Report

Red Hill Mining Lease EIS

Hydraulics Technical Report

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Prepared for

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Abbreviations

Abbreviation	Description
1D	one-dimensional
2D	two-dimensional
AEP	Annual Exceedence Probability
AHD	Australian Height Datum
BMA	BHP Billiton Mitsubishi Alliance
BRM	Broadmeadow underground mine
BSO	Broadmeadow Sustaining Operations
CFD	Computational Fluid Dynamic
EIS	Environmental Impact Statement
GRB	Goonyella Riverside and Broadmeadow
GRM	Goonyella Riverside Mine
HEC-RAS	Hydrologic Engineering Centre – River Analysis System
IMG	Incidental mine gas
LiDAR	light detection and ranging
mAHD	metres Australian Height Datum
MIA	mine industrial area
MLA	mine lease area
NRM	Department of Natural Resources and Mines
RL	Relative Level
RHM	Red Hill Mine
TUFLOW	two-dimensional hydraulics model

Units	Description
m	metre
m/m	metres per metre
m/s	metres per second
m^3/s	cubic metres per second
km	kilometre
W/m^2	Watts per square metre

Executive Summary

A study of the flood hydraulic conditions within the watercourses traversing the Red Hill Mining Lease (the project) Environmental Impact Statement (EIS) study area was undertaken to assess the flooding impacts of the proposed project. Six 'waterways' classified as defined *watercourses* (under section 5 of the *Water Act 2000*) have been identified within the EIS study area. These are the Isaac River and its tributaries: Goonyella Creek; Eureka Creek; 12 Mile Gully; Fisher Creek; and Platypus Creek.

Basecase Conditions

A series of one-dimensional and two-dimensional hydraulic baseline models were developed to simulate the flooding conditions prior to the project. The purpose of the basecase hydraulic models included:

- Estimation of flood hydraulic parameters (water level, velocity, and stream power) for the frequent flood events to the 1 in 50 Annual Exceedence Probability (AEP) in order to:
  - provide a basecase hydraulic condition prior to the project in order to compare hydraulic parameters and estimate potential impacts; and
  - provide input to the Red Hill Mining Lease EIS Appendix I6.
- Estimation of flood extents and water levels for the large to rare flood events (1 in 100 AEP to 1 in 2,000 AEP) for comparison to the proposed project conditions and estimate the potential impacts of the project.

The hydraulic models utilised the estimated peak flows from the Red Hill Mining Lease EIS Appendix I4 as input to the models.

Project Conditions

The basecase conditions hydraulic models were modified to include the proposed project infrastructure that could impact the flood hydraulics of the Isaac River and its tributaries within the EIS study area. Similarly, basecase models were developed for 1 in 50 AEP events, and for large to rare events including the 1 in 100 AEP and 1 in 2,000 AEP events.

Frequent Events (up to 1 in 50 AEP) Flood Modelling Results

The project case flood hydraulic model results, flow velocity and stream power, for the frequent floods are summarised in Table A, with the basecase results presented for comparison. The flood modelling results indicate that hydraulic conditions fall within a similar hydraulic range to the basecase. Higher velocities and stream power are likely at the upstream end of the subsidence areas and un-subsided pillar areas, and lower velocities and stream power within the subsided panels.

Executive Summary

Table A Summary Project Case Flood Hydraulics for Isaac River, Goonyella and 12 Mile Gully

Hydraulic Parameter	Flood Event (AEP)	Base Case Results (Reach Average)	Project Case Results (Reach Average)
Isaac River from Upstream Project Boundary to Eureka Creek			
Velocity (m/s)	1 in 10 1 in 20 1 in 50	1.8 2.0 2.2	1.6 1.8 2.0
Stream Power (W/m^2)	1 in 10 1 in 20 1 in 50	68 94 106	97 132 148
Goonyella Creek from Isaac River Confluence to 8.03 km Upstream			
Velocity (m/s)	1 in 2 1 in 5 1 in 10 1 in 20 1 in 50	1.4 1.6 1.8 1.9 2.1	1.3 1.5 1.7 1.8 2.0
Stream Power (W/m^2)	1 in 2 1 in 5 1 in 10 1 in 20 1 in 50	39 54 54 62 70	56 85 85 72 82
12 Mile Gully from Isaac River Confluence to 8.70 km Upstream			
Velocity (m/s)	1 in 2 1 in 5 1 in 10 1 in 20 1 in 50	1.1 1.3 1.3 1.4 1.5	1.0 1.1 1.1 1.4 1.5
Stream Power (W/m^2)	1 in 2 1 in 5 1 in 10 1 in 20 1 in 50	69 58 44 56 58	73 91 101 90 116

Large to Rare Events (up to 1 in 100 to 1 in 2,000 AEP) Flood Modelling Results

The flood level elevation for the basecase and project conditions were compared to assess the impact of the project on flood levels in the EIS study area for the large to rare events from 1 in 100 AEP to the 1 in 2,000 AEP flood events. The modelling results, as presented in Table B and Table C, show that the project case would not significantly increase flood levels or extents for flood events 1 in 50 to 1 in 2,000 AEP. The largest differences in water level are around 1 m lower as a result of the subsidence panels. These reductions in water level are not considered significant for flooding.

Goonyella Creek and 12 Mile Gully show maximum variation in water level of 1.5 m and 2.8 m lower, respectively, as a result of the subsidence panels. These reductions in water level are also not considered significant for flooding.

Executive Summary

Table B Comparisons of Water Surface Elevations at Upstream Mine Lease Boundary

AEP Event	Water Surface Elevation at Upstream EIS Study Boundary – Base Case (mAHD)	Water Surface Elevation at Upstream Mine Boundary – Proposed (mAHD)	Difference in Water Surface Elevations (m)
1 in 10	263.0	262.9	-0.1
1 in 20	264.4	264.3	-0.1
1 in 50	265.2	265.0	-0.2
1 in 100	268.9	268.6	-0.3
1 in 500	271.2	270.8	-0.4
1 in 1000	271.9	271.6	-0.3
1 in 2000	272.5	272.2	-0.3

Table C Comparison of Water Surface Elevations at Key Locations (Isaac River)

AEP Event	Confluence of Isaac River and Goonyella Creek (mAHD)			Confluence of Isaac River and 12 Mile Gully (mAHD)			Isaac River Downstream of Red Hill Subsidence Panels (mAHD)		
	Base Case	**Proposed**	**Difference (m)**	**Base Case**	**Proposed**	**Difference (m)**	**Base Case**	**Proposed**	**Difference (m)**
1 in 10	252.1	252.1	0.0	249.1	248.6	-0.5	246.3	246.5	0.2
1 in 20	253.2	253.1	-0.1	250.0	249.5	-0.5	247.1	247.2	0.1
1 in 50	254.0	253.9	-0.1	250.8	250.3	-0.5	248.0	247.8	-0.2
1 in 100	257.3	256.9	-0.4	254.3	253.7	-0.6	251.6	251.4	-0.2
1 in 500	259.3	258.4	-0.9	255.5	255.0	-0.5	252.9	252.7	-0.2
1 in 1000	259.9	258.9	-1.0	255.8	255.3	-0.5	253.2	253.0	-0.2
1 in 2000	260.5	259.4	-1.1	256.0	255.6	-0.4	253.5	253.3	-0.2

Potential Impacts of the Project on Flood Hydraulics

The potential impacts of the project on the hydraulics of the Isaac River and its tributaries, as modelled, are not considered significant. The differences in hydraulic parameters for the more frequent events are not significantly different from basecase to project conditions for the Isaac River and its tributaries within the EIS study area. Similarly the differences in water level of the large to rare flood events (1 in 100 to 1 in 2,000 AEP) show that the water levels would potentially be lower through the EIS study area as a result of the project (primarily due to subsidence). Additional discussion regarding potential impacts from the project from the hydraulic modelling is presented in the Red Hill Mining Lease EIS Appendix I6.

1 Introduction

The Red Hill Mining Lease is located adjacent to the existing Goonyella, Riverside and Broadmeadow (GRB) mine complex in the Bowen Basin, approximately 20 kilometres north of Moranbah and 135 kilometres south-west from Mackay, Queensland.

BHP Billiton Mitsubishi Alliance (BMA), through its joint venture manager, BM Alliance Coal Operations Pty Ltd, proposes to convert the existing Red Hill Mining Lease Application (MLA 70421) to enable the continuation of existing mining operations associated with the GRB mine complex. Specifically, the mining lease conversion will allow for:

- An extension of three longwall panels (14, 15 and 16) of the existing Broadmeadow underground mine (BRM). Key aspects include:
  - No new mining infrastructure is proposed other than infrastructure required for drainage of incidental mine gas (IMG) to enable safe and efficient mining.
  - Management of waste and water produced from drainage of IMG will be integrated with the existing BRM waste and water management systems.
  - The mining of the Broadmeadow extension is to sustain existing production rates of the BRM and will extend the life of mine by approximately one year.
  - The existing BRM workforce will complete all work associated with the extension.
- A future incremental expansion option of the existing Goonyella Riverside Mine (GRM). Key aspects include:
  - underground mining associated with the RHM underground expansion option to target the Goonyella Middle Seam (GMS) on mining lease (ML) 1763;
  - a new mine industrial area (MIA);
  - a coal handling and preparation plant (CHPP) adjacent to the Riverside MIA on MLA1764 and ML1900 − the Red Hill CHPP will consist of up to three 1,200 tonne per hour modules;
  - construction of a drift for mine access;
  - a conveyor system linking RHM to the Red Hill CHPP;
  - associated coal handling infrastructure and stockpiles;
  - a new conveyor linking product coal stockpiles to a new rail load-out facility located on ML1900; and
  - means for providing flood protection to the mine access and MIA, potentially requiring a levee along the west bank of the Isaac River.
- A future Red Hill Mine (RHM) underground expansion option located to the east of the GRB mine complex to target the GMS on MLA70421, as well as development of key infrastructure including:
  - a network of bores and associated surface infrastructure over the underground mine footprint for mine gas pre-drainage (IMG) and management of goaf methane drainage to enable the safe extraction of coal;
  - the proposed mine layout consists of a main drive extending approximately west to east with longwall panels ranging to the north and south;
  - a ventilation system for the underground workings;

1 Introduction

- a bridge across the Isaac River for all-weather access. This will be located above the main headings, and will also provide a crossing point for other mine related infrastructure including water pipelines and power supply;
- a new accommodation village (Red Hill accommodation village) for the up to 100% remote construction and operational workforces with capacity for up to 3,000 workers; and
- potential production capacity of 14 million tonnes per annum (mtpa) of high quality hard coking coal over a life of 20 to 25 years.

The three project elements described above are collectively referred to as 'the project'.

A thick seam mining operation is proposed for the project, where subsidence of the existing terrain is predicted to average between 3 to 5 m with a maximum of up to 6 m (IMC 2011).

A hydraulic modelling study was conducted to estimate the hydraulic characteristics of the existing watercourses for a range of flood events. This was then compared to the proposed project works to estimate the potential impacts of the project on surrounding watercourses.

A study of the hydraulic conditions within the watercourses traversing the environmental impact statement (EIS) study area was undertaken to assess the flooding impacts of the proposed project. Six 'waterways' classified as defined *watercourses* (under section 5 of the *Water Act 2000*) have been identified within the EIS study area. These are the Isaac River and its tributaries: Goonyella Creek; Eureka Creek; 12 Mile Gully; Fisher Creek; and Platypus Creek. All other streams located in the EIS study area are contributing drainage systems to these watercourses.

The key objectives of this investigation were to identify adverse flooding impacts from the project on the environment, and to estimate the likely flood risk to the project development and operations.

The methodology for the hydraulic flood modelling assessment was as follows:

- develop hydraulic models of the basecase and calibrate the model to recorded water levels at the Goonyella gauge on the Isaac River;
- develop hydraulic models of the basecase to estimate flows, inundated areas, depths, velocity and stream power for a range of design flood events;
- develop hydraulic models of the proposed project case to estimate flows, inundated areas, depths, velocity and stream power for a range of design flood events;
- assess the extent of flood levees required to protect mine infrastructure;
- compare basecase and proposed development case hydraulic model results to assess the potential change in flow conditions as a result of the project; and
- identify mitigation measures to mitigate adverse impacts on flooding.

The results of the hydraulic study were used to support the geomorphic assessment to assess fluvial geomorphological impacts of the project.

Flood hydraulics were modelled on the October 2011 mine plan. A new mining sequence has since been developed for the RHM, Broadmeadow extension and the existing approved BRM. Further, both the BRM and the proposed Broadmeadow extension footprints have been revised. This has the potential to alter hydraulic flooding over the life of mine. However, the mine plan and revised schedule are indicative only and sequencing of production and annual production rates may vary. Regardless of this, the changes are not anticipated to have a significant impact on modelling predictions.

Methodology

2.1 Overview

A flood hydraulics analysis was conducted using a combination of site visit and computational investigations. The analysis has also included examination of previous studies and relevant reports, aerial photographs, and topographic data. The assimilated data was used to quantify the basecase and proposed project hydraulics within the watercourses.

2.2 Available Data

2.2.1 Data Review

A review of available data was conducted for purposes of input to the hydraulic models:

- Light detection and ranging (LiDAR) topographic data of the EIS study area from May 2010 was supplied by BMA. Additional aerial LiDAR data was available from December 2010, however after a review of the information, it was not considered suitable for flood modelling purposes. This was because critical areas of the surveyed surface were inundated by flood waters when the LiDAR was flown.
- Hydraulic modelling results and detailed design of the Broadmeadow Sustaining Operations (BSO) levee project.
- Flood hydrology modelling results for the Isaac River and the tributaries, as presented in the Red Hill Mining Lease EIS Appendix I4. The hydrology study estimated discharges in the Isaac River and the tributaries for a wide range of design flood estimates including Annual Exceedence Probabilities (AEP) 1 in 10, 1 in 20, 1 in 50, 1 in 100, 1 in 1,000, and 1 in 2,000 events.
- Information from the BRM operation:
  - estimated maximum subsidence depth contours; and
  - estimated timing of subsidence of each panel.
- Information for the project:
  - estimated maximum subsidence depth contours (IMC 2011); and
  - panel spatial alignments relative to the river and creek watercourses.

2.3 Modelling Assumptions

A number of assumptions were made, and agreed with the proponent for the purposes of the hydraulic modelling. The assumptions generally focussed on the infrastructure that was expected to be in place both prior to the project and at the conclusion of the project.

- Basecase models:
  - Surface topography should reflect conditions expected in the year 2020 (before initiation of the Red Hill Mine underground expansion option), including:
    - BSO levee constructed and in place;
    - spoil piles would be constructed as designed from the BSO project;
    - breaching of the right bank on Eureka Creek immediately upstream of GS4A for flood events with magnitudes greater than the 1 in 50 AEP flood event;
    - previously approved subsided panels 1 to 7, and predicted maximum subsidence depths, from the BRM operation;
  - previously approved open cut operation extents at GRM.

- Proposed project (subsided) models:
  - Surface topography should reflect conditions at the conclusion of the project, including:
    - items described in the basecase assumptions;
    - maximum predicted subsidence from the project;
    - previously approved subsided panels and predicted maximum subsidence depths from the BRM operation; and
    - proposed Red Hill levee to protect the proposed MIA and mine entrance.
  - The surface topography was not modified to include the following items:
    - The previously approved Railway and Lenton Pits.
    - An eroded surface within the river and stream channel to reflect erosion of the un-subsided roadways (pillars).
    - A new bridge will also be required across the Isaac River on the main headings to provide access to the eastern part of the mine footprint for IMG drainage and also to access environmental monitoring and management areas. The bridge will be designed to provide a suitable level of flood immunity and also to minimise impediment to flood flows within the river channel or floodplain. These requirements will be determined during detailed design.
    - Proposed IMG water production contingency dam located in the Isaac River, 12 Mile Gully and Goonyella Creek floodplain. The size and location of the IMG water production dam has not been determined at this stage, but it was assumed that the dam will be located in an area that has minimal impact to the floodplain flows.

