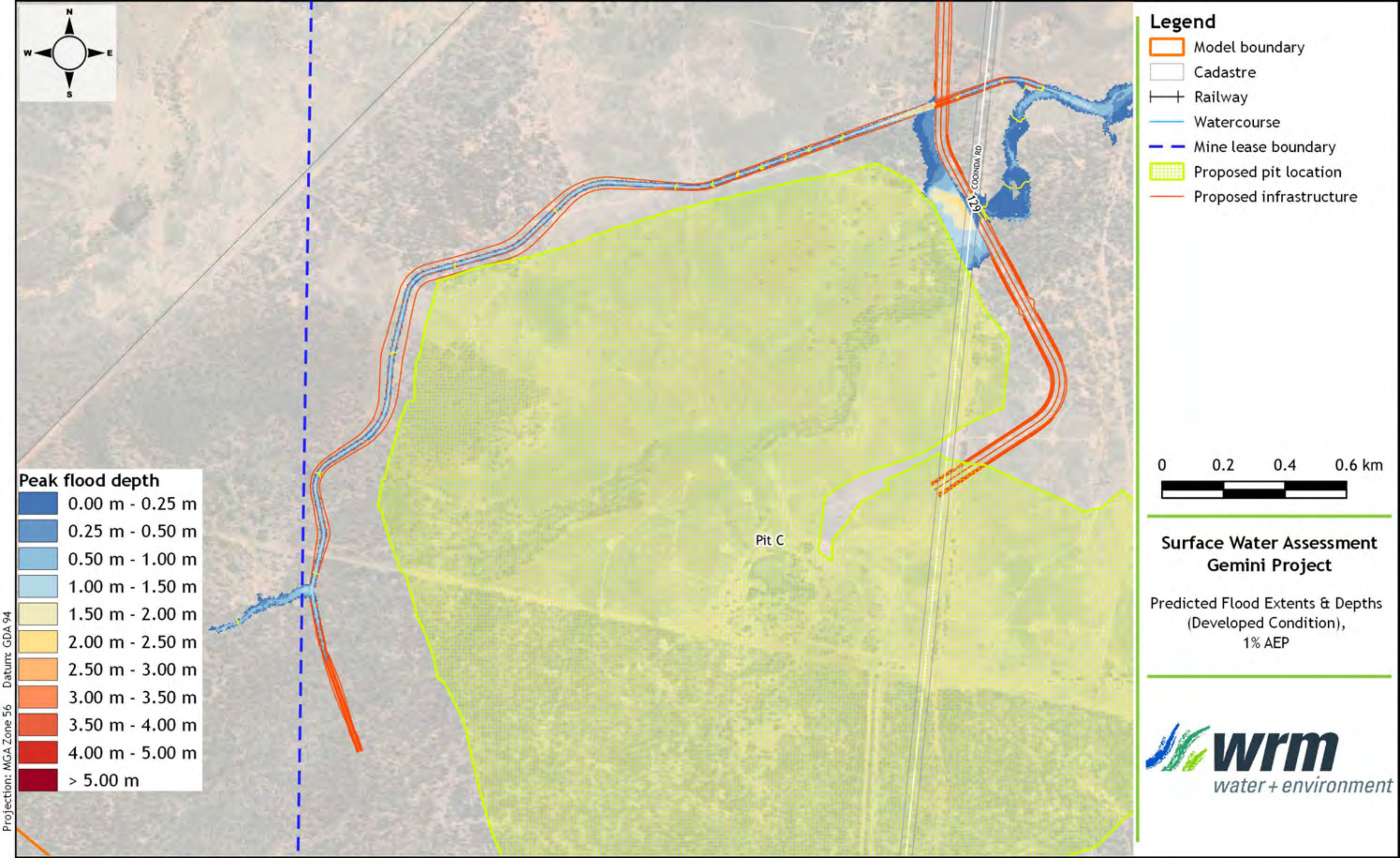
Predicted Flood Extents & Depths (Developed Condition), 50% AEP

wrm water + environment

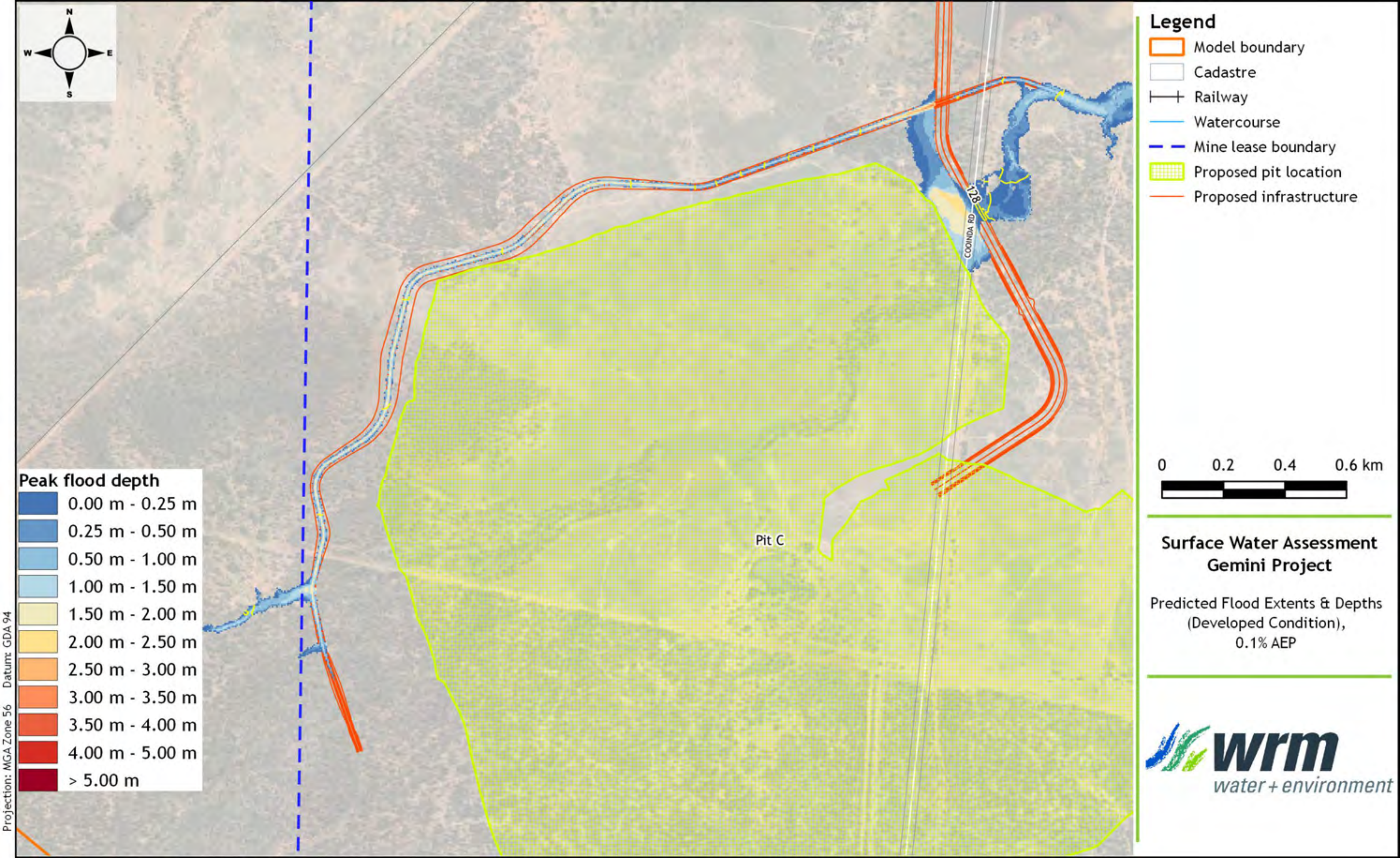

N
E
S
W
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
COOINDA RD
Pit C
Peak flood depth
0.00 m - 0.25 m
0.25 m - 0.50 m
0.50 m - 1.00 m
1.00 m - 1.50 m
1.50 m - 2.00 m
2.00 m - 2.50 m
2.50 m - 3.00 m
3.00 m - 3.50 m
3.50 m - 4.00 m
4.00 m - 5.00 m
> 5.00 m
0
0.2
0.4
0.6 km
Projection: MGA Zone 56
Datum: GDA 94
Surface Water Assessment
Gemini Project
Predicted Flood Extents & Depths
(Developed Condition),
10% AEP
wrm
water + environment



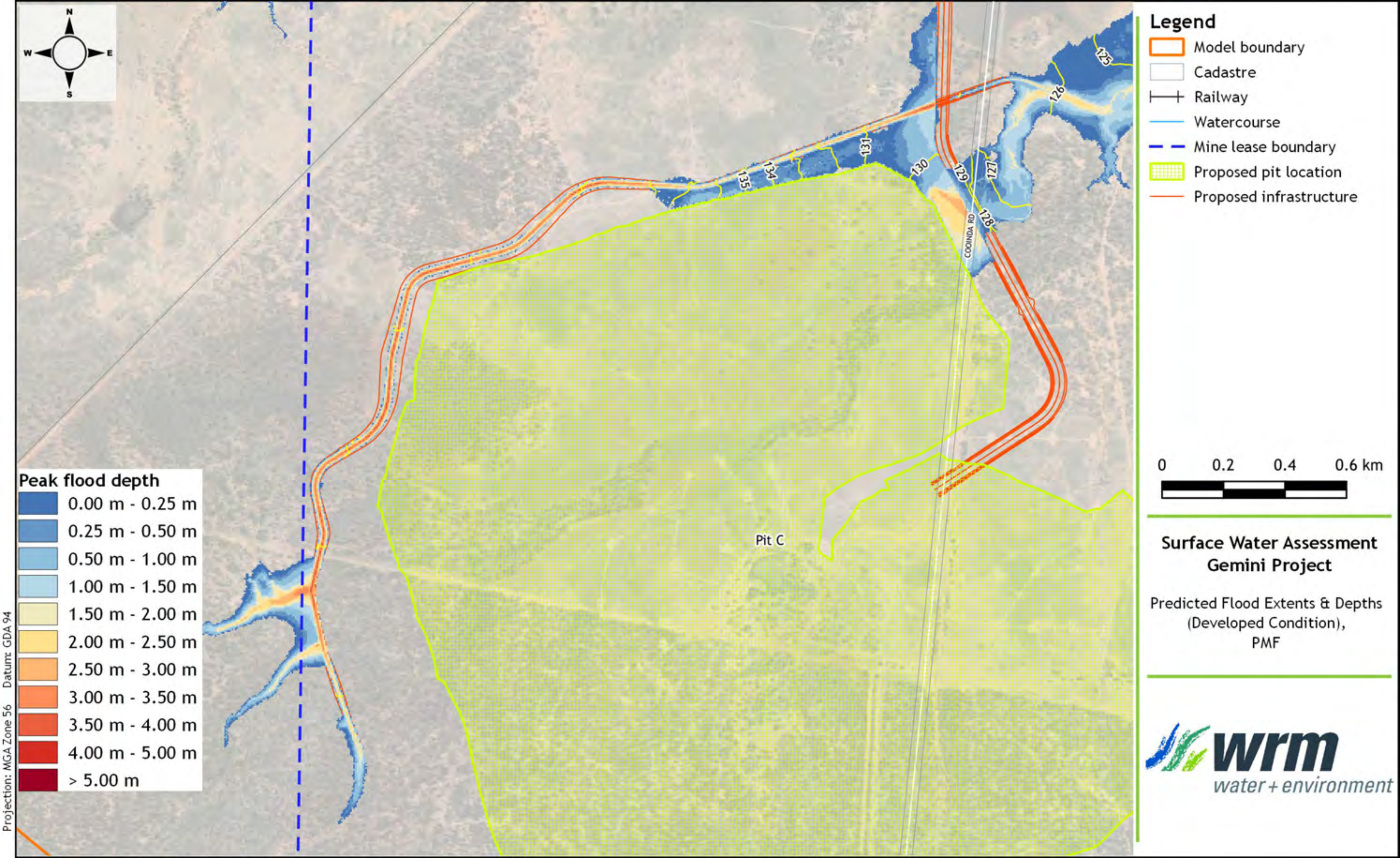
N
S
E
W
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
COOINDA RD
129
Pit C
0
0.2
0.4
0.6 km
Peak flood depth
0.00 m - 0.25 m
0.25 m - 0.50 m
0.50 m - 1.00 m
1.00 m - 1.50 m
1.50 m - 2.00 m
2.00 m - 2.50 m
2.50 m - 3.00 m
3.00 m - 3.50 m
3.50 m - 4.00 m
4.00 m - 5.00 m
> 5.00 m
Projection: MGA Zone 56
Datum: GDA 94
Surface Water Assessment
Gemini Project
Predicted Flood Extents & Depths
(Developed Condition),
2% AEP
wrm
water + environment

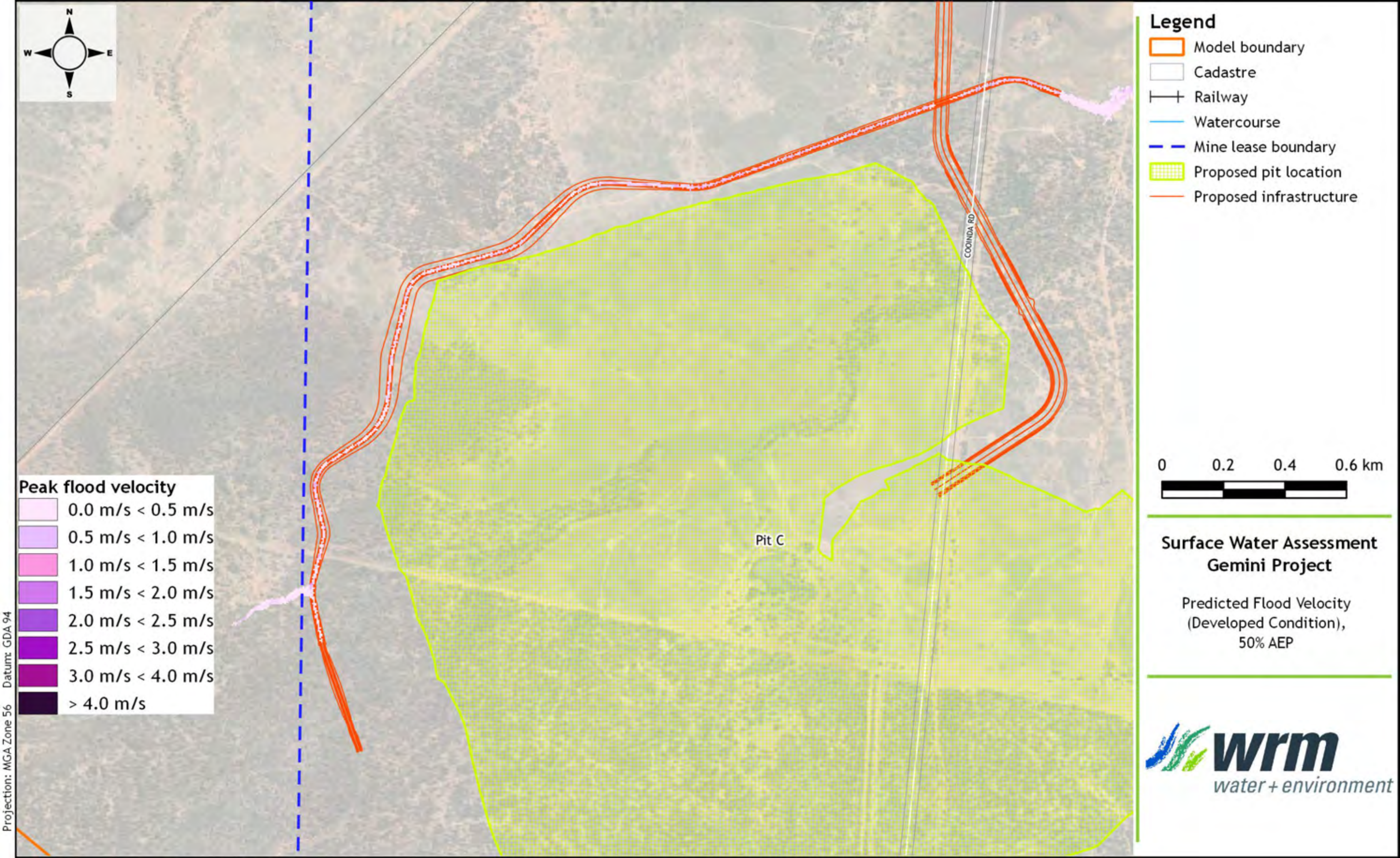


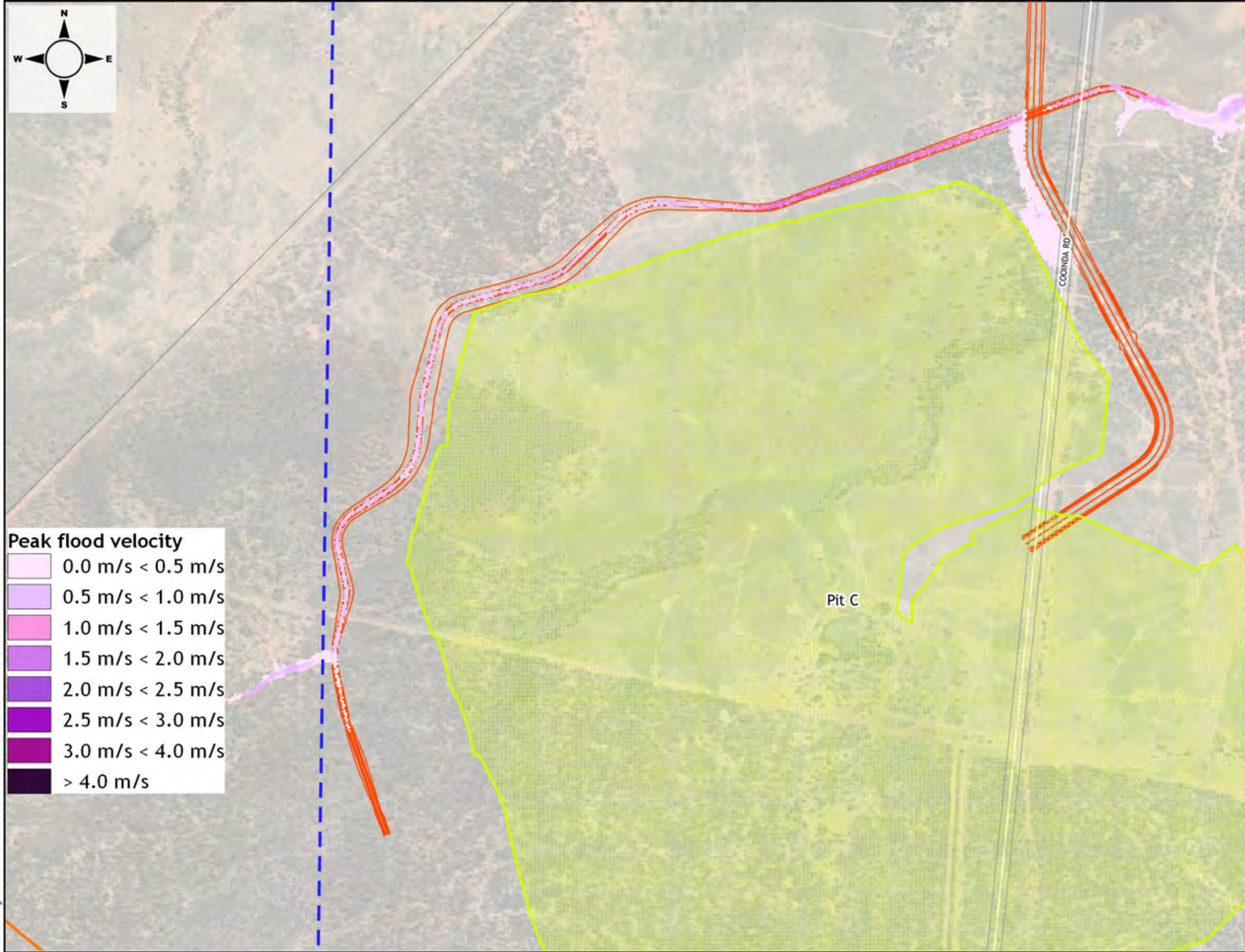
N
W
E
S
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
COOINDA RD
129
Pit C
0
0.2
0.4
0.6 km
Peak flood depth
0.00 m - 0.25 m
0.25 m - 0.50 m
0.50 m - 1.00 m
1.00 m - 1.50 m
1.50 m - 2.00 m
2.00 m - 2.50 m
2.50 m - 3.00 m
3.00 m - 3.50 m
3.50 m - 4.00 m
4.00 m - 5.00 m
> 5.00 m
Projection: MGA Zone 56 Datum: GDA 94
Surface Water Assessment
Gemini Project
Predicted Flood Extents & Depths
(Developed Condition),
1% AEP
wrm
water + environment



N
E
S
W
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
128
COOINDA RD
Pit C
0 0.2 0.4 0.6 km
Peak flood depth
0.00 m - 0.25 m
0.25 m - 0.50 m
0.50 m - 1.00 m
1.00 m - 1.50 m
1.50 m - 2.00 m
2.00 m - 2.50 m
2.50 m - 3.00 m
3.00 m - 3.50 m
3.50 m - 4.00 m
4.00 m - 5.00 m
> 5.00 m
Projection: MGA Zone 56 Datum: GDA 94
Surface Water Assessment
Gemini Project
Predicted Flood Extents & Depths
(Developed Condition),
0.1% AEP
wrm
water + environment

