Lake Vermont Meadowbrook Project EIS

Flood Modelling Assessment Report

Bowen Basin Coal Pty Ltd
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Executive Summary

The 'Lake Vermont Meadowbrook Project' (the Project) is an extension of the existing Lake Vermont Coal Mine, proposed by Bowen Basin Coal Pty Ltd (BBC). The Project is located in central Queensland, approximately 30 kilometres northeast of Dysart and approximately 180 kilometres southwest of Mackay. The Project would include the development of a double-seam underground longwall coal mine, along with a small-scale 'satellite' open-cut pit targeting coal resources to the north and adjacent to the existing Lake Vermont Mine.

WRM Water & Environment Pty Ltd (WRM) was commissioned by Bowen Basin Coal to undertake a surface water assessment for the Project which will form part of an Environmental Impact Statement (EIS) for the Project under the *Environment Protection Act 1994* (QLD). This report comprises the flood modelling component of the surface water assessment.

This report assesses the impact of the Project on both local and regional flood behaviour. The flood model presented in this report also forms the basis of a more localised assessment of the impact of the Project on flow conditions in the mine lease area, which is detailed in the geomorphological assessment (WRM, 2022).

An XP-RAFTS hydrologic model, reconciled to a flood frequency analysis of the annual series of peak flows recorded at the Deverill stream gauge, was used to derive inflows for the Isaac River. An XP-RAFTS model for local creek flooding was calibrated to the flood hydrograph recorded at Lake Vermont Resources' water level gauge on Phillips Creek for the March 2017 storm event. Flows for Phillips Creek were also reconciled to a flood frequency analysis of historical peak annual flows recorded at the now closed DNRME Tayglen stream gauge.

These hydrological outputs were used as inputs to a TUFLOW 2d hydraulic model developed to derive flood depths, extents and velocities for the 50%, 10%, 2%, 1%, 0.1% AEP and PMF design flood events.

The modelled flood heights in the 0.1% AEP design flood were used as the basis of protection works around the surface operations (at the open cut pit and mine infrastructure area).

The hydraulic model was used to simulate flood conditions under approved site conditions (base case), operational conditions (with full longwall mining subsidence), post-closure conditions and cumulative impact scenarios. The results show the Project would alter local flood conditions via a number of mechanisms:

- underground mine subsidence would locally reduce flood levels but increase the depth and extent of flooding;
- underground mining would redirect floodplain flow along subsidence panels – however, the effects will be mitigated by bunding across the panels to reduce the potential for this to occur;
- subsidence would increase floodplain storage, which has the effect of reducing downstream flood flows, levels and extents;
- the haul road embankment would cause some obstruction to floodplain and channel flows – locally increasing upstream flood levels. However, the vertical alignment design and cross-drainage structures limit the upstream impacts and preserve the downstream flow distribution;
- levees around the open cut operation and MIA would locally reduce floodplain conveyance and storage – this would have the effect of locally increasing upstream flood levels and redistributing downstream flow to the opposite floodplains until the levees were decommissioned and the floodplain landform returned to pre-mining levels.

The impacts from the Project however will be largely contained on site, on land owned by the proponent, and will cause minimal off-site impacts on flood levels and velocities both upstream and downstream of the mine lease area for events up to the 1% AEP.

Contents

List of Figures

List of Tables

List of Annexures

1 Hydrological modelling

1.1 OVERVIEW

The area of the proposed mining lease is crossed by the floodplains of Phillips Creek Boomerang Creek and One Mile Creek, west of their confluence with the Isaac River. This flood impact assessment includes an analysis of regional flooding in the Isaac River and local flooding in the above creek systems.

Separate XP-RAFTS (Innovyze 2019) runoff-routing models of the Isaac River and local creek catchments were used to estimate the 50%, 10%, 2%, 1%, and 0.1% AEP peak design discharges as well as the probable maximum flood (PMF) for a range of durations up to 48 hours. Rainfall data (rainfall depths, areal reduction factors and temporal patterns) were applied in accordance with ensemble event procedures in Australian Rainfall & Runoff (ARR) (Ball et al., 2019).

The regional flood model was calibrated to flows recorded at Queensland Department of Natural Resources Mines and Energy's (DNRME's) streamflow gauges at Goonyella and Deverill on the Isaac River for the February 2008, December 2010 and March 2017 events. Design peak flows from the regional Isaac River model were reconciled against the flood frequency analysis (FFA) of the peak annual flow series at the Deverill gauge. The local flood model was calibrated to flows recorded at Lake Vermont Resources' Phillips Creek streamflow gauge during the Cyclone Debbie flood event (March 2017). Design peak flows in Phillips Creek were reconciled against the flood frequency analysis of the peak annual flow series of historical flow data recorded at the Tayglen gauge. All local creek design flows were validated by comparing against the Regional Flood Frequency Estimation Model (RFFE).

The development, validation and calibration of the regional and local hydrological models are described separately in the following sections.

1.2 ISAAC RIVER XP-RAFTS REGIONAL HYDROLOGICAL MODEL

1.2.1 Spatial configuration

Figure 1.1 shows the XP-RAFTS Isaac River regional model configuration. The model extends downstream to the confluence of Phillips Creek with the Isaac River and has a total catchment area of 5,693 km^2. It includes 248 subcatchments ranging in size from 0.2 km^2 to 204 km^2.

1.2.2 Subcatchment parameters

Model parameters for each subcatchment were determined as follows:

- A percentage impervious of zero was adopted for all subcatchments;
- Catchment slopes were determined based on the available topographic data;
- A subcatchment storage coefficient multiplication factor 'Bx' of 1.0 was adopted for all events;
- Subcatchment PERN 'n' values were determined based on the density of vegetation in each subcatchment. The adopted subcatchment PERN 'n' values range between 0.04 and 0.08; and
- The selection of initial and continuing losses for design events is described in Section 1.3.9.

1.2.3 Spatial and areal variability

A comparison of the Isaac River design rainfall intensities at the southern and western catchment boundaries, and at the centroid, revealed on average less than 5% variance in rainfall for the 1% AEP event across all durations. The design rainfall intensities at the eastern catchment boundary were on average within 7% of the design rainfall intensities at the centroid of the catchment. The design rainfall intensities at the northern catchment boundary were on average within 15% of the design rainfall intensities at the centroid of the catchment.

Due to the small variation in design rainfall estimates over most of the catchment, a uniform spatial rainfall distribution was adopted across the model.

Areal reduction factors appropriate for the entire Isaac River catchment to the Phillips Creek confluence were applied to all design events up to the 0.1% AEP event as recommended in ARR (Ball et al., 2019). No ARF was adopted for the PMP rainfall as catchment area is already incorporated into the PMP rainfall estimation.

1.2.4 Temporal patterns

The East Coast North temporal patterns from ARR Data Hub (Geoscience Australia, 2019) were used for design events up to 1% AEP event. For the 0.1% AEP and PMP events, ARR recommends using the GTSMR (BOM, 2005) temporal patterns for storm durations of 24 hours and longer. The ensemble of GTSMR temporal patterns for the standard area 5,000 (for catchment areas between 3,750 and 7,500 km^2) was used for these events as well as the Average Variable Method (AVM) pattern.

1.2.5 Design rainfall losses

The design losses were selected based on reconciliation against a flood frequency analysis (FFA) to the annual series of recorded peak flood discharges at DNRME's Deverill gauge as described in section 1.2.8. Table 1.1 summarises the initial and continuing rainfall losses adopted in the XP-RAFTS model for the design events. The losses for the 0.1% AEP event follow the recommendation of ARR 2019 of varying the continuing loss between the 1% AEP and PMP loss rates.

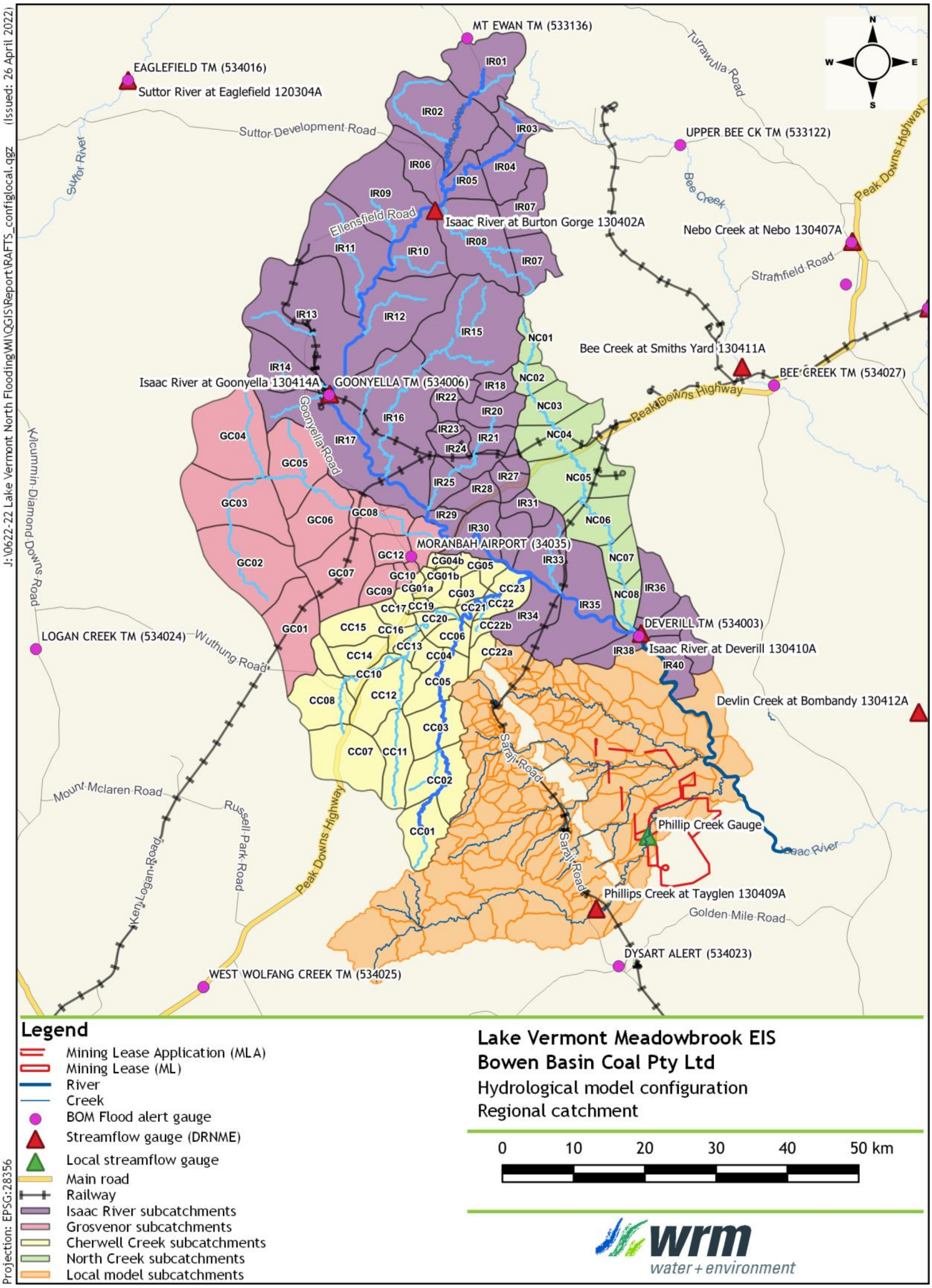

Figure 1.1 – XP-RAFTS regional configuration

Table 1.1 - Adopted initial and continuing losses

Event	Initial loss (mm)	Continuing loss (mm/hr)
50% AEP	40	2.5
10% AEP	25	2.5
2% AEP	7.5	2.5
1% AEP	5	2.5
0.1% AEP	0	2.0
PMP	0	1.0

1.2.6 PMP storm

The Isaac River catchment is greater than 1,000 km^2 and so only the Generalised Tropical Storm Method Revised (GTSMR) for durations greater than 24 hrs is applicable for calculating the Probable Maximum Precipitation (PMP) storm. GTSMR rainfall values for the coastal zone were calculated and applied in accordance with BOM 2003 methodology. Table 1.2 summarises the rainfall adjustment factors that were applied for the Isaac River catchment.

Table 1.2 – PMP GTSMR rainfall factors for regional model

Topological Adjustment Factor (TAF)	Decay Amplitude Factor (DAF)	Extreme Precipitable Water (EPW)	Annual Moisture Adjustment Factor (EPW/120)
1.0	1.0	91.86	0.77

1.2.7 XP-RAFTS model calibration

The XP-RAFTS model was calibrated to discharge hydrographs recorded at the Deverill and Goonyella stream flow stations for three flood events (2008, 2010 and 2017). The routing parameters and losses were adjusted to match the timing and magnitude of peak discharges at each gauge.

The available data for the three calibration events is summarised in Table 1.3. In addition to the public rain station data, data was also provided by 3rd party mines including Burton and Moorvale (Peabody Energy), Isaac Plain (Stanmore) and Moranbah North (Anglo). The rainfall data included daily and sub-daily data and was used to understand the spatial variation in rainfall across the catchment.

Table 1.3 - Available rainfall and streamflow data

Station ID	Station name	Data type	Data frequency	Source	Calibration event		
					Feb-08	Dec-10	Mar-17
130410A	Isaac River at Deverill	Rainfall	Sub-daily	DNRME	✓	✓	✓
		Discharge	Sub-daily		✓	✓	✓
130414A	Isaac River at Goonyella	Discharge	Sub-daily	DNRME	✓	✓	✓
534023	Isaac River Bridge	Rainfall	Sub-daily	BOM	✓	✓	-
34038	Moranbah WTP	Rainfall	Sub-daily	BOM	✓	✓	-
34035	Moranbah Airport	Rainfall	Sub-daily	BOM	-	-	✓

The model was calibrated using sub-daily rainfall data as well as streamflow data recorded at the Deverill and Goonyella stream flow stations on the Isaac River. Table 1.4 shows recorded rainfall and peak discharges for each of the calibration events. Each subcatchment of the model was assigned the rainfall from the nearest rainfall station.

Table 1.4 – Adopted calibration events, Isaac River catchment

Flood event	Start date	Event duration	Recorded peak discharge (m^3/s)		Total event rainfall (mm)	
		(days)	Goonyella	Deverill	Goonyella	Deverill
February 2008	09/02/2008	9	1,070	2,142	n/a	567
December 2010	18/01/2010	15	910	1,827	n/a	518
March 2017	27/03/2017	7	199	1,614	n/a	168

The calibration of the XP-RAFTS model was achieved by adjusting the catchment and routing parameters and adjusting initial and continuing rainfall losses to obtain the best fit between recorded and predicted discharge hydrographs. The adopted initial and continuing losses for the three events are shown in Table 1.5.

Table 1.5 – Adopted initial and continuing loss rates, calibration events

Flood event	Initial loss (mm)	Continuing loss (mm)
February 2008	20	4.0
December 2010	8	3.0
March 2017	45	3.0

Table 1.6 compares recorded and predicted peak discharges in the Isaac River at the Goonyella and Deverill gauging stations. A discussion of the calibration results is given below.

Table 1.6 - Comparison of recorded and modelled peak flood discharges, Isaac River at Goonyella and Deverill gauging stations

Calibration event	Peak discharge at Goonyella (m^3/s)		Difference	Peak discharge at Deverill (m^3/s)		Difference
	Recorded	Modelled		Recorded	Modelled	
February 2008	1,070	1,108	4%	2,142	2,149	0.3%
December 2010	910	868	-5%	1,827	1,854	1.5%
March 2017	199	254	28%	1,624	1,614	-0.6%

1.2.7.1 February 2008 calibration

Figure 1.2 and Figure 1.3 show comparisons of recorded and predicted discharge hydrographs at the Goonyella and Deverill gauging stations for the February 2008 event. The model reproduced the timing and shapes of the hydrographs relatively well. However, the model overestimates the peak discharge and flood volumes at both gauges. This is likely due to spatial variation in rainfall that was not covered by the recorded rainfall data.

1.2.7.2 December 2010 calibration

Figure 1.4 and Figure 1.5 show comparisons of recorded and predicted discharge hydrographs at the Goonyella and Deverill gauging stations for the December 2010 event. A good calibration was achieved for both gauges, with the XP-RAFTS model satisfactorily reproducing the flood peaks, timing and shapes of the hydrographs.

1.2.7.3 March 2017 calibration

Figure 1.6 and Figure 1.7 show comparisons of recorded and predicted discharge hydrographs at the Goonyella and Deverill gauging stations for the March 2017 event. A good calibration was achieved at the Deverill station, with the XP-RAFTS model satisfactorily reproducing the flood peaks, and the timing and shapes of the hydrographs. However, the model moderately overestimates the peak flows at Goonyella.

Three storages at Burton Gorge Dam, Teviot Dam and Lake Elphinstone were also modelled in the 2017 event. The following occurred during the 2017 event:

- Lake Elphinstone is not gauged but was not observed to spill in the 2017 event and did not spill in the XP-RAFTS model;
- Teviot Dam did not record a spill during the event, and no spill occurred in the XP-RAFTS model; and
- Burton Gorge Dam had a spill event, with a recorded peak discharge of about 235 m^3/s at the Burton Gorge Dam gauging station, compared to a peak discharge of about 211 m^3/s in the XP-RAFTS model.

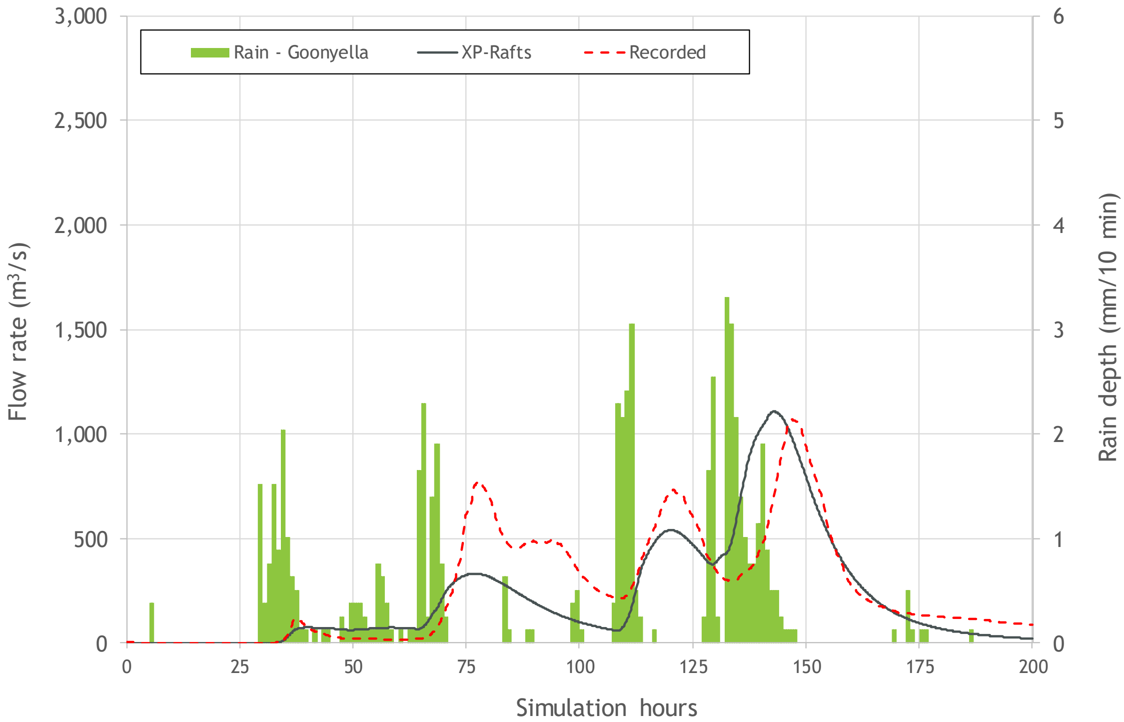

Figure 1.2 - Comparison of recorded and modelled discharge hydrographs, February 2008, Isaac River at Goonyella

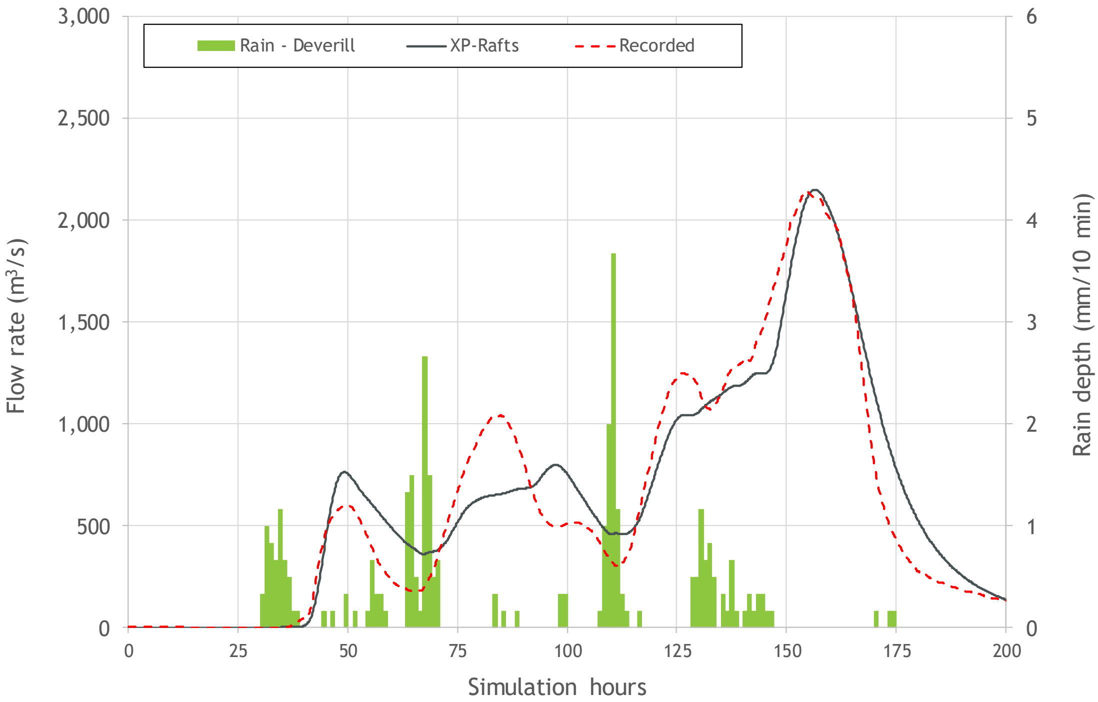

Figure 1.3 - Comparison of recorded and modelled discharge hydrographs, February 2008, Isaac River at Deverill

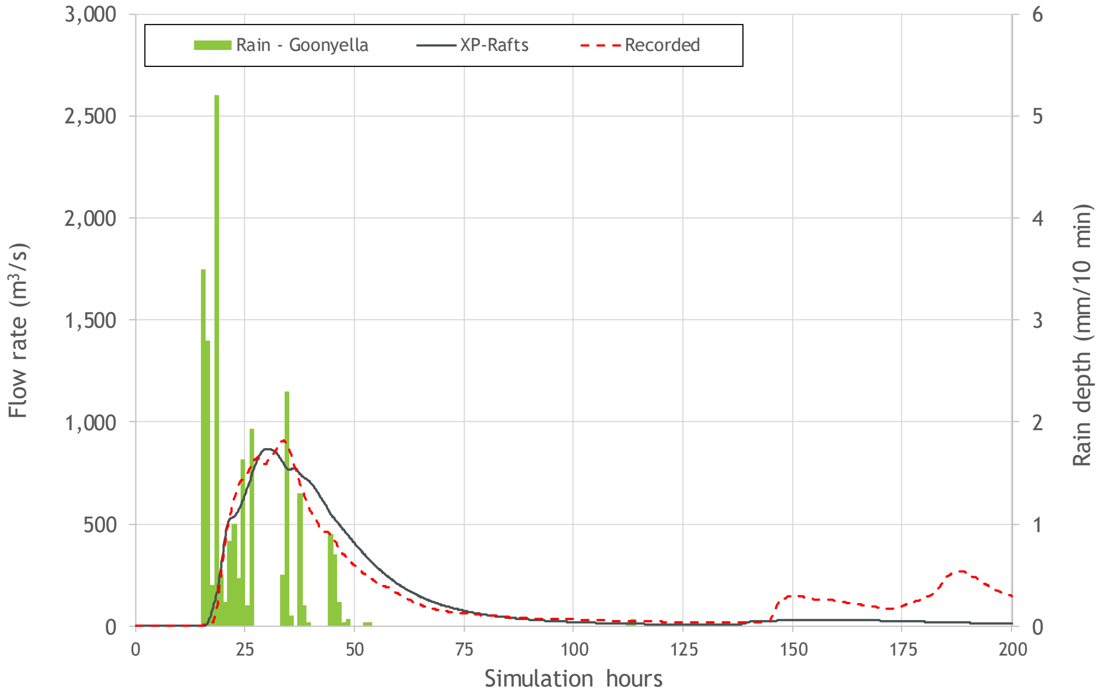

Figure 1.4 - Comparison of recorded and modelled discharge hydrographs, December 2010, Isaac River at Goonyella

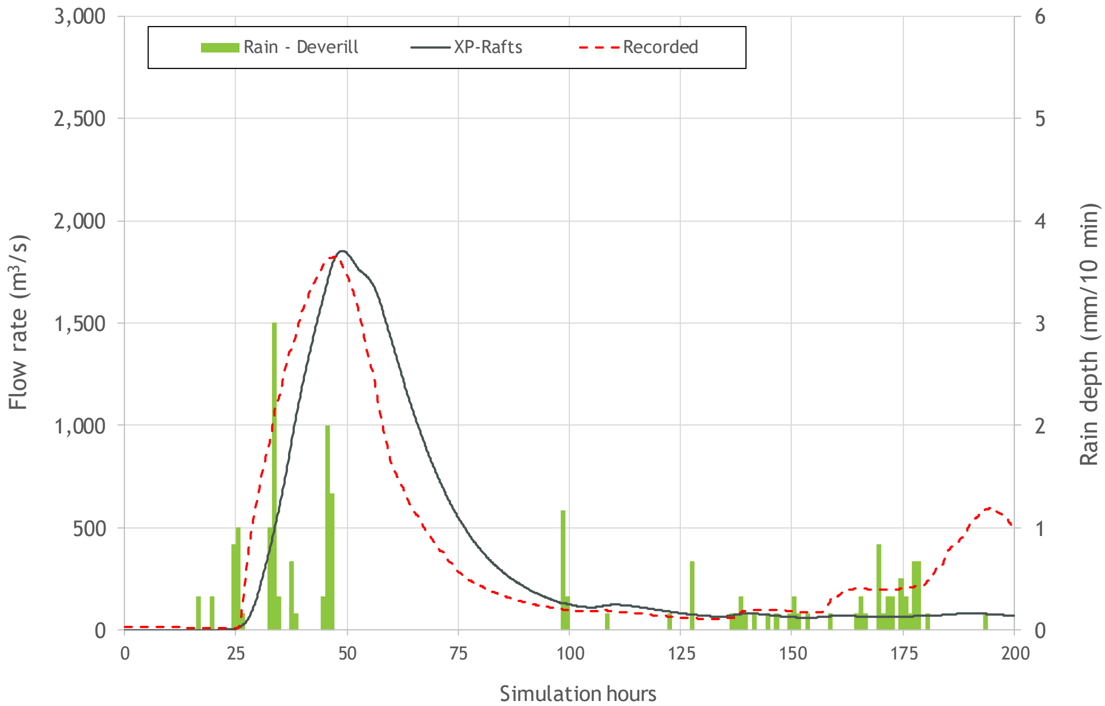

Figure 1.5 - Comparison of recorded and modelled discharge hydrographs, December 2010, Isaac River at Deverill

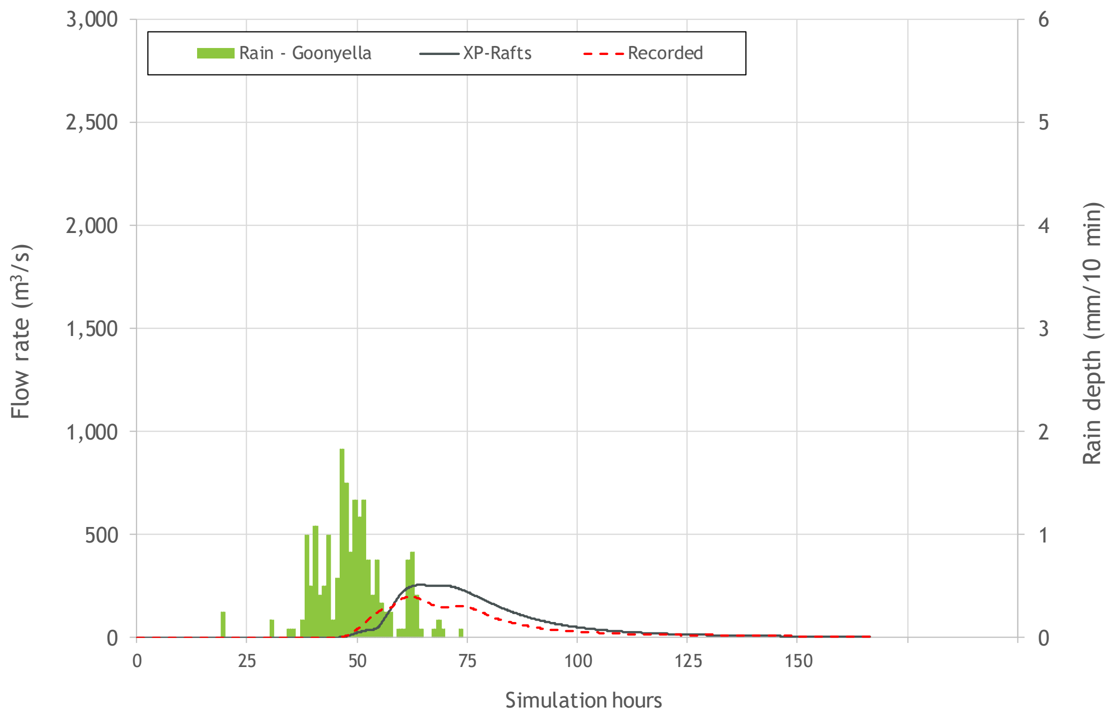

Figure 1.6 - Comparison of recorded and modelled discharge hydrographs, March 2017, Isaac River at Goonyella

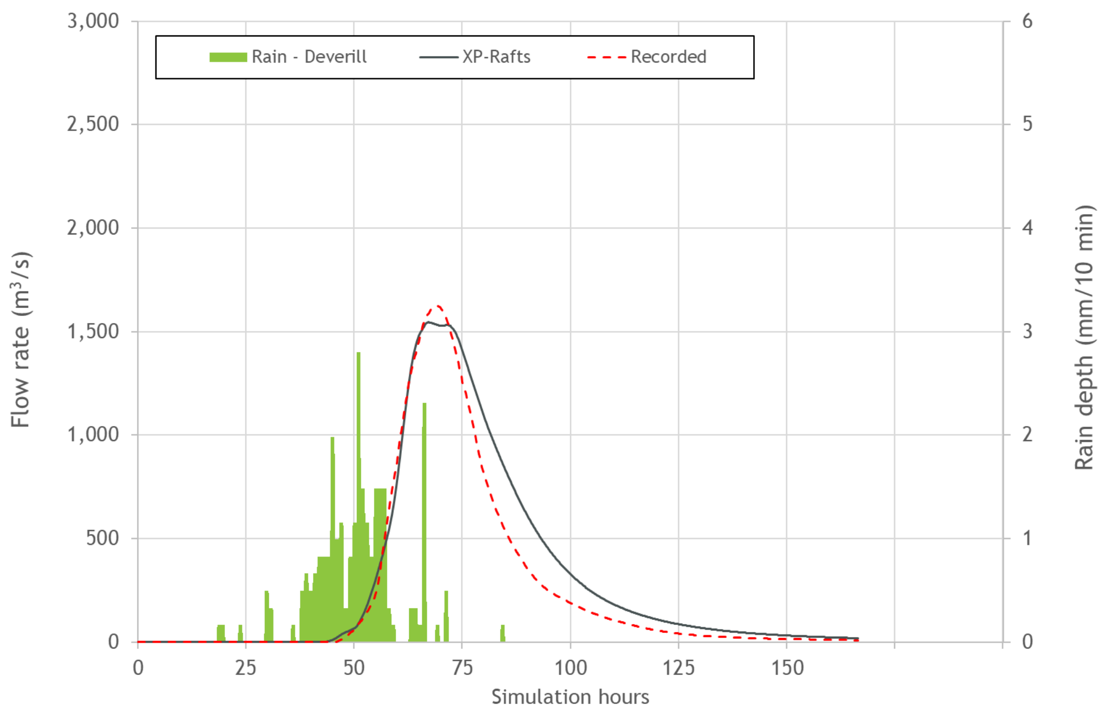

Figure 1.7 - Comparison of recorded and modelled discharge hydrographs, March 2017, Isaac River at Deverill

1.2.8 Flood frequency analysis at Deverill

A Log Pearson III (LP3) distribution was fitted to the annual series of recorded peak flood discharges at DNRME's Deverill gauge using the Bayesian inference methodology recommended in ARR (Ball et al., 2019). FLIKE software (BMT, 2017) was used to generate the FFA, giving the option to censor low flows to improve the LP3 fit for the larger events. For the purpose of the FFA, an October to September water year was adopted.

The hydraulic model adopted for this study was used to review the high flow rating at the stream gauge. The hydraulic modelling showed that as the creek banks are perched, with the adjacent floodplain flowing at substantially different levels to the recorded river levels, the DNRME rating curve may not accurately convert recorded water levels to peak discharges for the large overbank flood events.

An FFA was undertaken for the annual maximum series obtained using the adjusted flood peaks from a revised rating curve from the hydraulic model. Table 1.7 shows the updated nine (9) annual maximum flow rates using the hydraulic model rating. The revised rating resulted in a significant increase in the flow rate for the two largest events and a slight decrease for the next seven largest events. The lower in-channel event peaks were not changed.

The XP-RAFTS discharges were derived by applying areal reduction factors (ARF) from ARR (Ball et al., 2019) based upon the 3,850 km^2 of catchment area upstream of the Deverill gauge. The design discharges from the FFA at the Deverill gauge are shown in Table 1.8. The LPIII distribution is shown in Figure 1.8. Table 1.9 compares the peak FFA discharges and the mean discharges for the XP-RAFTS model.

Table 1.7 – Updated annual maximum flow rates using the TUFLOW rating curve

Year (Oct-Sep)	Recorded water level (mAHD)	Peak flow (m^3/s)		Difference in peak flow (m^3/s)
		Deverill rating curve (DRNME, 2016)	TUFLOW rating curve	
1987/88	11.43	2,638	3,701	+1,062
1990/91	11.20	2,429	3,037	+607
2007/08	10.86	2,142	1,975	-166
1988/89	10.85	2,137	1,971	-166
1978/80	10.82	2,113	1,949	-165
2010/11	10.44	1,827	1,783	-44
2015/16	10.38	1,791	1,761	-31
1997/98	10.17	1,706	1,687	-19
1977/79	10.16	1,703	1,682	-21

Table 1.8 – Updated FFA design discharges at Deverill using the TUFLOW rating curve

Design event	Peak discharge (m^3/s)	Lower confidence limit (m^3/s)	Upper confidence limit (m^3/s)
50% AEP (2 Year ARI)	362	249	532
10% AEP (10 Year ARI)	1,880	1,360	2,664
2% AEP (50 Year ARI)	3,852	2,611	7,117
1% AEP (100 Year ARI)	4,750	3,051	10,082

Table 1.9 – Comparison of FFA and XP-RAFTS design discharges at Deverill

Design event	Peak discharge (m^3/s)	XP-RAFTS (m^3/s)	% Diff
50% AEP (2 Year ARI)	362	352	2.8
10% AEP (10 Year ARI)	1,880	1,928	-2.5
2% AEP (50 Year ARI)	3,852	3,849	0.0
1% AEP (100 Year ARI)	4,750	4,996	5.0

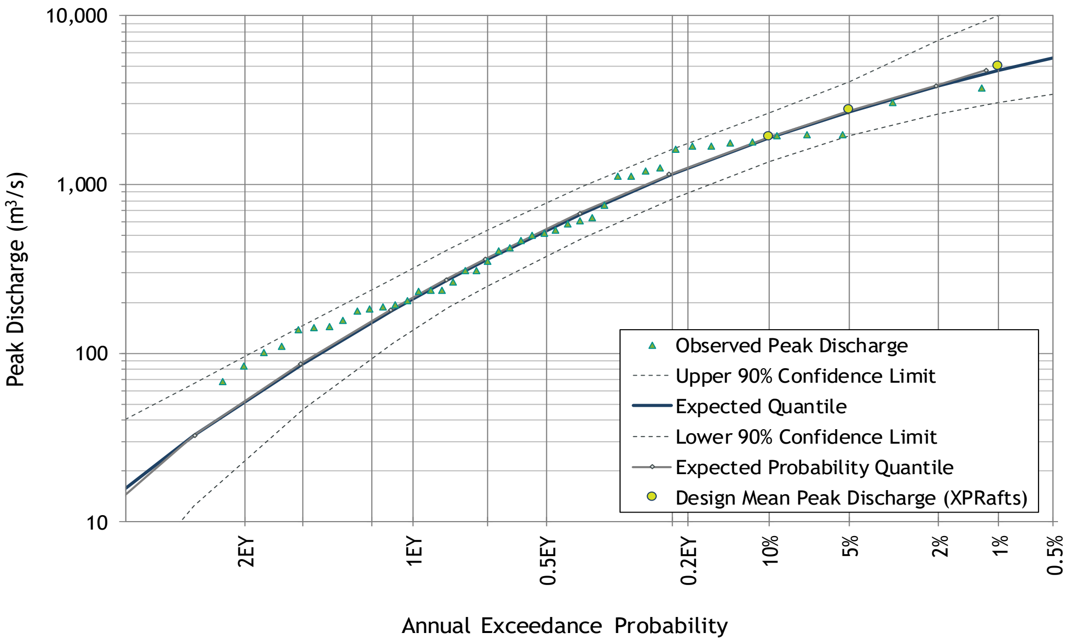

Figure 1.8 – LP3 distribution fitted to the updated Isaac River at Deverill annual series, 1968 to 2019

1.2.9 Design discharges

Design discharges were determined using an 'ensemble' of 10 temporal patterns, producing 10 design hydrographs (and peak discharges) for each duration for each AEP. The temporal pattern which resulted in a peak discharge closest to, but higher than, the ensemble mean was selected as the representative temporal pattern for that storm duration. The critical storm was determined at catchment IR42 adjacent to the mining lease area at the confluence of Boomerang Creek and the Isaac River. For the PMP storm, the storm producing the maximum peak discharge was selected. The peak discharges and the selected critical duration and temporal pattern at catchment IR42 are summarised in Table 1.10.

Table 1.10 – XP-RAFTS design discharges at IR42

Design event	Peak discharge (m^3/s)	Critical storm duration (hours)	Temporal pattern
50% AEP	450	24	10
10% AEP	2,295	24	6
2% AEP	4,517	24	3
1% AEP	5,907	24	10
0.1% AEP	12,370	24	3
PMF	52,225	36	3

1.3 LOCAL CREEKS XP-RAFTS HYDROLOGICAL MODEL

1.3.1 Overview

An XP-RAFTS model of the local creek system was developed as the basis of the present hydrological analysis for local flooding conditions. The local creek hydrological model includes the catchments of Boomerang, Ripstone, One Mile and Phillips Creeks and extends to the confluence of Phillips Creek with the Isaac River. One Mile Creek and Ripstone Creek flow into Boomerang Creek which discharges into the Isaac River approximately 4 km upstream of the confluence with Phillips Creek.

The model was calibrated to flows recorded at Lake Vermont Resources' Phillips Creek streamflow gauge during the Cyclone Debbie flood event (March 2017). Design peak flows in Phillips Creek were reconciled against the flood frequency analysis of the peak annual flow series of historical flow data recorded at the Tayglen gauge. All local creek design flows were validated by comparing against the Regional Flood Frequency Estimation Model (RFFE).

The local model was used to determine creek inflows for the 50%, 10%, 2%, 1%, 0.1% AEP and PMF design events.

1.3.2 Spatial configuration

Figure 1.9 shows the XP-RAFTS model configuration for the local creek model. The model extends downstream to the confluence of Phillips Creek with the Isaac River and has a total catchment area of 1,375 km^2. The model configuration includes subcatchments ranging in size from 0.2 km^2 to 59.8 km^2.

1.3.3 Subcatchment parameters

Model parameters for each subcatchment were determined as follows:

- A percentage impervious of zero was adopted for all subcatchments;

- Catchment slopes were determined based on the available topographic data;
- A subcatchment storage coefficient multiplication factor ‘Bx’ of 0.9 was adopted for all events based on model calibration;
- Subcatchment PERN ‘n’ values were determined based on the density of vegetation in each subcatchment. A PERN ‘n’ value of 0.04 was adopted for all subcatchments

The selection of initial and continuing losses for design events is described in Section 1.3.9.

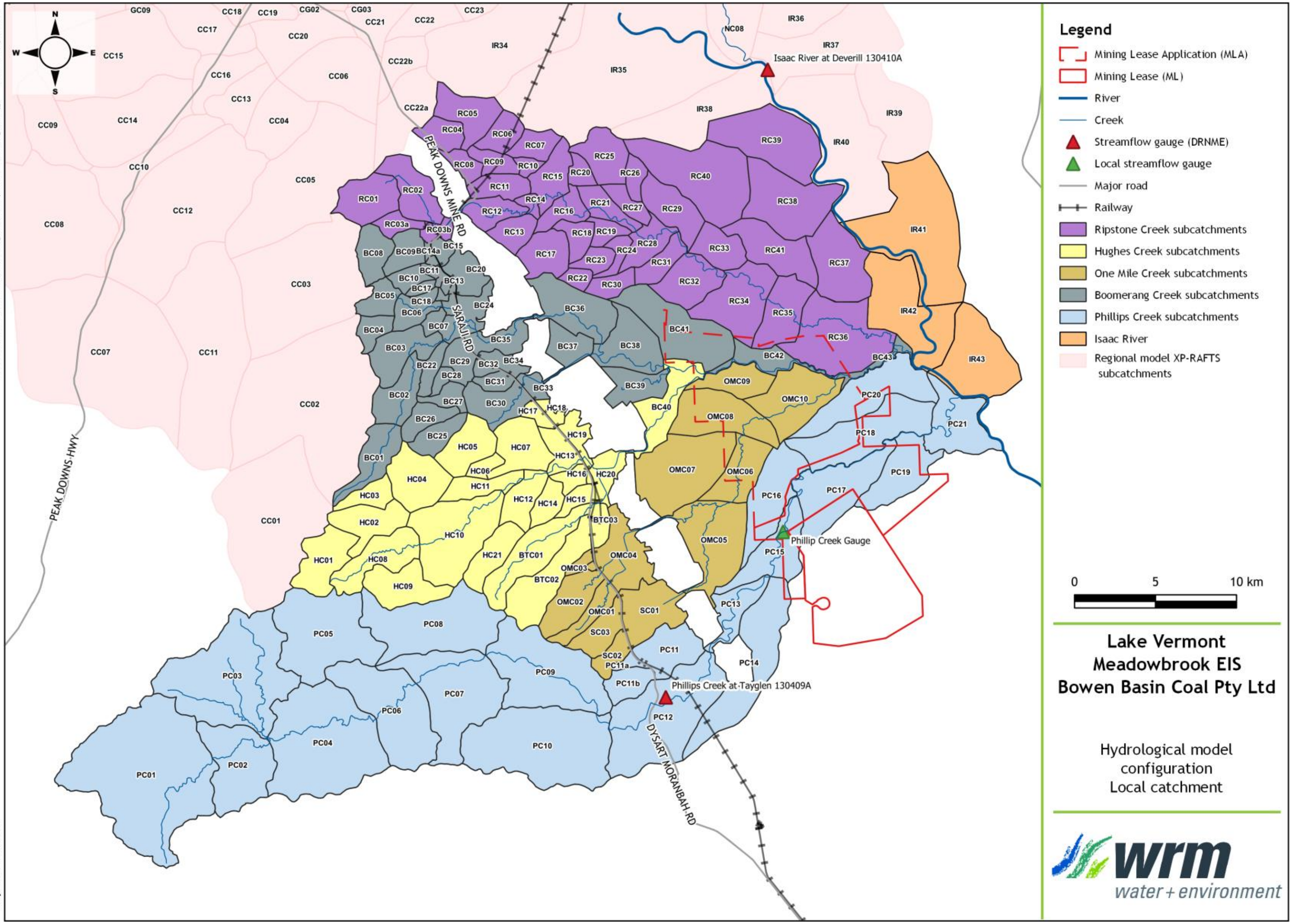

Figure 1.9 – XP-RAFTS local configuration

1.3.4 XP-RAFTS model calibration

The XP-RAFTS model was calibrated to a discharge hydrograph recorded at Lake Vermont Resources' Phillips Creek stream flow gauge for the Cyclone Debbie flood event in March 2017. The routing parameters and losses were adjusted to match the timing and magnitude of the peak discharge at the gauge.

The calibration event used local sub-daily rainfall data recorded onsite and provided by Lake Vermont Resources. The rainfall event began at 0000 hrs on 28 March 2017 for a period of approximately two days for a total cumulative rainfall of 169 mm.

A rating curve was developed using a TUFLOW model at the location of the Phillips Creek gauge to convert recorded stream flow levels to discharges.

The recorded rainfall was adjusted by a factor of 0.85 for the upstream catchments of Phillips Creek. The catchment storage factor Bx was adjusted to 0.9 to match the timing of the recorded peak. Initial and continuing rainfall losses were adjusted to obtain the best fit between recorded and predicted discharge hydrographs. The adopted initial and continuing losses for the event were 40 mm and 3.5 mm respectively.

Figure 1.10 compares the recorded and modelled discharge hydrographs at the Phillips Creek gauge. There is a very good match between the recorded and modelled timing of the peak discharge. The peak discharge of the modelled hydrograph occurs 35 minutes after the peak discharge of the recorded hydrograph. The peak recorded discharge of 428 m^3/s is within 2% of the modelled peak of 435 m^3/s. There is a very good match in the rate of rise of the recorded and modelled hydrographs and a reasonably similar match for the rate of recession.

Overall, the calibration of the XP-RAFTS hydrological model is excellent for the shape, timing and peak discharge in comparison with the recorded flow. The calibration provides confidence that the model is fit for the purpose of estimating design peak discharges for impact assessment.

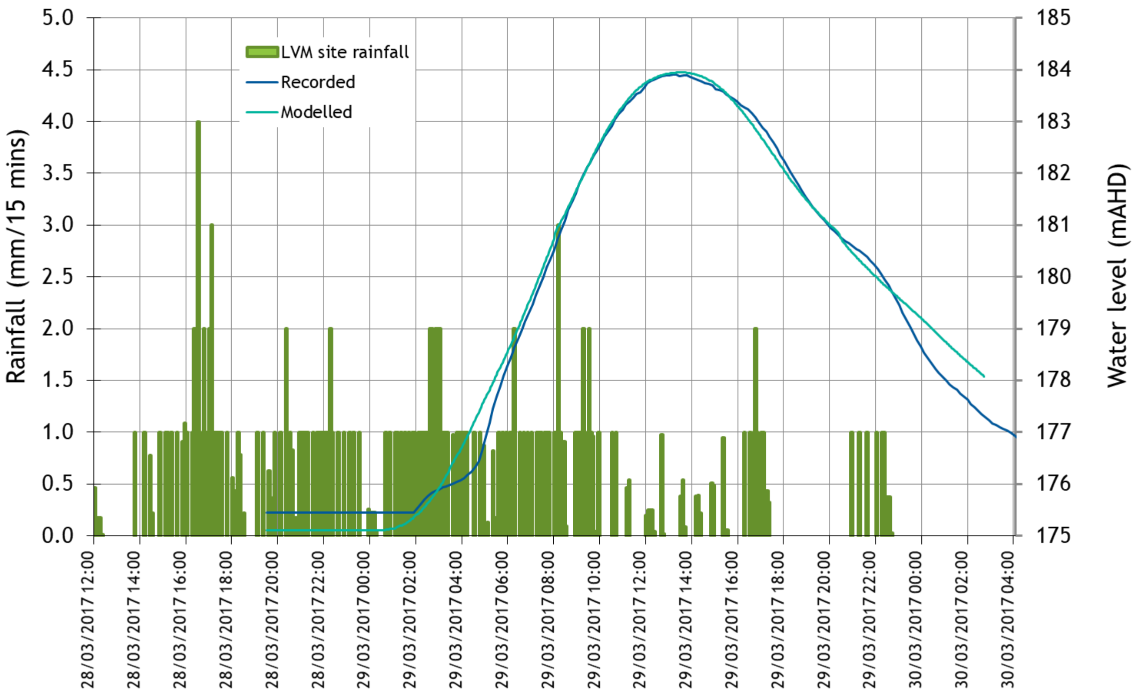

Figure 1.10 - Comparison of recorded and modelled discharge hydrographs, March 2017, Phillips Creek gauge

1.3.5 Flood frequency analysis at Tayglen

An FFA of DNRME's now closed gauge at Tayglen on Phillips Creek was developed using the FLIKE software. A Log Pearson III (LP3) distribution was fitted to 20 years of annual maxima. Table 1.11 summarises the peak discharges derived from the FFA of the annual series of historical flows.

Table 1.12 compares the XP-RAFTS peak discharges at Tayglen and the FFA. The modelled 1% AEP discharge is 8% higher than the FFA but within the 90th percentile confidence limits. Results for the other AEP events are within 20 percent of the expected quantile and well within the 90% confidence limits.

Table 1.11 – FFA design discharges at Tayglen

Design event	Peak discharge (m^3/s)	Lower confidence limit (m^3/s)	Upper confidence limit (m^3/s)
50% AEP (1.44 Year ARI)	108	74	158
10% AEP (10 Year ARI)	376	227	622
2% AEP (50 Year ARI)	819	359	1,868
1% AEP (100 Year ARI)	1,083	402	2,922

Table 1.12 – Comparison of FFA and XP-RAFTS design discharges at Tayglen

Design event	Peak discharge (m^3/s)	XP-RAFTS (m^3/s)	% Diff
50% AEP (1.44 Year ARI)	108	97	-10
10% AEP (10 Year ARI)	376	466	24
2% AEP (50 Year ARI)	819	970	18
1% AEP (100 Year ARI)	1,083	1,170	8

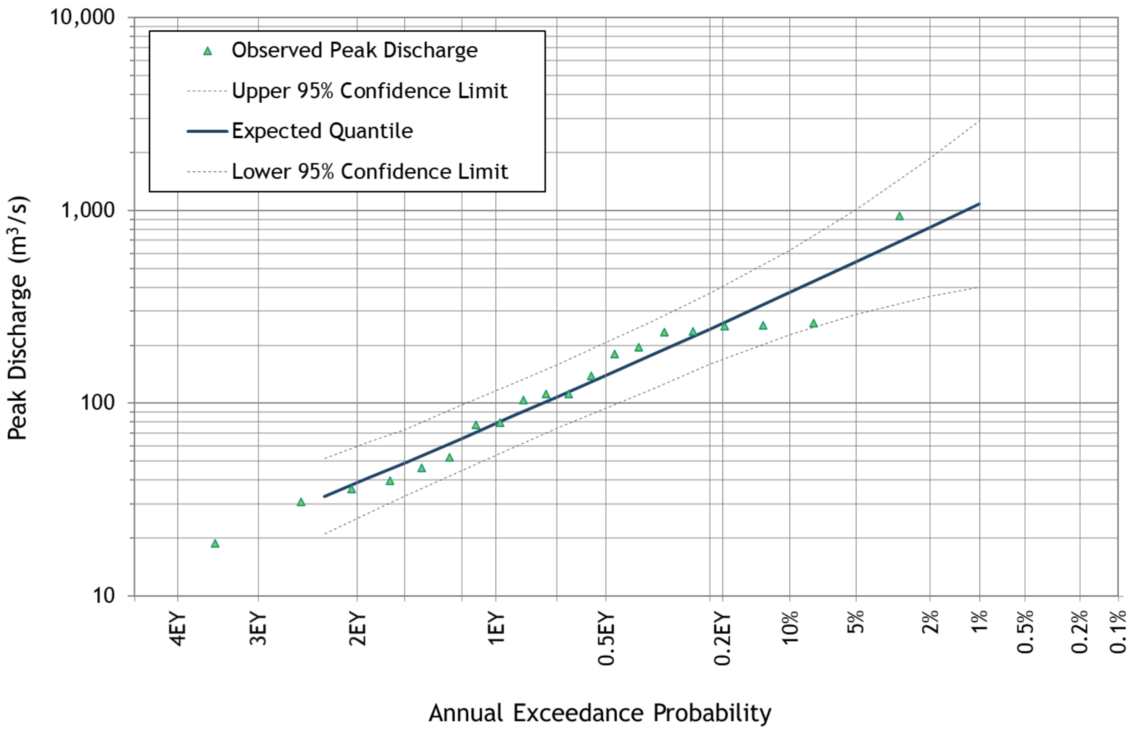

Figure 1.11 – Flood Frequency Analysis to Phillips Creek at Tayglen, 1968 to 1988

1.3.6 Comparison with Regional Flood Frequency Estimation Model (RFFE)

The Regional Flood Frequency Model (RFFE) is an automated web-based tool developed as part of ARR 2019 (Ball et al, 2019) to estimate peak discharges for ungauged catchments based on data from nearby catchments. The RFFE is suitable for catchments with little (<10%) to no urbanisation and less than 1,000 km^2 in area. These criteria are satisfied by the local creek catchments assessed for the Project.

An RFFE analysis was undertaken for the Boomerang, Ripstone, One Mile and Phillips Creeks to compare peak XP-RAFTS discharges at the catchment outlets to RFFE estimates. Table 1.13, Table 1.14, Table 1.15 and Table 1.16 show the comparisons between the RFFE values and XP-RAFTS discharges for the Boomerang, One Mile, Ripstone and Phillips Creeks.

As suggested in ARR 2019, there will be considerable uncertainty in RFFE estimates for ungauged catchments because of the limited number of gauged catchments available to develop the method and the wide range of catchment types that exist throughout Australia. It is also recognised that there will be uncertainty in the observed flood data due to factors such as limitations in record length and rating curve extrapolation. This uncertainty is reflected in the significant range of RFFE results between the confidence limits.

In general, expected peak discharge values for the RFFE are lower than the peak discharges from XP-RAFTS for Boomerang and One Mile Creeks and higher for Phillips and Ripstone Creeks. Values for the 50% AEP event are generally a poor match, falling outside the confidence bounds. However, all other values fall within the confidence bounds of the RFFE.

There is a lack of similar gauged catchments in the vicinity of the Project, and therefore caution should be exercised in comparing the RFFE to XP-RAFTS. The Phillips Creek RFFE also shows a large disparity with the results of the FFA at the Tayglen gauge.

Table 1.13 - Comparison of RFFE and XP-RAFTS design discharges for Boomerang Creek

AEP (%)	RFFE (Expected)	Lower confidence limit (m^3/s)	Upper confidence limit (m^3/s)	XP-RAFTS (m^3/s)	% Diff
50% AEP (1.44 Year ARI)	245	140	447	108	-126
10% AEP (10 Year ARI)	470	264	888	469	0
2% AEP (50 Year ARI)	709	354	1,540	892	26
1% AEP (100 Year ARI)	822	388	1,910	1,097	33

Table 1.14 - Comparison of RFFE and XP-RAFTS design flows for One Mile Creek

AEP (%)	RFFE (Expected)	Lower confidence limit (m^3/s)	Upper confidence limit (m^3/s)	XP-RAFTS (m^3/s)	%Diff
50% AEP (1.44 Year ARI)	85	48	157	32	-165
10% AEP (10 Year ARI)	166	92	321	152	8
2% AEP (50 Year ARI)	254	123	580	296	17
1% AEP (100 Year ARI)	297	135	736	370	25

Table 1.15 - Comparison of RFFE and XP-RAFTS design flows for Ripstone Creek

AEP (%)	RFFE (Expected)	Lower confidence limit (m^3/s)	Upper confidence limit (m^3/s)	XP-RAFTS (m^3/s)	% Diff
50% AEP (1.44 Year ARI)	224	129	404	67	-234
10% AEP (10 Year ARI)	429	242	801	305	-29
2% AEP (50 Year ARI)	645	325	1,390	587	-9
1% AEP (100 Year ARI)	748	355	1,740	734	-2

Table 1.16 – Comparison of RFFE and XP-RAFTS design flows for Phillips Creek

AEP (%)	RFFE (Expected)	Lower confidence limit (m^3/s)	Upper confidence limit (m^3/s)	XP-RAFTS (m^3/s)	%Diff
50% AEP (1.44 Year ARI)	381	225	665	104	-266
10% AEP (10 Year ARI)	715	264	888	469	-35
2% AEP (50 Year ARI)	1,060	354	1,540	900	-15
1% AEP (100 Year ARI)	1,230	388	1,910	1,130	-8

1.3.7 Spatial and areal variability

A comparison of the design rainfall intensities at the western, eastern, and northern catchment boundaries of the local creek system, and at the centroid, revealed on average less than 2% variance in rainfall for the 1% AEP event across all durations. The rainfall intensities at the southern catchment boundary were on average within 3% of the values at the centroid the catchment.

Due to the small variation in design rainfall estimates over most of the catchment, a uniform spatial rainfall distribution was adopted across the catchment.

For a conservative estimation of peak flow discharges, no areal reduction factors were applied to the rainfall for the local creek system. No ARF was adopted for the PMP rainfall as catchment area is already incorporated into the PMP rainfall estimation.

1.3.8 Temporal patterns

The East Coast North temporal patterns from ARR Data Hub (Geoscience Australia, 2019) were used for design events up to 1% AEP event. For the 0.1% AEP, ARR recommends using temporal patterns for storm durations applied to the PMP. The temporal patterns used for the PMP rainfall events are discussed in 1.3.10.

1.3.9 Design rainfall losses

The losses determined from the reconciliation with the FFA at Tayglen were applied to the XP-RAFTS model. Table 1.17 summarises the initial and continuing rainfall losses adopted for the design events. The loss for the 0.1% AEP event follows the recommendation of ARR 2019 of varying the continuing loss between the loss for the 1% AEP and PMP.

Table 1.17 - Adopted initial and continuing losses for local model

AEP	Initial loss (mm)	Continuing loss (mm/hr)
50% AEP	50	3.0
10% AEP	40	3.0
2% AEP	40	3.0
1% AEP	40	3.0
0.1% AEP	0	2.0
PMP	0	1.0

1.3.10 PMP storm

The PMP rainfall was determined separately for Boomerang, One Mile, Ripstone and Phillips Creeks. Each catchment required an assessment using the Generalised Short Duration Method (GSDM) (BOM, 2003) (for catchments <1,000 km^2 and durations up to 6 hrs) and the GTSMR method for durations of 24 hrs and longer. Rainfall values were interpolated using the results of both methods for durations falling between 6 hrs and 24 hrs. Values for the 4.5 hr storm were also interpolated from the 4 hr and 5 hr GSDM storms.

For the GSDM method, all catchments were classified as fully rough based on an examination of the topography. The Elevation Adjustment Factor (EAF) and Moisture Adjustment Factor (MAF) for all catchments were 1.0 and 0.9 respectively.

GTMSR rainfall values for the coastal zone were calculated and applied in accordance with BOM 2003 methodology. Table 1.18 summarises the rainfall adjustment factors that were applied for each creek catchment.

For the GSDM, the ensemble of ten temporal patterns developed by Jordan et al. were used (Jordan, 2005). For the GTSMR, the appropriate ensemble of coastal storm patterns was used depending on the catchment size along with the AVM pattern. Durations between 6 hrs and 24 hrs were assessed by applying both sets of temporal patterns in accordance with the recommendation given in ARR 2019.

Table 1.18 – PMP GTSMR rainfall factors for local model

Catchment	Topological Adjustment Factor (TAF)	Decay Amplitude Factor (DAF)	Extreme Precipitable Water (EPW)	Annual Moisture Adjustment Factor (EPW/120)
Boomerang Creek	1.0	1.0	90.92	0.76
One Mile Creek	1.0	1.0	90.49	0.76
Ripstone Creek	1.0	1.0	91.69	0.76
Phillips Creek	1.0	1.0	90.49	0.75

1.3.11 Design discharges

Design discharges were determined using an ‘ensemble’ of 10 temporal patterns, which produces 10 design hydrographs (and peak discharges) for each duration for each AEP. The temporal pattern which results in a peak discharge closest to, but higher than, the ensemble mean is selected as the representative temporal pattern for that storm duration. For the PMP storm, the storm producing the maximum peak discharge was selected. The peak design discharges are summarised in Table 1.19. For each AEP event a single representative critical duration and temporal pattern was selected. The selected duration and temporal for each AEP event for hydraulic modelling is summarised in Table 1.20.

Table 1.19 – Peak design discharges, critical storm duration and temporal pattern

Key location	Event	XP-RAFTS design peak discharge (m^3/s)	Critical storm duration (hours)	Temporal pattern
RC35	50%	60	24	10
	10%	245	6	5
	2%	478	6	5
	1%	584	6	1
	0.1%	1,303	6	9
	PMF	3,763	9	14
BC40	50%	136	24	10
	10%	555	6	7
	2%	1,062	6	6
	1%	1,290	6	6
	0.1%	2,819	6	5
	PMF	7,581	9	14
OMC05	50%	25	24	10
	10%	113	6	7
	2%	225	6	6
	1%	276	6	5
	0.1%	614	6	9
	PMF	2,123	6	3
PC15	50%	120	24	10
	10%	538	9	5
	2%	1,059	6	5
	1%	1,308	6	4
	0.1%	2,989	6	5
	PMF	8,592	9	14

Table 1.20 – Selected critical storm duration and temporal pattern

Event	Critical storm duration (hours)	Temporal pattern
50%	24	10
10%	9	5
2%	6	6
1%	6	4
0.1%	6	5
PMF	9	14

1.3.12 Climate change assessment

An impact assessment for climate change on peak flows for the 50%, 10%, 2% and 1% AEP events was based on the Representative Concentration Pathway (RCP) 8.5 scenario for 2060. RCP8.5 corresponds to a worst-case scenario. The ARR datahub provides a Climate Change Factor (CCF) for each RCP for each decade from 2030 up to 2090. As the Project finishes sometimes between 2050 and 2060 the year 2060 was selected for this assessment. According to the ARR Datahub the increase in rainfall intensity for RCP8.5 at the location of the Project for 2060 is 11.5%.

The rainfall intensity for the selected flood events was therefore factored up by 1.115 and new discharges derived at the key locations. The impact on the annual exceedance probability of flood events at the key locations selected is summarised in Table 1.21. For instance as the location of PC15 a discharge that is currently estimated as being a 1% AEP flood event, under the climate change scenario assessed here, will now have an AEP of 1.6%.

Table 1.21 – Impact on AEP of flood events from RCP8.5 2060 Climate Change Scenario

Location	Revised Annual Exceedance Probability				
	50% AEP	10% AEP	2% AEP	1% AEP	0.1% AEP
RC35	56.2	17.0	3.8	1.6	0.27
BC40	59.2	16.6	3.7	1.8	0.27
OMC05	56.2	16.8	3.8	2.0	0.28
PC15	56.1	17.2	3.8	1.6	0.28

Based on these results, under climate change, in the vicinity of the project disturbance, the flood maps would be representative of flow conditions in more frequent events, as described below:

- the 50% AEP map would have an AEP of about 56%;
- the 10% AEP map would have an AEP of about 17%;
- the 2% AEP map would have an AEP of about 3.8%;
- the 1% AEP map would have an AEP of about 1.8%; and
- the 0.1% AEP map would have an AEP of about 0.3%.

2 Hydraulic modelling

2.1 OVERVIEW

Due to the flat topography of the Isaac River floodplain and the interaction of overbank flows between the various watercourses in the Project area, a two-dimensional hydraulic model was adopted to ensure that the movement of water across the floodplain was adequately simulated.

The TUFLOW hydrodynamic model (BMT, 2018) was used to simulate the flow behaviour of the Isaac River, Ripstone Creek, Boomerang Creek, Hughes Creek, One Mile Creek and Phillips Creek in the vicinity of the Project including flood extents, depths and velocities.

TUFLOW represents hydraulic conditions on a fixed grid by solving the full two-dimensional depth averaged momentum and continuity equations for free surface flow (BMT, 2018). The model automatically calculates breakout points and flow directions within the Project area. The most recent version of the TUFLOW software (Build 2020-10-AB) was used for this study.

The TUFLOW model was run using the Heavily Parallelised Compute (HPC) GPU solver which uses adaptive time stepping. The Maximum Courant Number was limited to 0.8 to improve model stability in the sections of the Isaac River where the water depth exceeded 20 m for the extreme events.

Hydraulic models were prepared for the following scenarios which are described in the following sections:

- Pre-mining approved conditions - which assumes the already approved Lake Vermont satellite pit and final landform and Phillips Creek diversion are in place.
- Developed conditions (Year 26 mine site conditions) – representing the greatest amount of disturbance to the floodplain – with:
    - mine subsidence at its full extent,
    - earthworks and cross-drainage for the haul road,
    - levees around the MIA,
    - levees around the full extent of the open cut operation,
    - the implementation of channels and bunds to mitigate the extent of subsidence-induced ponding.
- Post-closure scenario - with the removal of all operational site activities, rehabilitation of much of the floodplain to pre-mining ground levels, leaving the final in-pit emplacement area and associated rehabilitated overburden stockpile, haul road, mine subsidence, and measures to mitigate subsidence-induced ponding.
- Cumulative impact conditions - with all levees in place associated with the proposed Olive Downs Project. The cumulative impact scenario was run for both Year 26 mine site conditions and the post-closure conditions.

2.2 TUFLOW MODEL CONFIGURATION – APPROVED CONDITIONS

2.2.1 Model extent and resolution

Figure 2.1 shows the configuration of the approved conditions TUFLOW model. The hydraulic model includes approximately 50 km of the Isaac River and the downstream ends of Ripstone Creek, Boomerang Creek, Hughes Creek, One Mile Creek and Phillips Creek. The modelled area covers approximately 434 km^2.