2.4 Hydraulic Modelling Methodology

The purpose of the hydraulic analysis was to quantify key hydraulic parameters for a range of flood events in order to estimate potential impacts from the project. Parameters of interest to characterise the flood hydraulics were peak water level, flood inundation extents, channel flood velocity, bed shear stress, stream power, and depth of flow. These parameters are further described as follows:

- Estimated flood water level and inundation extent results were used to estimate potential levee locations to protect mining infrastructure and estimate potential changes in flood levels and extents around the EIS study area as a result of the predicted subsidence extents.
- Flow velocity (the speed of flow along the river) is commonly used for initial assessments of the potential for erosion.
- The bed shear stress represents the force between the river flow and resistance to flow provided by the bed and banks of the river channel. Shear stress is commonly used to determine the potential for sediment movement.
- Stream power provides the most reliable indicator of the potential sedimentation and erosion within the river channel based on the energy dissipation rate of flow along the river. It is calculated as the product of shear stress and velocity.

Isaac River

The Hydrologic Engineering Centre River Analysis System (HEC-RAS) version 4.1.0 was utilised for the hydraulic modelling of frequent flood events (1 in 10 to 1 in 50 AEP). HEC-RAS was determined to be an appropriate model for the frequent flood events where the majority of flow is generally confined within defined channels or is conveyed in one direction.

2 Methodology

To model the infrequent, extreme flood events (1 in 100 to 1 in 2,000 AEP), TUFLOW was utilised. TUFLOW is a one-dimensional (1D) and two-dimensional (2D) flood and tide simulation software package, suitable for modelling braided channel systems or river systems with 2D interactions. It is a widely used and accepted flood modelling software package in Australia.

Tributaries to Isaac River in Project Area

The Hydrologic Engineering Centre River Analysis System (HEC- RAS) version 4.1.0 was used for the hydraulic modelling of all flood events (1 in 2 to 1 in 2,000 AEP) for the tributaries contributing to the Isaac River within the EIS study area:

- Goonyella Creek;
- 12-Mile Gully;
- Eureka Creek; and
- Fisher, Platypus, and Holding Creeks.

One-dimensional modelling was considered appropriate as peak discharge of these tributaries would occur prior to the peak discharge in Isaac River. Accordingly the worst case scenario of flooding in the Isaac River floodplain would not be exacerbated by interaction of peak discharges from the tributaries. Further, 1D modelling of the tributaries for extreme events was deemed suitable based on the complexity of the floodplains and proximity to the proposed expansion works.

Basecase Hydraulic Model Development - HEC-RAS

3.1 Model Data and Extents

Topographic data used to define the existing channel geometry in the HEC-RAS models was based on aerial photogrammetric survey as flown in May 2010. It was supplemented with aerial survey data from October 2009 in regions where the 2010 data did not extend. The basecase topography was supplemented with the following information to represent conditions assumed in the year 2015:

- BSO levee and stockpiles which was under construction at the time of this report.
- Overtopping of the Eureka Creek right bank and Isaac River diversion spoil upstream of storage GS4A and downstream of storage GS4B. This area is comprised of uncompacted spoil material that was placed as part of the open cut mining operations. The BSO flood modelling and geotechnical investigations suggest that this area would likely overtop and erode for events with flood events of magnitude greater than a 1 in 20 AEP event.
- Subsided panels 1 to 7, and predicted maximum subsidence depths, from the BRM operation.
- Existing structure crossings of the river and creeks.
- Proposed bridge crossing of the Isaac River near the proposed MIA. It was assumed that the bridge would be designed to minimal to no impact on flood hydraulics and was therefore not included in the model.

The Isaac River HEC-RAS model extends from the most upstream intersection with the EIS study area boundary and extends 10 km downstream of the EIS study area. Cross-section orientation relative to the streams and river were selected to model the flood flow perpendicular to the direction of flow. Additionally, the number of cross-sections was selected to assist in future comparison to the project (subsided) conditions model results, with minimal adjustment for flow re-direction due to subsidence. In this case, cross-sections were generally located upstream of subsided panels, within the subsided area, along the un-subsided pillar areas and the header mains.

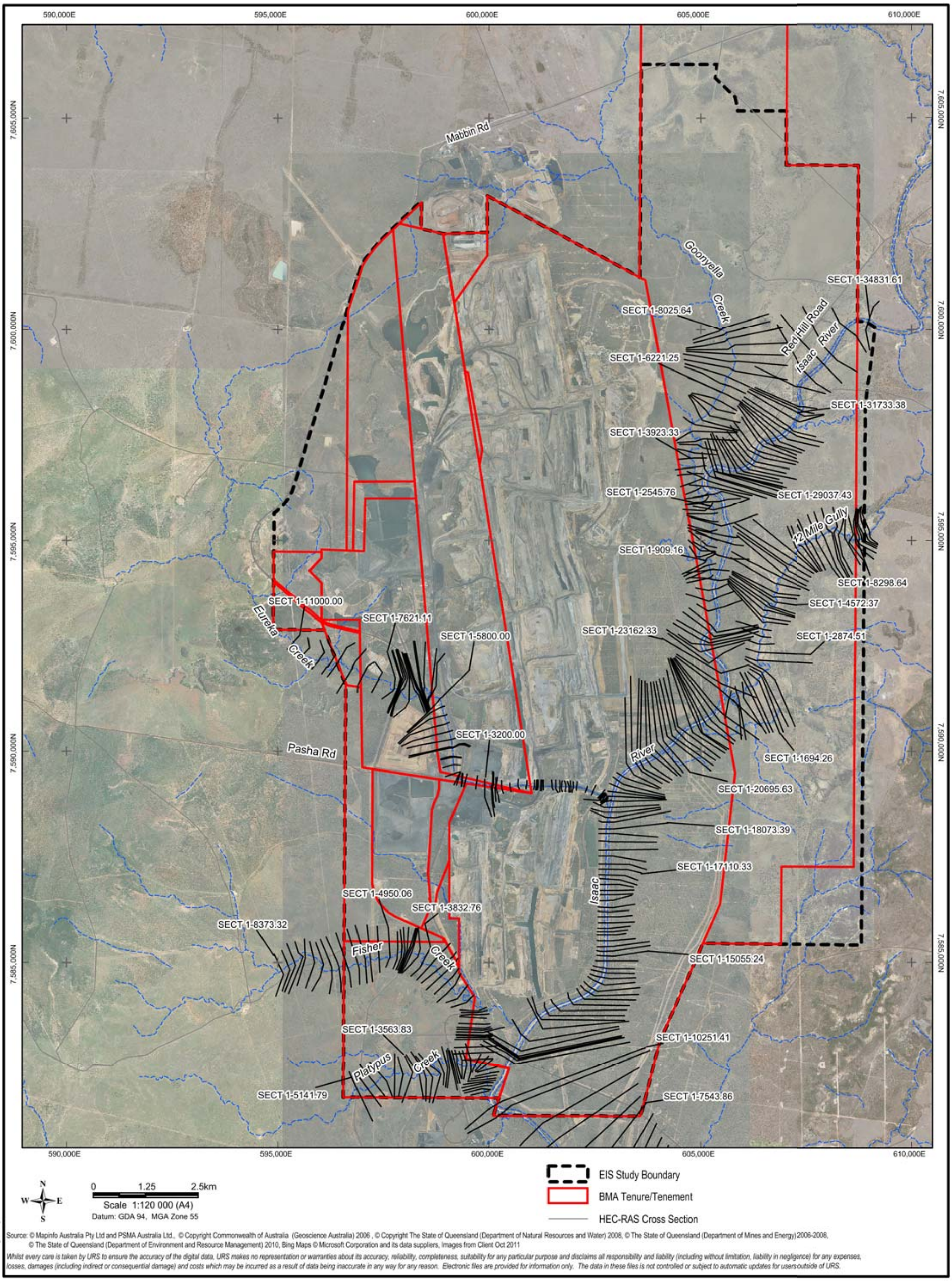
Models of the tributaries (12 Mile Gully, Fisher Creek, Platypus Creek) extend to the EIS study area with the exception of Eureka Creek and Goonyella Creek which were modelled further upstream to better represent the channel hydraulics. Each water course was modelled individually. The layout of the existing conditions HEC-RAS models is presented in Figure 3-1.

3.2 Hydraulic Roughness

Manning's 'n' roughness values were assigned to the channels and floodplains in the basecase HEC-RAS models. These were based on the site visits to the watercourses, site photos and aerial photography showing vegetation extents within the watercourse channel and floodplain areas.

3.2.1 Isaac River

The hydraulic roughness for Isaac River was confirmed through calibration of the HEC-RAS model using recorded flood measurements at the Department of Natural Resources and Mines (NRM) (previously the Department of Environment and Resource Management) Goonyella gauging station (130414A) which has been operational since 1983. The recorded water level and estimated discharge at the gauge were run through the model to compare the observed water surface elevation with the modelled water surface elevation for the five largest recorded flood events. It is noted that the maximum gauged river height was 8.88 m in January 1991, as shown in Table 3-1.



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EXISTING CONDITIONS HEC-RAS MODEL SCHEMATICS

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SURFACE WATER - HYDRAULICS

Figure: **3-1**

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Table 3-1 Largest Recorded Flood Events at NRM Goonyella Gauge Station (130414A)

Date	Water Level (RL in m)
08/01/1991	8.88
07/01/1991	8.81
02/03/1988	8.59
01/03/1988	7.61
05/04/1989	7.61
15/02/2008	7.02
19/12/2010	6.49
12/02/2008	5.97
04/01/1991	5.87
14/02/2008	5.83

The Manning's 'n' roughness value in the main channel was iteratively adjusted to minimise the differences in modelled to recorded water levels for the five flood events, as shown in Table 3-2. A channel roughness value of 0.04 was selected for the main channel, which fits the general channel description of a clean, winding channel, with some pools and shoals and some weeds and stones. The overbank (floodplain) roughness coefficient was assumed to be 0.06, which is indicative of floodplains with sparse shrubs and trees.

Table 3-2 HEC-RAS Model Calibration Results to Goonyella Gauge Station

Date	Discharge (m^3/s)	Water Level (RL in m)	Water Level (mAHD)	Water Level from HEC-RAS Model (mAHD)			Difference in Water Level (m)		
				n = 0.040	n = 0.039	n = 0.041	n = 0.040	n = 0.039	n = 0.041
08/01/1991	1,733	8.88	238.9	239.1	239.2	239.1	0.2	0.3	0.1
07/01/1991	1,705	8.81	238.9						
02/03/1988	1,598	8.59	238.7	238.8	238.9	238.7	0.1	0.2	0.1
01/03/1988	1,235	7.61	237.7						
05/04/1989	1,265	7.61	237.7	237.5	237.6	237.5	-0.1	-0.1	-0.2
15/02/2008	1,070	7.02	237.1	236.8	236.9	236.8	-0.3	-0.2	-0.3
19/12/2010	910	6.49	236.6	236.2	236.3	236.1	-0.4	-0.3	-0.4

3.2.2 Eureka, Fisher, Platypus, Goonyella Creeks and 12 Mile Gully

Manning's 'n' roughness values for Eureka Creek, Fisher Creek, Platypus Creek, Goonyella Creek and 12 Mile Gully were derived from site inspection and site photographs in comparison to descriptions of standard Manning's 'n' roughness values. A channel roughness of 0.045 was adopted for these tributaries. Natural streams with a channel roughness of 0.045 are generally characterised by a main channel that is clean winding, some pools and shoals, some weeds and stones. The overbank (floodplain) roughness coefficient was assumed to be 0.06, which is indicative of floodplains with sparse shrubs and trees.

3.3 Reach Boundary Conditions

Model boundary conditions were selected to represent the boundaries that are physically located at the model extents. The flow throughout the various stream reaches was expected to be characterised as both subcritical and supercritical due to the variation in bed slope. Therefore mixed flow simulations were necessary, which require both upstream and downstream external boundary conditions. Two exceptions are Isaac River and Goonyella Creek which have moderate variations in bed slope and are typified by subcritical flow. Normal depth (channel slope) was adopted where there was no downstream or upstream structures affecting the natural flow regime within the channel. Known water surfaces were adopted at each confluence of the tributaries into Isaac River using modelled water surface elevations from HEC-RAS and TUFLOW Isaac River models. The boundary conditions adopted for each reach are presented in Table 3-3.

Table 3-3 Downstream Boundary Conditions for Basecase HEC-RAS Models

Reach Model	1 in 10 AEP (mAHD)	1 in 20 AEP (mAHD)	1 in 50 AEP (mAHD)	1 in 100 AEP (mAHD)	1 in 500 AEP (mAHD)	1 in 1000 AEP (mAHD)	1 in 2000 AEP (mAHD)
Goonyella Creek	251.6	252.6	253.4	256.9	258.4	258.9	259.4
12 Mile Gully	248.6	249.5	250.3	253.7	255.1	255.5	255.9
Eureka Creek	243.0	243.9	245.0	248.3	249.8	250.2	250.6
Platypus Creek	234.3	235.0	235.9	239.2	240.2	240.5	240.9
Fisher Creek (with Platypus Creek)	236.2	236.3	236.5	239.3	240.3	240.6	241.0
Isaac River	normal depth slope of 0.0010 m/m						

3.4 Model Inflows

Model inflows have been developed as part of the hydrologic study (Red Hill Mining Lease EIS Appendix I4). The input flows for each tributary are summarised in Table 3-4.

Table 3-4 HEC-RAS Model Inflows

Reach	River Station	Description	Model Inflow (m³/s for AEP (1 in X years))						
			10 yr	20 yr	50 yr	100 yr	500 yr	1000 yr	2000 yr
Isaac River	34831.61	Model boundary	395	687	889	-	-	-	-
	25545.16	Goonyella Creek Confluence	424	689	917	-	-	-	-
	22199.31	12 Mile Gully Confluence	510	714	945	-	-	-	-

3 Basecase Hydraulic Model Development - HEC-RAS

Reach	River Station	Description	Model Inflow (m³/s for AEP (1 in X years))						
			10 yr	20 yr	50 yr	100 yr	500 yr	1000 yr	2000 yr
	18472.07	Eureka Creek Confluence	691	913	1250	-	-	-	-
	11590.02	Platypus Creek Confluence	811	1066	1399	-	-	-	-
	1873.70	Fisher Creek Confluence	782	1046	1441	-	-	-	-
Eureka Creek	11000	Model Boundary	216	353	506	660	1020	1184	1358
	6092.13	Confluence	223	344	504	668	1034	1220	1409
12 Mile Gully	8693.89	Model Boundary	191	278	379	509	813	972	1139
Fisher Creek	8373.32	Model Boundary	82	125	178	240	385	462	545
	1283.01	Holding Creek Confluence	127	196	278	373	597	720	847
Platypus Creek	5141.79	Model Boundary	64	99	130	193	306	361	420

- Denotes events modelled using TUFLOW (refer to Section 4)

3.5 Hydraulic Structures

Hydraulic structures modelled in each reach are summarised below.

3.5.1 Isaac River

The Isaac River Rail Bridge, as shown in Figure 3-2, is located near the southern end of the EIS study area. The rail bridge consists of a concrete deck that extends across the river from bank to bank with five concrete piers, as shown in Figure 3-2, and was input into the model at HEC-RAS River station 11645, as shown in Table 3-5.