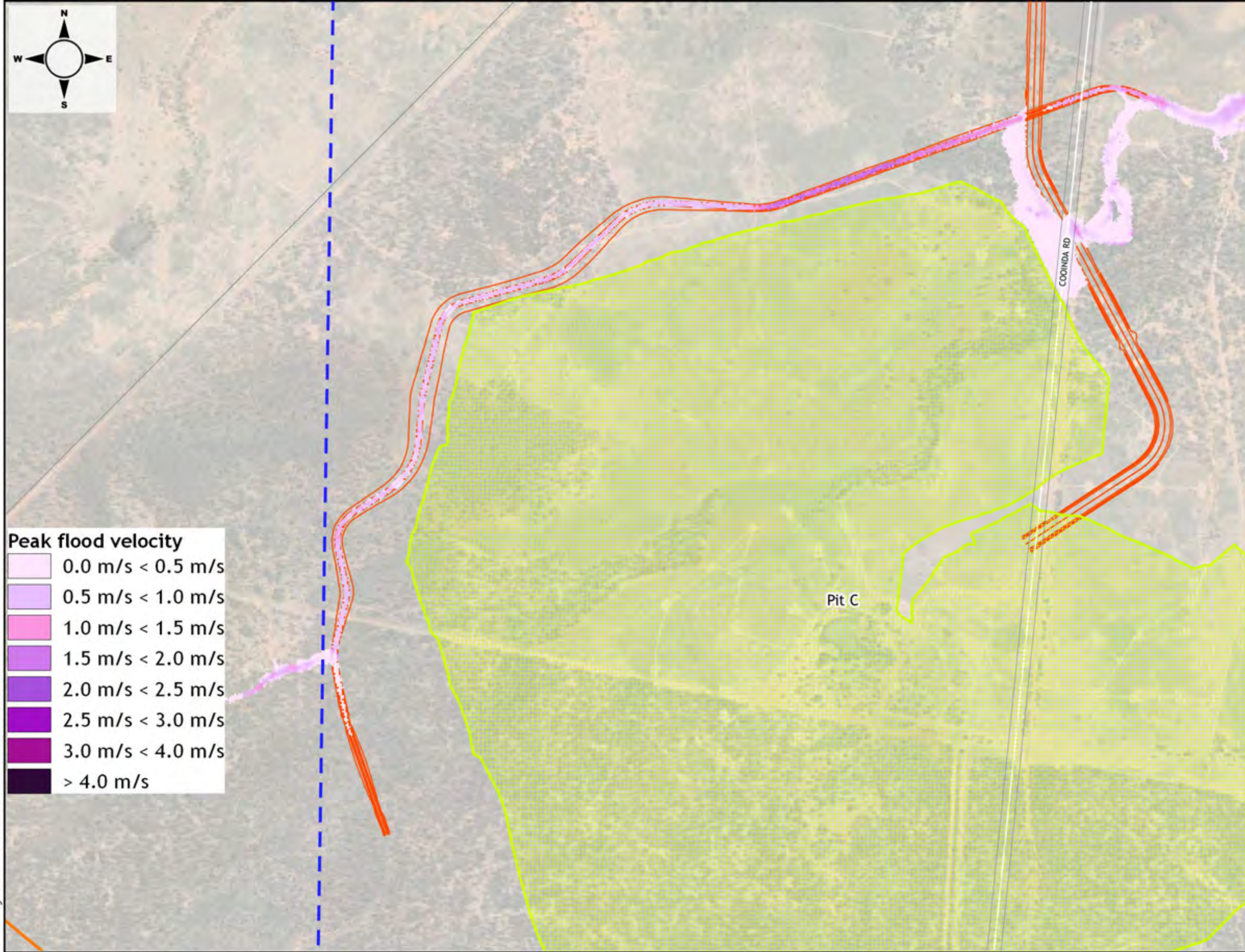

N
W
E
S
125
126
127
128
129
130
131
134
135
COOINDA RD
Pit C
Peak flood depth
0.00 m - 0.25 m
0.25 m - 0.50 m
0.50 m - 1.00 m
1.00 m - 1.50 m
1.50 m - 2.00 m
2.00 m - 2.50 m
2.50 m - 3.00 m
3.00 m - 3.50 m
3.50 m - 4.00 m
4.00 m - 5.00 m
> 5.00 m
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
0
0.2
0.4
0.6 km
Surface Water Assessment
Gemini Project
Predicted Flood Extents & Depths
(Developed Condition),
PMF
wrm
water + environment
Projection: MGA Zone 56
Datum: GDA 94


N
S
W
E
Peak flood velocity
0.0 m/s < 0.5 m/s
0.5 m/s < 1.0 m/s
1.0 m/s < 1.5 m/s
1.5 m/s < 2.0 m/s
2.0 m/s < 2.5 m/s
2.5 m/s < 3.0 m/s
3.0 m/s < 4.0 m/s
> 4.0 m/s
Pit C
COOINDA RD
Projection: MGA Zone 56 Datum: GDA 94
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
0 0.2 0.4 0.6 km
Surface Water Assessment
Gemini Project
Predicted Flood Velocity
(Developed Condition),
50% AEP
wrm
water + environment



Surface Water Assessment
Gemini Project

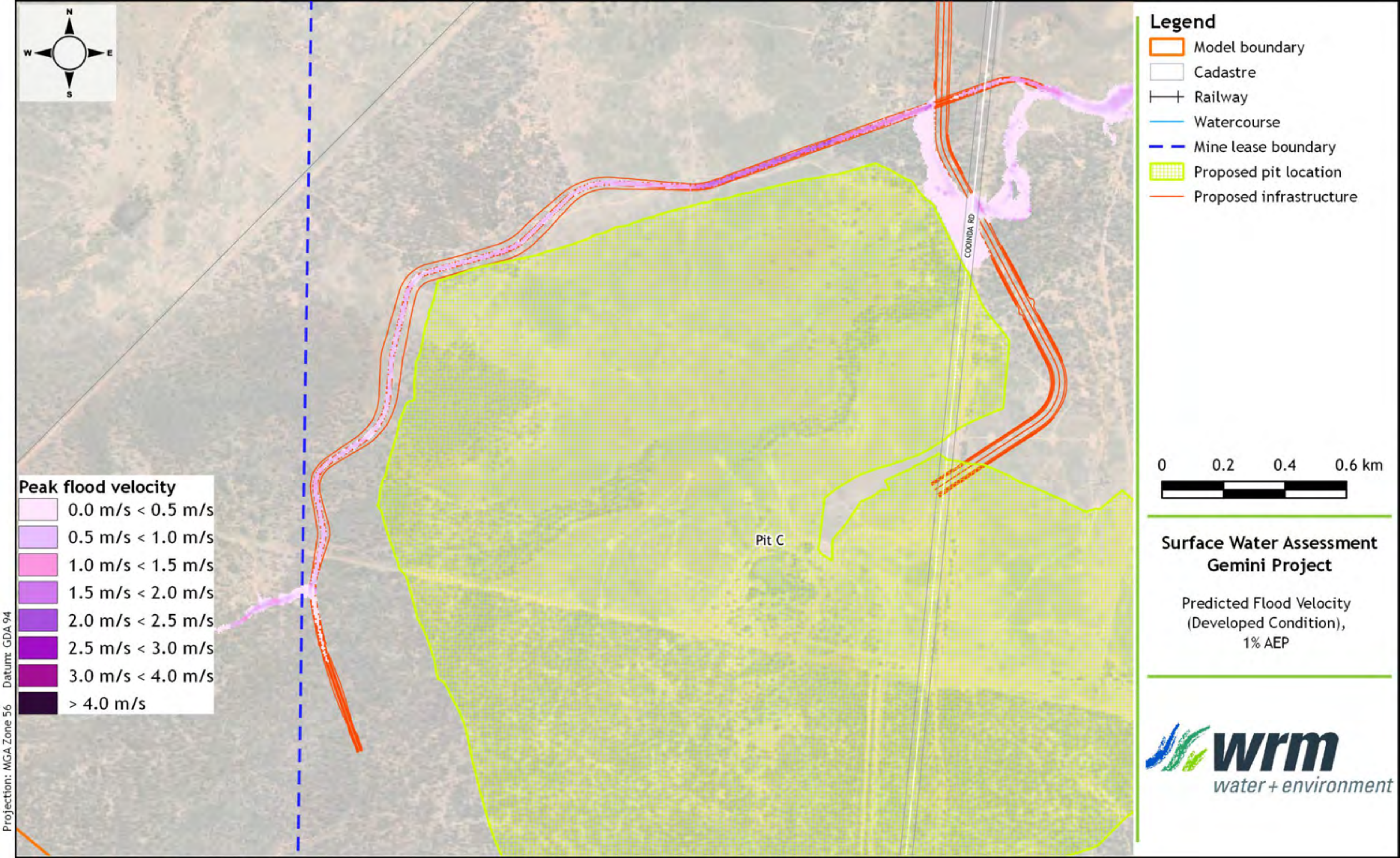
Predicted Flood Velocity
(Developed Condition),
10% AEP



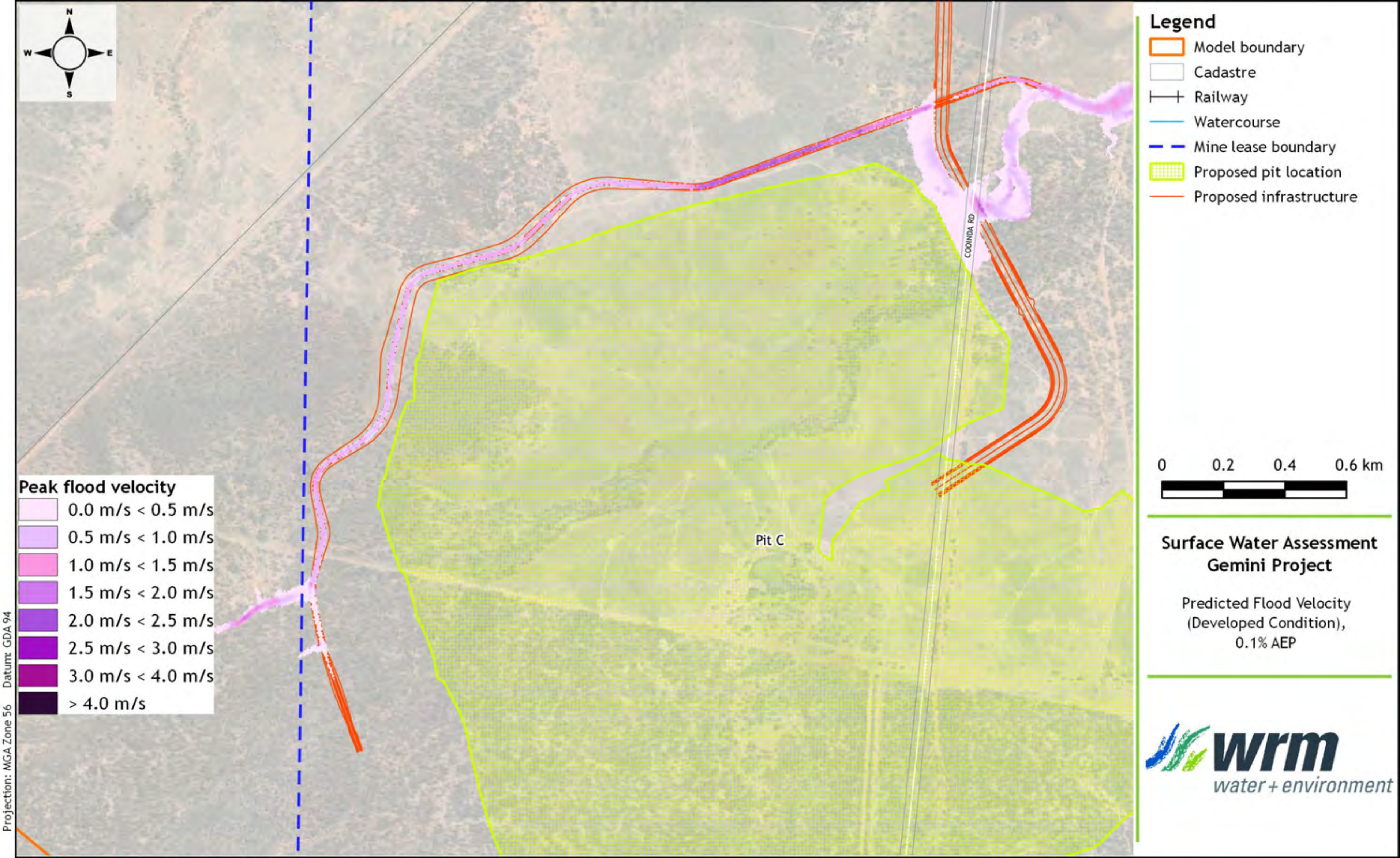
Surface Water Assessment
Gemini Project

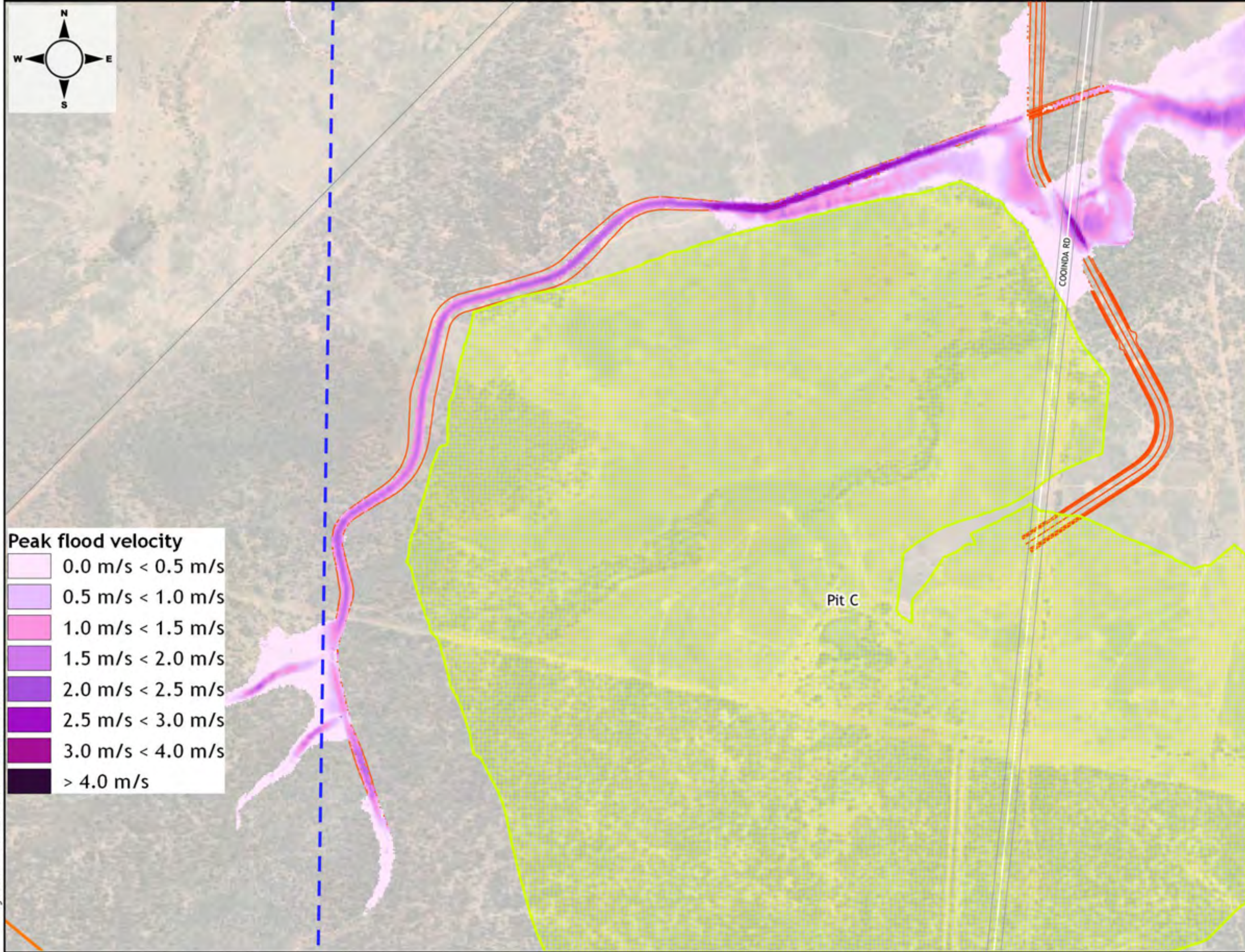
Predicted Flood Velocity
(Developed Condition),
2% AEP

wrm water+environment



N
S
E
W
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
Peak flood velocity
0.0 m/s < 0.5 m/s
0.5 m/s < 1.0 m/s
1.0 m/s < 1.5 m/s
1.5 m/s < 2.0 m/s
2.0 m/s < 2.5 m/s
2.5 m/s < 3.0 m/s
3.0 m/s < 4.0 m/s
> 4.0 m/s
COOINDA RD
Pit C
0
0.2
0.4
0.6 km
Projection: MGA Zone 56
Datum: GDA 94
Surface Water Assessment
Gemini Project
Predicted Flood Velocity
(Developed Condition),
1% AEP
wrm
water + environment


N
S
W
E
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
COOINDA RD
Pit C
Peak flood velocity
0.0 m/s < 0.5 m/s
0.5 m/s < 1.0 m/s
1.0 m/s < 1.5 m/s
1.5 m/s < 2.0 m/s
2.0 m/s < 2.5 m/s
2.5 m/s < 3.0 m/s
3.0 m/s < 4.0 m/s
> 4.0 m/s
0
0.2
0.4
0.6 km
Projection: MGA Zone 56 Datum: GDA 94
Surface Water Assessment
Gemini Project
Predicted Flood Velocity
(Developed Condition),
0.1% AEP
wrm
water + environment



Legend

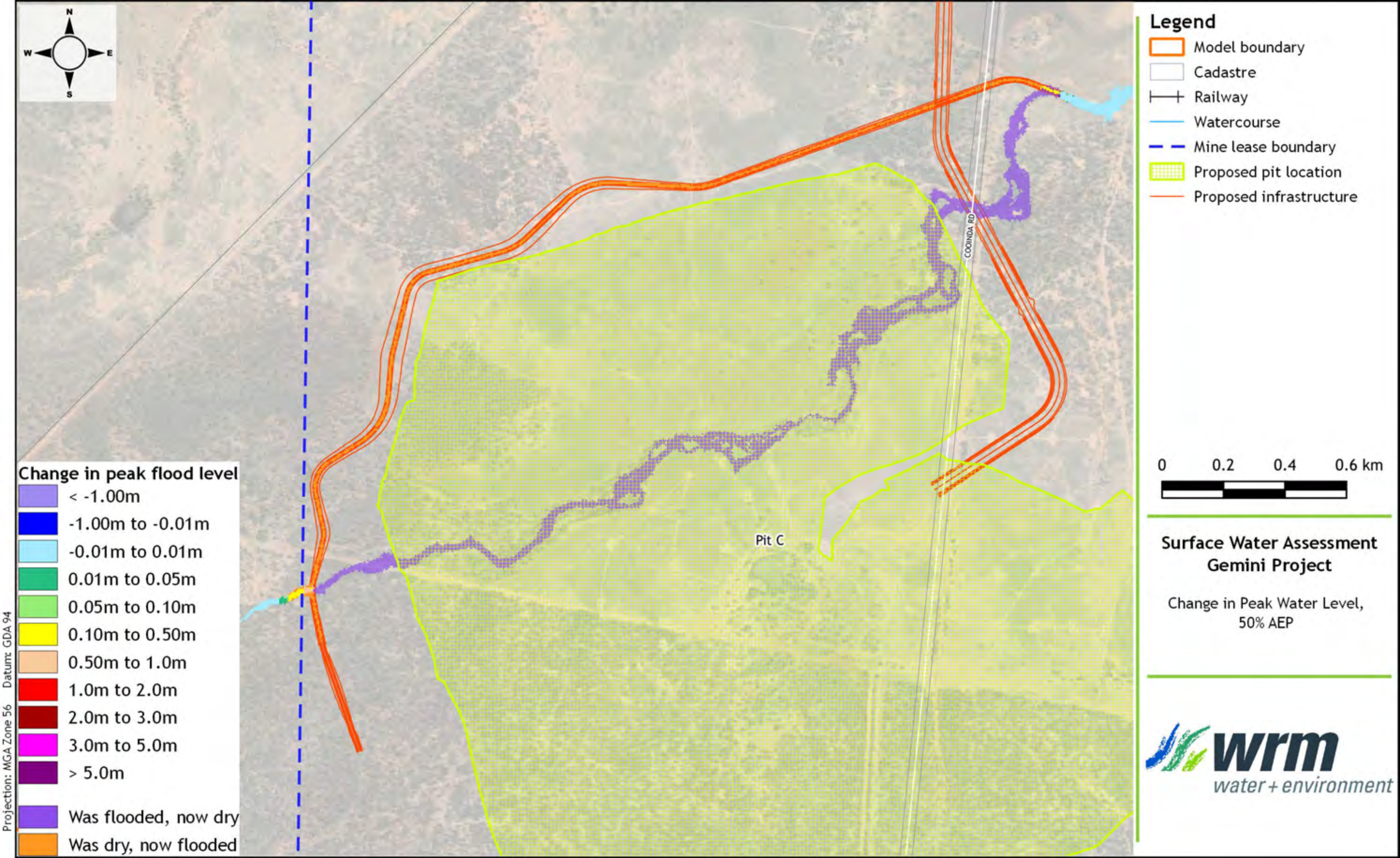
- Model boundary
- Cadastre
- Railway
- Watercourse
- Mine lease boundary
- Proposed pit location
- Proposed infrastructure