The TUFLOW model uses topographic aerial survey data (LiDAR) supplied by AAM Pty Limited via Lake Vermont Resources. The ground surface model was obtained by LiDAR capture on 7, 8 and 17 April 2019. AAM quote the LiDAR data as having a vertical RMS error of 0.15 m. The LiDAR was supplied at 1 m resolution and used as the basis for the TUFLOW model.

LiDAR data supplied by Peabody was used to extend the TUFLOW model approximately 13 km further upstream along the Isaac River to Deverill. The data was obtained from Fugro Spatial Solutions who acquired it in November 2012. The LiDAR was captured between 16 June and 29 July 2012. The data was supplied as thinned LiDAR ground strikes (1 m grid) with a nominal vertical accuracy of 0.12 m.

The grid size was varied throughout the model using a quadtree mesh. Complex areas within the Project area were modelled using a fine mesh, while floodplain areas of less importance to the impact assessment were modelled using a coarse mesh.

The quadtree configuration for the approved development configuration is shown in Figure 2.2. An 8 m cell size was adopted for the Isaac River channel and most of the Project area. The subsidence zones, and the nearby channels of Boomerang, One Mile and Phillips Creeks were modelled with a 4 m cell size. The reaches of Boomerang and One Mile Creeks subject to detailed geomorphological assessment and the proposed ponding mitigation channels were modelled using a 2m cell size.

Sub-grid sampling (SGS) was enabled so that each 2d cell face was represented by multiple elevation values. The number and spacing of SGS sampling points varies with cell size.

2.2.2 Inflow and outflow boundaries

Figure 2.1 shows the locations of the 2D inflow and outflow boundaries used in the TUFLOW model. The discharge hydrographs estimated using the XP-RAFTS runoff-routing model were adopted as inflows to the TUFLOW model. The names of the inflow boundaries correspond to the names of the subcatchments shown in Annexure A. The XP-RAFTS inflows for all watercourses were applied concurrently.

Inflows from the hydrological model draining to the upstream extents of the hydraulic model were applied as total hydrograph inflows at these locations. The positions of these inflow boundaries were chosen so that flows were as confined as possible at their point of entry into the hydraulic model - with minimum flow break out. The flows from the subcatchments within the hydraulic model were applied as local source area inflows. These source areas supply the flow to the lowest cells within the source area polygons.

The outflow boundary on the Isaac River, approximately 16 km downstream of its confluence with Phillips Creek, uses an automatically generated rating curve based on a 0.1% slope.

2.2.3 Adopted Manning's 'n' roughness

The TUFLOW model uses Manning’s ‘n’ values to represent hydraulic resistance. Manning’s ‘n’ values were adopted based on typical published values (for example those of Chow, 1959) and consistent with Manning’s ‘n’ values adopted in nearby flood studies which were calibrated to recorded water level hydrographs at Deverill gauging station for the March 2017 event.

Table 2.1 shows the adopted Manning’s ‘n’ values for the TUFLOW model and Figure 2.3 shows the location of each land use.

Table 2.1 – Adopted Manning’s ‘n’ values

Land use	Manning’s ‘n’
Isaac River sand bed	0.025
Channel bed	0.035
Light vegetation	0.045
Medium vegetation	0.06
Dense vegetation	0.07
Exposed soil / unsealed road	0.025
Water body / dam	0.015

2.2.4 Hydraulic structures

The approved conditions TUFLOW model incorporates the following works approved as part of the existing Lake Vermont operation:

- the proposed Phillips Creek diversion;
- the proposed Lake Vermont final landform (encroaching onto the southern floodplain of Phillips Creek); and
- the Satellite pit.

Otherwise, model conditions are the same as existing site conditions. The approved conditions model contains no other structures.

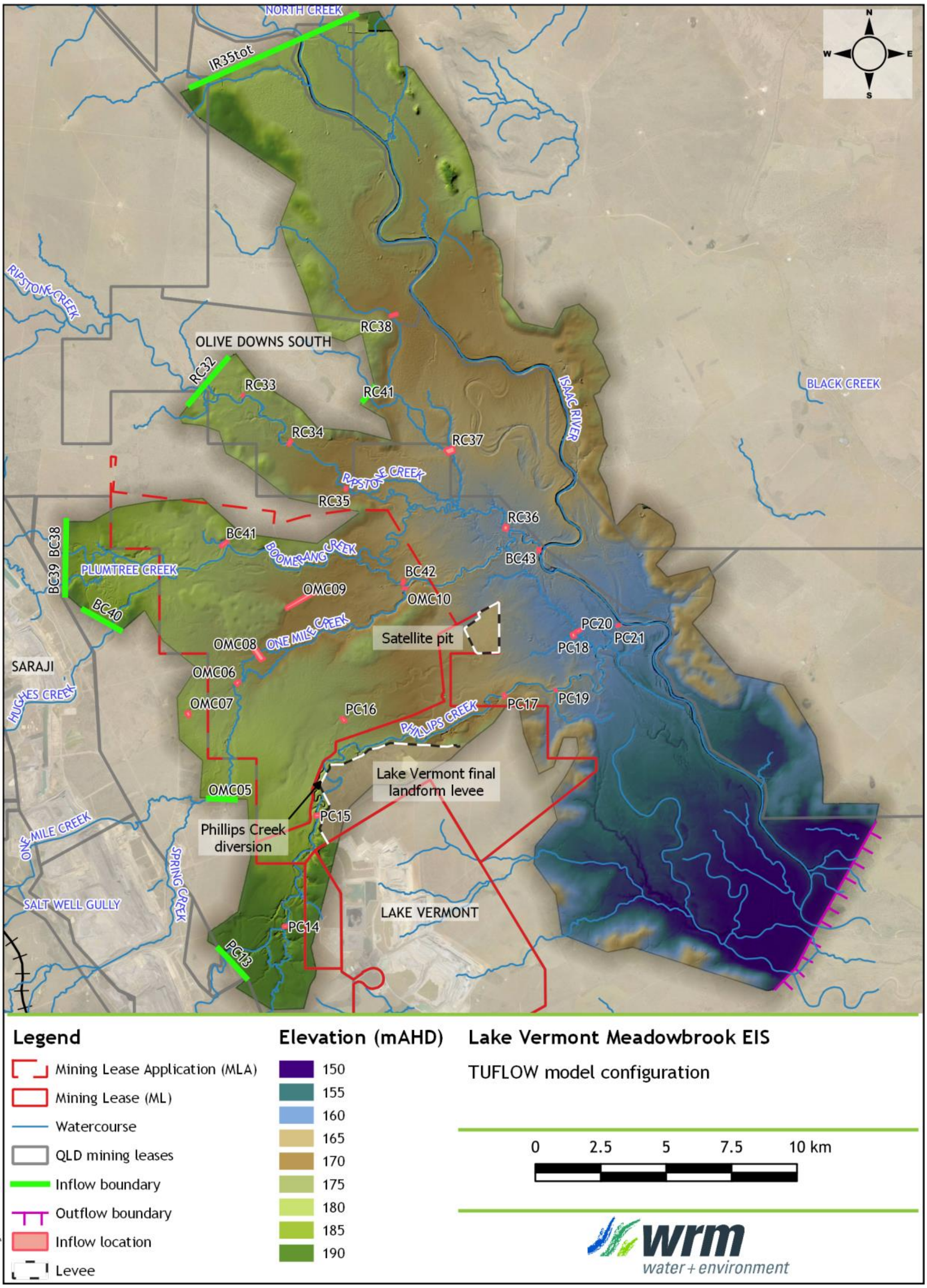

Figure 2.1 – TUFLOW approved conditions model configuration

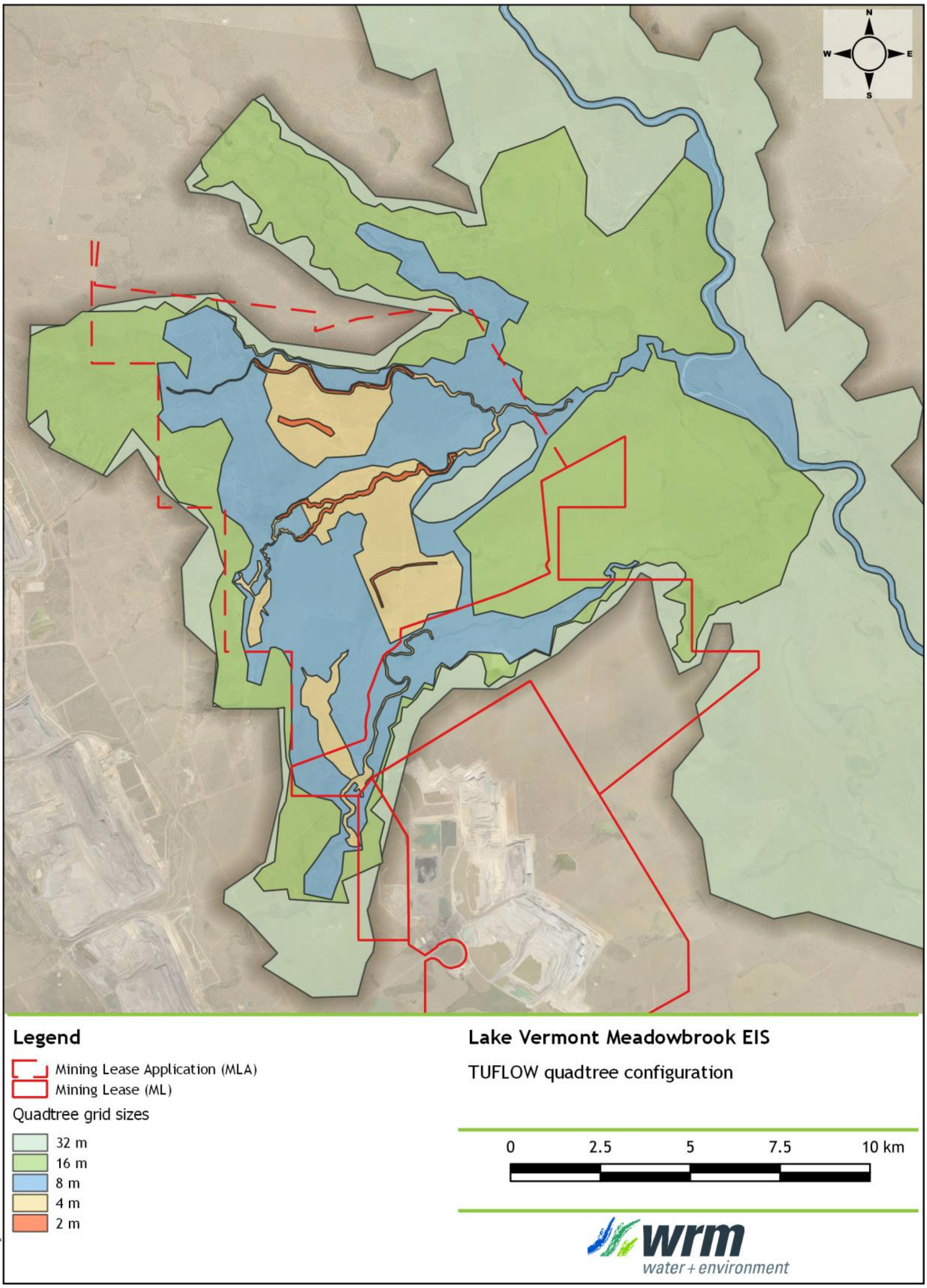

Figure 2.2 – TUFLOW quadtree configuration

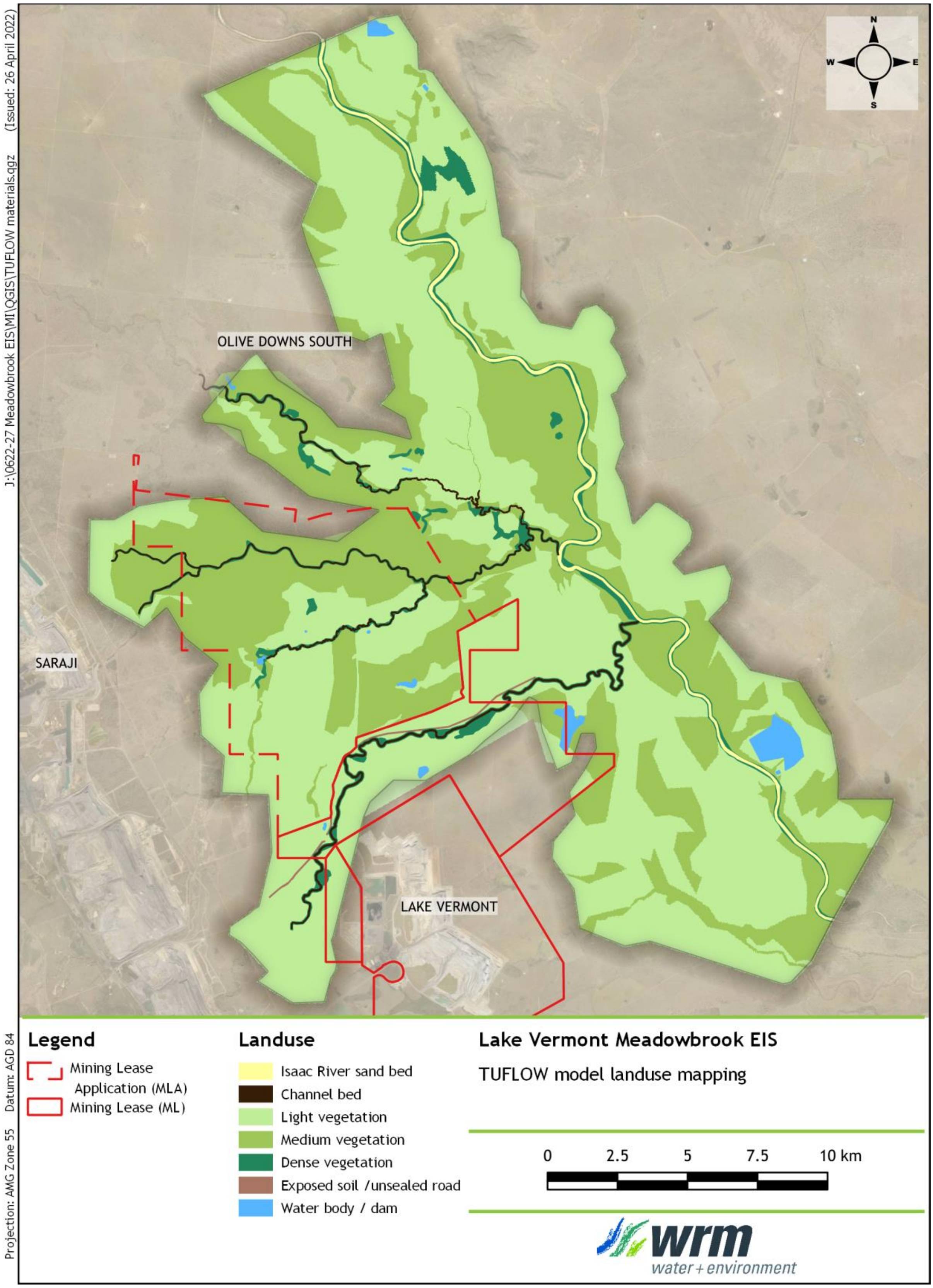

Figure 2.3 – TUFLOW land use mapping

2.3 TUFLOW MODEL CONFIGURATION – DEVELOPED CONDITIONS

The approved conditions flood model was adjusted to include project conditions in Year 26, which represents the period of greatest disturbance to the floodplain from the Project. Estimated subsidence contours representing the extent of surface depression at 0.05 m intervals were provided by Gordon Geotechniques Pty Ltd. The surface depressions for Year 26 were stamped onto the existing surface. In addition to the impacts of subsidence from the longwall panels, the following elements of infrastructure have an impact on flood behaviour:

- The haul road between the proposed Mine Infrastructure Area and the existing Lake Vermont operations to the south. The haul road crosses Phillips Creek, the Phillips Creek northern floodplain and One Mile Creek, and incorporates several cross-drainage structures;
- The Mine Infrastructure Area adjacent to One Mile Creek which would be protected from inundation by a levee;
- The open cut mine which extends onto the Phillips Creek and One Mile Creek floodplains and would be protected by a temporary levee around the ultimate pit extent;
- Construction of two diversion drains:
    - The drain adjacent to the Mine Infrastructure Area diverting flow from a tributary through a cross-drainage structure along the haul road to the channel of One Mile Creek;
    - A drain diverting flow in the northern Phillips Creek floodplain around the southern edge of the open-cut pit;
- The implementation of mitigation measures to decrease the amount of pondage in the subsidence areas including:
    - A drainage channel to alleviate the extent of ponding within the subsidence panels immediately to the north of Phillips Creek that diverts flow downstream to a tributary of Phillips Creek;
    - The insertion of bunds across these subsidence panels to prevent floodwater flowing north and into One Mile Creek;
    - A drainage channel to alleviate the extent of ponding in the subsidence panels to the south of Boomerang Creek near inflow OMC09.

The configuration of the TUFLOW model for the Year 26 project conditions with mitigation measures implemented is shown in Figure 2.4.

The haul road has the most potential for causing significant off-lease impacts upstream of the lease area. These risks were mitigated during the preliminary design of the road embankment and associated cross-drainage structures. It should be noted that prior to construction, the haul road design will be refined further, with the vertical profile and cross-drainage structure details chosen to ensure impacts do not exceed those in the preliminary design. For the purposes of this study, the preliminary design and the indicative number and sizing of cross drainage structures along the haul road summarised in Table 2.2 were adopted. The haul road alignment and chainages are shown in Figure 2.5.

Table 2.2 – Haul Road cross drainage structures

Approximate chainage (m)	Structure details
4,080	1 x 1200 mm x 600 mm RCBC
4,780	2 x 750 mm x 600 mm RCBC
6,000	2 x 3600 mm x 1800 mm RCBC
8,350	2 x 1200 mm x 600 mm RCBC
11,120	1 x 1200 mm x 600 mm RCBC
11,680	1 x 1200 mm x 600 mm RCBC

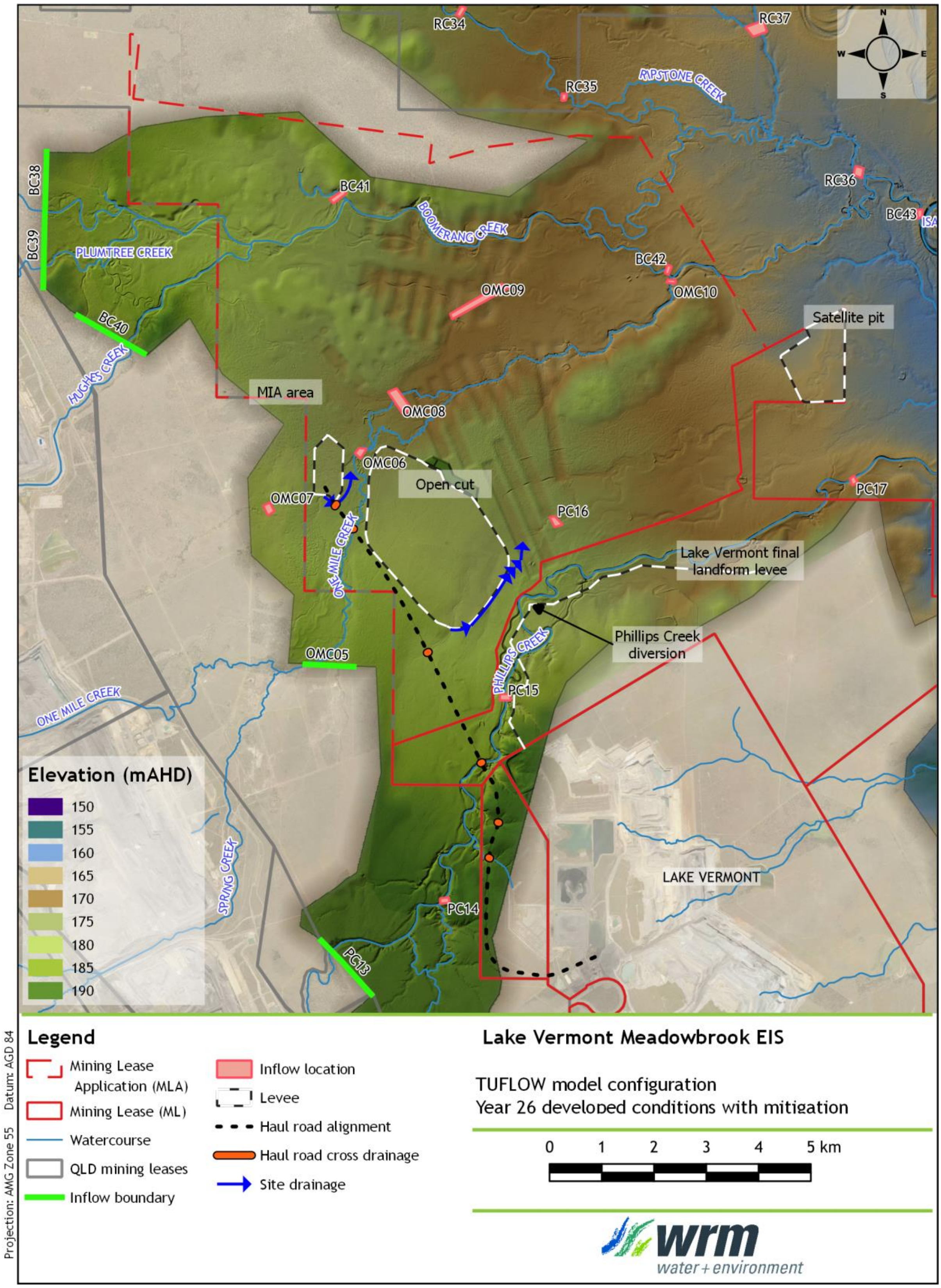

Figure 2.4 – TUFLOW Year 26 developed conditions configuration with mitigation measures

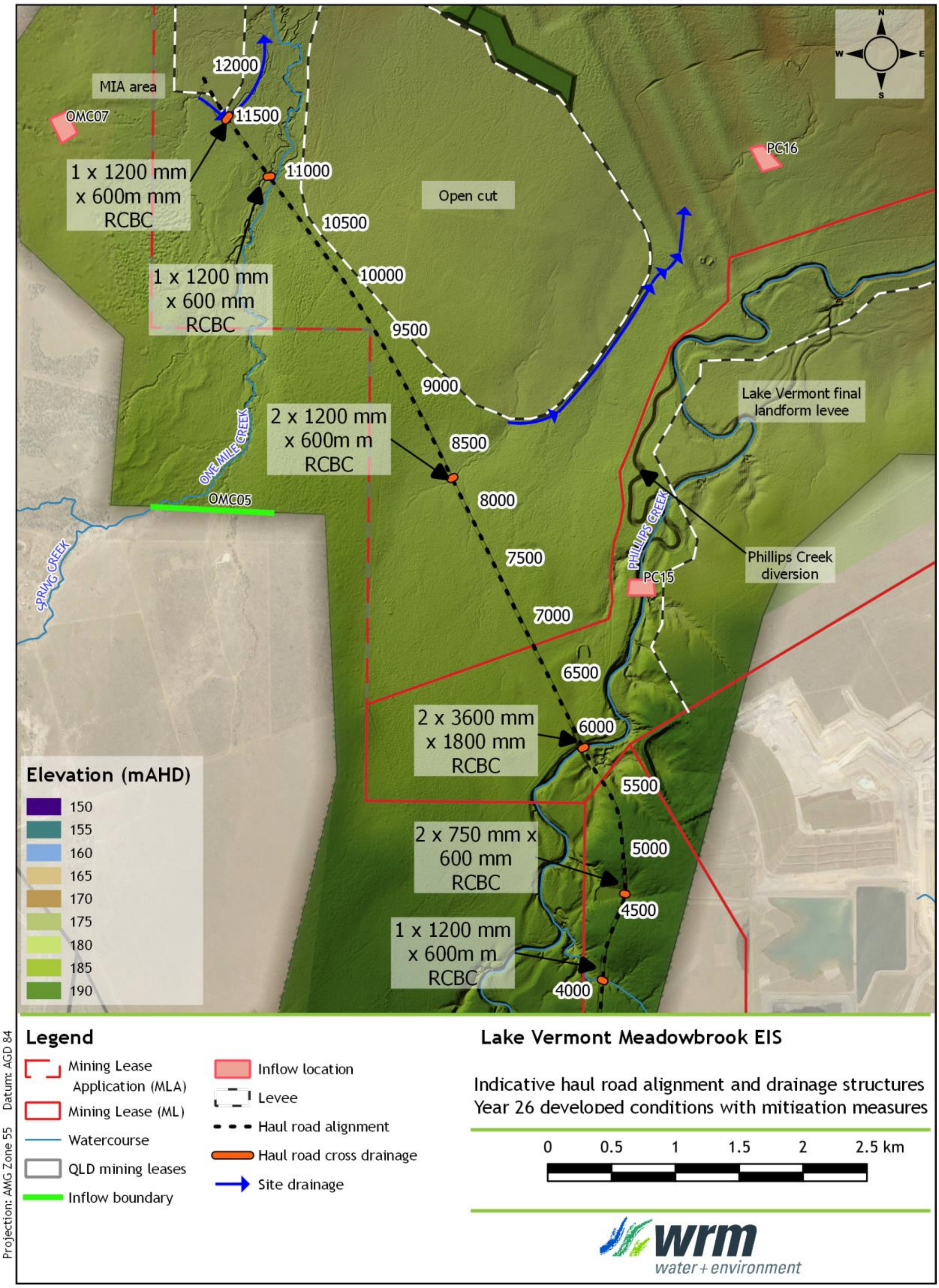

Figure 2.5 – Location of haul road alignment and cross drainage structures

2.4 TUFLOW MODEL CONFIGURATION REGIONAL MODEL

The TUFLOW model was also used to simulate regional flooding with peak inflows from the Isaac River. The 1%, 0.1% and PMF flooding in the Isaac River catchment was assessed for both approved conditions and the Year 26 mine site conditions with mitigation measures implemented. Peak flows in the Isaac River were also used to assess the cumulative impact case discussed in Section 4.

The TUFLOW model for the regional Isaac River flooding events is identical to the TUFLOW model used to assess local creek flooding except for the quadtree configuration that determines model cell size throughout the model. The quadtree arrangement for the TUFLOW model for regional Isaac River flooding is shown in Figure 2.6.

2.5 TUFLOW MODEL CONFIGURATION – POST-CLOSURE CONDITIONS

The TUFLOW model was used to simulate conditions after the completion of the Project. The post-closure scenario incorporated the following changes to the Year 26 model configuration:

- The incorporation of the land final landform dump for the open cut mine;
- The incorporation of a 150 m wide landform barrier to exclude flood water from the final in-pit emplacement area in extreme floods;
- The removal of the Mine Infrastructure Area;
- The removal of site drainage works.

The model retains the Year 26 subsidence and the mitigation measures put in place to reduce the extent of ponding as well as the haul road. The configuration of the post-closure conditions model is shown in Figure 2.7.

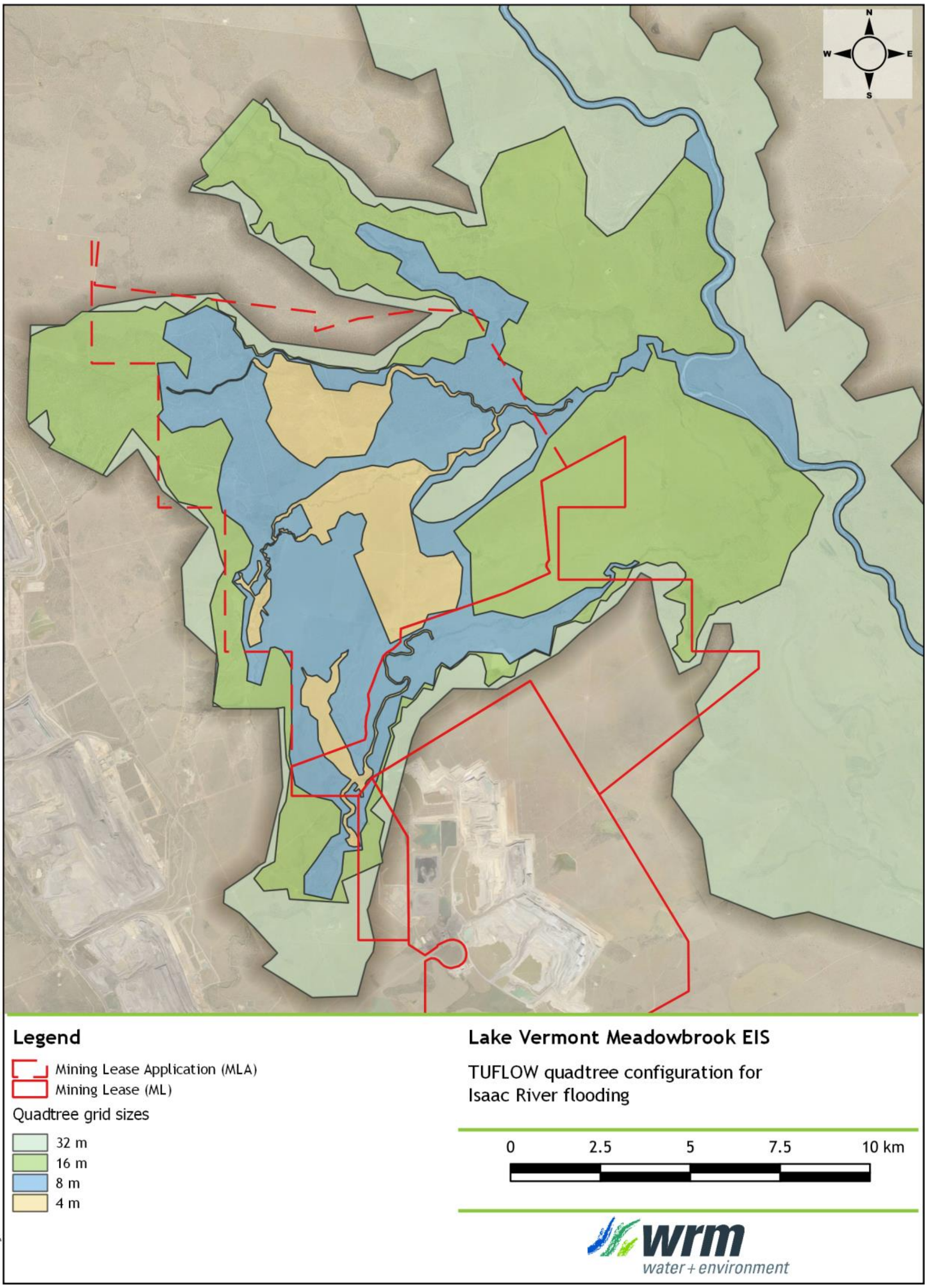

Figure 2.6 – TUFLOW quadtree configuration for Isaac River flooding

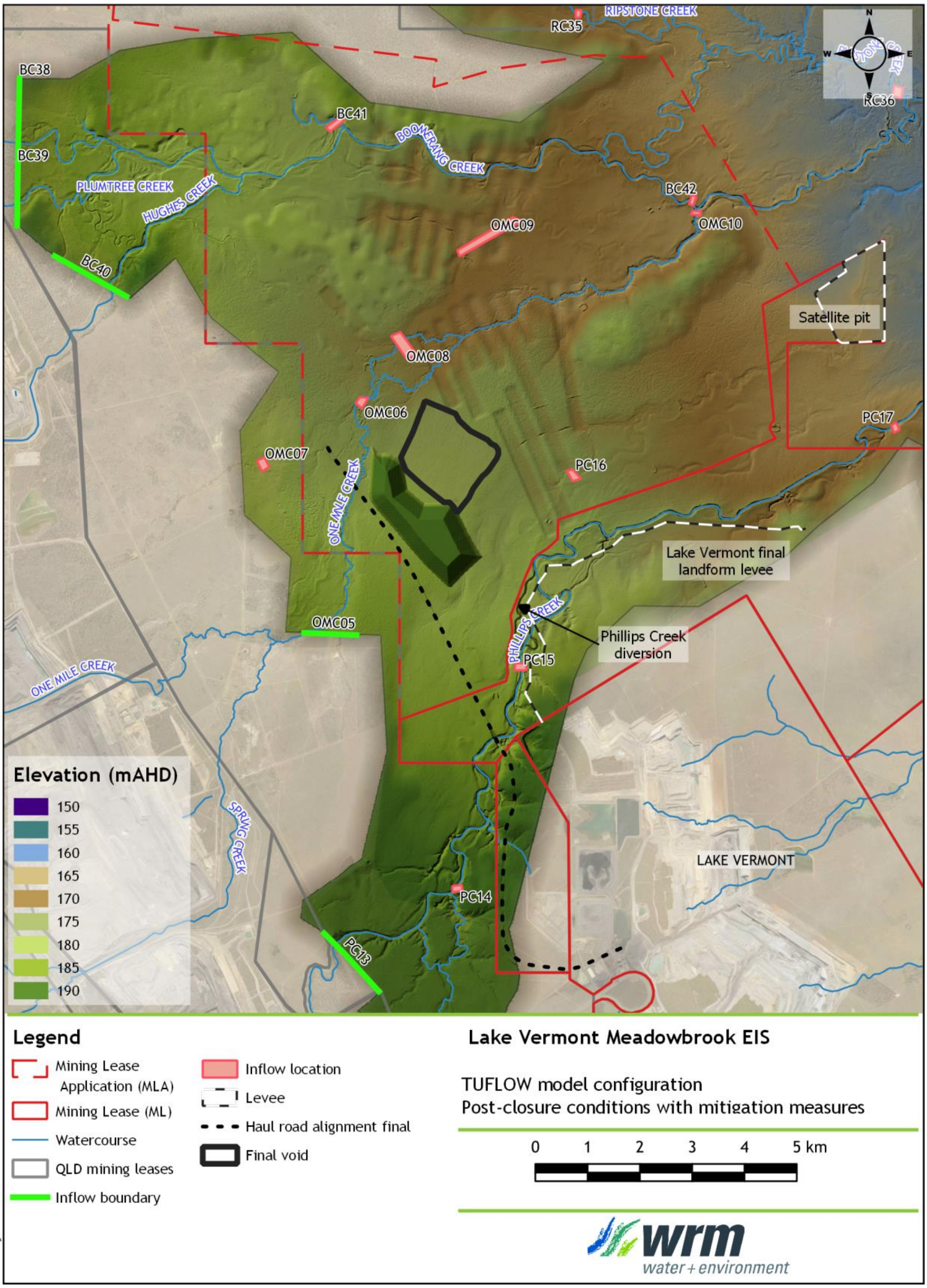

Figure 2.7 – TUFLOW configuration for post-closure scenario

3 Flood modelling results

3.1 OVERVIEW

The TUFLOW hydraulic model was used to assess the impacts of the Project on flooding over a range of design flood events. The following development scenario/event combinations were modelled:

- Approved conditions:
  - Local flooding: 50%, 10%, 2%, 1%, 0.1% and PMF;
  - Regional flooding: 1%, 0.1% and PMF.
- Year 26 development conditions:
  - Local flooding: 50%, 10%, 2%, 1%, 0.1% and PMF;
  - Regional flooding: 1%, 0.1% and PMF.
- Post-closure conditions:
  - Local flooding: 1%, 0.1% and PMF.

For impact assessment, the modelled pre-Meadowbrook (approved conditions) flood levels and velocities were subtracted from the flood levels and velocities modelled under the developed scenarios. A positive value of impact therefore represents an increase in peak flood levels and velocities and conversely a negative value of impact represents a reduction in peak flood level or velocity. The locations where flooding did not occur under approved pre-mining or developed conditions were also identified.

The results of modelling of approved conditions and the impacts of each development scenario are described in detail in the following sections.

3.2 APPROVED CONDITIONS

3.2.1 Local creek flooding behaviour

Modelled 1% AEP local flood depths and extents for the approved conditions scenario are shown in Figure 3.1 and Annexure C.

Ripstone, One Mile, and Boomerang Creeks all have relatively shallow channels that experience flow breakouts even in relatively frequent floods. Through much of the Project area, the catchment boundary of One Mile Creek extends to a natural levee along the southern bank of Boomerang Creek. Minor indistinct floodplain flow paths direct runoff from the catchment boundary southeast across the proposed mining area towards One Mile Creek. In the 50% AEP flood, two breakouts direct Boomerang Creek flow into this local drainage system. These breakouts drain overland and join One Mile Creek further downstream. In larger floods, these breakouts become more significant flow paths, and in the 2% AEP and greater events, the One Mile Creek floodplain joins with Boomerang Creek.

Phillips Creek has a much greater channel capacity than the northern streams, and flow is confined in-bank in the 50% AEP event. In the 10% AEP event, minor out-of-bank flows from the channel upstream of the Project area connect to a drainage line further downstream on the northern Phillips Creek floodplain. In the 2% AEP event, this breakout becomes fully developed over the Phillips Creek northern floodplain and forms a continuous flow path parallel to Phillips Creek before re-joining the main channel just upstream of its confluence with the Isaac River. This northern floodplain flow constitutes a significant drainage path through the Project area. In the 2% AEP event, flow begins to overflow from this northern tributary towards the lower reaches of Boomerang Creek (upstream of the approved Lake Vermont Satellite Pit).

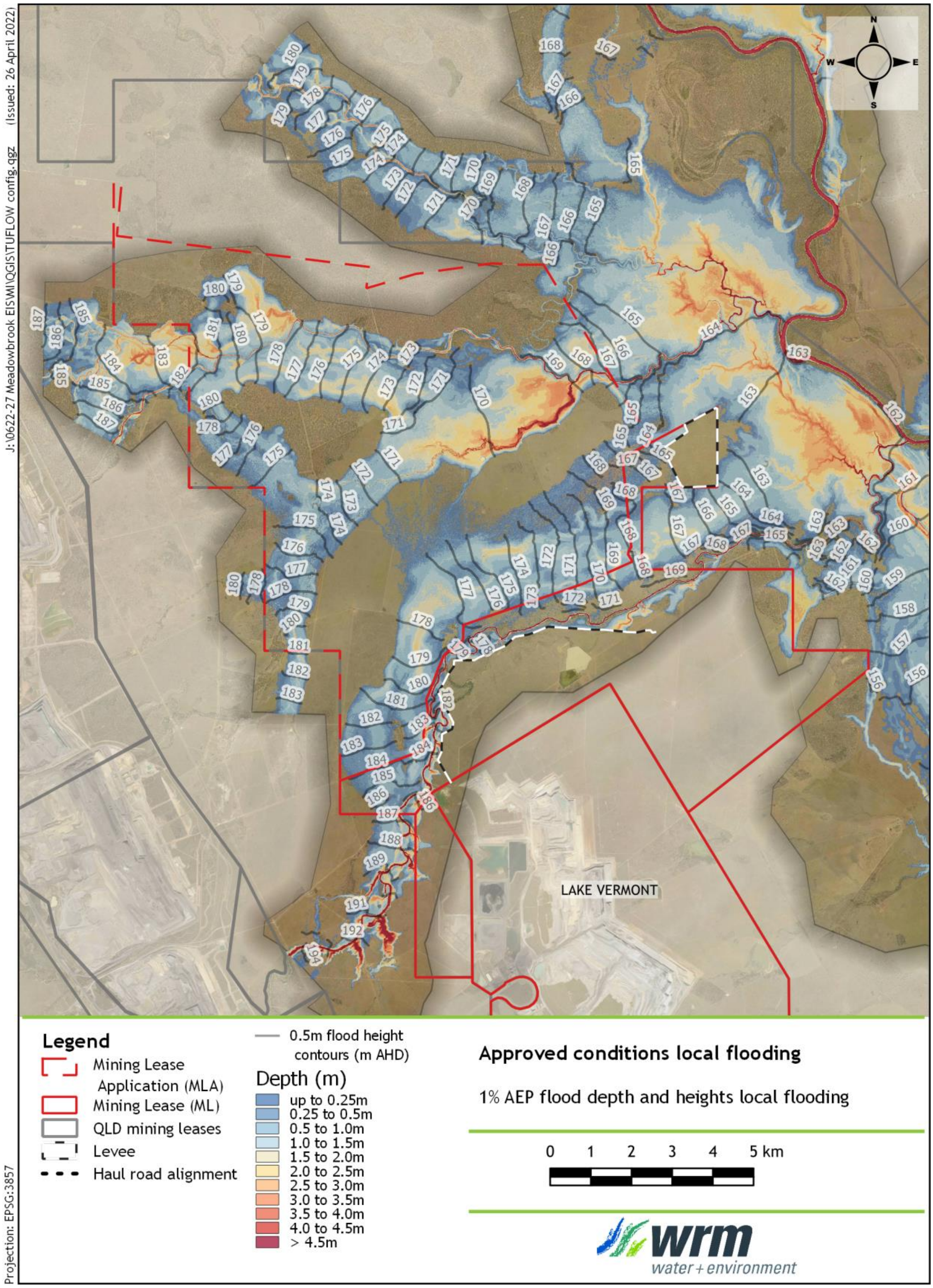

Figure 3.1 – 1% AEP approved conditions local flood depths and heights

Further upstream, in large flows approaching the 1% AEP, floodwater begins to overflow from the Phillips Creek floodplain through the proposed underground mining area towards One Mile Creek. These flow paths become fully engaged in the 1 in 1,000 (0.1%) AEP event.

Modelled flood velocities for the approved case conditions 1% AEP event for local creek flooding are shown in Figure 3.2. In the 50% AEP event, point channel velocities typically range between 1.3 and 1.8 m/s. However, One Mile Creek flow velocities are lower than for the other streams (typically less than 0.5 m/s). In the 1% AEP event, flows in Phillips Creek reach up to 2.5 m/s but are below 1 m/s along One Mile Creek and its floodplain through the Project area. Boomerang Creek velocities are approximately 1.3 to 1.5 m/s. One of the breakouts from Boomerang Creek flowing across to One Mile Creek experiences velocities of up to 1.5 m/s. Flow breaks out over the Phillips Creek northern floodplain at velocities up to 1.2 m/s.

3.2.2 Isaac River flooding behaviour

The TUFLOW model was also used to simulate flood behaviour in the 1%, 0.1% and PMF Isaac River flood events. The 1% AEP flood depths and velocities for the approved conditions regional flooding are shown in Figure 3.7 and Figure 3.8 and full results are provided in Annexure C.

While the depth of Isaac River floodplain flow is significantly greater than for local creek flooding, the increased flood levels do not significantly impact flood levels in the Project area. In the absence of large local creek flows, breakouts flowing overland from the Phillips Creek northern floodplain to One Mile and Boomerang Creeks are not evident in flows less than the 1 in 1,000 (0.1%) AEP.

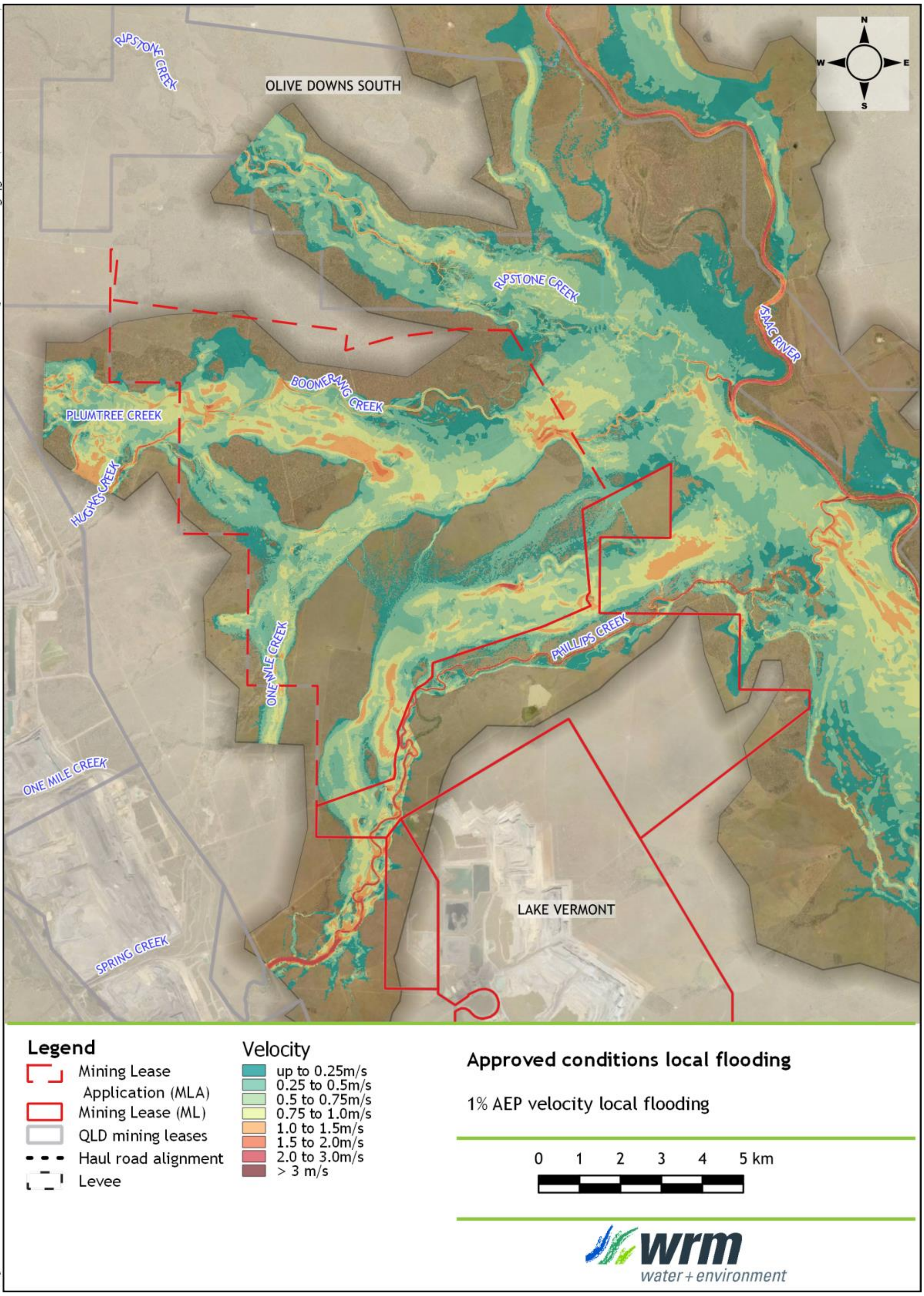

Figure 3.2 – 1% AEP approved conditions local flood velocity

3.3 YEAR 26 DEVELOPED CONDITIONS

Full mapping of results of the flood modelling at the maximum extent of operations (Year 26 conditions with mitigation) are presented in Annexure C. The results show the proposed works would alter flood conditions via a number of mechanisms:

- underground mine subsidence would locally reduce flood levels but increase the depth and extent of flooding;
- underground mining would redirect floodplain flow along subsidence panels – adverse effects will largely be mitigated by bunding across the panels to reduce the potential for this to occur;
- subsidence would increase floodplain storage, which has the effect of reducing downstream flood flows, levels and extents;
- the haul road embankment would obstruct floodplain and channel flows – locally increasing upstream flood levels. However, the vertical alignment design and cross-drainage structures limit the upstream impacts and preserve the downstream flow distribution;
- levees around the open cut operation and MIA would locally reduce floodplain conveyance and storage – this would have the effect of locally increasing upstream flood levels, and redistributing downstream flow to the opposite floodplains until the levees were decommissioned and the floodplain landform returned to pre-mining levels.
- the detailed levee designs would incorporate appropriate erosion protection measures such as rock armouring where velocities are sufficient to erode the compacted earth embankment. Velocities adjacent to the MIA levee and northern open cut levee are predicted to be less than 1.5 m/s in the 1 in 1000 AEP flood, and erosion protection works are therefore unlikely to be required in these areas. The southern open cut levee would likely require erosion protection works near the southern and northeastern corners.

Details of the modelled impacts are summarised in the following sections.

3.3.1 Flood level impacts near the subsidence zone

The most significant reductions in flood levels tend to be localised around the subsidence areas and are of a similar magnitude to the predicted subsidence depths.

Over the subsidence panels on the Phillips Creek floodplain downstream of the open cut mine, reductions in flood level are up to two meters in some areas in the 10% AEP event. In larger events, reductions in level are smaller but are generally within the range of 700 mm to 850 mm. In the 50% and 10% AEP events there is a reduction in the extent of inundation of the floodplain downstream of the subsidence.

For the subsidence areas on One Mile Creek, reductions in level range from one meter to 700 mm. Along Boomerang Creek some flood levels have reduced by as much as three meters in the 10% AEP event to 2.5 meters in the PMF in the most affected locations.

The increase in flood storage in the subsidence areas results in a reduction of 50% and 10% AEP flood levels further downstream on Phillips Creek, One Mile Creek and Boomerang Creek of between 50 and 100 mm. For the 2% AEP and larger flow events, reductions in flow along the tributary of Phillips Creek that lies on the subsided floodplain become more significant between 100 and 250 mm as flow is diverted along the subsidence panels and joins One Mile Creek. This results in increases of 50 to 100 mm along the floodplains of One Mile and Boomerang Creek downstream of their subsided areas.

Afflux downstream of the mine lease area is negative for all events – ranging from a 600 mm reduction at the Isaac River in the 50% AEP to 300 mm in the 10% AEP. Reductions in the floodplain of the Isaac River in the larger events from the 2% AEP to the PMF range from 60 to 100 mm. In the 1 in 1,000 (0.1%) AEP and PMF events there is also some positive afflux in the vicinity of the confluence of the Boomerang and Isaac Rivers of approximately 30 to 50 mm.

There are no significant changes in velocity downstream of the mine lease area in design flood events.

3.3.2 Flood level Impacts upstream of the haul road and mine lease area

Maps of the results of modelling the 1% AEP event under the Year 26 development scenario are shown in Figure 3.3 to Figure 3.6.

The modelled changes in flood level for the Year 26 mine site conditions compared with approved conditions for the 1% AEP event is shown in Figure 3.4. The haul road is the upstream-most obstruction to flow in the Year 26 scenario and has the most potential to cause off-lease increases in flood level and extent. Immediately upstream of the haul road crossing of Spring Creek (a southern tributary of One Mile Creek), the haul road causes local afflux of approximately 400 mm in the 1% AEP flood. However, the afflux does not extend significantly off-lease at this location. Upstream of One Mile Creek, the 2% and 1% AEP flood levels are increased by 120 to 150 mm at the mine lease boundary, but the impacts cover only a very small area. The Mine Infrastructure Area to the north causes some minor additional off-lease inundation, to depths of up to 150 mm adjacent to One Mile Creek. This increases to 200 mm in the 1 in 1,000 (0.1%) AEP event.

There are increases in flood level upstream of the crossing of the Phillips Creek northern floodplain in the 10% to 1% AEP event, but these impacts are contained within the mine lease area.

In the 10%, 2% and 1% AEP events, the low-level crossing of Phillips Creek becomes drowned, and the afflux is reduced so that off-lease flood levels upstream of the haul road are not increased by the Project. The 1 in 1,000 (0.1%) AEP and PMF flood events show no afflux in Phillips Creek upstream of the haul road crossing. In small flows, when the proposed low flow crossing is not drowned, the afflux created by the haul road is sufficient to extend off the mine lease area. In the 50% AEP design event, the afflux is confined to areas within the channel, with a maximum of 60 mm at the lease boundary.

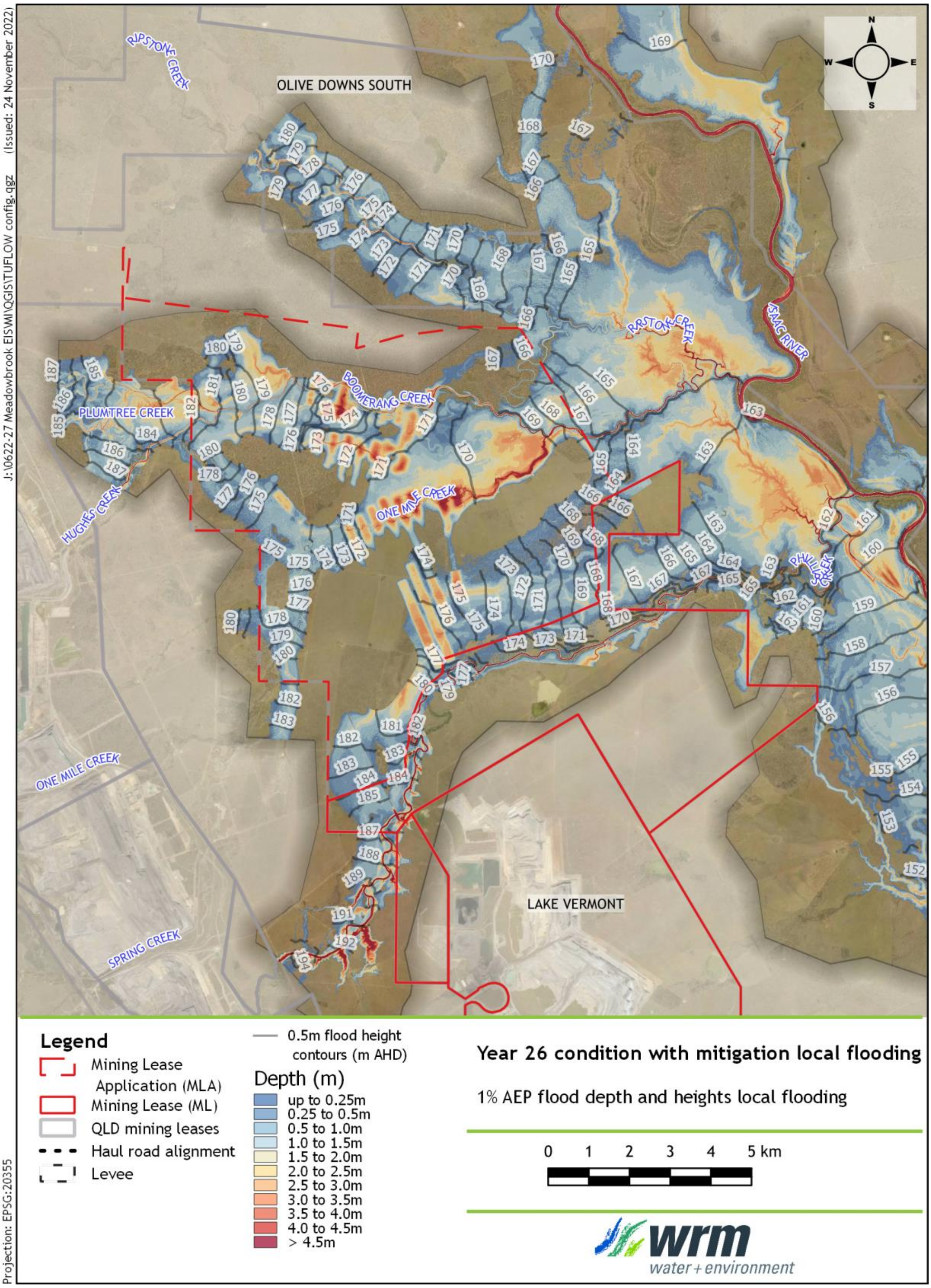

Figure 3.3 – 1% AEP Year 26 conditions local flood depths and heights

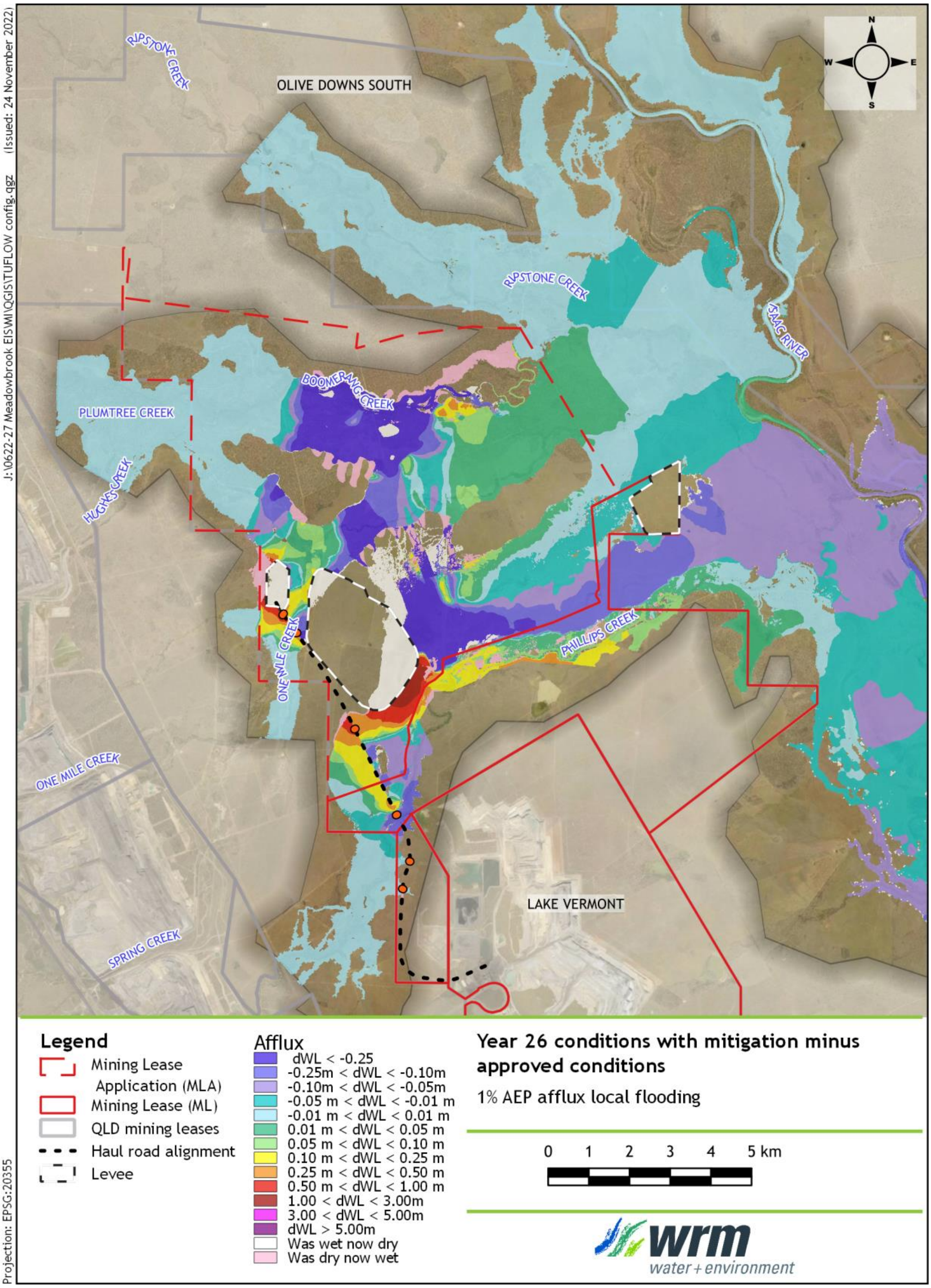

Figure 3.4 – 1% AEP afflux (Year 26 conditions minus approved conditions)

3.3.3 Impacts on flow velocity

The modelled 1% AEP flood velocities for the Year 26 operations scenario are shown in Figure 3.5. The modelled changes in velocity for the Year 26 mine site conditions compared with approved conditions for the 1% AEP event are shown in Figure 3.6.

Velocity impacts within the mine lease area are complex owing to the nature of the subsided areas. A detailed assessment of velocity impacts is described in the geomorphology report (WRM, 2022). Overall impacts on flow velocity are briefly described below.

Generally, velocities would increase over chain pillars and reduce within each subsidence panel. Across the range of events, the subsidence panels would typically experience velocity reductions of up to 0.5 m/s, and velocity increases between the panels of up to 0.7 m/s (with some areas experiencing increases up to 1.2 m/s).

The Phillips Creek floodplain near the southeastern corner of the open cut mine is predicted to experience the greatest velocity increases. Modelled point velocity increases range from 0.8 m/s in the 10% AEP event to approximately 1.3 m/s in the 2% and 1% AEP events, and up to 1.5 m/s in the 1 in 1,000 (0.1%) AEP event. These velocity increases would be temporary until the operational pit protection levee was decommissioned and the floodplain landform returned to pre-mining levels. The proposed levee would be designed to ensure it could withstand the predicted velocities during operations.

Minimal upstream velocity impacts are predicted in the 50% AEP and 10% AEP floods. In the 2% and 1% AEP events, increases of 0.2 m/s would occur upstream of the haul road in the channel of Phillips Creek and increases of 0.1 to 0.2 m/s along the haul road on the Phillips Creek northern floodplain. There are minimal increases in velocity predicted in the 1 in 1,000 (0.1%) AEP event.

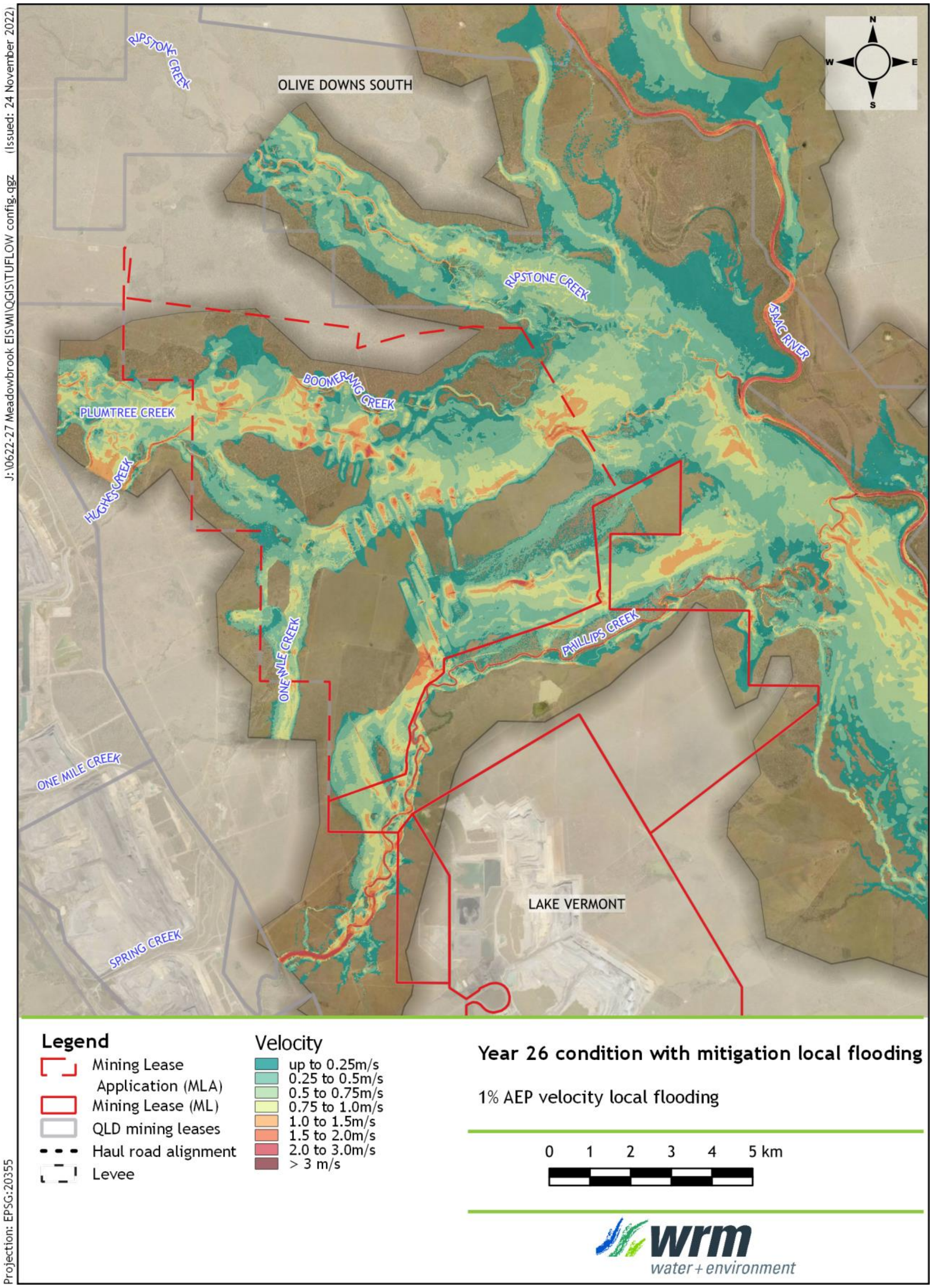

Figure 3.5 – 1% AEP Year 26 conditions local flood velocity

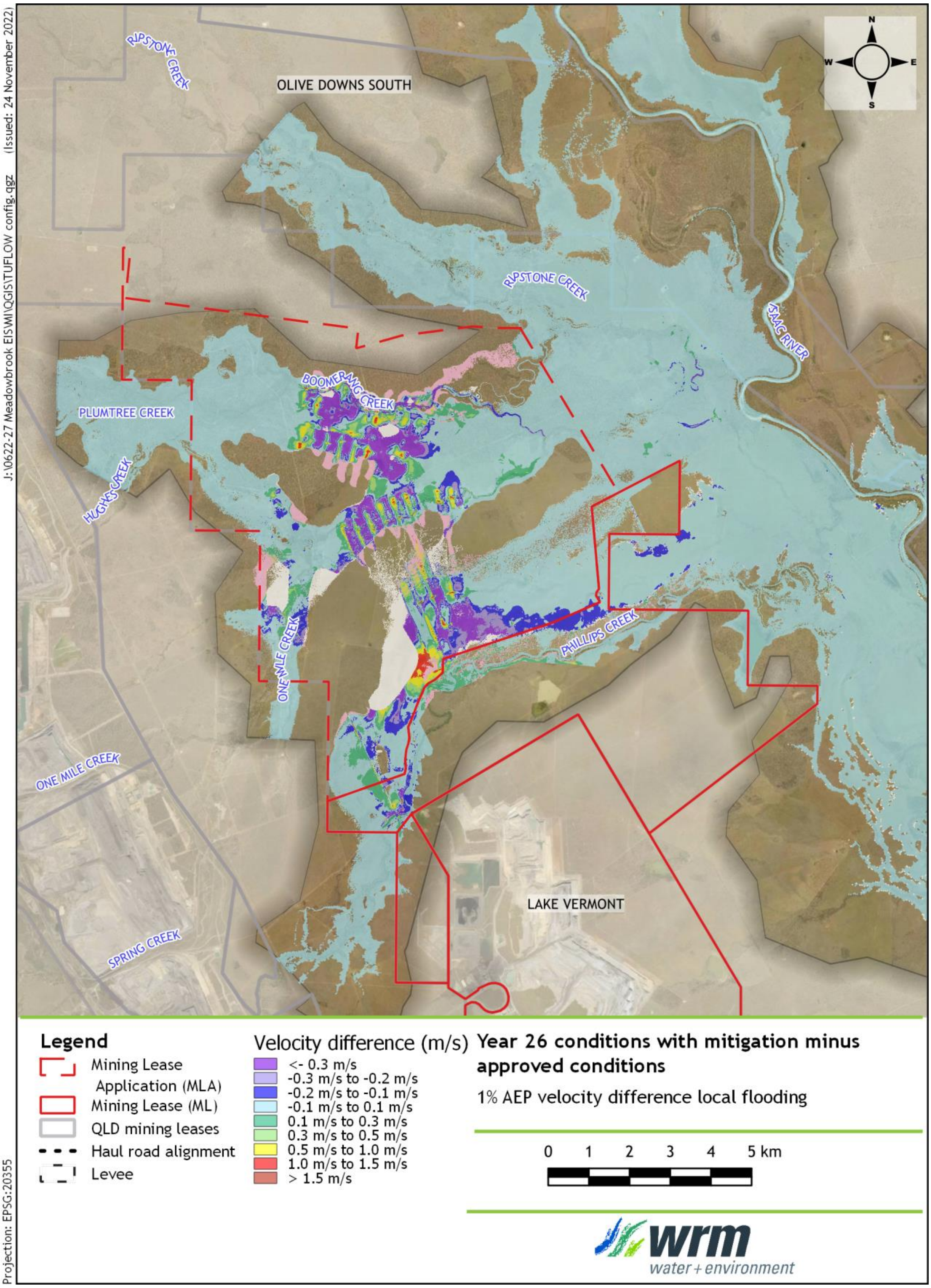

Figure 3.6 – 1% AEP Year 26 velocity difference (Year 26 conditions minus approved conditions)

3.3.4 Regional Isaac River flooding conditions

Due to the lower rates of flow through the Project area under the Isaac River flooding scenario, the impacts upstream of the Project area, and upstream of the haul road crossings, are less than in the local flooding events. In the 1% AEP flood, impacts are contained within the mine lease.