Figure 3-2 Isaac River Rail Bridge Looking Downstream

Table 3-5 Isaac River Rail Bridge input Parameters to HEC-RAS Model

Bridge Structure Parameter	Value
Invert (mAHD)	239.9
Obvert (mAHD)	243.3
No. of piers	5
Contraction coefficient	0.1
Expansion coefficient	0.3

3.5.2 Eureka Creek

There were five hydraulic structures included in the Eureka Creek model as outlined below

- Riverside access road crossing culverts: located at HEC-RAS River Station 7500 (refer to Table 3-6).
- Riverside railway loop bridge crossing: located at HEC-RAS River Station 6585 (refer to Table 3-7).
- Riverside haul road crossing culverts: located at HEC-RAS River Station 3808 (refer to Table 3-8).
- Goonyella haul road crossing culverts: located at HEC-RAS River Station 1900 (refer to Table 3-9).
- GS4A (Red Hill Road) culvert crossing: located at HEC-RAS River Station 369 on the east side of the open cut mine area (refer to Table 3-10).

Table 3-6 Riverside Access Road Crossing Culverts (River Station 7500)

	Units	Box Culvert 1	Box Culvert 2	Box Culvert 3	Box Culvert 4	Box Culvert 5	Box Culvert 6	Box Culvert 7
Invert (inlet)	m AHD	255.0	255.0	255.0	255.0	255.1	255.1	255.0
Invert (outlet)	m AHD	255	255	255	255	255	255	255
Culvert length	m	10	10	10	10	10	10	10
Manning's n		0.013	0.013	0.013	0.013	0.013	0.013	0.013
Width	m	3.65	3.85	3.65	3.85	3.65	3.85	3.65
Height	m	3.65	3.85	3.65	3.85	3.65	3.85	3.65
No. of culverts		7	7	7	7	7	7	7
Entry Loss coefficient		0.5	0.5	0.5	0.5	0.5	0.5	0.5
Exit Loss coefficient		1.0	1.0	1.0	1.0	1.0	1.0	1.0

3 Basecase Hydraulic Model Development - HEC-RAS

Table 3-7 Riverside Railway Loop Bridge Crossing (River Station 6585)

Location	Level (mAHD)
Road deck upstream invert (mAHD)	264
Road deck upstream obvert (mAHD)	266
Road deck downstream invert (mAHD)	264
Road deck downstream obvert (mAHD)	266

Table 3-8 Riverside Haul Road Crossing Culverts (River Station 3808)

	Culvert 1	Culvert 2	Culvert 3	Culvert 4
Invert (inlet) (mAHD)	250.5	250.5	250.5	250.5
Invert (outlet) (mAHD)	250.2	250.2	250.2	250.2
Culvert length (m)	75	75	75	75
Manning's n	0.013	0.013	0.013	0.013
Diameter (m)	6	6	6	6
No. of culverts	4	4	4	4
Contraction coefficient	0.8	0.8	0.8	0.8
Entry Loss coefficient	0.5	0.5	0.5	0.5
Exit Loss coefficient	1.0	1.0	1.0	1.0

Table 3-9 Goonyella Haul Road Crossing Culverts (River Station 1900)

	Culvert 1	Culvert 2	Culvert 3
Invert (inlet) (mAHD)	244.4	243.2	244.3
Invert (outlet) (mAHD)	244.0	242.7	243.9
Culvert length (m)	55	55	55
Manning's n	0.013	0.013	0.013
Diameter (m)	8	8	8
No. of culverts	3	3	3
Contraction coefficient	0.8	0.8	0.8
Entry Loss coefficient	0.5	0.5	0.5
Exit Loss coefficient	1.0	1.0	1.0

Table 3-10 GS4A (Red Hill Road) Culverts (River Station 369)

Item	Value
Invert (Upstream and Downstream (mAHD)	246.68
Manning's n	0.013
Width (m)	2.4
Height (m)	2.7
Culvert length (m)	9
Number of culverts	15
Entry Loss coefficient	0.4
Exit Loss coefficient	1.0

3.5.3 Fisher Creek

There were three hydraulic structures included in the Fisher Creek HEC-RAS models as outlined below:

- Fisher creek road crossing culverts – located at HEC-RAS River Station 4480 (refer to Table 3-11).
- Fisher creek rail crossing culvers – located at HEC-RAS River Station 1220 (refer to Table 3-12).
- Fisher creek road crossing culverts through diversion – located at HEC-RAS River Station 733 (refer to Table 3-13).

Table 3-11 Fisher Creek Road Crossing Culverts (River Station 4480)

Item	Value
Upstream Invert (mAHD)	246,2
Downstream Invert (mAHD)	246
Culvert Length (m)	12
Manning's n	0.013
Diameter (m)	2.0
No. of culverts	7
Entry Loss coefficient	0.5
Exit Loss coefficient	1

Table 3-12 Fisher Creek Rail Crossing Culverts (River Station 1220)

Item	Value
Invert (mAHD)	236.9
Culvert Length (m)	7
Manning's n	0.013
Diameter (m)	2.96
No. of culverts	7
Entry Loss coefficient	0.5
Exit Loss coefficient	1

Table 3-13 Fisher Creek Road Crossing Culverts through Diversion (River Station 733)

Item	Value
Invert (mAHD)	237.5
Manning's n	0.013
Width (m)	3.75
Height (m)	3.75
Culvert length (m)	9
No. of culverts	7
Entry Loss coefficient	0.5
Exit Loss coefficient	1.0

3.5.4 Platypus Creek

There was one hydraulic structure included in the Platypus Creek model at the rail crossing, located at HEC-RAS River Station 1805 (refer to Table 3-14).

Table 3-14 Platypus Creek Rail Crossing Culverts (River Station 1805)

Item	Value
Invert (mAHD)	237.4
Obvert (mAHD)	236.8
Culvert Length (m)	12.5
Manning's n	0.027
Diameter (m)	5.9
No. of culverts (corrugated steel)	3
Entry Loss coefficient	0.5
Exit Loss coefficient	1.0

3.6 Eureka Creek HEC-RAS Model Calibration

The Eureka Creek HEC-RAS model was calibrated using the Computational Fluid Dynamic (CFD) modelling results undertaken for the 2009 GS4A spillway repair report (URS 2009). Water levels were compared upstream of the GS4A culverts for the 1 in 10 AEP event as this was the only event that did not overtop the spillway structure. The downstream boundary condition and flow discharge adopted for the CFD modelling and for the calibration are outlined in Table 3-15.

Table 3-15 CFD Model Input Parameters

Parameter	Value
Downstream Water level (mAHD)	243.5
Flow discharge (1 in 10 AEP) (m^3/s)	172

In order to reduce the contraction and drawdown effects at the spillway structure, a point located approximately 50 metres upstream from the centreline of Red Hill Road from the CFD modelling was selected for obtaining the water level for comparison to the HEC-RAS model. The CFD modelling results showed that this level was approximately 249 m AHD for the 1 in 10 AEP event. The corresponding location in the Eureka HEC-RAS model for the project was at river station 420 and was used as the location for calibration. The culvert input parameters in the HEC-RAS model were modified until the estimated water level closely matched the level from the CFD model. From the calibration, the water surface elevation at the two bounding cross-sections to this location were 249.0 (river station 409.78) and 249.1 m (river station 600.00) using the parameters outlined in Table 3-6.

Base Case Hydraulic Model Development - TUFLOW

4.1 Model Data and Extents

A TUFLOW 2D model of the Isaac River through the EIS study area was developed using the aerial photogrammetric survey as flown in May 2010. It was supplemented with aerial survey data from October 2009 in regions where the 2010 data did not extend. The 2D model extends from the upstream limit of the EIS study area to approximately 10 km downstream of the southern EIS study area boundary. The base case (assumed as year 2015) topography was supplemented with the following information:

- BSO levee and stockpiles which are currently under construction.
- Overtopping of the Eureka Creek right bank and Isaac River diversion spoil upstream of GS4A and downstream of GS4B. This area is comprised of uncompacted spoil material that was placed as part of the open cut mining operations. The BSO flood modelling and geotechnical investigations suggest that this area would likely overtop and erode for events with flood events of magnitude greater than a 1 in 20 AEP event.
- Subsided panels 1 to 7 and predicted maximum subsidence depths, from the BRM operation.

The base case topographic data was then interpreted into TUFLOW using a grid resolution of 20 metres by 20 metres. The resolution selected was considered sufficient to adequately resolve the Isaac River channel network and floodplain terrain while maintaining a reasonable level of data management (i.e. input and output files) and subsequent 2D modelling performance (i.e. model run time). Once the base case topography was developed in the model, two crossings were added:

- Isaac River Rail crossing; and
- GS4A at Eureka Creek.

4.2 Hydraulic Roughness

The hydraulic roughness coefficients used in the 2D analysis were developed from interpretation of aerial photography (2010) and assigning values based on open channel hydraulics design guides. Areas of similar vegetation and terrain were delineated and assigned a Manning's roughness value. A summary of the roughness classifications and associated Manning's roughness values are presented in Table 4-1.

Table 4-1 Summary of Adopted Hydraulic Roughness Categories and Values

Land Use Category	Adopted Manning's Roughness Value
Shallow waterways and floodplain	0.06
Trees and vegetation	0.08
Small vegetation for short-term veg conditions	0.045

4.3 Boundary Conditions

4.3.1 Input Flow Locations

Model inflows have been developed as part of the hydrologic study (Red Hill Mining Lease EIS Appendix I4). The input flows from each tributary to the Isaac River were developed based on the estimated peak discharge in the Isaac River and were modelled using a constant flow hydrograph (i.e. steady-state). The hydrologic flood routing showed that the time of arrival of the peak discharge in the Isaac River is generally many hours after the peak arrives from the tributaries due to catchment size. Since the Isaac River discharges were of interest for the TUFLOW modelling, the estimated peak discharges in the Isaac River at each confluence from the hydrology study were maintained, thus the discharge entering from the tributaries were set as the difference in upstream discharge in the Isaac River and the discharge at the confluence. For example, the discharge in the Isaac River at the confluence with Goonyella creek for the 1 in 100 AEP event was estimated as 1,675 m^3/s and 1,620 m^3/s at the upstream model boundary, therefore the discharge from Goonyella Creek was modelled as 55 m^3/s (1,675 m^3/s – 1,620 m^3/s = 55 m^3/s). The inflows to the TUFLOW models are summarised in Table 4-2, and the total flows in the Isaac River are presented in Table 4-3.

Table 4-2 TUFLOW Model Inflows at Model Boundaries

Reach	Description	Model Inflow (m^3/s for AEP (1 in X years))			
		100 yr	500 yr	1000 yr	2000 yr
Isaac River	Upstream Model boundary	1,620	2,743	3,312	3,933
	Goonyella Creek Confluence	55	103	44	60
	12 Mile Gully Confluence	83	119	182	183
	Eureka Creek Confluence	191	347	387	454
	Platypus Creek Confluence	199	294	323	391
	Fisher Creek Confluence	372	552	599	733

Table 4-3 TUFLOW – Total Flow in Isaac River

Reach	Description	Total Flow in Isaac River (m^3/s for AEP (1 in X years))			
		100 yr	500 yr	1000 yr	2000 yr
Isaac River	Upstream Model boundary	1,620	2,743	3,312	3,933
	Goonyella Creek Confluence	1,675	2,846	3,356	3,993
	12 Mile Gully Confluence	1,758	2,964	3,538	4,176
	Eureka Creek Confluence	1,949	3,312	3,926	4,631
	Platypus Creek Confluence	2,148	3,606	4,249	5,022
	Fisher Creek Confluence	2,520	4,158	4,848	5,754

4.3.2 Downstream Boundary Conditions

The TUFLOW downstream boundary condition was modelled as an elevation-discharge rating table with an estimated water surface elevation for specific discharge. The rating table, as presented in Table 4-4, was derived from the HEC-RAS model output at that location by simulating the larger events specifically for estimating the rating curve.

Table 4-4 Summary of Downstream Water Surface Elevations

AEP	Discharge (m^3/s)	Water Level (mAHD)
1 in 100	2,520	230.7
1 in 500	4,158	231.5
1 in 1,000	4,848	231.8
1 in 2,000	5,754	232.1

Base Case Hydraulic Model Results

5.1 Overview

Base case modelling results for the 1 in 2 AEP through 1 in 2,000 AEP flood events are presented in this section. The results have been categorised based on stream power, stream velocity, shear stress, water surface elevation and inundation extents.

5.2 Stream Power and Velocity (up to 1 in 50 AEP)

When considering the geomorphic environment of alluvial river channels, a useful concept is that of stream power. Stream power is the rate of energy expenditure in flowing water, and is a useful measure of the energy available to do geomorphic work along the channel. It can be calculated for any discharge, but in geomorphic studies is usually determined for the bankfull discharge event. The bankfull discharge is generally considered to be the channel forming event.

It is important to recognise that velocity and shear stress provide an indication of local and immediate erosion potential only. Velocity and shear stress parameters generally indicate whether there is erosion potential to cause enlargement of the local channel cross section (depth and width). The long-term stability of a channel's alignment is related to the morphological context of the reach. Stream power is a more useful indicator of hydraulic conditions reflecting the morphology of the channel, particularly for 'bank-full' flows that are commonly known to be 'channel forming' events.

A summary of the flow velocity and stream power for each of the reaches of relevance to the project are presented in Table 5-1. Additional base case hydraulic results for all of the modelled watercourses are presented in **Appendix A** to **C** for completeness.

Flooding extents for events from 1 in 10 to 1 in 50 AEP for the base case are presented in Figure 5-1 to Figure 5-3. Details of the base case HEC-RAS hydraulic modelling results for the 1 in 2 through 1 in 50 AEP events (Isaac River 1 in 10 to 1 in 50 AEP) are presented in summary tables in **Appendix A**. The baseline water surface elevation, stream velocity and stream power results are also presented as a series of longitudinal profile plots in Section 7 to show the difference between base and proposed conditions. The chainages presented on the plots correspond to the HEC-RAS river chainages.

Table 5-1 Summary of Base Case Hydraulic Results (1 in 10 AEP to 1 in 50 AEP)

Hydraulic Parameter	Flood Event (AEP)	Base case Results (Reach Average)
Isaac River from Upstream Project Boundary to Eureka Creek		
Velocity (m/s)	1 in 10 1 in 20 1 in 50	1.8 2.0 2.2
Stream Power (W/m^2)	1 in 10 1 in 20 1 in 50	68 94 106
Goonyella Creek from Isaac River Confluence to 8.03 km Upstream		
Velocity (m/s)	1 in 2 1 in 5 1 in 10 1 in 20 1 in 50	1.4 1.6 1.8 1.9 2.1
Stream Power (W/m^2)	1 in 2 1 in 5 1 in 10 1 in 20 1 in 50	39 54 54 62 70
12 Mile Gully from Isaac River Confluence to 8.7 km Upstream		
Velocity (m/s)	1 in 2 1 in 5 1 in 10 1 in 20 1 in 50	1.1 1.3 1.3 1.4 1.5
Stream Power (W/m^2)	1 in 2 1 in 5 1 in 10 1 in 20 1 in 50	69 58 44 56 58

5.3 Large to Rare Events (1 in 100 AEP to 1 in 2000 AEP)

The purpose of modelling a range of flood events from the 1 in 100 AEP flood event to the 1 in 2000 AEP was to quantify key hydraulic parameters, in particular maximum flood level. The flood levels will serve as baseline elevations for later comparison to the project case. Flooding extents for all flood events (1 in 100 to 1 in 2,000 AEP) for the existing river system are presented in Figure 5-4 to Figure 5-7. A summary of the estimated water surface elevations in Isaac River and tributaries at the upstream and downstream boundaries of the mine lease are presented in Table 5-2 (flood elevations for the select frequent events have been included for completeness). Details of the HEC-RAS results for events 1 in 100 to 1 in 2,000 are presented in summary tables in **Appendix B**. Longitudinal plots showing the water surface elevation, stream power and stream velocity are also included Section 7 as part of the comparison between base case and project conditions. Base case TUFLOW model results are also presented in **Appendix G**.