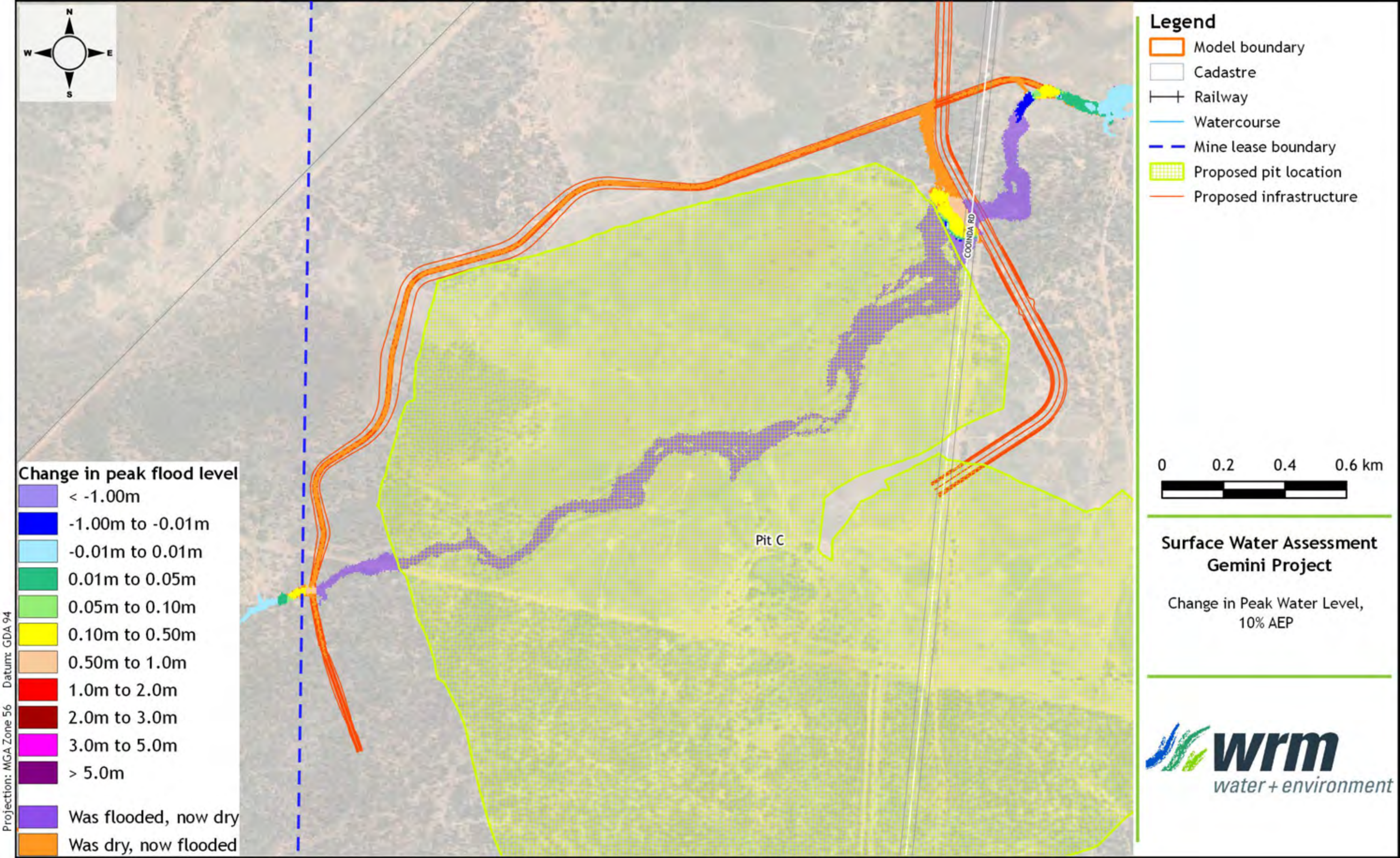
0 0.2 0.4 0.6 km

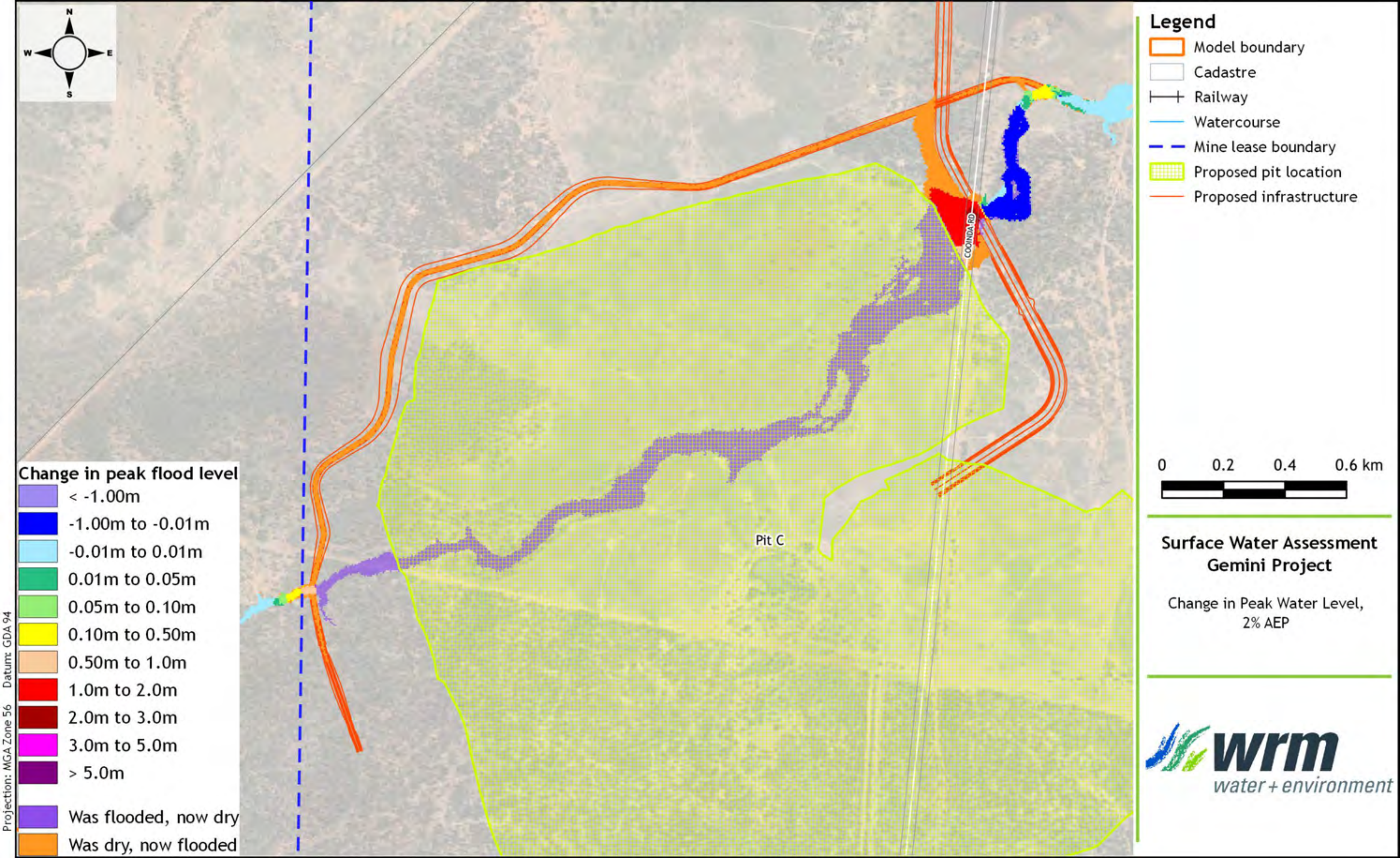
Surface Water Assessment
Gemini Project

Predicted Flood Velocity
(Developed Condition),
PMF

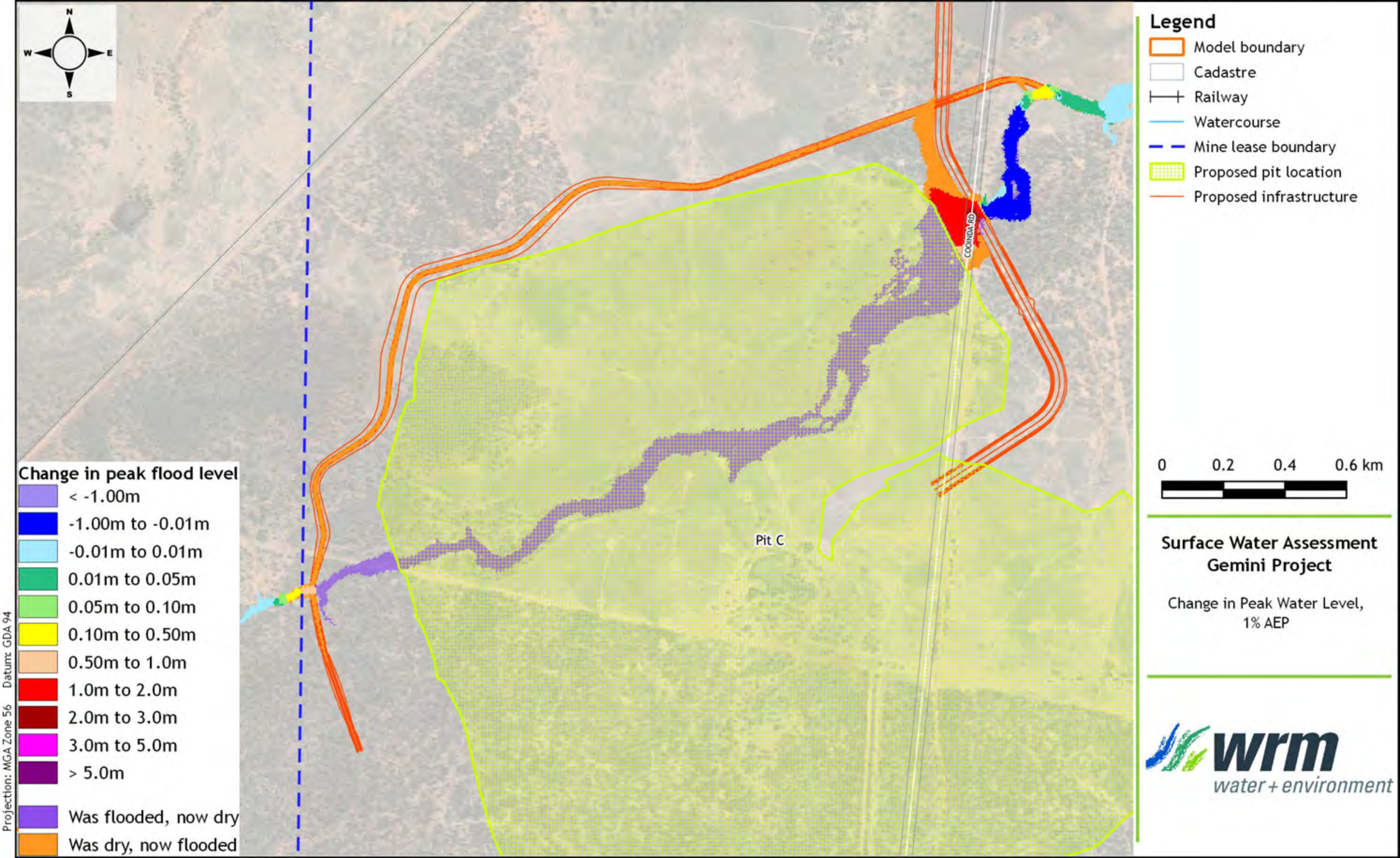
wrm
water + environment

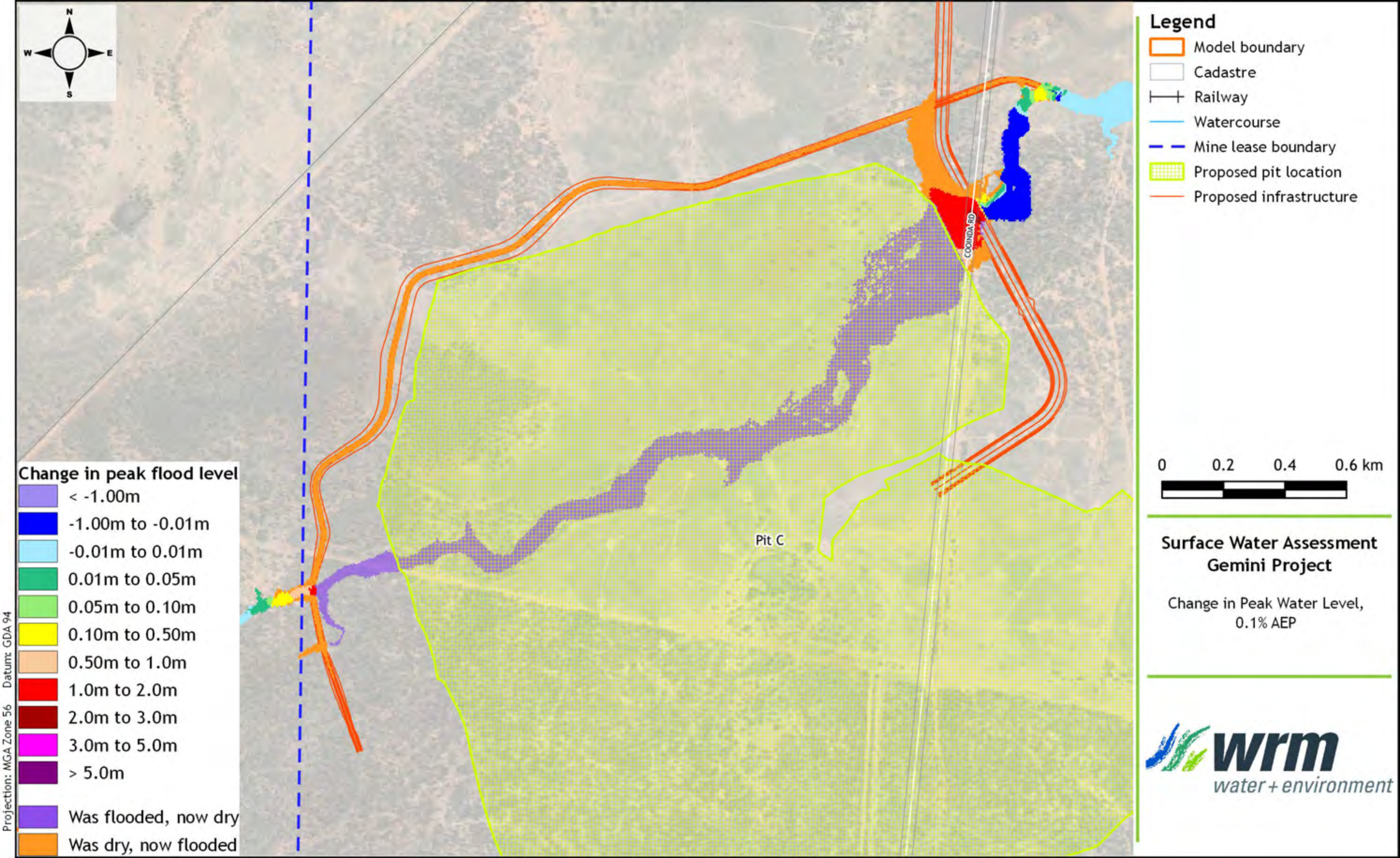

N
S
E
W
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
COOINDA RD
Pit C
0
0.2
0.4
0.6 km
Change in peak flood level
< -1.00m
-1.00m to -0.01m
-0.01m to 0.01m
0.01m to 0.05m
0.05m to 0.10m
0.10m to 0.50m
0.50m to 1.0m
1.0m to 2.0m
2.0m to 3.0m
3.0m to 5.0m
> 5.0m
Was flooded, now dry
Was dry, now flooded
Projection: MGA Zone 56 Datum: GDA 94
Surface Water Assessment
Gemini Project
Change in Peak Water Level,
50% AEP
wrm
water + environment


N
S
E
W
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
COOINDA RD
Pit C
Change in peak flood level
< -1.00m
-1.00m to -0.01m
-0.01m to 0.01m
0.01m to 0.05m
0.05m to 0.10m
0.10m to 0.50m
0.50m to 1.0m
1.0m to 2.0m
2.0m to 3.0m
3.0m to 5.0m
> 5.0m
Was flooded, now dry
Was dry, now flooded
0 0.2 0.4 0.6 km
Projection: MGA Zone 56 Datum: GDA 94
Surface Water Assessment
Gemini Project
Change in Peak Water Level,
10% AEP
wrm
water + environment

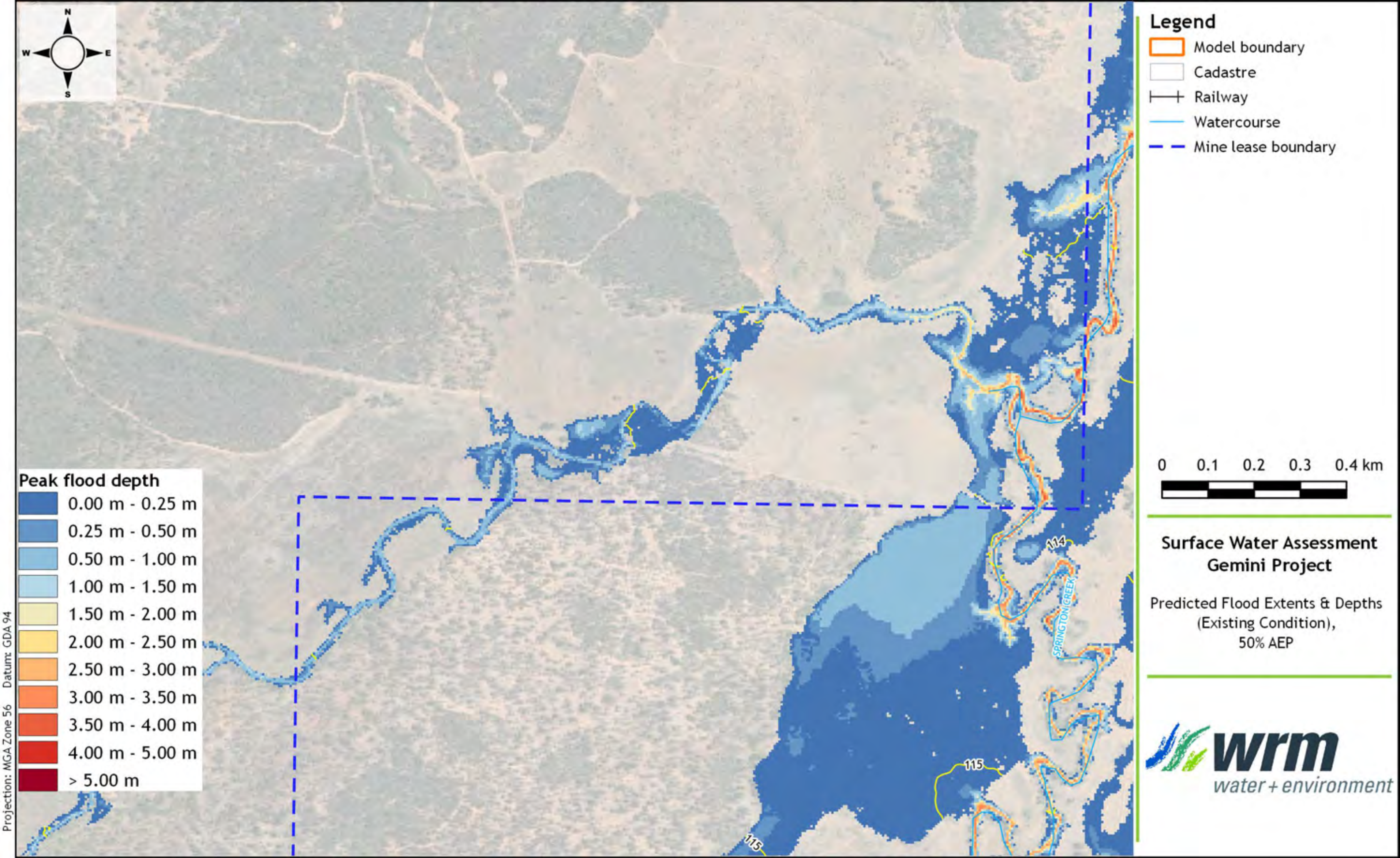


N
S
E
W
Pit C
COOINDA RD
Change in peak flood level
< -1.00m
-1.00m to -0.01m
-0.01m to 0.01m
0.01m to 0.05m
0.05m to 0.10m
0.10m to 0.50m
0.50m to 1.0m
1.0m to 2.0m
2.0m to 3.0m
3.0m to 5.0m
> 5.0m
Was flooded, now dry
Was dry, now flooded
Projection: MGA Zone 56
Datum: GDA 94
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
0
0.2
0.4
0.6 km
Surface Water Assessment
Gemini Project
Change in Peak Water Level,
2% AEP
wrm
water + environment

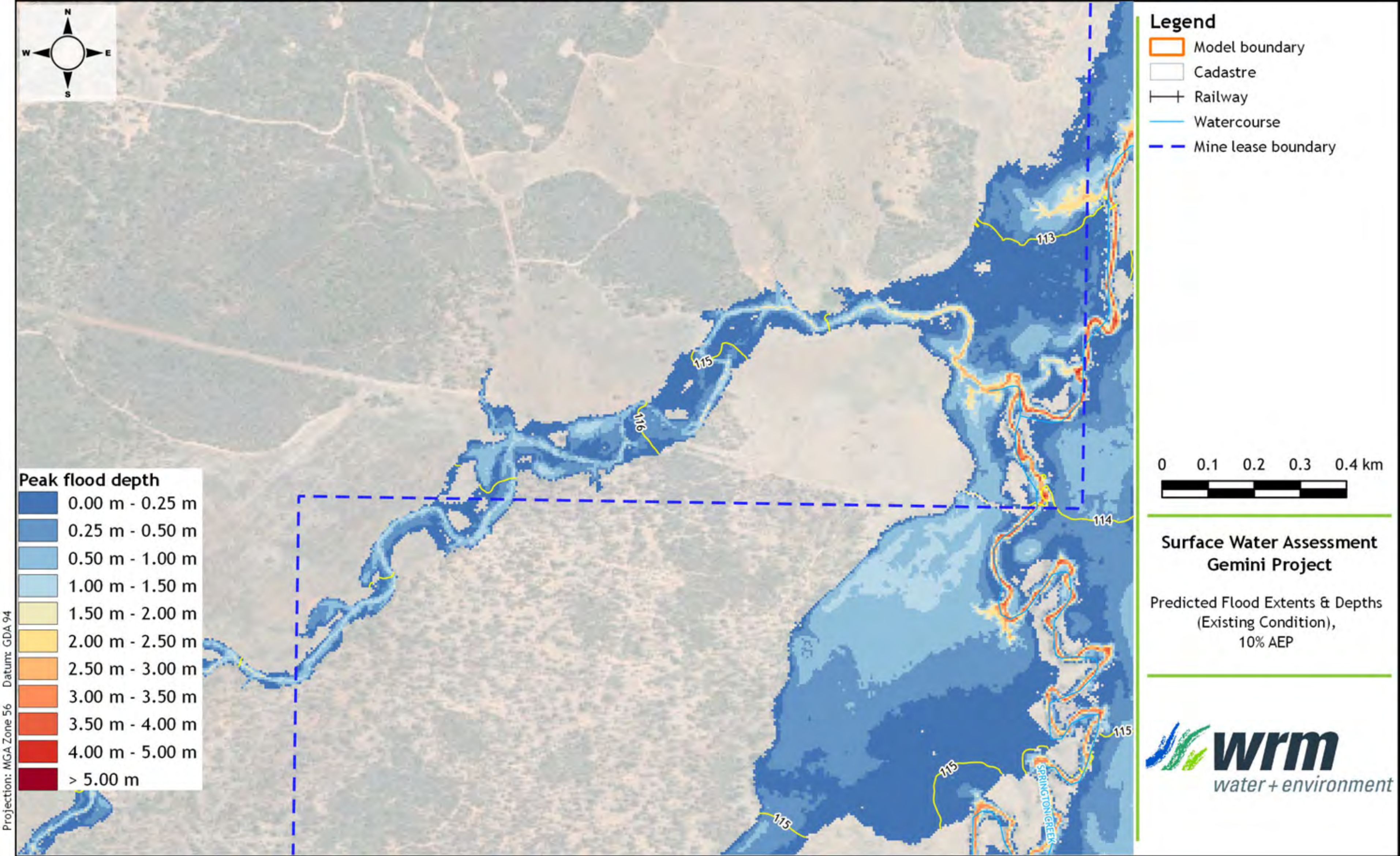

N
E
S
W
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
0
0.2
0.4
0.6 km
Surface Water Assessment
Gemini Project
Change in Peak Water Level,
1% AEP
wrm
water + environment
Change in peak flood level
< -1.00m
-1.00m to -0.01m
-0.01m to 0.01m
0.01m to 0.05m
0.05m to 0.10m
0.10m to 0.50m
0.50m to 1.0m
1.0m to 2.0m
2.0m to 3.0m
3.0m to 5.0m
> 5.0m
Was flooded, now dry
Was dry, now flooded
Pit C
COOINDA RD
Projection: MGA Zone 56
Datum: GDA 94



N
S
E
W
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
COOINDA RD
Pit C
0
0.2
0.4
0.6 km
Change in peak flood level
< -1.00m
-1.00m to -0.01m
-0.01m to 0.01m
0.01m to 0.05m
0.05m to 0.10m
0.10m to 0.50m
0.50m to 1.0m
1.0m to 2.0m
2.0m to 3.0m
3.0m to 5.0m
> 5.0m
Was flooded, now dry
Was dry, now flooded
Projection: MGA Zone 56
Datum: GDA 94
Surface Water Assessment
Gemini Project
Change in Peak Water Level,
0.1% AEP
wrm
water+environment