Impacts in subsided areas are very similar to local flooding impacts. In the 1% AEP event off-lease impacts are limited to the Phillips Creek northern floodplain with reductions of up to 100 mm just to the south of the Satellite pit and small increases of 30 mm to the western side of the Satellite pit. In the 1 in 1,000 (0.1%) AEP flood event, reductions downstream in the Phillips Creek northern tributary are approximately 150 mm.

The diversion of flow from Phillips Creek northern tributary along the subsidence panels to One Mile Creek is less significant in a regional flood scenario. This increase of flow only becomes apparent in the 1 in 1,000 (0.1%) AEP event with increases off lease in the Isaac River floodplain of approximately 20 mm.

The 1% AEP flood depths and velocities for the Year 26 mine site conditions for regional flooding as well as afflux and velocity impacts are shown in Figure 3.9 to Figure 3.12.

In regards to flooding impacts to haul road crossings (from an operational mining perspective) calculation of the Average Annual Time of Closure (AATOC) at all the haul road crossings was also undertaken. These calculations followed the methodology outlined in the 'Guide to Road Design Part 5B' Ch 4 (Austroads, 2013). The Time of Submergence (TOS) and AATOC at all six crossings along the haul road are summarised in Table 3.1.

Table 3.1 – Summary of TOS and AATOC at haul road crossings

Location	TOS (hours) AEP								AATOC (hours)
	63%*	50%	10%	5%	2%	1%	0.10%	PMF	
OMC1	9.6	9.7	18.5	19.3	20.5	21.7	23.5	27.2	10.6
OMC2	0.0	0.0	10.3	11	12.5	13.5	16	19.5	3.2
Phillips NFP	0.0	0.0	0.0	8.3	11.5	13.2	17.5	22.0	0.8
Phillips Creek	20.0	22.0	28.0	28.2	29.2	30.2	31.8	35.7	19.3
Phillips Trib 1	0.0	0.0	0.0	0.0	0.0	0.0	7.3	12.8	0.04
Phillips Trib 2	0.0	0.0	0.0	2.3	6.0	7.8	12.2	16.3	0.4

*Estimate only

The low flow creek crossing at 'Phillips Creek' has the least degree of flood immunity along the haul road, with an expected AATOC of 19.3 hours. This crossing would be overtopped in a flow of approximately 26 m^3/s, which is less than the 50% AEP flow (and likely significantly less than the 63% AEP flow). i.e. the Phillips Creek crossing would be expected to be overtopped at least once in most years.

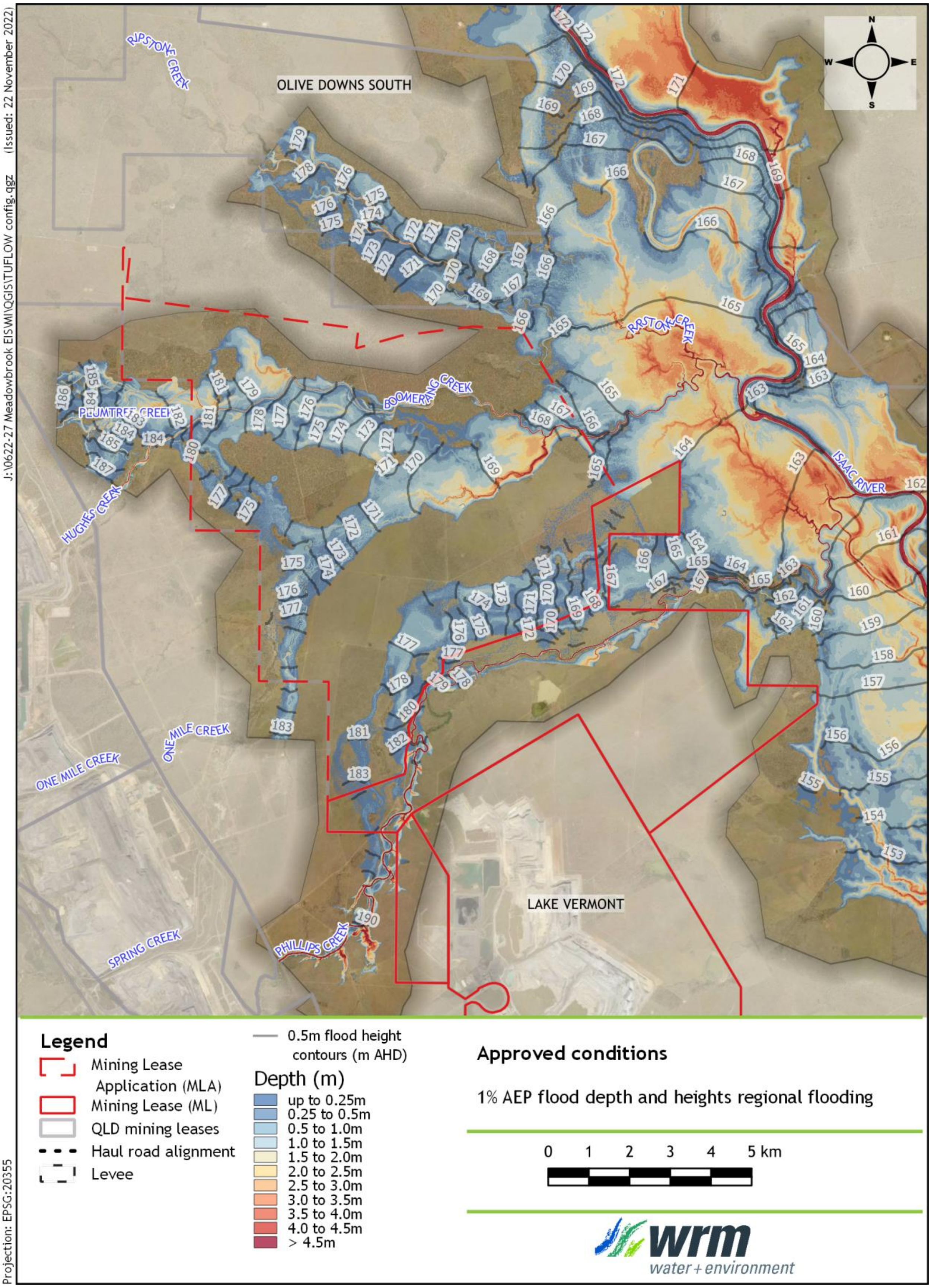

Figure 3.7 – 1% AEP approved conditions regional flood depths and heights

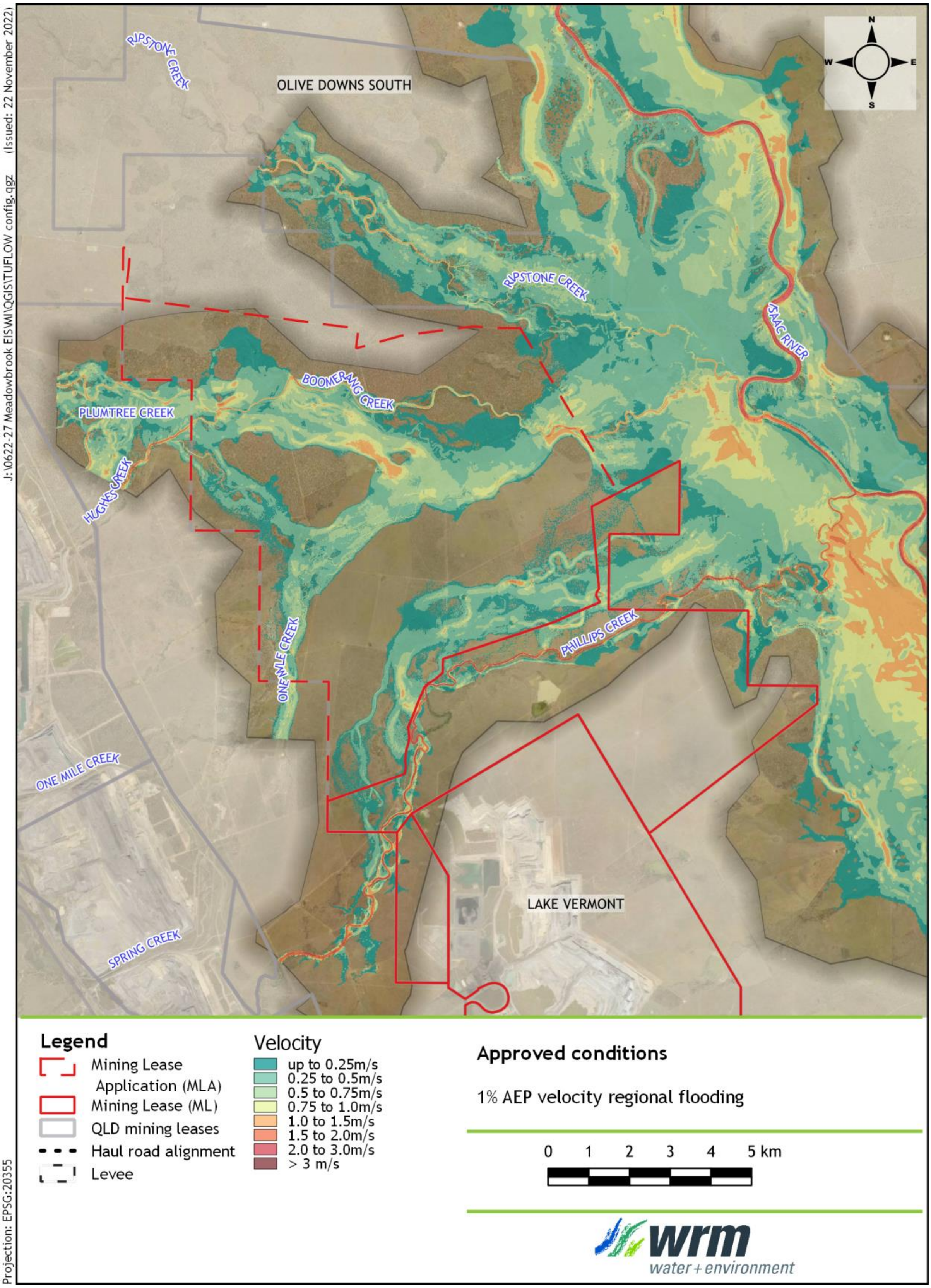

Figure 3.8 – 1% AEP approved conditions regional flood velocity

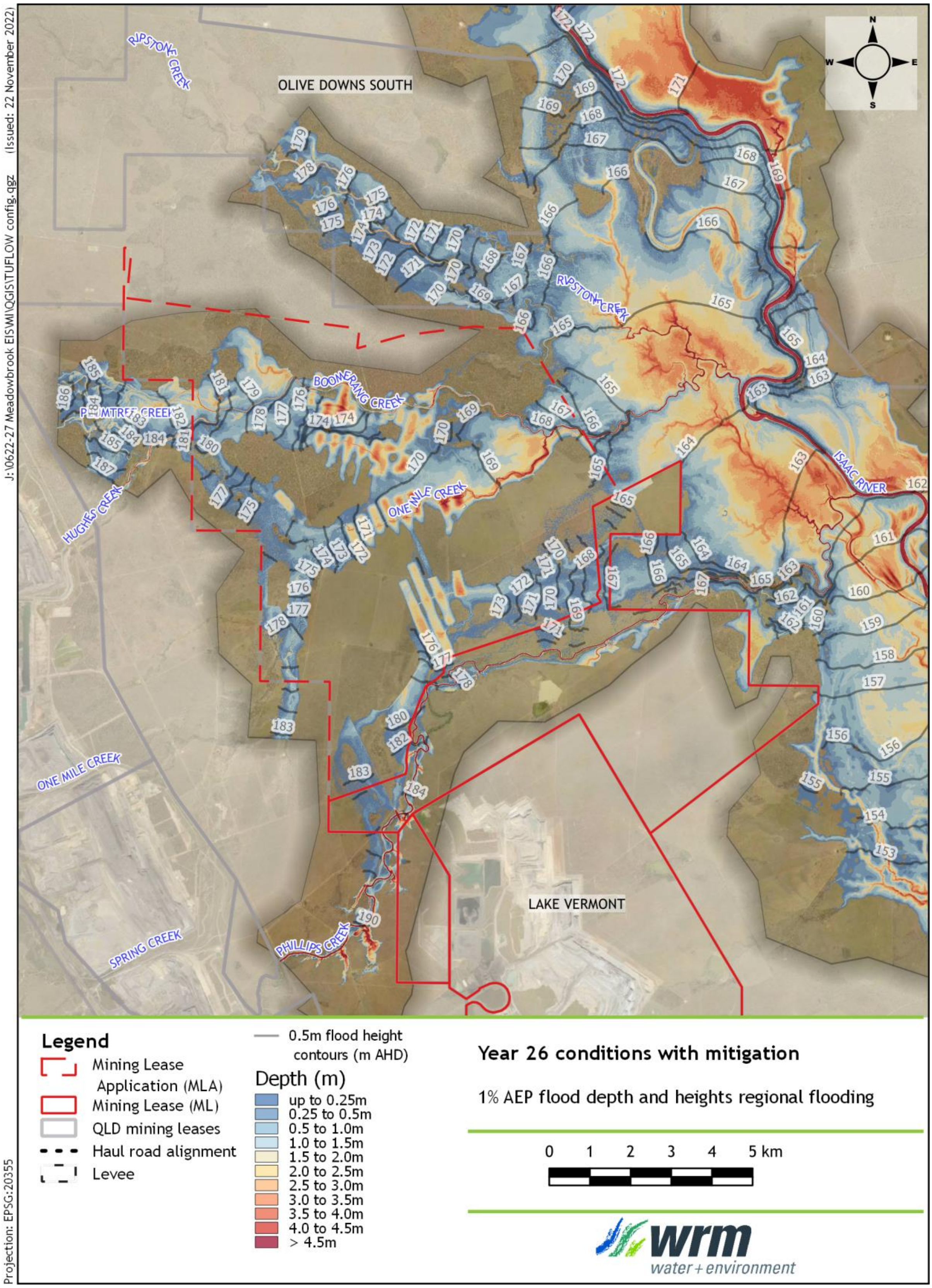

Figure 3.9 – 1% AEP Year 26 conditions regional flood depths and heights

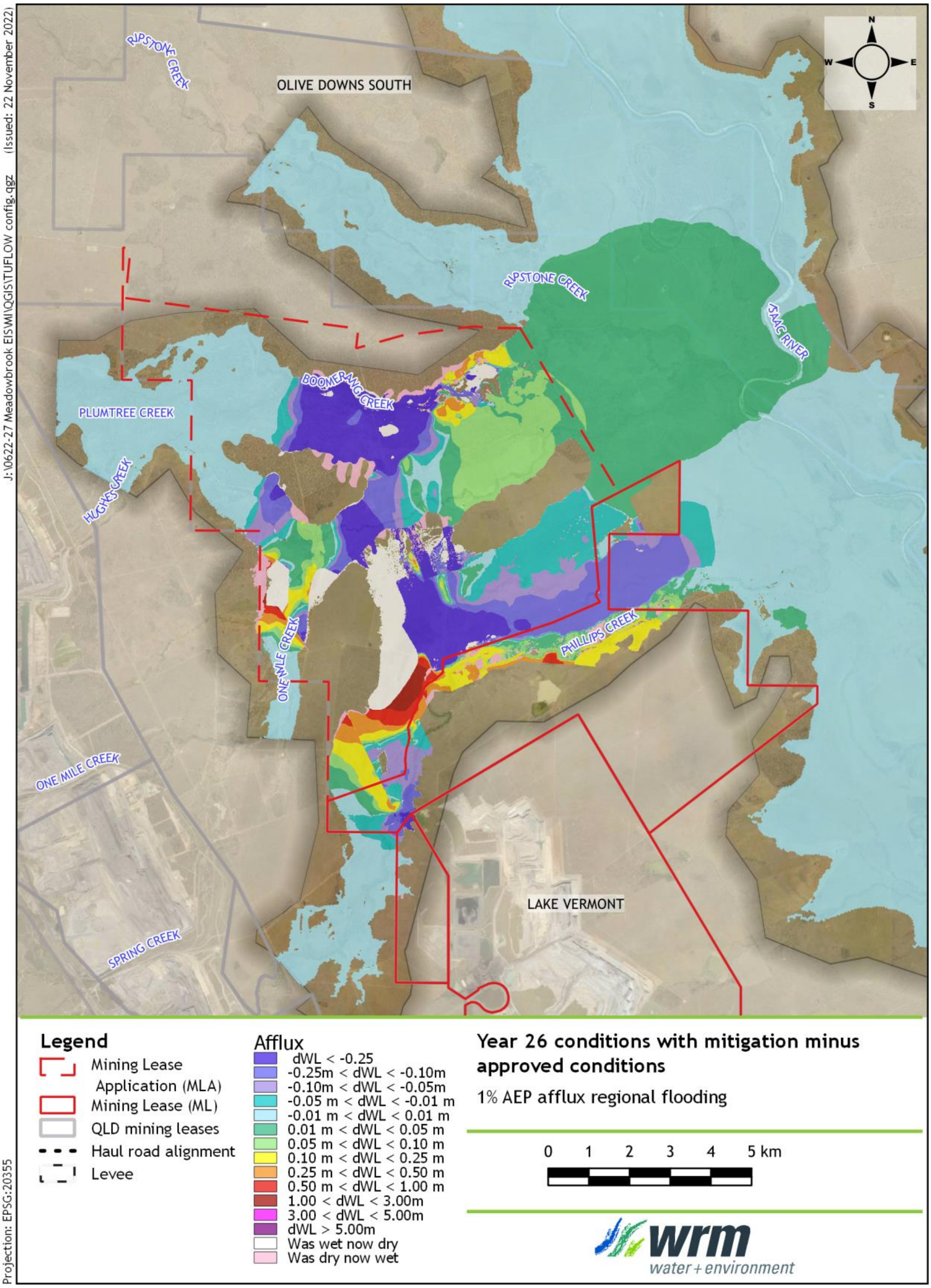

Figure 3.10 – 1% AEP regional flood afflux (Year 26 conditions minus approved conditions)

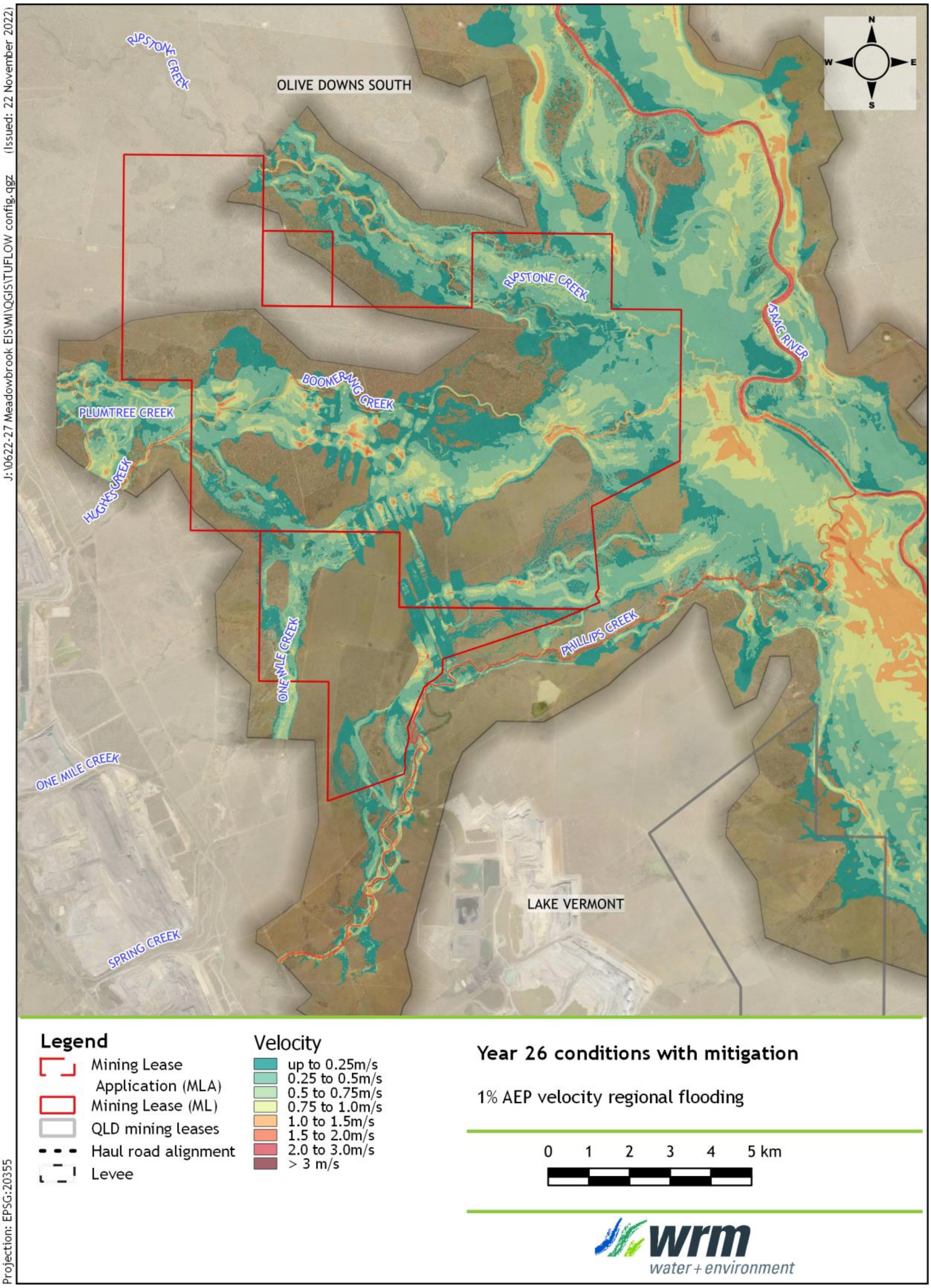

Figure 3.11 – 1% AEP Year 26 conditions regional flood velocity

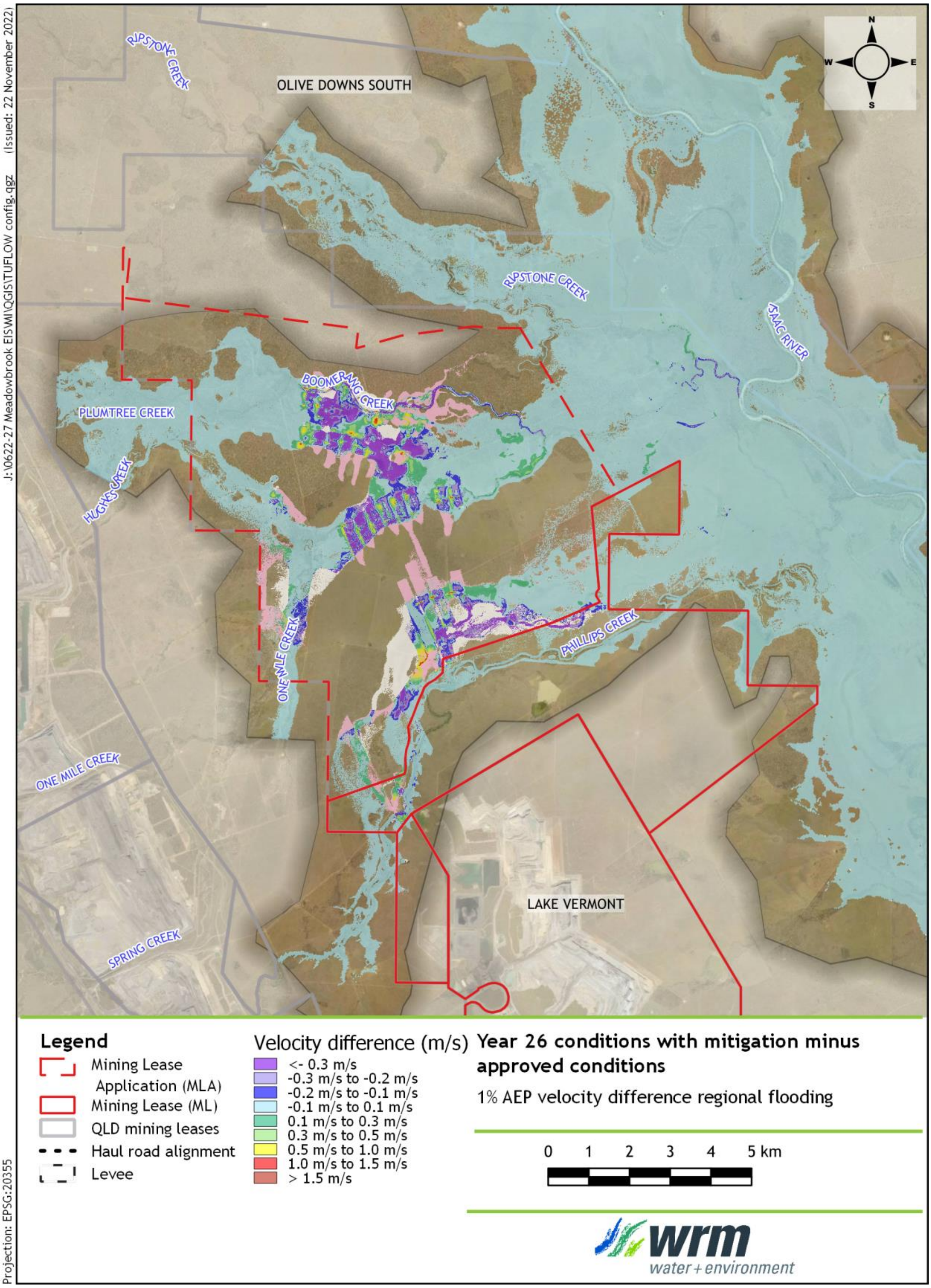

Figure 3.12 – 1% AEP Year 26 velocity difference (Year 26 conditions minus approved conditions)

3.4 POST-CLOSURE CONDITIONS

The TUFLOW model was used to simulate post-closure conditions for local creek flooding for the 1 in 1,000 (0.1%) AEP and PMF flood events. The depth and velocity results for the 1 in 1,000 (0.1%) AEP flood event are shown in Figure 3.13 and Figure 3.14.

While the lower elevation areas of the in-pit emplacement are located outside the 0.1% AEP flood extents, the surrounding final landform surface will be shaped to ensure that flood events up to the 0.1 % AEP flood will not extend into the in-pit emplacement area. The results of analysis of the PMF under post closure conditions are provided in Annexure C.

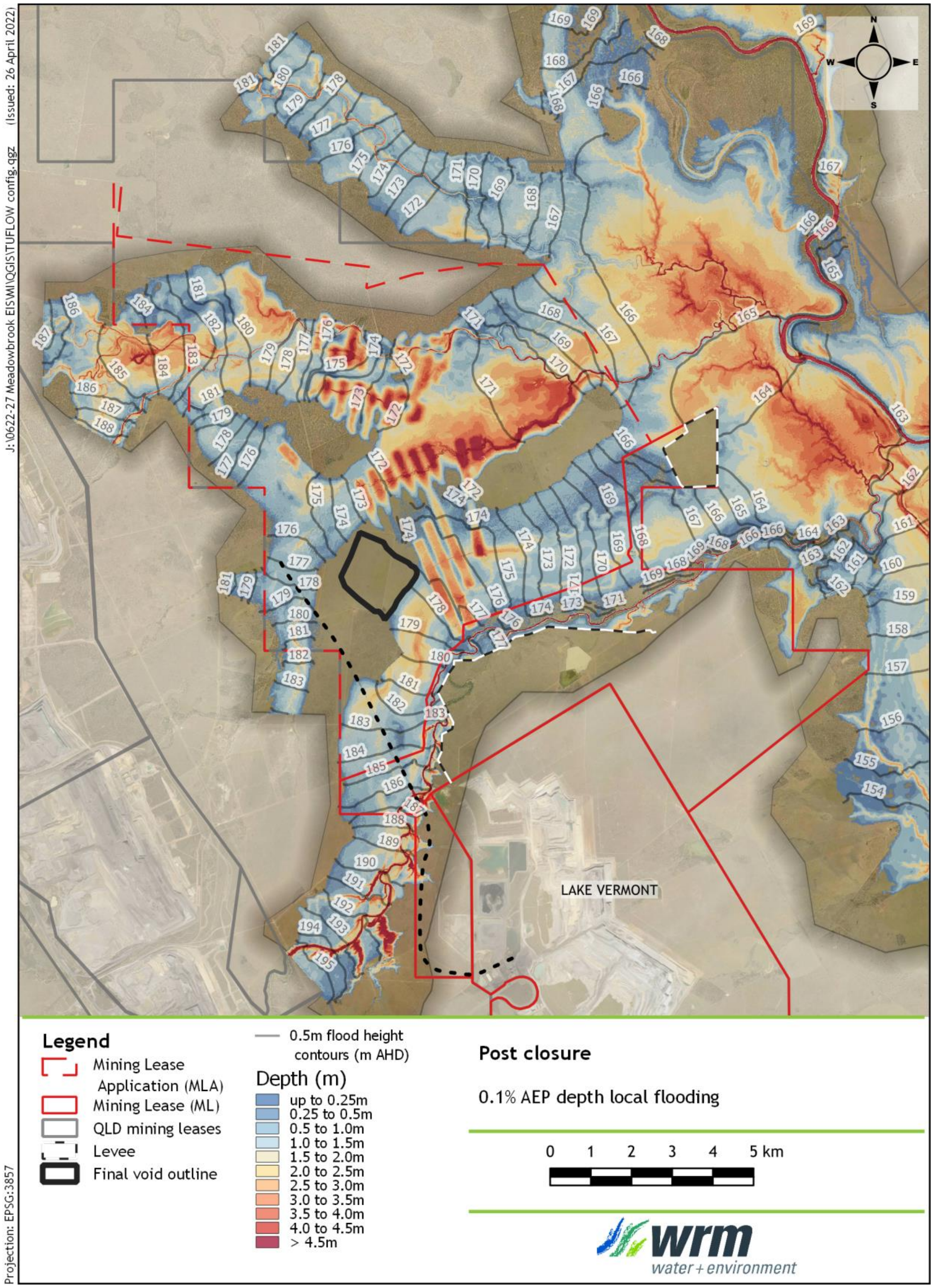

Figure 3.13 – 0.1% AEP flood depths and heights post-closure conditions

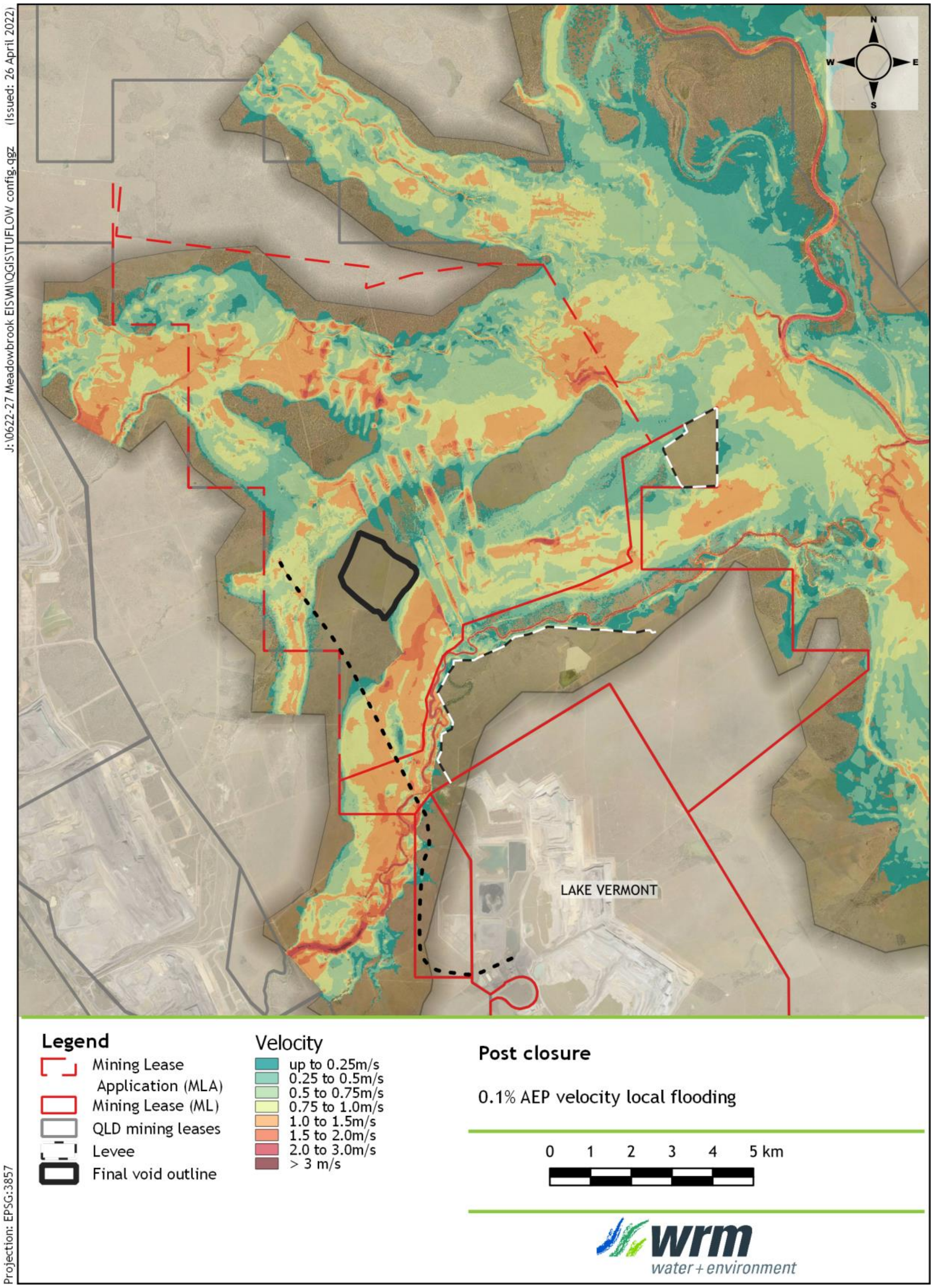

Figure 3.14 – 0.1% AEP velocity post-closure conditions

4 Cumulative impact assessment

4.1 CUMULATIVE IMPACT SCENARIOS

The Willunga and Olive Downs South domains of the proposed Olive Downs project extend onto the Isaac River floodplain downstream and upstream of the Meadowbrook Project, and the flood impacts of the two projects would potentially interact.

The TUFLOW model was used to simulate two scenarios representing the combined impact of the projects:

- Meadowbrook Year 26 operational mine site conditions with mitigation measures – plus other projects. The configuration of the TUFLOW model for this scenario is shown in Figure 4.1;
- Meadowbrook post-closure conditions – plus other projects.

For this assessment, it was conservatively assumed that the maximum disturbance of all projects would occur simultaneously. The cumulative impact modelling was undertaken for the 1 in 1,000 (0.1%) AEP regional flood event.

4.2 IMPACT ASSESSMENT RESULTS

The flood depths, heights and cumulative afflux for the Meadowbrook Year 26 operational scenario are shown in Figure 4.2 and Figure 4.3. Results for all scenarios are shown in Annexure C.

The cumulative flood impact outside of the Project area is dominated by the relatively large impacts of the disturbance on the Isaac River floodplain approved for other projects. The impacts of the Meadowbrook project are relatively minor and there is minimal interaction with the impacts of the other projects.

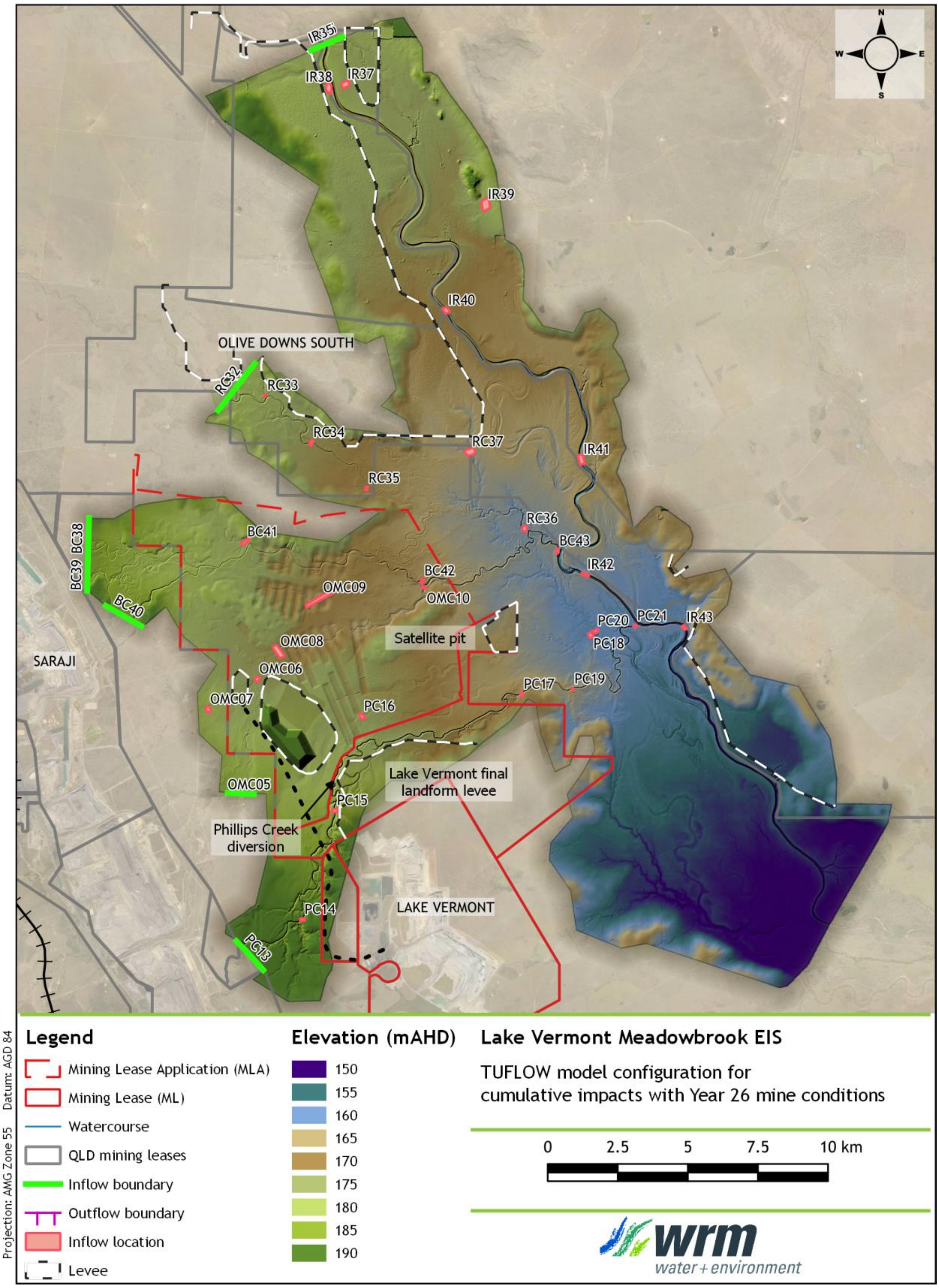

Figure 4.1 – TUFLOW cumulative impact model configuration (Year 26 mine site conditions)

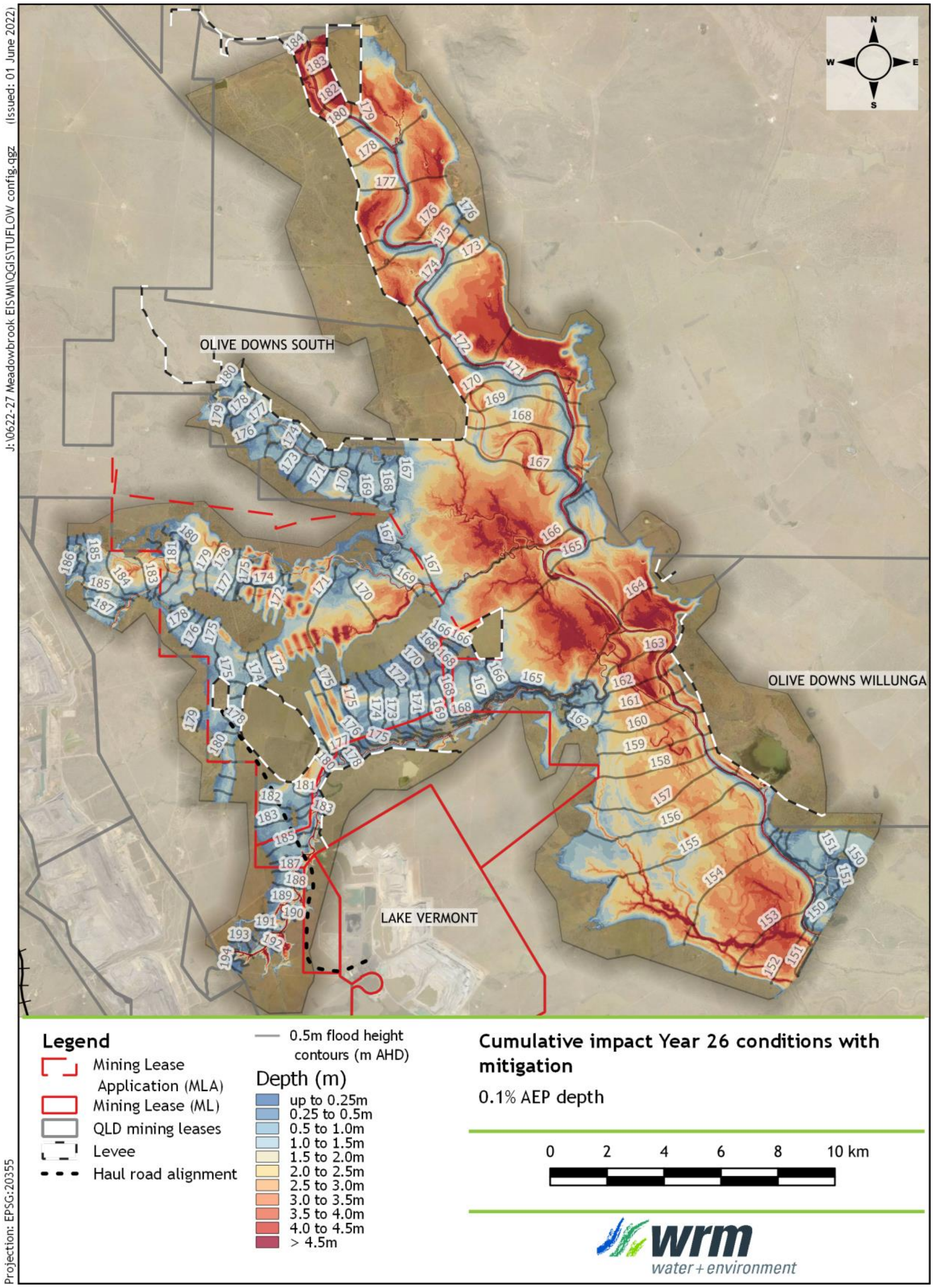

Figure 4.2 – 0.1% AEP flood depths and heights cumulative impact Year 26 conditions

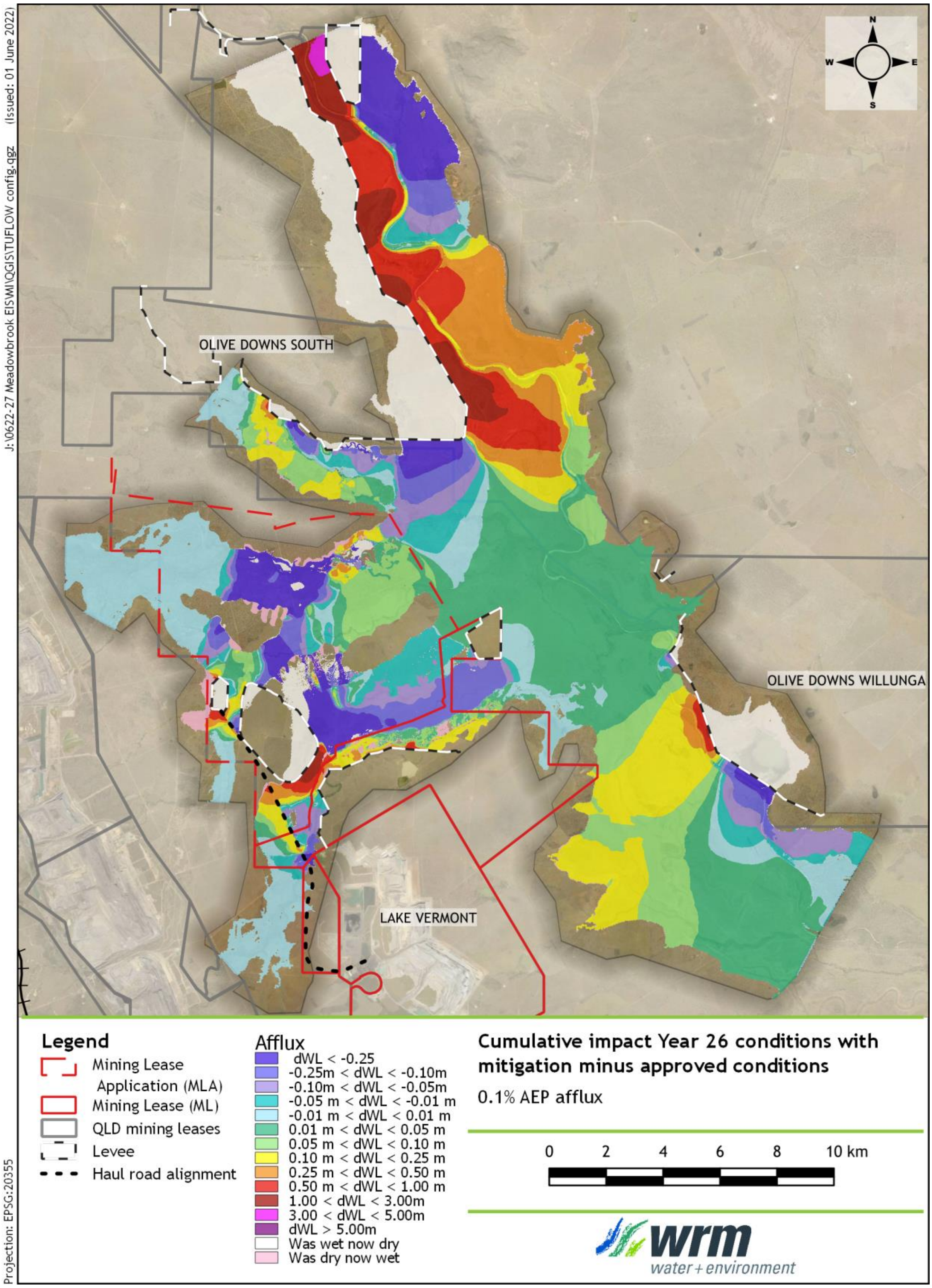

Figure 4.3 – 0.1% AEP afflux cumulative impact Year 26 conditions

5 Summary of findings

Bowen Basin Coal is proposing to develop a double seam underground longwall and open cut mine in a mining lease area immediately to the north of the Lake Vermont Coal mine (ML 70331). The proposed open cut mine would be protected from flooding by a levee between Phillips Creek and One Mile Creek and the longwall panels would be located below the floodplain of Phillips Creek, One Mile Creek and Boomerang Creek. The proposed activities will therefore alter flood behaviour in the vicinity.

Hydrologic and hydraulic models were used to assess flood behaviour and impacts arising from the Project for the 50%, 10%, 2%, 1%, 0.1% AEP and PMF flood events. The hydraulic model was used to simulate flood conditions under approved site conditions (base case), operational conditions (with full longwall mining subsidence), post-closure conditions and cumulative impact scenarios. The results show the proposed works would alter flood conditions via a number of mechanisms:

- underground mine subsidence would locally reduce flood level but increase the depth and extent of flooding;
- underground mining would redirect floodplain flow along subsidence panels – adverse effects are largely to be mitigated by bunding across the panels to reduce the potential for this to occur;
- subsidence would increase floodplain storage, which has the effect of reducing downstream flood flows, levels and extents;
- the haul road embankment would obstruct floodplain and channel flows – locally increasing upstream flood levels. However, the vertical alignment design and cross-drainage structures limit the upstream impacts and preserve the downstream flow distribution;
- levees around the open cut operation and MIA would locally reduce floodplain conveyance and storage – this would have the effect of locally increasing upstream flood levels, and redistributing downstream flow to the opposite floodplains until the levees were decommissioned and the floodplain landform returned to pre-mining levels.

The results of the investigation for local creek flooding and regional Isaac River flooding through the Project area are summarised as follows:

- Changes in flood level and velocity would largely be confined to the lease area. In events greater 50% AEP, the proposed haul road would increase upstream off-lease flood levels within the channel of Phillips Creek by less than 60 mm. Elsewhere, water level increases are predicted to be largely confined to the lease area. The depth and extent of any off-lease impacts would be minimal in events up to the 0.1% AEP.
- For the 2% AEP and greater floods, northern Phillips Creek floodplain flow could be diverted along the subsidence panels towards One Mile Creek. This effect would be mitigated by the construction of bunds across the subsidence panels - limiting afflux in the One Mile and Boomerang Creek floodplains to 50 to 100 mm. The subsidence would result in a small reduction in flood levels downstream of the subsidence zone.
- Velocity impacts on the subsidence areas are complex, with velocities increasing over chain pillars and reducing in subsidence panels. Velocity increases in the vicinity of the southeastern corner of the open cut mine range from 0.8 m/s in the 10% AEP event to 2 m/s increases in the PMF.
- Off-lease velocity impacts are predicted to be minimal;

The surrounding final landform surface will be shaped to ensure that flood events up to the 0.1 % AEP flood will not extend into the in-pit emplacement area.

The loss in floodplain storage caused by other upstream developments in the regions will be offset to some degree by the increase in flood storage induced by subsidence at the Meadowbrook Project. The cumulative impact of all known proposed floodplain developments in the nearby reaches of the Isaac River floodplain is to increase water levels in the vicinity of the Project by 60 mm in the post-closure cumulative impact scenario.

The impacts of the project on flooding would be largely confined to the lease area on land owned by the proponent. Impacts on flood levels upstream and downstream of the lease area would be minimal.

6 References

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WRM, 2022	*Meadowbrook Project Geomorphology Assessment,* WRM Water & Environment, March 2022 (Lake Vermont Meadowbrook Extension Project Environmental Impact Statement, Appendix W).

Annexure A. XP-RAFTS model parameters

List of Tables

Table A.1: XP-RAFTS model parameters

Sub-catchment ID	Catchment Area (ha)	Catchment Slope (%)	Catchment PERN n
BC01	829	0.93	0.04
BC02	796	0.63	0.04
BC03	922	1.2	0.04
BC04	335	3.54	0.04
BC05	420	2.54	0.04
BC06	395	2.97	0.04
BC07	159	4.06	0.04
BC08	560	2.29	0.04
BC09	416	0.58	0.04
BC10	265	2.41	0.04
BC11	61	1.18	0.04
BC12_1	22	1.58	0.04
BC12_2	29	1.58	0.04
BC13	67	1.3	0.04
BC14_1	45	1.77	0.04
BC14_2	39	3.6	0.04
BC15	176	0.39	0.04
BC16	26	3	0.04
BC17	107	3.61	0.04
BC18	101	2.85	0.04
BC19	41	3.5	0.04
BC20	524	1.02	0.04
BC21	98	1.89	0.04
BC22	287	2.45	0.04
BC23	187	0.45	0.04
BC24	424	0.89	0.04
BC25	471	1.32	0.04
BC26	441	1.77	0.04
BC27	293	3.05	0.04
BC28	143	2.65	0.04
BC29	409	1.02	0.04
BC30	767	1.13	0.04
BC31_1	108	3.18	0.04
BC31_2	123	0.63	0.04
BC32	114	3.7	0.04
BC33	205	0.35	0.04
BC34	261	0.44	0.04
BC35	527	0.3	0.04
BC36	1,303	0.3	0.04
BC37	536	0.41	0.04

Sub-catchment ID	Catchment Area (ha)	Catchment Slope (%)	Catchment PERN n
BC38	1,145	0.54	0.04
BC39	676	0.1	0.04
BC40	1,013	0.33	0.04
BC41	1,819	0.29	0.04
BC42	832	0.22	0.04
BC43	264	0.14	0.04
BTC1	1,367	1.18	0.04
BTC2	1,308	1.27	0.04
BTC3	302	0.7	0.04
CC1	4,956	1.1	0.08
CC10	1,418	0.6	0.07
CC11	5,108	2	0.08
CC12	5,709	1	0.08
CC13	908	0.6	0.06
CC14	2,909	1.5	0.07
CC15	3,963	0.8	0.07
CC16	908	0.6	0.06
CC17	1,483	1	0.07
CC18	739.5	0.8	0.06
CC19	542	0.5	0.06
CC2	6,316	2	0.08
CC20	1,400	0.4	0.06
CC21	1,111	0.2	0.06
CC22	828	0.28	0.06
CC22a	1,554	0.28	0.06
CC22b	716	0.28	0.06
CC23	2,373	0.3	0.07
CC3	4,543	2	0.08
CC4	1,331	0.8	0.06
CC5	4,335	0.6	0.07
CC6	2,151	0.6	0.07
CC7	7,835	0.8	0.07
CC8	5,545	1.2	0.07
CC9	1,323	1	0.08
CG1	883	0.6	0.06
CG1a	424	0.6	0.06
CG1b	195	0.6	0.06
CG2	1,716	0.5	0.05
CG3	1,267	0.5	0.06
CG4	795	0.6	0.05
CG4a	246	0.6	0.05
CG4b	632	0.6	0.05

Sub-catchment ID	Catchment Area (ha)	Catchment Slope (%)	Catchment PERN n
CG5	976	0.7	0.06
DN_BC1	0.1	0.01	0.04
DN_BC2	0.1	0.01	0.04
DN_HC1	0.1	0.01	0.04
DN_HC2	0.1	0.01	0.04
DN_PC1	0.1	0.01	0.04
DN_PC2	0.1	0.01	0.025
DN_PC3	0.10	0.01	0.04
DN_RC31	0.1	0.01	0.04
DN1	1	1	0.07
DN10	10	0.1	0.06
DN11	10	0.1	0.06
DN12.PDhwy	10	0.1	0.06
DN12b	10	0.1	0.06
DN13	10	0.1	0.06
DN14	1	0.01	0.06
DN15	10	1	0.06
DN2.Burton	1	1	0.07
DN3	1	1	0.07
DN4	1	1	0.07
DN5.NG	1	0.01	0.06
DN6	10	0.1	0.06
DN7	1	0.01	0.06
DN8	10	0.1	0.06
DN9	10	0.1	0.06
EC1	1,320	0.7	0.06
EC2	1,340	0.6	0.06
EC3	1,580	0.8	0.06
EC4	1,210	0.8	0.06
EC5	810	0.6	0.06
EC6	1,410	0.7	0.05
EC7	290	0.6	0.05
EC8	80	0.5	0.05
EC9	60	0.5	0.05
GC1	7,867	1	0.06
GC10	670	0.8	0.05
GC11	299	1	0.05
GC12	2,157	0.8	0.05
GC13	2,557	0.6	0.05
GC2	10,980	0.8	0.06
GC3	10,470	0.7	0.07
GC4	11,370	0.3	0.07

Sub-catchment ID	Catchment Area (ha)	Catchment Slope (%)	Catchment PERN n
GC5	7,798	0.3	0.07
GC6	7,214	1.2	0.05
GC7	8,023	0.6	0.05
GC8	3,765	0.4	0.05
GC9	2,217	0.5	0.05
HC01	1,014	2.52	0.04
HC02	879	1.59	0.04
HC03	412	2.13	0.04
HC04	1,089	1.29	0.04
HC05	841	0.74	0.04
HC06	201	2.04	0.04
HC07	966	0.43	0.04
HC08	1,073	0.96	0.04
HC09	983	0.84	0.04
HC10	2,150	0.51	0.04
HC11	542	1.11	0.04
HC12	631	0.79	0.04
HC13	440	0.33	0.04
HC14	395	1.53	0.04
HC15	232	1.54	0.04
HC16	236	0.48	0.04
HC16_1	24	2.51	0.04
HC17	179	1.21	0.04
HC18	131	0.37	0.04
HC19	343	0.31	0.04
HC20	488	0.28	0.04
HC21	708	1.79	0.04
IR1	8,292	1	0.07
IR10	5,780	1.5	0.07
IR11	10,720	0.5	0.06
IR12	11,370	0.7	0.07
IR13	1,590	0.5	0.06
IR14_1	1,940	0.9	0.07
IR14_2	3,860	0.9	0.07
IR14_3	1,110	0.5	0.07
IR15	16,240	0.6	0.07
IR16	20,410	0.8	0.07
IR17	12,330	0.5	0.07
IR18	1,942	2.3	0.05
IR19	787	1.3	0.06
IR2	12,140	1	0.07
IR20	3,420	0.8	0.06

Sub-catchment ID	Catchment Area (ha)	Catchment Slope (%)	Catchment PERN n
IR21	2,307	1.2	0.06
IR22	1,738	1.5	0.07
IR23	713	2.6	0.06
IR24	3,650	1	0.05
IR25	2,514	1.2	0.06
IR26	1,075	2	0.05
IR27	1,825	1.7	0.05
IR28	2,408	1.2	0.05
IR29	1,518	0.5	0.05
IR3	2,430	0.8	0.07
IR30	4,444	1.2	0.06
IR31	2,124	0.5	0.06
IR32	2,540	0.6	0.06
IR33a	1,498	0.5	0.06
IR33b	1,160	0.5	0.06
IR33c	2,077	0.5	0.06
IR34	5,013	0.2	0.07
IR35	13,559	0.5	0.06
IR36	4,210	0.5	0.07
IR37	3,050	0.4	0.06
IR38	2,440	0.5	0.06
IR39	2,060	0.8	0.07
IR4	5,436	2	0.08
IR40	3,970	0.1	0.06
IR41	3,668	0.25	0.04
IR42	2,369	0.14	0.04
IR43	1,908	0.37	0.04
IR5	2,560	1	0.07
IR6	4,800	1	0.07
IR7	4,125	1.5	0.07
IR8	9,830	0.6	0.06
IR9	11,110	1	0.06
NC1	1,528	0.6	0.07
NC2	2,093	0.6	0.07
NC3	3,770	0.6	0.07
NC4	5,798	0.6	0.07
NC5	9,351	0.6	0.07
NC6	5,078	0.6	0.07
NC7	2,943	0.6	0.07
NC8	2,498	0.3	0.06
NorthDam	83	0.6	0.07
OMC01	481	1.45	0.04

Sub-catchment ID	Catchment Area (ha)	Catchment Slope (%)	Catchment PERN n
OMC02	874	1.43	0.04
OMC03	123	3.84	0.04
OMC03_1	26	3.99	0.04
OMC04	1,163	0.33	0.04
OMC05	1,835	0.3	0.04
OMC06	1,011	0.27	0.04
OMC07	2,188	0.47	0.04
OMC08	1,437	0.34	0.04
OMC09	549	0.17	0.04
OMC10	1,306	0.17	0.04
PC01	5,985	1.15	0.04
PC02	1,830	1.01	0.04
PC03	4,110	1.16	0.04
PC04	3,985	0.47	0.04
PC05	2,702	0.95	0.04
PC06	2,481	0.88	0.04
PC07	2,699	1.14	0.04
PC08	2,668	0.58	0.04
PC09	2,812	0.44	0.04
PC10	3,717	0.94	0.04
PC11	928	0.74	0.04
PC11_1	120	2.49	0.04
PC11_2	489	1.82	0.04
PC12_1	1,520	0.67	0.04
PC12_2	1,655	0.46	0.04
PC13	691	0.24	0.04
PC14	2,103	0.35	0.04
PC15	1,205	0.24	0.04
PC16	1,313	0.15	0.04
PC17	1,712	0.27	0.04
PC18	1,947	0.2	0.04
PC19	1,179	0.36	0.04
PC20	1,696	0.12	0.04
PC21	1,289	0.4	0.04
RC01	933	0.65	0.04
RC02	908	0.25	0.04
RC03a	284	1.25	0.04
RC03b	232	3.32	0.04
RC04	453	0.45	0.04
RC05	864	0.39	0.04
RC06	467	0.93	0.04
RC07	432	1.38	0.04

Sub-catchment ID	Catchment Area (ha)	Catchment Slope (%)	Catchment PERN n
RC08	300	0.37	0.04
RC09	344	0.43	0.04
RC10	144	0.38	0.04
RC11	508	0.53	0.04
RC12	527	0.56	0.04
RC13	459	0.31	0.04
RC14	143	0.57	0.04
RC15	680	0.48	0.04
RC16	472	0.47	0.04
RC17	737	0.44	0.04
RC18	382	0.94	0.04
RC19	274	0.51	0.04
RC20	247	1.03	0.04
RC21	484	0.16	0.04
RC22	199	0.49	0.04
RC23	298	0.69	0.04
RC24	245	0.71	0.04
RC25	808	0.44	0.04
RC26	274	0.55	0.04
RC27	335	0.41	0.04
RC28	587	0.14	0.04
RC29	886	0.25	0.04
RC30	352	0.36	0.04
RC31	468	0.47	0.04
RC32	943	0.38	0.04
RC33	656	0.36	0.04
RC34	1,507	0.46	0.04
RC35	1,027	0.42	0.04
RC36	2,209	0.32	0.04
RC37	1,458	0.11	0.04
RC38	1,814	0.25	0.04
RC39	1,981	0.35	0.04
RC40	2,411	0.4	0.04
RC41	1,196	0.36	0.04
Saraji	0.1	0.01	0.04
SC01	1,113	0.62	0.04
SC02	340	1.61	0.04
SC03	593	0.81	0.04
Teviot	4,065	1.5	0.07