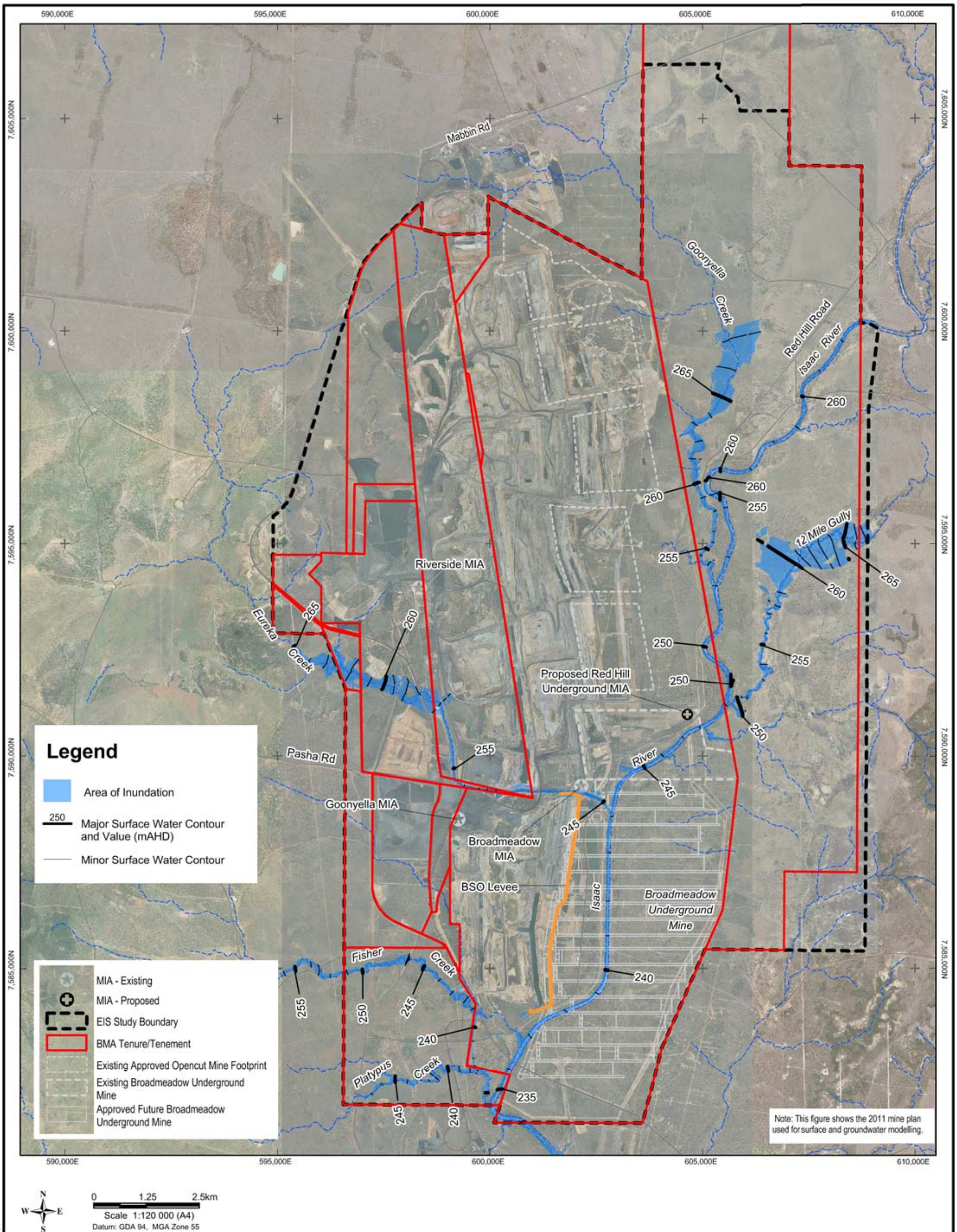
5 Base Case Hydraulic Model Results

Table 5-2 Estimation of Base Case Water Surface Elevations in all Reaches at Mine Lease Boundary

Reach	AEP Event	Water Surface Elevation at Upstream Mine Lease Boundary (mAHD)	Water Surface Elevation at Downstream Mine Lease Boundary (mAHD)
Isaac River	1 in 10	263.0	234.2
Upstream Min Ground Level = 257.8 mAHD	1 in 20	264.4	235.0
	1 in 50	265.2	235.9
	1 in 100	268.9	238.5
Downstream Min Ground Level of the River = 228.3 mAHD	1 in 500	271.2	239.6
	1 in 1,000	272.0	240.0
	1 in 2,000	272.5	240.4
Eureka Creek	1 in 10	262.1	244.0
Upstream Min Ground Level = 260.1 mAHD	1 in 20	262.4	244.8
	1 in 50	262.7	245.8
	1 in 100	262.9	249.4
Downstream Min Ground Level = 240.7 mAHD	1 in 500	263.5	250.9
	1 in 1,000	263.9	251.3
	1 in 2,000	264.3	251.7
12 Mile Gully	1 in 10	267.6	248.9
Upstream Min Ground Level = 265.5mAHD	1 in 20	267.8	249.8
	1 in 50	267.9	250.6
	1 in 100	268.1	254.4
Downstream Min Ground Level = 243.4 mAHD	1 in 500	268.5	255.5
	1 in 1,000	268.6	255.8
	1 in 2,000	268.8	256
Goonyella Creek	1 in 10	267.5	251.7
Upstream Min Ground Level = 264.6 mAHD	1 in 20	267.7	252.9
	1 in 50	267.9	253.6
	1 in 100	268.1	257.3
Downstream Min Ground Level = 247.0 mAHD	1 in 500	268.5	259.3
	1 in 1,000	268.7	260.0
	1 in 2,000	268.8	260.5

5 Base Case Hydraulic Model Results

Reach	AEP Event	Water Surface Elevation at Upstream Mine Lease Boundary (mAHD)	Water Surface Elevation at Downstream Mine Lease Boundary (mAHD)
Fisher Creek	1 in 10	251	236.9
Upstream Min Ground Level = 249.7 mAHD	1 in 20	251.3	237.2
	1 in 50	251.6	237.4
	1 in 100	251.8	239.3
Downstream Min Ground Level = 235.5 mAHD	1 in 500	252.3	240.3
	1 in 1,000	252.5	240.6
	1 in 2,000	252.7	241
Platypus Creek	1 in 10	247.6	234.2
Upstream Min Ground Level = 245.6 mAHD	1 in 20	247.9	235.0
	1 in 50	248.2	235.8
	1 in 100	248.6	239.3
Downstream Min Ground Level = 231.5 mAHD	1 in 500	249.1	240.3
	1 in 1,000	249.3	240.6
	1 in 2,000	249.5	241.0



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FLOODING EXTENTS FOR THE BASECASE CONDITIONS 1:10 AEP FLOOD EVENT

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SURFACE WATER - HYDRAULICS

Figure: **5-1**

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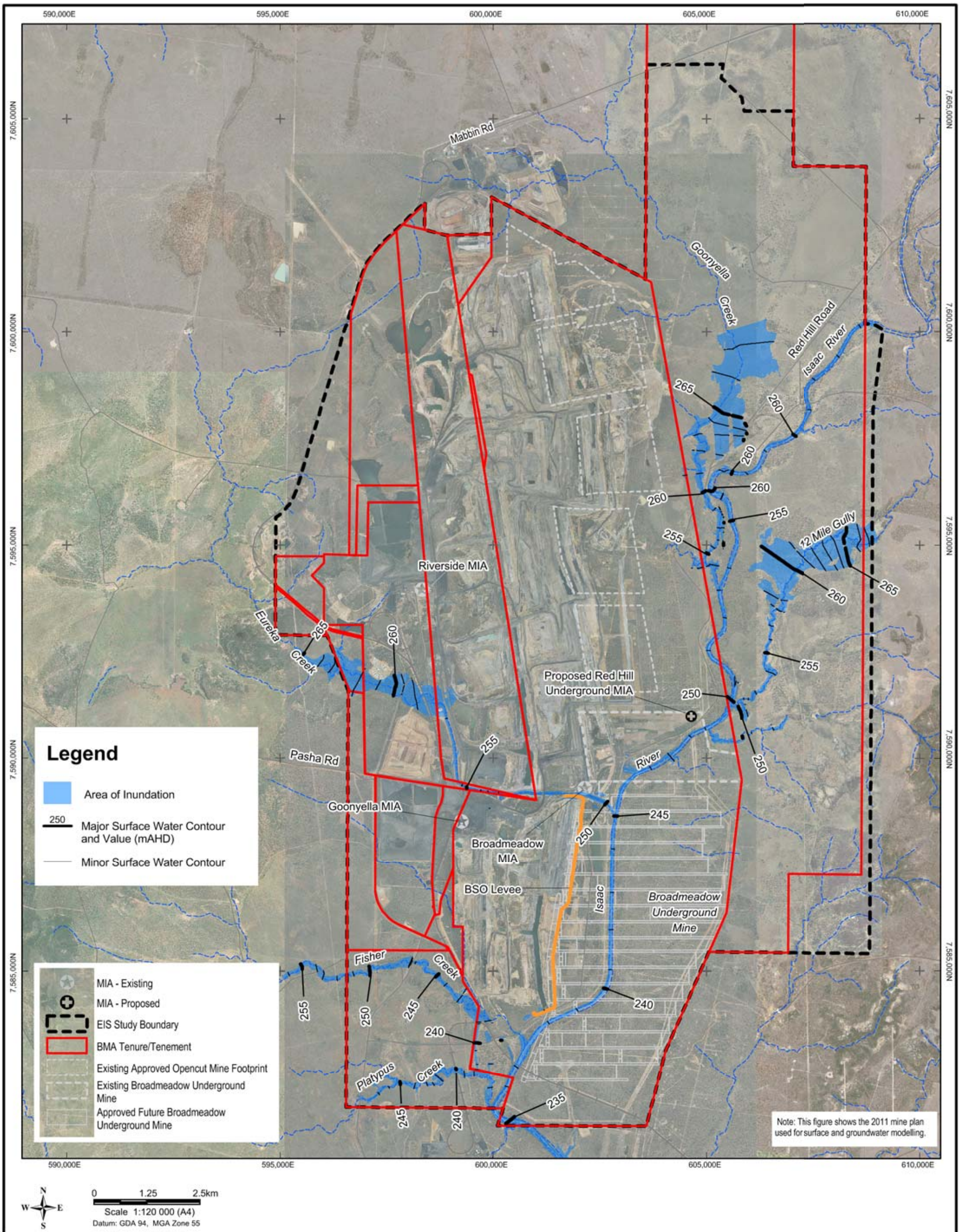

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FLOODING EXTENTS FOR THE BASECASE CONDITIONS 1:20 AEP FLOOD EVENT

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Figure: 5-2

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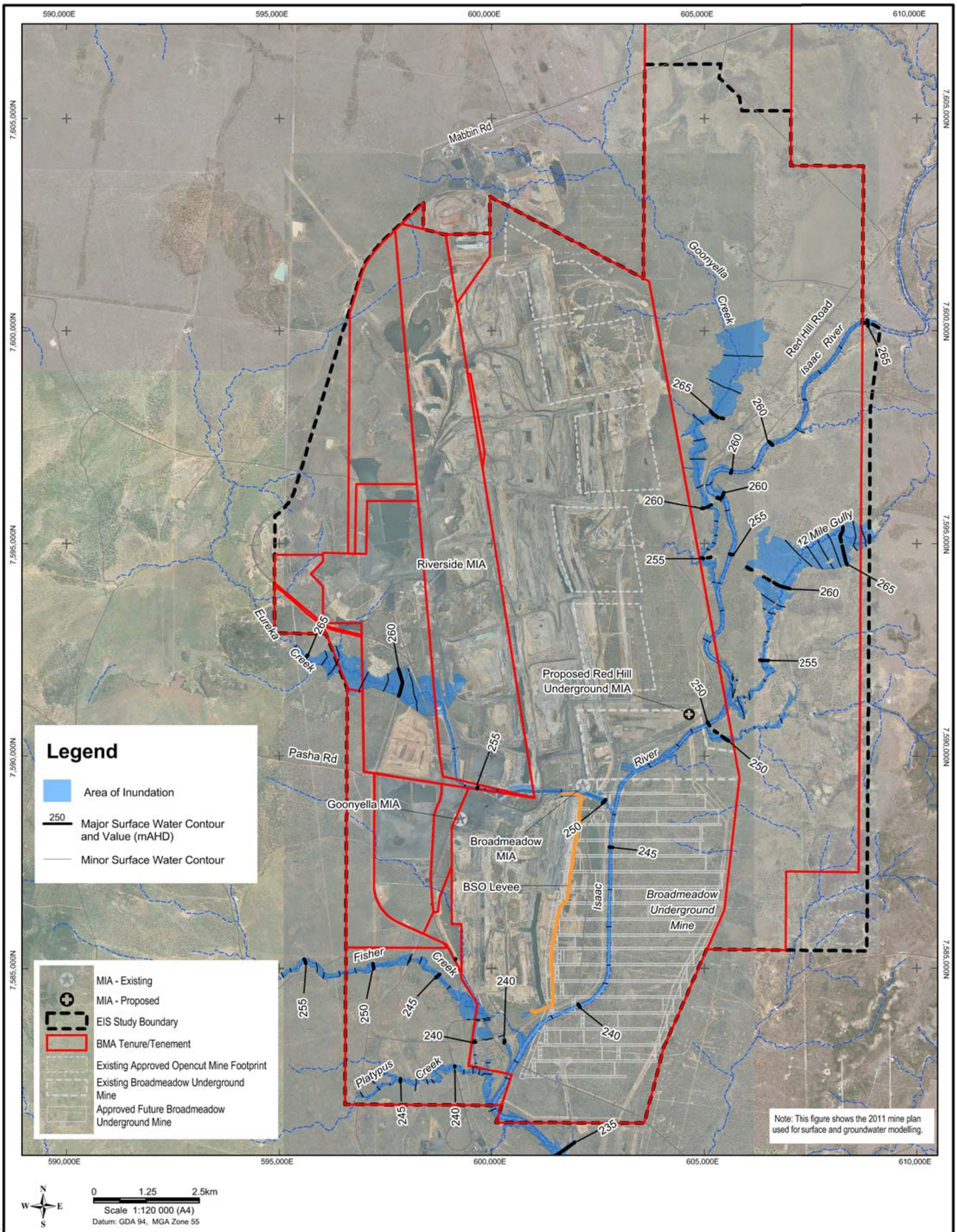