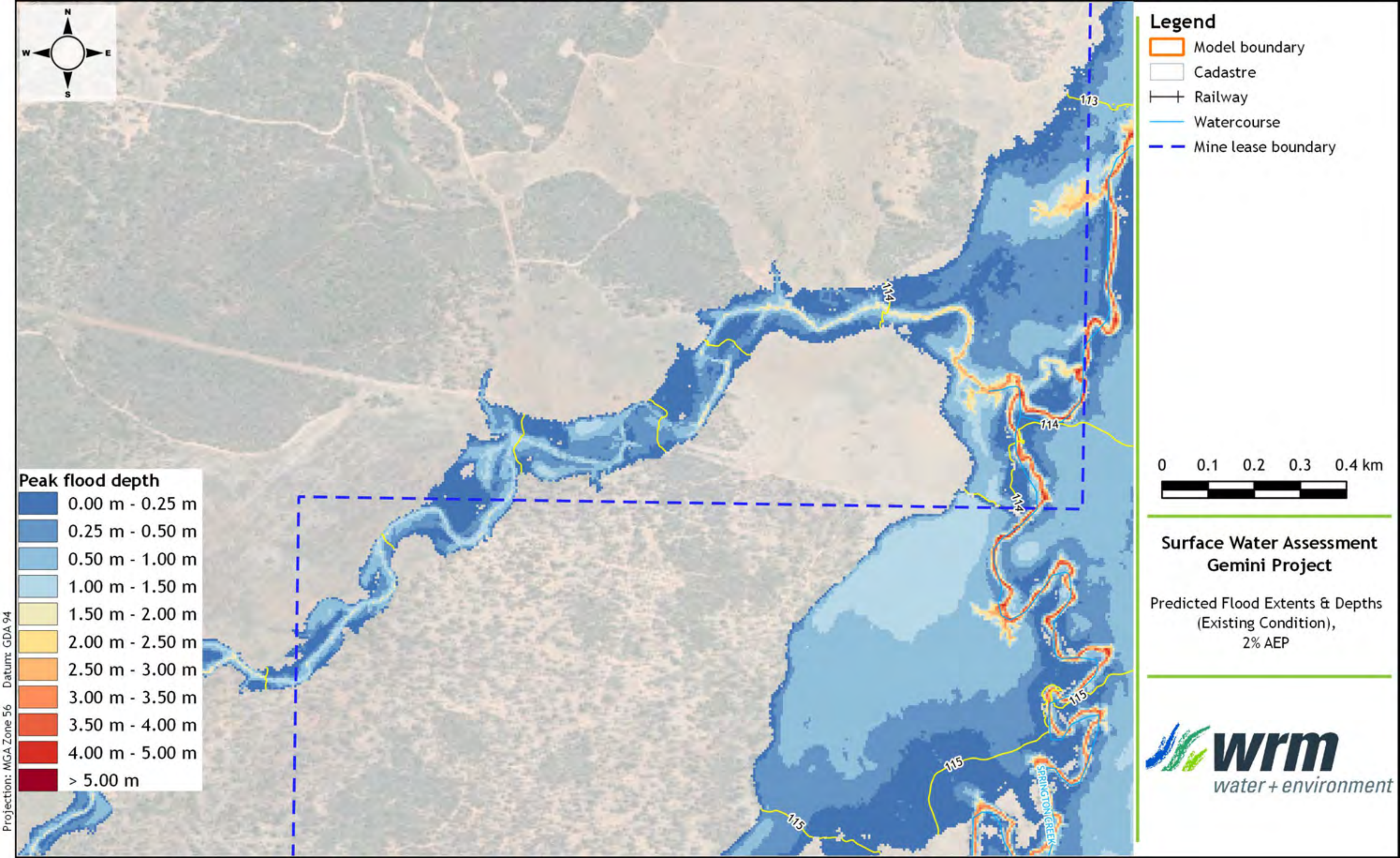
N
W
E
S
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Peak flood depth
0.00 m - 0.25 m
0.25 m - 0.50 m
0.50 m - 1.00 m
1.00 m - 1.50 m
1.50 m - 2.00 m
2.00 m - 2.50 m
2.50 m - 3.00 m
3.00 m - 3.50 m
3.50 m - 4.00 m
4.00 m - 5.00 m
> 5.00 m
0 0.1 0.2 0.3 0.4 km
114
115
115
SPRINGTON CREEK
Projection: MGA Zone 56 Datum: GDA 94
Surface Water Assessment
Gemini Project
Predicted Flood Extents & Depths (Existing Condition), 50% AEP
wrm
water + environment



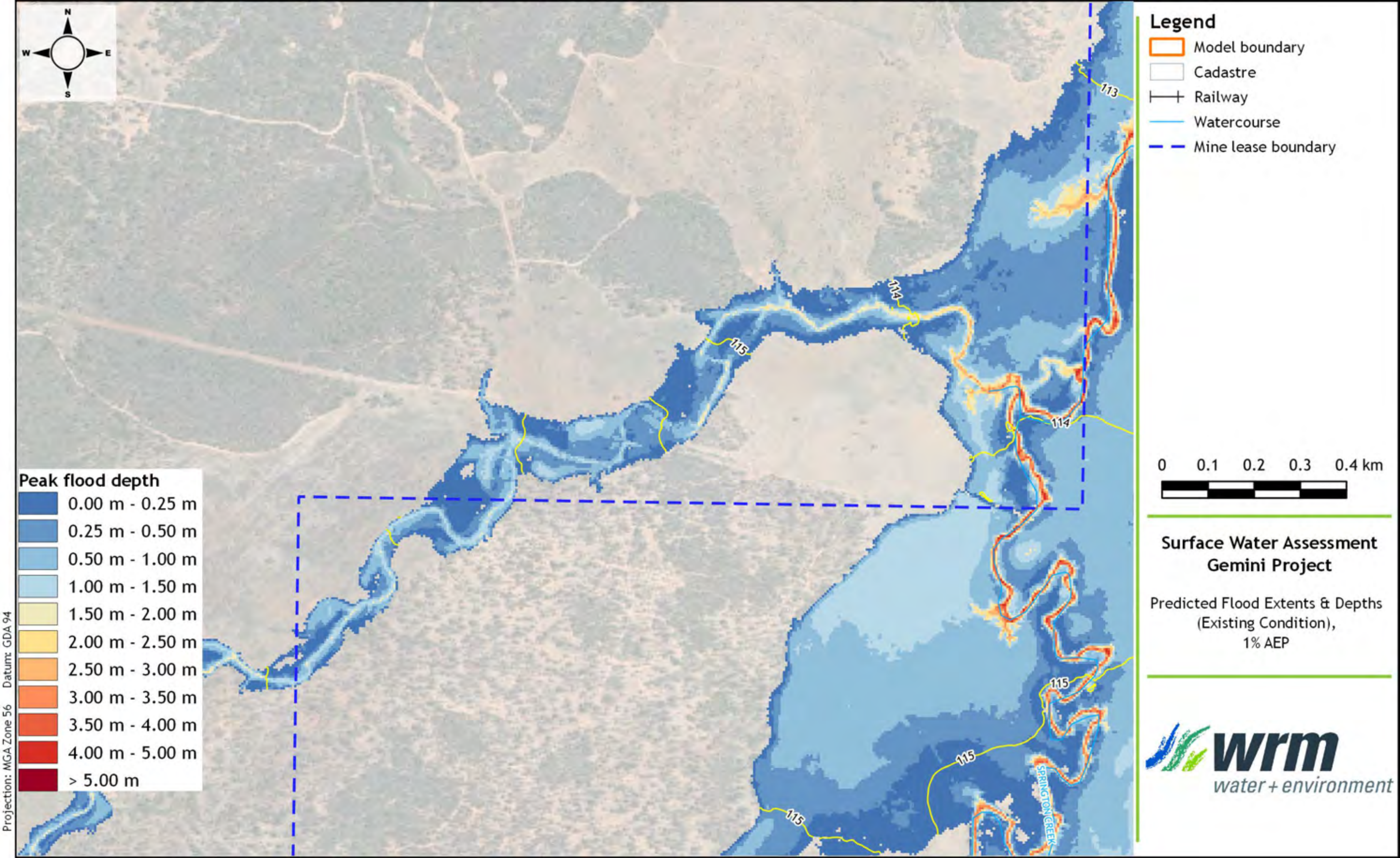
Surface Water Assessment
Gemini Project

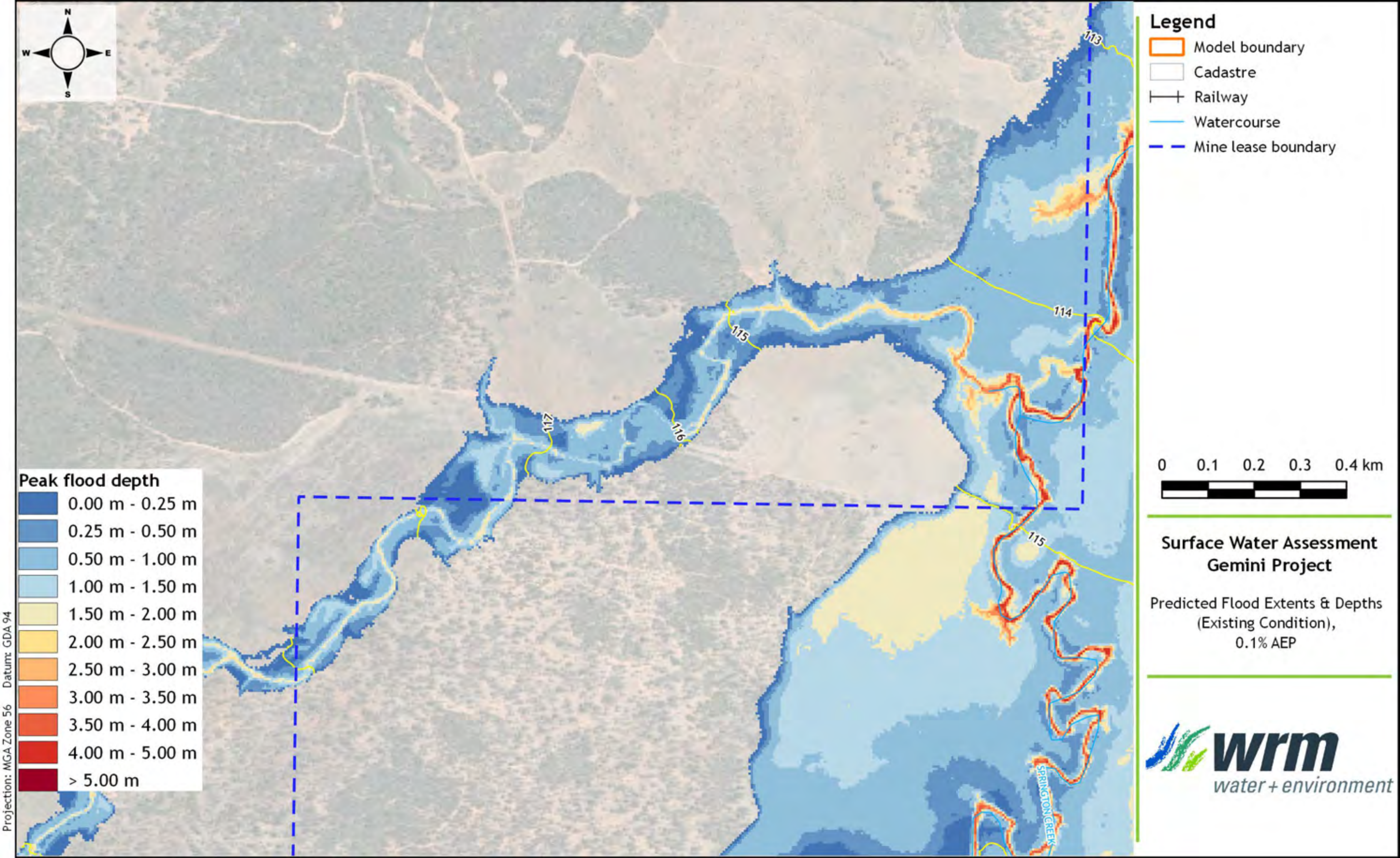
Predicted Flood Extents & Depths (Existing Condition), 10% AEP

wrm water + environment

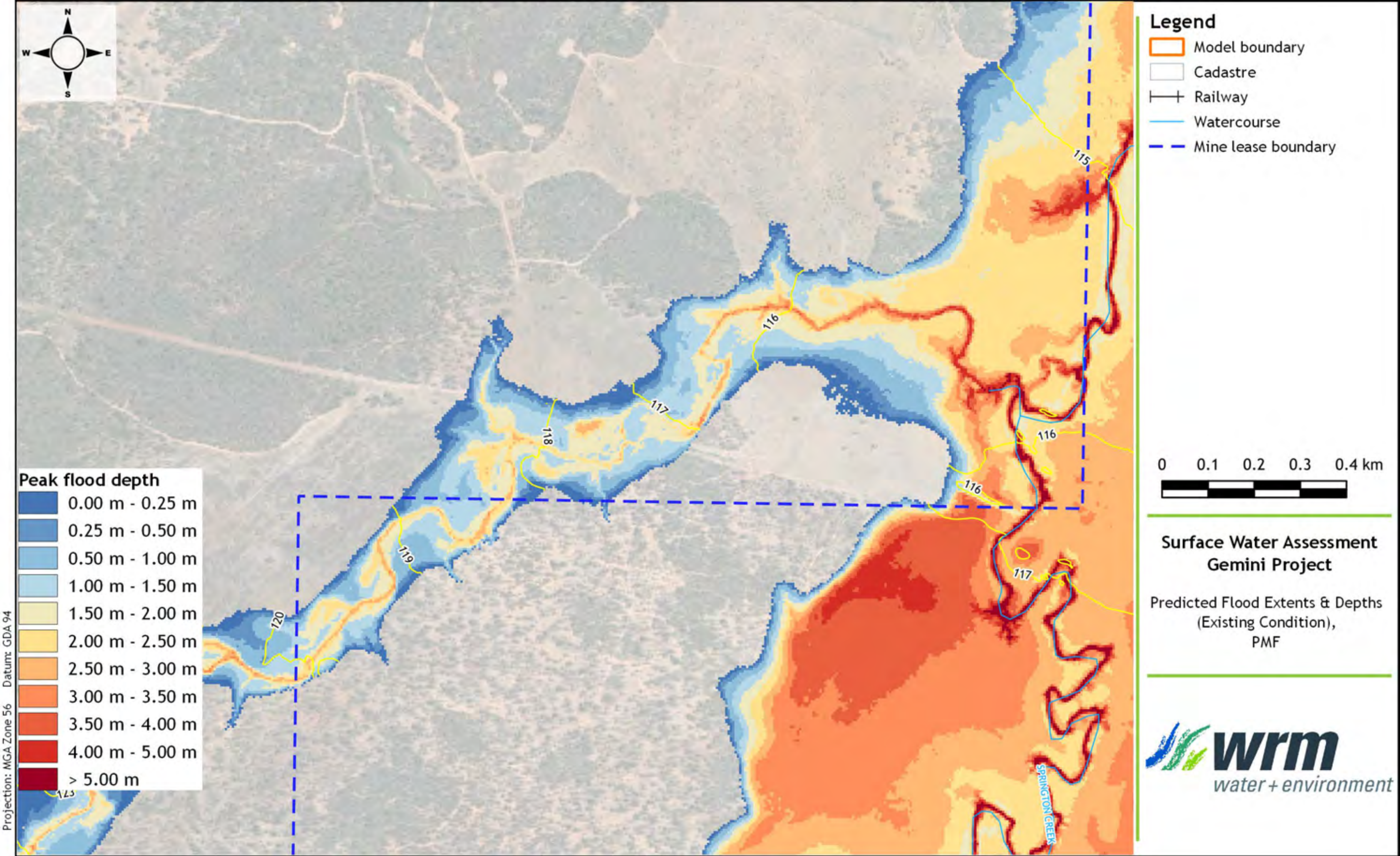


N
W
E
S
113
114
114
114
114
115
115
115
SPRINGTON CREEK
Peak flood depth
0.00 m - 0.25 m
0.25 m - 0.50 m
0.50 m - 1.00 m
1.00 m - 1.50 m
1.50 m - 2.00 m
2.00 m - 2.50 m
2.50 m - 3.00 m
3.00 m - 3.50 m
3.50 m - 4.00 m
4.00 m - 5.00 m
> 5.00 m
Projection: MGA Zone 56 Datum: GDA 94
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
0 0.1 0.2 0.3 0.4 km
Surface Water Assessment
Gemini Project
Predicted Flood Extents & Depths
(Existing Condition),
2% AEP
wrm
water + environment

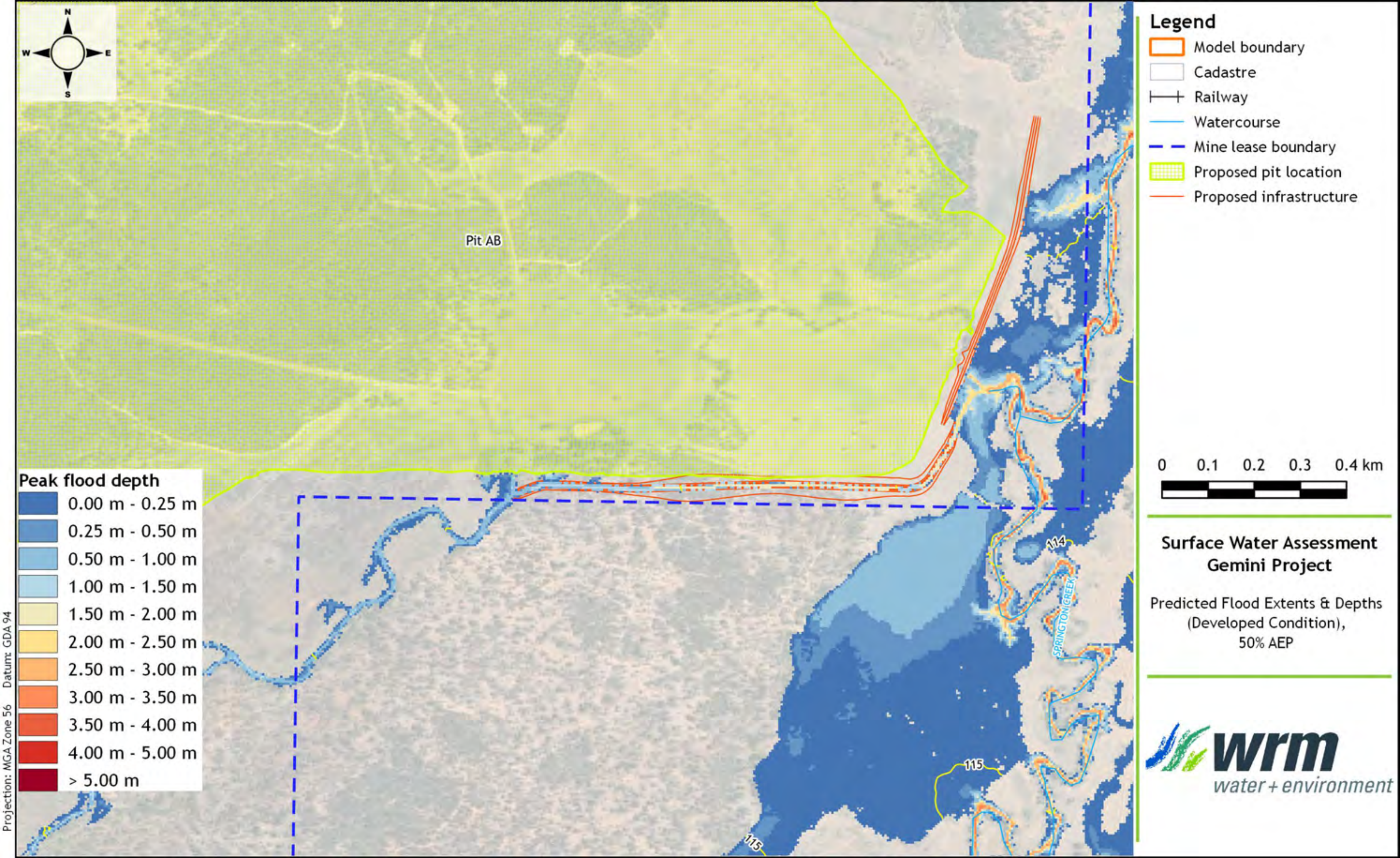

N
W
E
S
113
114
115
114
115
115
115
SPRINGTON CREEK
Peak flood depth
0.00 m - 0.25 m
0.25 m - 0.50 m
0.50 m - 1.00 m
1.00 m - 1.50 m
1.50 m - 2.00 m
2.00 m - 2.50 m
2.50 m - 3.00 m
3.00 m - 3.50 m
3.50 m - 4.00 m
4.00 m - 5.00 m
> 5.00 m
Projection: MGA Zone 56 Datum: GDA 94
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
0 0.1 0.2 0.3 0.4 km
Surface Water Assessment
Gemini Project
Predicted Flood Extents & Depths
(Existing Condition),
1% AEP
wrm
water + environment



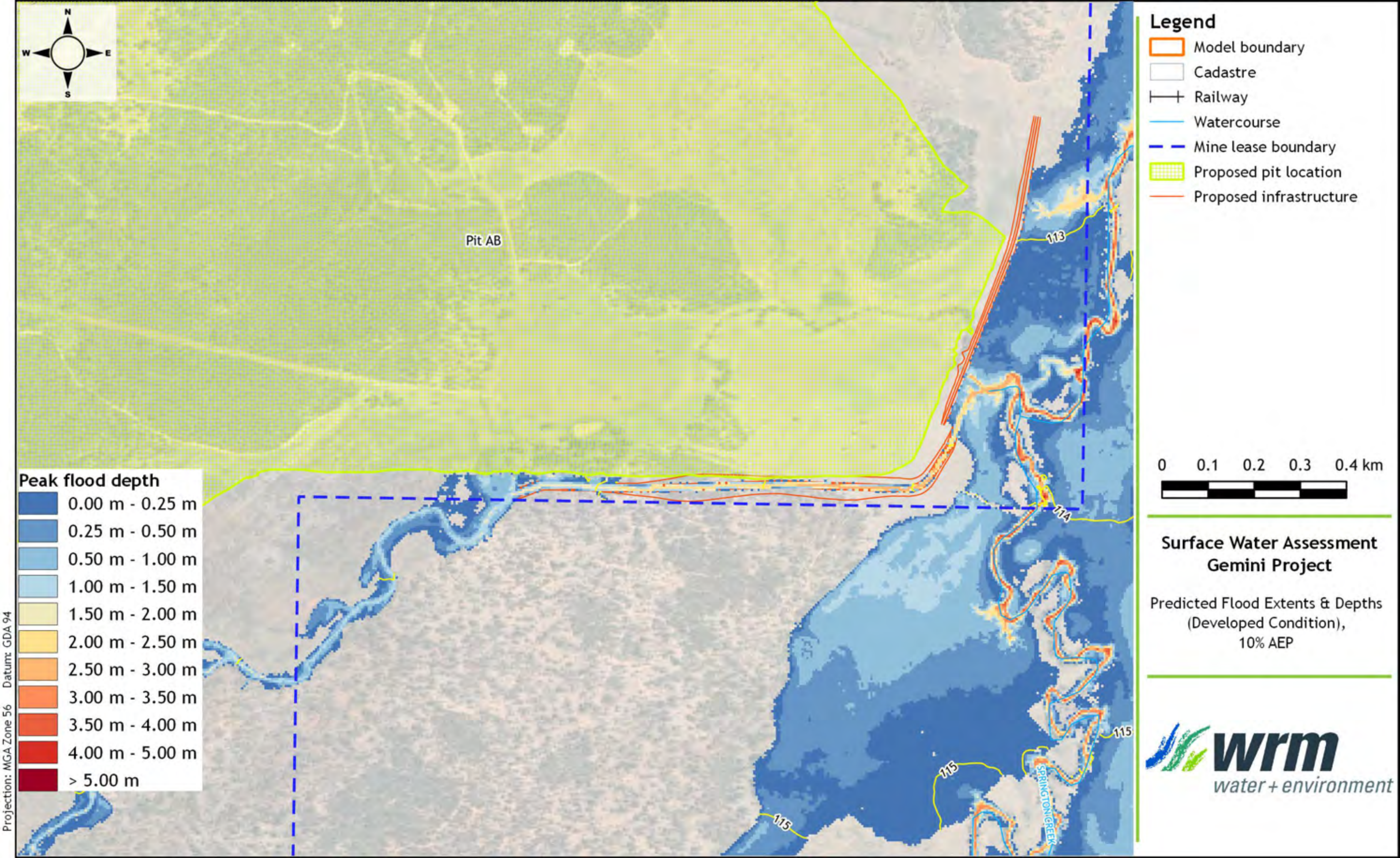
N
W
E
S
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
113
114
115
116
117
115
SPRINGTON CREEK
Peak flood depth
0.00 m - 0.25 m
0.25 m - 0.50 m
0.50 m - 1.00 m
1.00 m - 1.50 m
1.50 m - 2.00 m
2.00 m - 2.50 m
2.50 m - 3.00 m
3.00 m - 3.50 m
3.50 m - 4.00 m
4.00 m - 5.00 m
> 5.00 m
0 0.1 0.2 0.3 0.4 km
Projection: MGA Zone 56 Datum: GDA 94
Surface Water Assessment
Gemini Project
Predicted Flood Extents & Depths
(Existing Condition),
0.1% AEP
wrm
water + environment