Annexure B. XP-RAFTS design discharge box and whisker plots

List of Figures

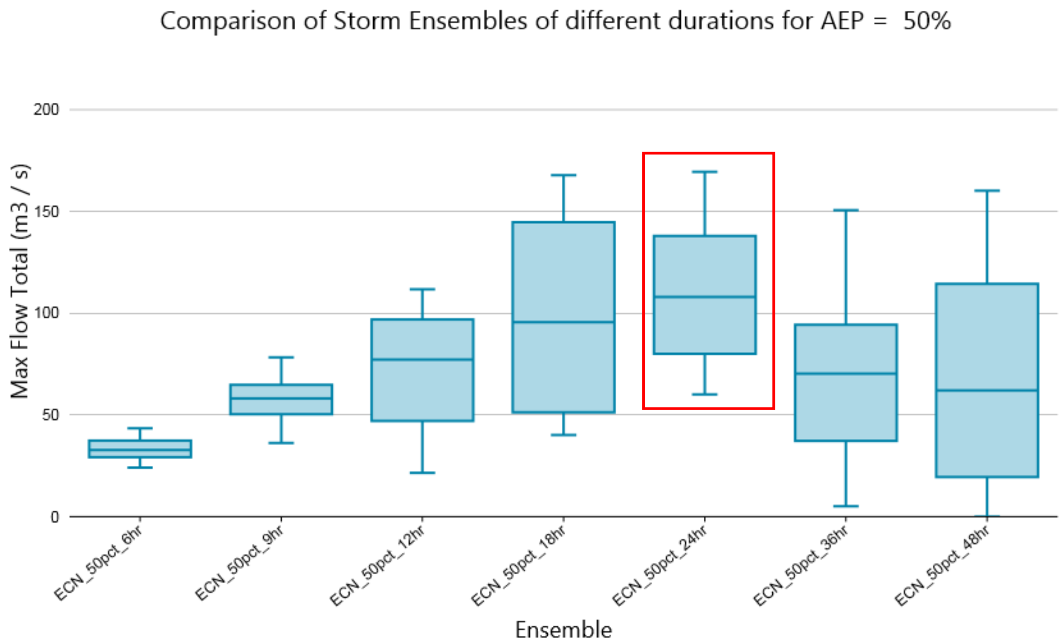

Figure B.1: 50% AEP Catchment PC15 Phillips Creek local flooding

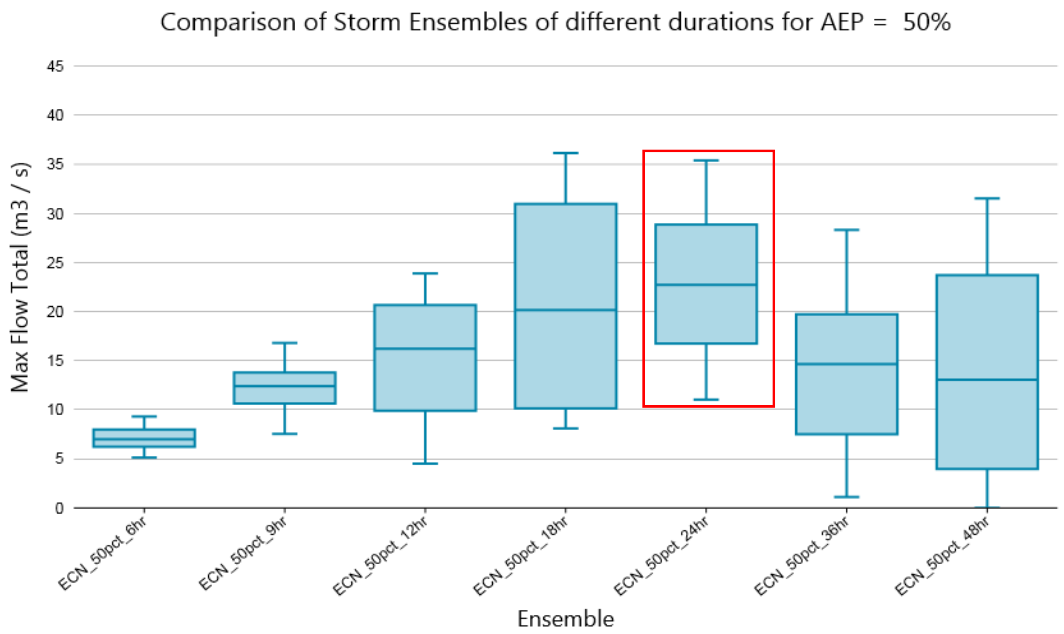

Figure B.2: 50% AEP Catchment OMC05 One Mile Creek local flooding

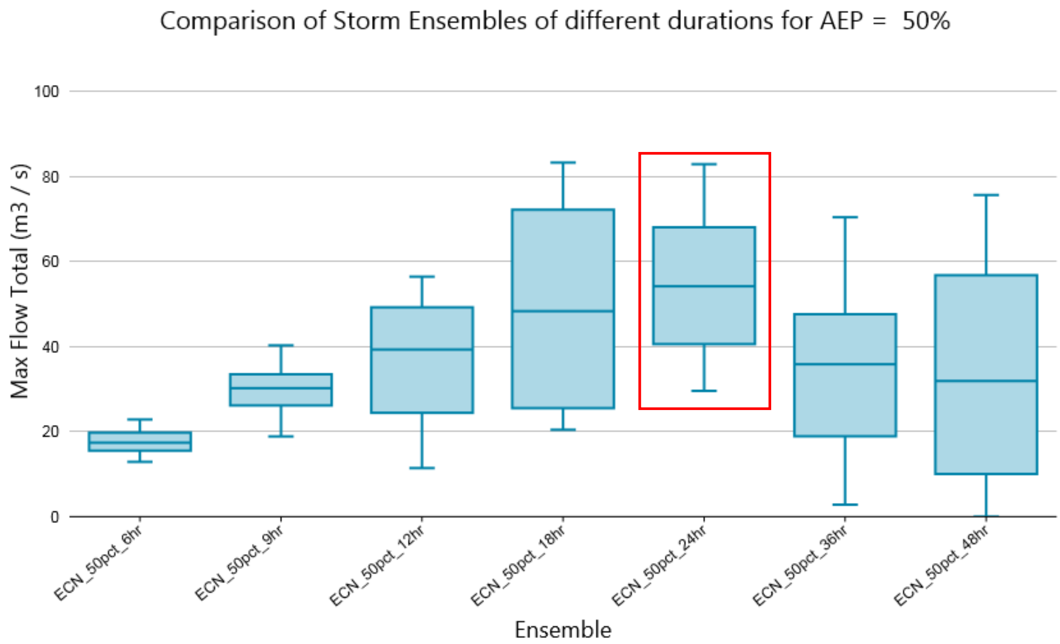

Figure B.3: 50% AEP Catchment RC35 Ripstone Creek local flooding

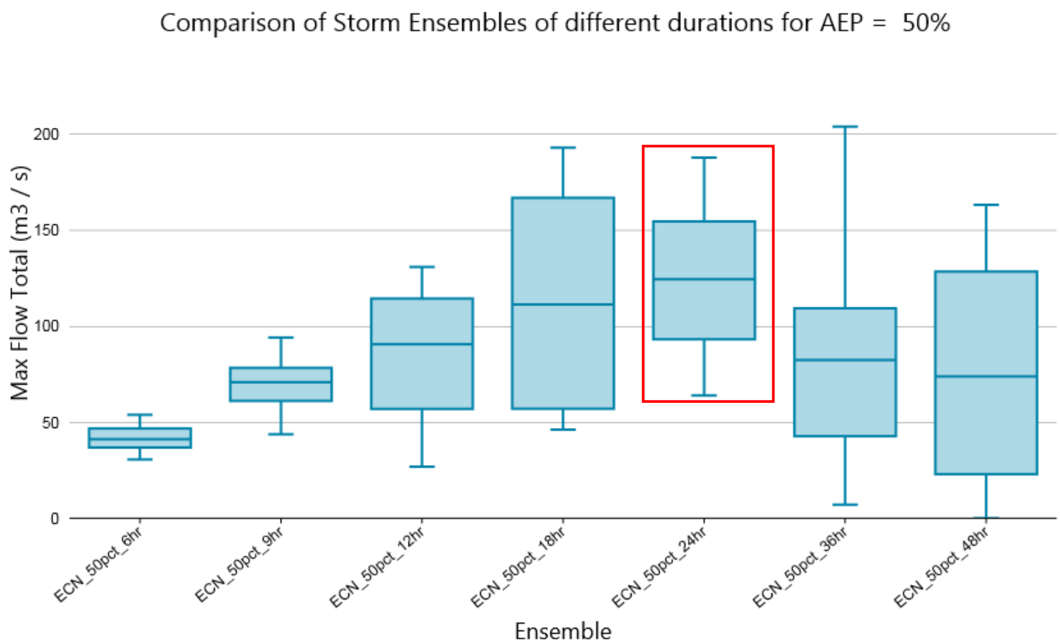

Figure B.4: 50% AEP Catchment BC40 Boomerang Creek local flooding

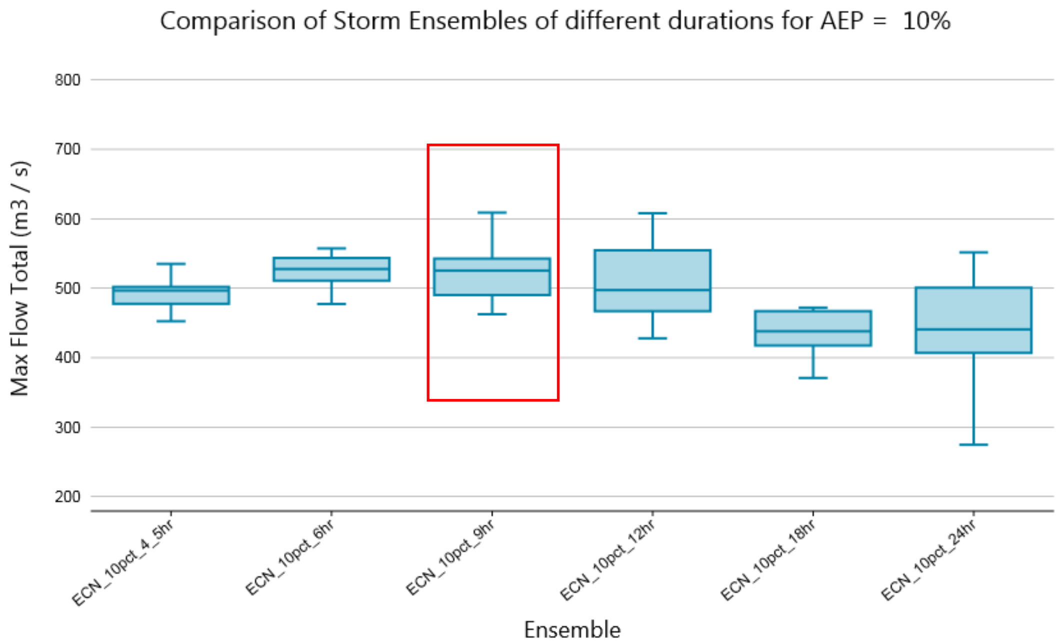

Figure B.5: 10% AEP Catchment PC15 Phillips Creek local flooding

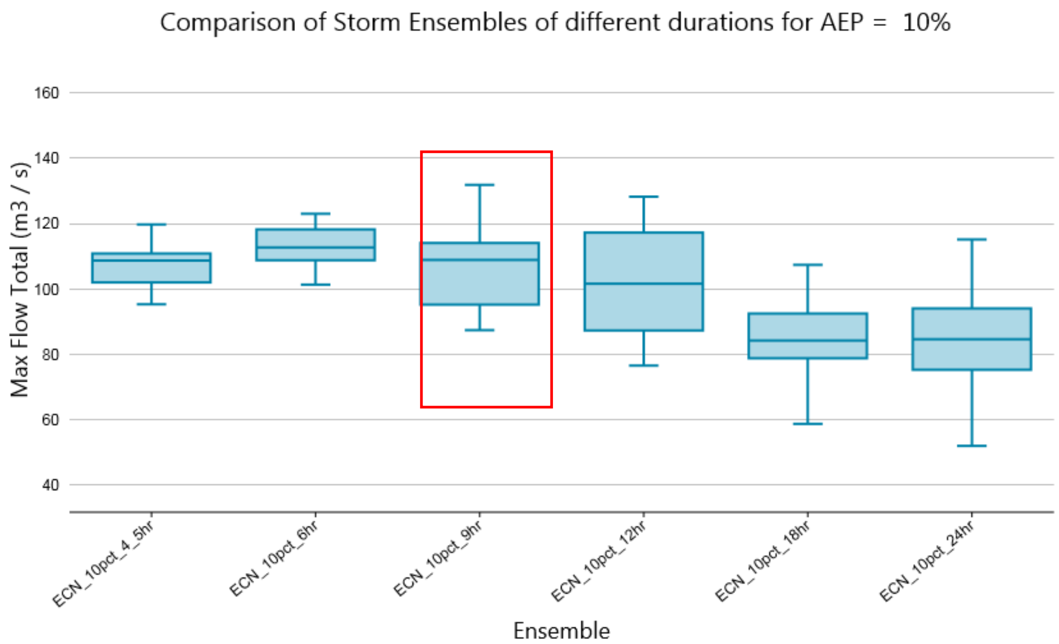

Figure B.6: 10% AEP Catchment OMC05 One Mile Creek local flooding

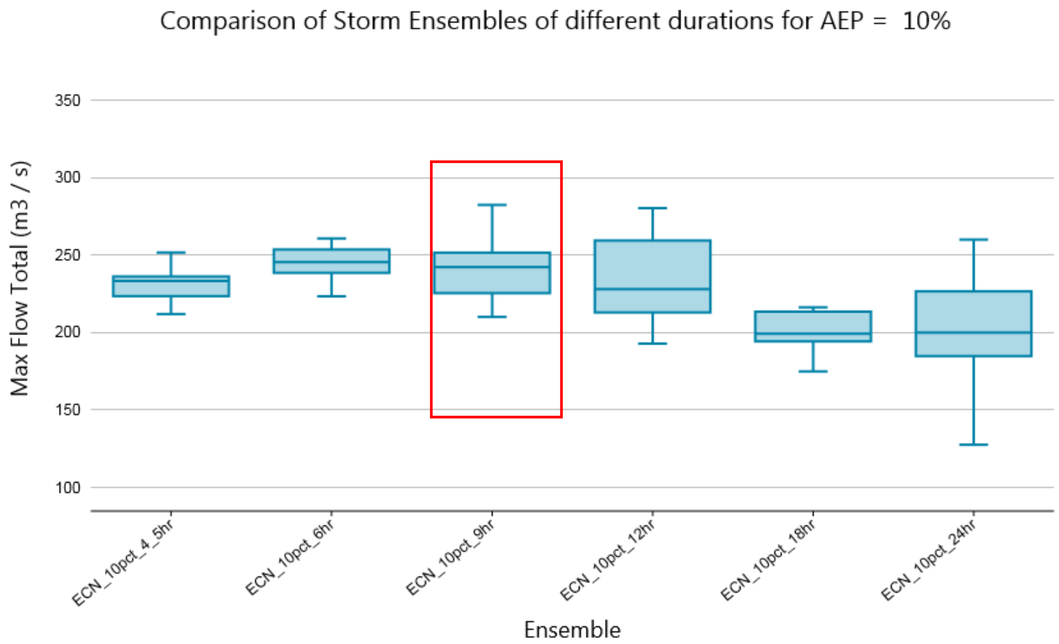

Figure B.7: 10% AEP Catchment RC35 Ripstone Creek local flooding

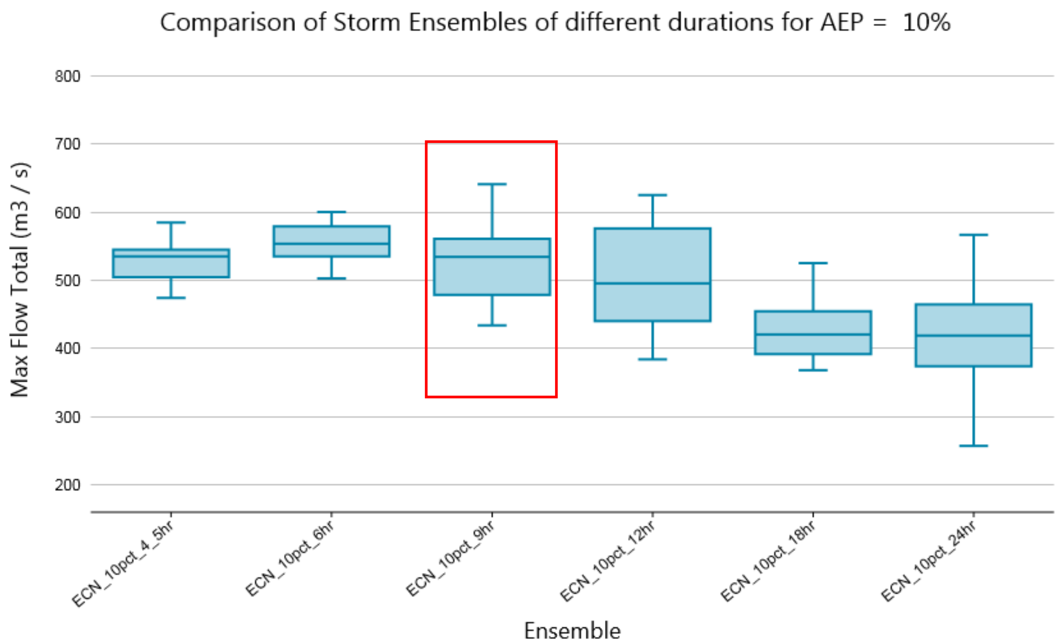

Figure B.8: 10% AEP Catchment RC35 Boomerang Creek local flooding

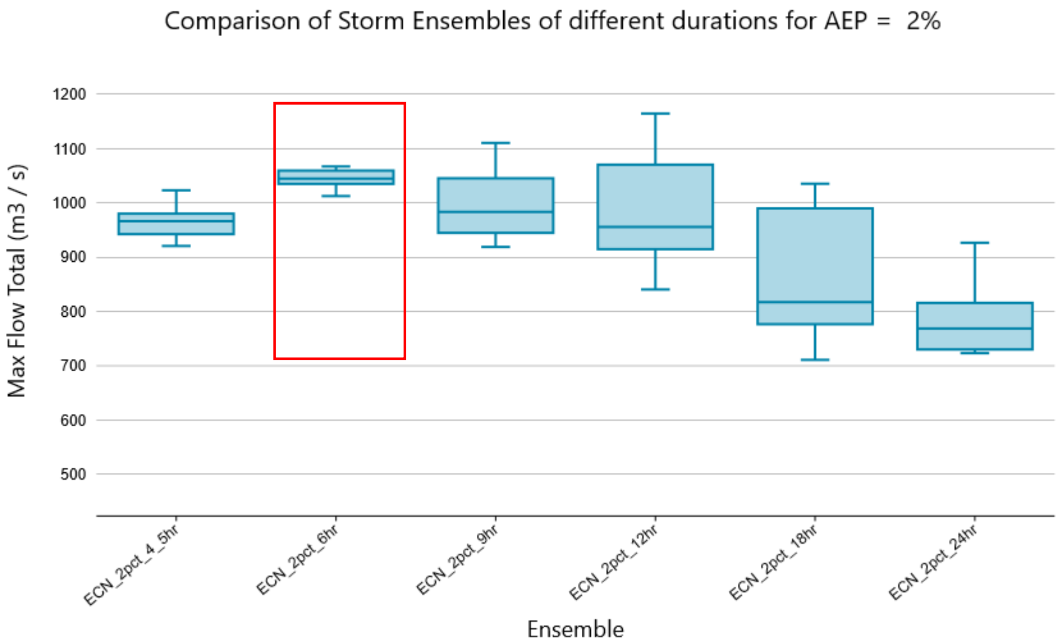

Figure B.9: 2% AEP Catchment PC15 Phillips Creek local flooding

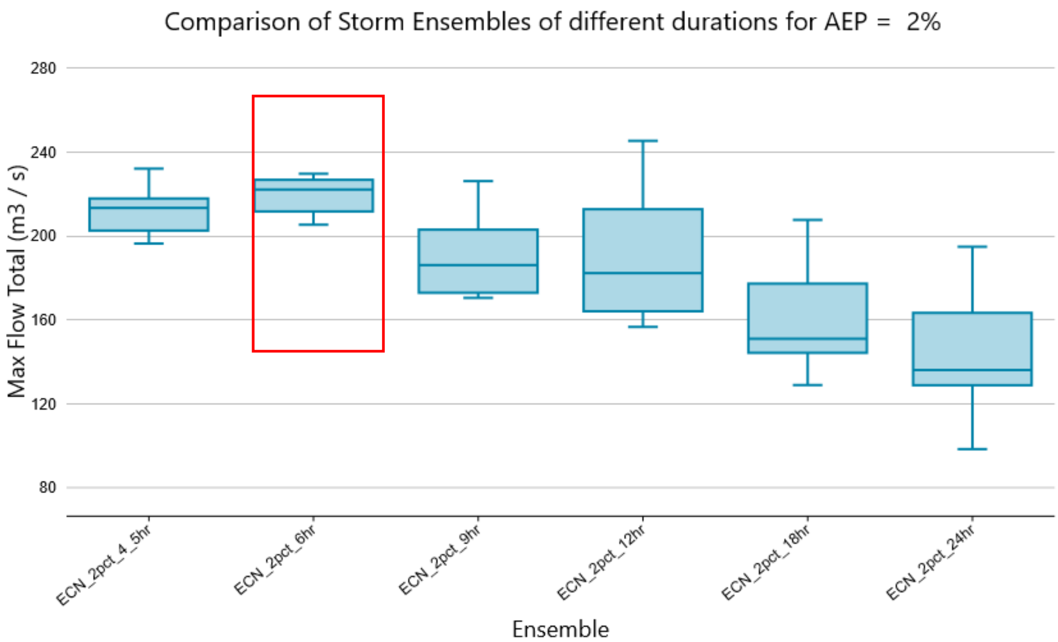

Figure B.10: 2% AEP Catchment OMC05 One Mile Creek local flooding

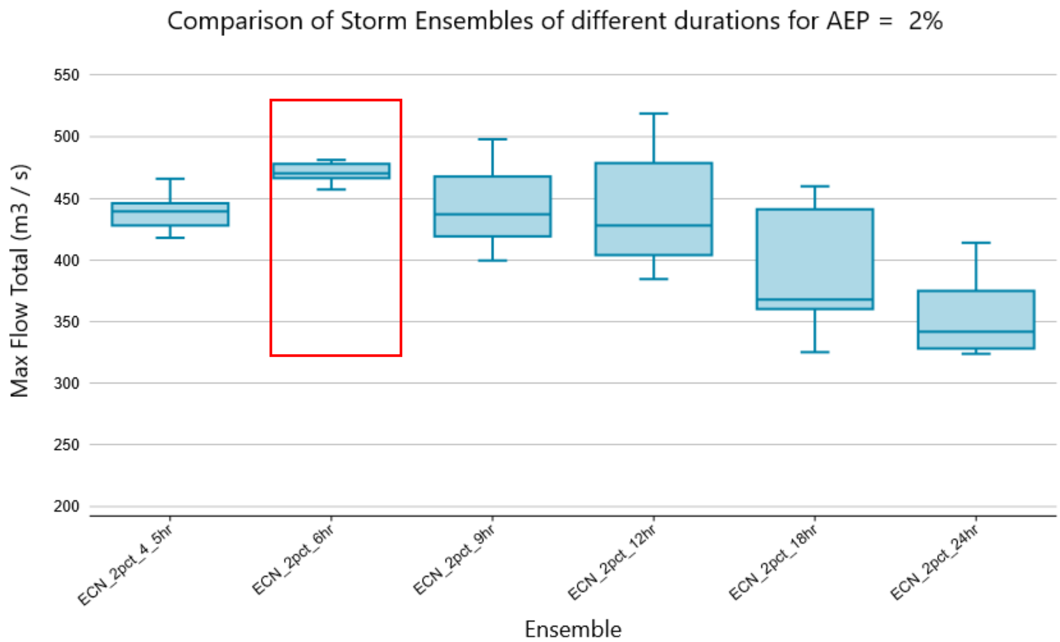

Figure B.11: 2% AEP Catchment RC35 Ripstone Creek local flooding

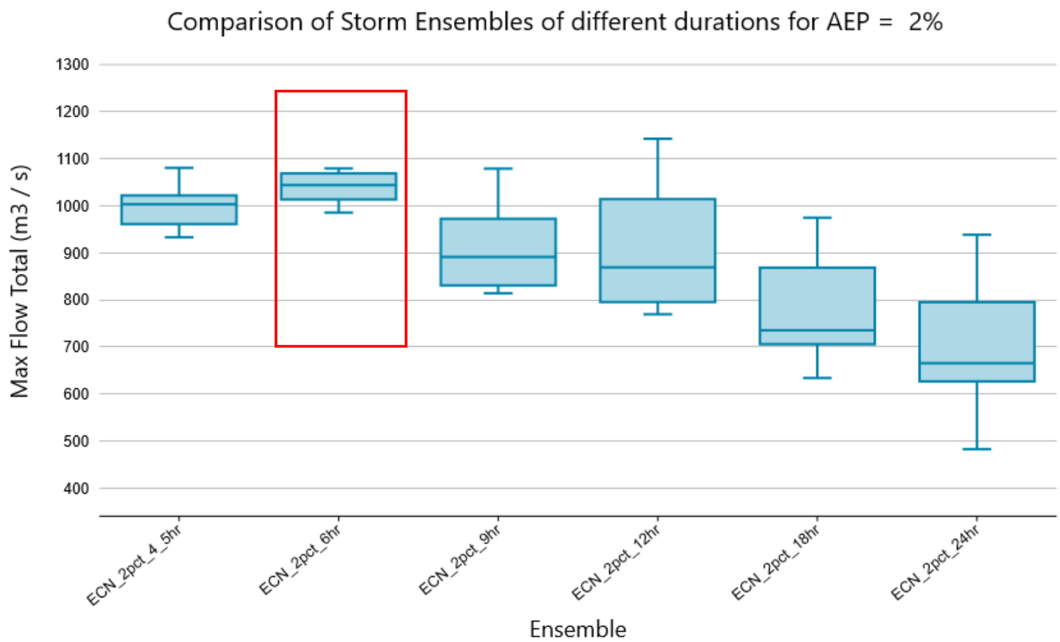

Figure B.12: 2% AEP Catchment BC40 Boomerang Creek local flooding

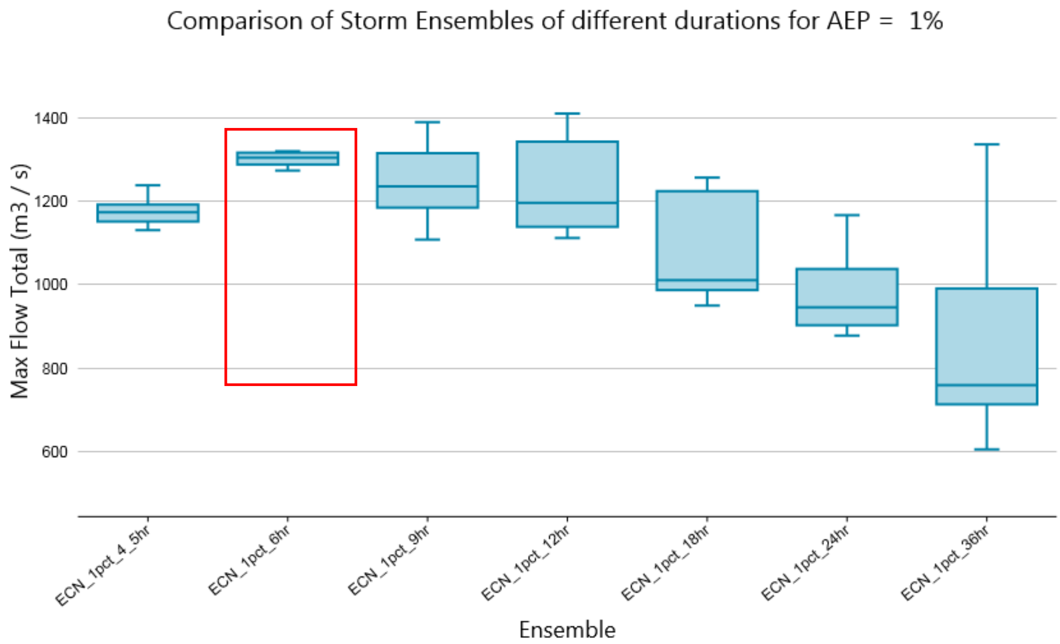

Figure B.13: 1% AEP Catchment PC15 Phillips Creek local flooding

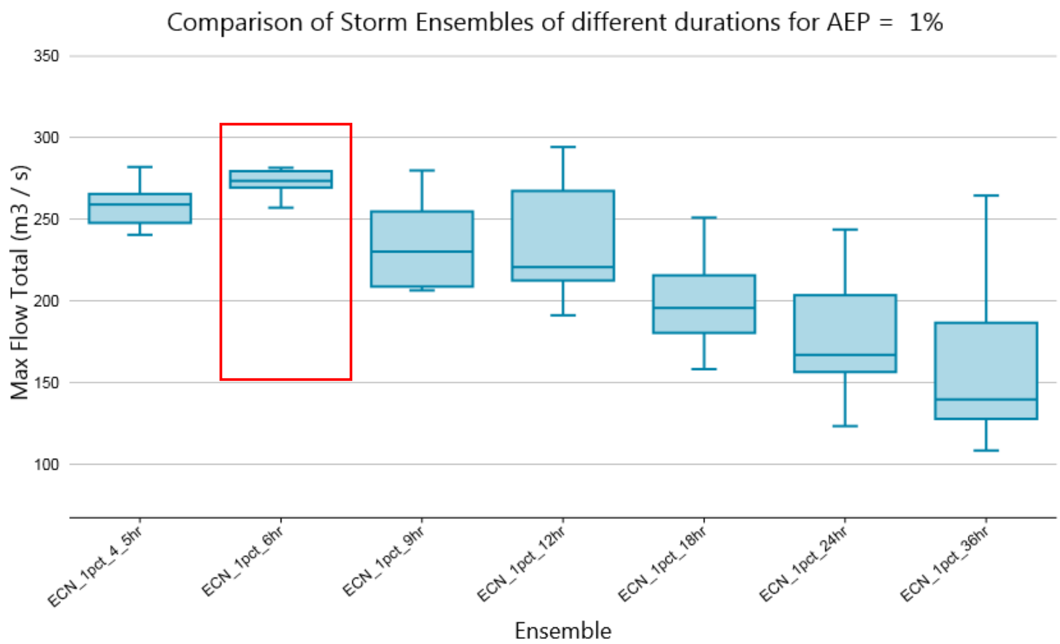

Figure B.14: 1% AEP Catchment OMC05 One Mile Creek local flooding

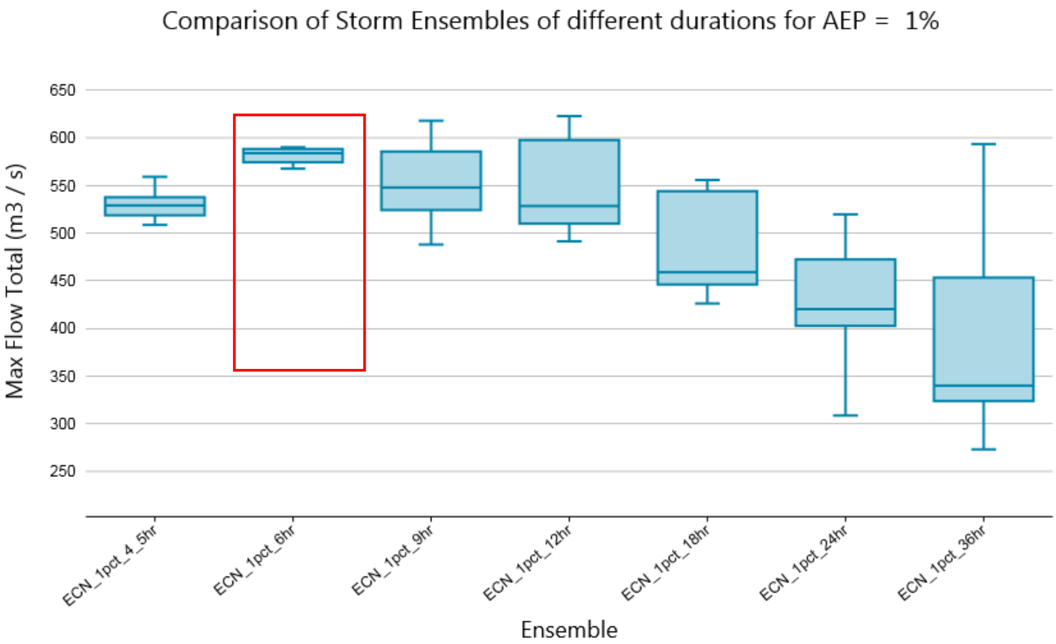

Figure B.15: 1% AEP Catchment RC35 One Mile Creek local flooding

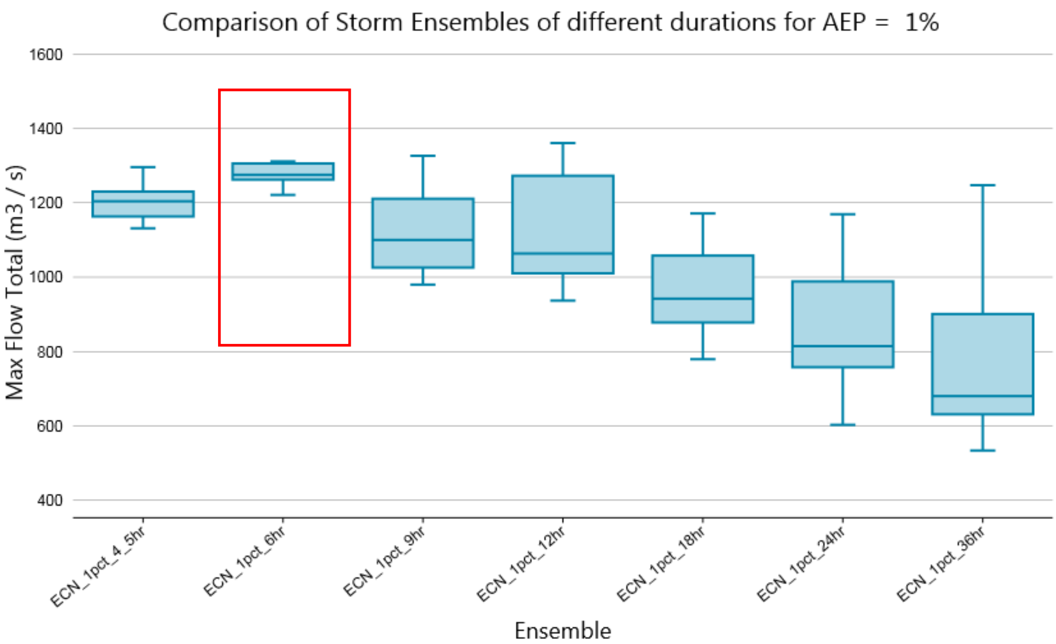

Figure B.16: 1% AEP Catchment BC40 Boomerang Creek local flooding

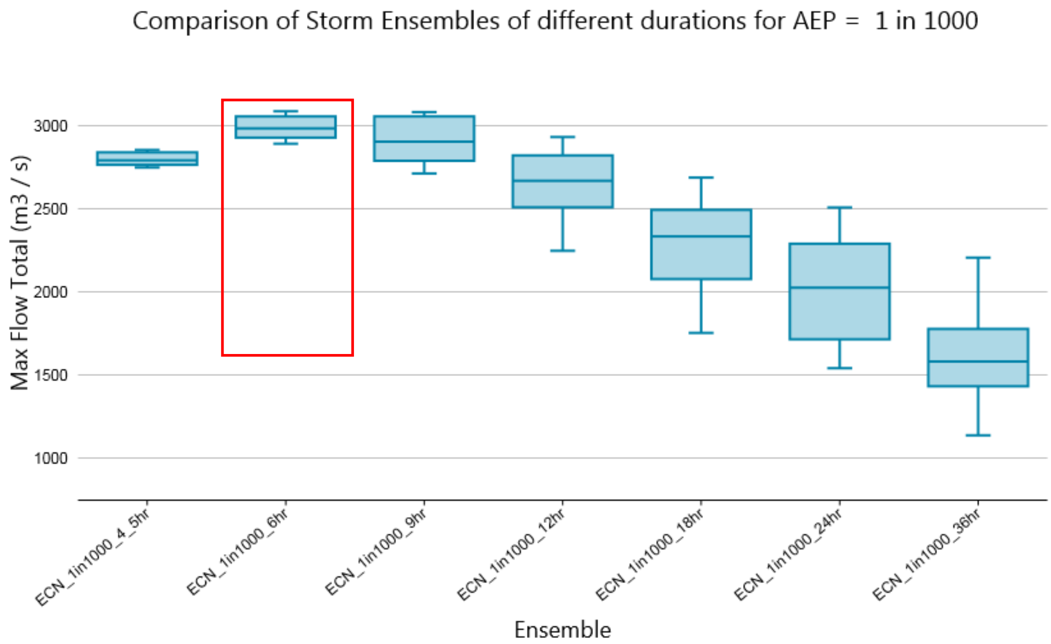

Figure B.17: 0.1% AEP Catchment PC15 Phillips Creek local flooding

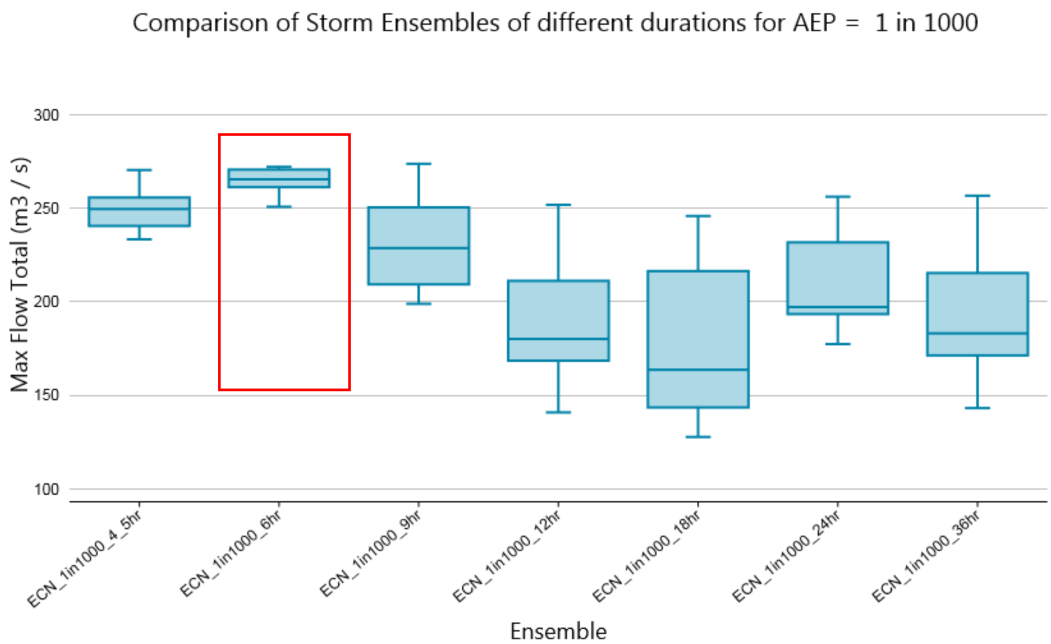

Figure B.18: 0.1% AEP Catchment OMC05 One Mile Creek local flooding

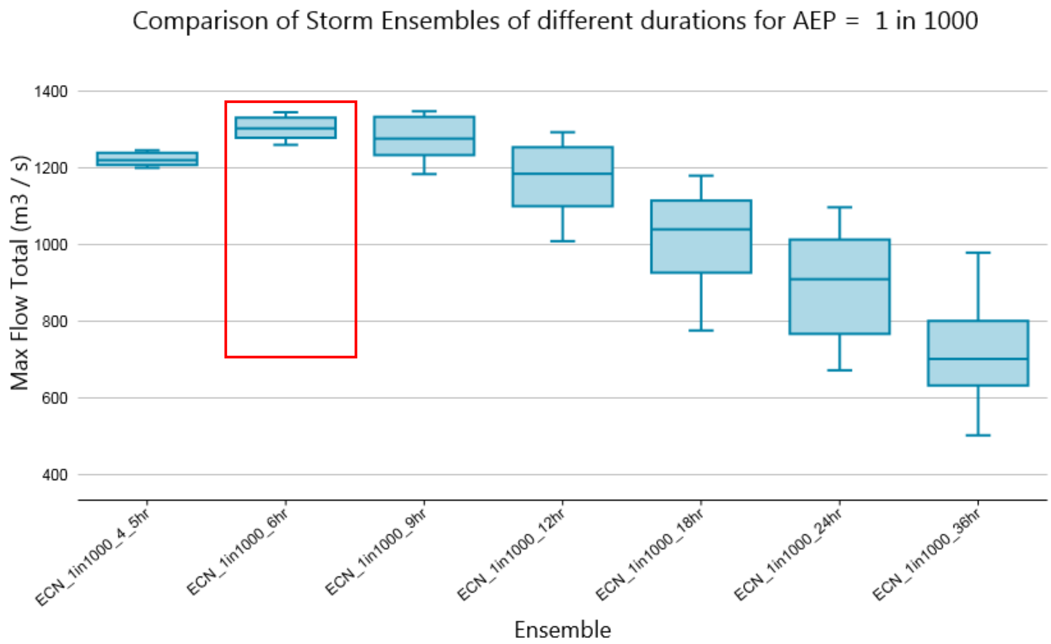

Figure B.19: 0.1% AEP Catchment RC35 Ripstone Creek local flooding

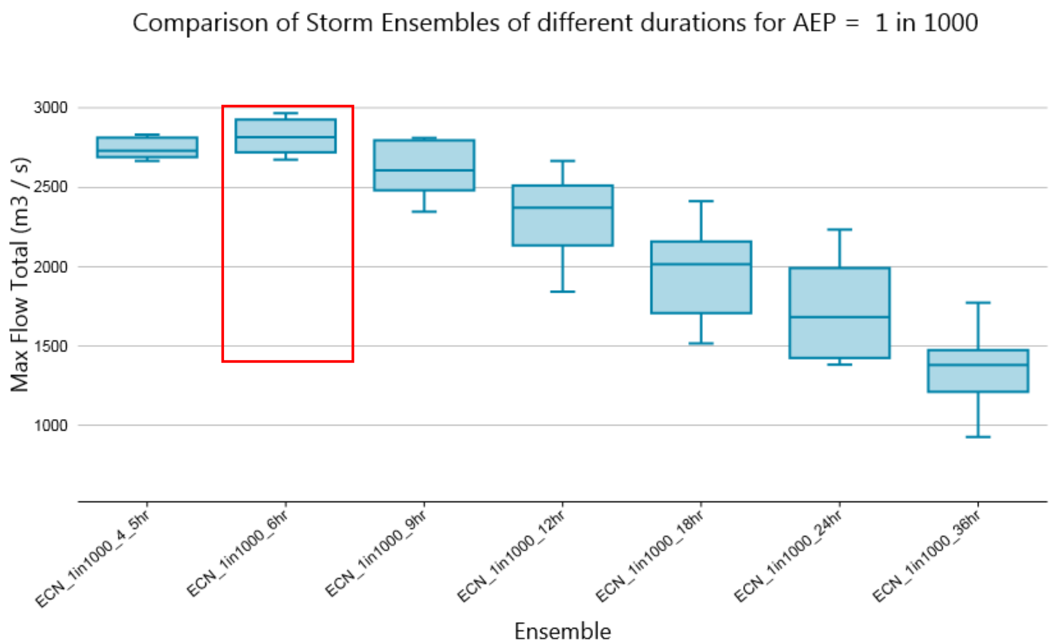

Figure B.20: 0.1% AEP Catchment BC40 Boomerang Creek local flooding

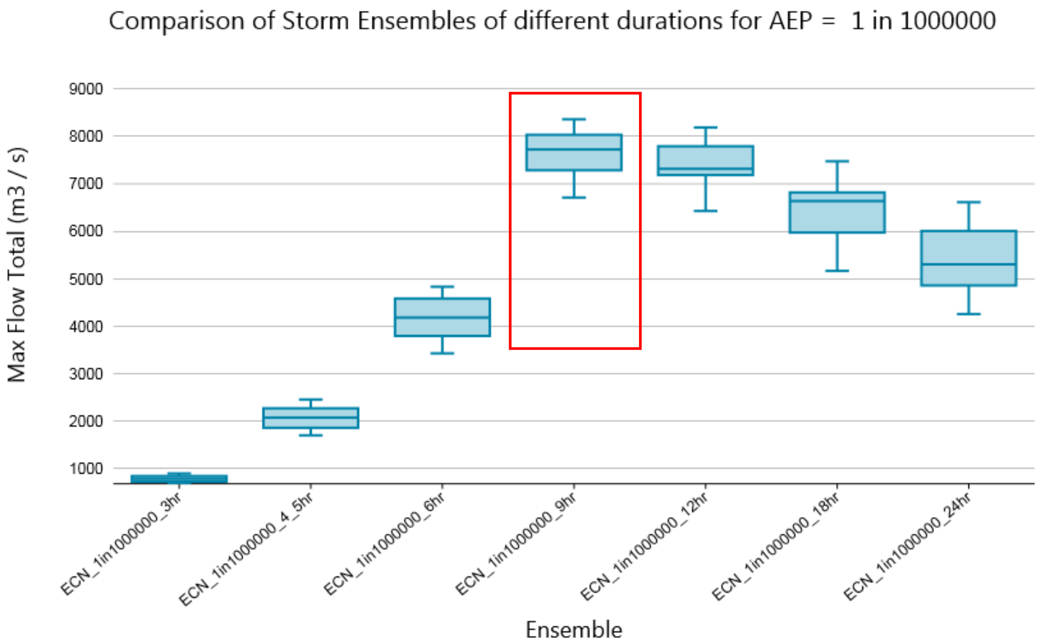

Figure B.21: PMF Catchment PC15 Phillips Creek local flooding

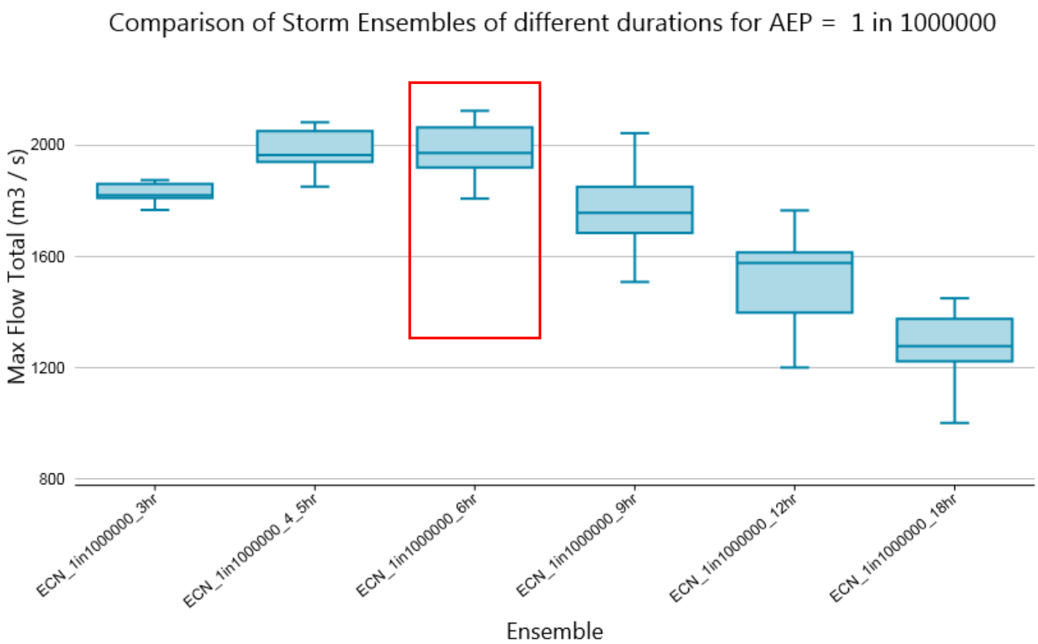

Figure B.22: PMF Catchment OMC05 One Mile Creek local flooding

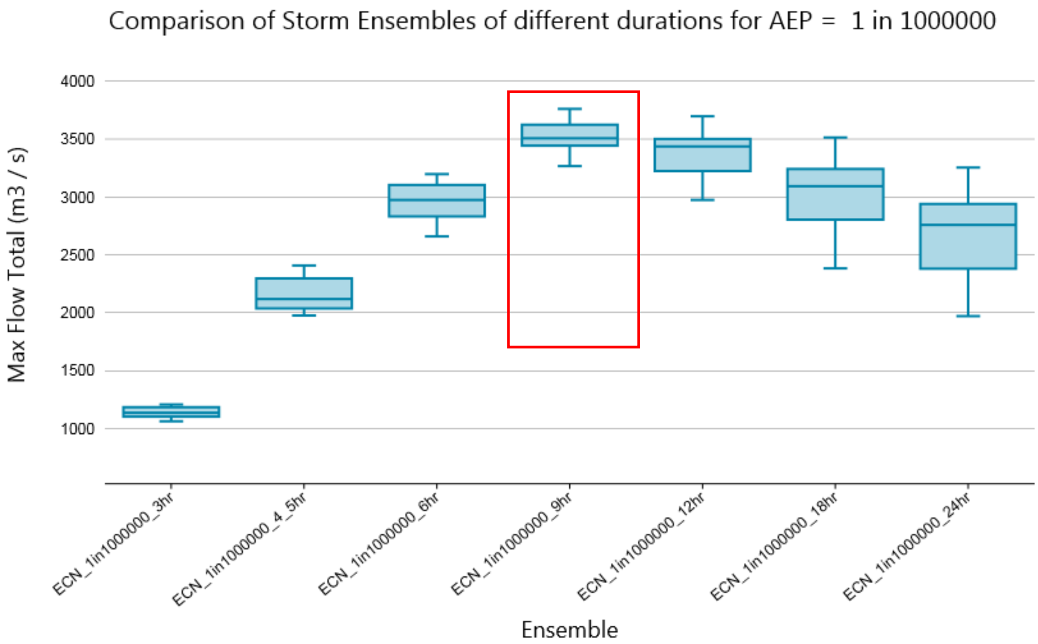

Figure B.23: PMF Catchment RC35 Ripstone Creek local flooding

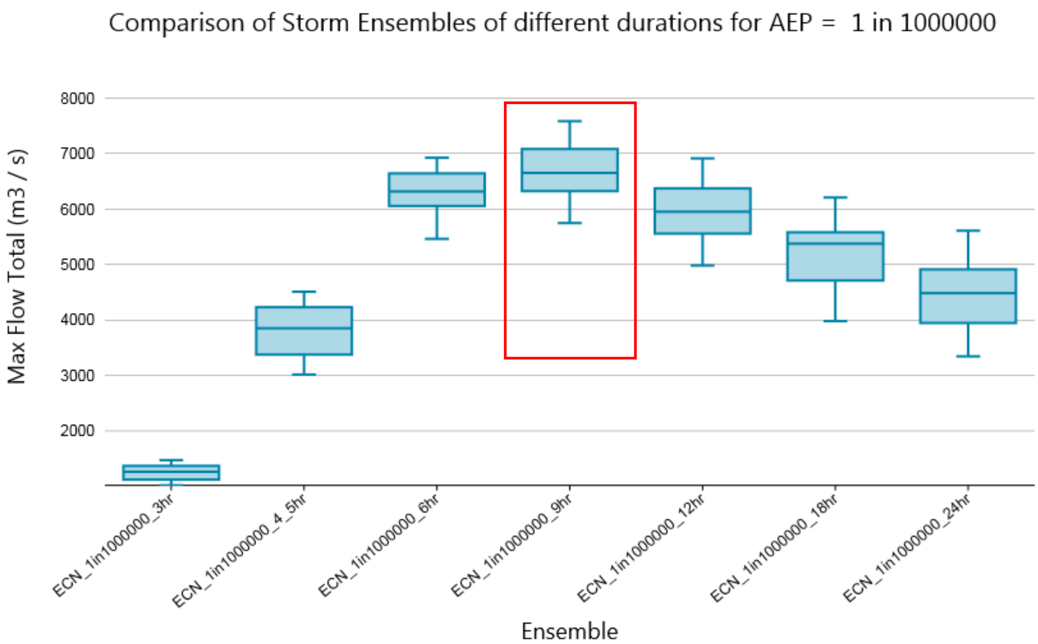

Figure B.24: PMF Catchment BC40 Boomerang Creek local flooding

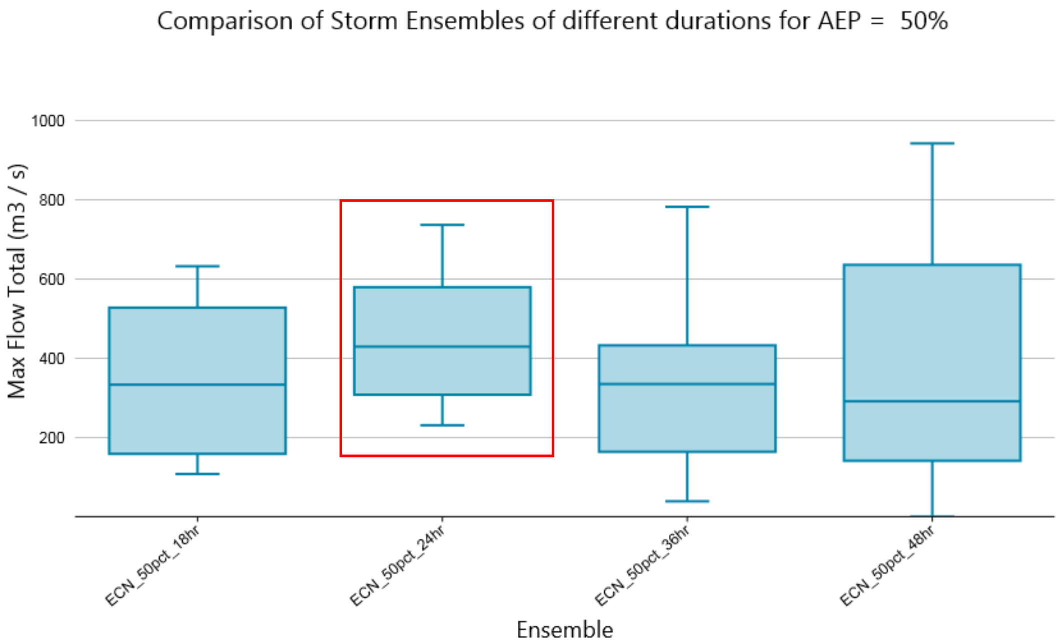

Figure B.25: 50% AEP Catchment IR42 Isaac River regional flooding

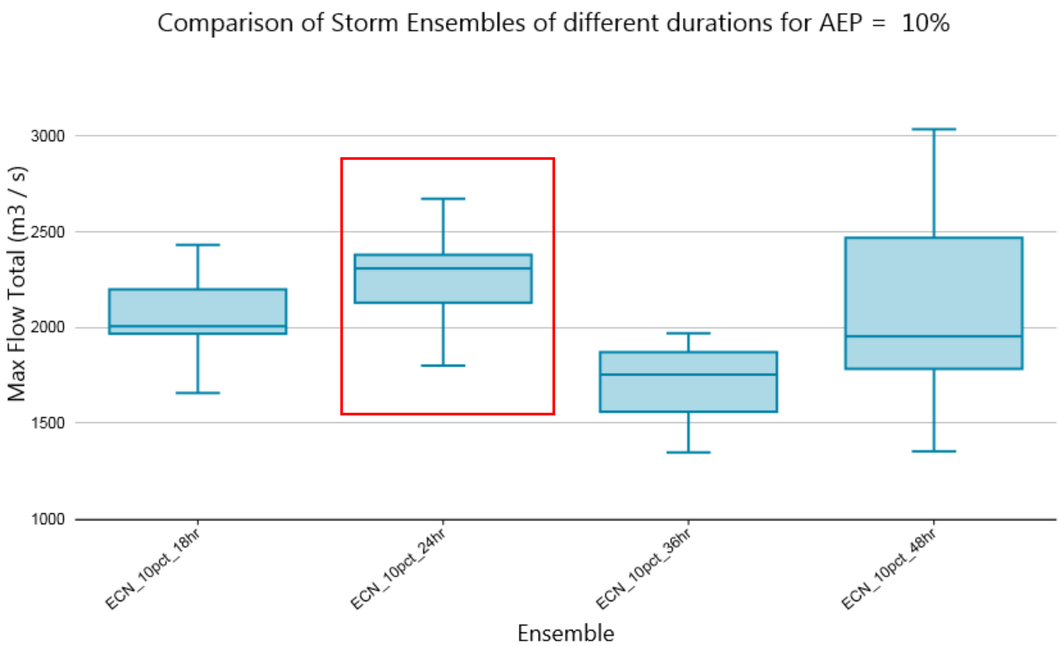

Figure B.26: 10% AEP Catchment IR42 Isaac River regional flooding

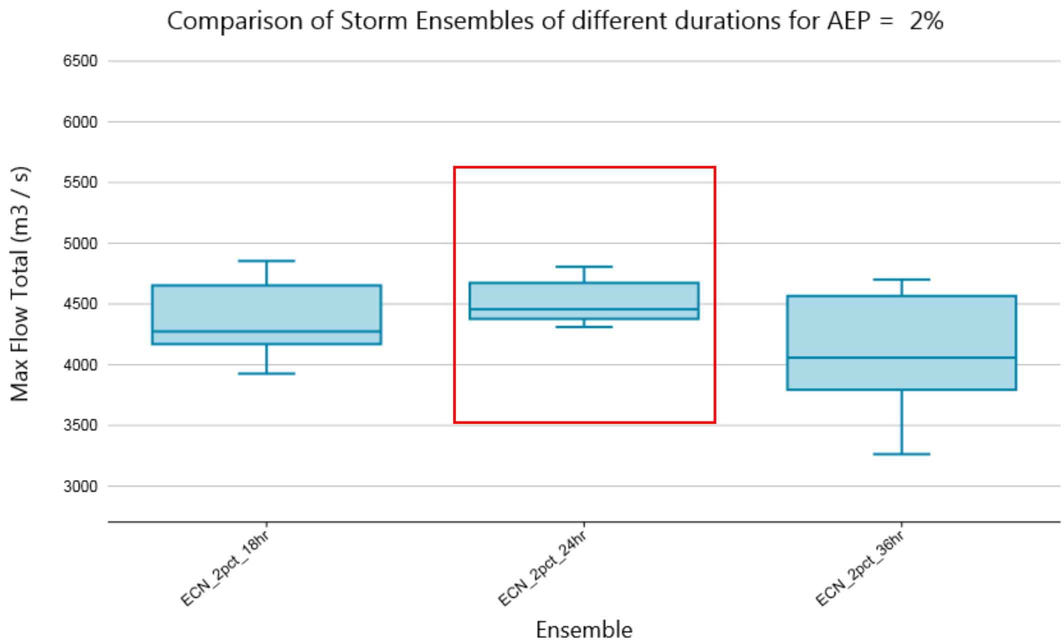

Figure B.27: 2% AEP Catchment IR42 Isaac River regional flooding

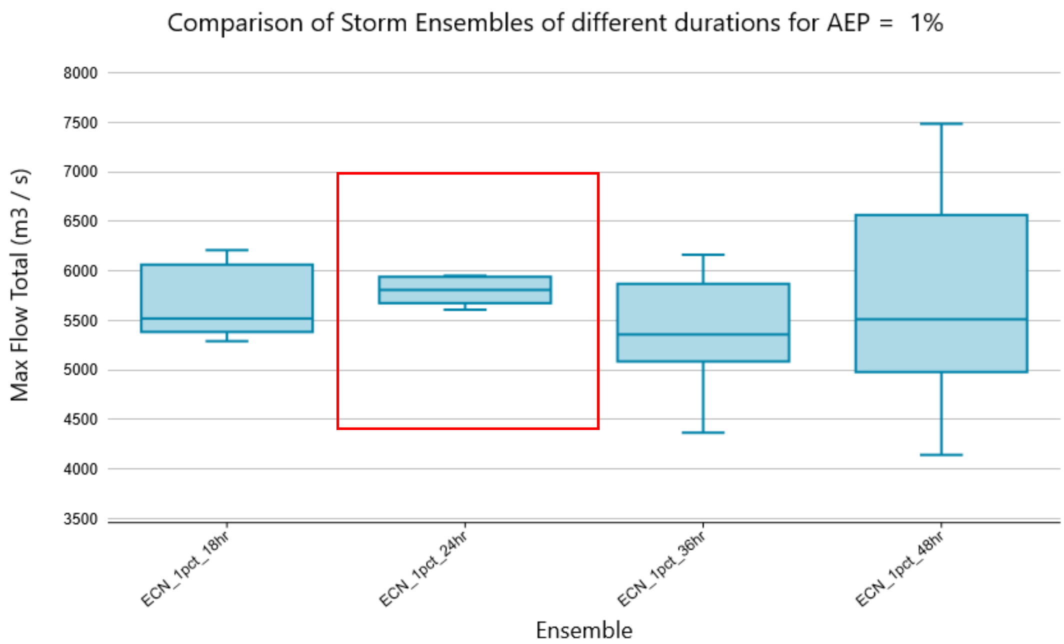

Figure B.28: 1% AEP Catchment IR42 Isaac River regional flooding

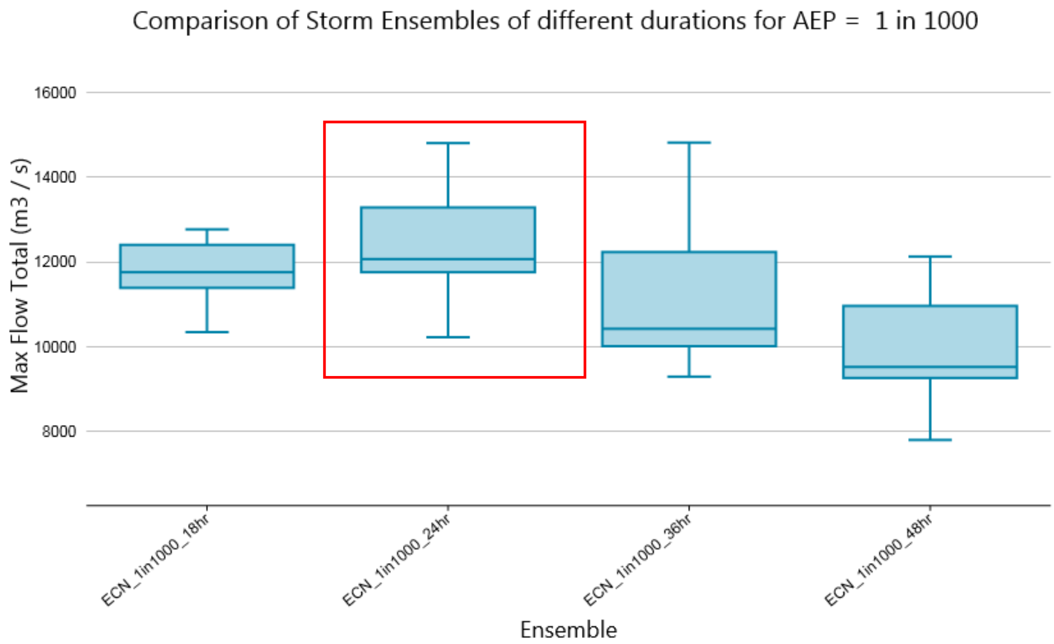

Figure B.29: 0.1% AEP Catchment IR42 Isaac River regional flooding

Annexure C. Maps of flood model results

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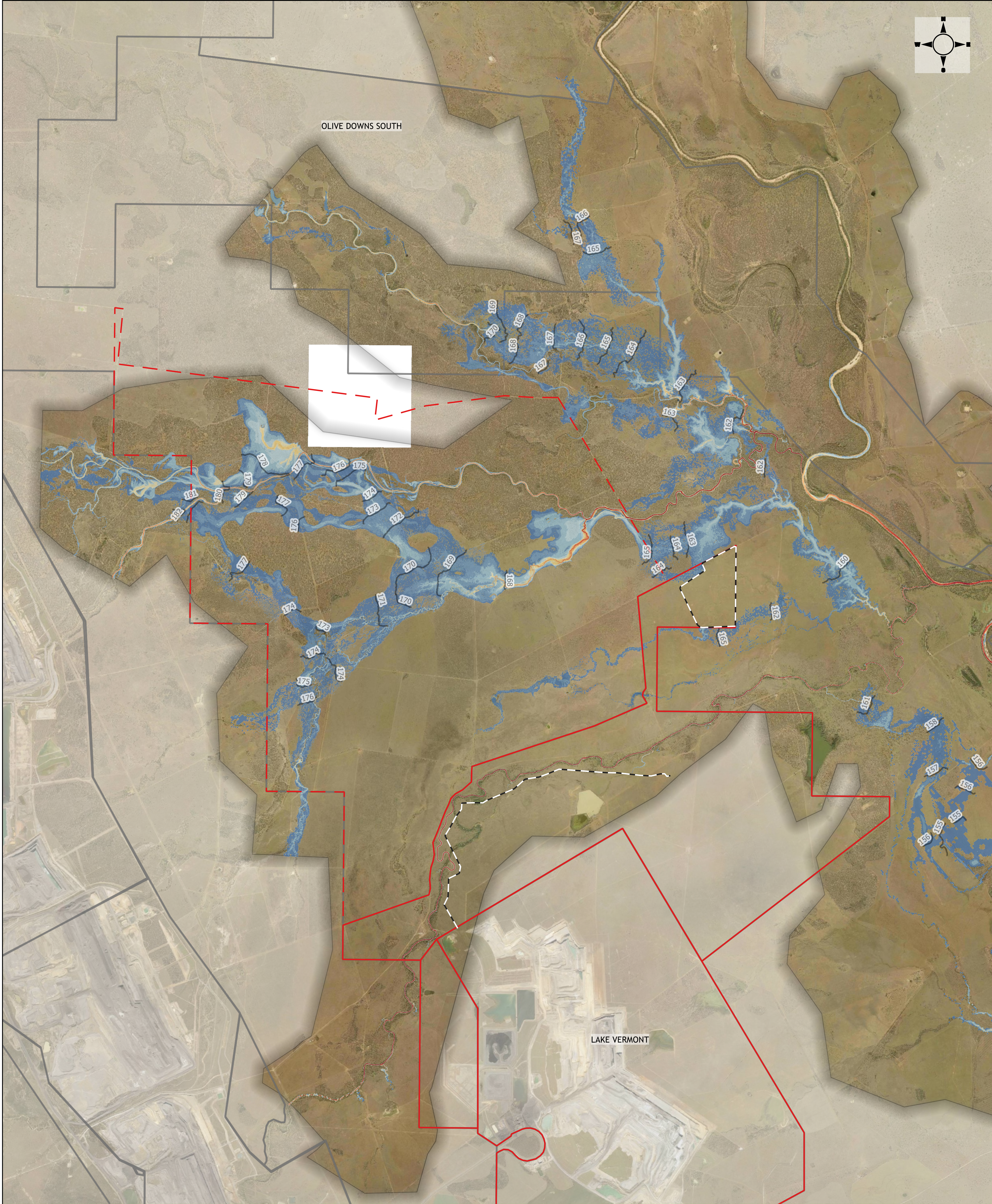


Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee
- 0.5m flood height contours (m AHD)

Depth (m)

- up to 0.25m
- 0.25 to 0.5m
- 0.5 to 1.0m
- 1.0 to 1.5m
- 1.5 to 2.0m
- 2.0 to 2.5m
- 2.5 to 3.0m
- 3.0 to 3.5m
- 3.5 to 4.0m
- 4.0 to 4.5m
- > 4.5m