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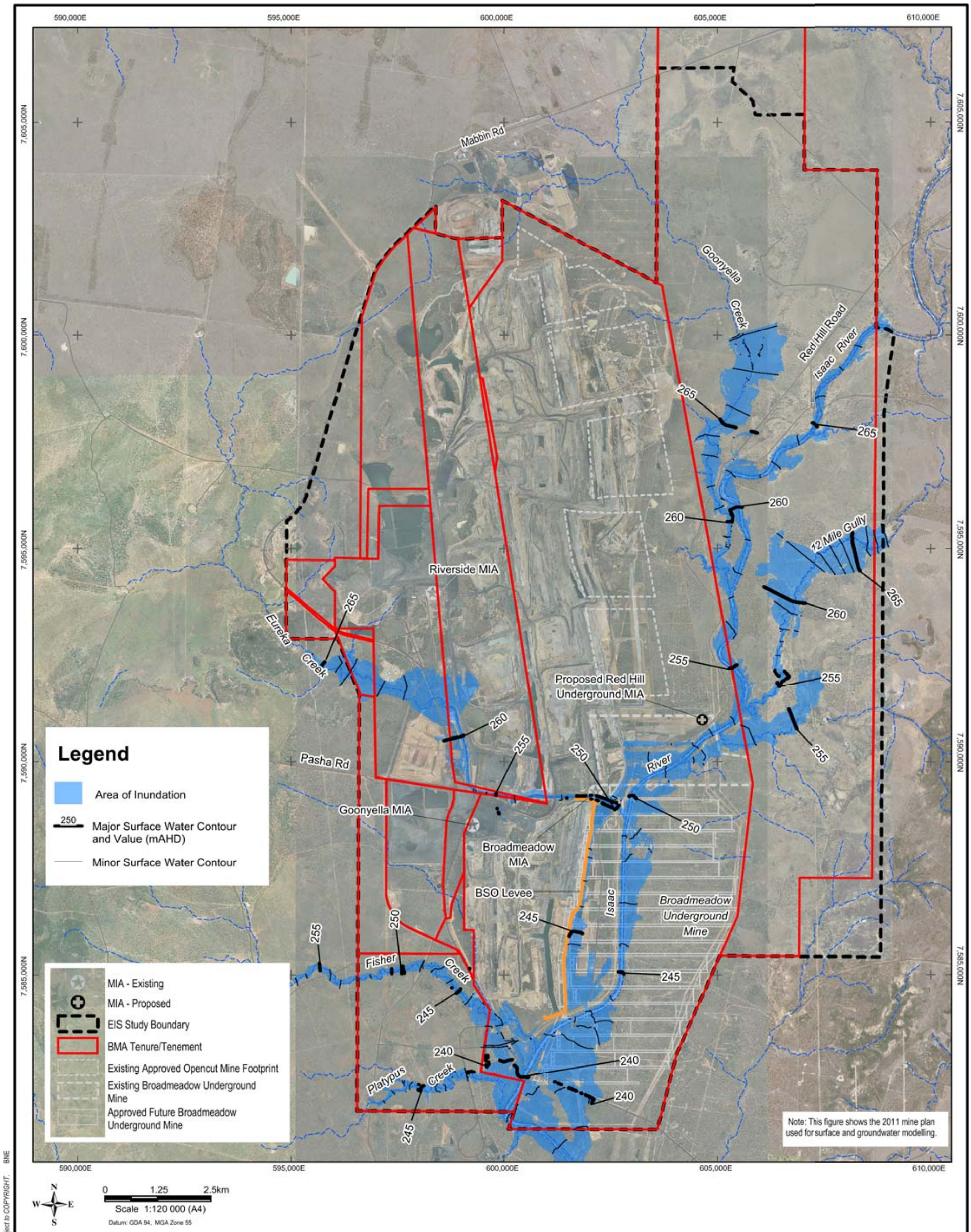

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FLOODING EXTENTS FOR THE BASECASE CONDITIONS 1:100 AEP FLOOD EVENT

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SURFACE WATER - HYDRAULICS

Figure: **5-4**

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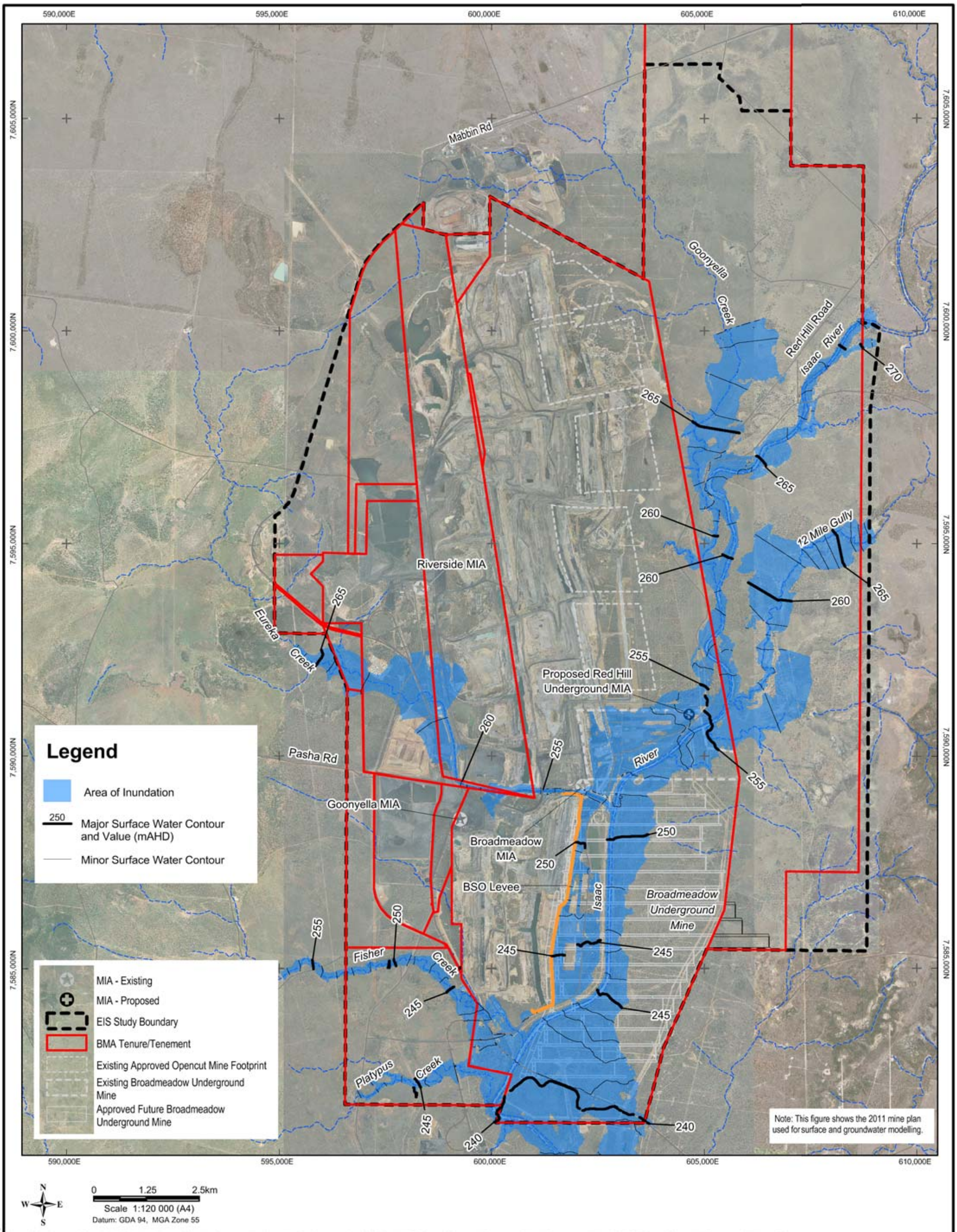

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SURFACE WATER - HYDRAULICS

Figure: 5-5

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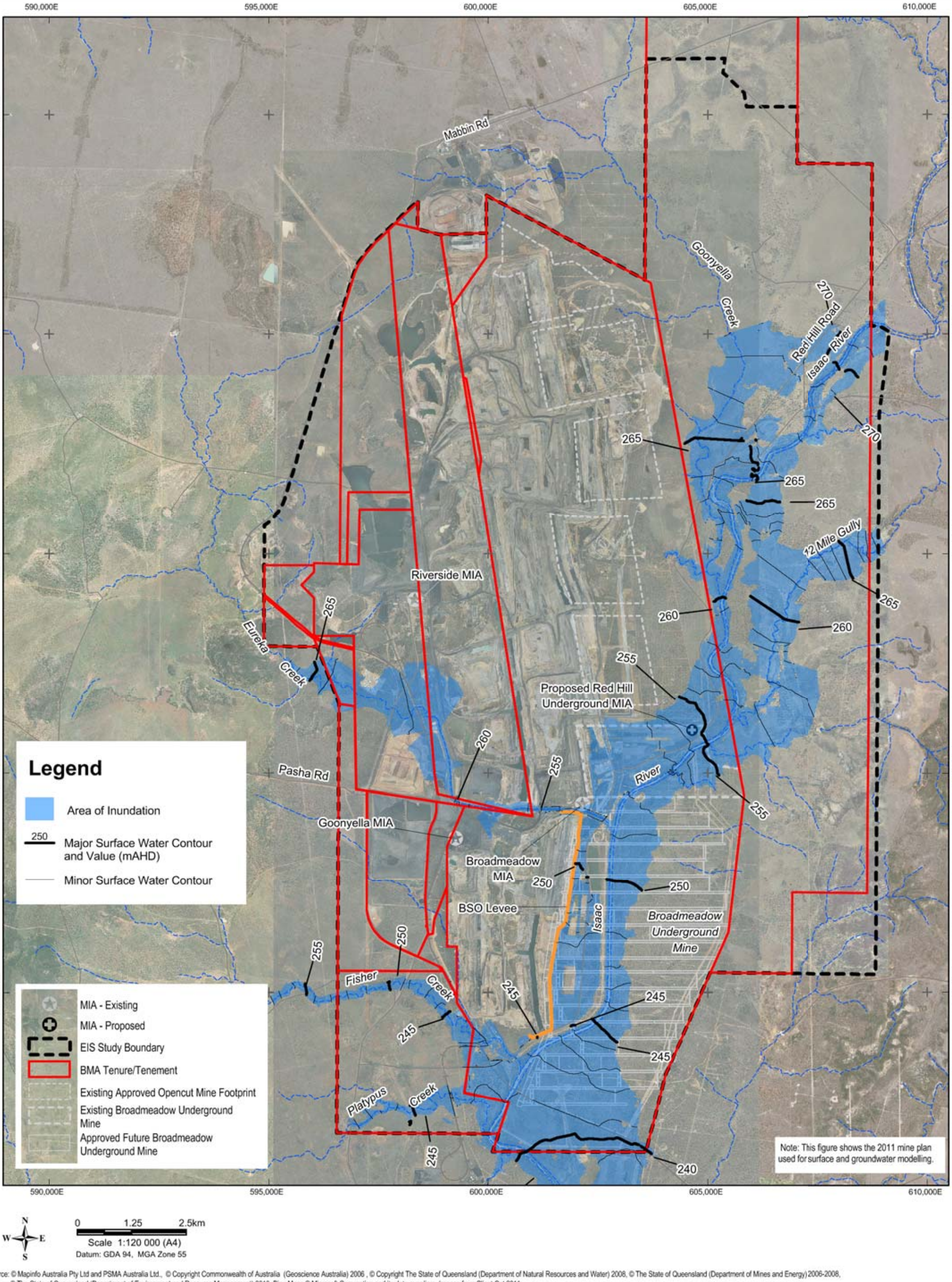

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Figure: **5-6**

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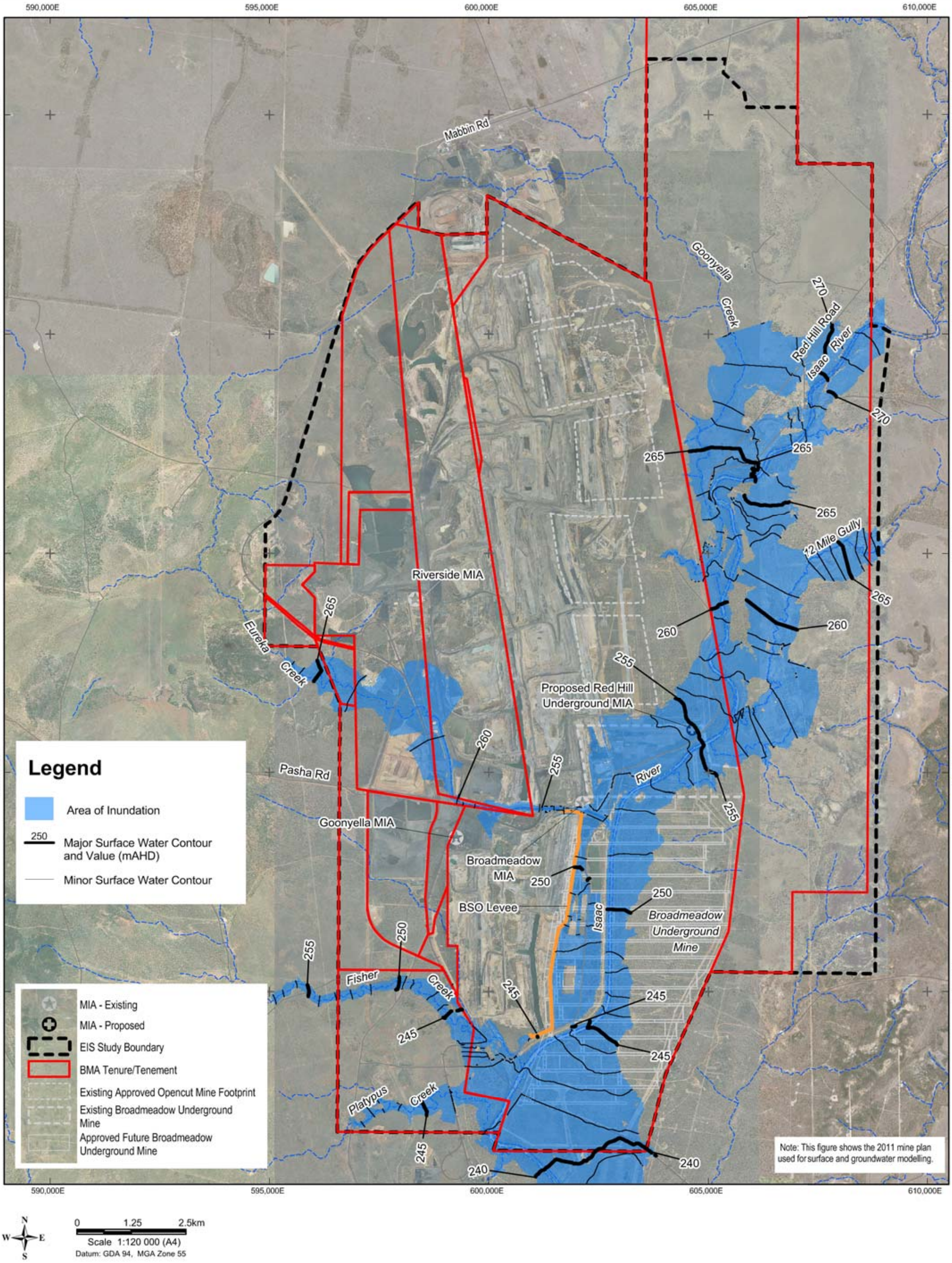

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Figure: 5-7

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Project Conditions Hydraulic Models

6.1 Overview of Proposed Conditions

Topographic data used to define the existing channel geometry in the HEC-RAS and TUFLOW models was based on aerial photogrammetric survey as flown in May 2010. It was supplemented with aerial survey data from October 2009 in regions where the 2010 data did not extend. Flood modelling for the proposed conditions was performed by modifying the base case conditions hydraulic models to include:

- The project predicted subsidence from IMC (2011).
- The proposed Red Hill levee to protect the proposed MIA and mine entrance, which starts immediately upstream of Isaac River and Eureka Creek confluence and continues north following Red Hill Road to a location between subsidence panel 102 and 103. A 'glass-wall' was adopted to model the levee to prevent the modelled levee from overtopping in the model and allow for water levels to be extracted for reporting purposes.

The surface topography was not modified to include the following items:

- The previously approved Railway and Lenton pits.
- An eroded surface within the river and stream channel to reflect future erosion of the un-subsided pillar areas.
- Two proposed Isaac River bridge crossings (one as part of the project and the other as part of existing operations) were not modelled because it was assumed the bridges will be designed to provide a suitable level of flood immunity and also to minimise impediment to flood flows within the river channel or floodplain. These requirements will be determined during detailed design.
- Proposed IMG water production dam located in the Isaac River, 12 Mile Gully and Goonyella Creek floodplain. The size and location of the IMG water production dam has not been determined at this stage, but it was assumed that the dam will be located in an area that has minimal impact to the floodplain flows.

6.2 Subsidence Topography

In longwall mining, a panel of coal, typically about 3 km long, 300 m wide and 3 to 10 m thick, is totally removed by long wall shearing machinery, which travels back and forth across the coalface. The area immediately in front of the coalface is supported by a series of hydraulic roof supports, which temporarily hold up the roof strata and provide a working space for the shearing conveyor and shearing machinery to be moved forward.