N
W
E
S
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
0 0.1 0.2 0.3 0.4 km
Peak flood depth
0.00 m - 0.25 m
0.25 m - 0.50 m
0.50 m - 1.00 m
1.00 m - 1.50 m
1.50 m - 2.00 m
2.00 m - 2.50 m
2.50 m - 3.00 m
3.00 m - 3.50 m
3.50 m - 4.00 m
4.00 m - 5.00 m
> 5.00 m
115
116
117
118
119
120
123
SPRINGTON CREEK
Projection: MGA Zone 56 Datum: GDA 94
Surface Water Assessment
Gemini Project
Predicted Flood Extents & Depths
(Existing Condition),
PMF
wrm
water + environment

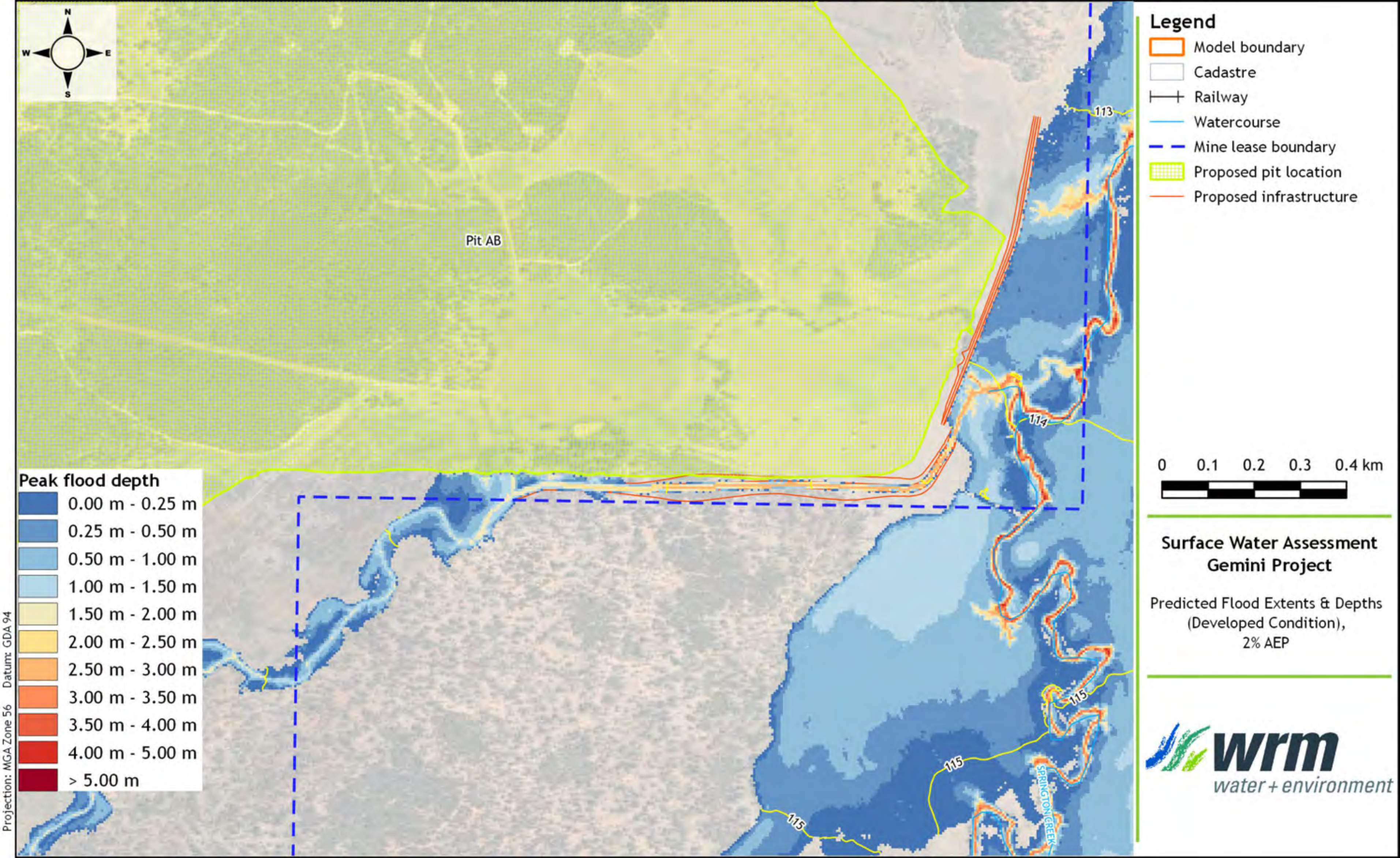


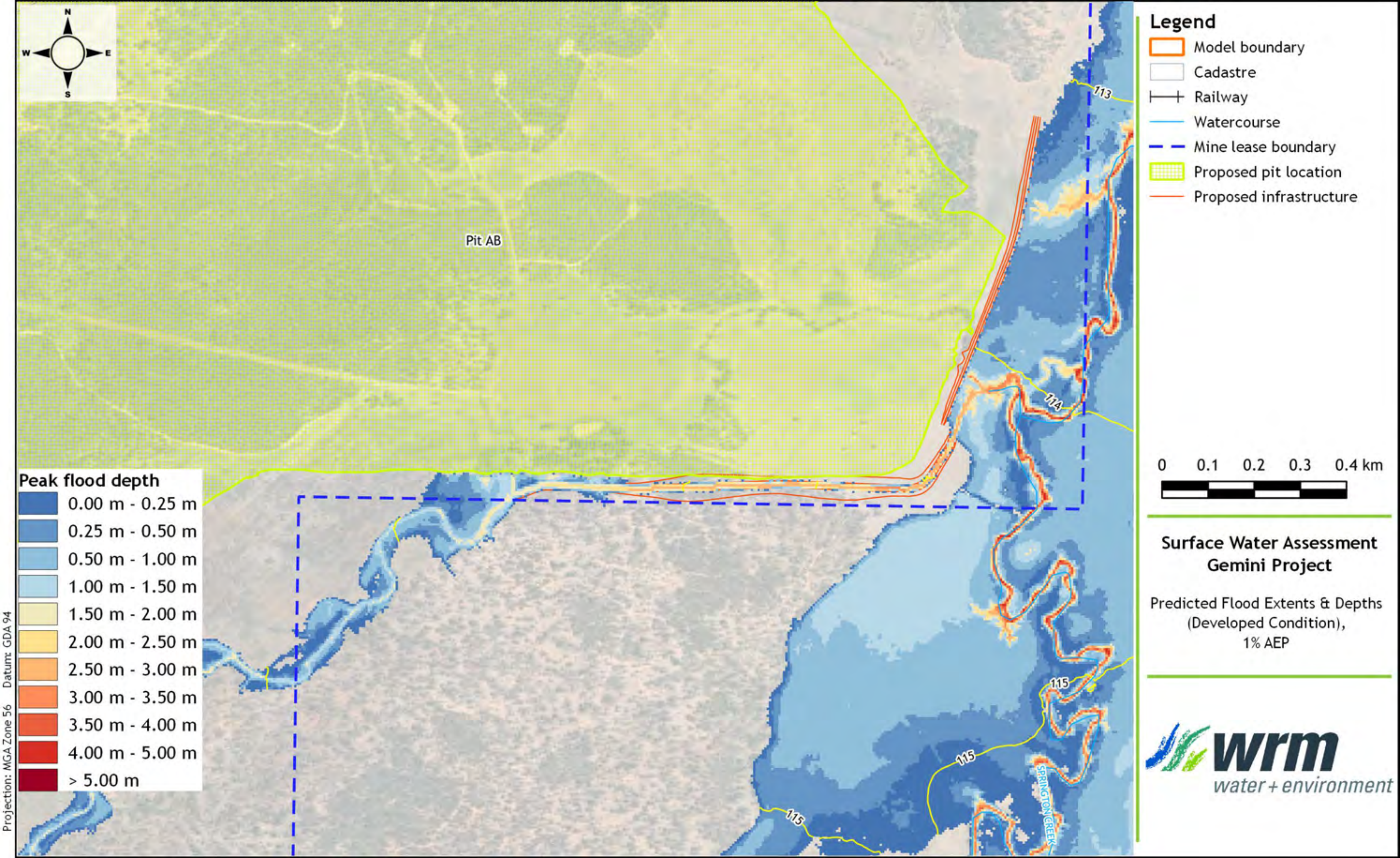
N
S
E
W
Pit AB
114
115
115
SPRINGTON CREEK
Peak flood depth
0.00 m - 0.25 m
0.25 m - 0.50 m
0.50 m - 1.00 m
1.00 m - 1.50 m
1.50 m - 2.00 m
2.00 m - 2.50 m
2.50 m - 3.00 m
3.00 m - 3.50 m
3.50 m - 4.00 m
4.00 m - 5.00 m
> 5.00 m
Projection: MGA Zone 56 Datum: GDA 94
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
0 0.1 0.2 0.3 0.4 km
Surface Water Assessment
Gemini Project
Predicted Flood Extents & Depths
(Developed Condition),
50% AEP
wrm
water + environment



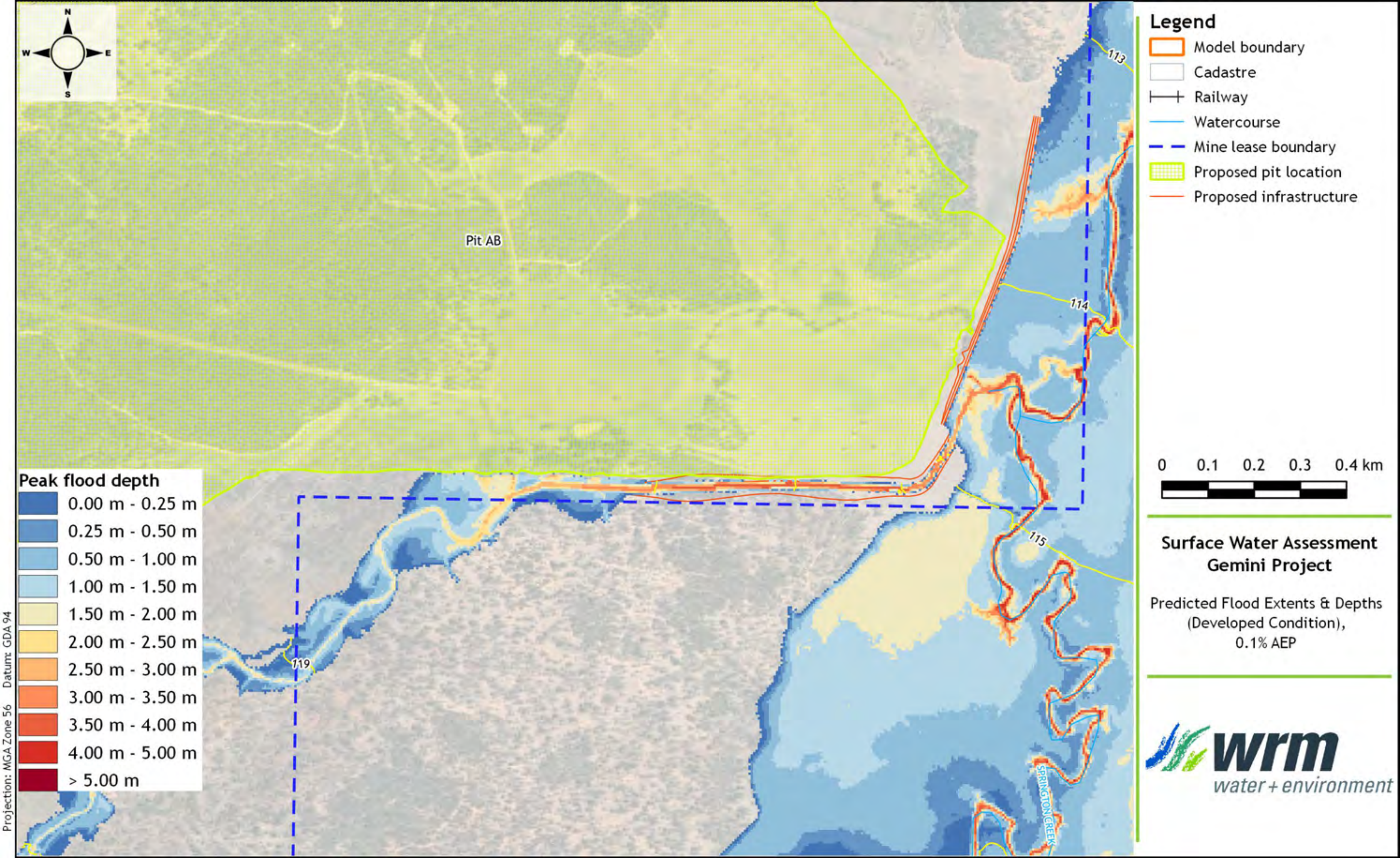
Surface Water Assessment
Gemini Project

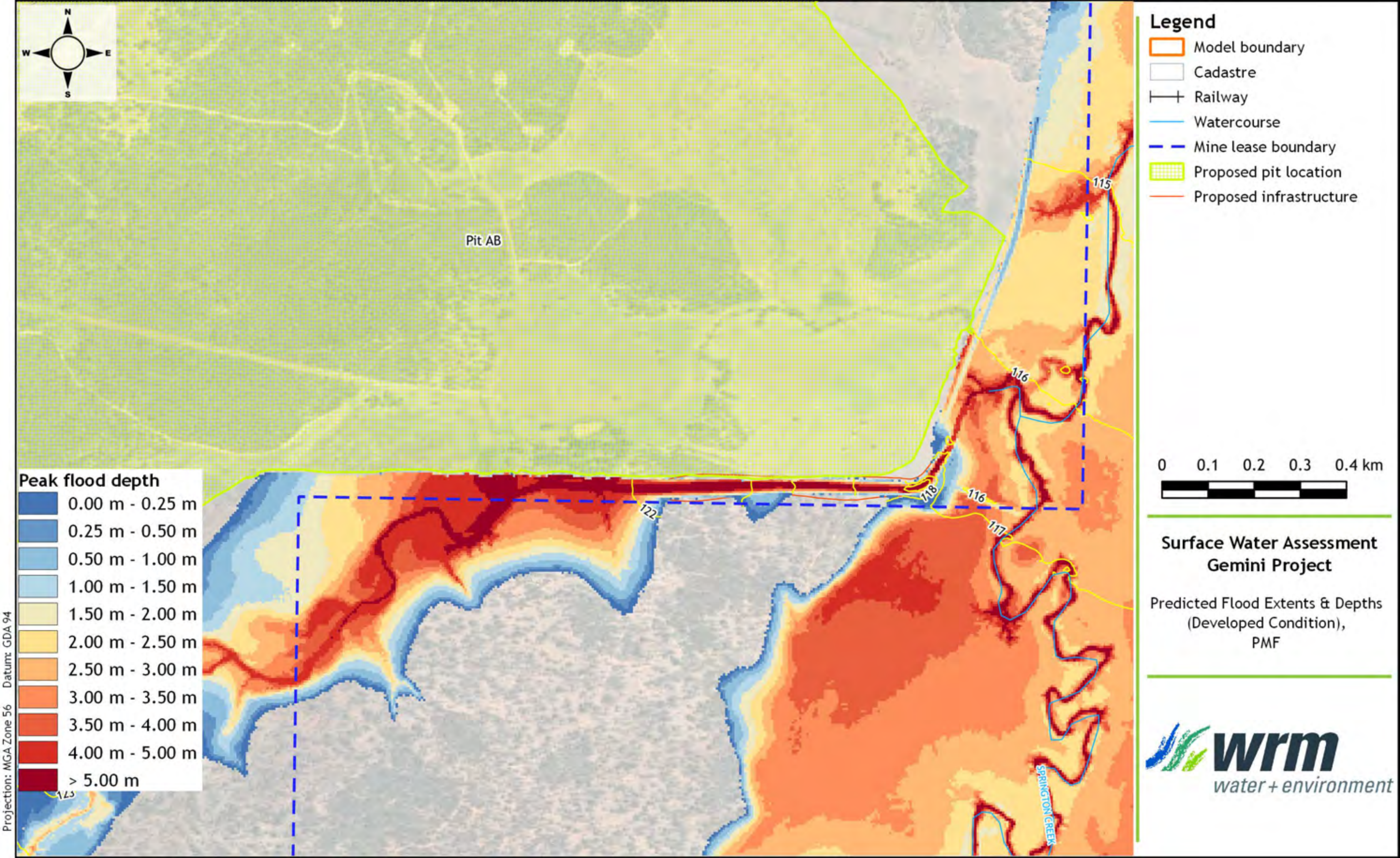
Predicted Flood Extents & Depths (Developed Condition), 10% AEP

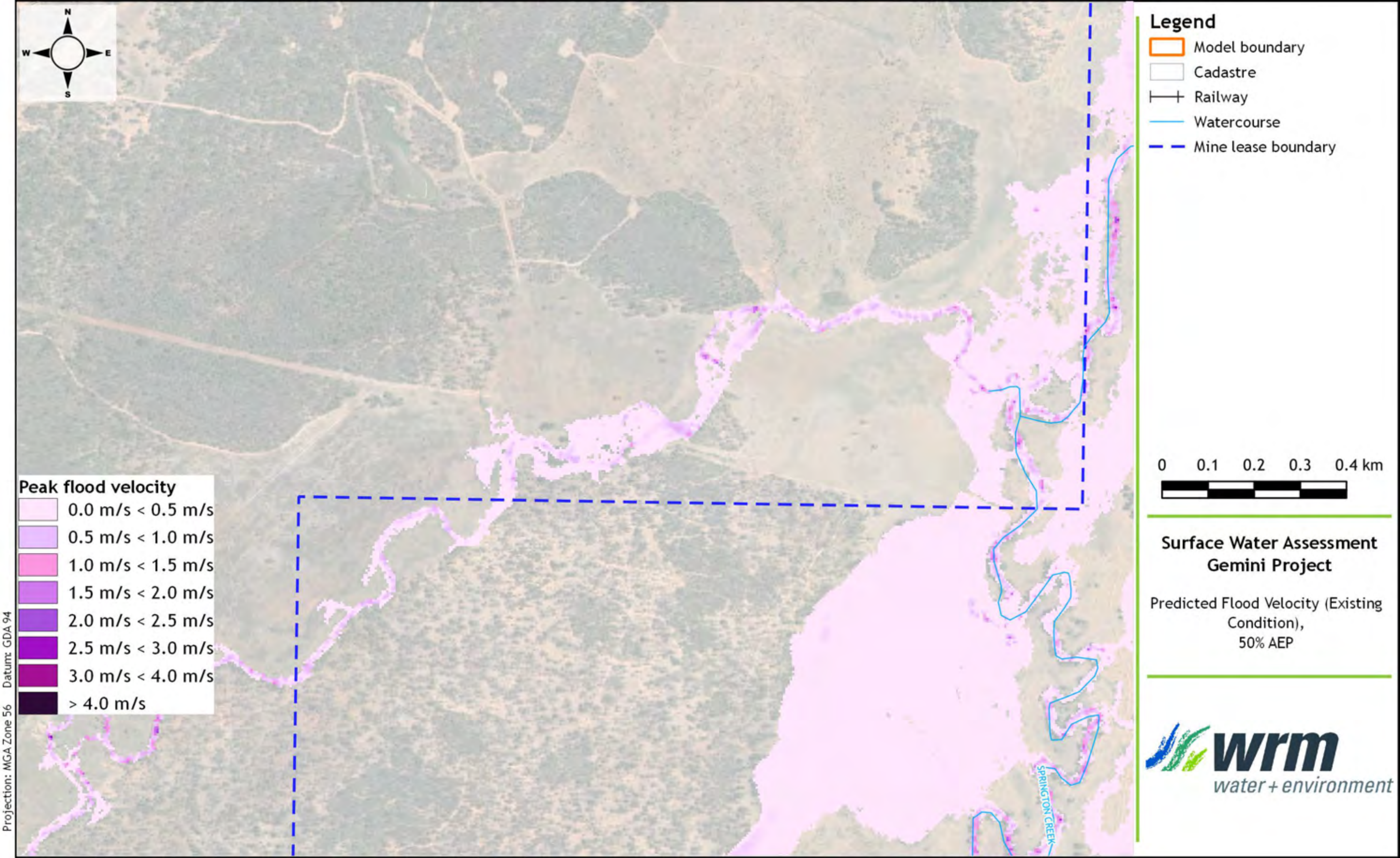

N
W
E
S
Pit AB
113
114
115
115
115
115
SPRINGTON CREEK
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
0 0.1 0.2 0.3 0.4 km
Peak flood depth
0.00 m - 0.25 m
0.25 m - 0.50 m
0.50 m - 1.00 m
1.00 m - 1.50 m
1.50 m - 2.00 m
2.00 m - 2.50 m
2.50 m - 3.00 m
3.00 m - 3.50 m
3.50 m - 4.00 m
4.00 m - 5.00 m
> 5.00 m
Projection: MGA Zone 56 Datum: GDA 94
Surface Water Assessment
Gemini Project
Predicted Flood Extents & Depths
(Developed Condition),
2% AEP
wrm
water + environment