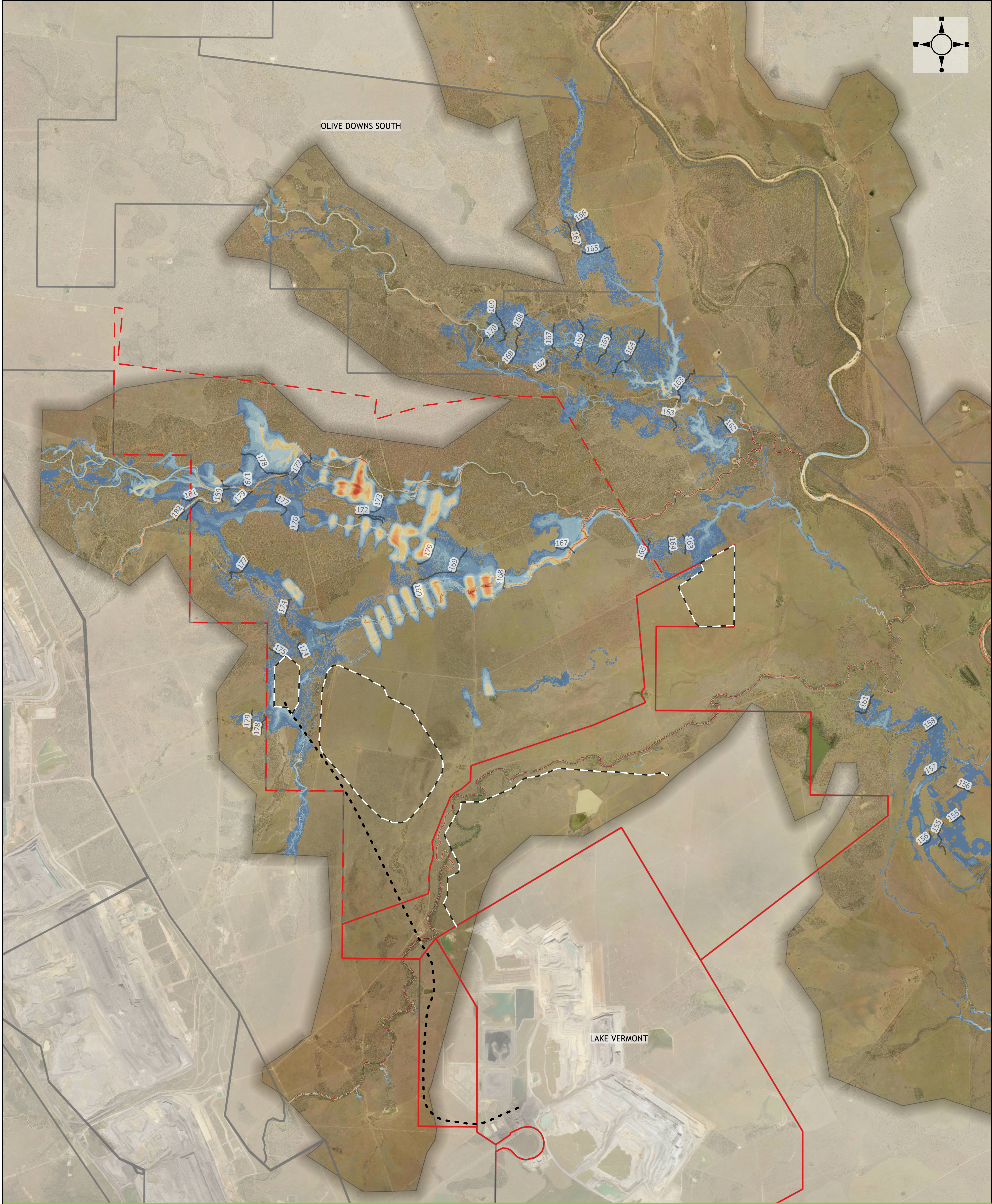
Lake Vermont Meadowbrook EIS

50% AEP flood depth and height local flooding
Approved conditions

0 1 2 3 4 5 km

wrm water + environment

Projection: EPSG:20355



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee
- Haul road alignment

0.5m flood height contours (m AHD)

Depth (m)

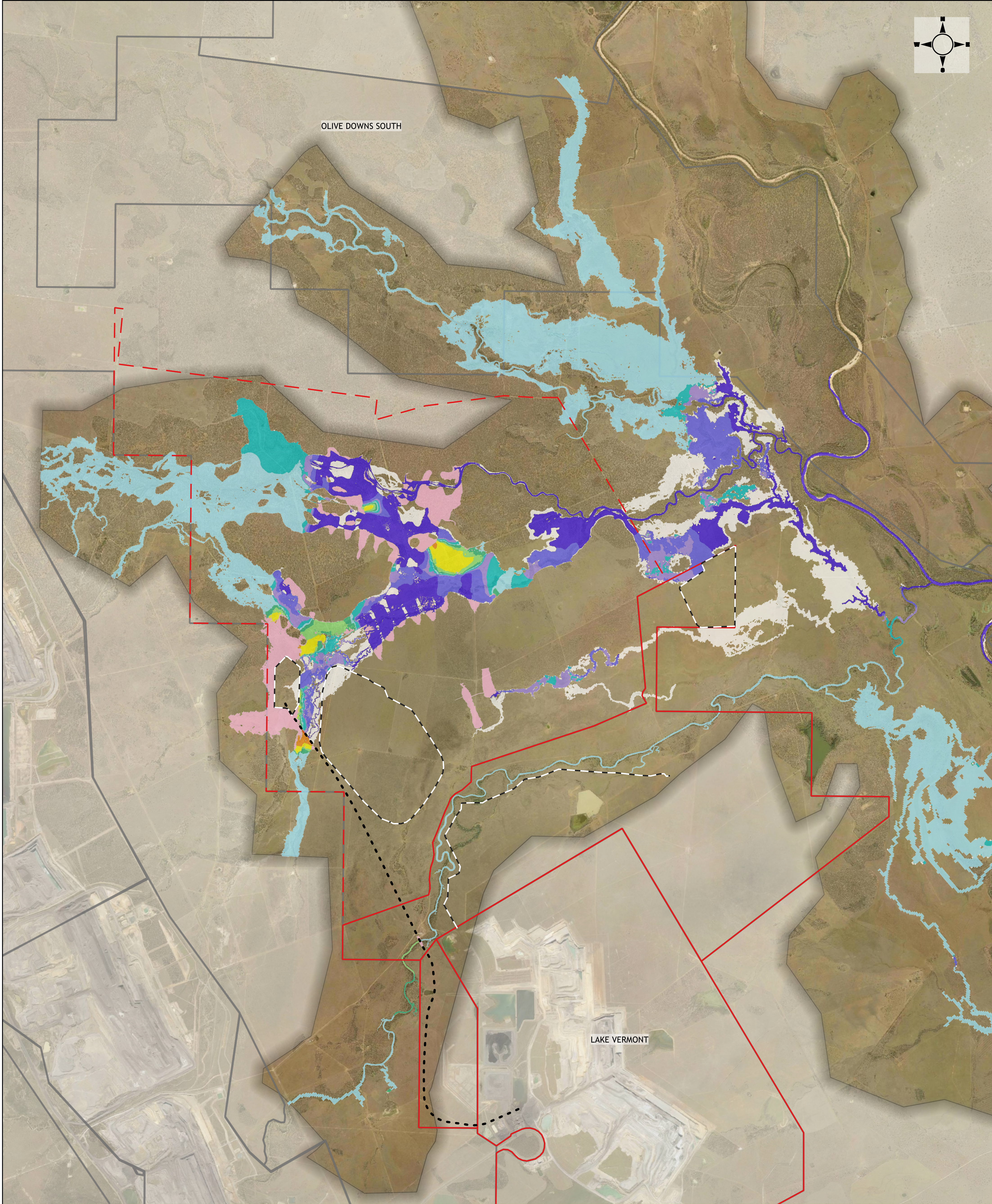
- up to 0.25m
- 0.25 to 0.5m
- 0.5 to 1.0m
- 1.0 to 1.5m
- 1.5 to 2.0m
- 2.0 to 2.5m
- 2.5 to 3.0m
- 3.0 to 3.5m
- 3.5 to 4.0m
- 4.0 to 4.5m
- > 4.5m

Lake Vermont Meadowbrook EIS

50% AEP flood depth and height local flooding
Year 26 conditions with mitigation

0 1 2 3 4 5 km

wrm
water + environment



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee
- Haul road alignment

Afflux

- dWL < -0.25
- -0.25m < dWL < -0.10m
- -0.10m < dWL < -0.05m
- -0.05 m < dWL < -0.01 m
- -0.01 m < dWL < 0.01 m
- 0.01 m < dWL < 0.05 m
- 0.05 m < dWL < 0.10 m
- 0.10 m < dWL < 0.25 m
- 0.25 m < dWL < 0.50 m
- 0.50 m < dWL < 1.00 m
- 1.00 < dWL < 3.00m
- 3.00 < dWL < 5.00m
- dWL > 5.00m
- Was wet now dry
- Was dry now wet

Lake Vermont Meadowbrook EIS

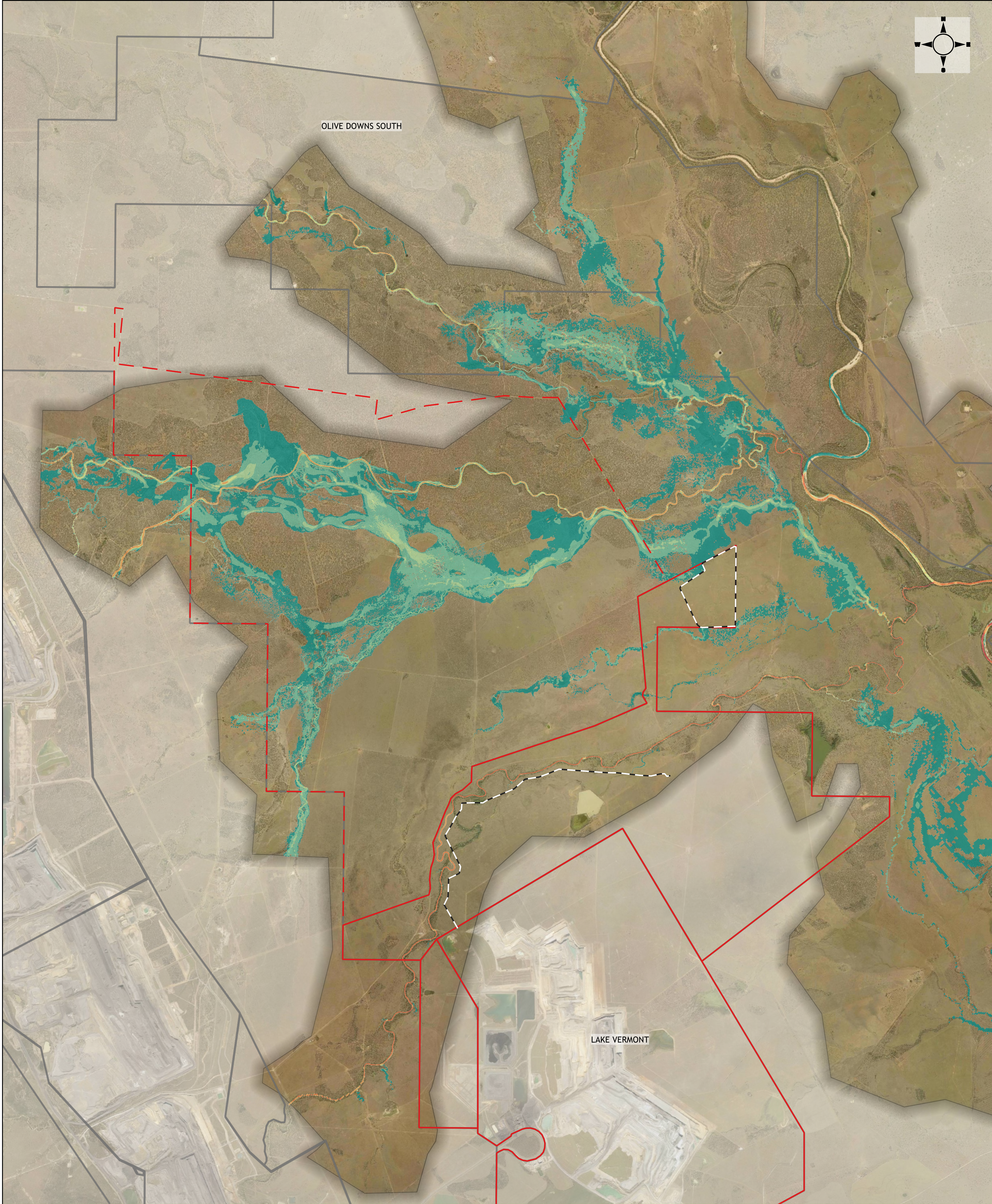
50% AEP afflux local flooding
Year 26 conditions with mitigation minus approved conditions

0 1 2 3 4 5 km

wrm water + environment

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 31 May 2022)

Projection: EPSG:20355



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee

Velocity

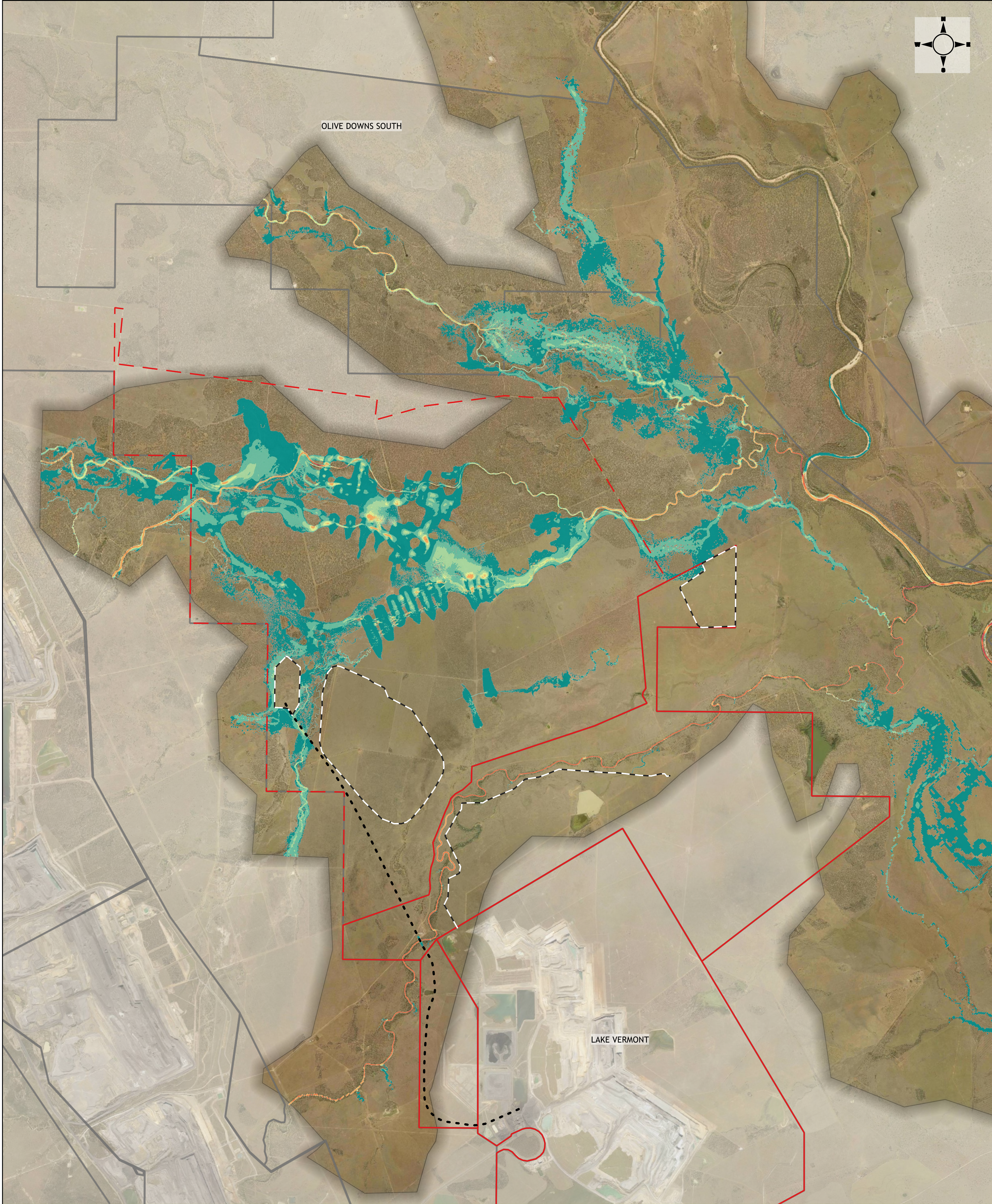
- up to 0.25m/s
- 0.25 to 0.5m/s
- 0.5 to 0.75m/s
- 0.75 to 1.0m/s
- 1.0 to 1.5m/s
- 1.5 to 2.0m/s
- 2.0 to 3.0m/s
- > 3 m/s

Lake Vermont Meadowbrook EIS

50% AEP velocity local flooding
Approved conditions

0 1 2 3 4 5 km

wrm water + environment



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee
- Haul road alignment

Velocity

- up to 0.25m/s
- 0.25 to 0.5m/s
- 0.5 to 0.75m/s
- 0.75 to 1.0m/s
- 1.0 to 1.5m/s
- 1.5 to 2.0m/s
- 2.0 to 3.0m/s
- > 3 m/s

Lake Vermont Meadowbrook EIS

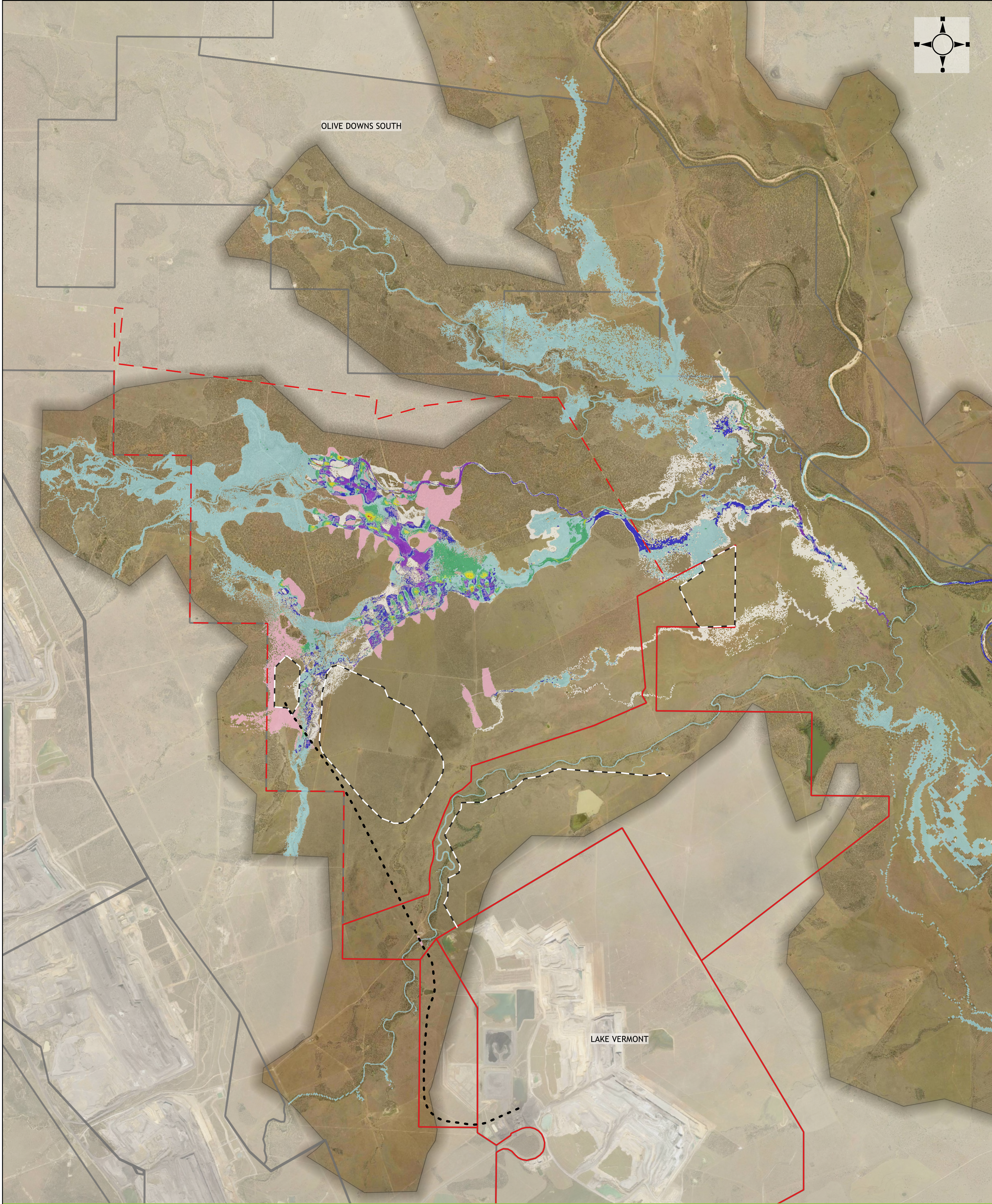
50% AEP velocity local flooding
Year 26 conditions with mitigation

0 1 2 3 4 5 km

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 31 May 2022)

Projection: EPSG:20355

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 31 May 2022)



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee
- Haul road alignment

Velocity diffference (m/s)

- <- 0.3 m/s
- -0.3 m/s to -0.2 m/s
- -0.2 m/s to -0.1 m/s
- -0.1 m/s to 0.1 m/s
- 0.1 m/s to 0.3 m/s
- 0.3 m/s to 0.5 m/s
- 0.5 m/s to 1.0 m/s
- 1.0 m/s to 1.5 m/s
- > 1.5 m/s
- Was wet now dry
- Was dry now wet

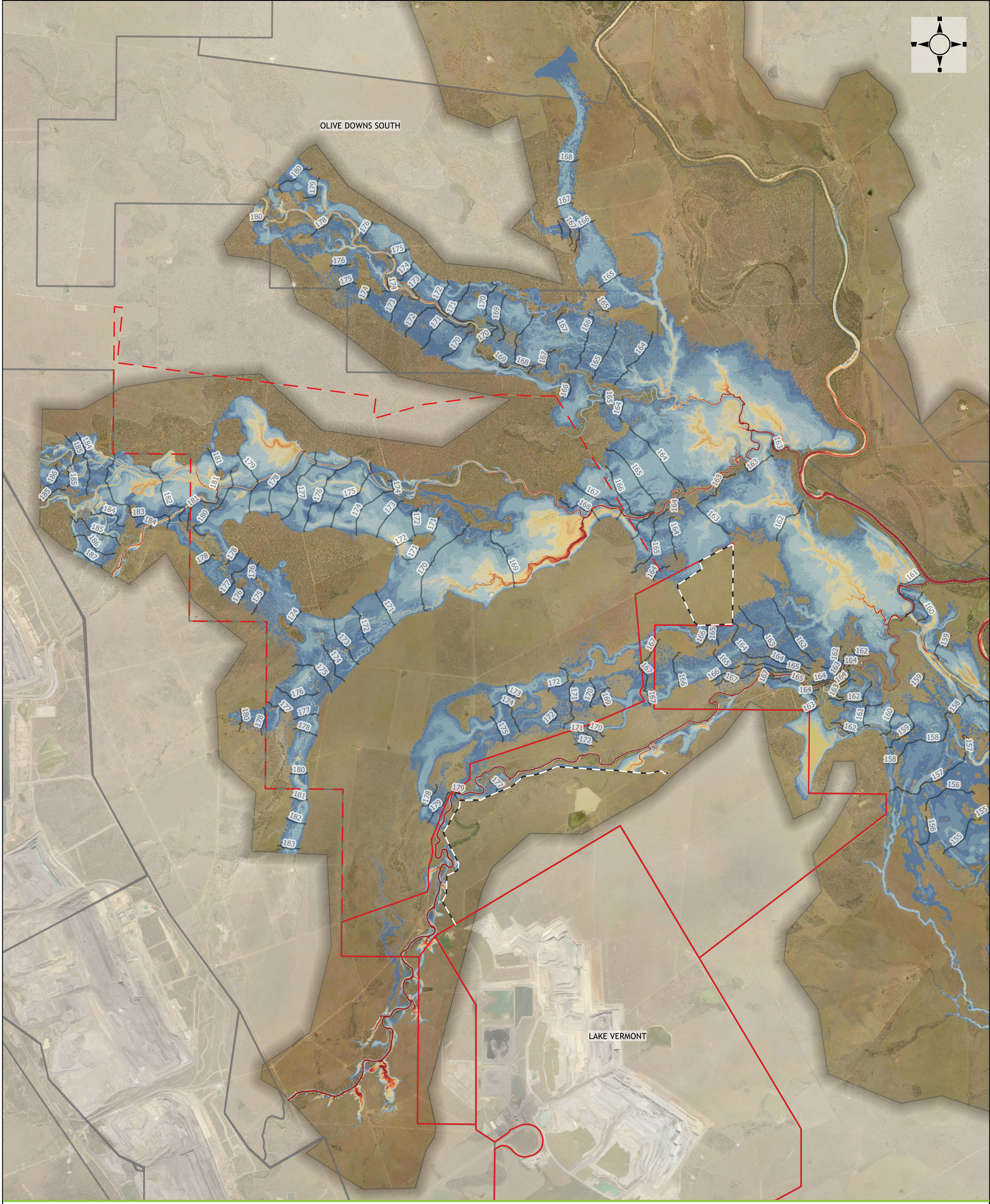
Lake Vermont Meadowbrook EIS

50% AEP velocity difference local flooding
Year 26 conditions with mitigation minus approved conditions

0 1 2 3 4 5 km

wrm water + environment

Projection: EPSG:20355



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee
- 0.5m flood height contours (m AHD)

Depth (m)

- up to 0.25m
- 0.25 to 0.5m
- 0.5 to 1.0m
- 1.0 to 1.5m
- 1.5 to 2.0m
- 2.0 to 2.5m
- 2.5 to 3.0m
- 3.0 to 3.5m
- 3.5 to 4.0m
- 4.0 to 4.5m
- > 4.5m

Lake Vermont Meadowbrook EIS

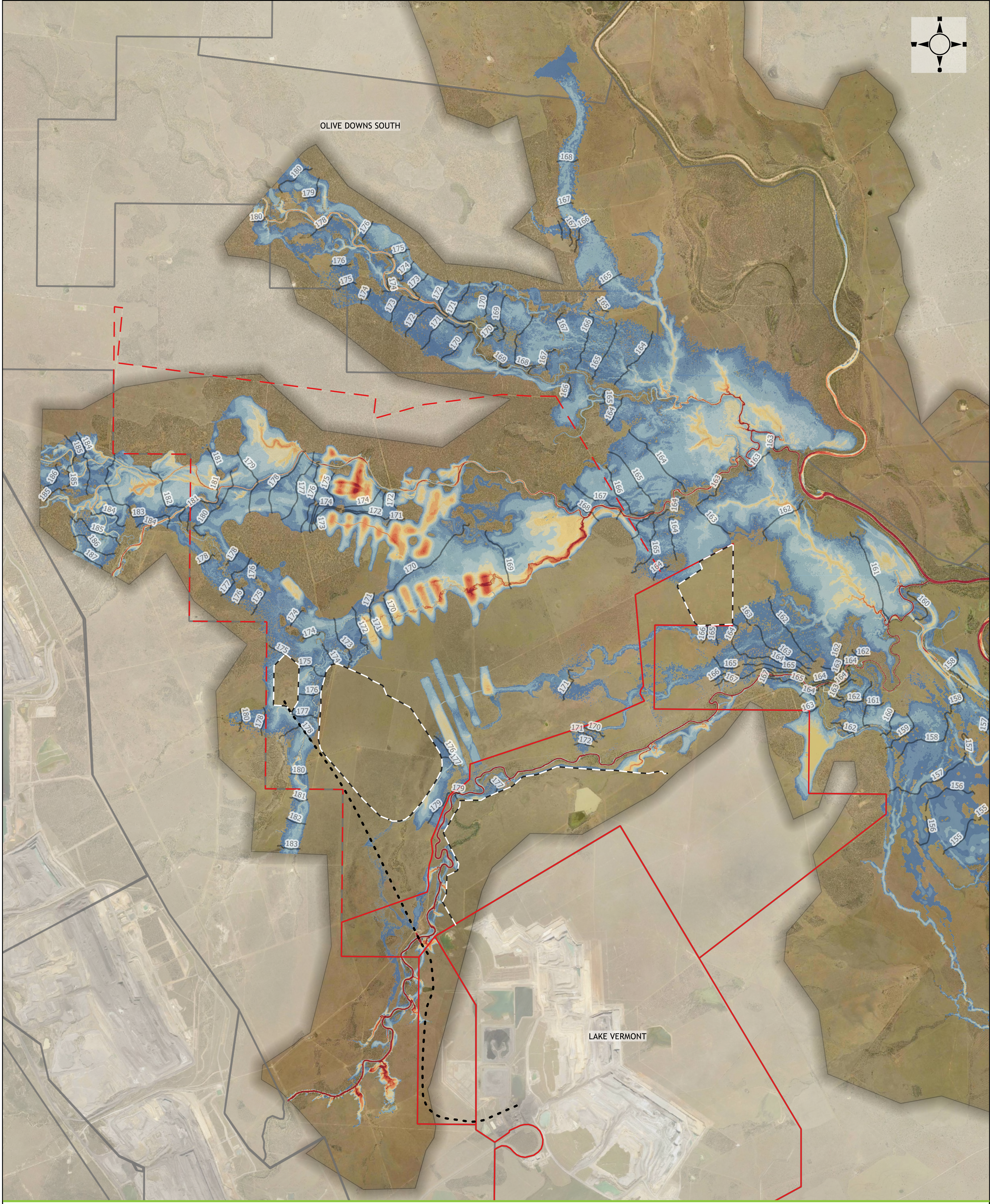
10% AEP flood depth and height local flooding
Approved conditions

0 1 2 3 4 5 km

wrm
water+environment

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 31 May 2022)

Projection: EPSG:20355



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee
- Haul road alignment
- 0.5m flood height contours (m AHD)

Depth (m)

- up to 0.25m
- 0.25 to 0.5m
- 0.5 to 1.0m
- 1.0 to 1.5m
- 1.5 to 2.0m
- 2.0 to 2.5m
- 2.5 to 3.0m
- 3.0 to 3.5m
- 3.5 to 4.0m
- 4.0 to 4.5m
- > 4.5m

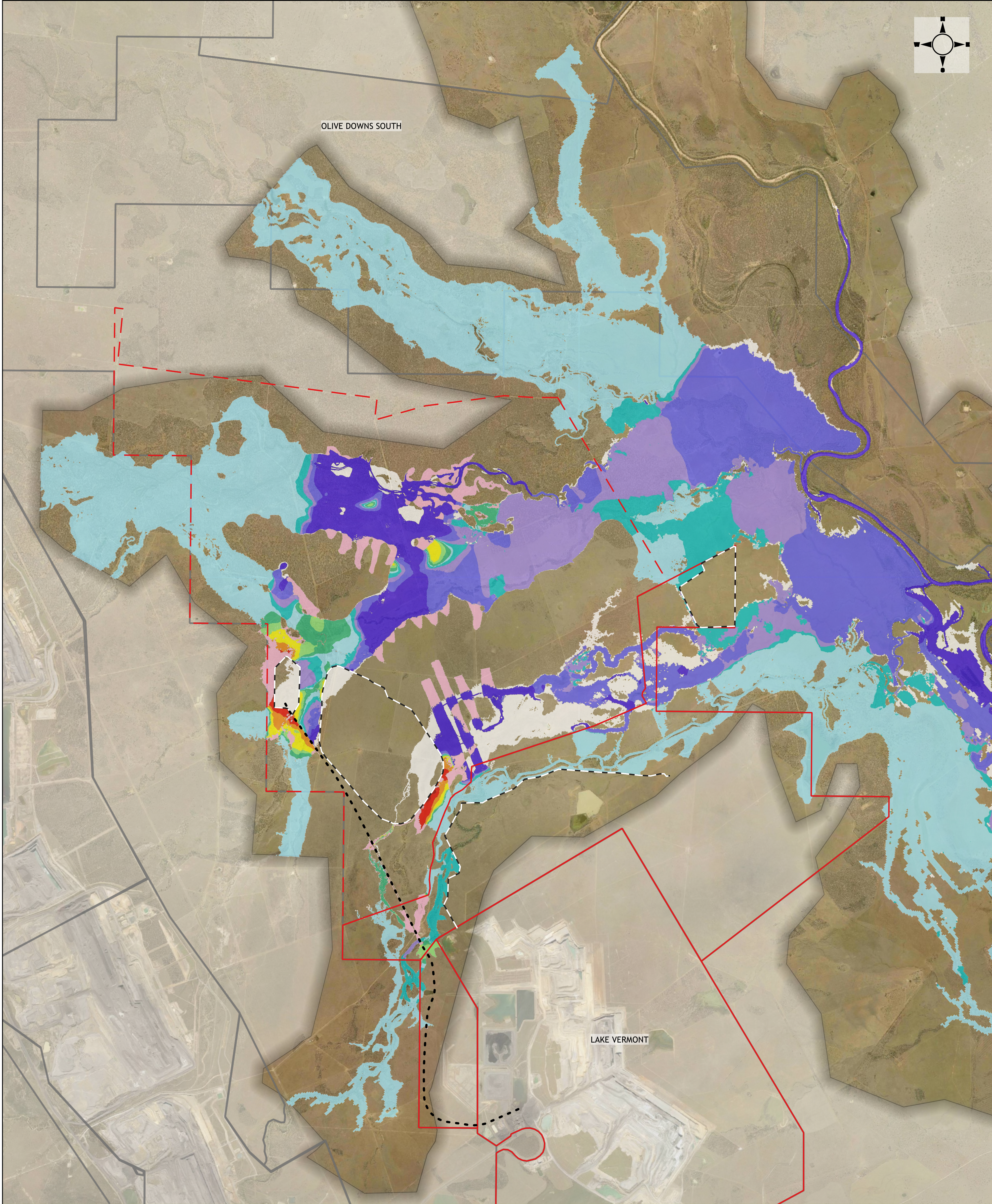
Lake Vermont Meadowbrook EIS

10% AEP flood depth and height local flooding
Year 26 conditions with mitigation

0 1 2 3 4 5 km

wrm water+environment

Projection: EPSG:20355



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee
- Haul road alignment

Afflux

- dWL < -0.25
- -0.25m < dWL < -0.10m
- -0.10m < dWL < -0.05m
- -0.05 m < dWL < -0.01 m
- -0.01 m < dWL < 0.01 m
- 0.01 m < dWL < 0.05 m
- 0.05 m < dWL < 0.10 m
- 0.10 m < dWL < 0.25 m
- 0.25 m < dWL < 0.50 m
- 0.50 m < dWL < 1.00 m
- 1.00 < dWL < 3.00m
- 3.00 < dWL < 5.00m
- dWL > 5.00m
- Was wet now dry
- Was dry now wet

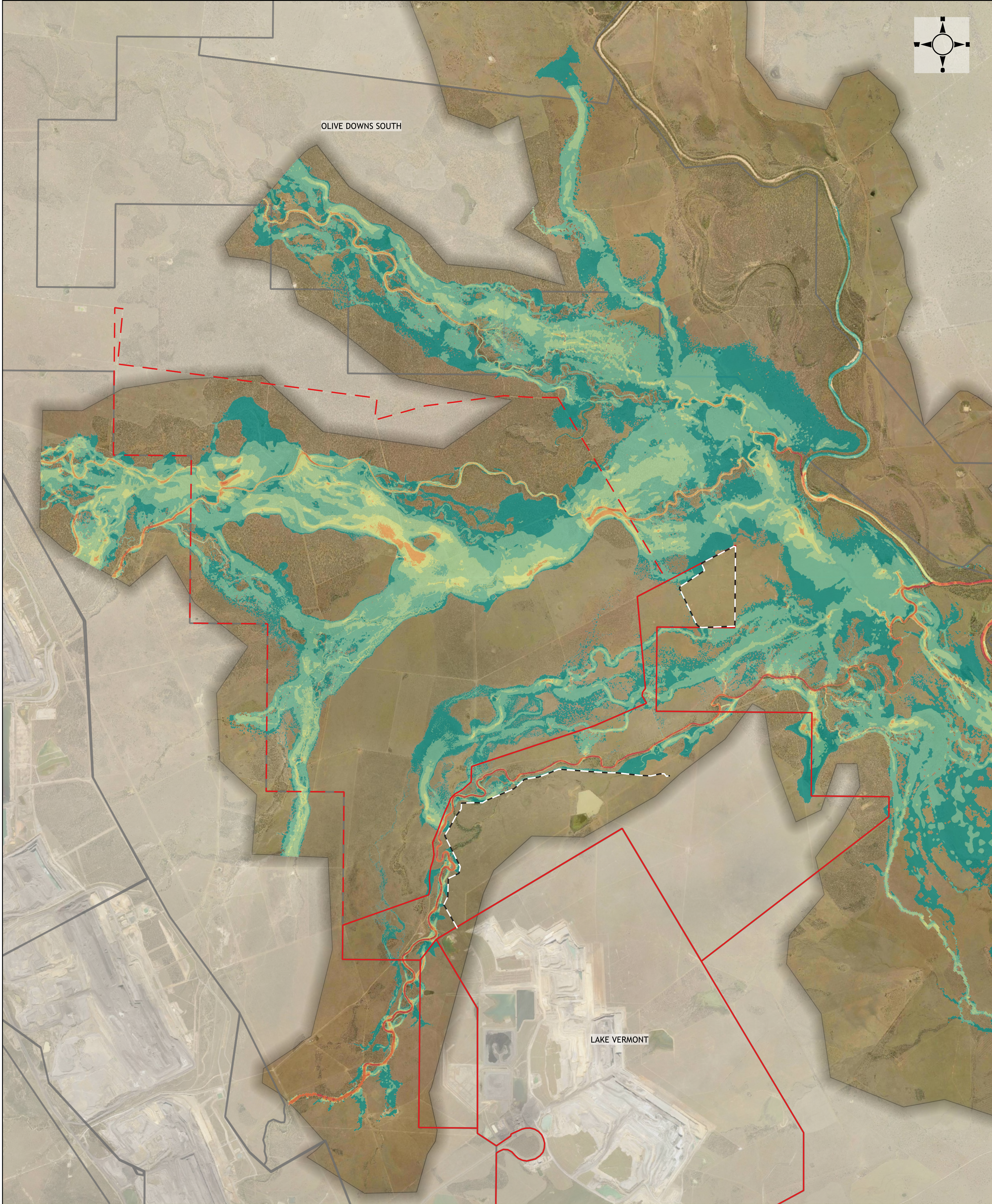
Lake Vermont Meadowbrook EIS

10% AEP afflux local flooding
Year 26 conditions with mitigation minus approved conditions

0 1 2 3 4 5 km

wrm water + environment

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 31 May 2022)



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee

Velocity

- up to 0.25m/s
- 0.25 to 0.5m/s
- 0.5 to 0.75m/s
- 0.75 to 1.0m/s
- 1.0 to 1.5m/s
- 1.5 to 2.0m/s
- 2.0 to 3.0m/s
- > 3 m/s

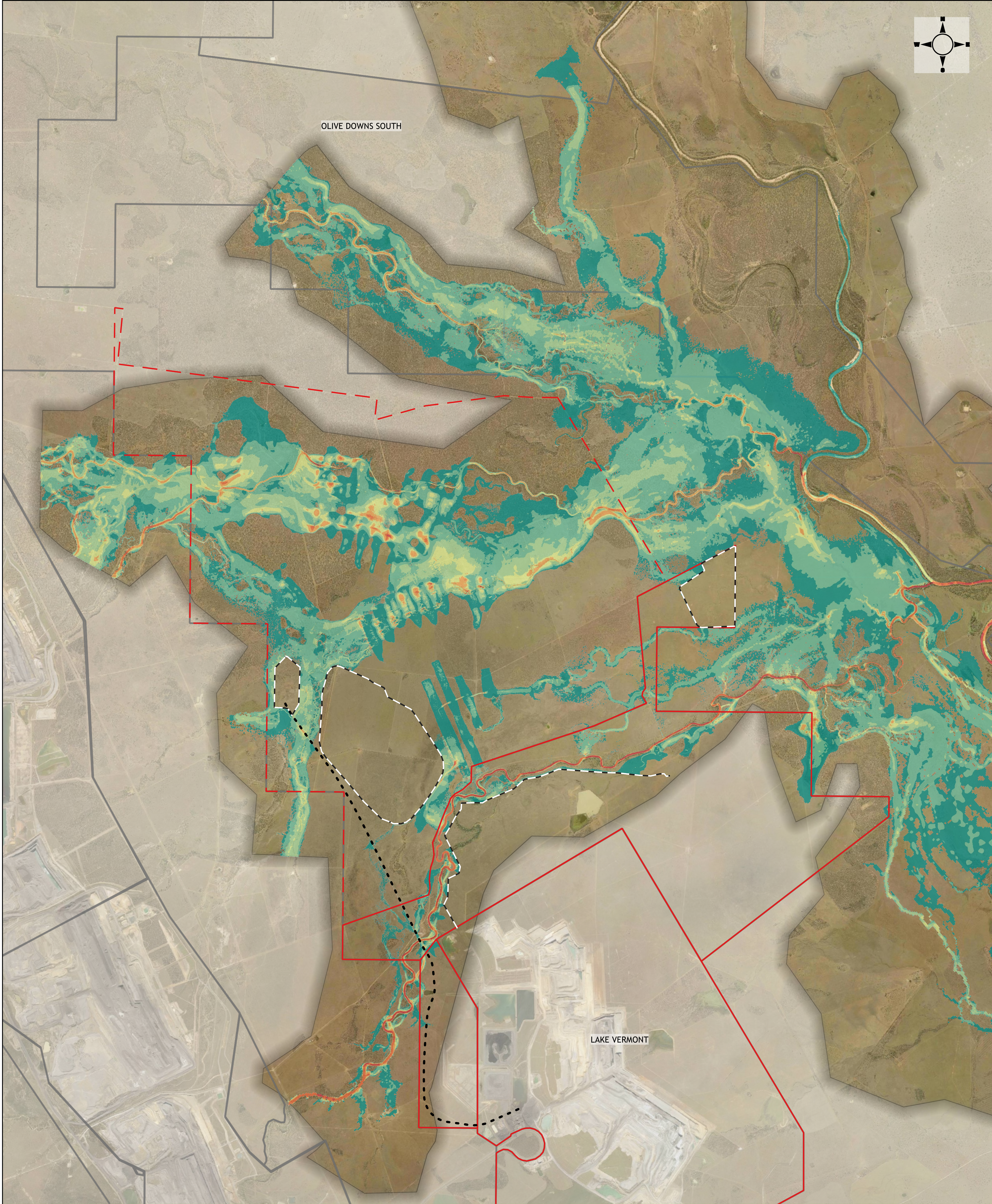
Lake Vermont Meadowbrook EIS

10% AEP velocity local flooding
Approved conditions

0 1 2 3 4 5 km

wrm water + environment

Projection: EPSG:20355



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee
- Haul road alignment

Velocity

- up to 0.25m/s
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- 2.0 to 3.0m/s
- > 3 m/s

Lake Vermont Meadowbrook EIS

10% AEP velocity local flooding
Year 26 conditions with mitigation

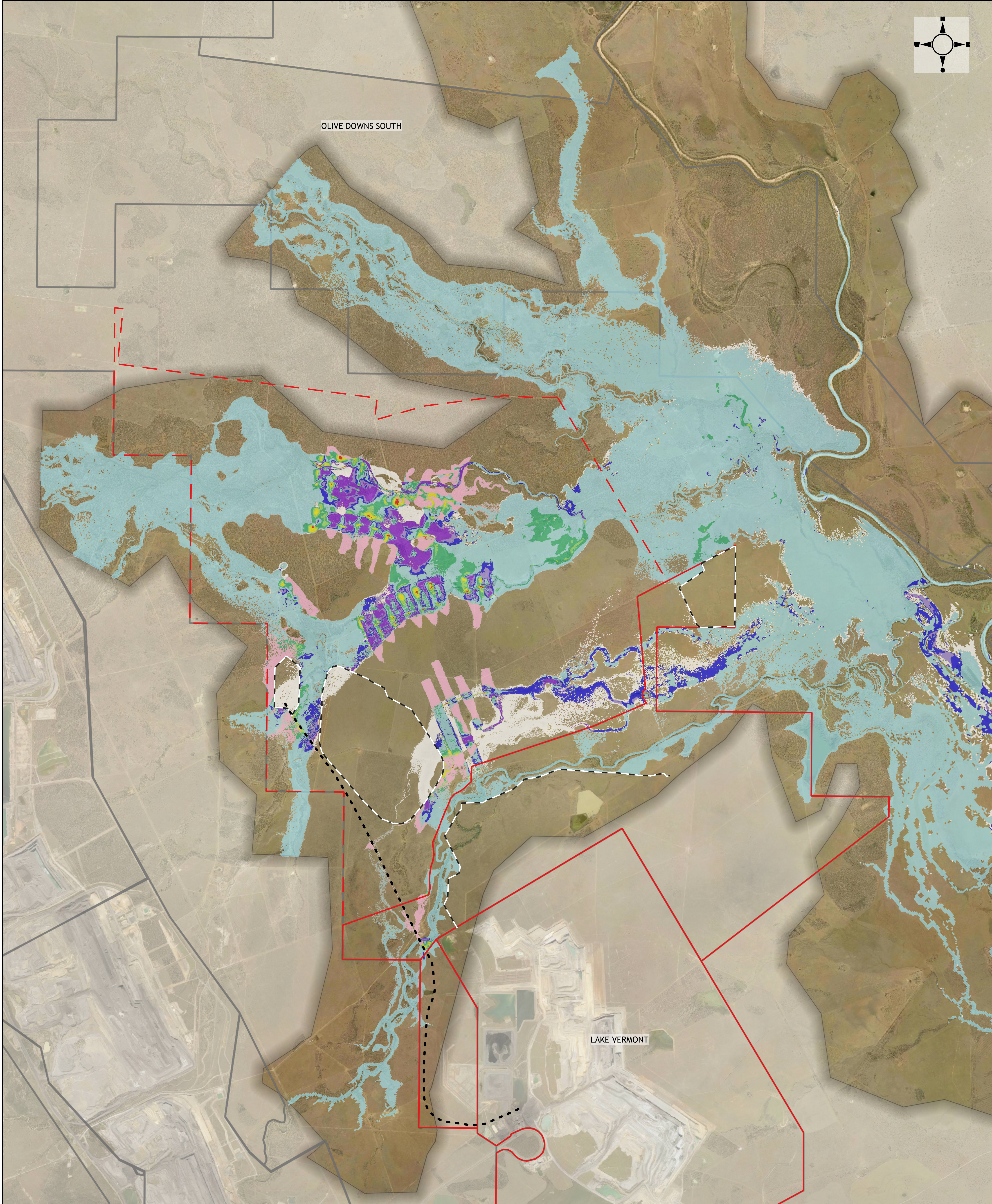
0 1 2 3 4 5 km

wrm water + environment

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 31 May 2022)

Projection: EPSG:20355

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 31 May 2022)



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee
- Haul road alignment

Velocity diffference (m/s)

- <- 0.3 m/s
- -0.3 m/s to -0.2 m/s
- -0.2 m/s to -0.1 m/s
- -0.1 m/s to 0.1 m/s
- 0.1 m/s to 0.3 m/s
- 0.3 m/s to 0.5 m/s
- 0.5 m/s to 1.0 m/s
- 1.0 m/s to 1.5 m/s
- > 1.5 m/s
- Was wet now dry
- Was dry now wet

Lake Vermont Meadowbrook EIS

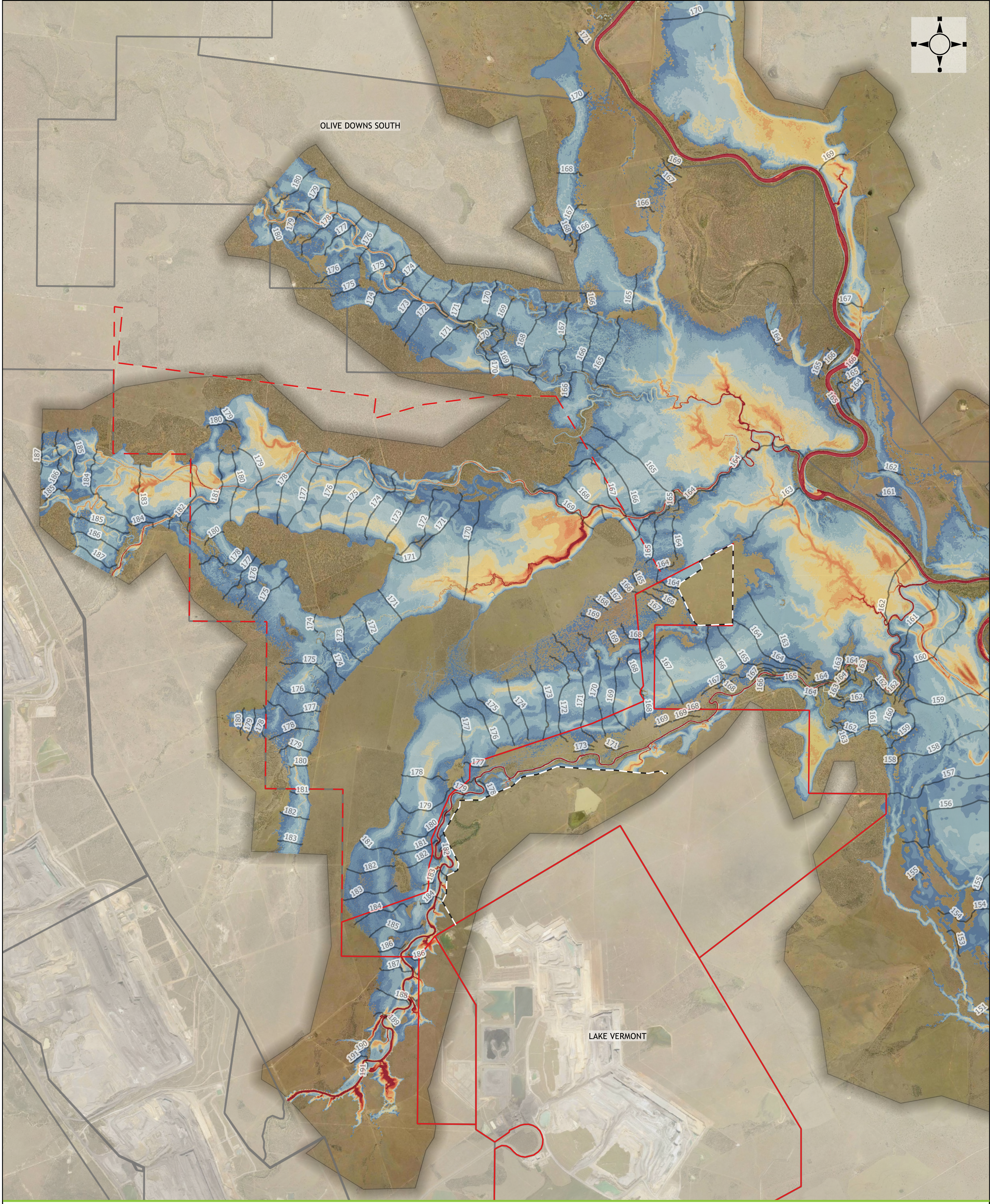
10% AEP velocity difference local flooding
Year 26 conditions with mitigation minus approved conditions

0 1 2 3 4 5 km

wrm water + environment

Projection: EPSG:20355

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 31 May 2022)



Legend

- Mining Lease Application (MLA)
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- QLD mining leases
- Levee

0.5m flood height contours (m AHD)

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- 1.5 to 2.0m
- 2.0 to 2.5m
- 2.5 to 3.0m
- 3.0 to 3.5m
- 3.5 to 4.0m
- 4.0 to 4.5m
- > 4.5m

Lake Vermont Meadowbrook EIS

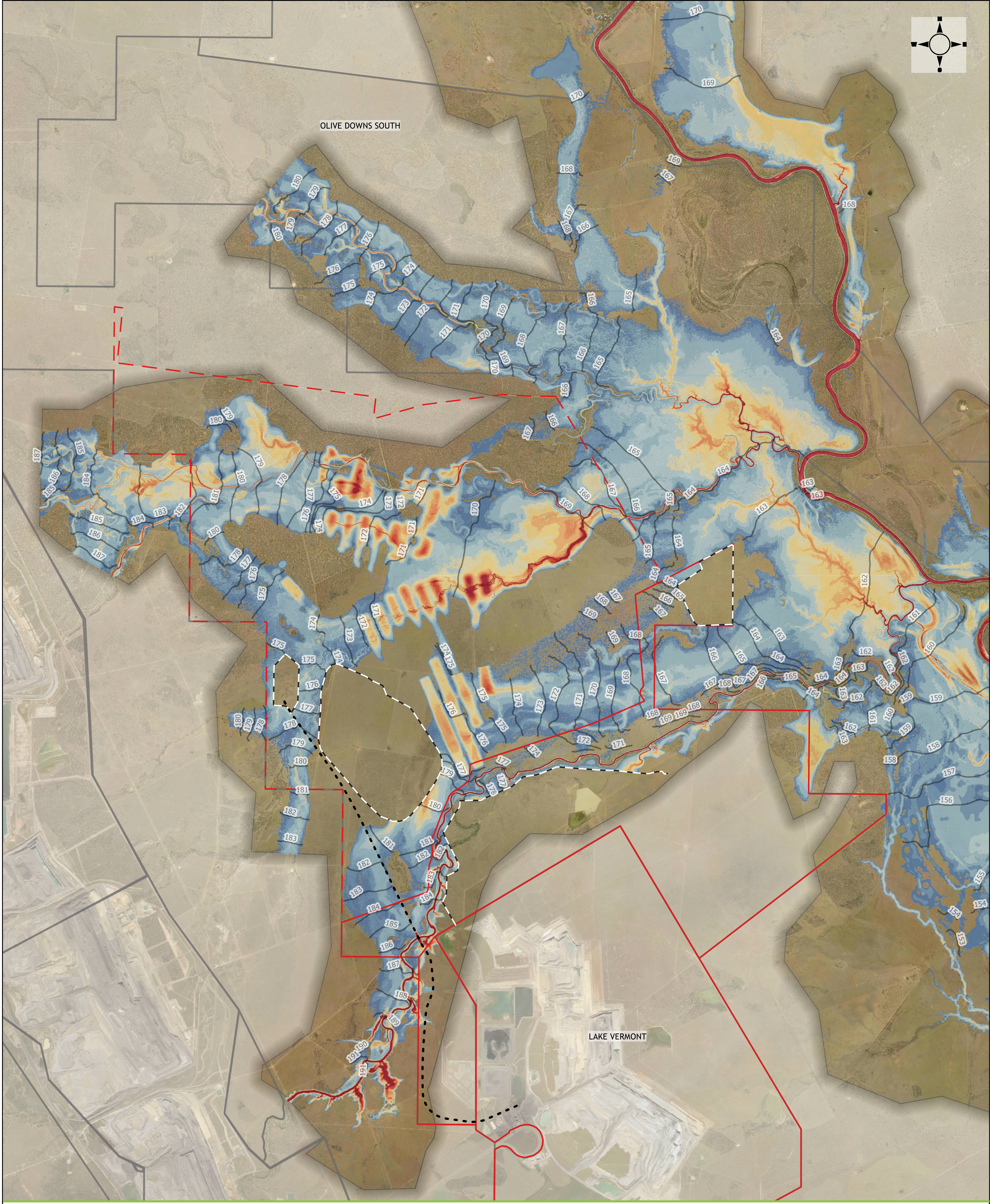
2% AEP flood depth and height local flooding
Approved conditions

0 1 2 3 4 5 km

wrm water+environment

Projection: EPSG:20355

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 31 May 2022)



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee
- Haul road alignment

0.5m flood height contours (m AHD)

Depth (m)

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- 2.0 to 2.5m
- 2.5 to 3.0m
- 3.0 to 3.5m
- 3.5 to 4.0m
- 4.0 to 4.5m
- > 4.5m

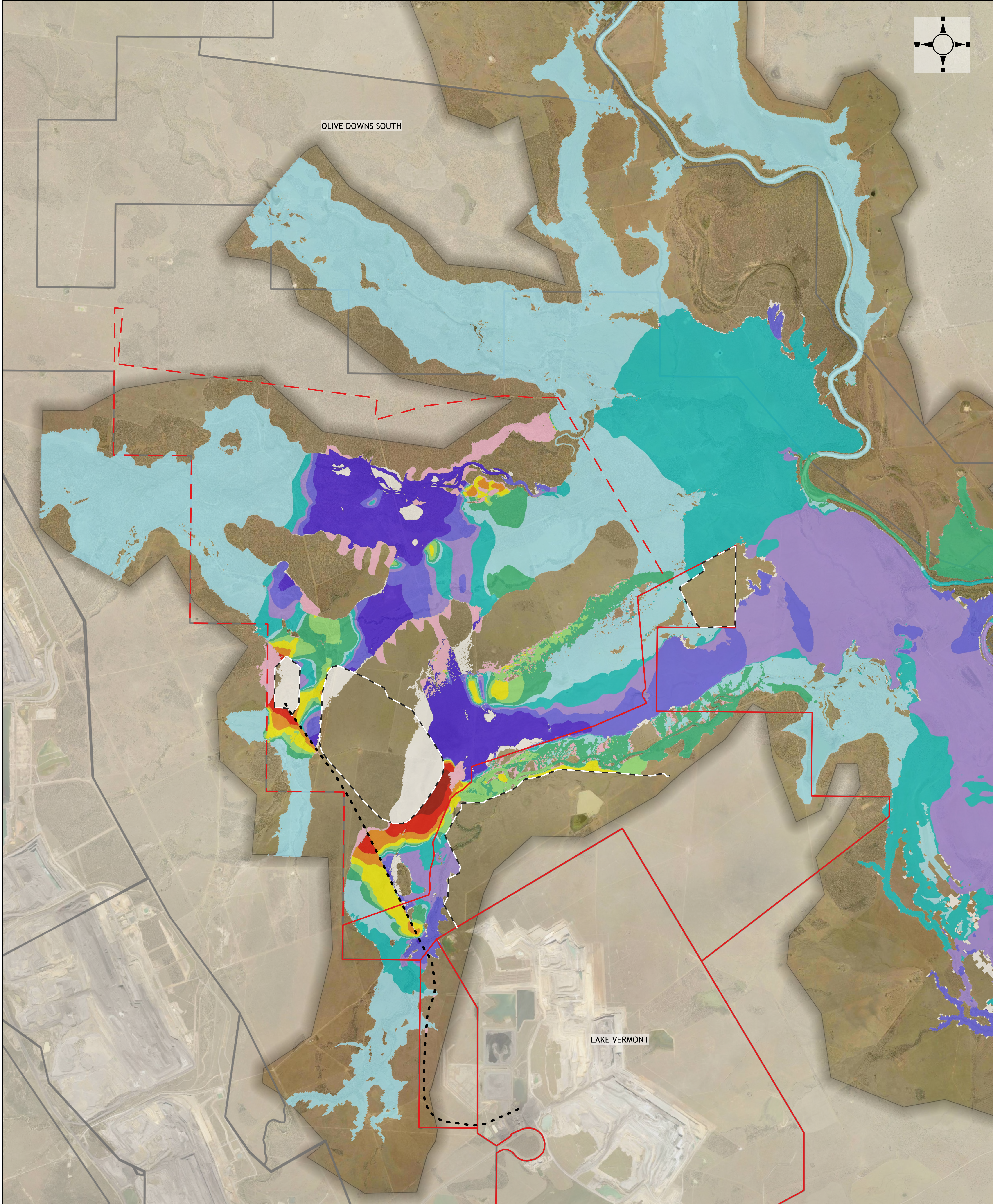
Lake Vermont Meadowbrook EIS

2% AEP flood depth and height local flooding
Year 26 conditions with mitigation

0 1 2 3 4 5 km

wrm water + environment

Projection: EPSG:20355



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee
- Haul road alignment

Afflux

- dWL < -0.25
- -0.25m < dWL < -0.10m
- -0.10m < dWL < -0.05m
- -0.05 m < dWL < -0.01 m
- -0.01 m < dWL < 0.01 m
- 0.01 m < dWL < 0.05 m
- 0.05 m < dWL < 0.10 m
- 0.10 m < dWL < 0.25 m
- 0.25 m < dWL < 0.50 m
- 0.50 m < dWL < 1.00 m
- 1.00 < dWL < 3.00m
- 3.00 < dWL < 5.00m
- dWL > 5.00m
- Was wet now dry
- Was dry now wet

Lake Vermont Meadowbrook EIS

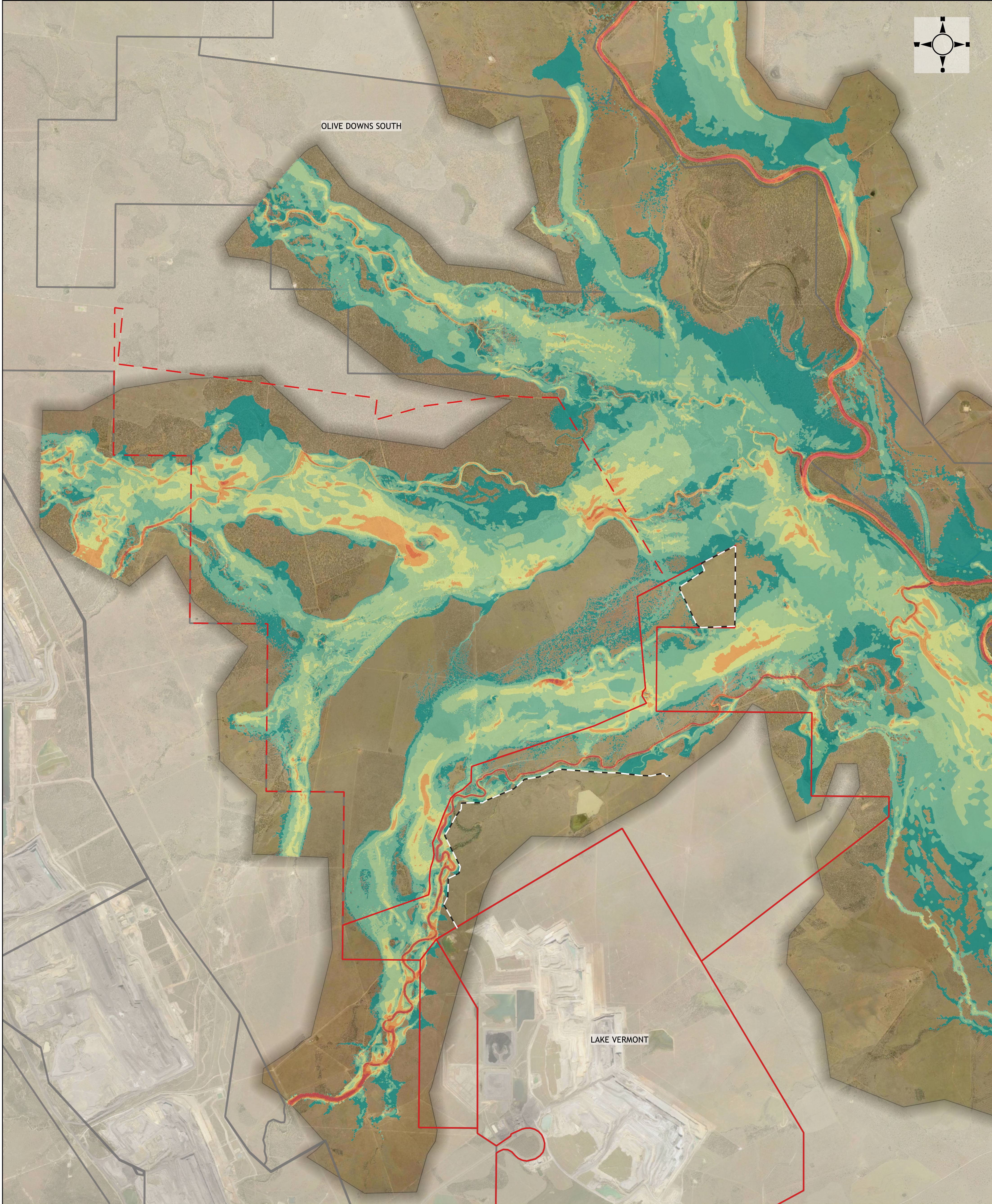
2% AEP afflux local flooding
Year 26 conditions with mitigation minus approved conditions

0 1 2 3 4 5 km

wrm water + environment

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 31 May 2022)

Projection: EPSG:20355



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee

Velocity

- up to 0.25m/s
- 0.25 to 0.5m/s
- 0.5 to 0.75m/s
- 0.75 to 1.0m/s
- 1.0 to 1.5m/s
- 1.5 to 2.0m/s
- 2.0 to 3.0m/s
- > 3 m/s