When coal is extracted using this method, the roof above the seam is allowed to collapse into the void that is left as the face retreats, referred to as goaf. As the roof collapses into the goaf, the fracturing settlement of the rock progresses through the overlying strata and results in sagging and bending of the near surface and subsidence of the ground above.

Generally, subsidence occurs over the centre of the longwall panel and tapers off around the perimeter of the long wall. The subsidence is typically less than the thickness of the coal extracted underground.

Several panels are mined in a series and chain pillars are left between the panels. The chain pillars crush and twist as the coal is removed from either side, however they do not totally collapse, providing a considerable amount of support to the strata above them.

The subsidence at the surface does not occur suddenly but develops progressively as the coal is extracted within the area of influence of the extracted panel. As further adjacent panels are extracted, additional subsidence can be experienced above the previously mined panel or panels. However, a point is also reached where a maximum value of subsidence is observed over the series of panels irrespective of whether more panels are later extracted. The subsidence effect at the surface occurs in the form of a very slow moving wave.

For this study, it was assumed that the un-subsided pillar areas would not erode over time and that sedimentation of the goaf would not occur.

6.3 Model Extents

The model extents for the Isaac River and the tributaries were not changed from the base case.

6.4 Proposed Reach Boundary Conditions

Similar to the basecase condition, the boundary conditions for the proposed models (HEC-RAS and TUFLOW) were based on normal depth at relevant upstream and downstream boundary locations and known water surface elevations at confluences. The boundary conditions adopted in the basecase study (TUFLOW) have been retained and applied to the proposed analysis. The known water surface elevations for the HEC-RAS modelling were updated with the project water surface for Isaac and Platypus Creek (at confluence with Fisher). Adopted boundary conditions for the project HEC-RAS modelling are shown in Table 6-1.

Table 6-1 Boundary Conditions of Project Conditions HEC-RAS Models

Reach Model	1 in 10 AEP (mAHD)	1 in 20 AEP (mAHD)	1 in 50 AEP (mAHD)	1 in 100 AEP (mAHD)	1 in 500 AEP (mAHD)	1 in 1000 AEP (mAHD)	1 in 2000 AEP (mAHD)
Goonyella Creek	251.7	252.9	253.6	257.3	259.3	260.0	260.5
12 Mile Gully	248.9	249.8	250.6	254.3	255.5	255.8	256.0
Eureka Creek	244.0	244.8	245.8	249.4	250.9	251.3	251.7
Platypus Creek	234.2	235.0	235.9	239.3	240.3	240.6	241.0
Fisher Creek (with Platypus Creek)	251.7	252.9	253.6	257.3	259.3	260.0	260.5
Isaac River	normal depth slope of 0.0010 m/m						

6.5 Project Conditions Model Inflows

The inflows from the basecase study were not modified for the project conditions models.

Project Conditions Hydraulic Results

7.1 Frequent Events (up to 1 in 50 AEP) Flood Modelling Results

Modelling of the proposed case for floods up to the 1 in 50 flood event was undertaken by modifying the baseline HEC-RAS models to compare the hydraulic conditions of the project with basecase conditions. Hydraulic results including the water surface elevation, stream velocity and stream power were used to assess the potential impacts from the proposed case.

The project case flood hydraulic model results, flow velocity and stream power, for the frequent floods are summarised in Table 7-1, with the basecase results presented for comparison. Data is presented as an average for each stream reach.

The flood modelling results indicate that hydraulic conditions fall within a similar hydraulic range to the basecase. Higher velocities and stream power are likely at the upstream end of the subsidence areas and un-subsided pillar areas, and lower velocities and stream power within the subsided panels. As described previously, erosion and sediment deposition were not simulated in the analysis and hence actual changes to stream power and velocity would be less as the waterways geo-morphologically adapt to the subsided profile. A more detailed discussion regarding the potential impacts of the changes in hydraulics to the Isaac River and its tributaries is included in the Red Hill Mining Lease EIS Appendix I6.

Plots illustrating the longitudinal variation in water surface elevation, stream velocity and stream power between baseline and proposed conditions for all reaches are shown in **Appendix C**. Separate plots are shown for each reach and event (1 in 10 to 1 in 50 AEP). Summary tables presenting the range of water surface elevation, stream velocity and stream power within each reach are presented in **Appendix D**.

Table 7-1 Summary Project Case Flood Hydraulics for Isaac River, Goonyella and 12 Mile Gully

Hydraulic Parameter	Flood Event (AEP)	Base Case Results (Reach Average)	Project Case Results (Reach Average)
Isaac River from Upstream Project Boundary to Eureka Creek			
Velocity (m/s)	1 in 10 1 in 20 1 in 50	1.8 2.0 2.2	1.6 1.8 2.0
Stream Power (W/m^2)	1 in 10 1 in 20 1 in 50	68 94 106	97 132 148
Goonyella Creek from Isaac River Confluence to 8.03 km Upstream			
Velocity (m/s)	1 in 2 1 in 5 1 in 10 1 in 20 1 in 50	1.4 1.6 1.8 1.9 2.1	1.3 1.5 1.7 1.8 2.0
Stream Power (W/m^2)	1 in 2 1 in 5 1 in 10 1 in 20 1 in 50	39 54 54 62 70	56 85 85 72 82

Hydraulic Parameter	Flood Event (AEP)	Base Case Results (Reach Average)	Project Case Results (Reach Average)
12 Mile Gully from Isaac River Confluence to 8.70 km Upstream			
Velocity (m/s)	1 in 2 1 in 5 1 in 10 1 in 20 1 in 50	1.1 1.3 1.3 1.4 1.5	1.0 1.1 1.1 1.4 1.5
Stream Power (W/m^2)	1 in 2 1 in 5 1 in 10 1 in 20 1 in 50	69 58 44 56 58	73 91 101 90 116

7.2 Large to Rare Events (1 in 100 AEP to 1 in 2,000 AEP) Flood Modelling Results

A 2D finite-difference hydraulic model (TUFLOW) was developed to assess the hydraulic conditions of the Isaac River for proposed conditions for the less frequent (large to rare) events. The flood level elevation for the basecase and project conditions were compared to assess the impact of the project on flood levels in the EIS study area. A comparison of the modelled flood levels at key locations within the EIS Study Area is presented in Table 7-2 and Table 7-3. The modelling results show that the project case would not significantly increase flood levels or extents for flood events 1 in 50 to 1 in 2,000 AEP. The largest differences in water level are around 1 m lower as a result of the subsidence panels. These reductions in water level are not considered significant for flooding and are discussed further in the Red Hill Mining Lease EIS Appendix I6.

Flood levels may potentially increase by up to 0.2 metres immediately downstream of the Red Hill subsidence panels for frequent events (1 in 10 and 1 in 20 AEP), but are considered relatively insignificant and are noted to be of similar magnitude to the accuracy of the topographic survey data. At this more frequent level of flooding (1 in 10 to 1 in 20 AEP) the flood extents are generally confined to the main Isaac River channel and no nearby facilities are located within the modelled flood extents.

The flood inundation extents for the 1 in 10 AEP and 1 in 2,000 AEP are presented in Figure 7-1 to Figure 7-7. The flood extents show that temporary flood inundation ponding may occur within the subsided panel areas during frequent flood events.

A complete series of TUFLOW model results for Isaac River are presented in **Appendix G** (Basecase), **Appendix H** (Proposed) and **Appendix I** (Difference Maps). Each appendix includes result maps of water surface elevation, water depth, stream velocity, stream power and bed shear stress maps.

Table 7-2 Comparisons of Water Surface Elevations at Upstream Mine Lease Boundary

AEP Event	Water Surface Elevation at Upstream EIS Study Boundary – Base Case (mAHD)	Water Surface Elevation at Upstream EIS Study Boundary – Proposed (mAHD)	Difference in Water Surface Elevations (m)
1 in 10	263.0	262.9	-0.1
1 in 20	264.4	264.3	-0.1
1 in 50	265.2	265.0	-0.2
1 in 100	268.9	268.6	-0.3
1 in 500	271.2	270.8	-0.4
1 in 1000	271.9	271.6	-0.3
1 in 2000	272.5	272.2	-0.3

Table 7-3 Comparison of Water Surface Elevations at key locations (Isaac River)

AEP Event	Confluence of Isaac River and Goonyella Creek (mAHD)			Confluence of Isaac River and 12 Mile Gully (mAHD)			Isaac River Downstream of Red Hill Subsidence Panels (mAHD)		
	Base Case	**Proposed**	**Difference (m)**	**Base Case**	**Proposed**	**Difference (m)**	**Base Case**	**Proposed**	**Difference (m)**
1 in 10	252.1	252.1	0.0	249.1	248.6	-0.5	246.3	246.5	0.2
1 in 20	253.2	253.1	-0.1	250.0	249.5	-0.5	247.1	247.2	0.1
1 in 50	254.0	253.9	-0.1	250.8	250.3	-0.5	248.0	247.8	-0.2
1 in 100	257.3	256.9	-0.4	254.3	253.7	-0.6	251.6	251.4	-0.2
1 in 500	259.3	258.4	-0.9	255.5	255.0	-0.5	252.9	252.7	-0.2
1 in 1000	259.9	258.9	-1.0	255.8	255.3	-0.5	253.2	253.0	-0.2
1 in 2000	260.5	259.4	-1.1	256.0	255.6	-0.4	253.5	253.3	-0.2

Hydraulic results for 12 Mile Gully, Goonyella Creek, Eureka Creek, Fisher Creek and Platypus Creek for the larger, less frequent events (1 in 100 to 1 in 2,000 AEP) are presented as longitudinal plots for events in **Appendix F**. The surface water elevations for proposed conditions are also summarised in tables in **Appendix E**. Eureka Creek, Fisher Creek and Platypus creek show no variation between basecase and Project conditions since the proposed underground operation and levee would be located sufficient distance upstream so as not to have a hydraulic impact. Goonyella Creek and 12-Mile Gully shows maximum variation in water level of 1.5 m and 2.8 m lower, respectively, as a result of the subsidence panels. These reductions in water level are not considered significant for flooding and are discussed further in the Red Hill Mining Lease EIS Appendix I6.

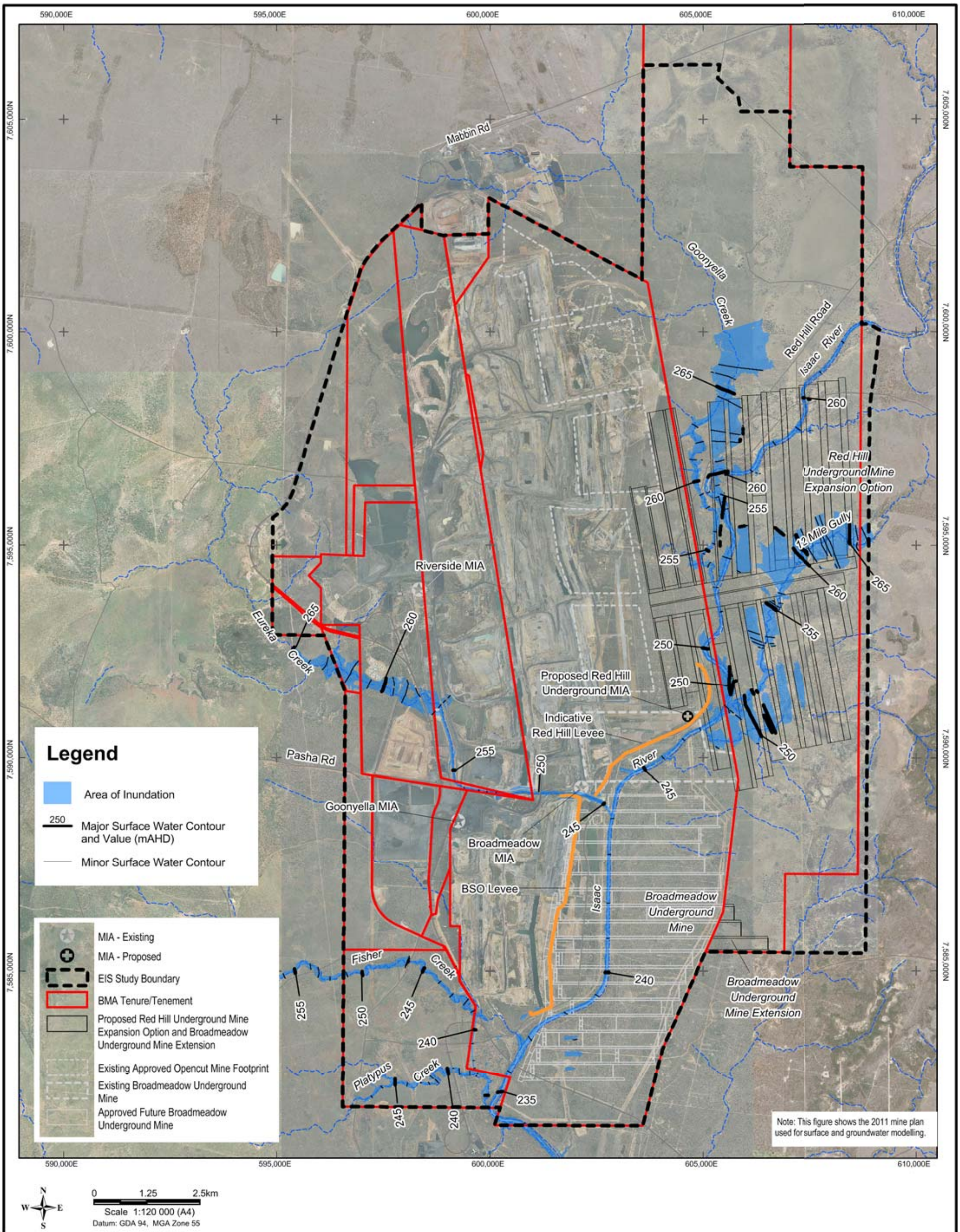

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Figure: **7-1**

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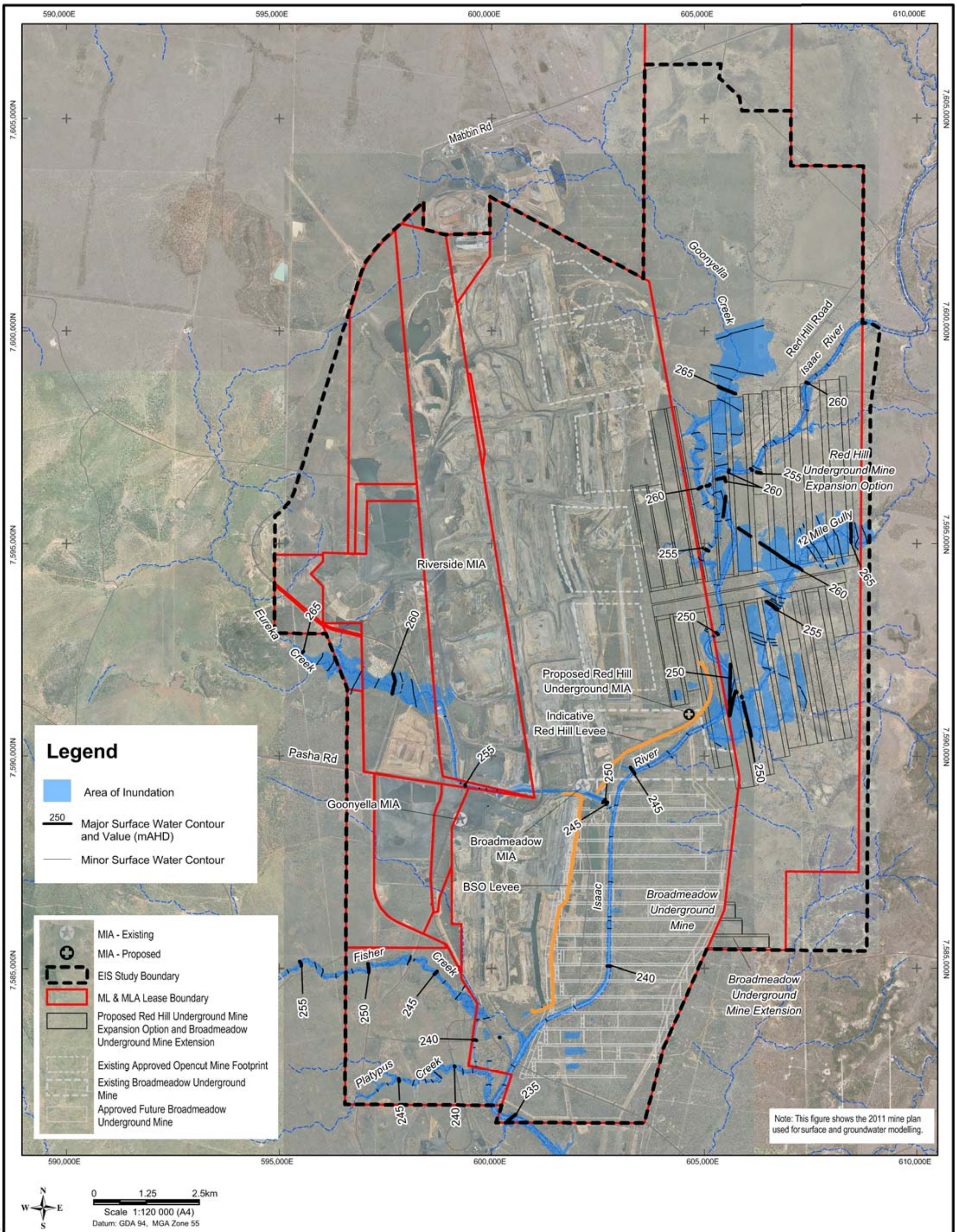