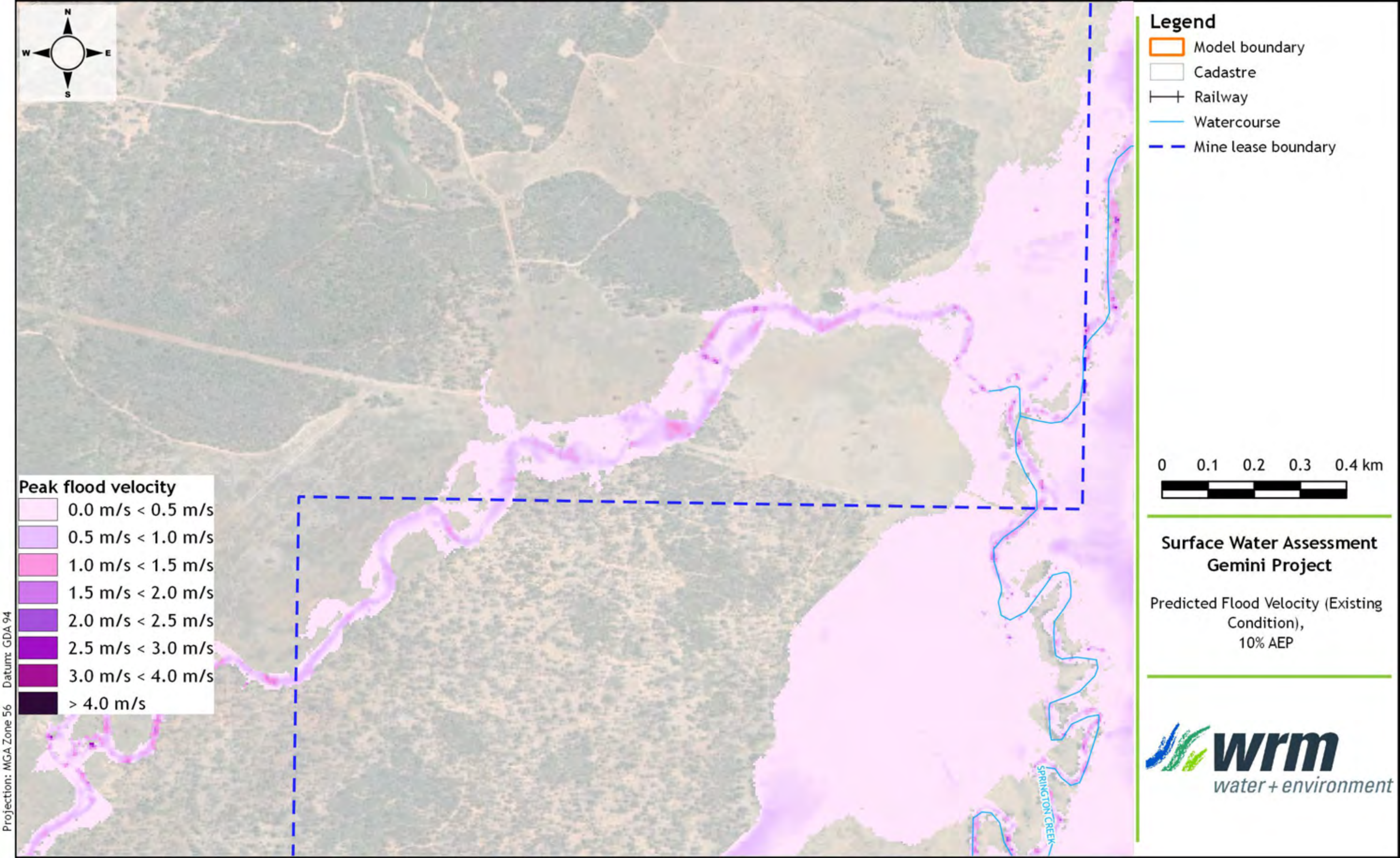


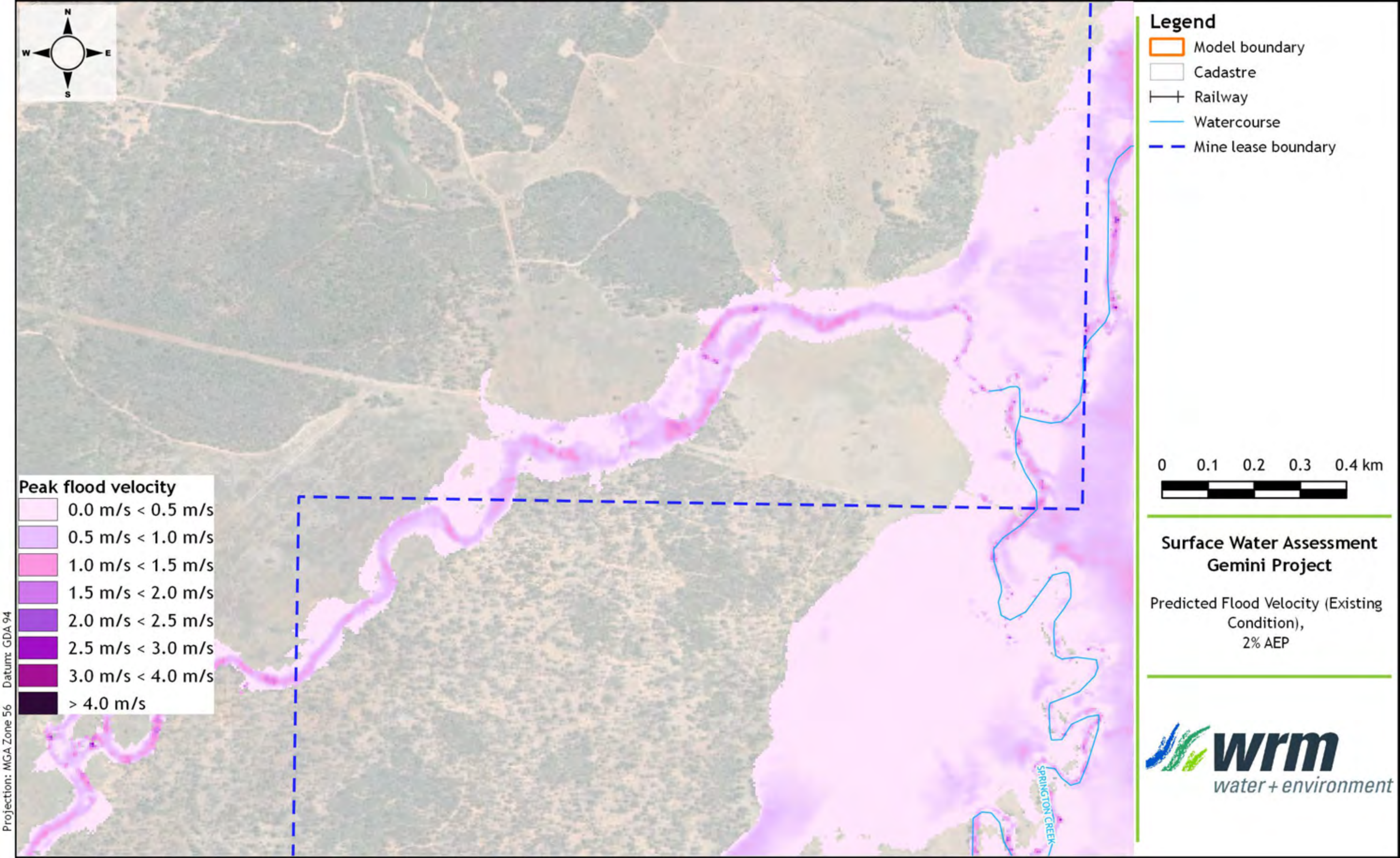
N
W
E
S
Pit AB
113
114
115
115
115
115
SPRINGTON CREEK
Peak flood depth
0.00 m - 0.25 m
0.25 m - 0.50 m
0.50 m - 1.00 m
1.00 m - 1.50 m
1.50 m - 2.00 m
2.00 m - 2.50 m
2.50 m - 3.00 m
3.00 m - 3.50 m
3.50 m - 4.00 m
4.00 m - 5.00 m
> 5.00 m
Projection: MGA Zone 56 Datum: GDA 94
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
0
0.1
0.2
0.3
0.4 km
Surface Water Assessment
Gemini Project
Predicted Flood Extents & Depths
(Developed Condition),
1% AEP
wrm
water + environment

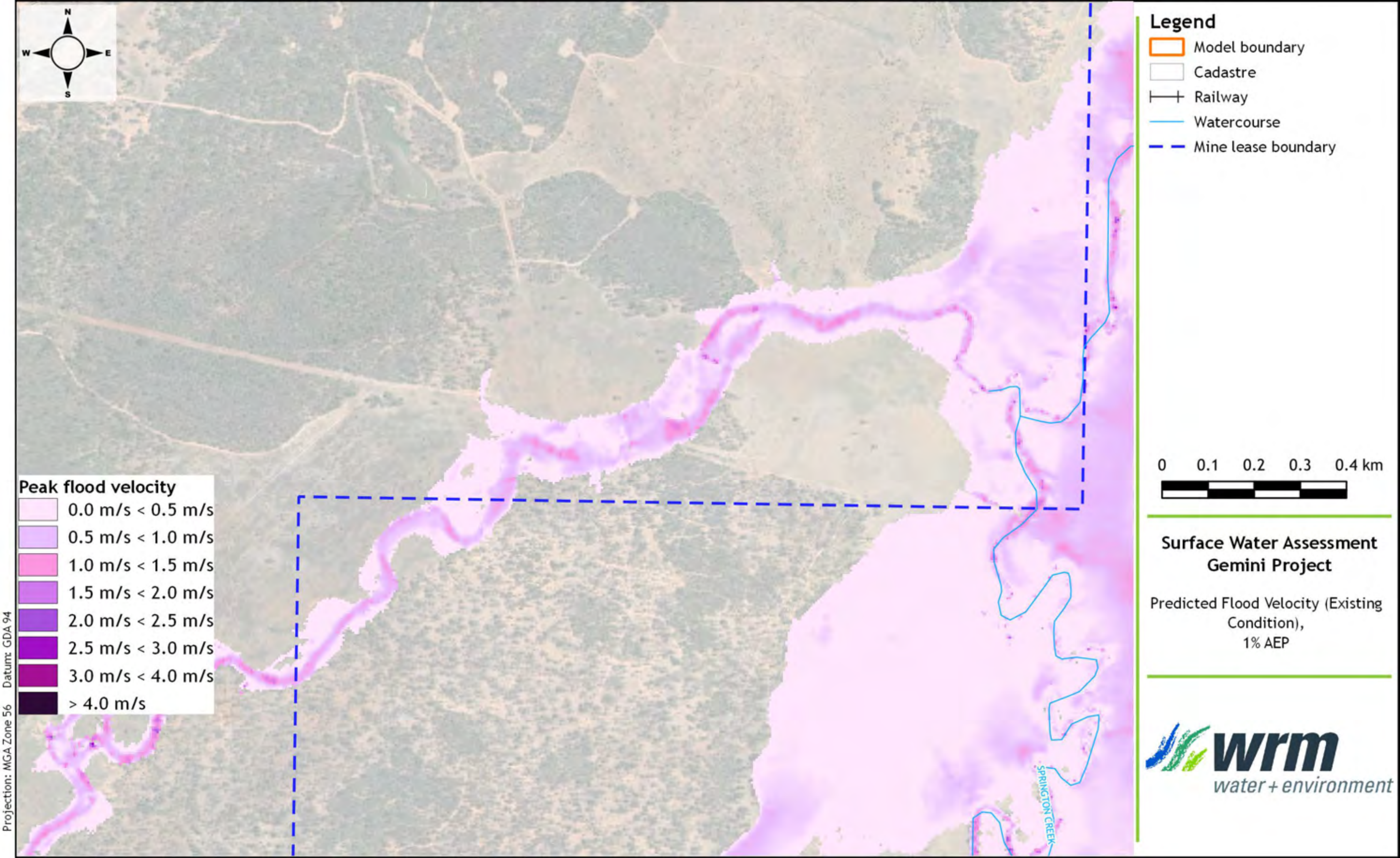

N
S
E
W
Pit AB
113
114
115
119
SPRINGTON CREEK
Peak flood depth
0.00 m - 0.25 m
0.25 m - 0.50 m
0.50 m - 1.00 m
1.00 m - 1.50 m
1.50 m - 2.00 m
2.00 m - 2.50 m
2.50 m - 3.00 m
3.00 m - 3.50 m
3.50 m - 4.00 m
4.00 m - 5.00 m
> 5.00 m
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
0 0.1 0.2 0.3 0.4 km
Surface Water Assessment
Gemini Project
Predicted Flood Extents & Depths (Developed Condition), 0.1% AEP
wrm
water + environment
Projection: MGA Zone 56 Datum: GDA 94


N
W
E
S
Pit AB
115
116
116
117
118
122
123
SPRINGTON CREEK
Peak flood depth
0.00 m - 0.25 m
0.25 m - 0.50 m
0.50 m - 1.00 m
1.00 m - 1.50 m
1.50 m - 2.00 m
2.00 m - 2.50 m
2.50 m - 3.00 m
3.00 m - 3.50 m
3.50 m - 4.00 m
4.00 m - 5.00 m
> 5.00 m
Projection: MGA Zone 56 Datum: GDA 94
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
0 0.1 0.2 0.3 0.4 km
Surface Water Assessment
Gemini Project
Predicted Flood Extents & Depths
(Developed Condition),
PMF
wrm
water + environment

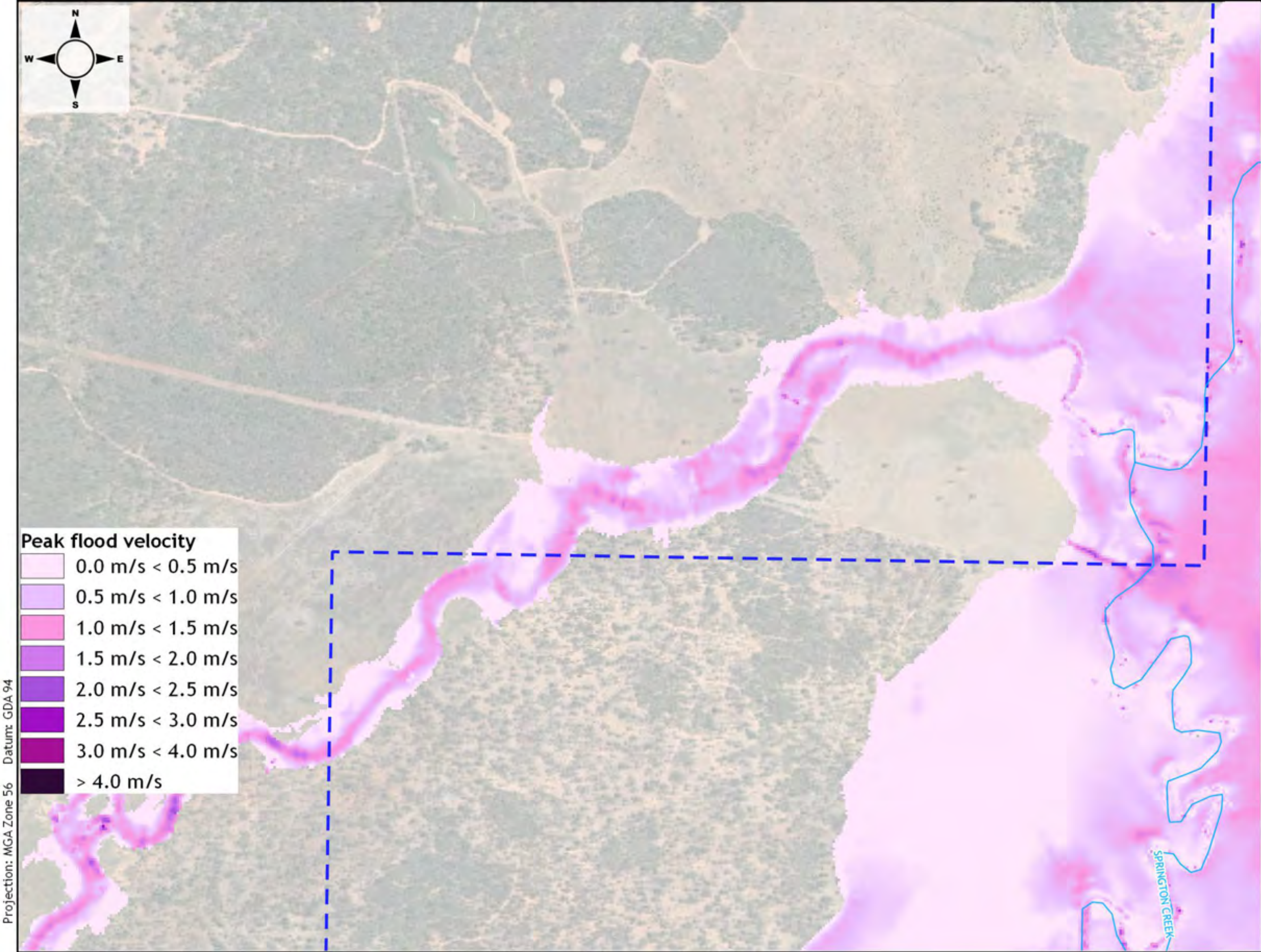

N
W
E
S
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Peak flood velocity
0.0 m/s < 0.5 m/s
0.5 m/s < 1.0 m/s
1.0 m/s < 1.5 m/s
1.5 m/s < 2.0 m/s
2.0 m/s < 2.5 m/s
2.5 m/s < 3.0 m/s
3.0 m/s < 4.0 m/s
> 4.0 m/s
0 0.1 0.2 0.3 0.4 km
SPRINGTON CREEK
Projection: MGA Zone 56 Datum: GDA 94
Surface Water Assessment
Gemini Project
Predicted Flood Velocity (Existing Condition),
50% AEP
wrm
water + environment


N
W
E
S
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
0 0.1 0.2 0.3 0.4 km
Peak flood velocity
0.0 m/s < 0.5 m/s
0.5 m/s < 1.0 m/s
1.0 m/s < 1.5 m/s
1.5 m/s < 2.0 m/s
2.0 m/s < 2.5 m/s
2.5 m/s < 3.0 m/s
3.0 m/s < 4.0 m/s
> 4.0 m/s
SPRINGTON CREEK
Projection: MGA Zone 56 Datum: GDA 94
Surface Water Assessment
Gemini Project
Predicted Flood Velocity (Existing Condition),
10% AEP
wrm
water + environment


N
W
E
S
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
0 0.1 0.2 0.3 0.4 km
Surface Water Assessment
Gemini Project
Predicted Flood Velocity (Existing Condition),
2% AEP
wrm
water + environment
Peak flood velocity
0.0 m/s < 0.5 m/s
0.5 m/s < 1.0 m/s
1.0 m/s < 1.5 m/s
1.5 m/s < 2.0 m/s
2.0 m/s < 2.5 m/s
2.5 m/s < 3.0 m/s
3.0 m/s < 4.0 m/s
> 4.0 m/s
SPRINGTON CREEK
Projection: MGA Zone 56 Datum: GDA 94



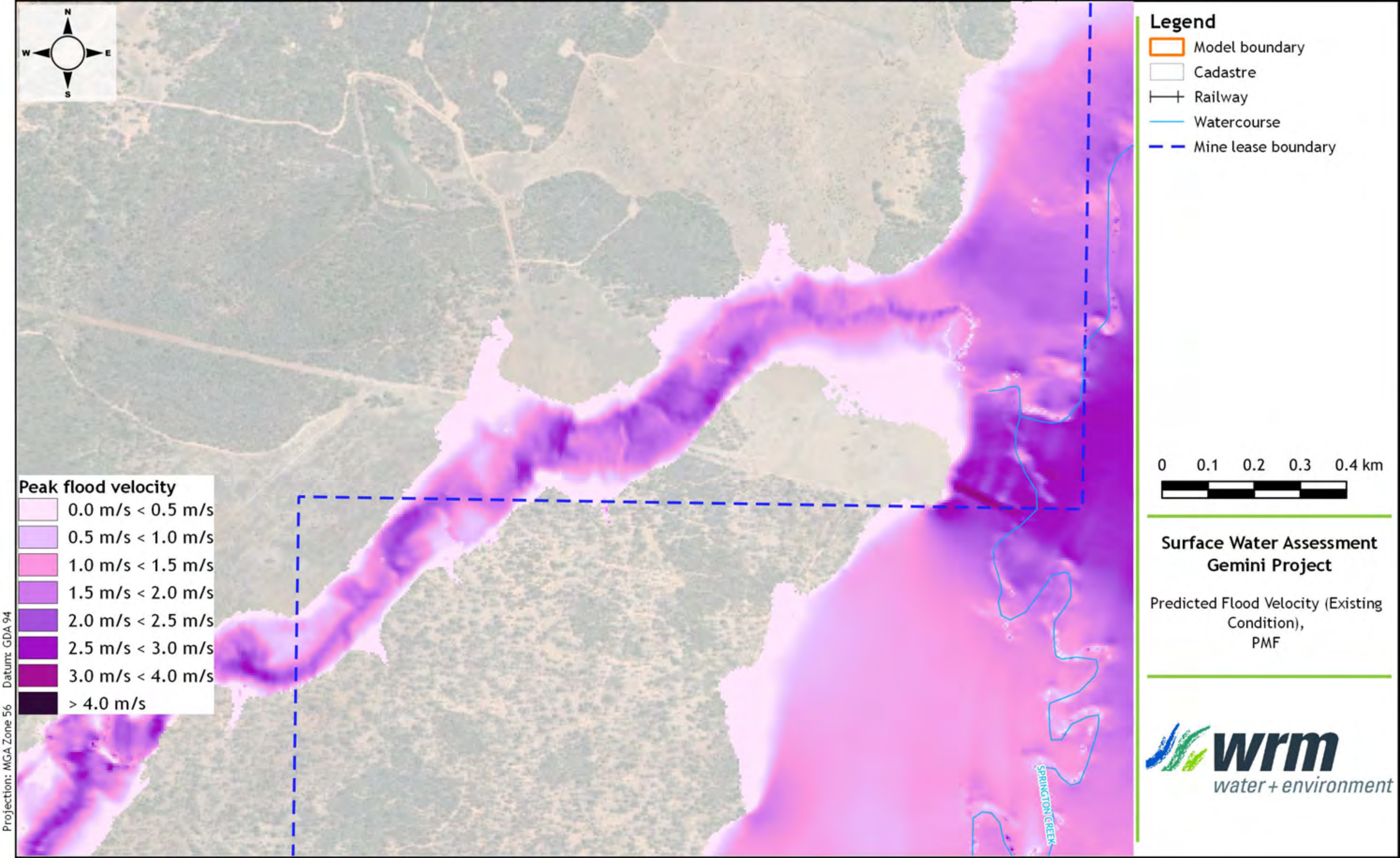
N
S
E
W
Peak flood velocity
0.0 m/s < 0.5 m/s
0.5 m/s < 1.0 m/s
1.0 m/s < 1.5 m/s
1.5 m/s < 2.0 m/s
2.0 m/s < 2.5 m/s
2.5 m/s < 3.0 m/s
3.0 m/s < 4.0 m/s
> 4.0 m/s
Projection: MGA Zone 56 Datum: GDA 94
SPRINGTON CREEK
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
0 0.1 0.2 0.3 0.4 km
Surface Water Assessment
Gemini Project
Predicted Flood Velocity (Existing Condition),
1% AEP
wrm
water + environment