Lake Vermont Meadowbrook EIS

2% AEP velocity local flooding
Approved conditions

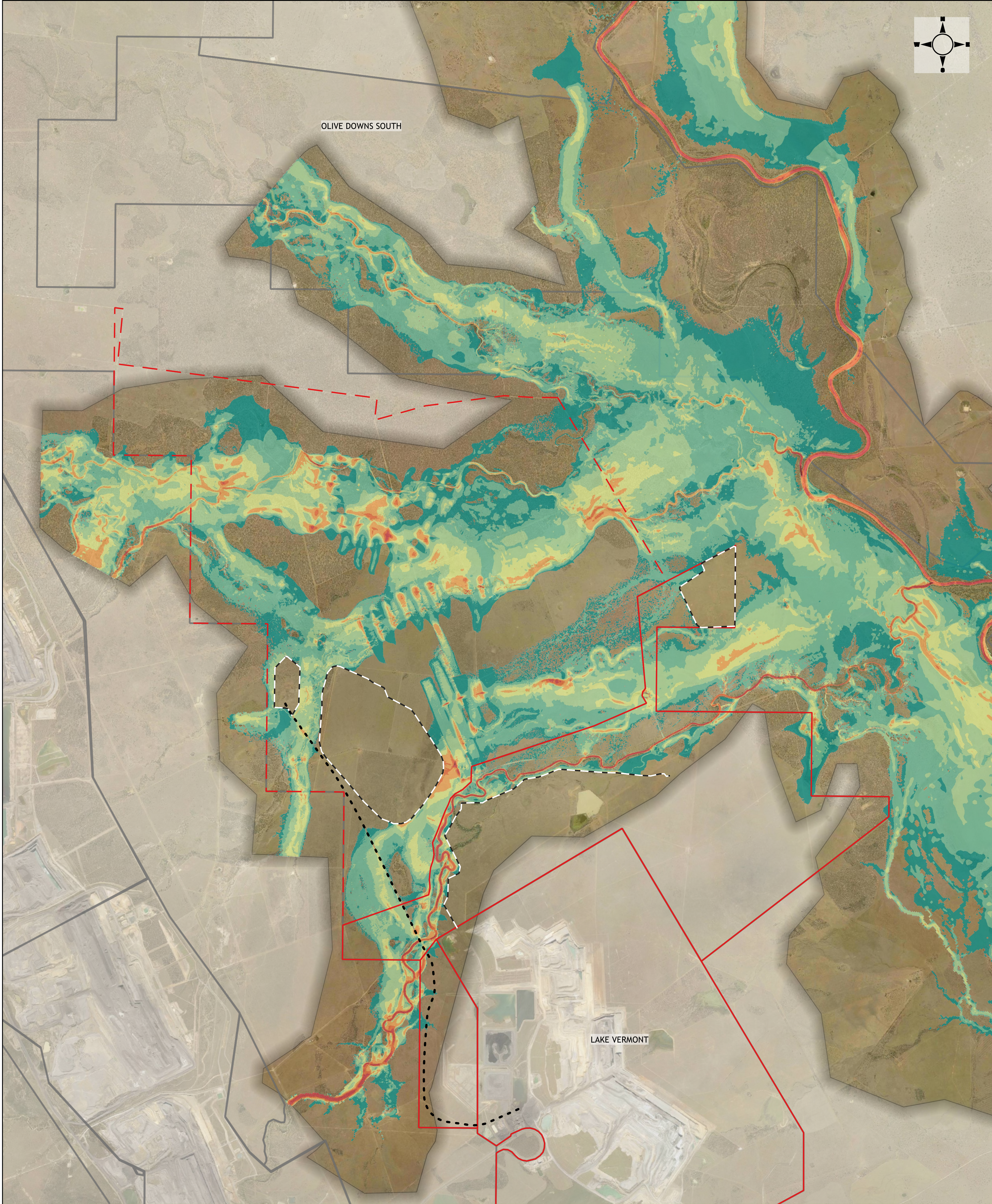
0 1 2 3 4 5 km

wrm water + environment

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 31 May 2022)

Projection: EPSG:20355

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 31 May 2022)



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee
- Haul road alignment

Velocity

- up to 0.25m/s
- 0.25 to 0.5m/s
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- 0.75 to 1.0m/s
- 1.0 to 1.5m/s
- 1.5 to 2.0m/s
- 2.0 to 3.0m/s
- > 3 m/s

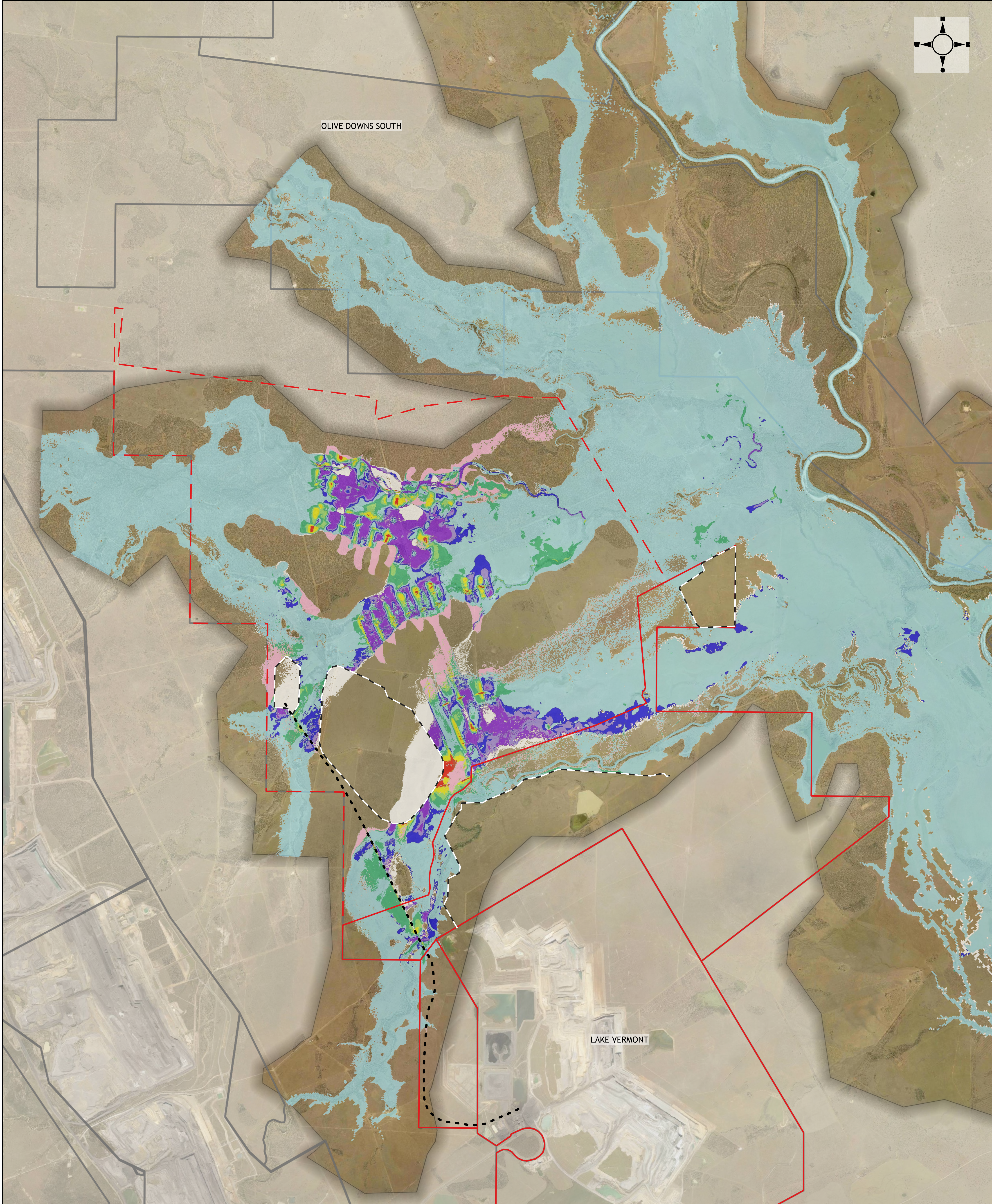
Lake Vermont Meadowbrook EIS

2% AEP velocity local flooding
Year 26 conditions with mitigation

0 1 2 3 4 5 km

wrm water+environment

Projection: EPSG:20355



J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 31 May 2022)

Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee
- Haul road alignment

Velocity diffference (m/s)

- <- 0.3 m/s
- -0.3 m/s to -0.2 m/s
- -0.2 m/s to -0.1 m/s
- -0.1 m/s to 0.1 m/s
- 0.1 m/s to 0.3 m/s
- 0.3 m/s to 0.5 m/s
- 0.5 m/s to 1.0 m/s
- 1.0 m/s to 1.5 m/s
- > 1.5 m/s
- Was wet now dry
- Was dry now wet

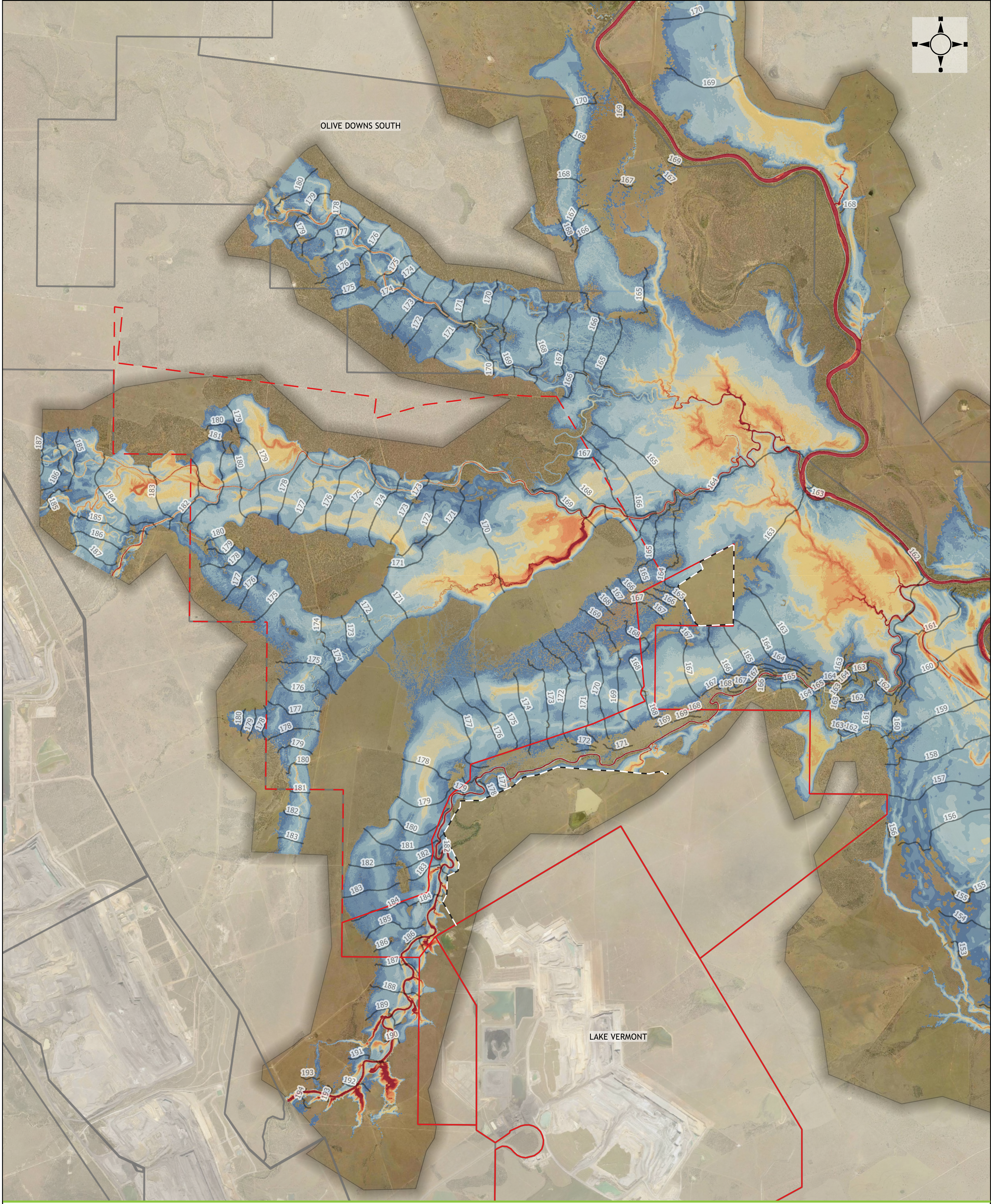
Lake Vermont Meadowbrook EIS

2% AEP velocity difference local flooding
Year 26 conditions with mitigation minus approved conditions

0 1 2 3 4 5 km

wrm water + environment

Projection: EPSG:20355



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee
- 0.5m flood height contours (m AHD)

Depth (m)

- up to 0.25m
- 0.25 to 0.5m
- 0.5 to 1.0m
- 1.0 to 1.5m
- 1.5 to 2.0m
- 2.0 to 2.5m
- 2.5 to 3.0m
- 3.0 to 3.5m
- 3.5 to 4.0m
- 4.0 to 4.5m
- > 4.5m

Lake Vermont Meadowbrook EIS

1% AEP flood depth and height local flooding
Approved conditions

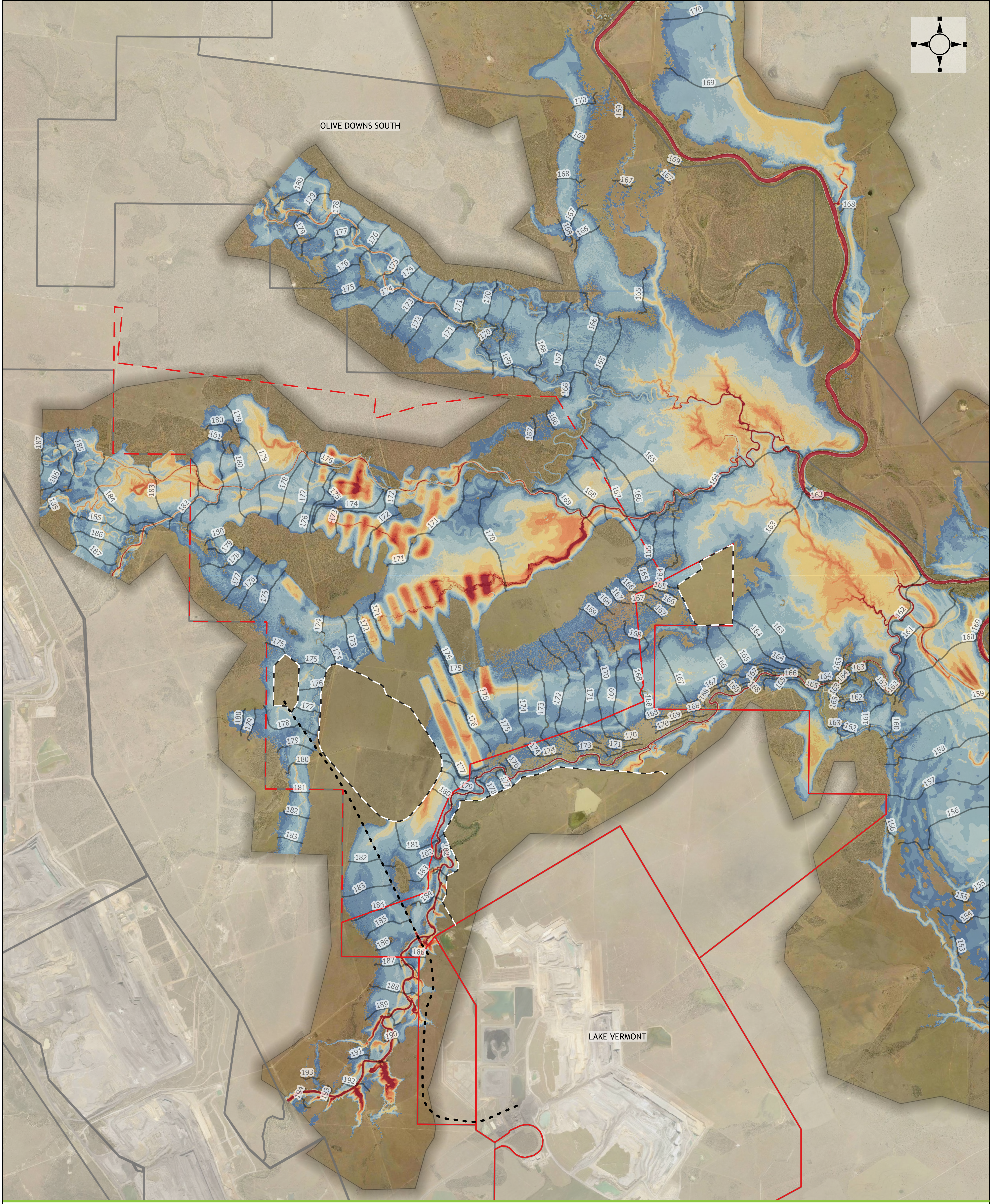
0 1 2 3 4 5 km

wrm water + environment

J:\0622-27 Meadowbrook EIS\M\QGIS\TUFLOW config.qgz (Issued: 31 May 2022)

Projection: EPSG:20355

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 31 May 2022)



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee
- Haul road alignment
- 0.5m flood height contours (m AHD)

Depth (m)

- up to 0.25m
- 0.25 to 0.5m
- 0.5 to 1.0m
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- 1.5 to 2.0m
- 2.0 to 2.5m
- 2.5 to 3.0m
- 3.0 to 3.5m
- 3.5 to 4.0m
- 4.0 to 4.5m
- > 4.5m

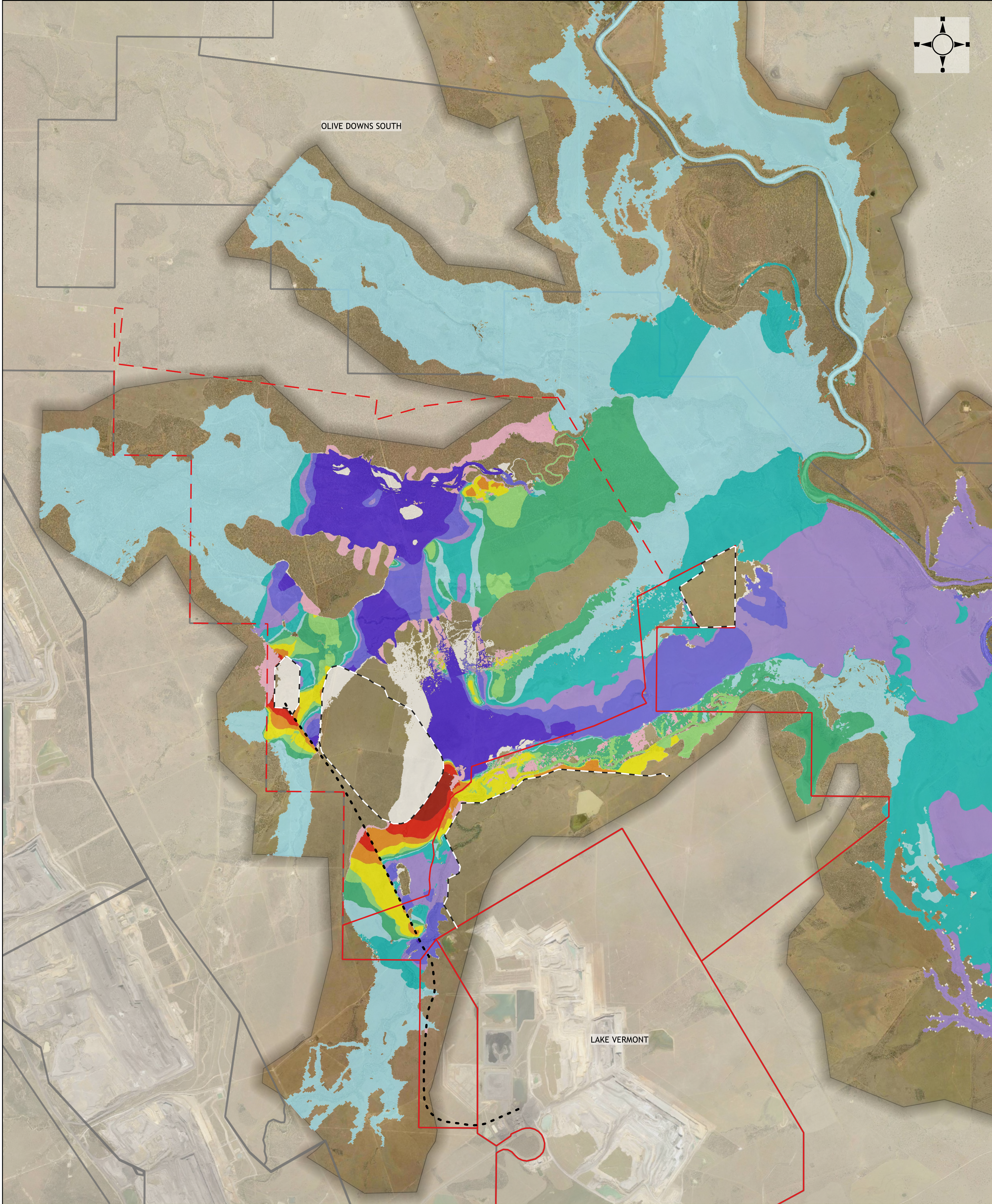
Lake Vermont Meadowbrook EIS

1% AEP flood depth and height local flooding
Year 26 conditions with mitigation

0 1 2 3 4 5 km

wrm water + environment

Projection: EPSG:20355



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee
- Haul road alignment

Afflux

- dWL < -0.25
- -0.25m < dWL < -0.10m
- -0.10m < dWL < -0.05m
- -0.05 m < dWL < -0.01 m
- -0.01 m < dWL < 0.01 m
- 0.01 m < dWL < 0.05 m
- 0.05 m < dWL < 0.10 m
- 0.10 m < dWL < 0.25 m
- 0.25 m < dWL < 0.50 m
- 0.50 m < dWL < 1.00 m
- 1.00 < dWL < 3.00m
- 3.00 < dWL < 5.00m
- dWL > 5.00m
- Was wet now dry
- Was dry now wet

Lake Vermont Meadowbrook EIS

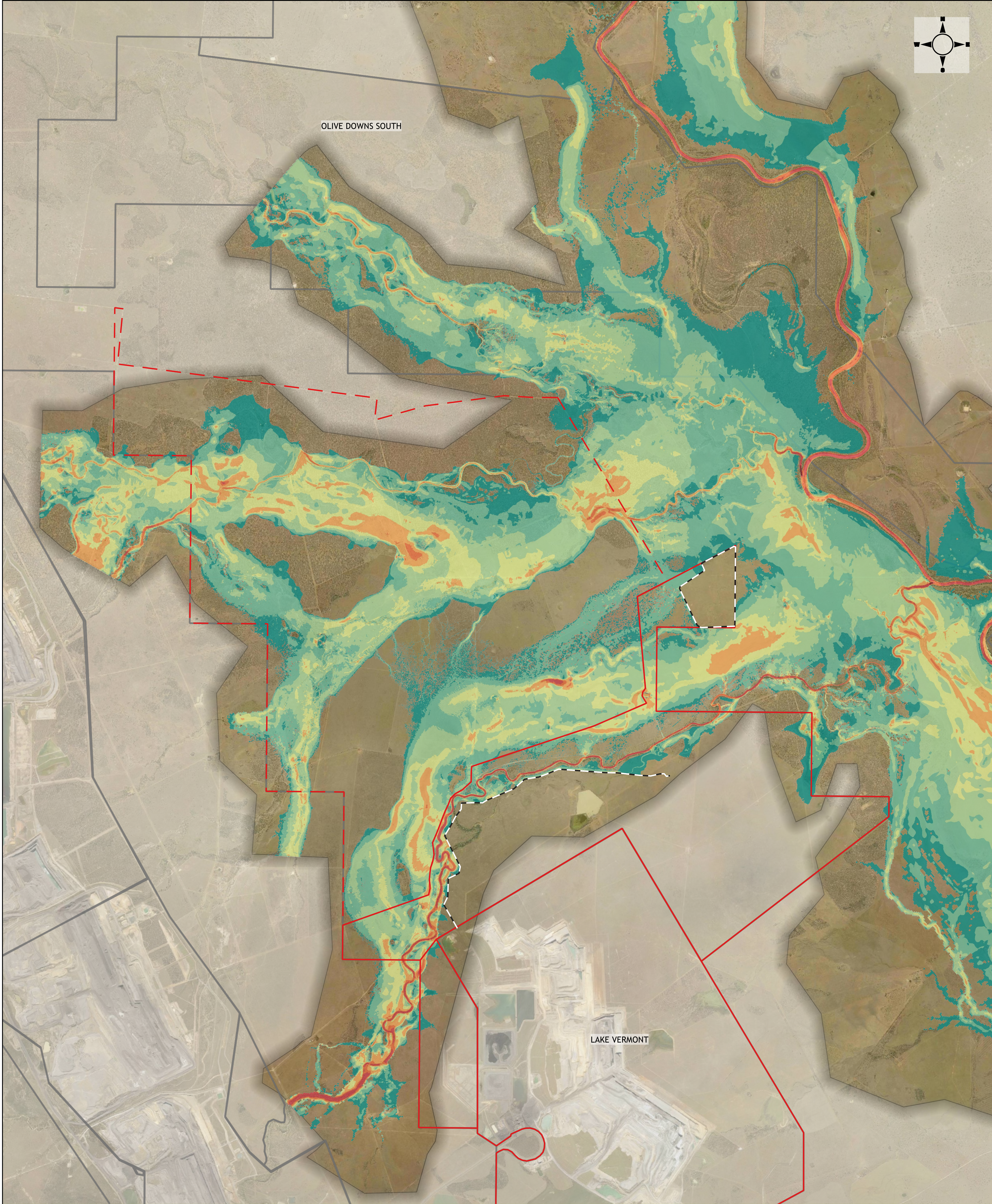
1% AEP afflux local flooding
Year 26 conditions with mitigation minus approved conditions

0 1 2 3 4 5 km

wrm water + environment

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 31 May 2022)

Projection: EPSG:20355



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee

Velocity

- up to 0.25m/s
- 0.25 to 0.5m/s
- 0.5 to 0.75m/s
- 0.75 to 1.0m/s
- 1.0 to 1.5m/s
- 1.5 to 2.0m/s
- 2.0 to 3.0m/s
- > 3 m/s

Lake Vermont Meadowbrook EIS

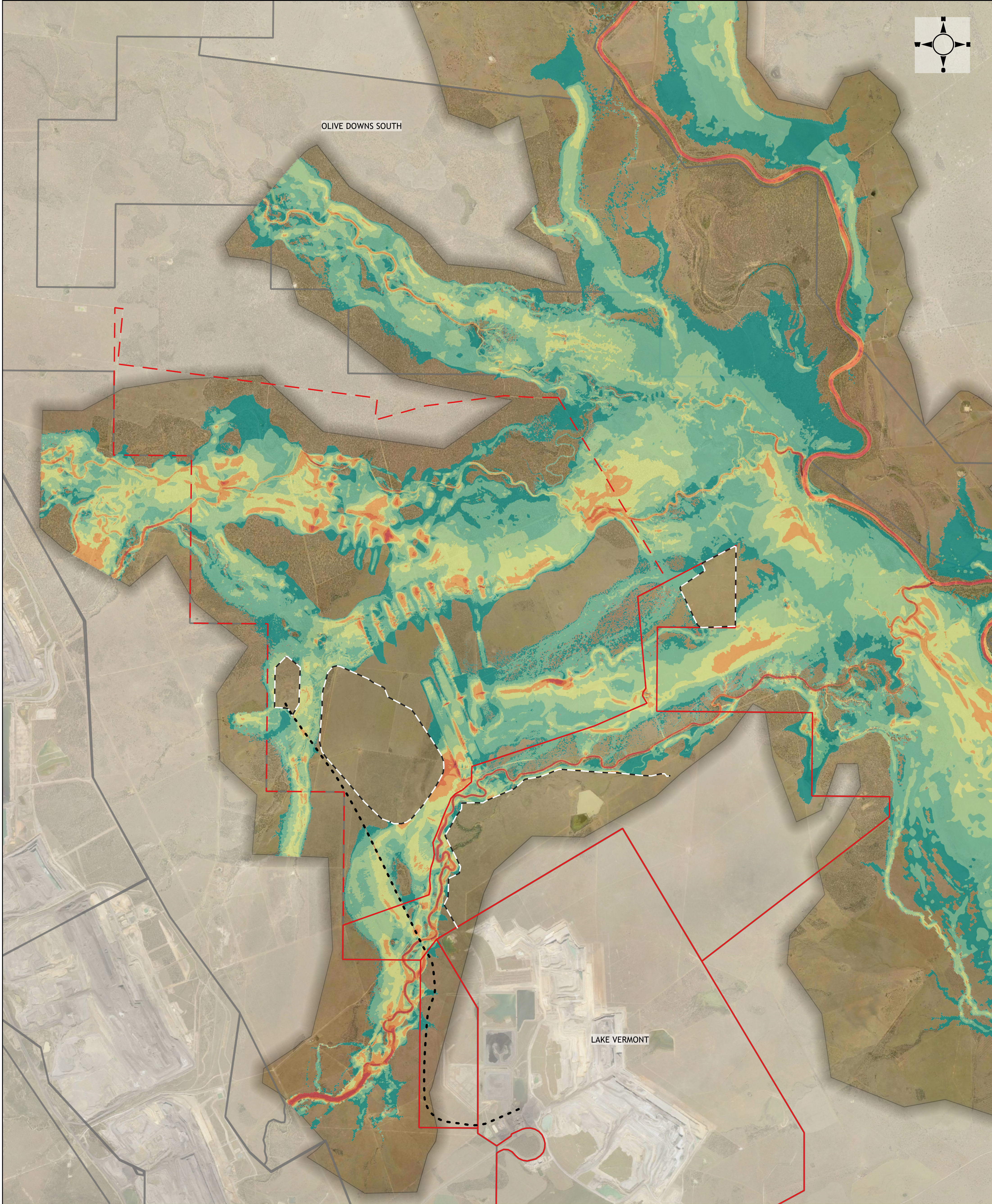
1% AEP velocity local flooding
Approved conditions

0 1 2 3 4 5 km

wrm water + environment

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 31 May 2022)

Projection: EPSG:20355



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee
- Haul road alignment

Velocity

- up to 0.25m/s
- 0.25 to 0.5m/s
- 0.5 to 0.75m/s
- 0.75 to 1.0m/s
- 1.0 to 1.5m/s
- 1.5 to 2.0m/s
- 2.0 to 3.0m/s
- > 3 m/s

Lake Vermont Meadowbrook EIS

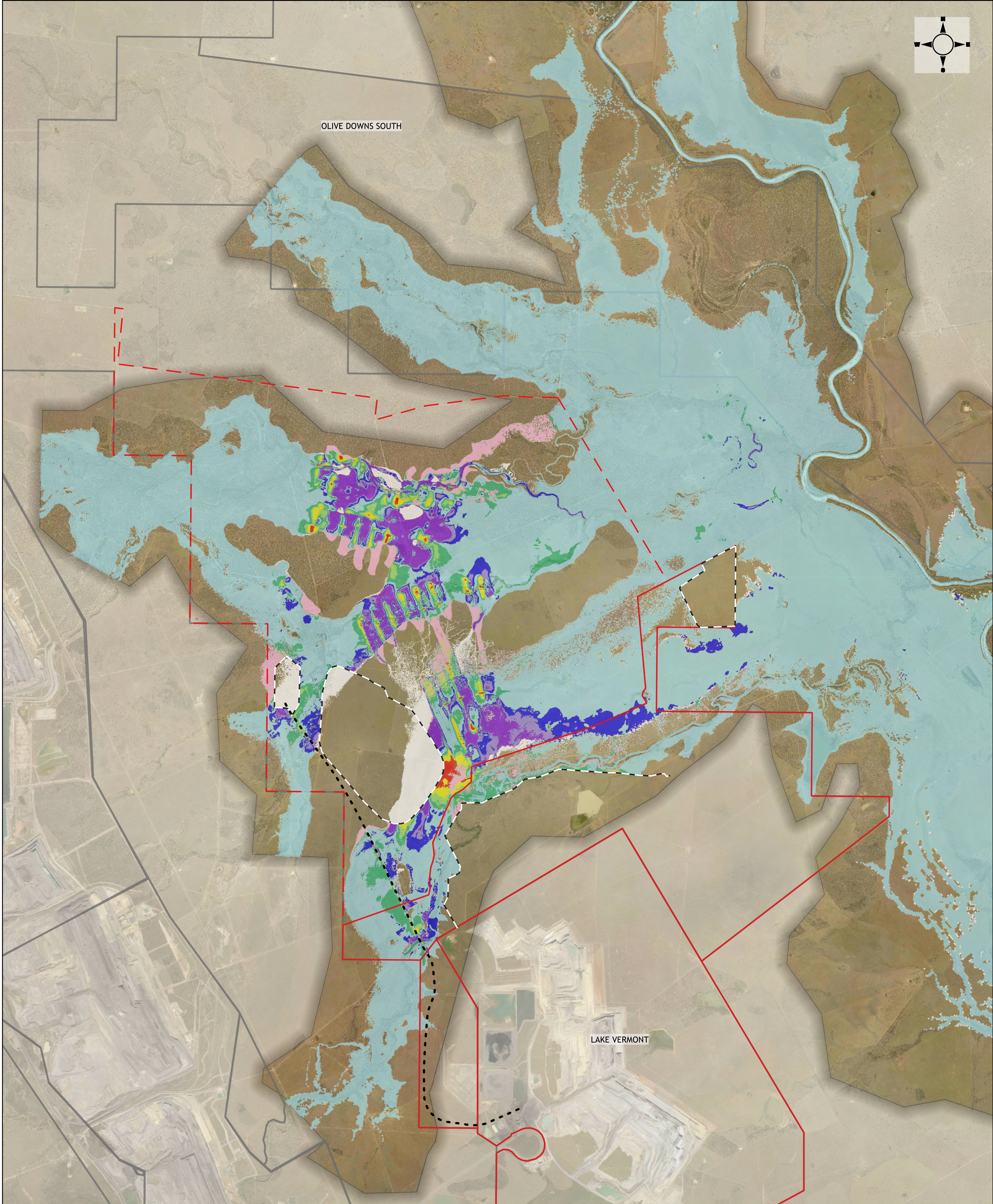
1% AEP velocity local flooding
Year 26 conditions with mitigation

0 1 2 3 4 5 km

wrm water + environment

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 31 May 2022)

Projection: EPSG:20355



J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 31 May 2022)

Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee
- Haul road alignment

Velocity diffference (m/s)

- <- 0.3 m/s
- -0.3 m/s to -0.2 m/s
- -0.2 m/s to -0.1 m/s
- -0.1 m/s to 0.1 m/s
- 0.1 m/s to 0.3 m/s
- 0.3 m/s to 0.5 m/s
- 0.5 m/s to 1.0 m/s
- 1.0 m/s to 1.5 m/s
- > 1.5 m/s
- Was wet now dry
- Was dry now wet

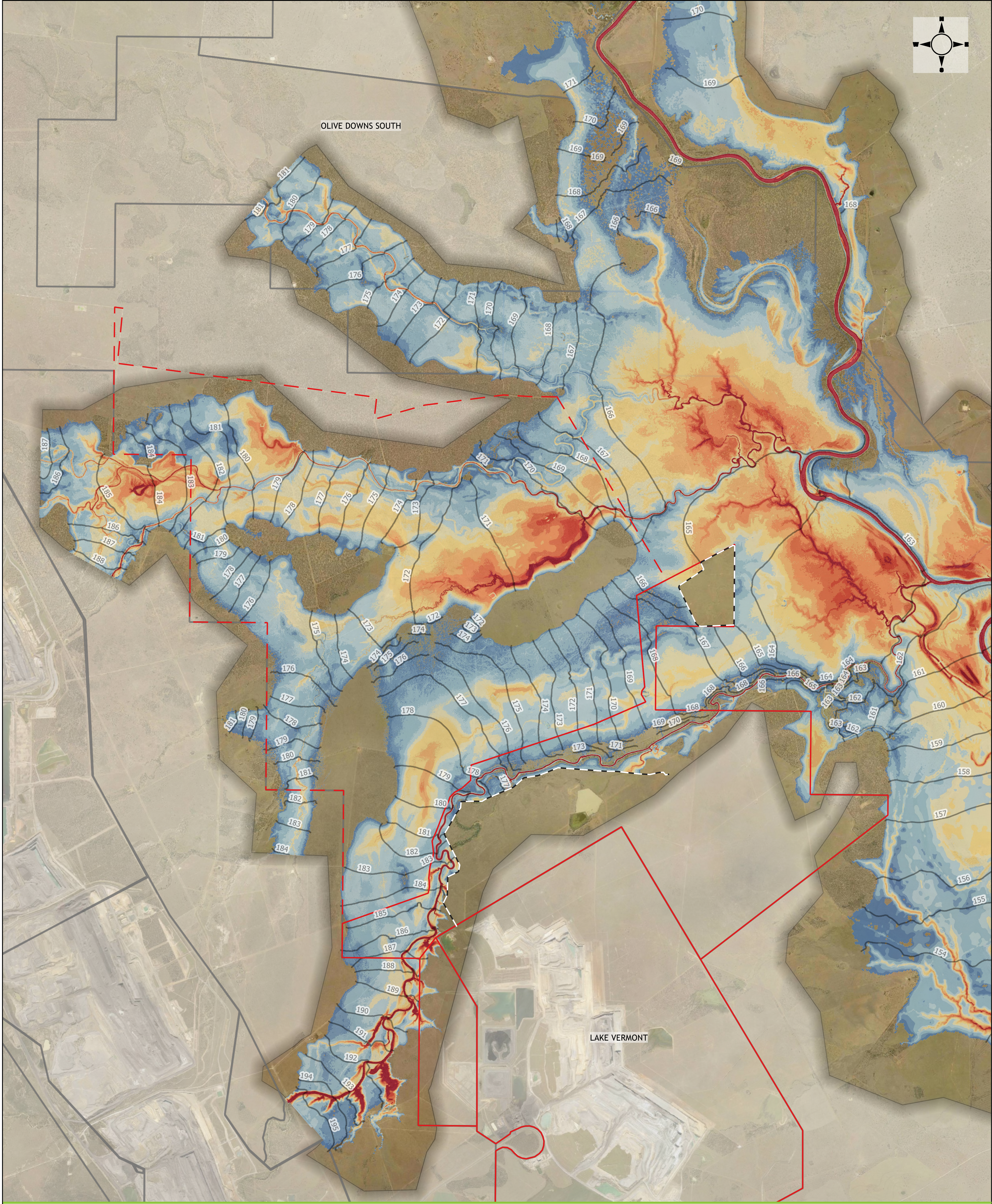
Lake Vermont Meadowbrook EIS

1% AEP velocity difference local flooding
Year 26 conditions with mitigation minus approved conditions

0 1 2 3 4 5 km

wrm water + environment

Projection: EPSG:20355



J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 31 May 2022)

Legend

- Mining Lease Application (MLA)
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- Levee
- 0.5m flood height contours (m AHD)

Depth (m)

- up to 0.25m
- 0.25 to 0.5m
- 0.5 to 1.0m
- 1.0 to 1.5m
- 1.5 to 2.0m
- 2.0 to 2.5m
- 2.5 to 3.0m
- 3.0 to 3.5m
- 3.5 to 4.0m
- 4.0 to 4.5m
- > 4.5m

Lake Vermont Meadowbrook EIS

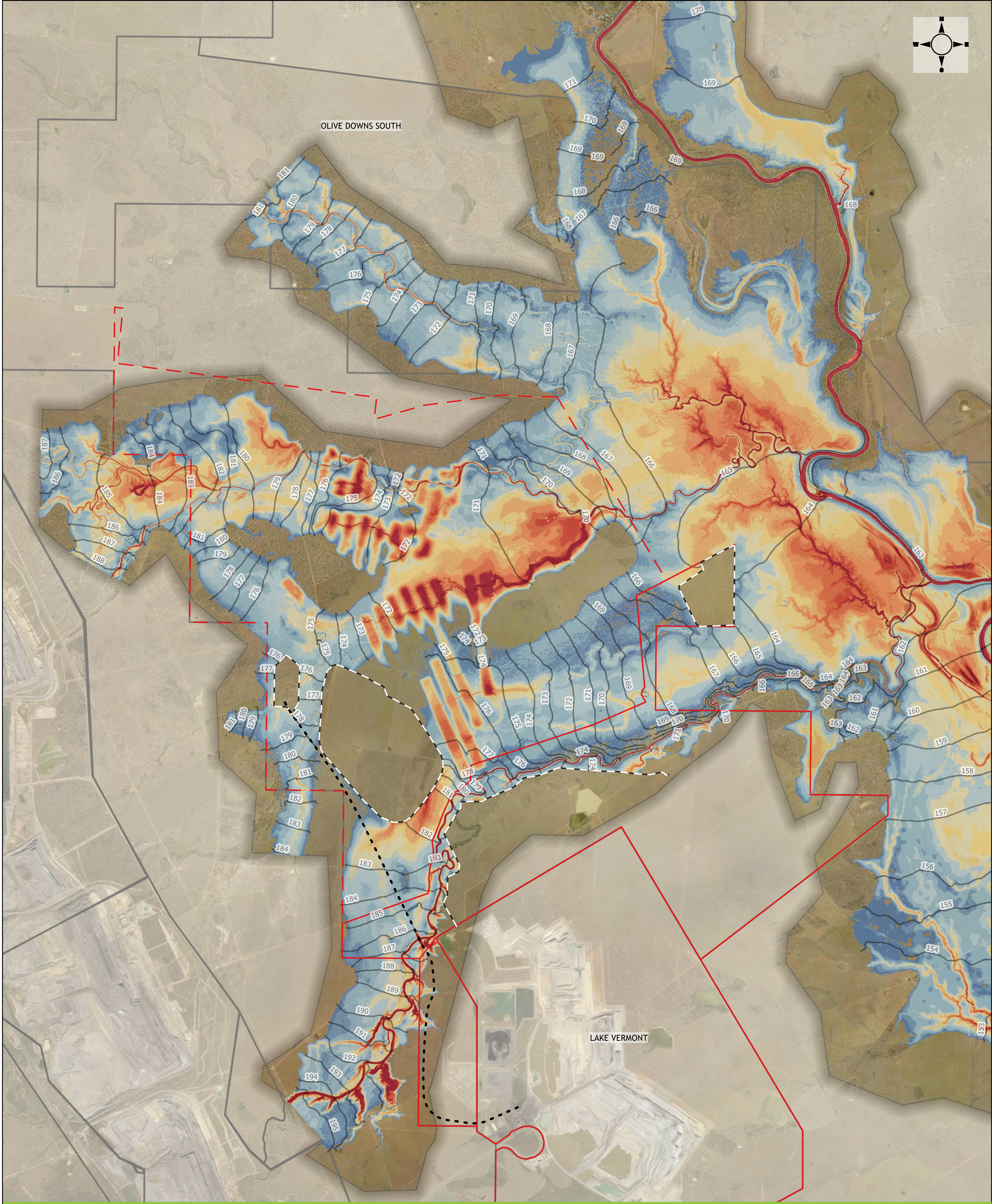
0.1% AEP flood depth and height local flooding
Approved conditions

0 1 2 3 4 5 km

wrm water + environment

Projection: EPSG:20355

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 31 May 2022)



Legend

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- QLD mining leases
- Levee
- Haul road alignment
- 0.5m flood height contours (m AHD)

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- 3.0 to 3.5m
- 3.5 to 4.0m
- 4.0 to 4.5m
- > 4.5m

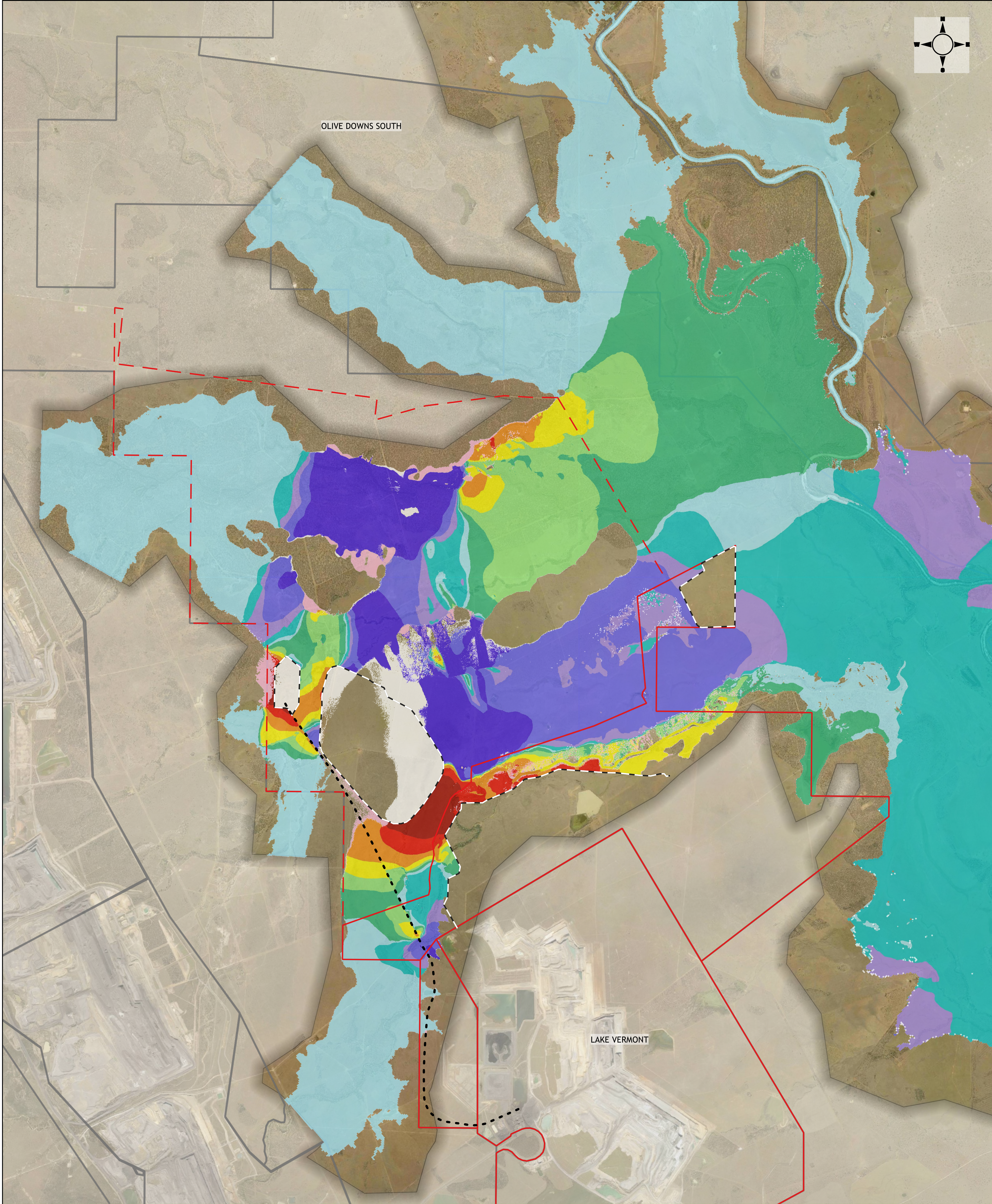
Lake Vermont Meadowbrook EIS

0.1% AEP flood depth and height local flooding
Year 26 conditions with mitigation

0 1 2 3 4 5 km

wrm water + environment

Projection: EPSG:20355



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee
- Haul road alignment

Afflux

- dWL < -0.25
- -0.25m < dWL < -0.10m
- -0.10m < dWL < -0.05m
- -0.05 m < dWL < -0.01 m
- -0.01 m < dWL < 0.01 m
- 0.01 m < dWL < 0.05 m
- 0.05 m < dWL < 0.10 m
- 0.10 m < dWL < 0.25 m
- 0.25 m < dWL < 0.50 m
- 0.50 m < dWL < 1.00 m
- 1.00 < dWL < 3.00m
- 3.00 < dWL < 5.00m
- dWL > 5.00m
- Was wet now dry
- Was dry now wet

Lake Vermont Meadowbrook EIS

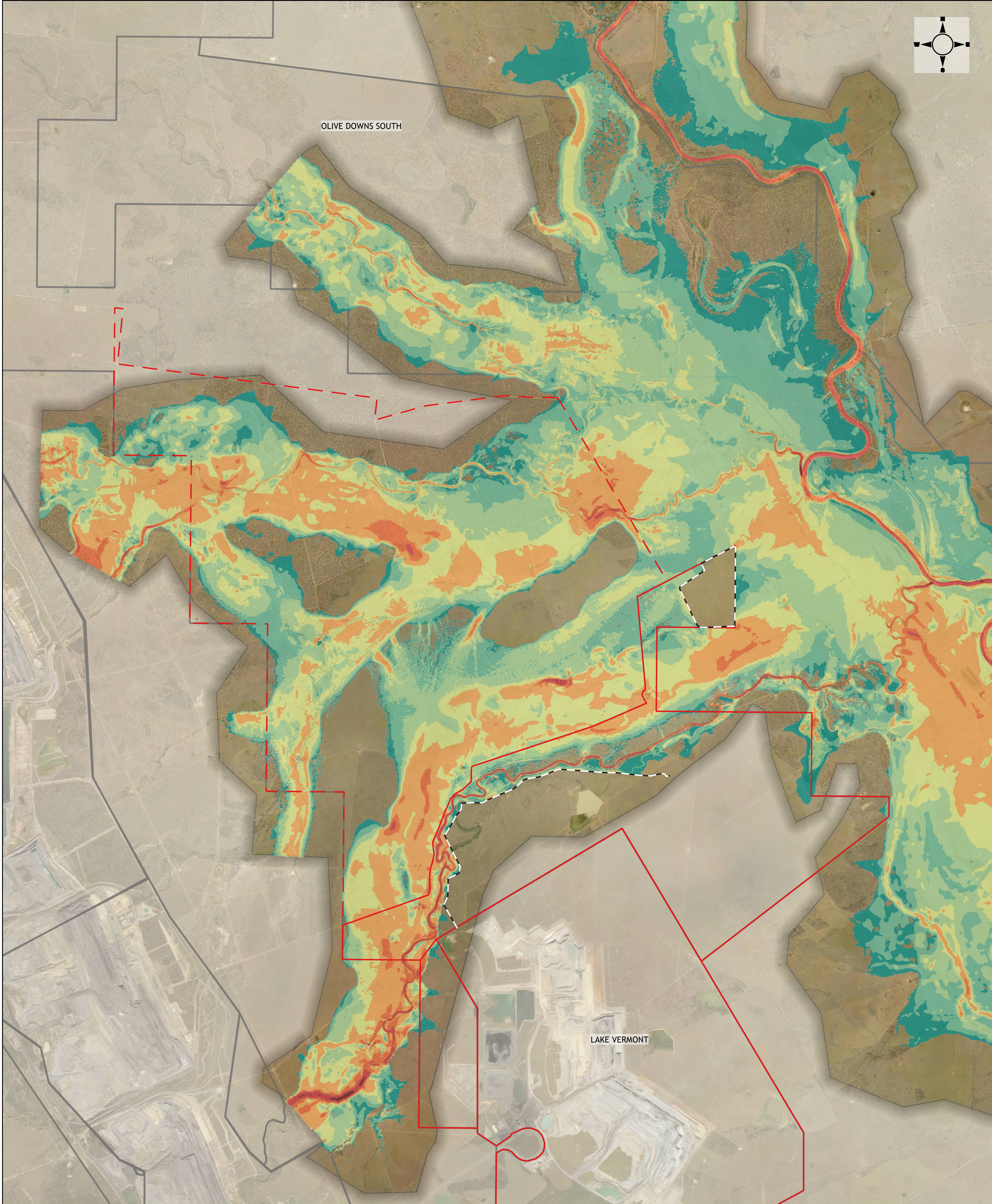
0.1% AEP afflux local flooding
Year 26 conditions with mitigation minus approved conditions

0 1 2 3 4 5 km

wrm water + environment

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 31 May 2022)

Projection: EPSG:20355



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee

Velocity

- up to 0.25m/s
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- 0.5 to 0.75m/s
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- 1.5 to 2.0m/s
- 2.0 to 3.0m/s
- > 3 m/s

Lake Vermont Meadowbrook EIS

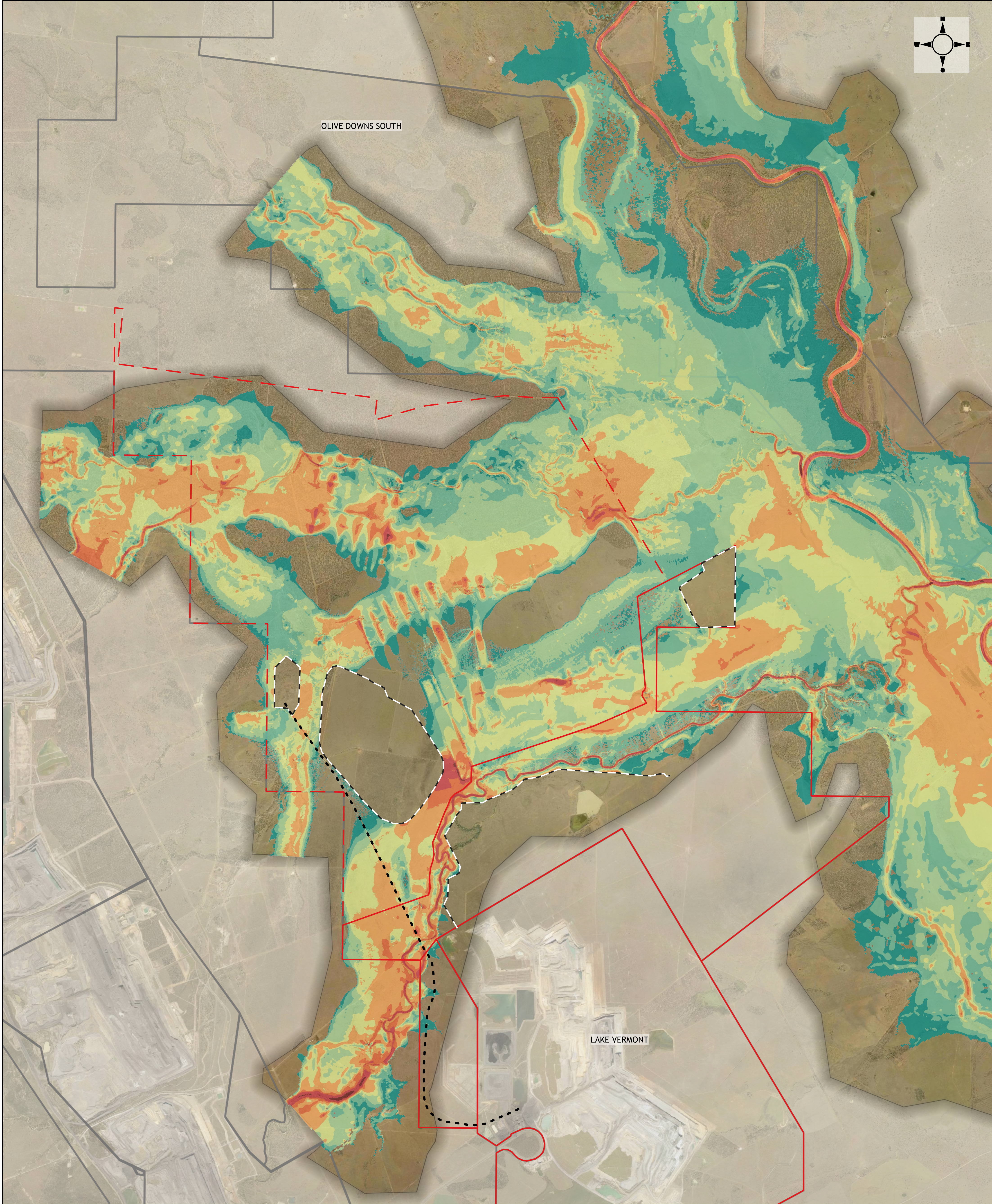
0.1% AEP velocity local flooding
Approved conditions

0 1 2 3 4 5 km

wrm water + environment

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (issued: 01 June 2022)

Projection: EPSG:20355



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee
- Haul road alignment

Velocity

- up to 0.25m/s
- 0.25 to 0.5m/s
- 0.5 to 0.75m/s
- 0.75 to 1.0m/s
- 1.0 to 1.5m/s
- 1.5 to 2.0m/s
- 2.0 to 3.0m/s
- > 3 m/s

Lake Vermont Meadowbrook EIS

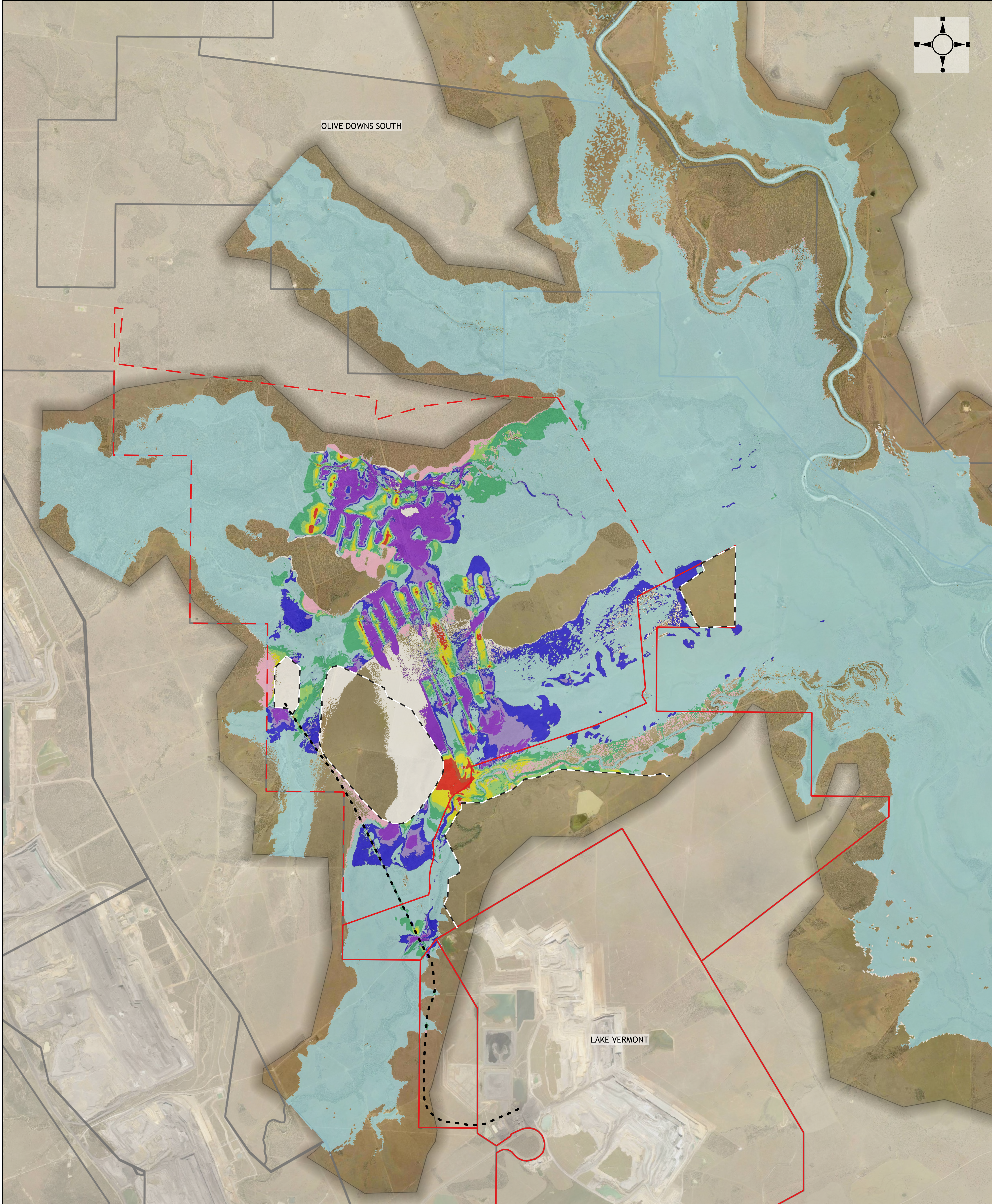
0.1% AEP velocity local flooding
Year 26 conditions with mitigation

0 1 2 3 4 5 km

wrm water+environment

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 01 June 2022)

Projection: EPSG:20355



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee
- Haul road alignment

Velocity diffference (m/s)

- <- 0.3 m/s
- -0.3 m/s to -0.2 m/s
- -0.2 m/s to -0.1 m/s
- -0.1 m/s to 0.1 m/s
- 0.1 m/s to 0.3 m/s
- 0.3 m/s to 0.5 m/s
- 0.5 m/s to 1.0 m/s
- 1.0 m/s to 1.5 m/s
- > 1.5 m/s
- Was wet now dry
- Was dry now wet

Lake Vermont Meadowbrook EIS

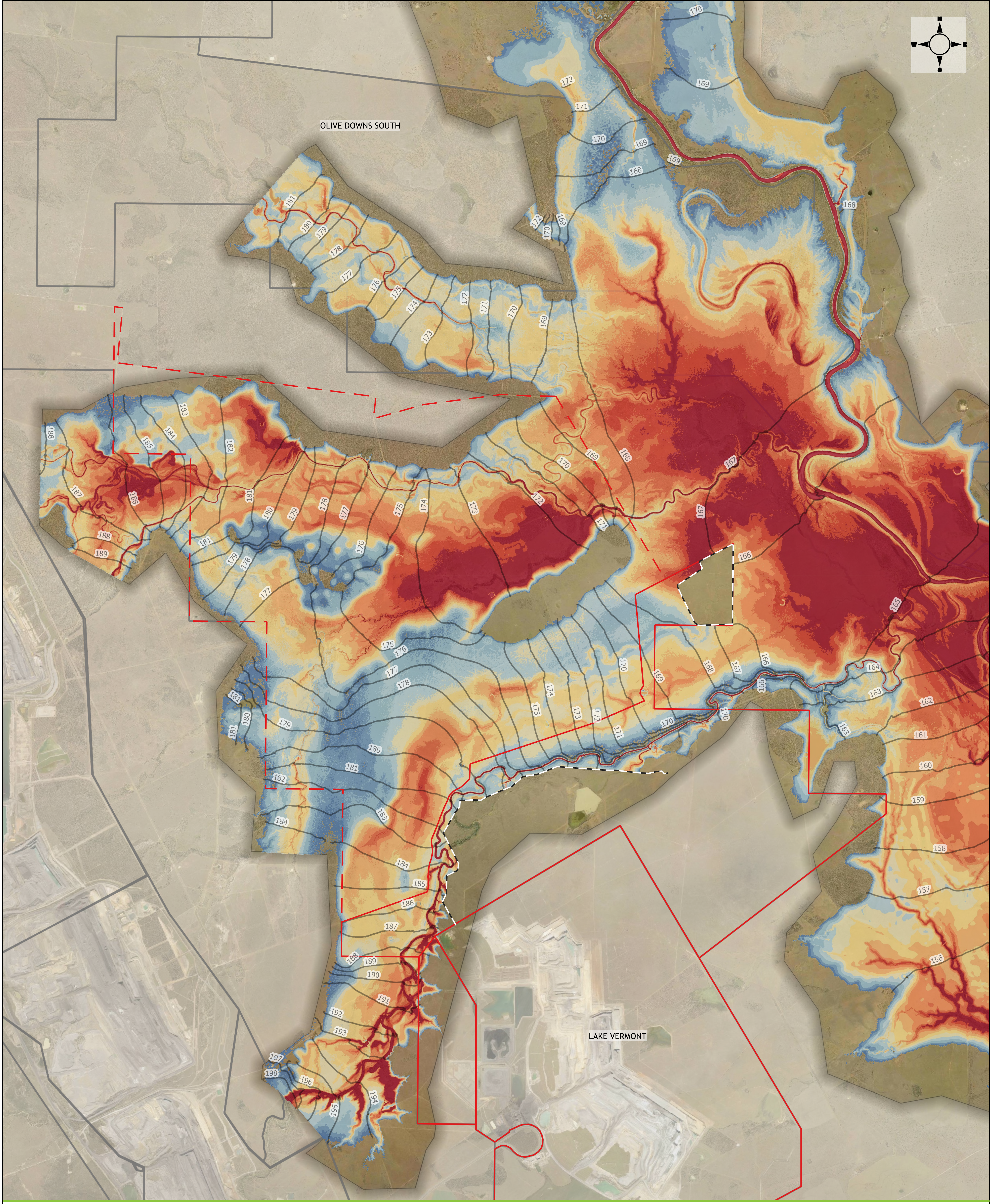
0.1% AEP velocity difference local flooding
Year 26 conditions with mitigation minus approved conditions

0 1 2 3 4 5 km

wrm water + environment

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 01 June 2022)

Projection: EPSG:20355



J:\0622-27 Meadowbrook EIS\WIN\QGIS\TUFLOW config.qgz (Issued: 01 June 2022)

Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee

0.5m flood height contours (m AHD)

Depth (m)

- up to 0.25m
- 0.25 to 0.5m
- 0.5 to 1.0m
- 1.0 to 1.5m
- 1.5 to 2.0m
- 2.0 to 2.5m
- 2.5 to 3.0m
- 3.0 to 3.5m
- 3.5 to 4.0m
- 4.0 to 4.5m
- > 4.5m