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Figure: **7-2**

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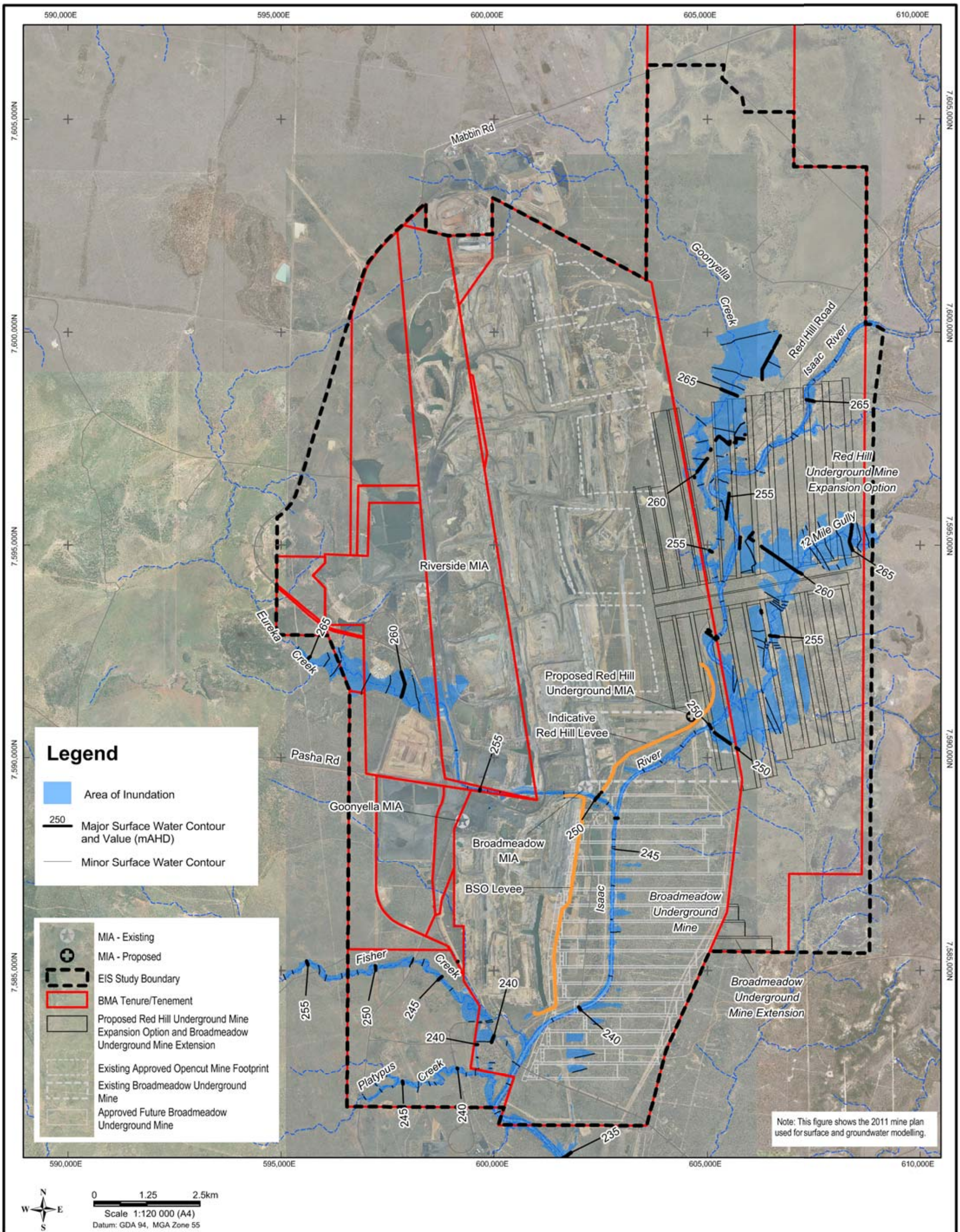

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Figure: **7-3**

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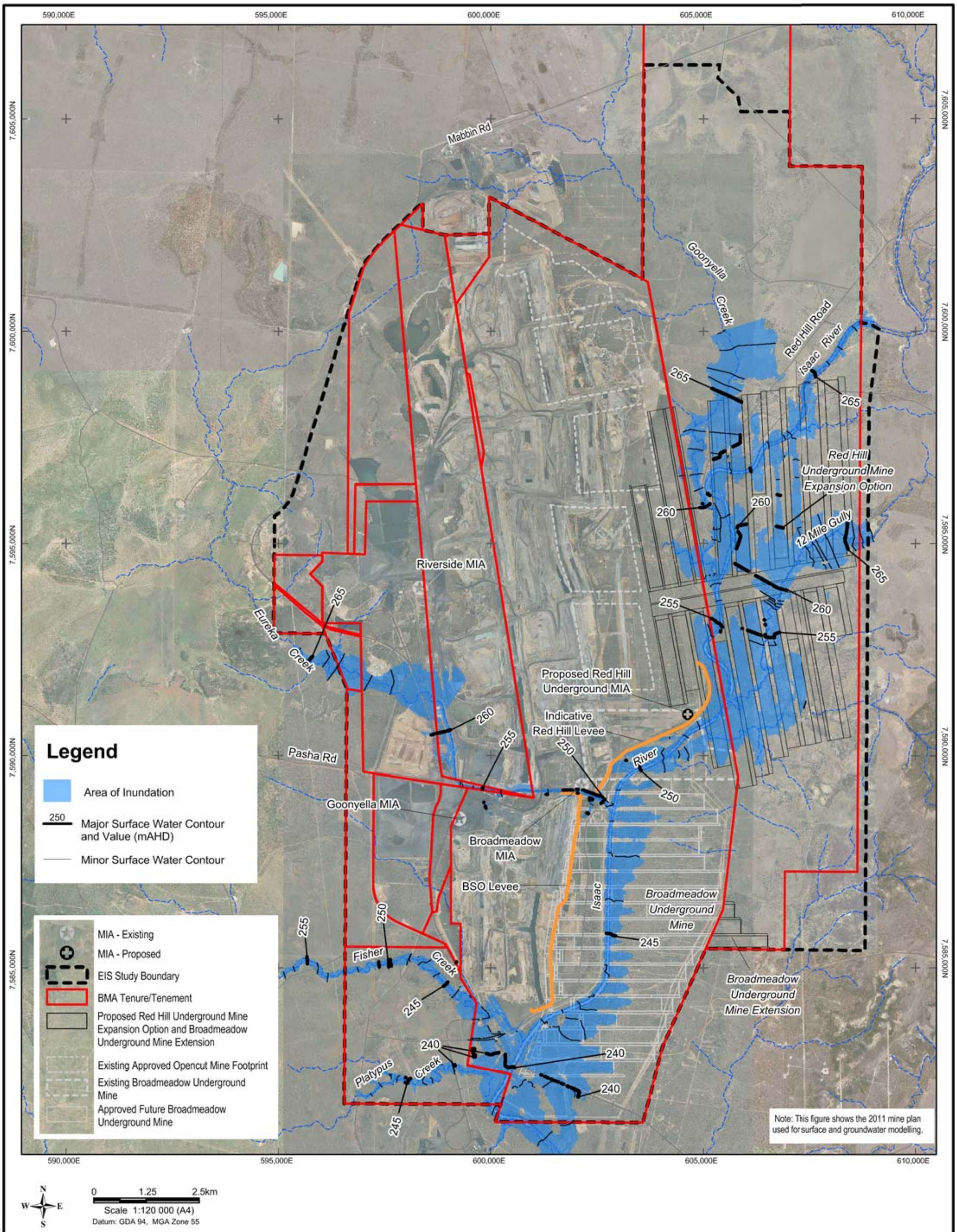

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Figure: **7-4**

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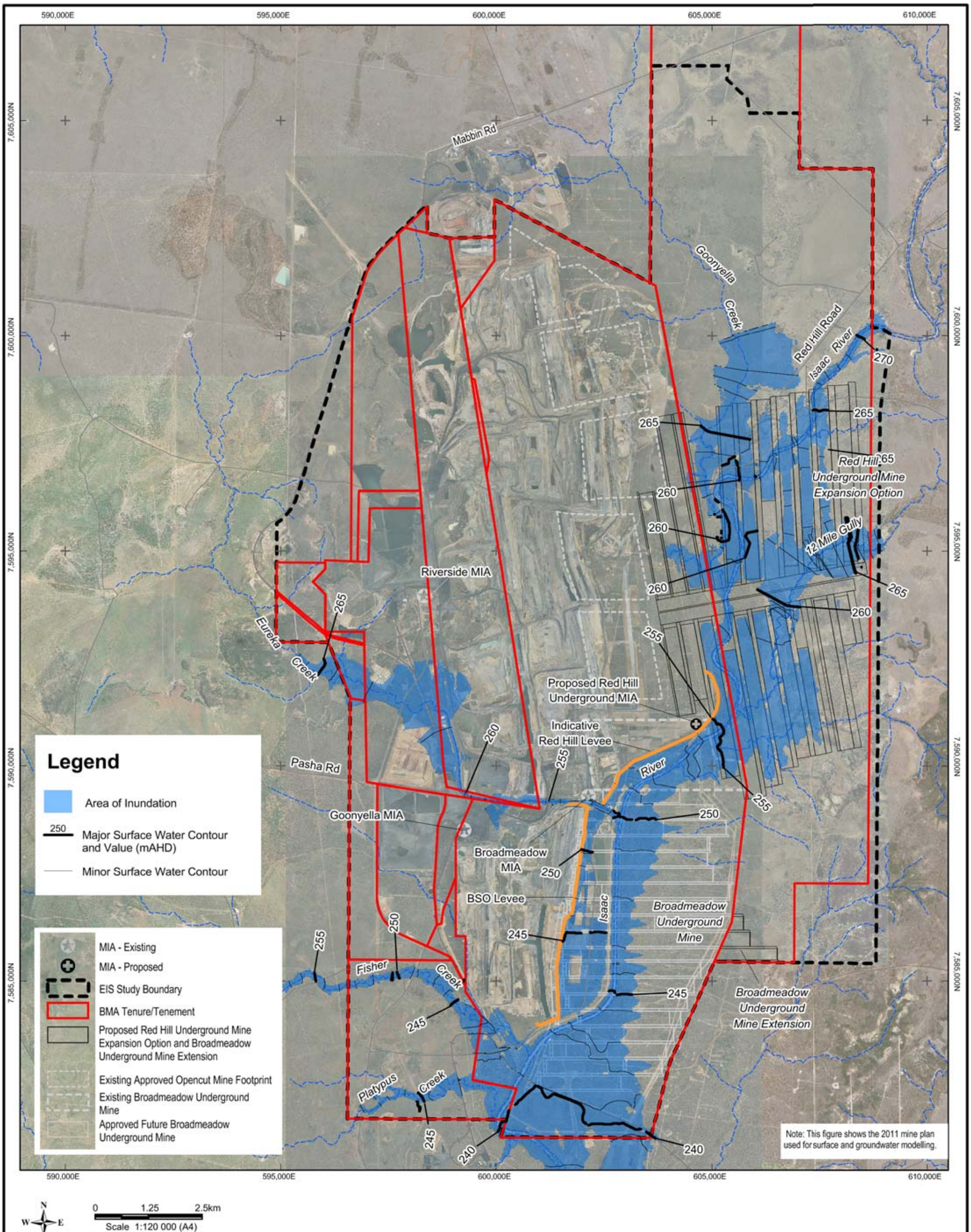

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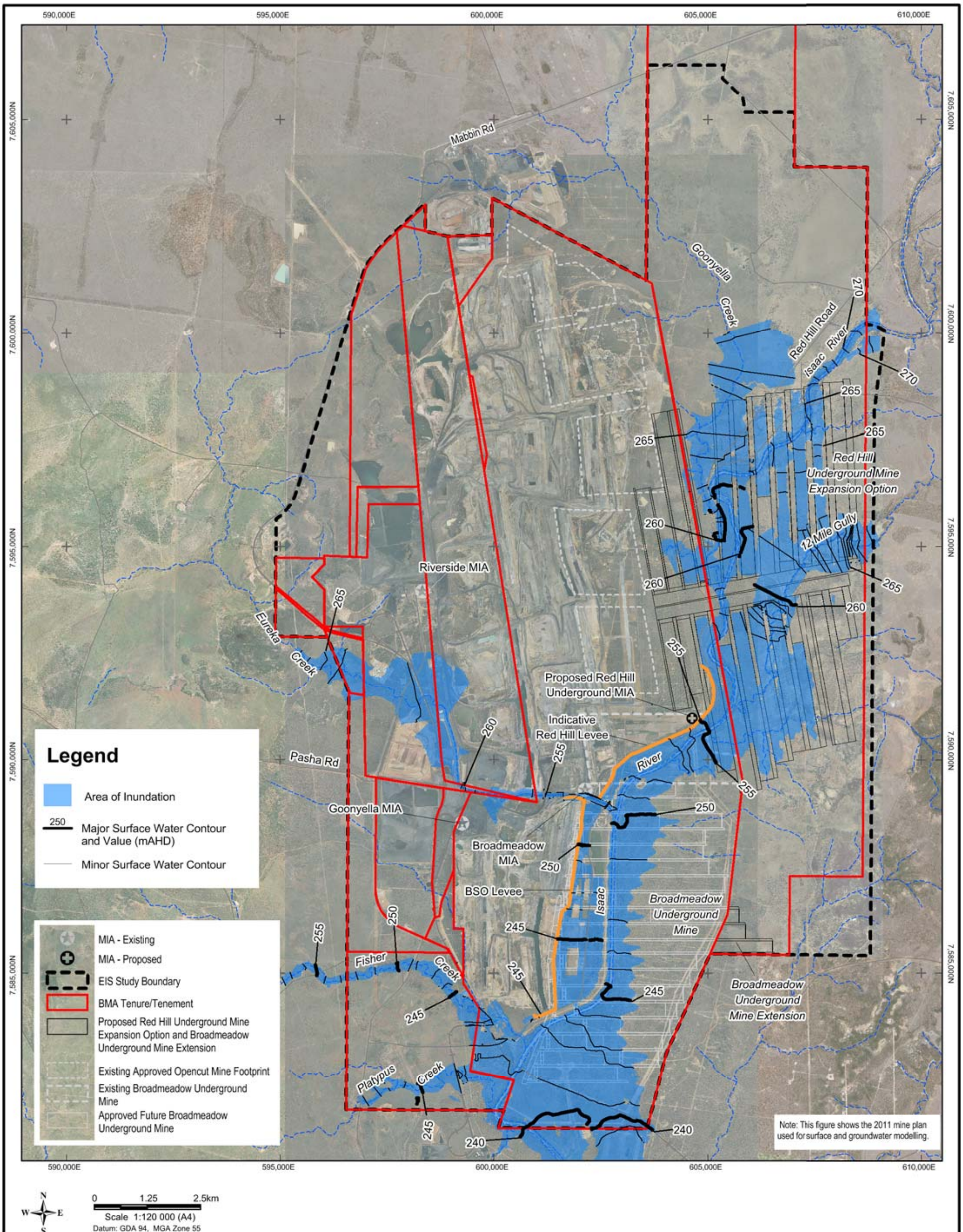