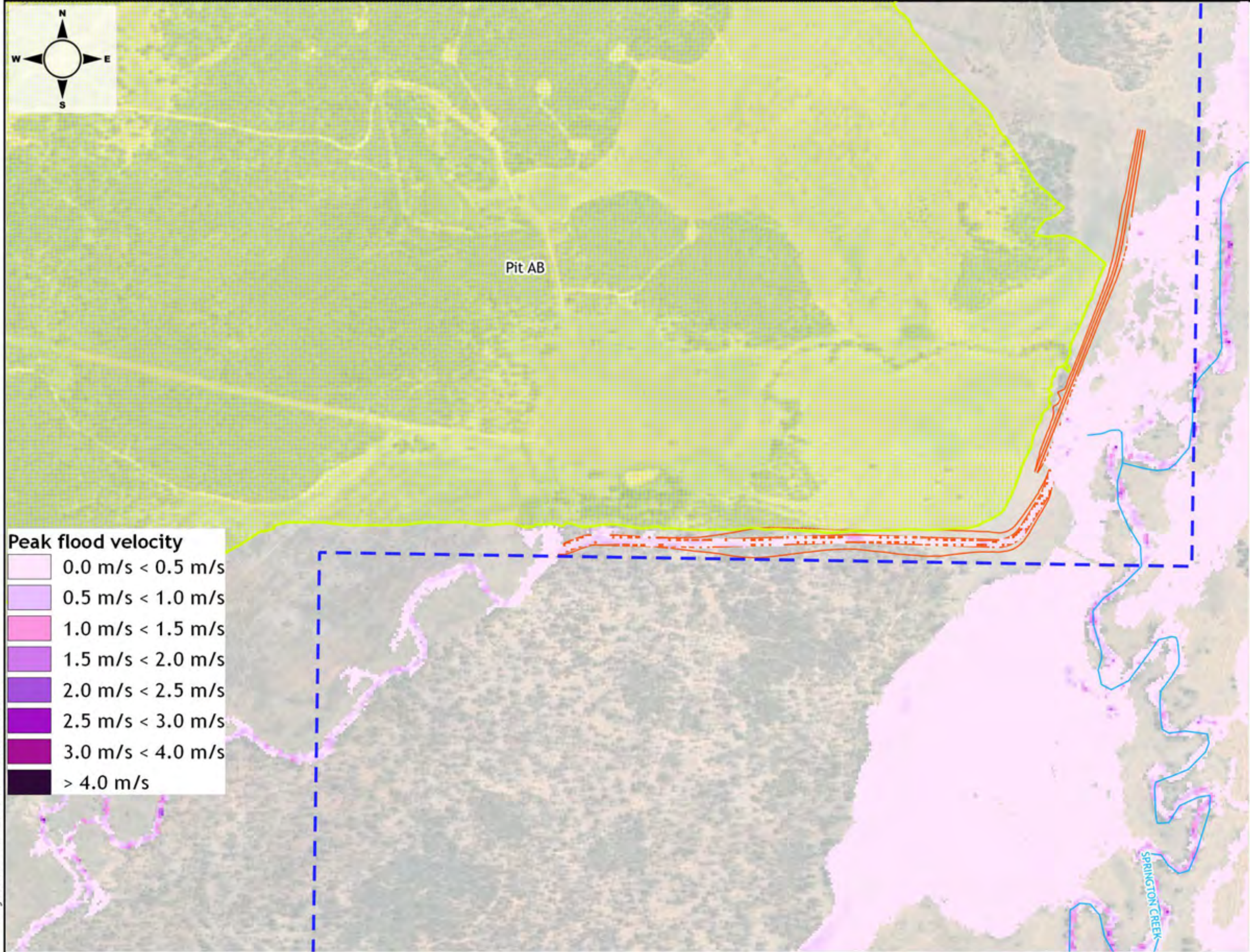
Surface Water Assessment
Gemini Project

Predicted Flood Velocity (Existing Condition),
0.1% AEP

wrm water + environment

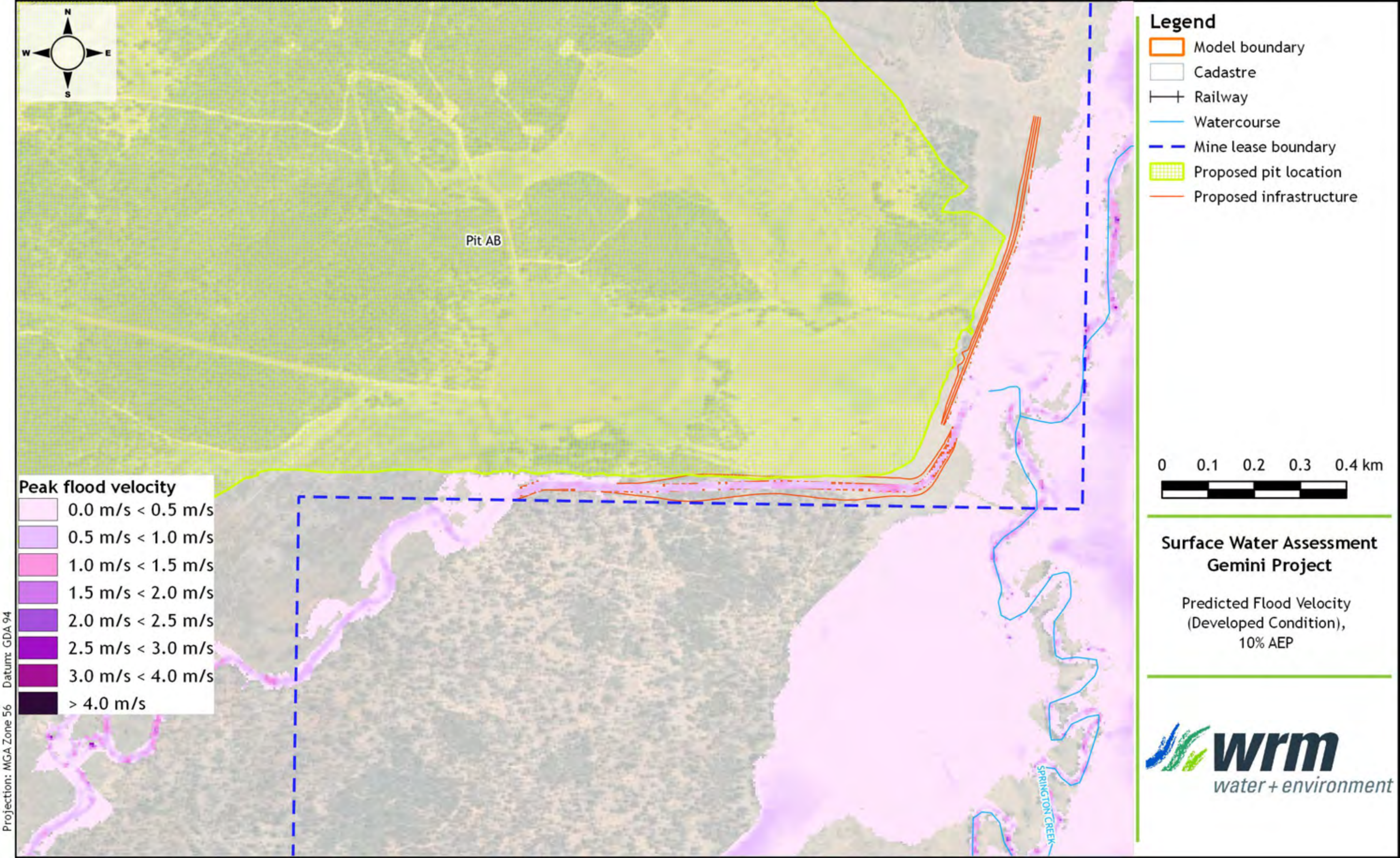


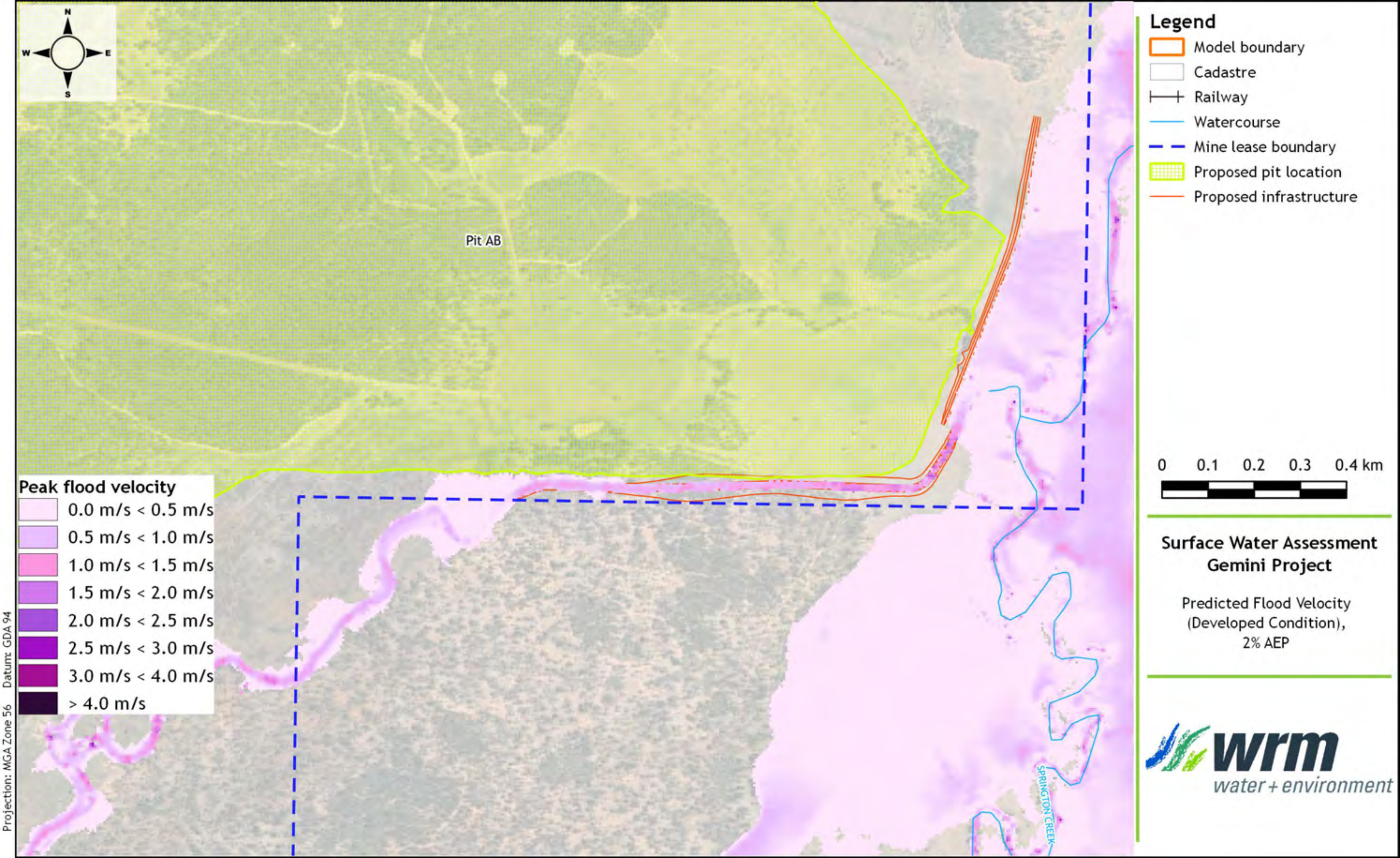
N
W
E
S
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
0
0.1
0.2
0.3
0.4 km
Surface Water Assessment
Gemini Project
Predicted Flood Velocity (Existing Condition),
PMF
wrm
water + environment
Peak flood velocity
0.0 m/s < 0.5 m/s
0.5 m/s < 1.0 m/s
1.0 m/s < 1.5 m/s
1.5 m/s < 2.0 m/s
2.0 m/s < 2.5 m/s
2.5 m/s < 3.0 m/s
3.0 m/s < 4.0 m/s
> 4.0 m/s
SPRINGTON CREEK
Projection: MGA Zone 56
Datum: GDA 94



Surface Water Assessment Gemini Project

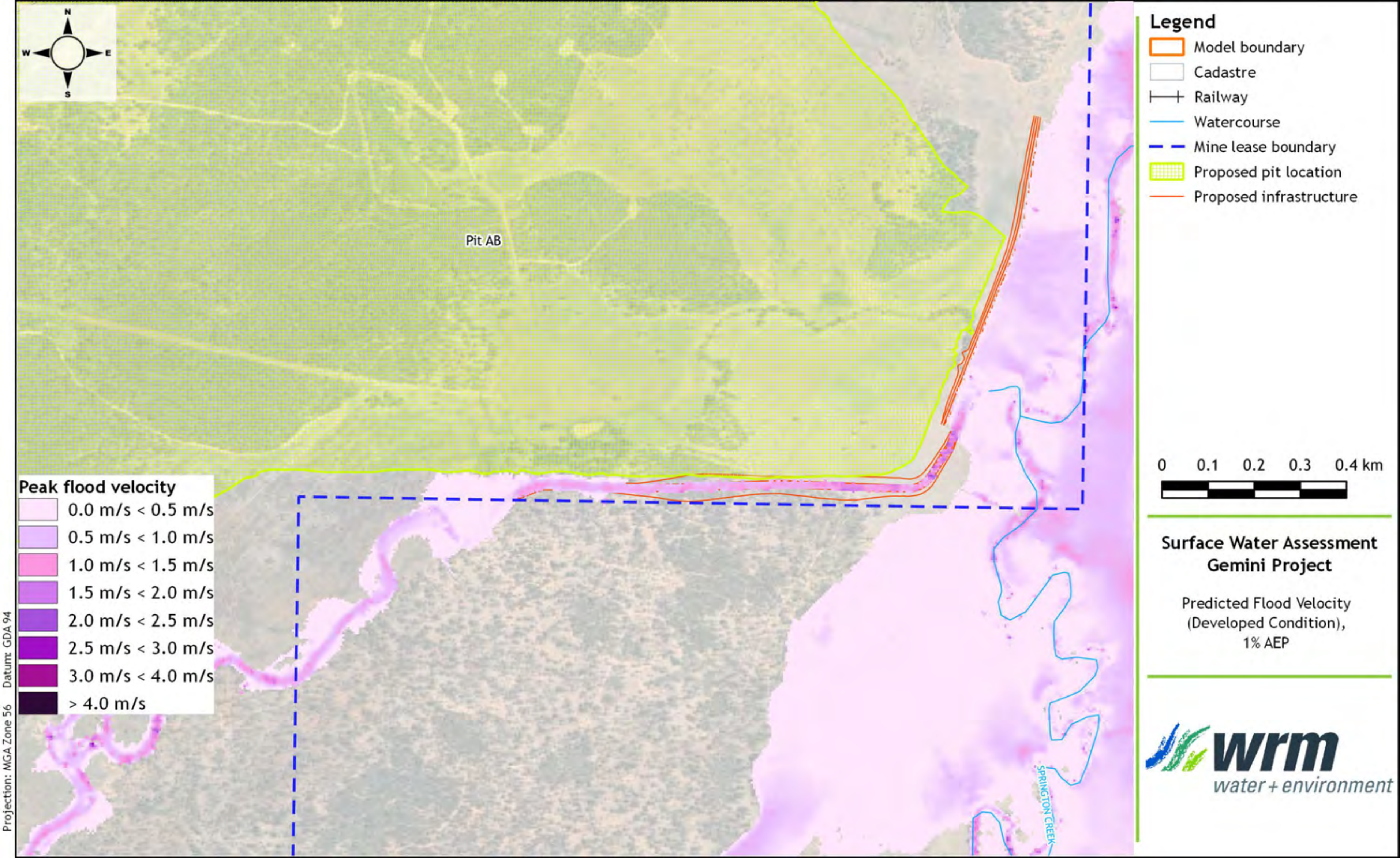
Predicted Flood Velocity (Developed Condition), 50% AEP


N
W
E
S
Pit AB
SPRINGTON CREEK
Peak flood velocity
0.0 m/s < 0.5 m/s
0.5 m/s < 1.0 m/s
1.0 m/s < 1.5 m/s
1.5 m/s < 2.0 m/s
2.0 m/s < 2.5 m/s
2.5 m/s < 3.0 m/s
3.0 m/s < 4.0 m/s
> 4.0 m/s
Projection: MGA Zone 56
Datum: GDA 94
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
0
0.1
0.2
0.3
0.4 km
Surface Water Assessment
Gemini Project
Predicted Flood Velocity
(Developed Condition),
10% AEP
wrm
water + environment

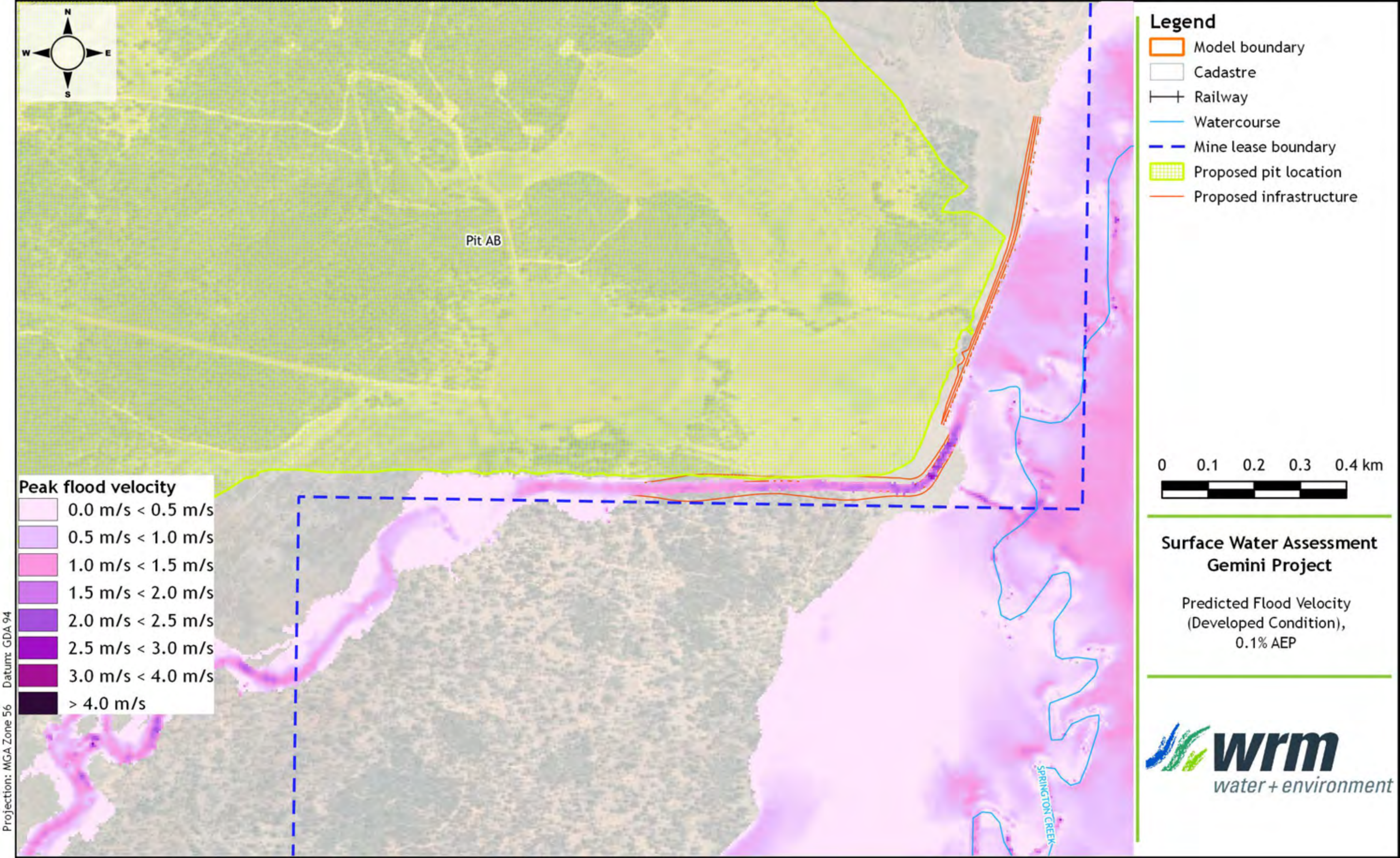


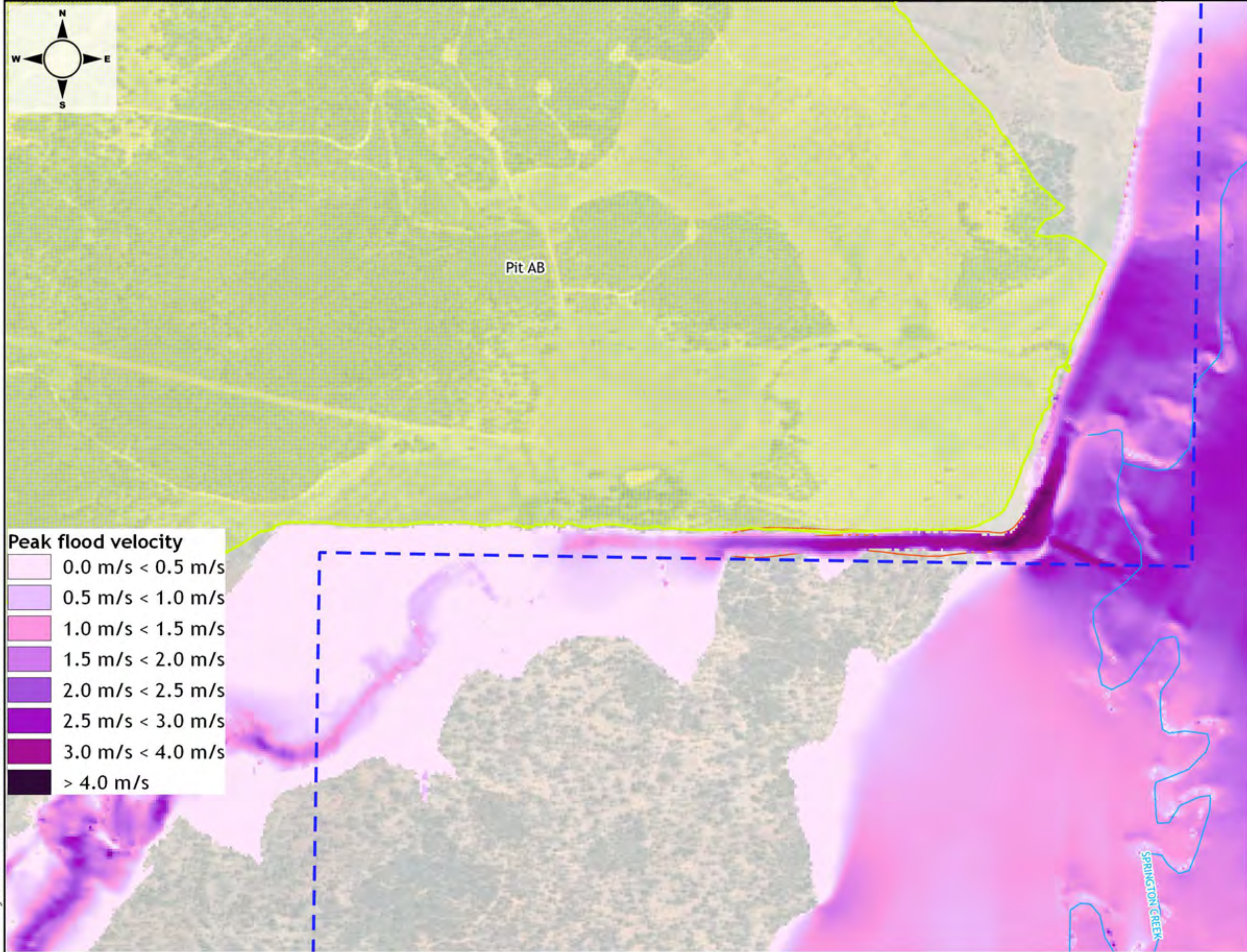
Surface Water Assessment Gemini Project

Predicted Flood Velocity (Developed Condition), 2% AEP



N
W
E
S
Pit AB
SPRINGTON CREEK
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
0 0.1 0.2 0.3 0.4 km
Peak flood velocity
0.0 m/s < 0.5 m/s
0.5 m/s < 1.0 m/s
1.0 m/s < 1.5 m/s
1.5 m/s < 2.0 m/s
2.0 m/s < 2.5 m/s
2.5 m/s < 3.0 m/s
3.0 m/s < 4.0 m/s
> 4.0 m/s
Projection: MGA Zone 56 Datum: GDA 94
Surface Water Assessment
Gemini Project
Predicted Flood Velocity
(Developed Condition),
1% AEP
wrm
water + environment