Lake Vermont Meadowbrook EIS

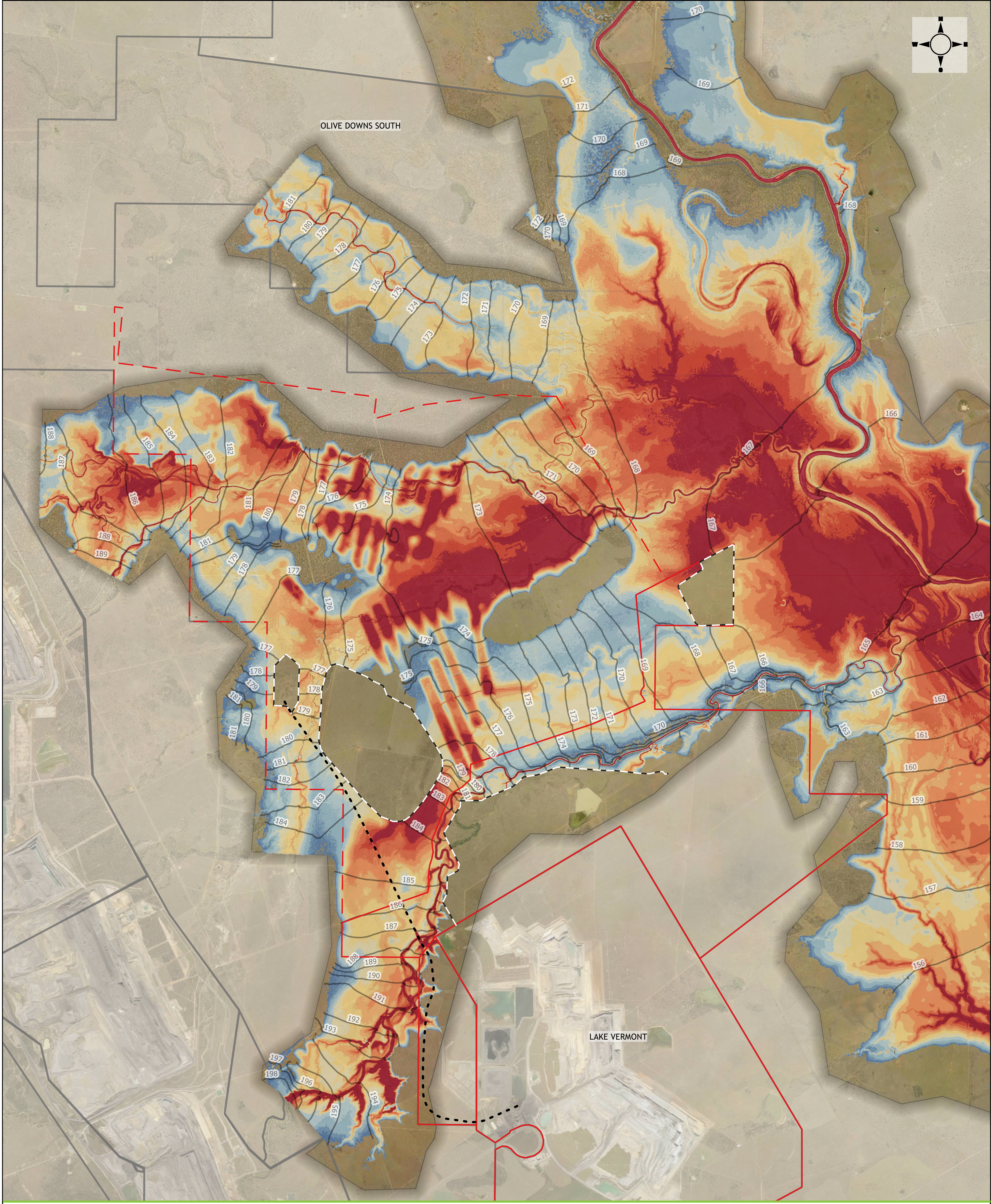
PMF flood depth and height local flooding
Approved conditions

0 1 2 3 4 5 km

wrm water+environment

Projection: EPSG:20355

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 01 June 2022)



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- 3.0 to 3.5m
- 3.5 to 4.0m
- 4.0 to 4.5m
- > 4.5m

Lake Vermont Meadowbrook EIS

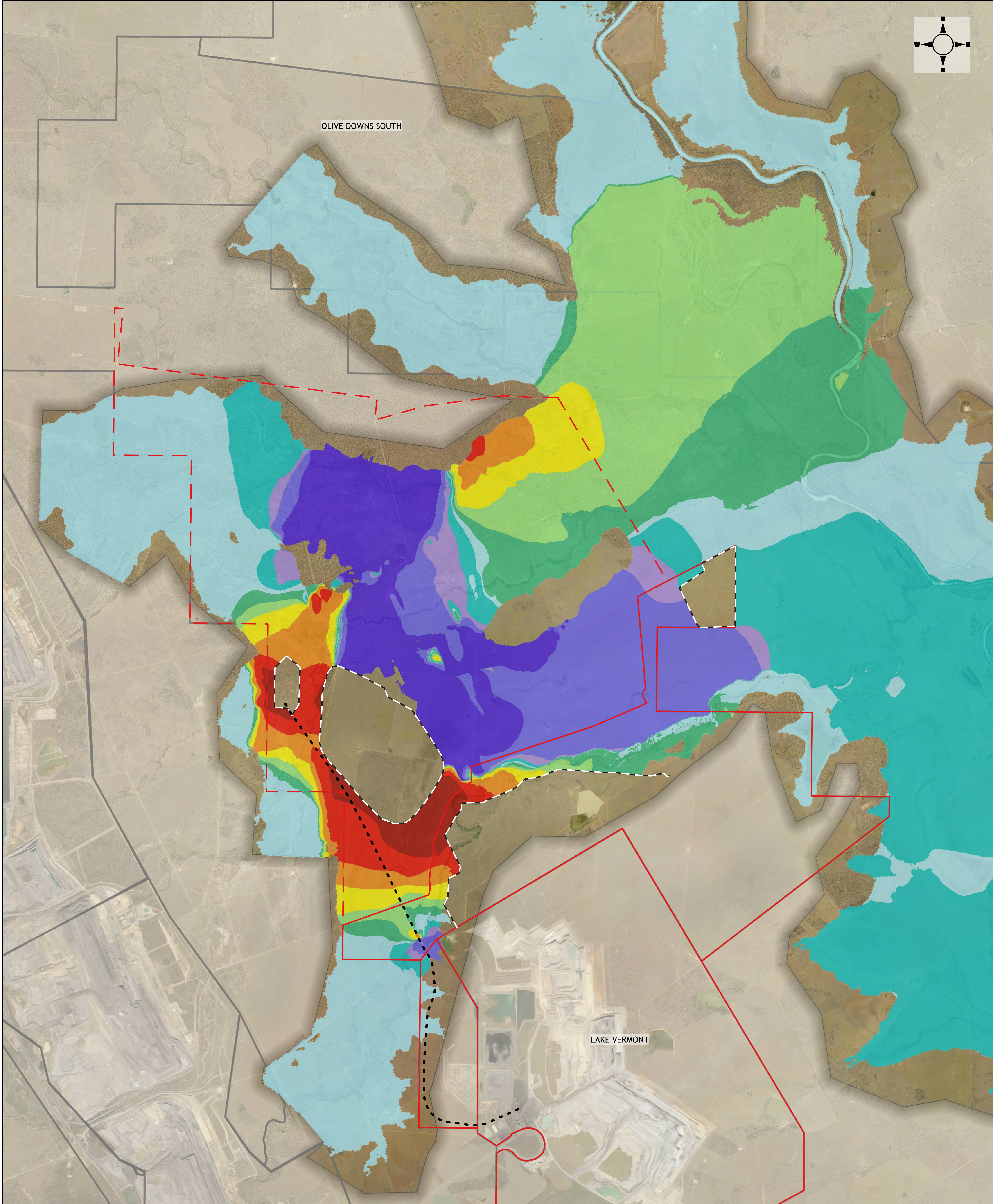
PMF flood depth and height local flooding
Year 26 conditions with mitigation

0 1 2 3 4 5 km

wrm water + environment

Projection: EPSG:20355

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 01 June 2022)



Legend

- Mining Lease Application (MLA)
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Afflux

- dWL < -0.25
- -0.25m < dWL < -0.10m
- -0.10m < dWL < -0.05m
- -0.05 m < dWL < -0.01 m
- -0.01 m < dWL < 0.01 m
- 0.01 m < dWL < 0.05 m
- 0.05 m < dWL < 0.10 m
- 0.10 m < dWL < 0.25 m
- 0.25 m < dWL < 0.50 m
- 0.50 m < dWL < 1.00 m
- 1.00 < dWL < 3.00m
- 3.00 < dWL < 5.00m
- dWL > 5.00m
- Was wet now dry
- Was dry now wet

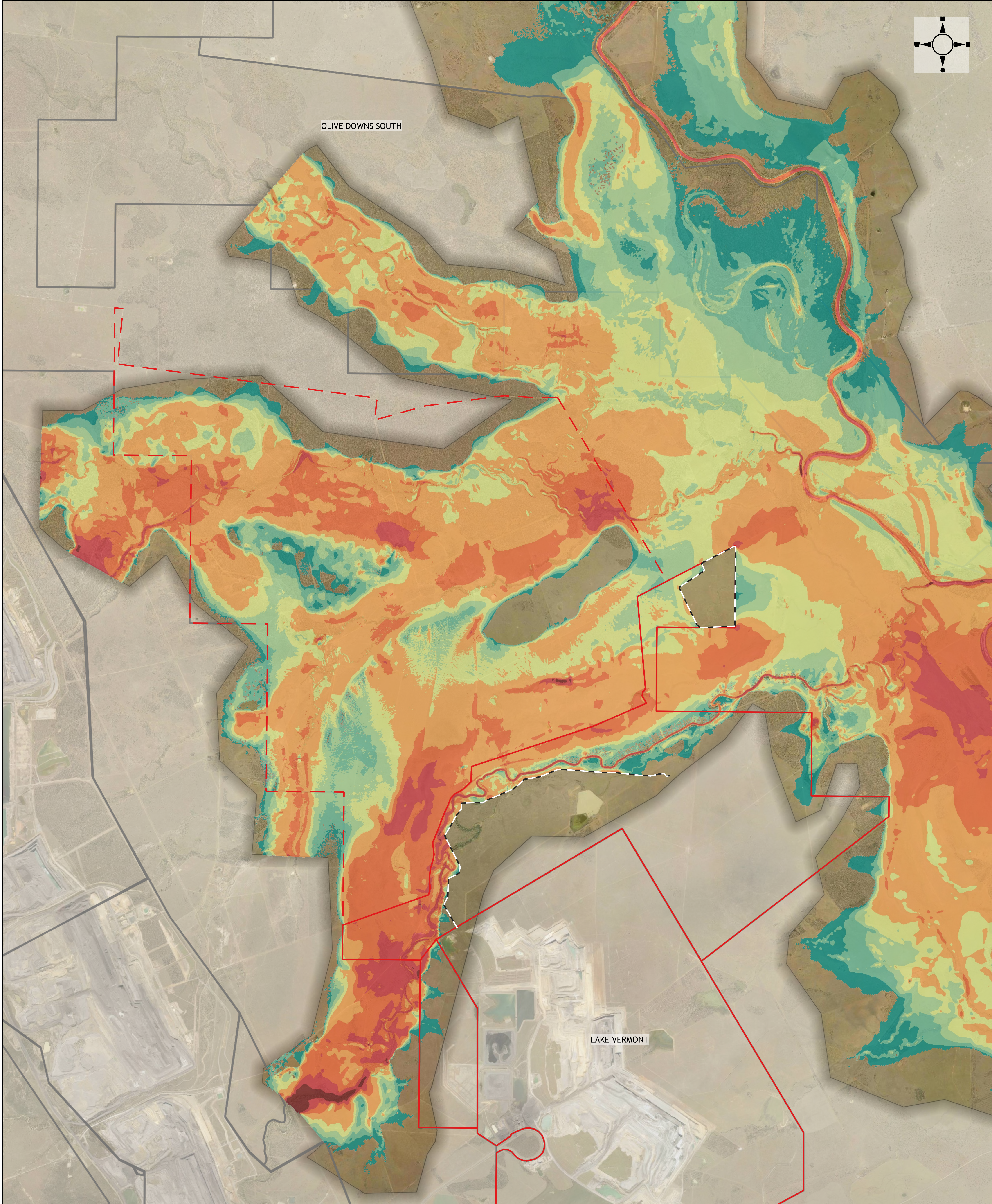
Lake Vermont Meadowbrook EIS

PMF afflux local flooding
Year 26 conditions with mitigation minus approved conditions

0 1 2 3 4 5 km

wrm water + environment

Projection: EPSG:20355



Legend

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- Mining Lease (ML)
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- Levee

Velocity

- up to 0.25m/s
- 0.25 to 0.5m/s
- 0.5 to 0.75m/s
- 0.75 to 1.0m/s
- 1.0 to 1.5m/s
- 1.5 to 2.0m/s
- 2.0 to 3.0m/s
- > 3 m/s

Lake Vermont Meadowbrook EIS

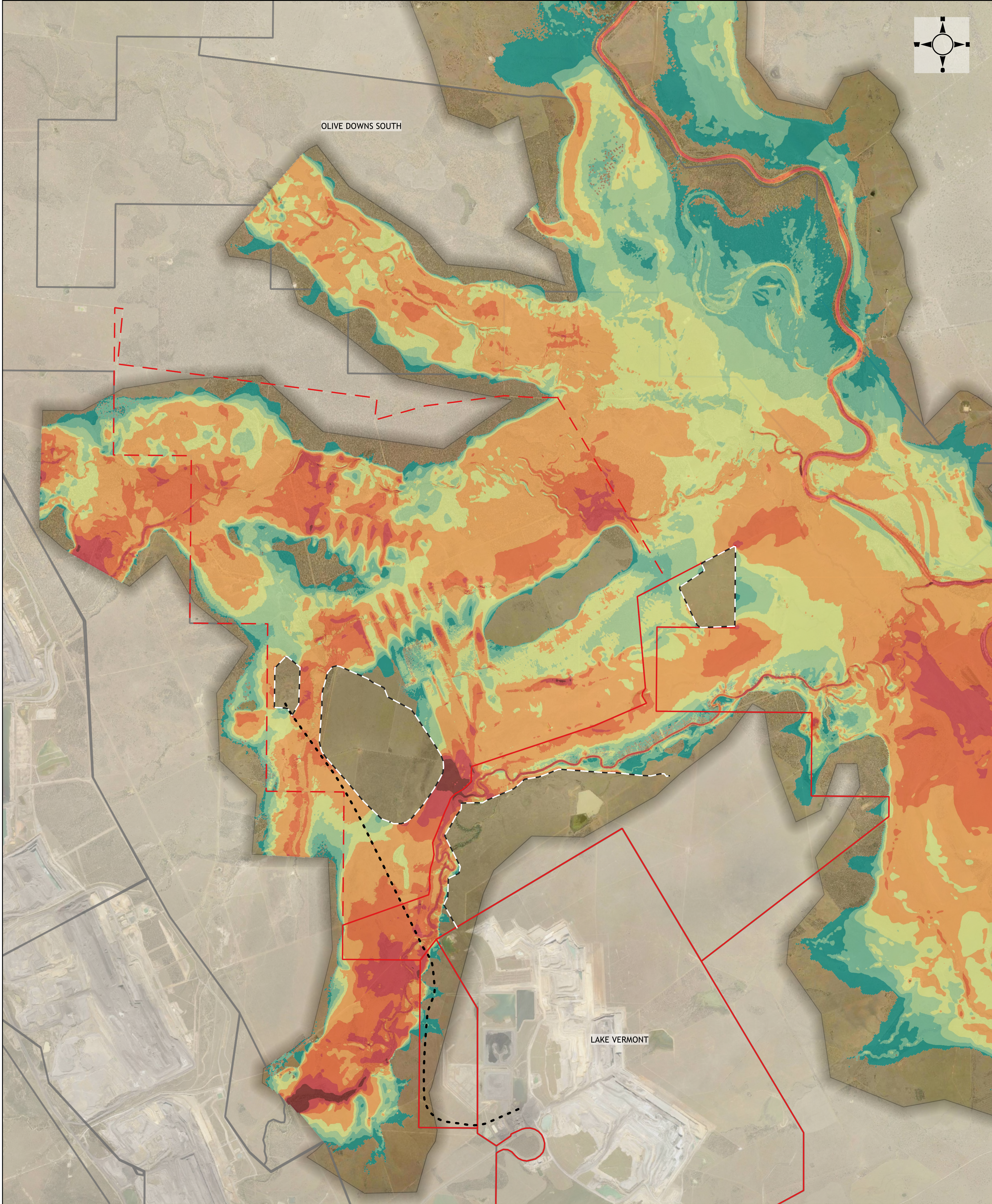
PMF velocity local flooding
Approved conditions

0 1 2 3 4 5 km

wrm water + environment

J:\0622-27 Meadowbrook EIS\WI\QGIS\TUFLOW config.qgz (Issued: 01 June 2022)

Projection: EPSG:20355



J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 01 June 2022)

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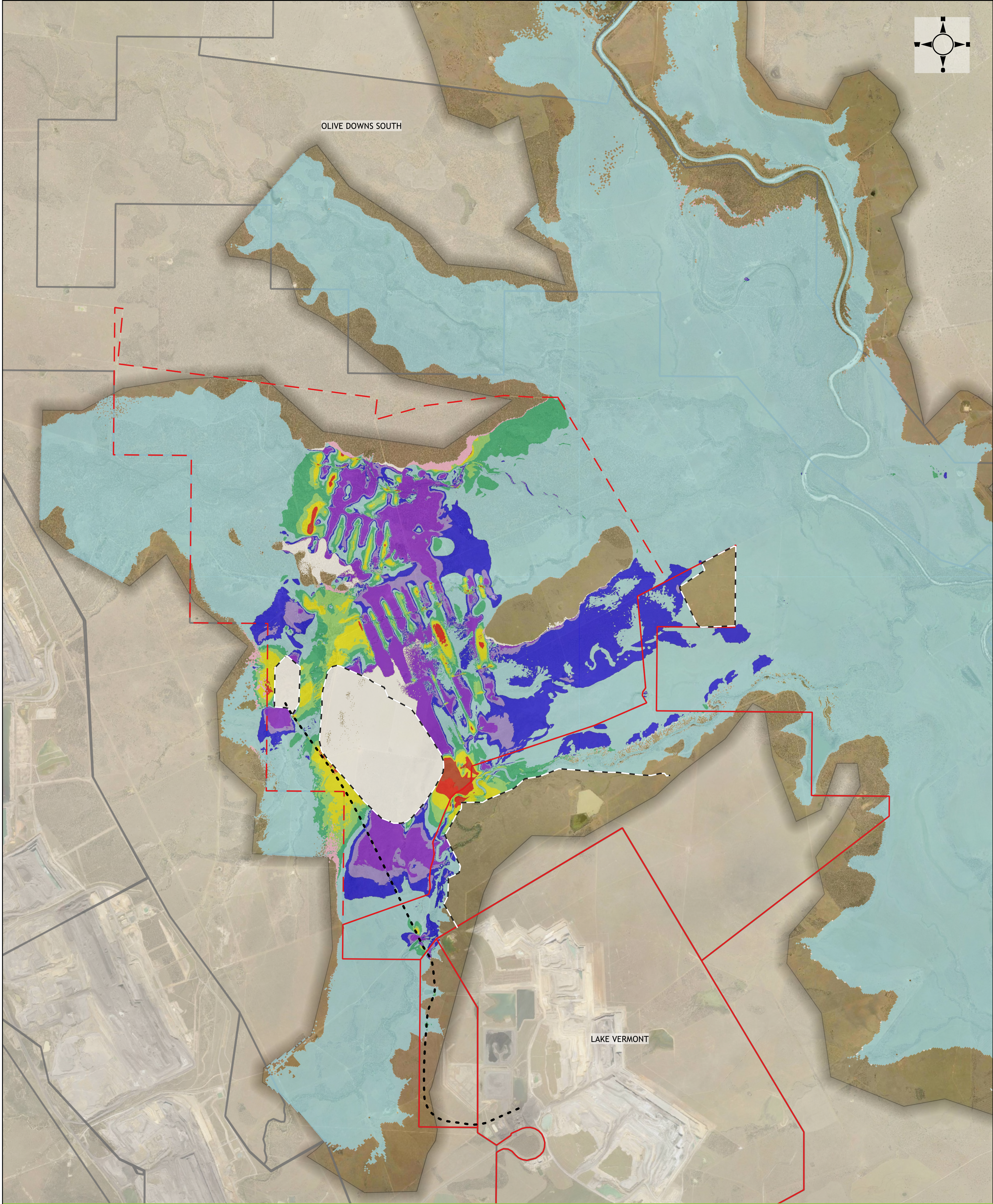
Lake Vermont Meadowbrook EIS

PMF velocity local flooding
Year 26 conditions with mitigation

0 1 2 3 4 5 km

wrm water + environment

Projection: EPSG:20355



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Velocity diffference (m/s)

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- -0.3 m/s to -0.2 m/s
- -0.2 m/s to -0.1 m/s
- -0.1 m/s to 0.1 m/s
- 0.1 m/s to 0.3 m/s
- 0.3 m/s to 0.5 m/s
- 0.5 m/s to 1.0 m/s
- 1.0 m/s to 1.5 m/s
- > 1.5 m/s
- Was wet now dry
- Was dry now wet

Lake Vermont Meadowbrook EIS

PMF velocity difference local flooding
Year 26 conditions with mitigation minus approved conditions

0 1 2 3 4 5 km

wrm water + environment

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 01 June 2022)

Projection: EPSG:20355

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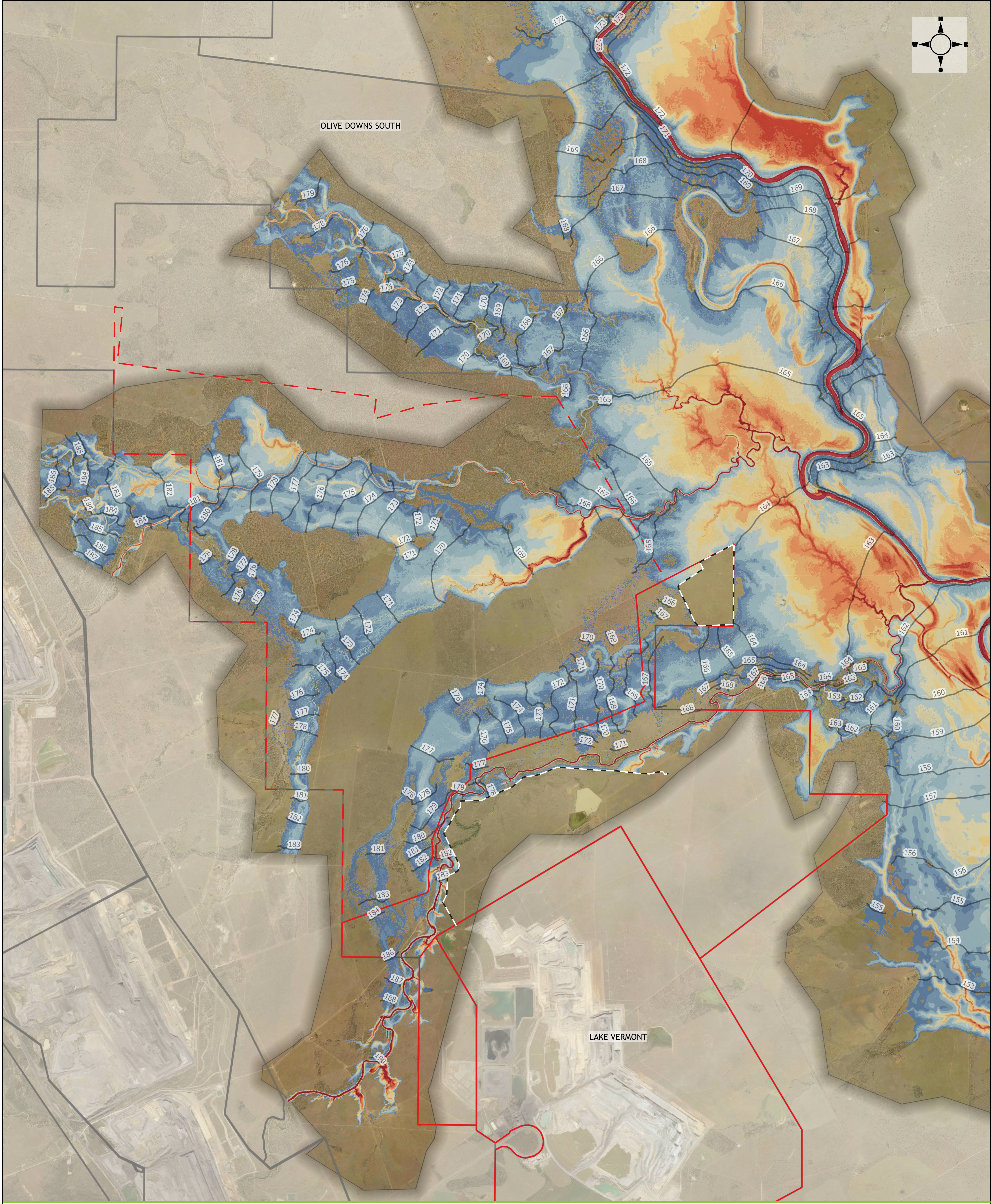

Legend

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- Levee

0.5m flood height contours (m AHD)

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- 2.0 to 2.5m
- 2.5 to 3.0m
- 3.0 to 3.5m
- 3.5 to 4.0m
- 4.0 to 4.5m
- > 4.5m

Lake Vermont Meadowbrook EIS

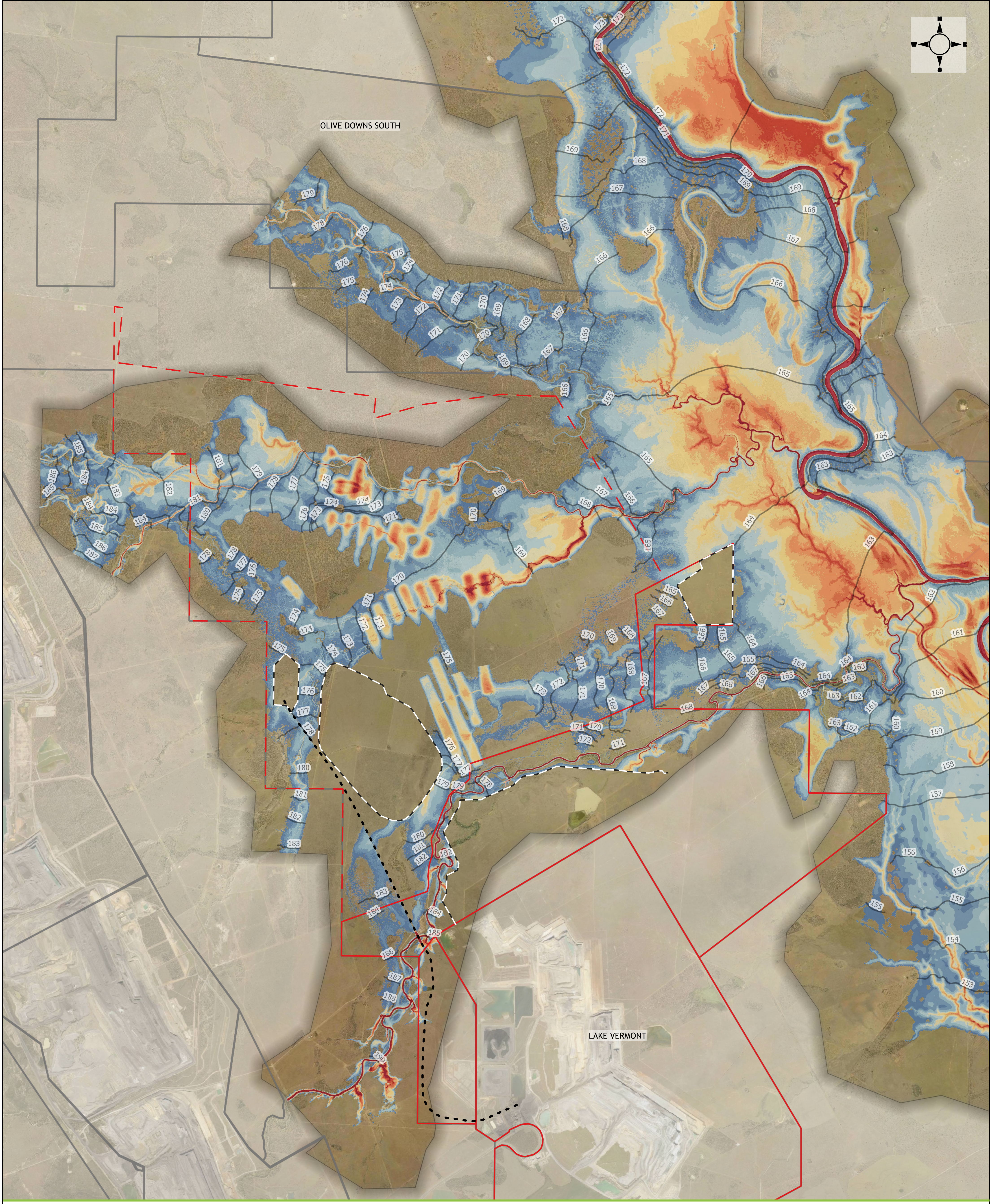
1% AEP flood depth and heights regional flooding
Approved conditions

0 1 2 3 4 5 km

wrm water+environment

Projection: EPSG:20355

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 01 June 2022)



Legend

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- Levee
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- 3.0 to 3.5m
- 3.5 to 4.0m
- 4.0 to 4.5m
- > 4.5m

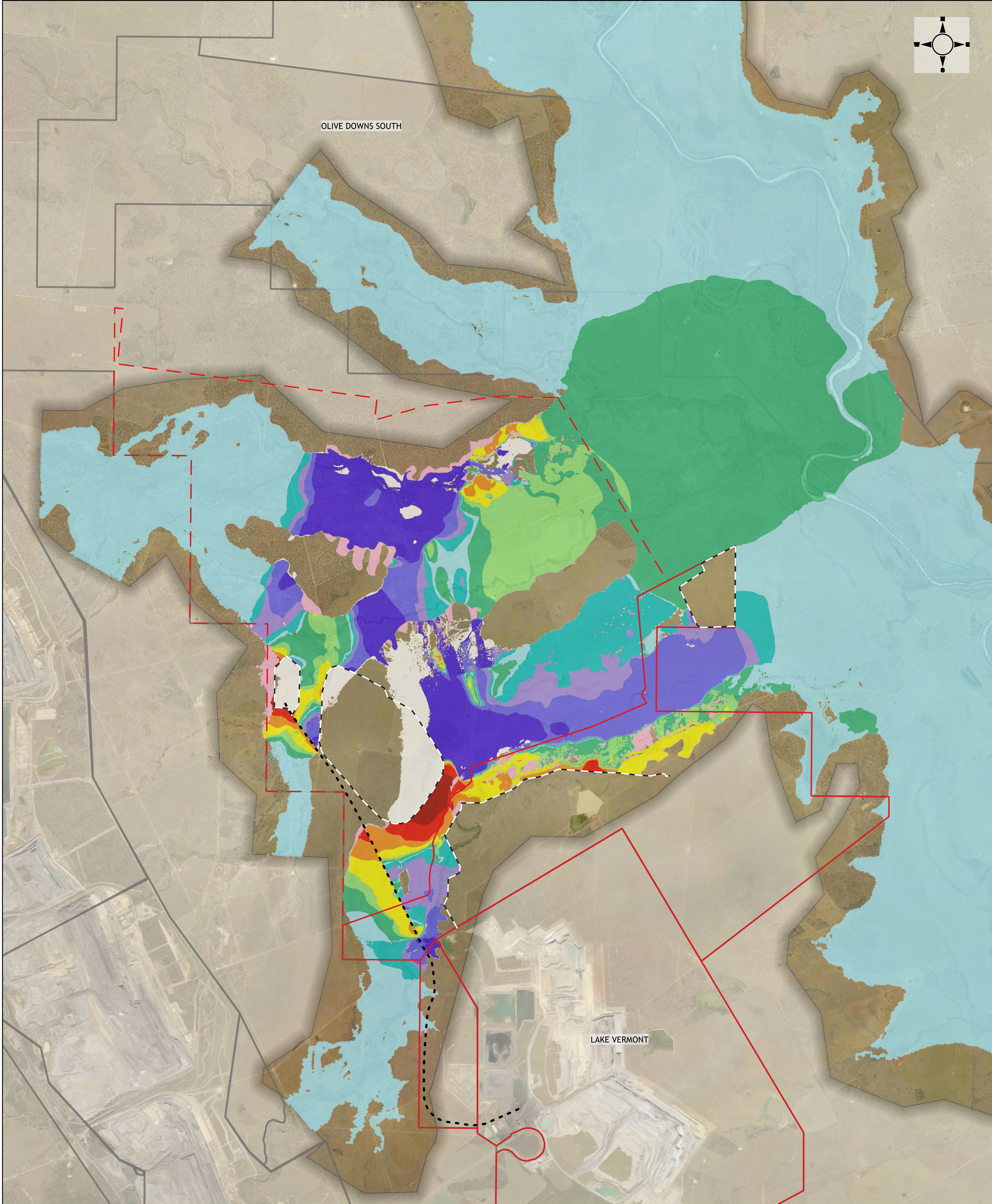
Lake Vermont Meadowbrook EIS

1% AEP flood depth and heights regional flooding
Year 26 conditions with mitigation

0 1 2 3 4 5 km

wrm water+environment

Projection: EPSG:20355



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee
- Haul road alignment

Afflux

- dWL < -0.25
- -0.25m < dWL < -0.10m
- -0.10m < dWL < -0.05m
- -0.05 m < dWL < -0.01 m
- -0.01 m < dWL < 0.01 m
- 0.01 m < dWL < 0.05 m
- 0.05 m < dWL < 0.10 m
- 0.10 m < dWL < 0.25 m
- 0.25 m < dWL < 0.50 m
- 0.50 m < dWL < 1.00 m
- 1.00 < dWL < 3.00m
- 3.00 < dWL < 5.00m
- dWL > 5.00m
- Was wet now dry
- Was dry now wet

Lake Vermont Meadowbrook EIS

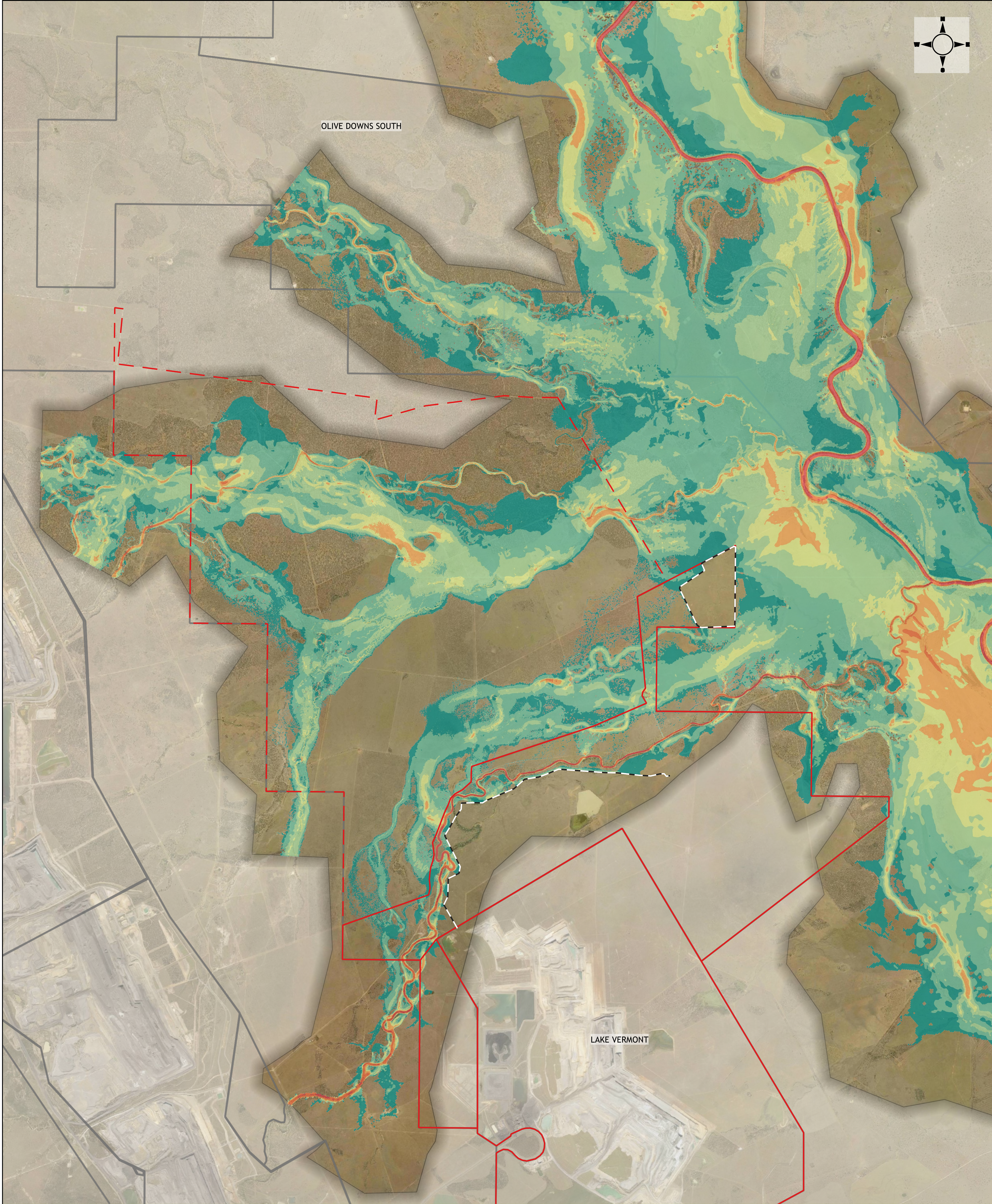
1% AEP afflux regional flooding
Year 26 conditions with mitigation minus approved conditions

0 1 2 3 4 5 km

wrm water + environment

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 01 June 2022)

Projection: EPSG:20355



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee

Velocity

- up to 0.25m/s
- 0.25 to 0.5m/s
- 0.5 to 0.75m/s
- 0.75 to 1.0m/s
- 1.0 to 1.5m/s
- 1.5 to 2.0m/s
- 2.0 to 3.0m/s
- > 3 m/s

Lake Vermont Meadowbrook EIS

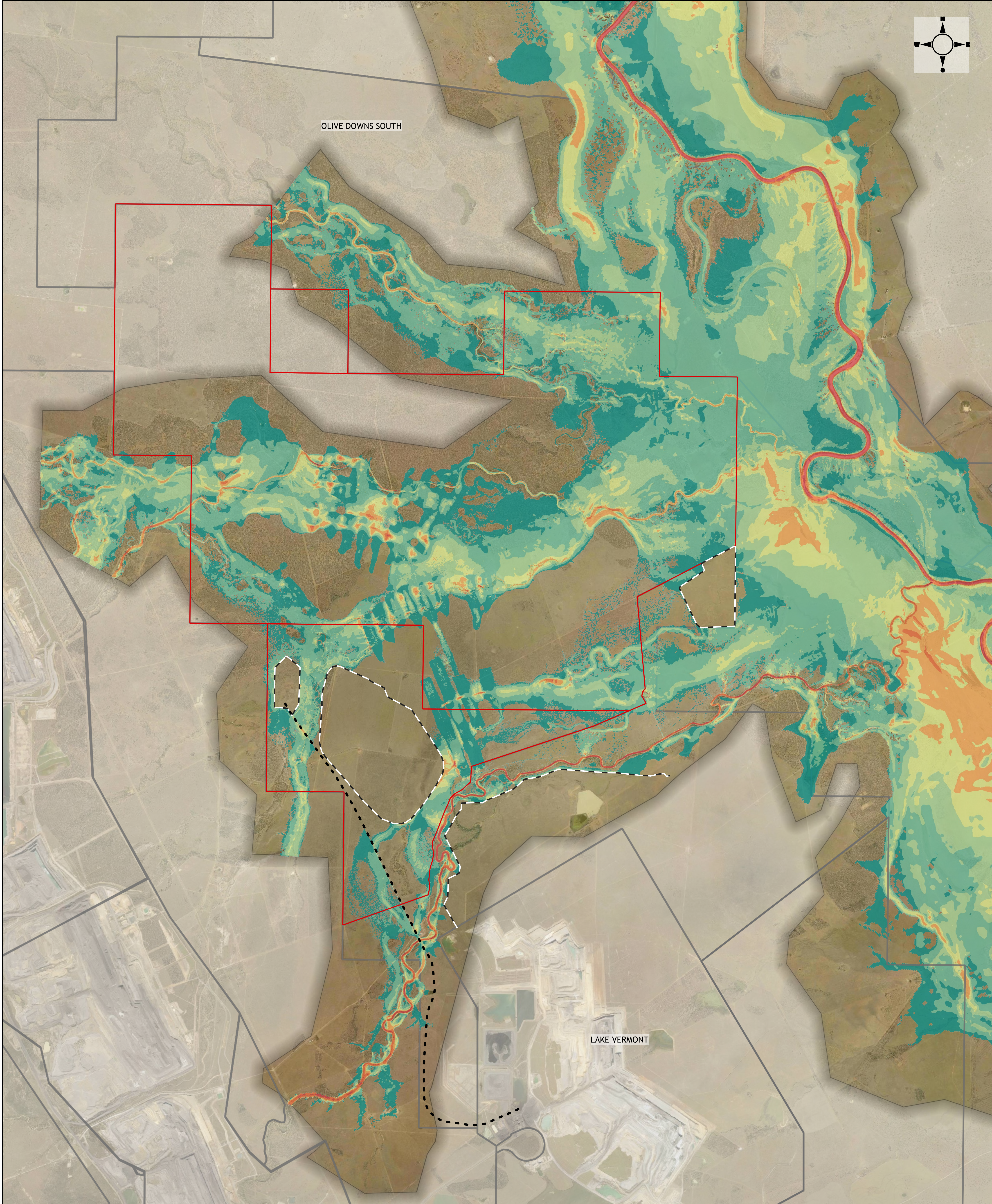
1% AEP velocity regional flooding
Approved conditions

0 1 2 3 4 5 km

wrm water + environment

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 01 June 2022)

Projection: EPSG:20355



J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 01 June 2022)

Legend

- Mining Lease Application (MLA)
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- Haul road alignment

Velocity

- up to 0.25m/s
- 0.25 to 0.5m/s
- 0.5 to 0.75m/s
- 0.75 to 1.0m/s
- 1.0 to 1.5m/s
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- 2.0 to 3.0m/s
- > 3 m/s

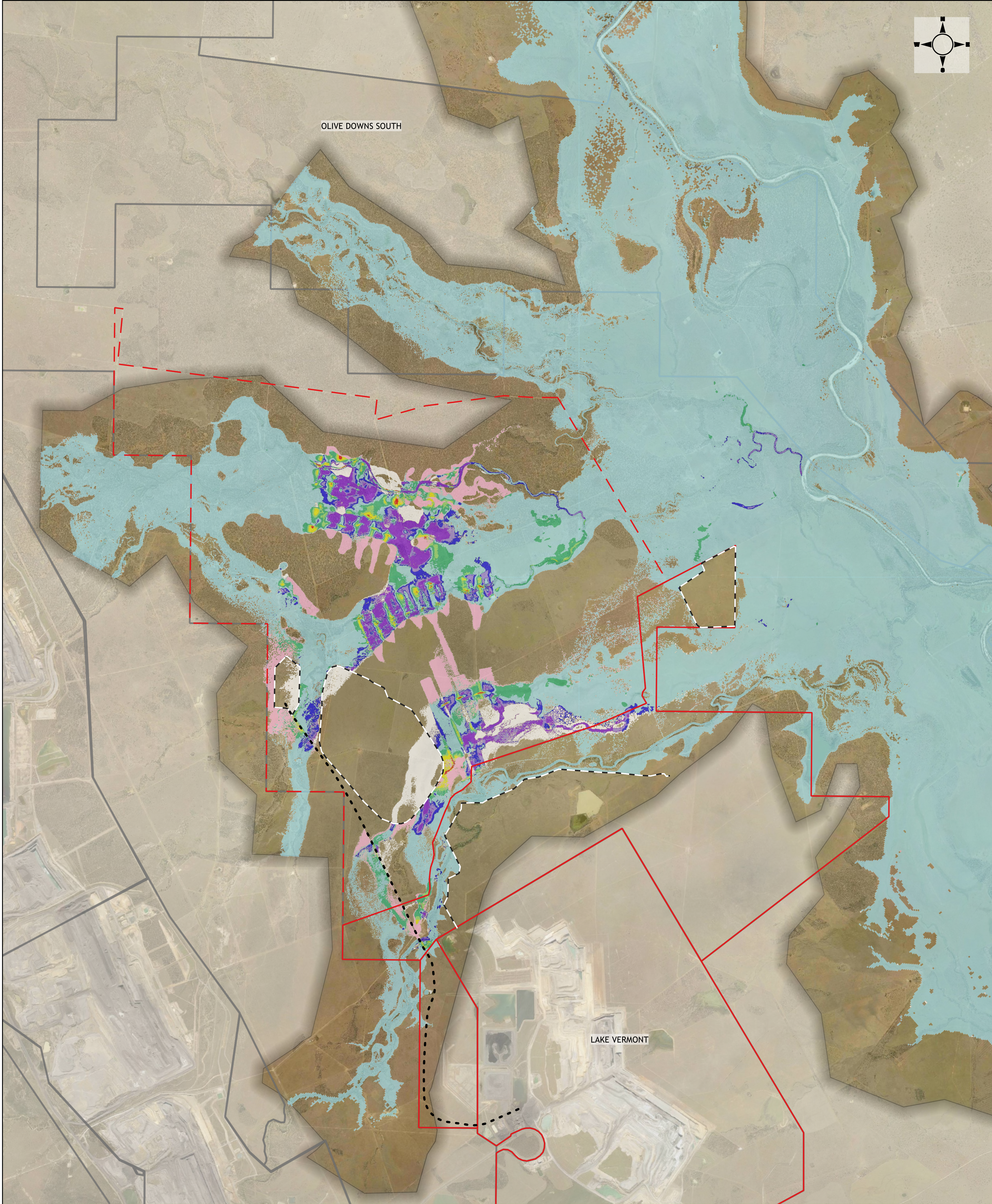
Lake Vermont Meadowbrook EIS

1% AEP velocity regional flooding
Year 26 conditions with mitigation

0 1 2 3 4 5 km

wrm water + environment

Projection: EPSG:20355



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
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- Levee
- Haul road alignment

Velocity diffference (m/s)

- <- 0.3 m/s
- -0.3 m/s to -0.2 m/s
- -0.2 m/s to -0.1 m/s
- -0.1 m/s to 0.1 m/s
- 0.1 m/s to 0.3 m/s
- 0.3 m/s to 0.5 m/s
- 0.5 m/s to 1.0 m/s
- 1.0 m/s to 1.5 m/s
- > 1.5 m/s
- Was wet now dry
- Was dry now wet

Lake Vermont Meadowbrook EIS

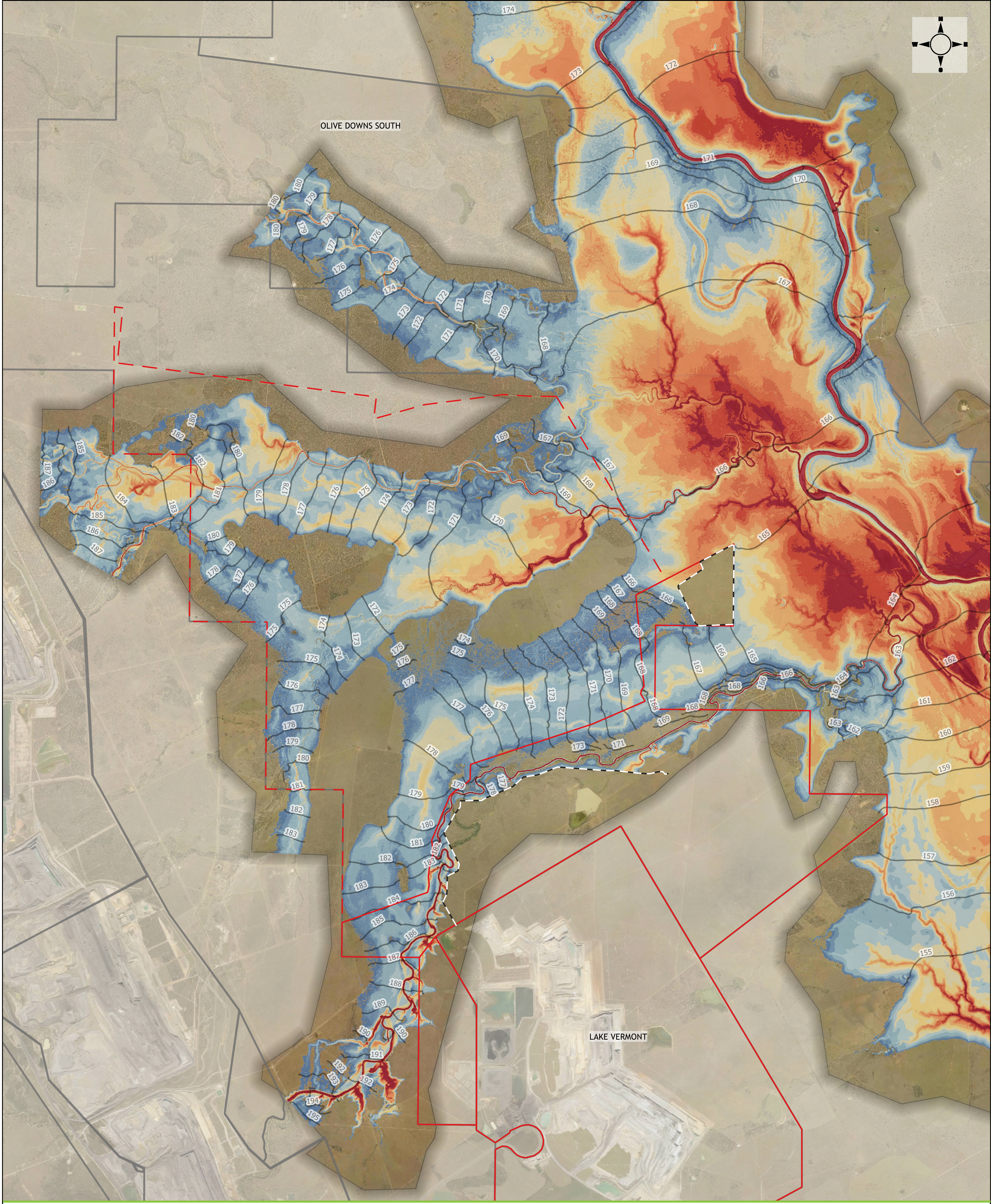
1% AEP velocity difference regional flooding
Year 26 conditions with mitigation minus approved conditions

0 1 2 3 4 5 km

wrm water + environment

J:\0622-27 Meadowbrook EIS\M\QGIS\TUFLOW config.qgz (Issued: 01 June 2022)

Projection: EPSG:20355



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee
- 0.5m flood height contours (m AHD)

Depth (m)

- up to 0.25m
- 0.25 to 0.5m
- 0.5 to 1.0m
- 1.0 to 1.5m
- 1.5 to 2.0m
- 2.0 to 2.5m
- 2.5 to 3.0m
- 3.0 to 3.5m
- 3.5 to 4.0m
- 4.0 to 4.5m
- > 4.5m

Lake Vermont Meadowbrook EIS

0.1% AEP flood depth and heights regional flooding
Approved conditions

0 1 2 3 4 5 km

wrm water + environment

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 01 June 2022)

Projection: EPSG:20355

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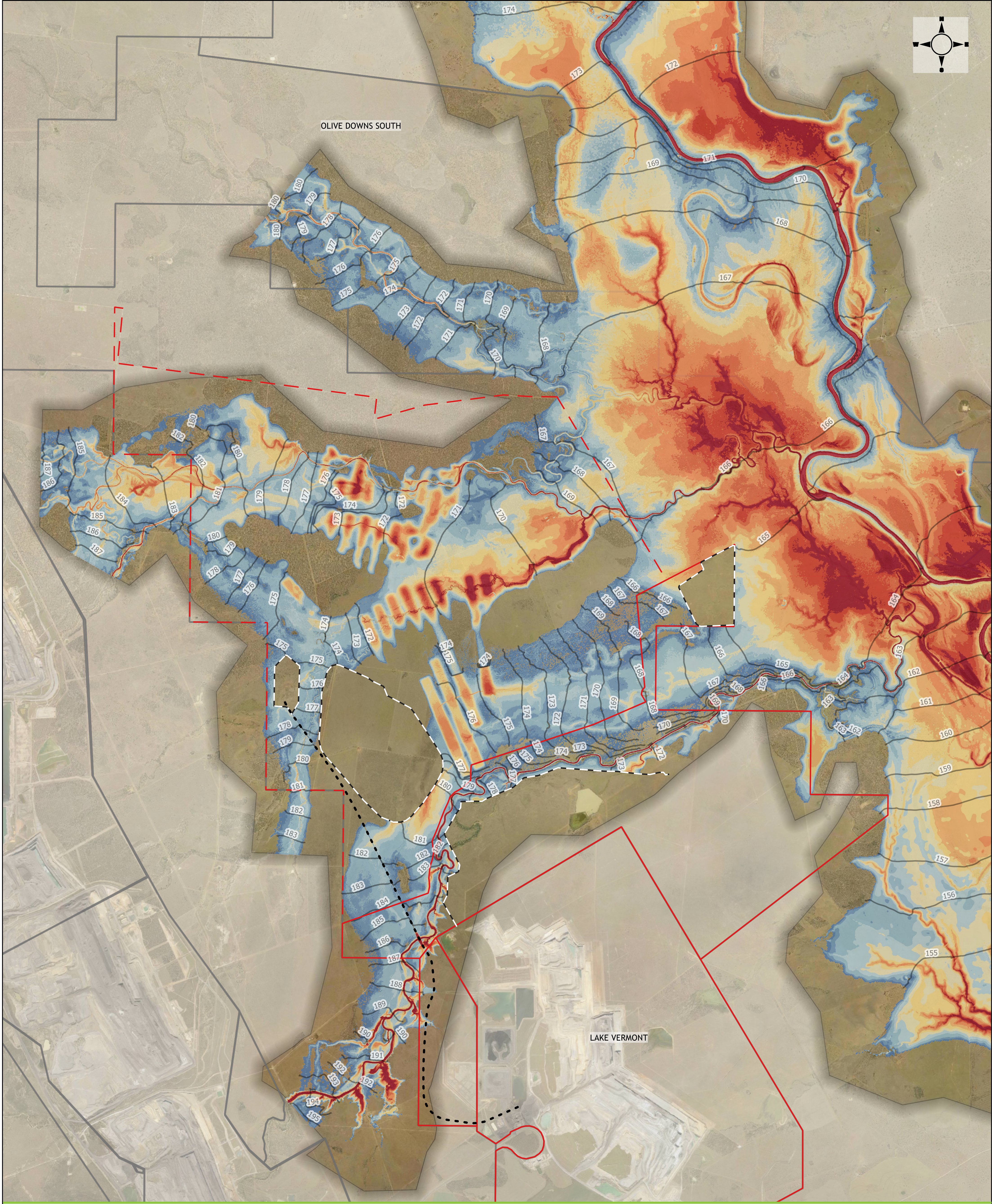

Legend

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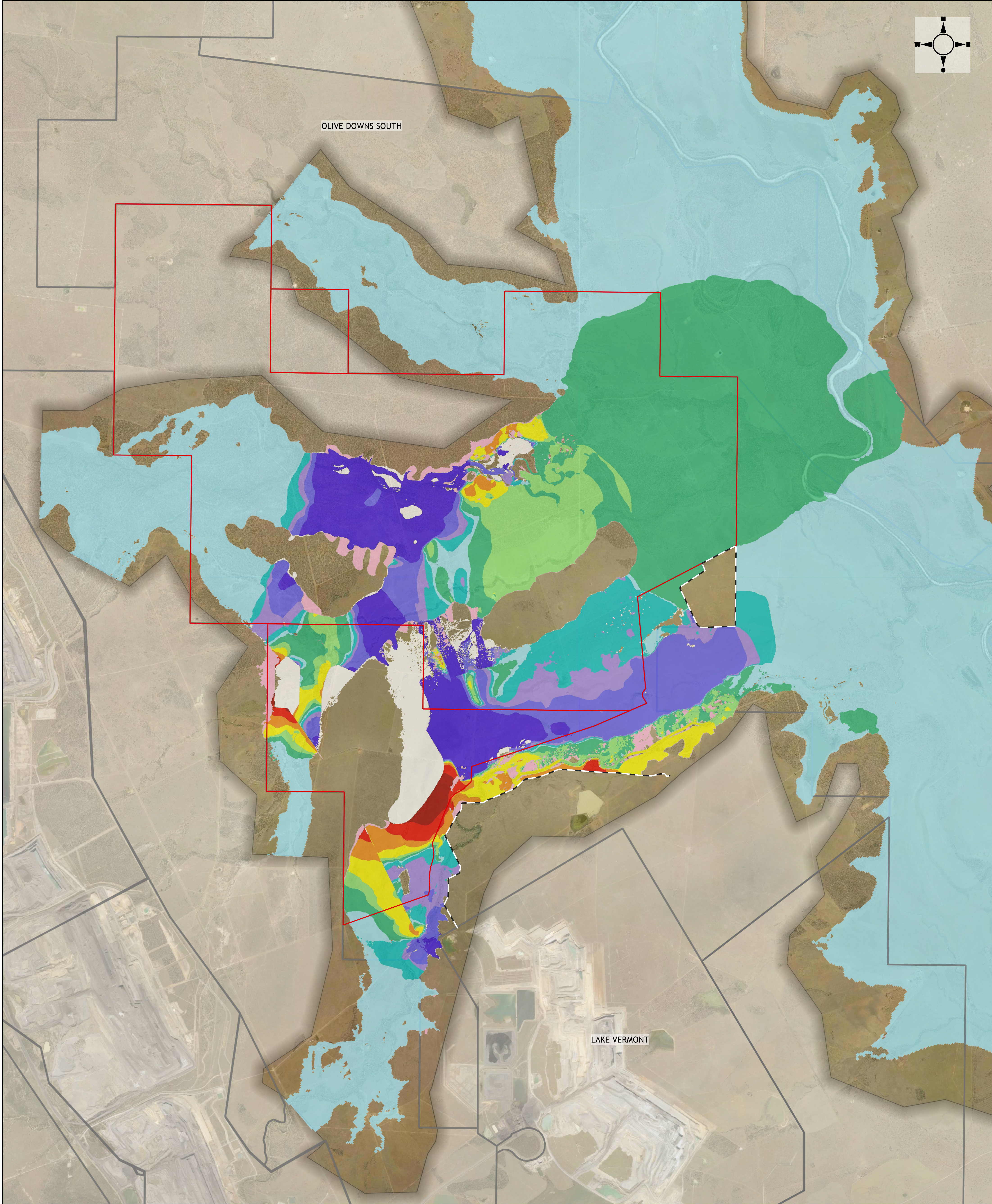
Lake Vermont Meadowbrook EIS

0.1% AEP flood depth and heights regional flooding
Year 26 conditions with mitigation

0 1 2 3 4 5 km

wrm water + environment

Projection: EPSG:20355



Legend

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- Haul road alignment

Afflux

- dWL < -0.25
- -0.25m < dWL < -0.10m
- -0.10m < dWL < -0.05m
- -0.05 m < dWL < -0.01 m
- -0.01 m < dWL < 0.01 m
- 0.01 m < dWL < 0.05 m
- 0.05 m < dWL < 0.10 m
- 0.10 m < dWL < 0.25 m
- 0.25 m < dWL < 0.50 m
- 0.50 m < dWL < 1.00 m
- 1.00 < dWL < 3.00m
- 3.00 < dWL < 5.00m
- dWL > 5.00m
- Was wet now dry
- Was dry now wet

Lake Vermont Meadowbrook EIS

0.1% AEP afflux regional flooding
Year 26 conditions with mitigation minus approved conditions

0 1 2 3 4 5 km

wrm water + environment

J:\0622-27 Meadowbrook EIS\WIN\QGIS\TUFLOW config.qgz (Issued: 01 June 2022)

Projection: EPSG:20355

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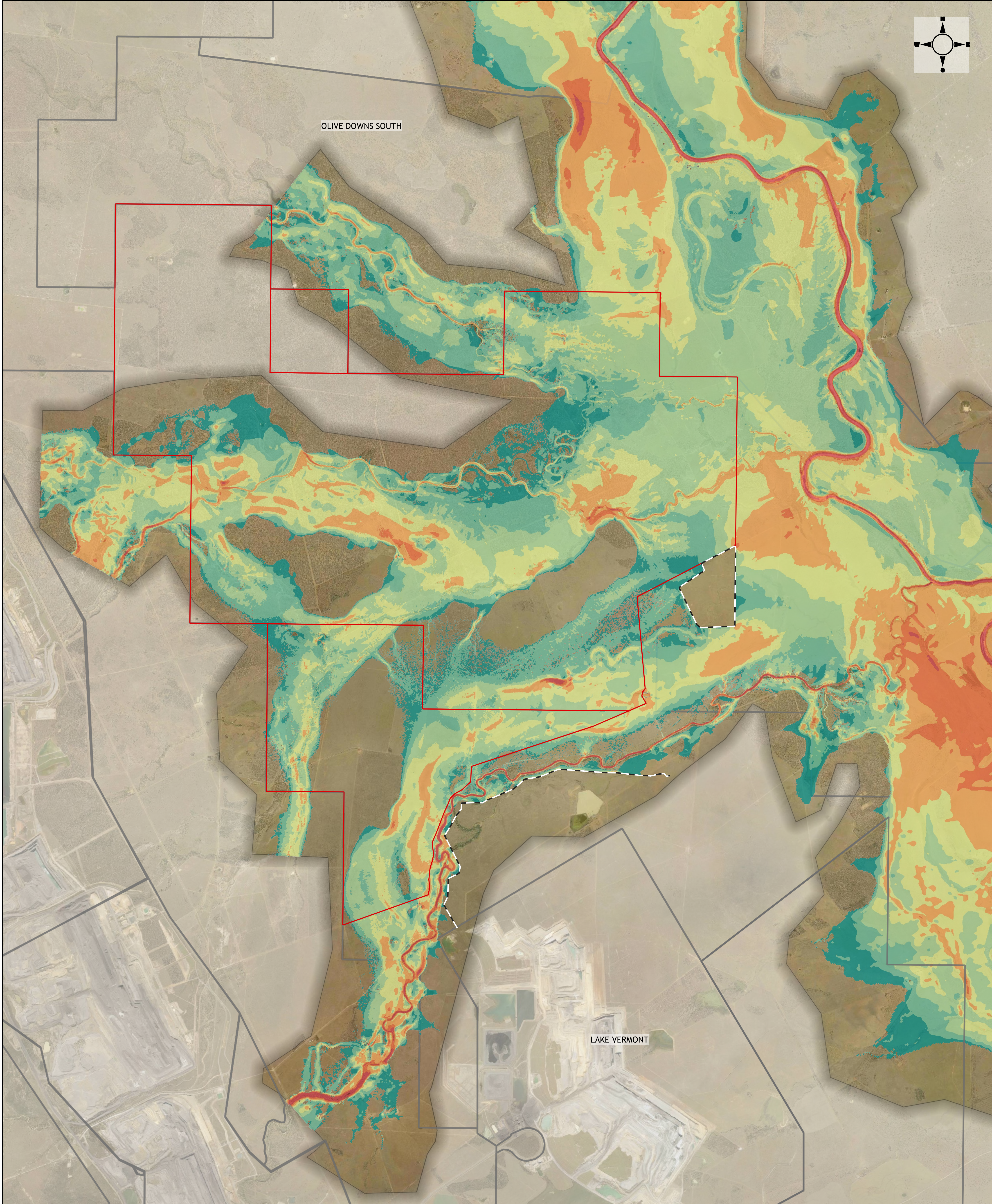

Legend

- Mining Lease Application (MLA)
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Velocity

- up to 0.25m/s
- 0.25 to 0.5m/s
- 0.5 to 0.75m/s
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- 1.0 to 1.5m/s
- 1.5 to 2.0m/s
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Lake Vermont Meadowbrook EIS

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wrm water + environment

Projection: EPSG:20355

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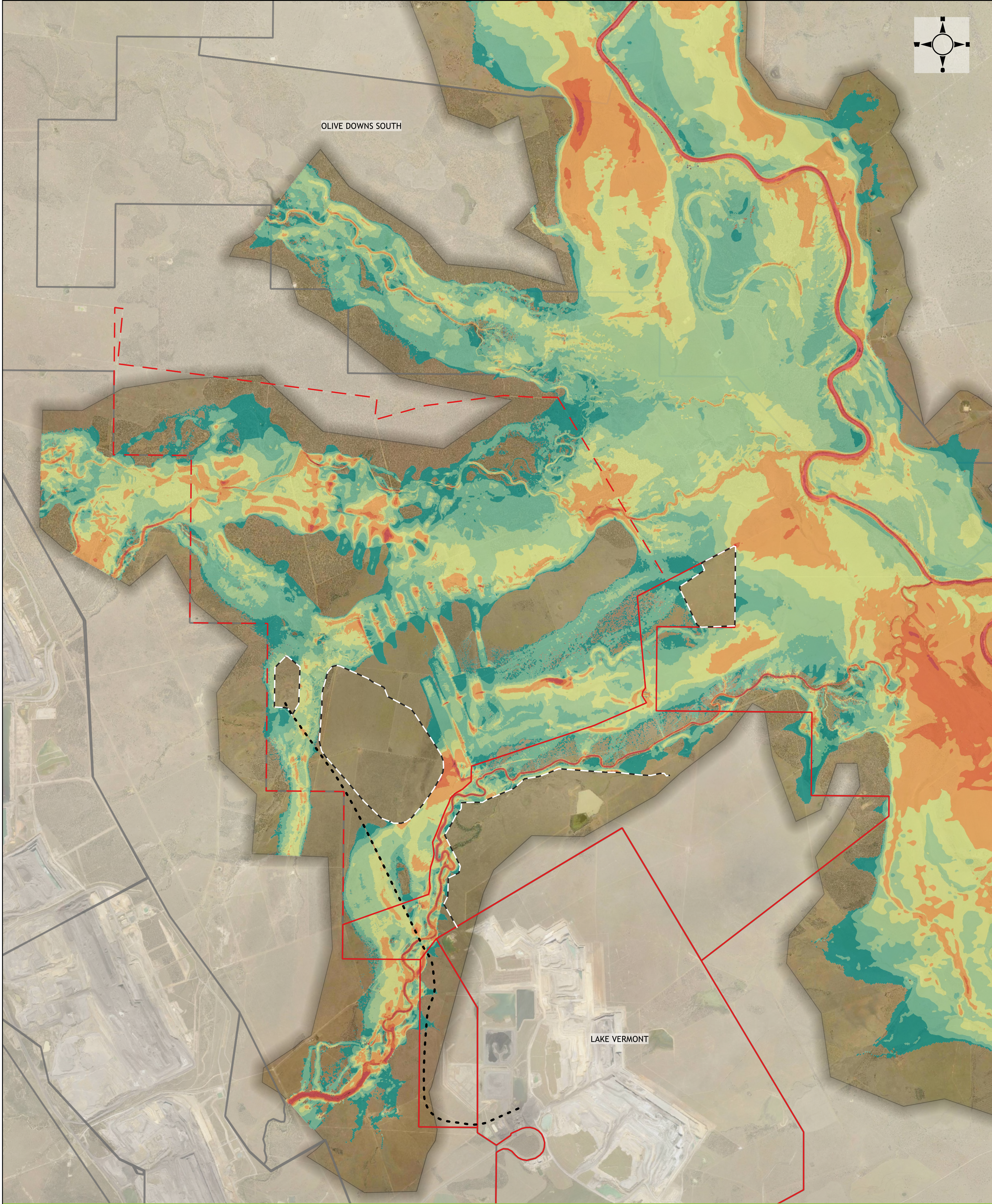