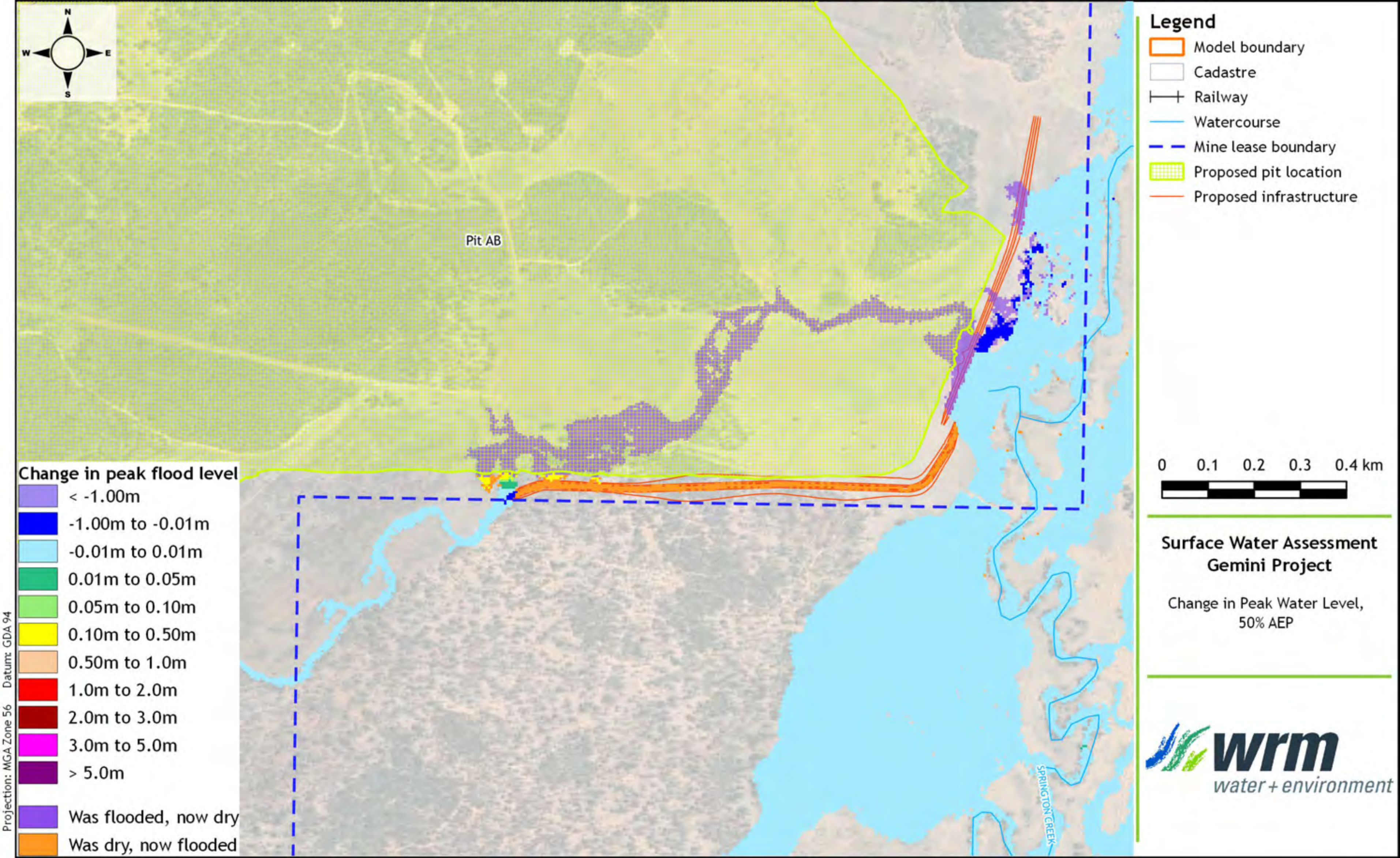

N
W
E
S
Pit AB
SPRINGTON CREEK
Peak flood velocity
0.0 m/s < 0.5 m/s
0.5 m/s < 1.0 m/s
1.0 m/s < 1.5 m/s
1.5 m/s < 2.0 m/s
2.0 m/s < 2.5 m/s
2.5 m/s < 3.0 m/s
3.0 m/s < 4.0 m/s
> 4.0 m/s
Projection: MGA Zone 56 Datum: GDA 94
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
0 0.1 0.2 0.3 0.4 km
Surface Water Assessment
Gemini Project
Predicted Flood Velocity
(Developed Condition),
0.1% AEP
wrm
water + environment

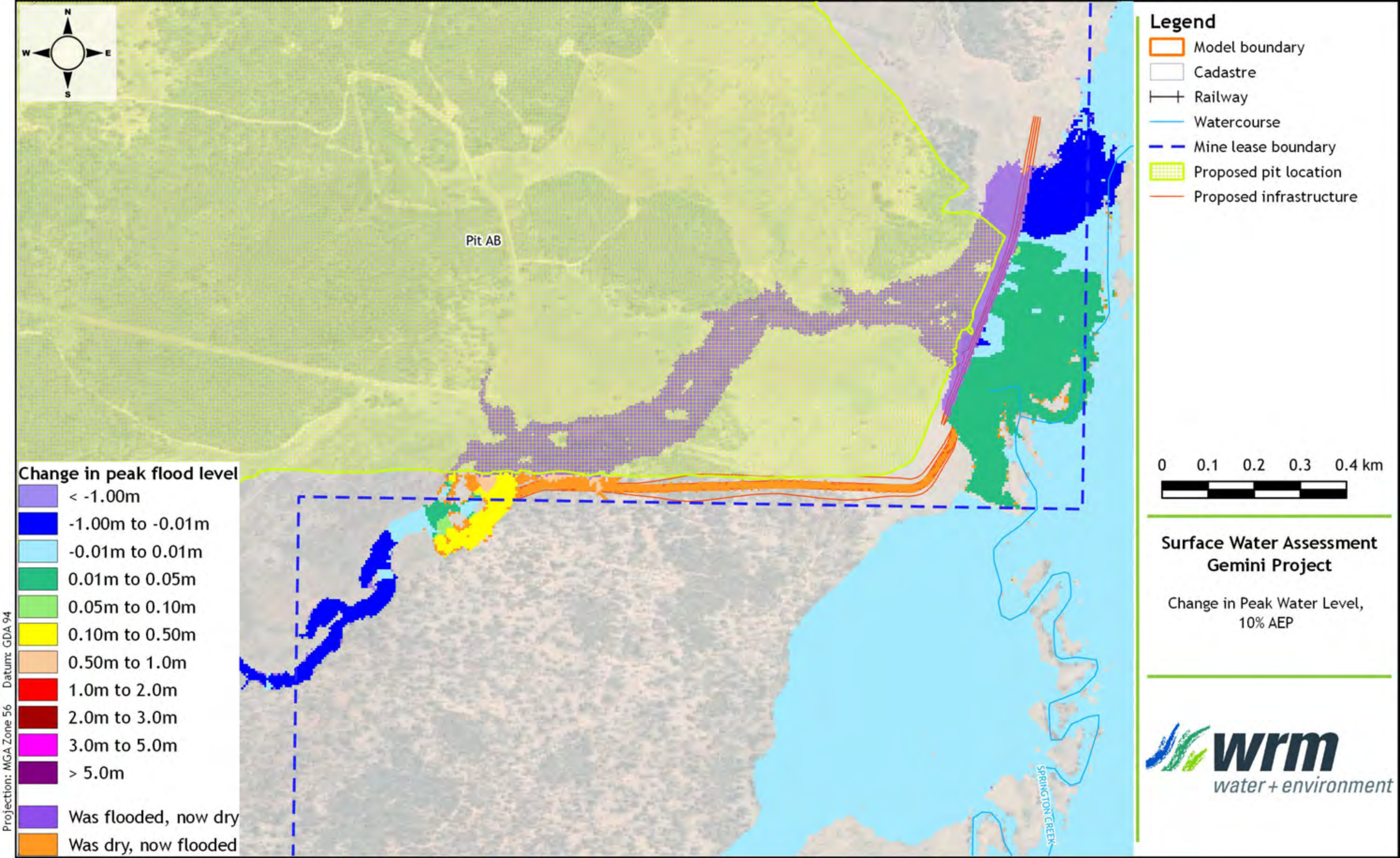


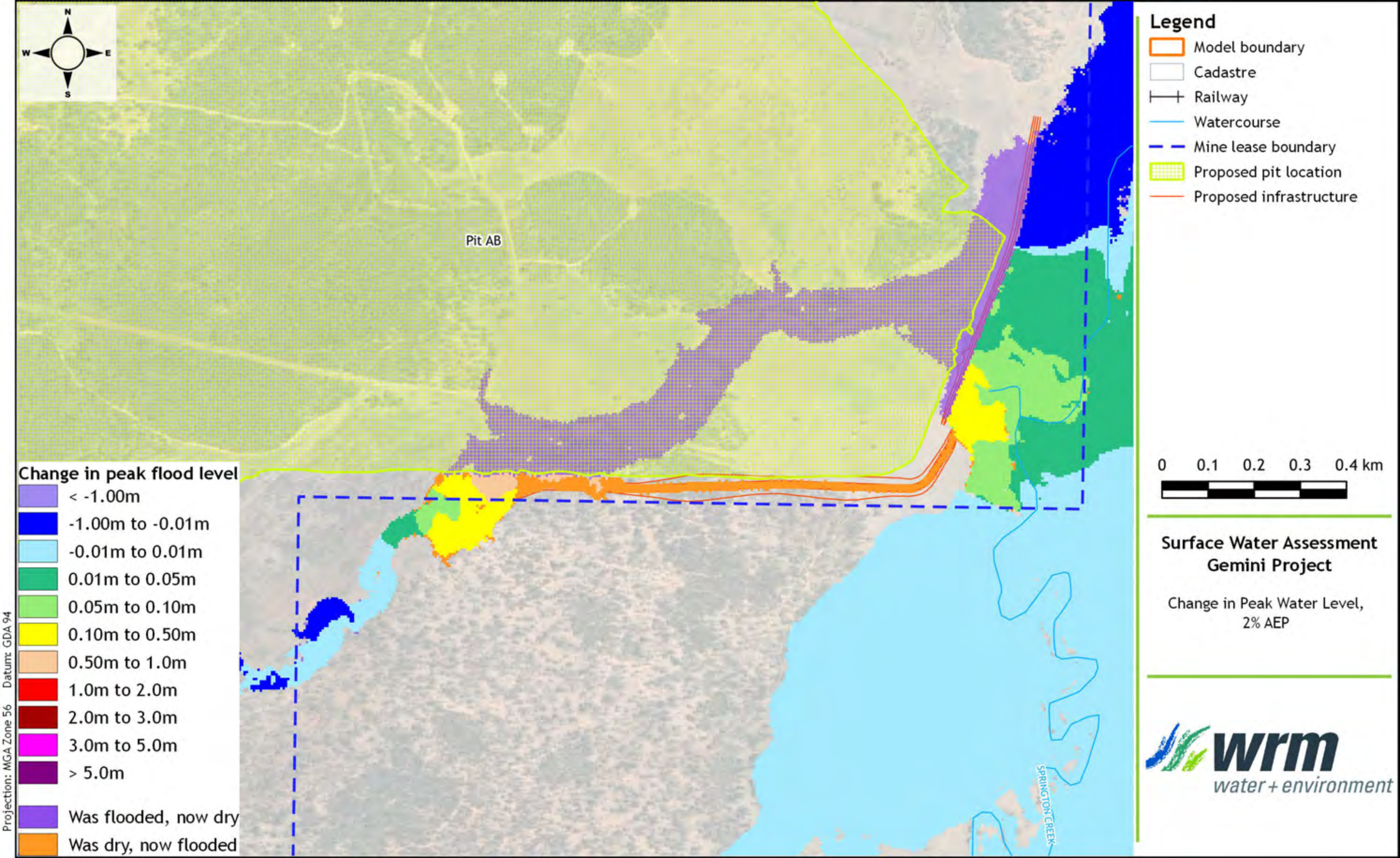
Surface Water Assessment
Gemini Project

Predicted Flood Velocity
(Developed Condition),
PMF

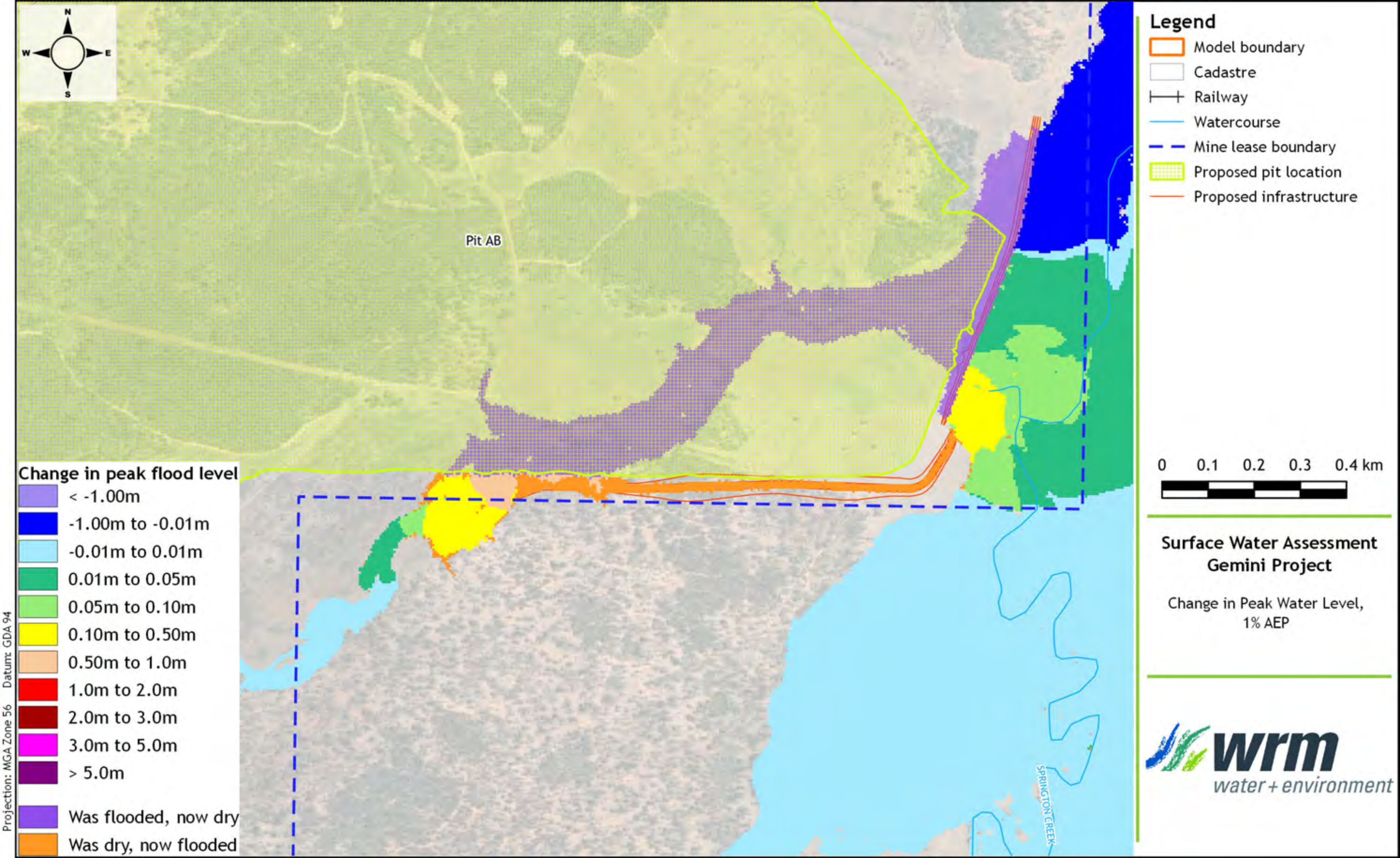
wrm water + environment

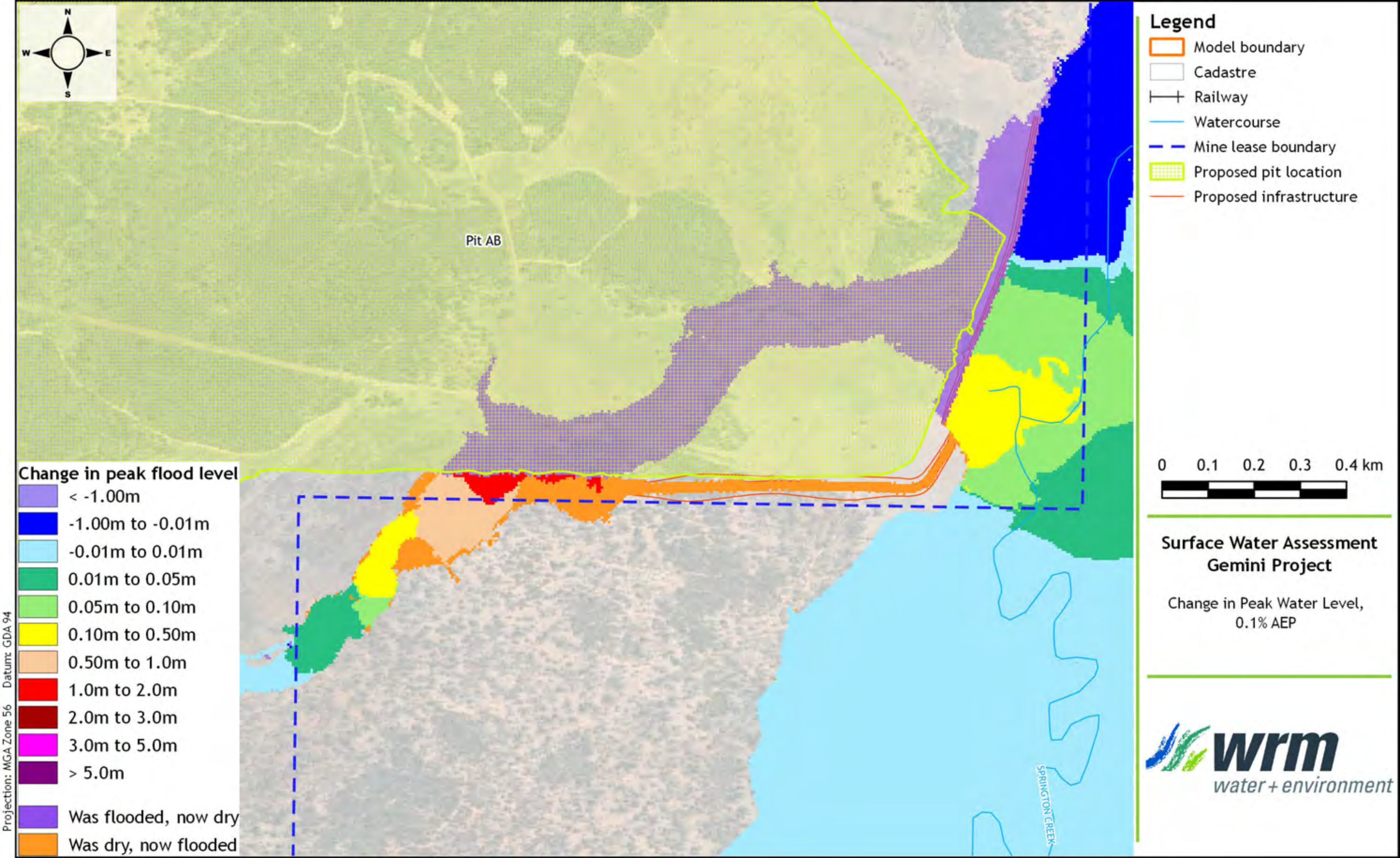

N
W
E
S
Pit AB
SPRINGTON CREEK
Change in peak flood level
< -1.00m
-1.00m to -0.01m
-0.01m to 0.01m
0.01m to 0.05m
0.05m to 0.10m
0.10m to 0.50m
0.50m to 1.0m
1.0m to 2.0m
2.0m to 3.0m
3.0m to 5.0m
> 5.0m
Was flooded, now dry
Was dry, now flooded
Projection: MGA Zone 56 Datum: GDA 94
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
0 0.1 0.2 0.3 0.4 km
Surface Water Assessment
Gemini Project
Change in Peak Water Level,
50% AEP
wrm
water + environment


N
S
W
E
Pit AB
SPRINGTON CREEK
Change in peak flood level
< -1.00m
-1.00m to -0.01m
-0.01m to 0.01m
0.01m to 0.05m
0.05m to 0.10m
0.10m to 0.50m
0.50m to 1.0m
1.0m to 2.0m
2.0m to 3.0m
3.0m to 5.0m
> 5.0m
Was flooded, now dry
Was dry, now flooded
Projection: MGA Zone 56 Datum: GDA 94
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
0 0.1 0.2 0.3 0.4 km
Surface Water Assessment
Gemini Project
Change in Peak Water Level,
10% AEP
wrm
water + environment



N
W
E
S
Pit AB
SPRINGTON CREEK
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
0 0.1 0.2 0.3 0.4 km
Change in peak flood level
< -1.00m
-1.00m to -0.01m
-0.01m to 0.01m
0.01m to 0.05m
0.05m to 0.10m
0.10m to 0.50m
0.50m to 1.0m
1.0m to 2.0m
2.0m to 3.0m
3.0m to 5.0m
> 5.0m
Was flooded, now dry
Was dry, now flooded
Projection: MGA Zone 56 Datum: GDA 94
Surface Water Assessment
Gemini Project
Change in Peak Water Level,
2% AEP
wrm
water + environment


N
W
E
S
Pit AB
SPRINGTON CREEK
Change in peak flood level
< -1.00m
-1.00m to -0.01m
-0.01m to 0.01m
0.01m to 0.05m
0.05m to 0.10m
0.10m to 0.50m
0.50m to 1.0m
1.0m to 2.0m
2.0m to 3.0m
3.0m to 5.0m
> 5.0m
Was flooded, now dry
Was dry, now flooded
Projection: MGA Zone 56 Datum: GDA 94
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
0 0.1 0.2 0.3 0.4 km
Surface Water Assessment
Gemini Project
Change in Peak Water Level,
1% AEP
wrm
water + environment


N
W
E
S
Pit AB
Change in peak flood level
< -1.00m
-1.00m to -0.01m
-0.01m to 0.01m
0.01m to 0.05m
0.05m to 0.10m
0.10m to 0.50m
0.50m to 1.0m
1.0m to 2.0m
2.0m to 3.0m
3.0m to 5.0m
> 5.0m
Was flooded, now dry
Was dry, now flooded
Projection: MGA Zone 56 Datum: GDA 94
SPRINGTON CREEK
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
0 0.1 0.2 0.3 0.4 km
Surface Water Assessment
Gemini Project
Change in Peak Water Level,
0.1% AEP
wrm
water + environment