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Lake Vermont Meadowbrook EIS

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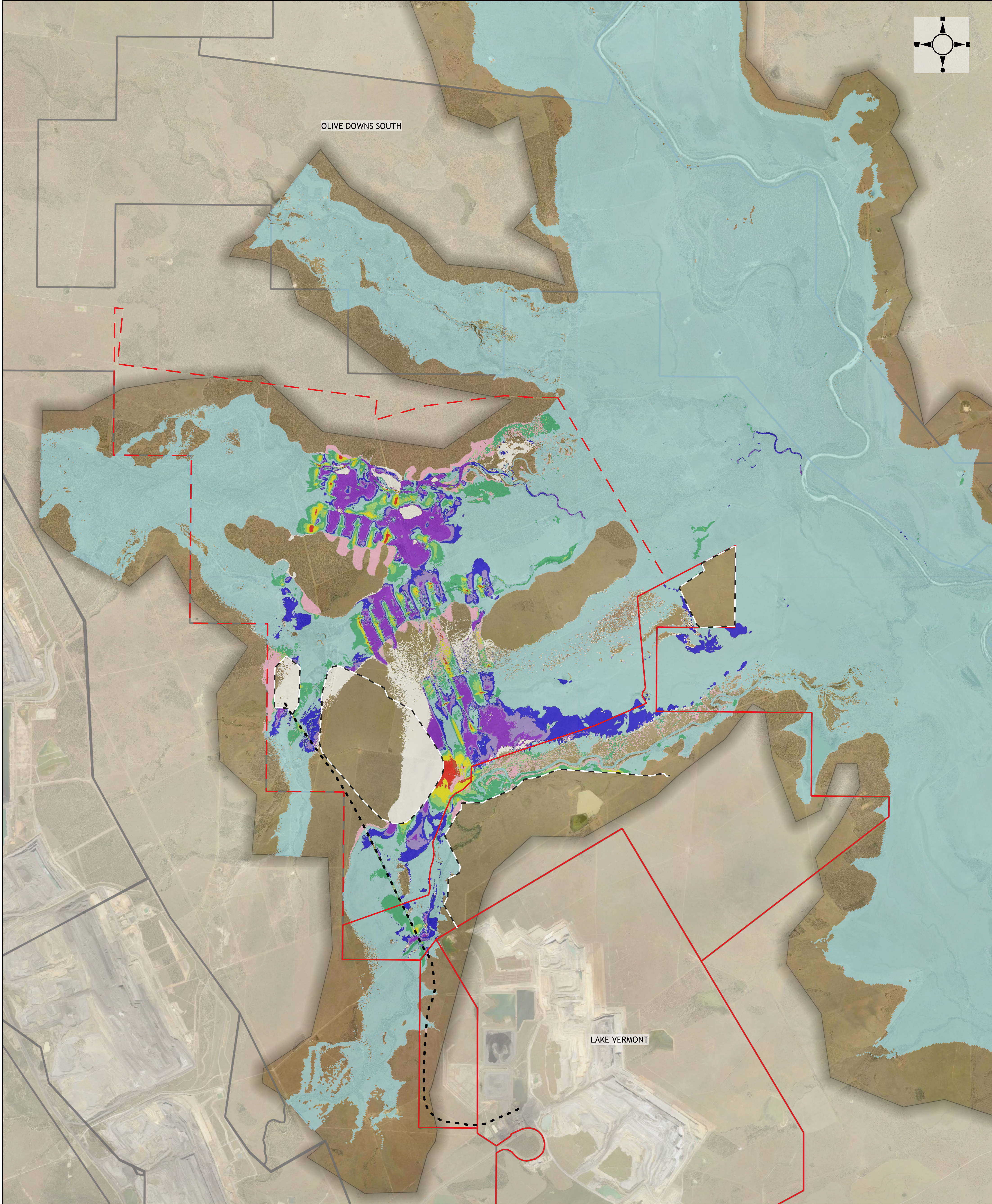
Projection: EPSG:20355



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee
- Haul road alignment

Velocity diffference (m/s)

- <- 0.3 m/s
- -0.3 m/s to -0.2 m/s
- -0.2 m/s to -0.1 m/s
- -0.1 m/s to 0.1 m/s
- 0.1 m/s to 0.3 m/s
- 0.3 m/s to 0.5 m/s
- 0.5 m/s to 1.0 m/s
- 1.0 m/s to 1.5 m/s
- > 1.5 m/s
- Was wet now dry
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Lake Vermont Meadowbrook EIS

0.1% AEP velocity difference regional flooding
Year 26 conditions with mitigation minus approved conditions

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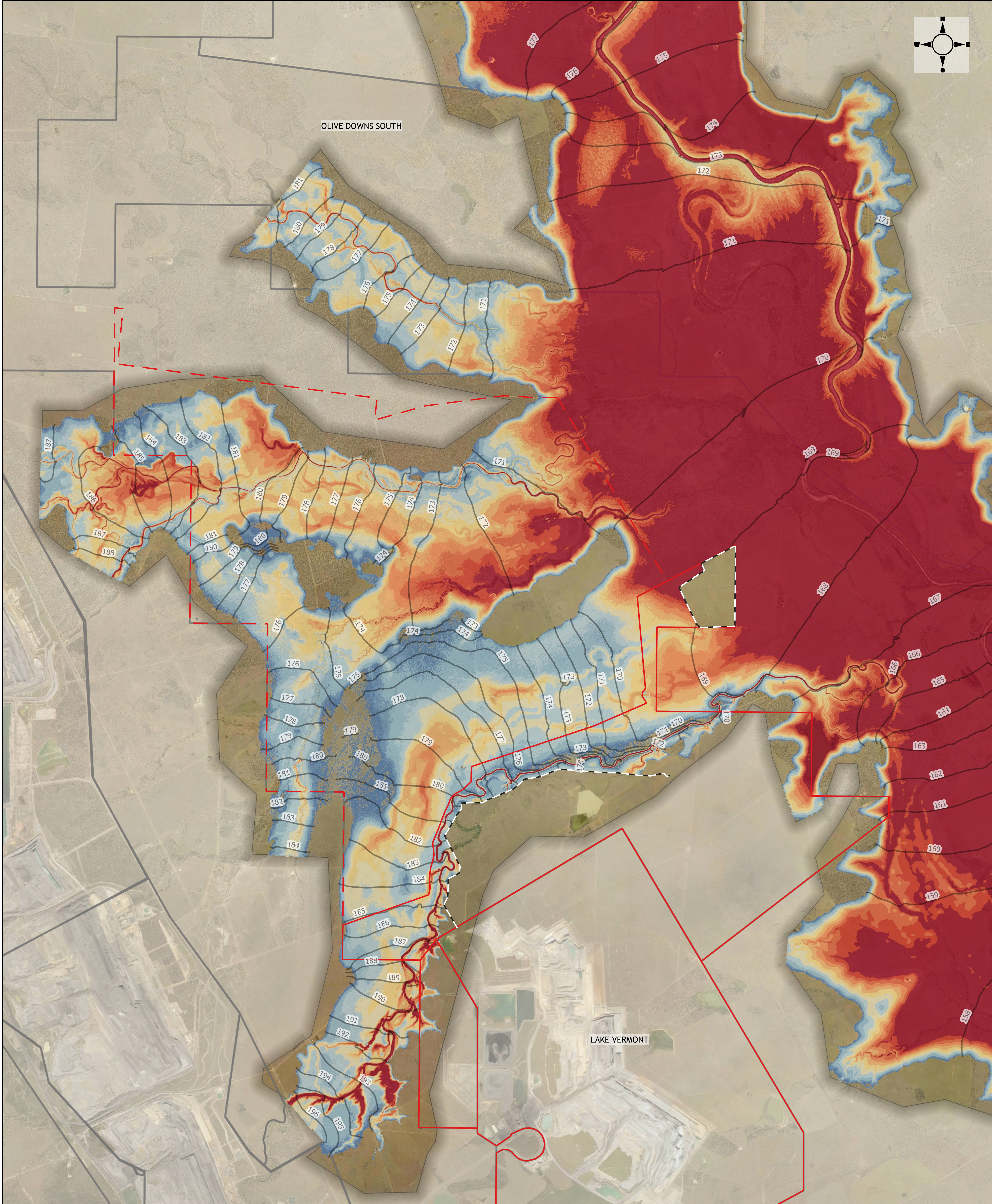
wrm water + environment

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 01 June 2022)

Projection: EPSG:20355



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- 2.5 to 3.0m
- 3.0 to 3.5m
- 3.5 to 4.0m
- 4.0 to 4.5m
- > 4.5m

Lake Vermont Meadowbrook EIS

PMF flood depth and heights regional flooding
Approved conditions

0 1 2 3 4 5 km

wrm water + environment

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 01 June 2022)

Projection: EPSG:20355

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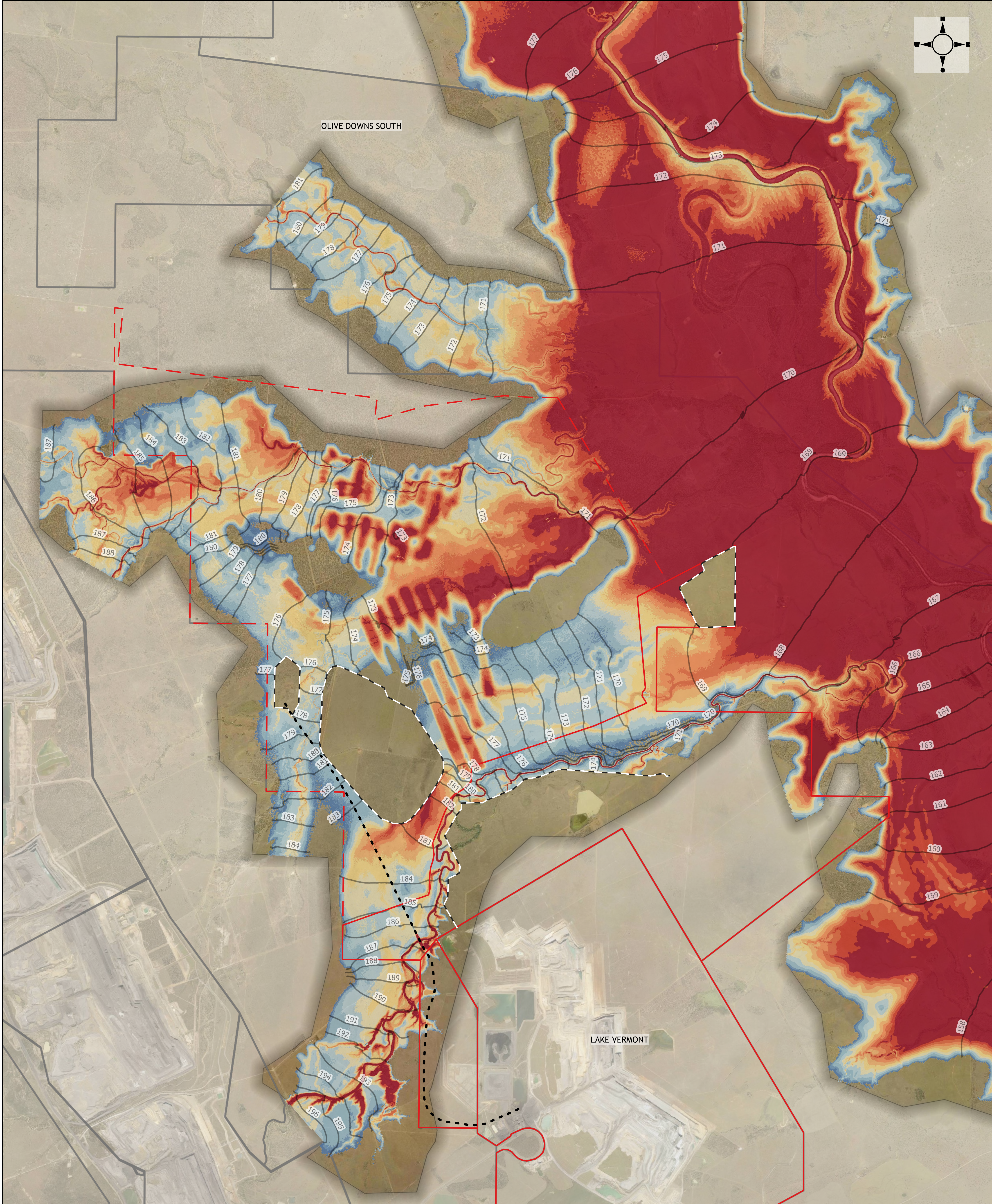

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- > 4.5m

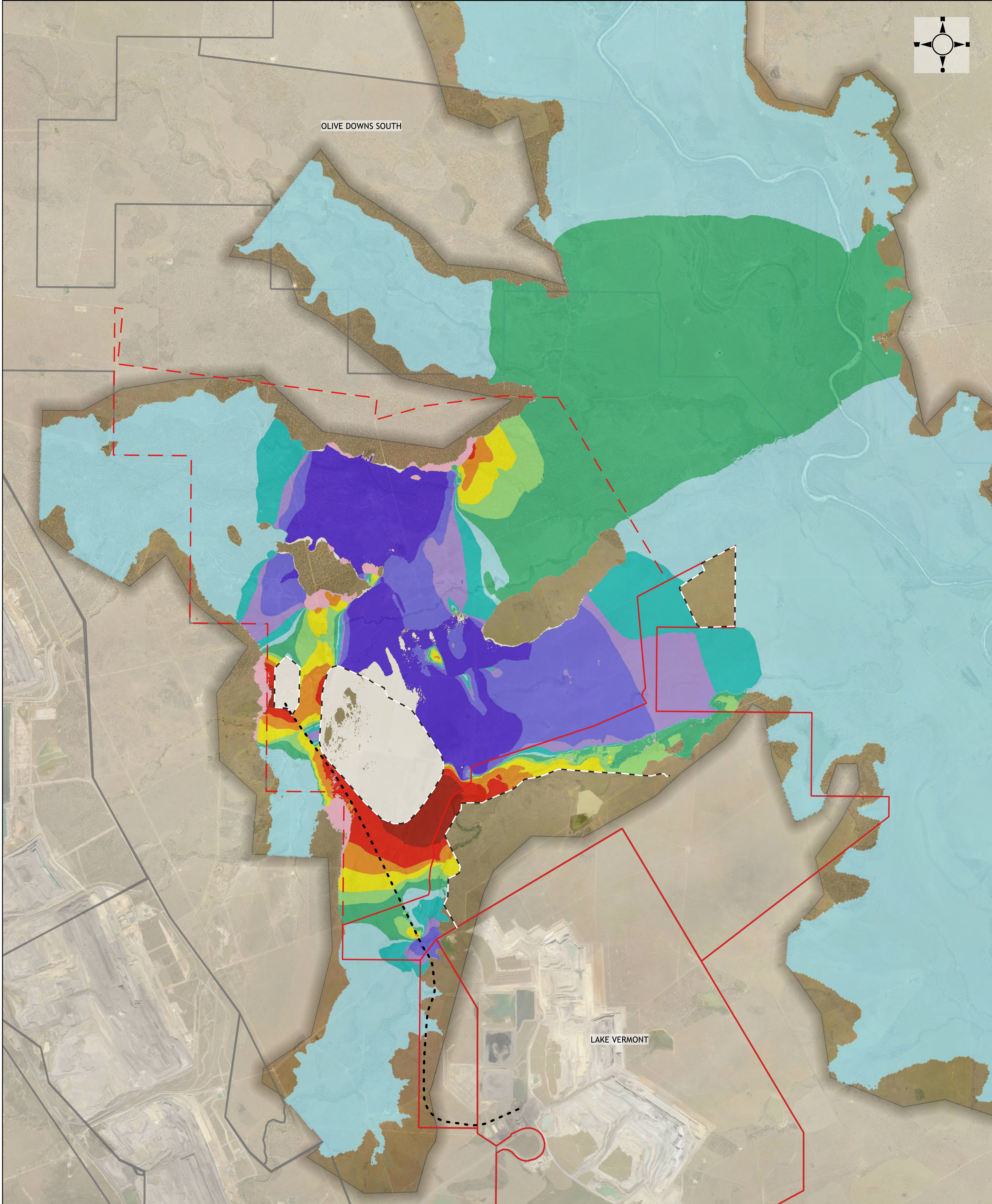
Lake Vermont Meadowbrook EIS

PMF flood depth and heights regional flooding
Year 26 conditions with mitigation

0 1 2 3 4 5 km

wrm water + environment

Projection: EPSG:20355



J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 01 June 2022)

Projection: EPSG:20355

Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee
- Haul road alignment

Afflux

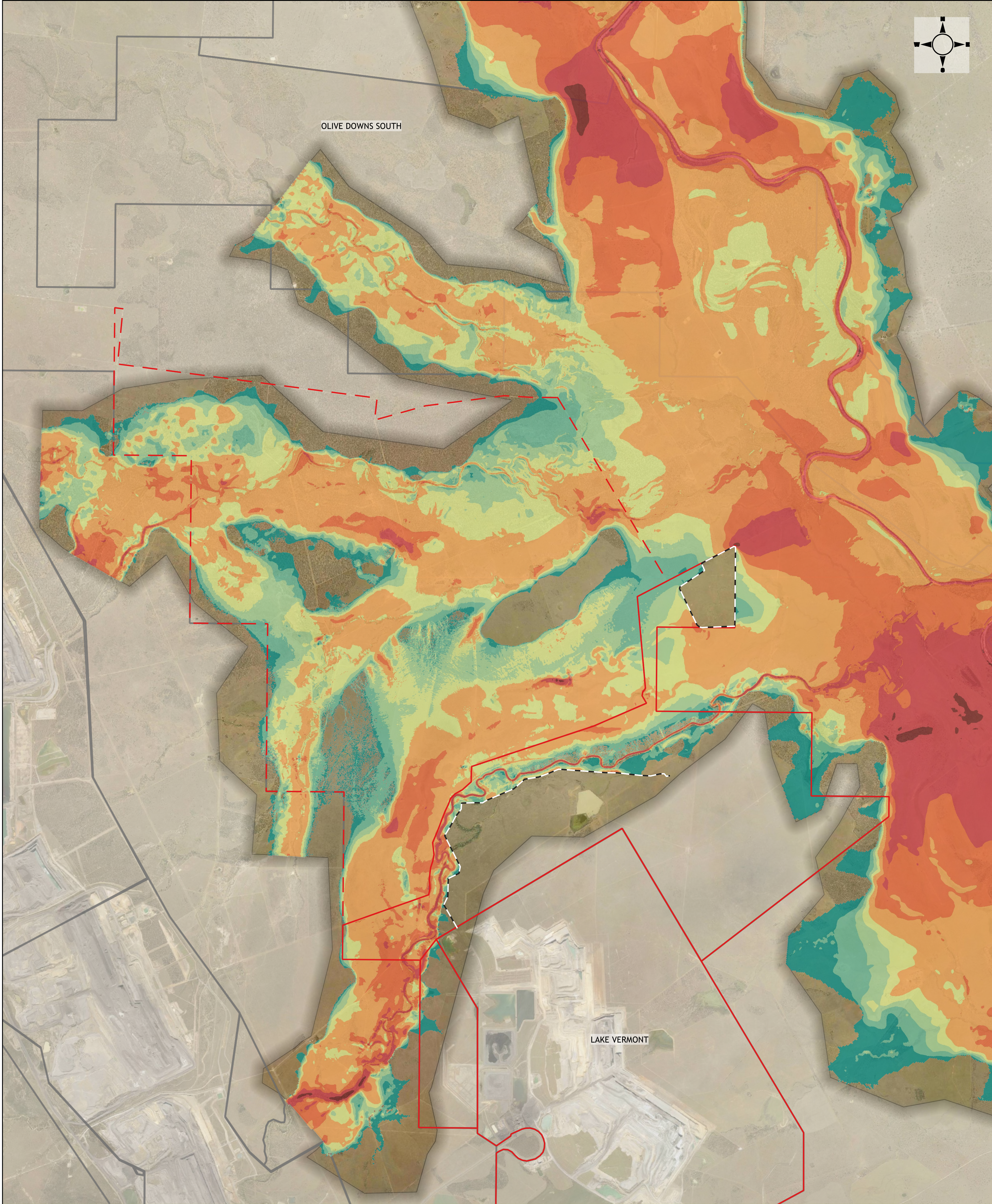
- dWL < -0.25
- -0.25m < dWL < -0.10m
- -0.10m < dWL < -0.05m
- -0.05 m < dWL < -0.01 m
- -0.01 m < dWL < 0.01 m
- 0.01 m < dWL < 0.05 m
- 0.05 m < dWL < 0.10 m
- 0.10 m < dWL < 0.25 m
- 0.25 m < dWL < 0.50 m
- 0.50 m < dWL < 1.00 m
- 1.00 < dWL < 3.00m
- 3.00 < dWL < 5.00m
- dWL > 5.00m
- Was wet now dry
- Was dry now wet

Lake Vermont Meadowbrook EIS

PMF afflux regional flooding
Year 26 conditions with mitigation minus approved conditions

0 1 2 3 4 5 km

wrm water + environment



J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 01 June 2022)

Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee

Velocity

- up to 0.25m/s
- 0.25 to 0.5m/s
- 0.5 to 0.75m/s
- 0.75 to 1.0m/s
- 1.0 to 1.5m/s
- 1.5 to 2.0m/s
- 2.0 to 3.0m/s
- > 3 m/s

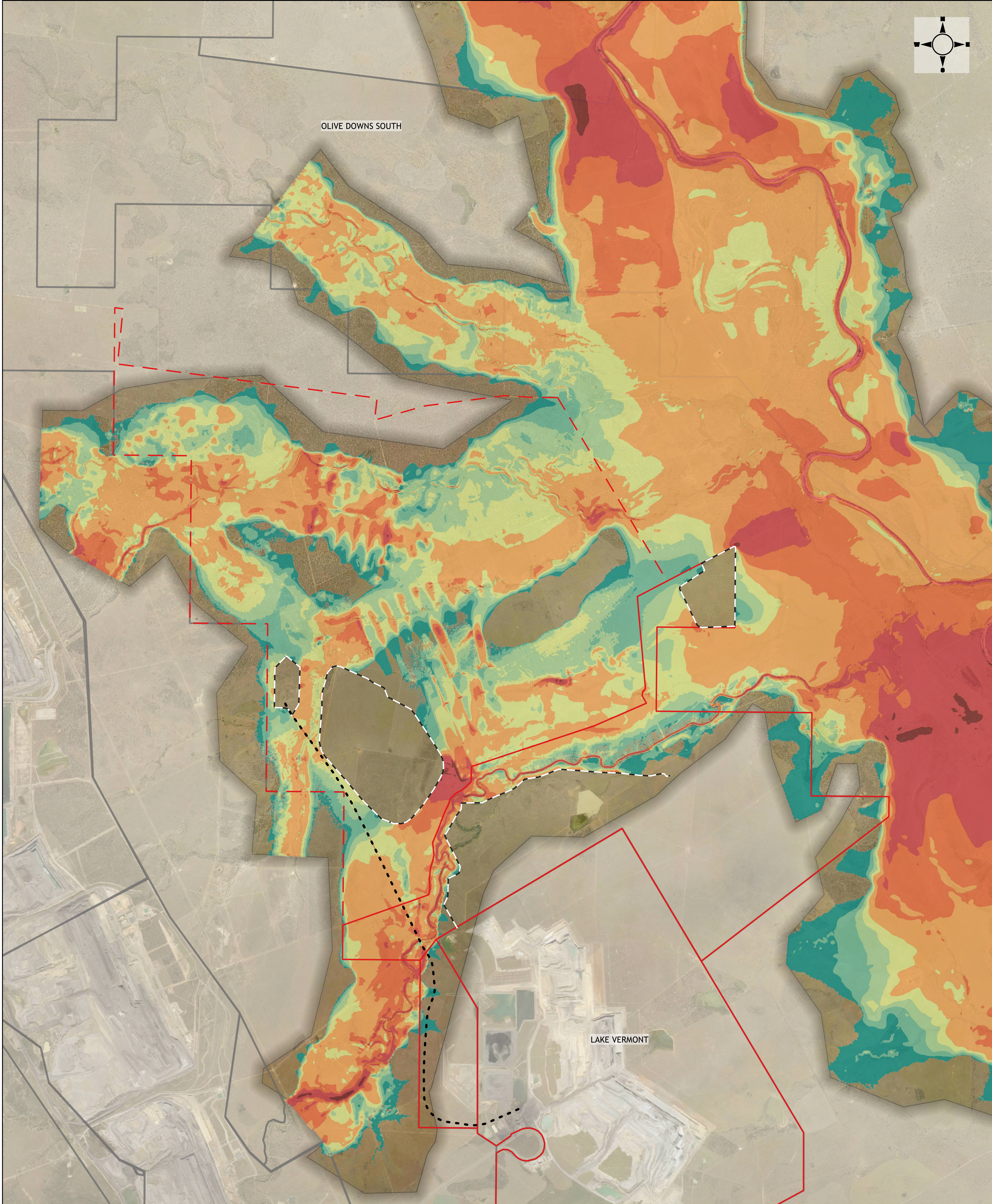
Lake Vermont Meadowbrook EIS

PMF velocity regional flooding
Approved conditions

0 1 2 3 4 5 km

wrm water + environment

Projection: EPSG:20355



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee
- Haul road alignment

Velocity

- up to 0.25m/s
- 0.25 to 0.5m/s
- 0.5 to 0.75m/s
- 0.75 to 1.0m/s
- 1.0 to 1.5m/s
- 1.5 to 2.0m/s
- 2.0 to 3.0m/s
- > 3 m/s

Lake Vermont Meadowbrook EIS

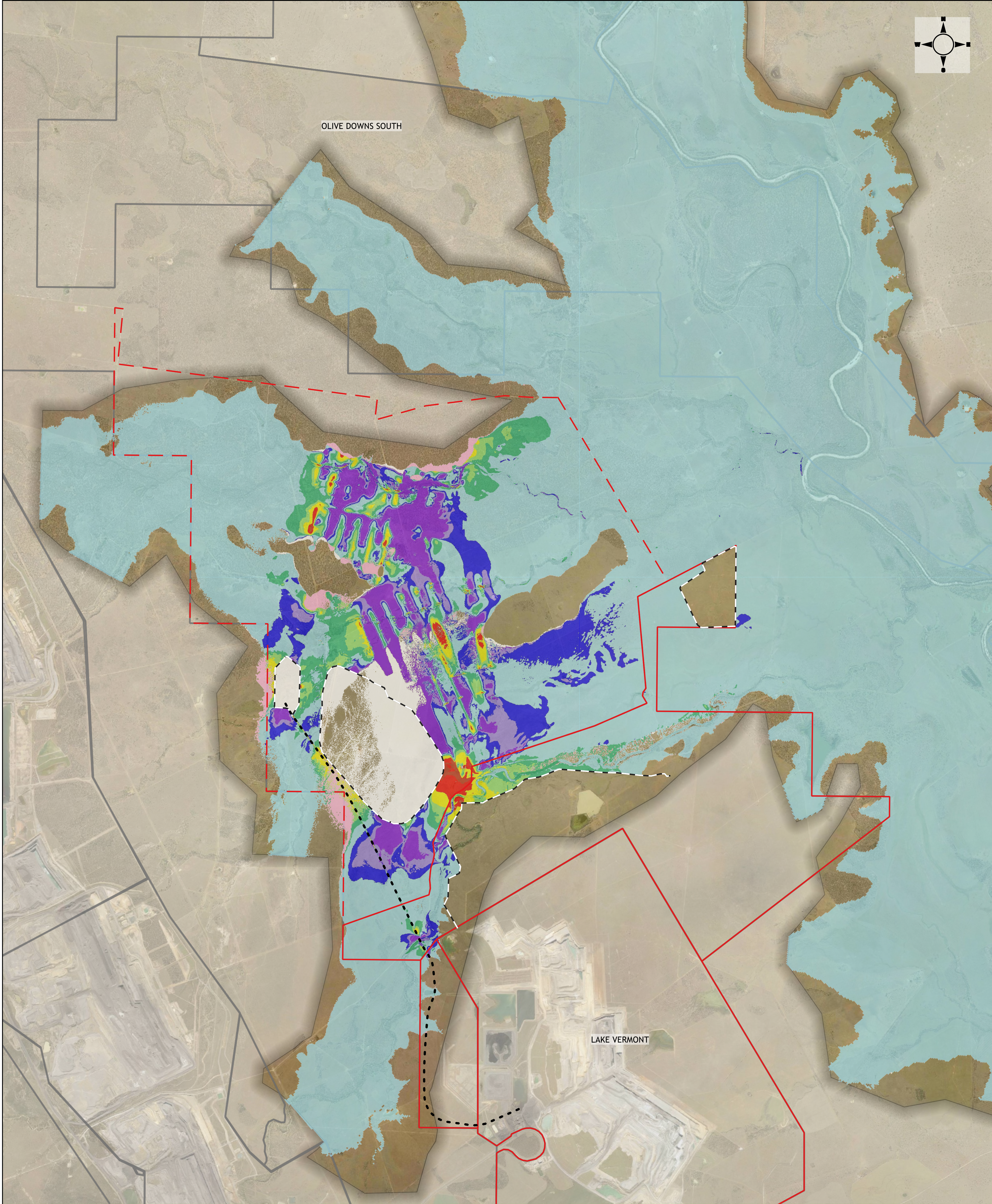
PMF velocity regional flooding
Year 26 conditions with mitigation

0 1 2 3 4 5 km

wrm water + environment

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 01 June 2022)

Projection: EPSG:20355



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee
- Haul road alignment

Velocity diffference (m/s)

- <- 0.3 m/s
- -0.3 m/s to -0.2 m/s
- -0.2 m/s to -0.1 m/s
- -0.1 m/s to 0.1 m/s
- 0.1 m/s to 0.3 m/s
- 0.3 m/s to 0.5 m/s
- 0.5 m/s to 1.0 m/s
- 1.0 m/s to 1.5 m/s
- > 1.5 m/s
- Was wet now dry
- Was dry now wet

Lake Vermont Meadowbrook EIS

PMF velocity difference regional flooding
Year 26 conditions with mitigation minus approved conditions

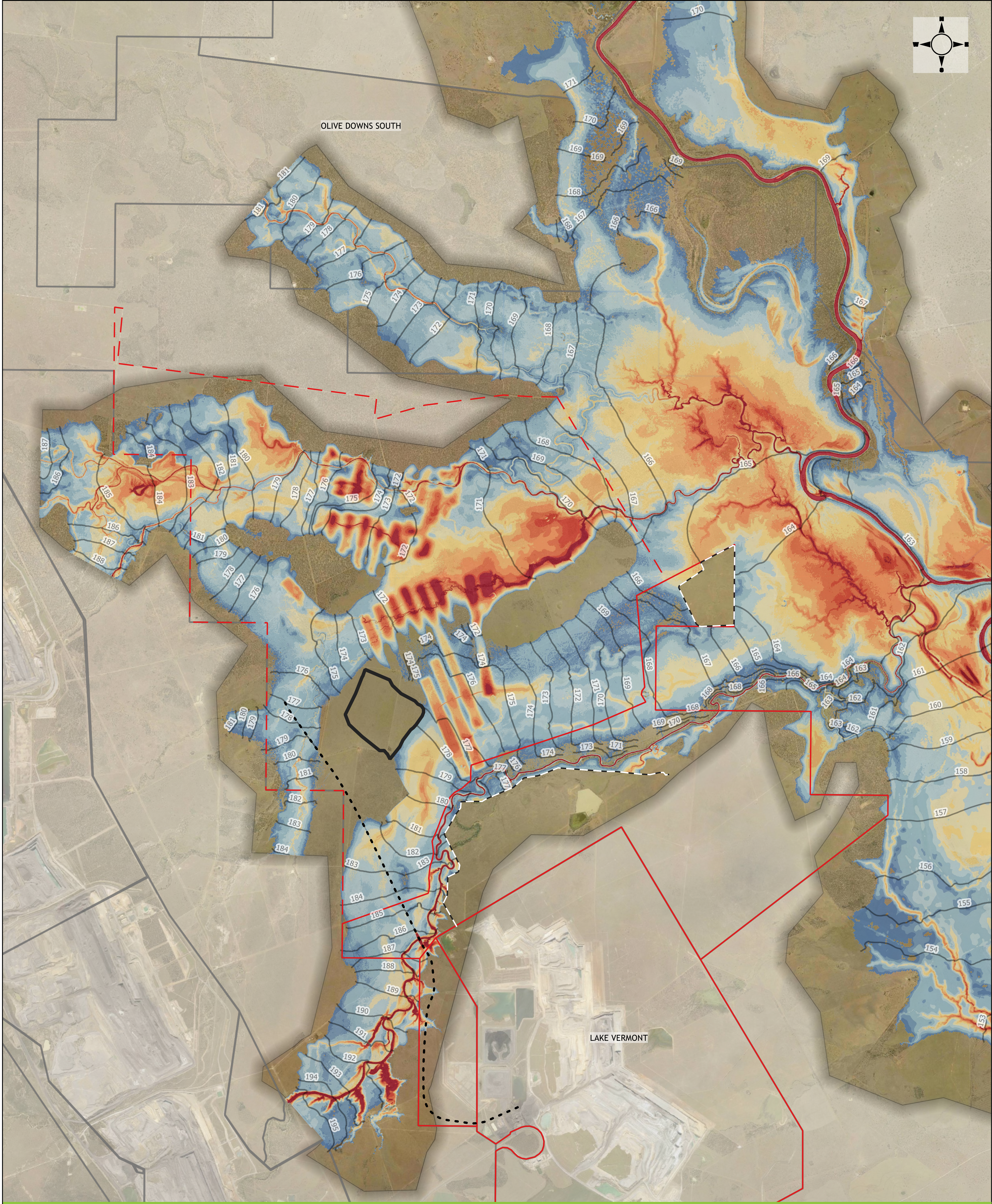
0 1 2 3 4 5 km

wrm water + environment

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 01 June 2022)

Projection: EPSG:20355

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 01 June 2022)



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee

0.5m flood height contours (m AHD)

Depth (m)

- up to 0.25m
- 0.25 to 0.5m
- 0.5 to 1.0m
- 1.0 to 1.5m
- 1.5 to 2.0m
- 2.0 to 2.5m
- 2.5 to 3.0m
- 3.0 to 3.5m
- 3.5 to 4.0m
- 4.0 to 4.5m
- > 4.5m

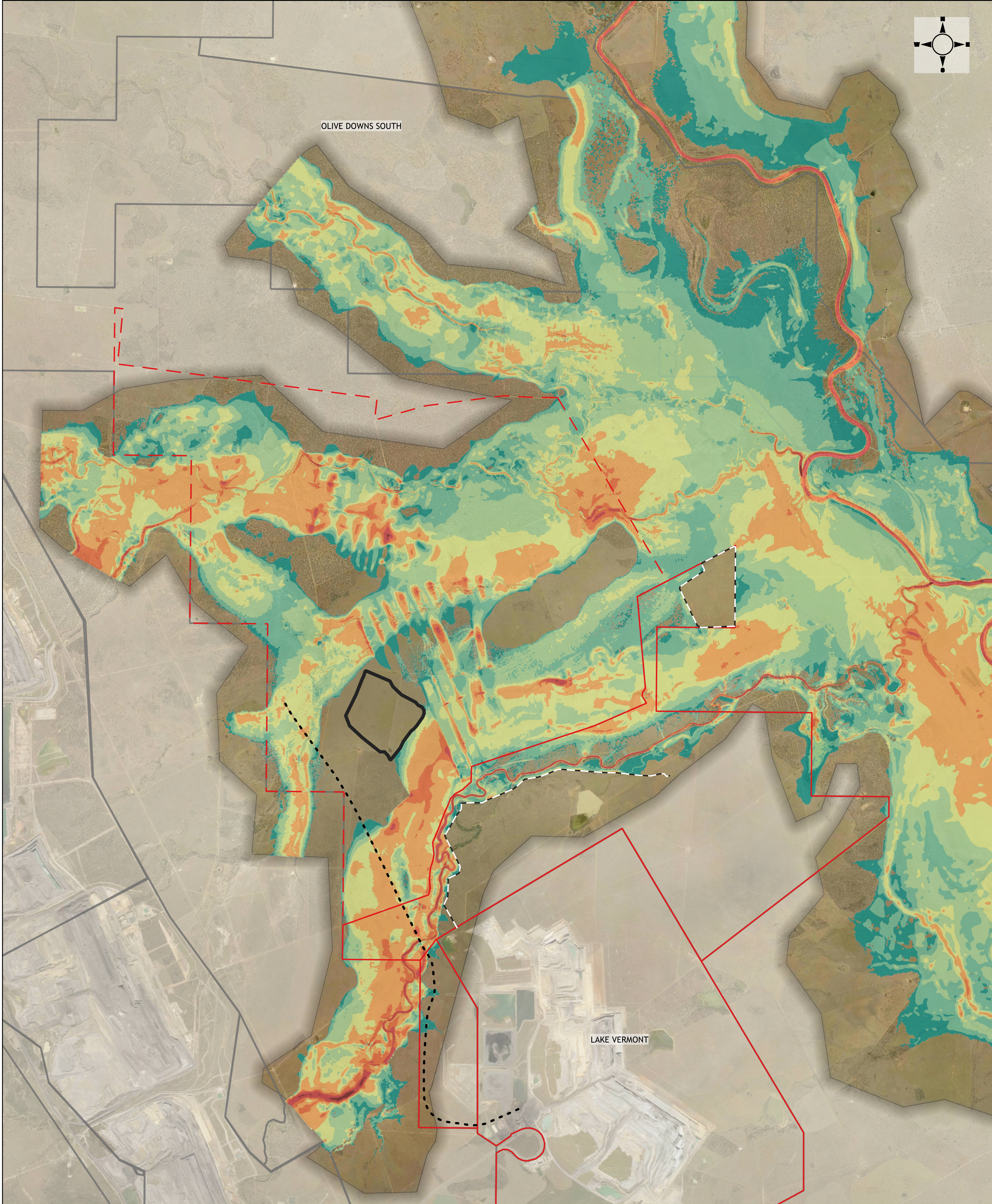
Lake Vermont Meadowbrook EIS

0.1% AEP depth local flooding
Post closure

0 1 2 3 4 5 km

wrm water + environment

Projection: EPSG:20355



J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 01 June 2022)

Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee

Velocity

- up to 0.25m/s
- 0.25 to 0.5m/s
- 0.5 to 0.75m/s
- 0.75 to 1.0m/s
- 1.0 to 1.5m/s
- 1.5 to 2.0m/s
- 2.0 to 3.0m/s
- > 3 m/s

Lake Vermont Meadowbrook EIS

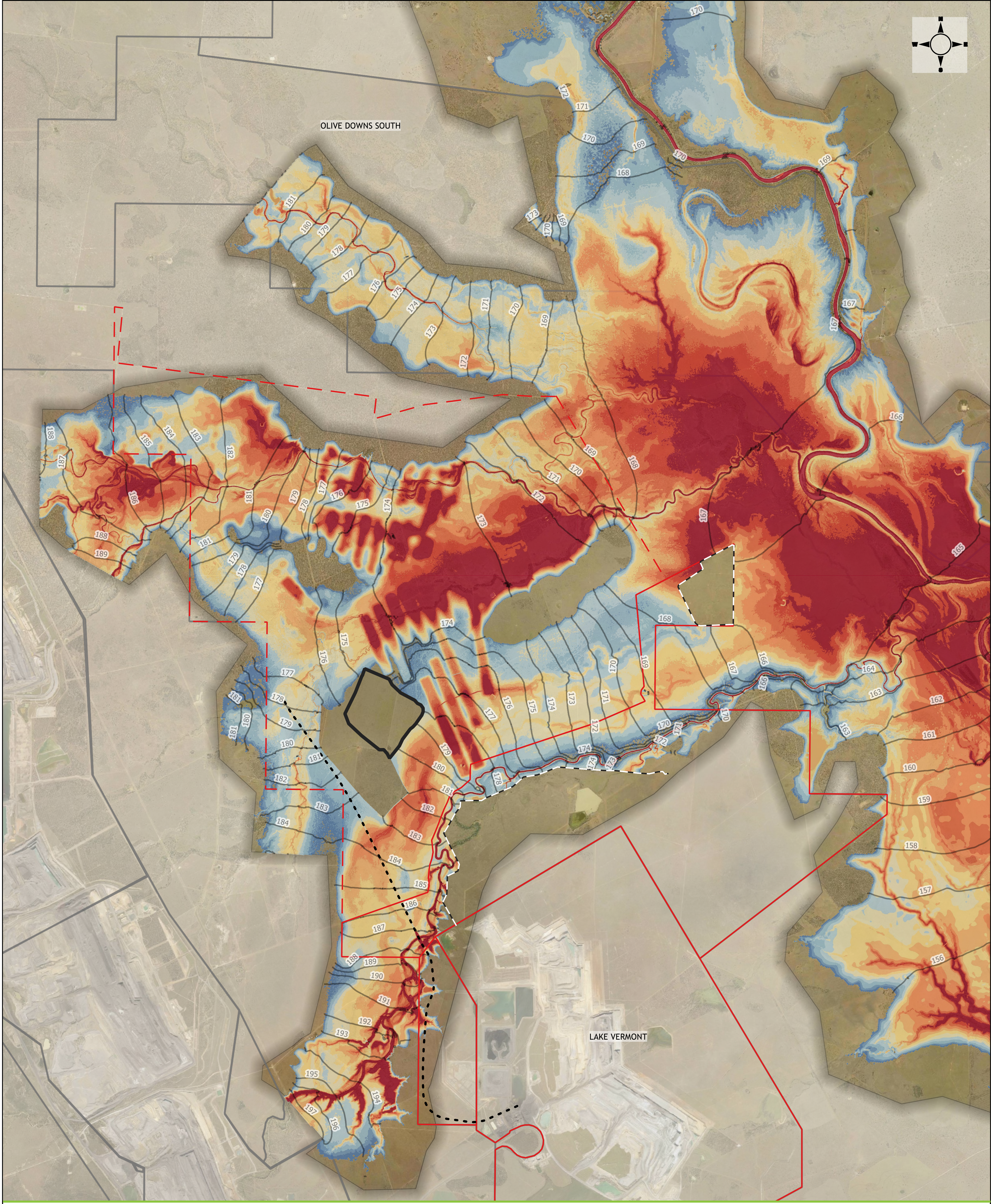
0.1% AEP velocity local flooding
Post closure

0 1 2 3 4 5 km

wrm water + environment

Projection: EPSG:20355

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 01 June 2022)



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee

0.5m flood height contours (m AHD)

Depth (m)

- up to 0.25m
- 0.25 to 0.5m
- 0.5 to 1.0m
- 1.0 to 1.5m
- 1.5 to 2.0m
- 2.0 to 2.5m
- 2.5 to 3.0m
- 3.0 to 3.5m
- 3.5 to 4.0m
- 4.0 to 4.5m
- > 4.5m

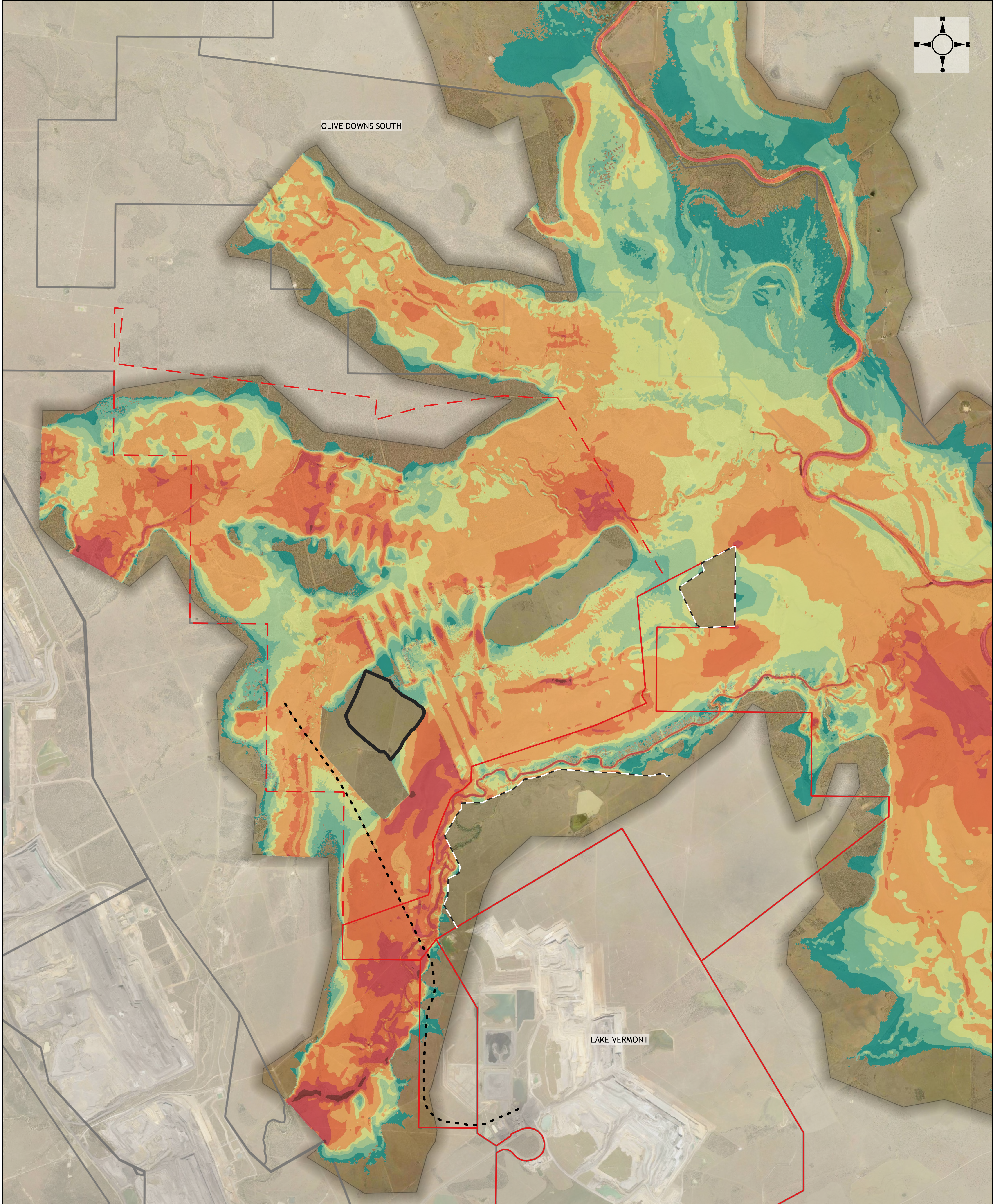
Lake Vermont Meadowbrook EIS

PMF depth local flooding
Post closure

0 1 2 3 4 5 km

wrm water+environment

Projection: EPSG:20355



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee

Velocity

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- 0.25 to 0.5m/s
- 0.5 to 0.75m/s
- 0.75 to 1.0m/s
- 1.0 to 1.5m/s
- 1.5 to 2.0m/s
- 2.0 to 3.0m/s
- > 3 m/s

Lake Vermont Meadowbrook EIS

PMF velocity local flooding
Post closure

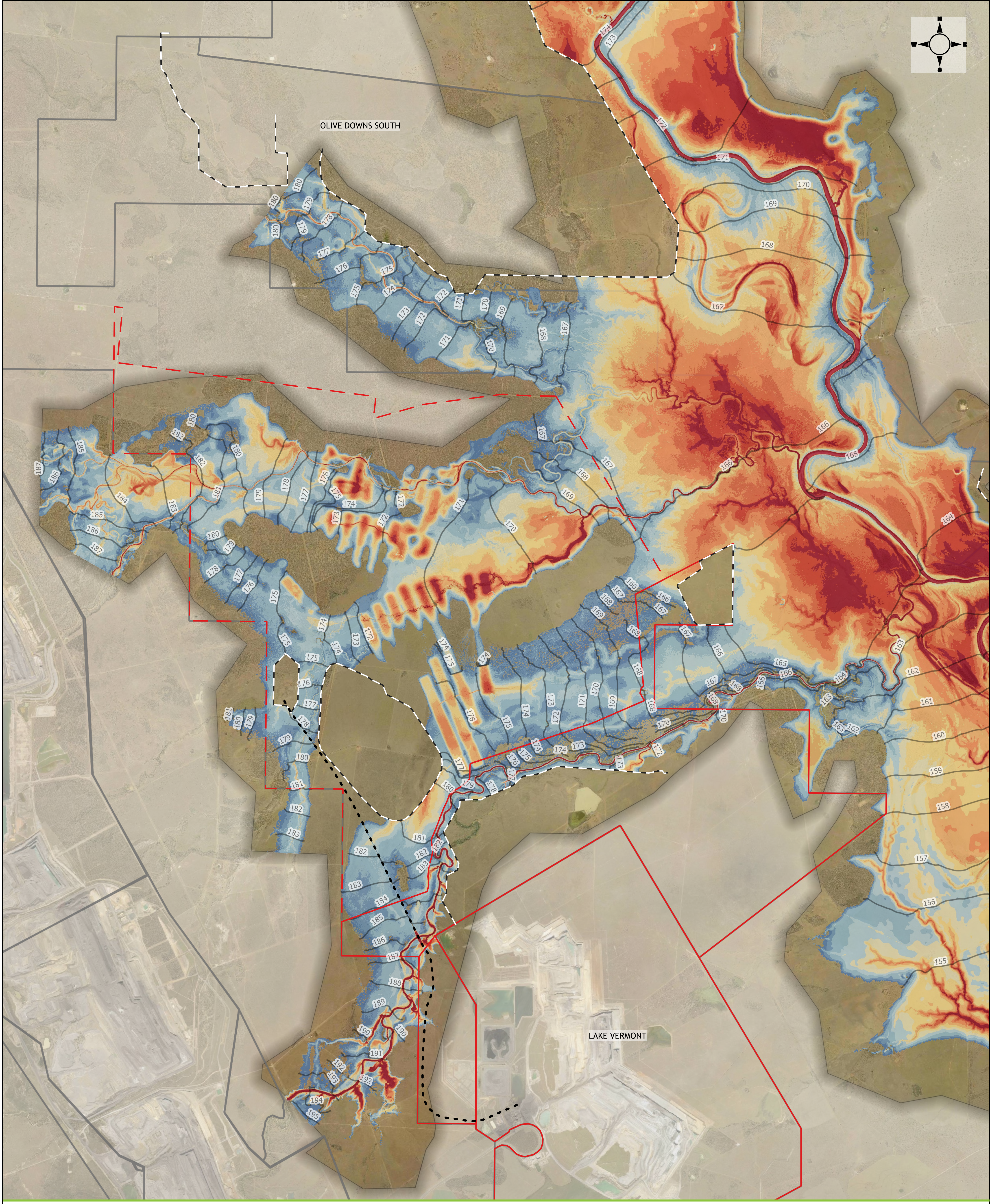
0 1 2 3 4 5 km

wrm water + environment

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 01 June 2022)

Projection: EPSG:20355

J:\0622-27 Meadowbrook EIS\MIQGIS\TUFLOW config.qgz (Issued: 01 June 2022)



Legend

- Mining Lease Application (MLA)
- Mining Lease (ML)
- QLD mining leases
- Levee
- Haul road alignment
- 0.5m flood height contours (m AHD)

Depth (m)

- up to 0.25m
- 0.25 to 0.5m
- 0.5 to 1.0m
- 1.0 to 1.5m
- 1.5 to 2.0m
- 2.0 to 2.5m
- 2.5 to 3.0m
- 3.0 to 3.5m
- 3.5 to 4.0m
- 4.0 to 4.5m
- > 4.5m

Lake Vermont Meadowbrook EIS

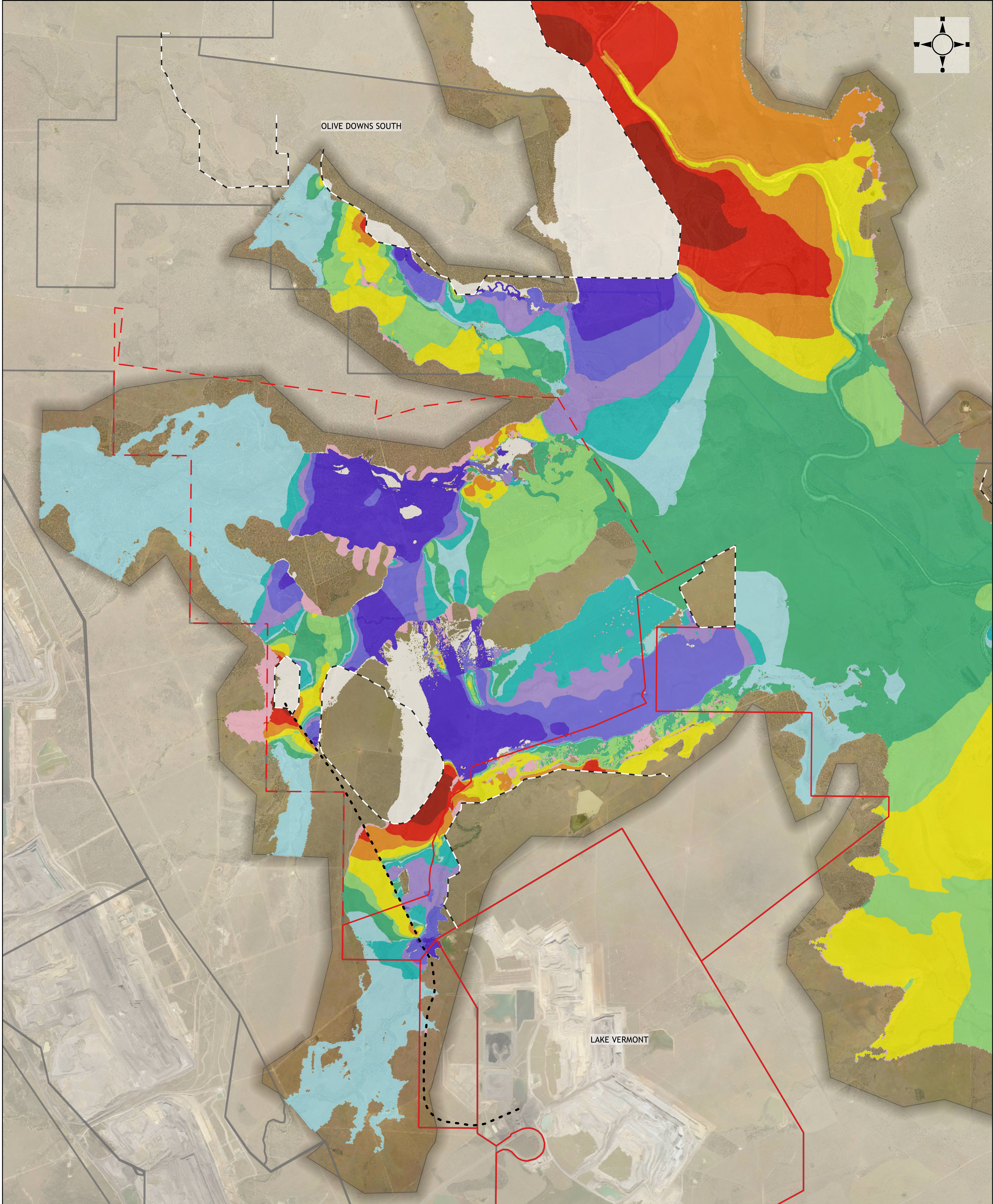
0.1% AEP depth regional flooding
Cumulative impact Year 26 conditions with mitigation

0 1 2 3 4 5 km

wrm water + environment

Projection: EPSG:20355

J:\0622-27 Meadowbrook EIS\MI\QGIS\TUFLOW config.qgz (Issued: 01 June 2022)



Legend

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- Mining Lease (ML)
- QLD mining leases
- Levee
- Haul road alignment

Afflux

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- -0.25m < dWL < -0.10m
- -0.10m < dWL < -0.05m
- -0.05 m < dWL < -0.01 m
- -0.01 m < dWL < 0.01 m
- 0.01 m < dWL < 0.05 m
- 0.05 m < dWL < 0.10 m
- 0.10 m < dWL < 0.25 m
- 0.25 m < dWL < 0.50 m
- 0.50 m < dWL < 1.00 m
- 1.00 < dWL < 3.00m
- 3.00 < dWL < 5.00m
- dWL > 5.00m
- Was wet now dry
- Was dry now wet

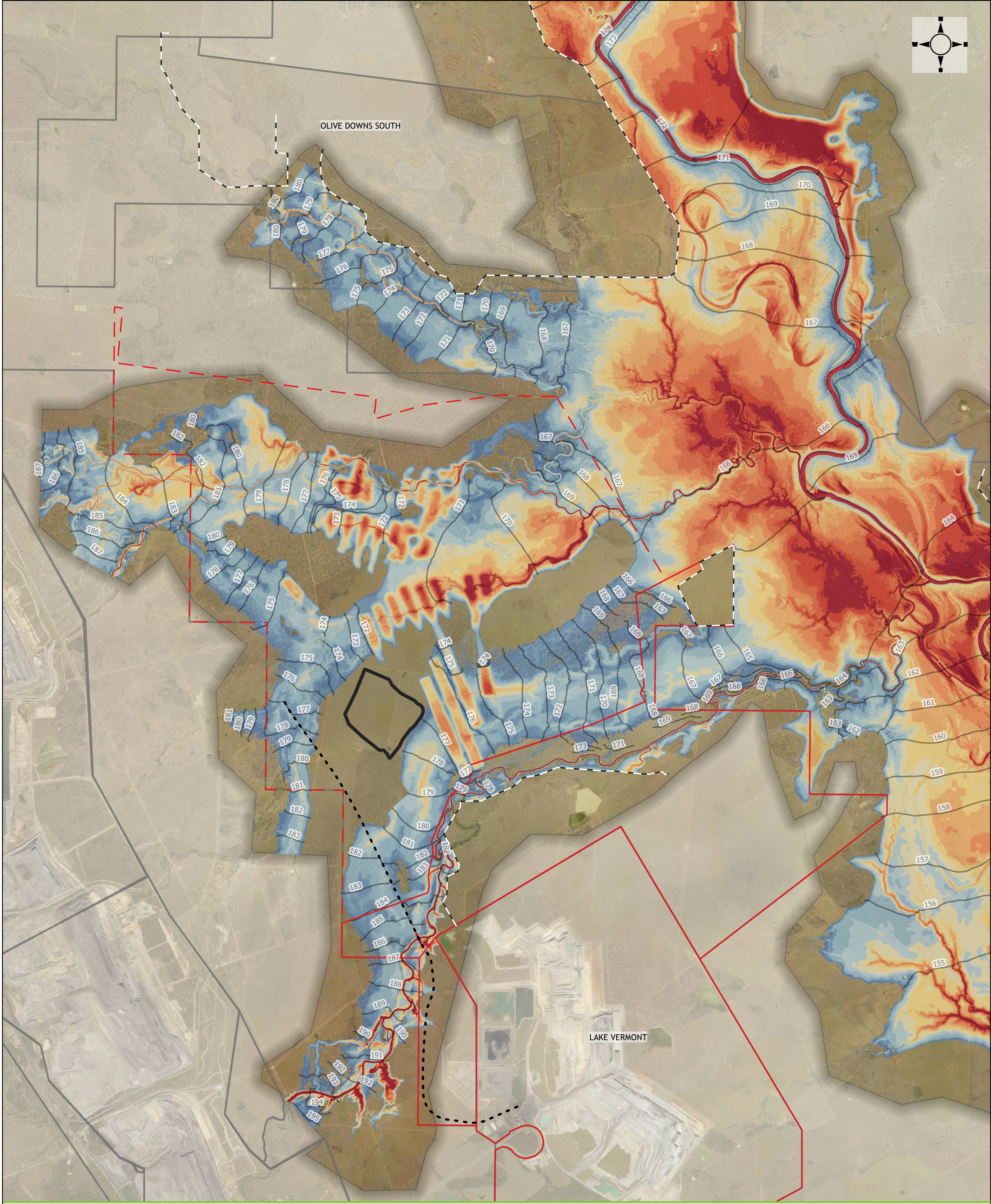
Lake Vermont Meadowbrook EIS

0.1% AEP afflux regional flooding
Cumulative impact Year 26 conditions with mitigation minus approved conditions

0 1 2 3 4 5 km

wrm water + environment

Projection: EPSG:20355



J:\0622-27 Meadowbrook EIS\MIQGIS\TUFLOW config.qgz (Issued: 01 June 2022)

Legend

- Mining Lease Application (MLA)
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- 1.5 to 2.0m
- 2.0 to 2.5m
- 2.5 to 3.0m
- 3.0 to 3.5m
- 3.5 to 4.0m
- 4.0 to 4.5m
- > 4.5m

Lake Vermont Meadowbrook EIS

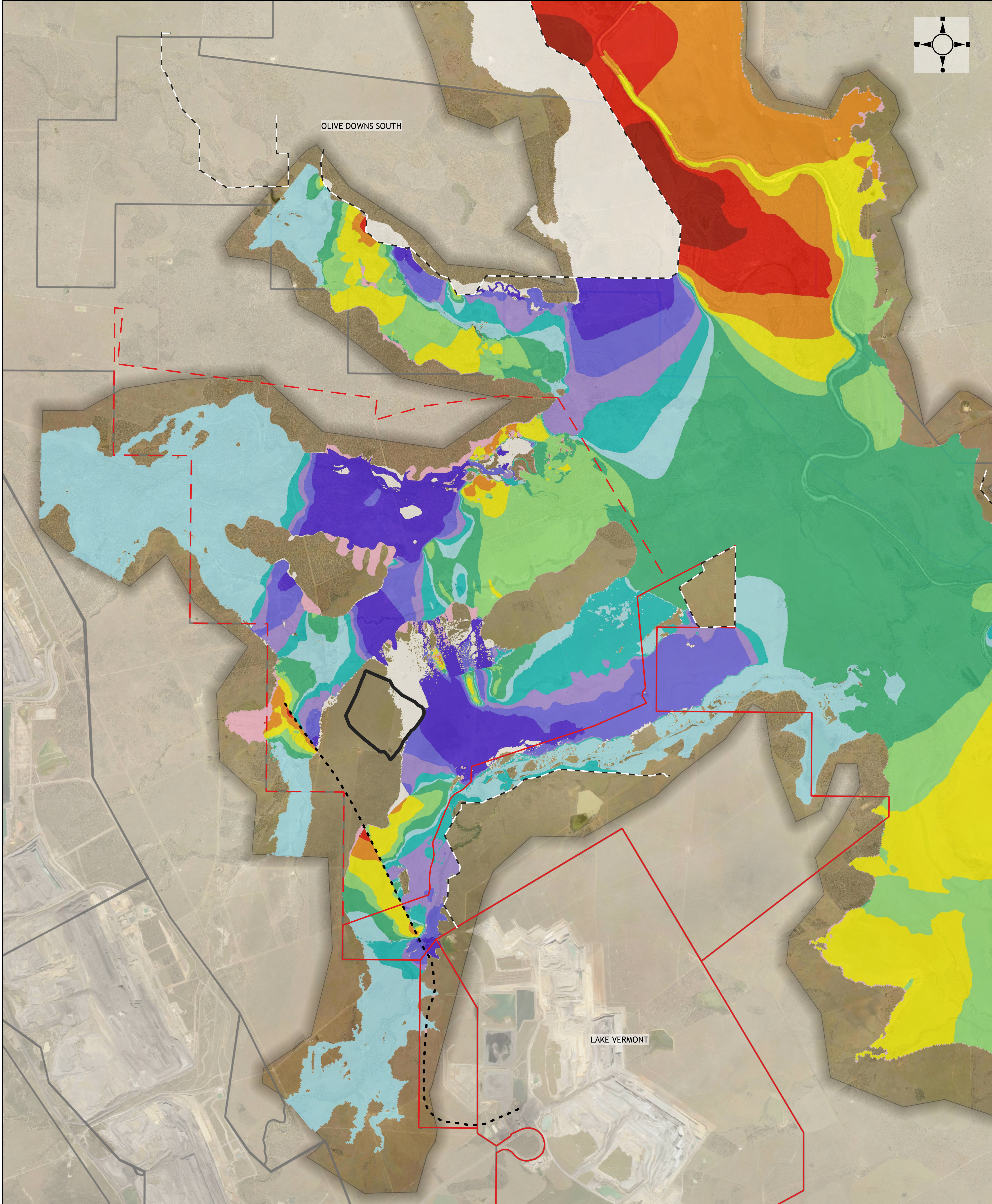
0.1% AEP depth regional flooding
Cumulative impact post closure conditions

0 1 2 3 4 5 km

wrm water + environment

Projection: EPSG:20355

J:\0622-27 Meadowbrook EIS\WI\QGIS\TUFLOW config.qgz (Issued: 01 June 2022)



Legend

- Mining Lease Application (MLA)
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- QLD mining leases
- Levee

Afflux

- dWL < -0.25
- -0.25m < dWL < -0.10m
- -0.10m < dWL < -0.05m
- -0.05 m < dWL < -0.01 m
- -0.01 m < dWL < 0.01 m
- 0.01 m < dWL < 0.05 m
- 0.05 m < dWL < 0.10 m
- 0.10 m < dWL < 0.25 m
- 0.25 m < dWL < 0.50 m
- 0.50 m < dWL < 1.00 m
- 1.00 < dWL < 3.00m
- 3.00 < dWL < 5.00m
- dWL > 5.00m
- Was wet now dry
- Was dry now wet

Lake Vermont Meadowbrook EIS

0.1% AEP afflux regional flooding
Cumulative impact post closure conditions minus approved conditions

0 1 2 3 4 5 km

wrm
water+environment

Projection: EPSG:20355