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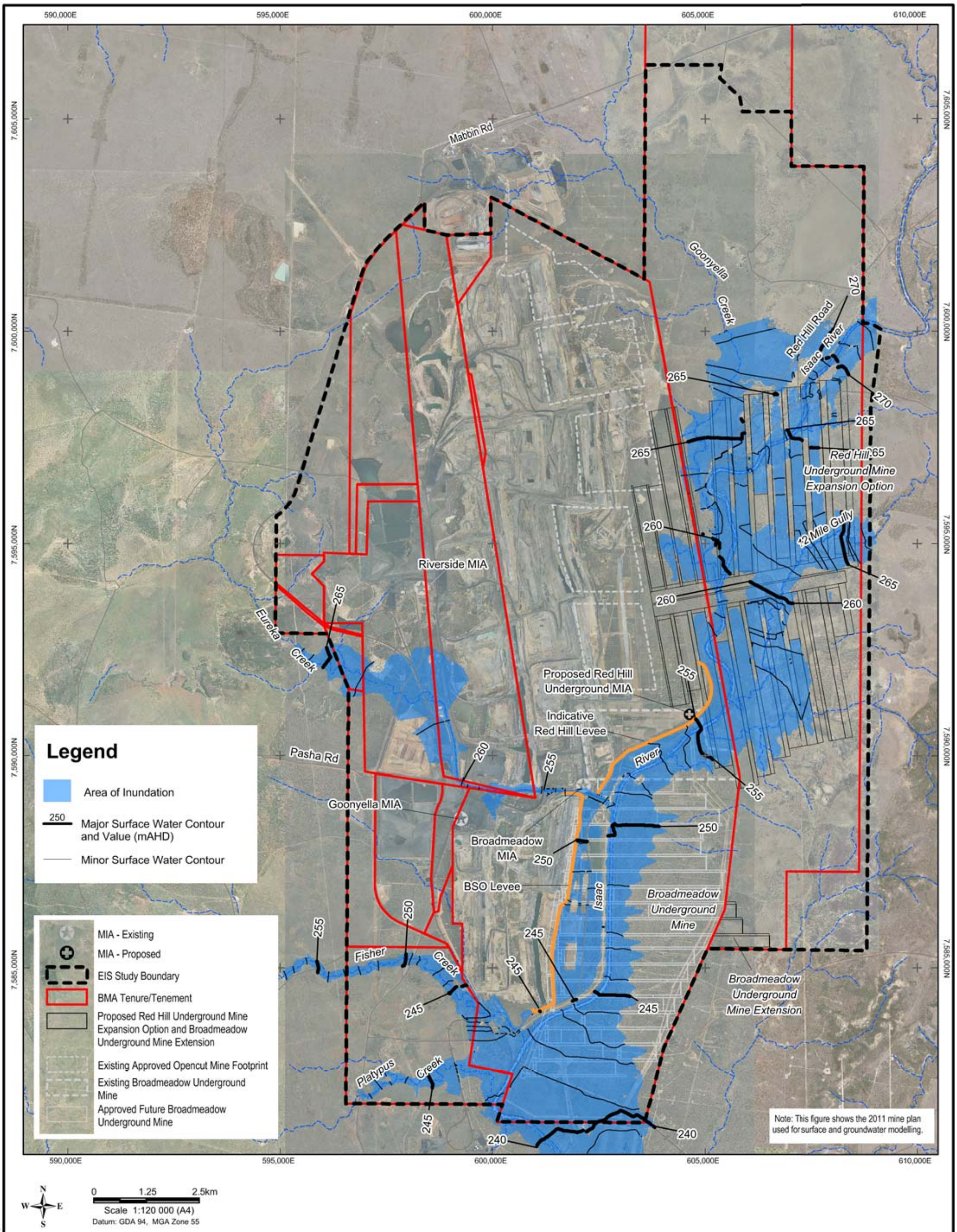

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Appendix A Basecase HECRAS Modelling Results (1 in 2 to 1 in 50 AEP)

Table Appendix A 1 Summary of Basecase Stream Power Results (1 in 2 to 1 in 50 AEP)

Creek	Stream Power (W/m²)				
	1 in 2 AEP	1 in 5 AEP	1 in 10 AEP	1 in 20 AEP	1 in 50 AEP
Isaac River to Goonyella confluence	Na	Na	10.8 – 145.7	11.2 – 194.2	11.6 – 210.6
Isaac River between Goonyella confluence and 12 Mile Gully confluence	Na	Na	13.5 – 113.0	27.6 – 138.6	28.3 – 159.2
Isaac River between confluence of 12 Mile Gully and Eureka Creek	Na	Na	8.9 – 252.8	9.9 – 301.8	7.3 – 258.0
Isaac River from Eureka Creek confluence to DS model boundary	Na	Na	6.1 – 357.9	7.6 – 402.5	11.0 – 457.5
12 Mile Gully	0.1 - 839.8	0.5 – 675.0	1.0 – 802.1	0.5 – 982.2	0.7 – 895.0
Goonyella Creek	2.4 – 188.6	0.3 – 330.9	3.7 – 205.8	4.3 – 256.3	4.7 – 326.7
Eureka Creek	0.2 – 5590.6	0.4 – 7634	0.5 – 8628	0.7 – 10538	0.5 – 12317
Fisher Creek	0.1 – 359	0.1 – 504	0.1 – 581	0.4 – 439	0.4 – 555
Platypus Creek	0.03 – 534	0.1 – 347	0.1 – 646	0.4 – 229	0.4 – 296

Table Appendix A 2 Summary of Basecase Stream Velocity Results (1 in 2 to 1 in 50 AEP)

Creek	Velocity (m/s)				
	1 in 2 AEP	1 in 5 AEP	1 in 10 AEP	1 in 20 AEP	1 in 50 AEP
Isaac River to Goonyella confluence	Na	Na	0.97 – 2.32	1.08 – 2.59	1.15 – 2.68
Isaac River between Goonyella confluence and 12 Mile Gully confluence	Na	Na	1.09 – 2.14	1.42 – 2.36	1.58 – 2.56
Isaac River between confluence of 12 Mile Gully and Eureka Creek	Na	Na	0.93 – 2.82	0.99 – 3.03	1.01 – 3.14
Isaac River from Eureka Creek confluence to DS model boundary	Na	Na	0.84 – 3.24	0.93 – 3.44	1.08 – 3.71
12 Mile Gully	0.22 - 3.57	0.36 – 4.78	0.54 – 3.49	0.46 – 3.79	0.51 – 3.82
Goonyella Creek	0.69 – 2.28	0.42 – 2.76	0.77 – 3.03	0.83 – 3.49	0.89 – 3.95
Eureka Creek	0.29 – 5.93	0.31 – 6.81	0.35 – 7.21	0.43 – 7.99	0.38 – 8.68
Fisher Creek	0.19 – 2.50	0.22 – 2.88	0.24 – 3.06	0.34 – 2.72	0.34 – 3.00
Platypus Creek	0.13 – 2.41	0.21 – 2.68	0.25 – 3.29	0.30 – 2.30	0.31 – 2.58

Appendix A - Basecase HECRAS Modelling Results (1 in 2 to 1 in 50 AEP)

Table Appendix A 3 Summary of Basecase Maximum Water Depths in Channel (1 in 2 to 1 in 50 AEP)

Creek	Maximum Flow Depth (m)				
	1 in 2 AEP	1 in 5 AEP	1 in 10 AEP	1 in 20 AEP	1 in 50 AEP
Isaac River to Goonyella confluence	Na	Na	4.1 – 6.1	4.6 – 6.7	5.3 – 7.4
Isaac River between Goonyella confluence and 12 Mile Gully confluence	Na	Na	4.5 – 6.3	6.4 – 8.3	6.4 – 8.3
Isaac River between confluence of 12 Mile Gully and Eureka Creek	Na	Na	3.0 – 6.1	3.9 – 6.9	4.9 – 7.9
Isaac River from Eureka Creek confluence to DS model boundary	Na	Na	3.8 – 6.8	4.4 – 7.5	5.1 – 8.6
12 Mile Gully	1.6 – 4.1	1.9 – 4.9	2.1 – 5.4	2.2 – 6.3	2.2 – 7.2
Goonyella Creek	1.8 – 3.8	2.1 – 4.4	2.5 – 5.2	2.8 – 6.0	3.1 – 6.8
Eureka Creek	0.6 – 6.1	0.8 – 7.0	1.0 – 7.4	1.2 – 8.2	1.5 – 9.0
Fisher Creek	0.5 – 3.2	0.7 – 3.8	0.8 – 4.1	1.1 – 5.4	1.3 – 6.6
Platypus Creek	0.3 – 3.9	0.6 – 4.3	0.6 – 4.4	0.8 – 4.7	1.1 – 4.9

B

Appendix B Basecase HECRAS Modelling Results (1 in 100 to 1 in 2000 AEP)

Table Appendix B 1 Summary of Basecase Stream Power Results (1 in 100 to 1 in 2000 AEP)

Creek	Stream Power (W/m2)			
	1 in 100 AEP	1 in 500 AEP	1 in 1000 AEP	1 in 2000 AEP
12 Mile Gully	0.2 – 222	0.3 – 343	0.4 – 357	0.5 – 263
Goonyella Creek	2.2 – 339	1.9 – 312	2.1 – 315	2.5 – 338
Eureka Creek	0.3 – 2145	0.2 – 592	0.2 – 795	0.2 – 1043
Fisher Creek	0.6 – 342	1.2 – 700	1.3 – 953	1.7 – 1285
Platypus Creek	0.04 – 354	0.1 – 218	0.1 – 252	0.1 – 258

Table Appendix B 2 Summary of Basecase Stream Power Results (1 in 100 to 1 in 2000 AEP)

Creek	Velocity (m/s)			
	1 in 100 AEP	1 in 500 AEP	1 in 1000 AEP	1 in 2000 AEP
12 Mile Gully	0.46 – 2.60	0.49 – 2.89	0.53 – 3.00	0.59 – 3.19
Goonyella Creek	0.90 – 4.31	0.89 – 4.41	0.92 – 4.57	0.98 – 4.88
Eureka Creek	0.32 – 5.37	0.35 – 4.08	0.37 – 4.36	0.37 – 4.77
Fisher Creek	0.39 – 2.79	0.52 – 3.62	0.56 – 4.05	0.61 – 4.50
Platypus Creek	0.24 – 2.48	0.28 – 2.44	0.31 – 2.60	0.30 – 2.65

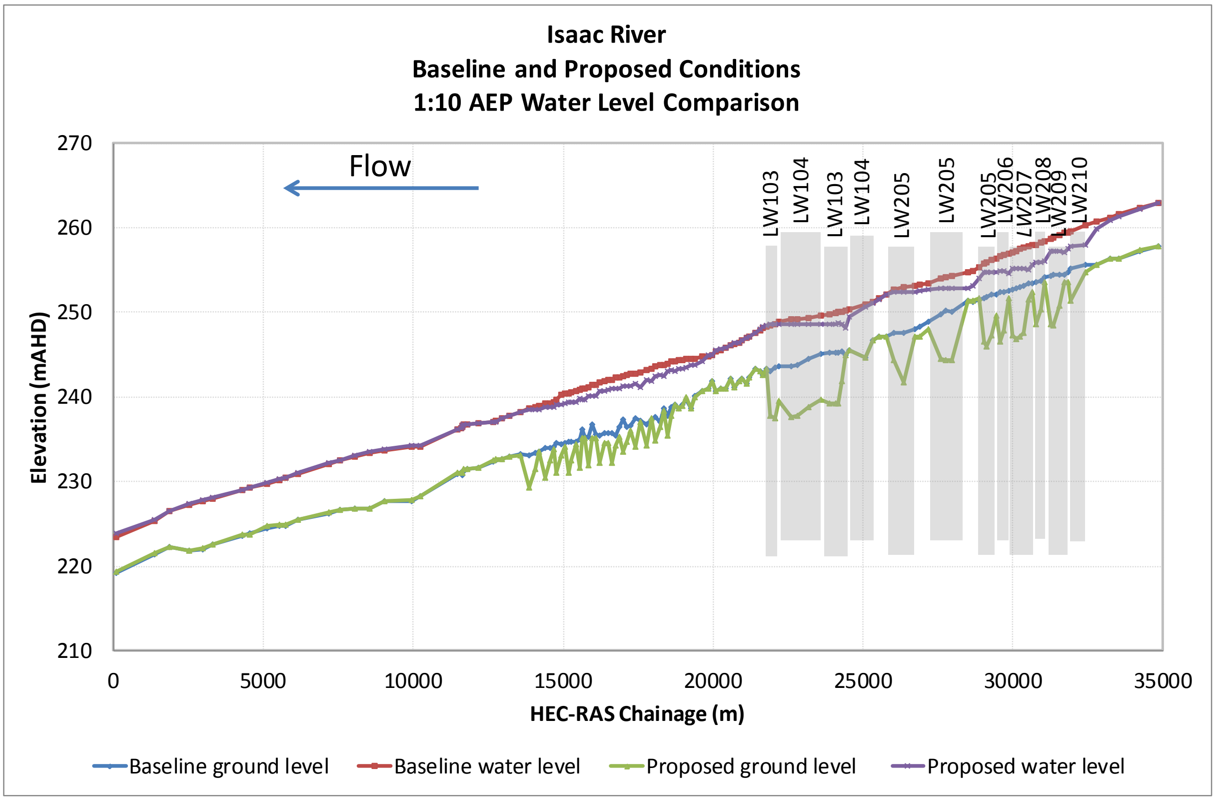
Table Appendix B 3 Summary of Basecase Stream Power Results (1 in 100 to 1 in 2000 AEP)

Creek	Maximum Flow Depth (m)			
	1 in 100 AEP	1 in 500 AEP	1 in 1000 AEP	1 in 2000 AEP
12 Mile Gully	2.2 – 10.9	2.5 – 12.1	2.7 – 12.4	2.8 – 12.6
Goonyella Creek	3.3– 10.3	3.7 – 12.3	3.9 – 13.0	4.1 – 13.5
Eureka Creek	2.8 – 10.2	3.3 – 12.9	3.5 – 13.4	3.7 – 13.8
Fisher Creek	1.6 – 6.8	2.1 – 7.1	2.2 – 7.2	2.4 – 7.3
Platypus Creek	1.3 – 7.9	1.8 – 8.9	1.9 – 9.2	2.1 – 9.6

C

Appendix C Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

Figure Appendix C 1 Longitudinal Plot of Isaac River Water Surface Elevation Comparison 1 in 10 AEP



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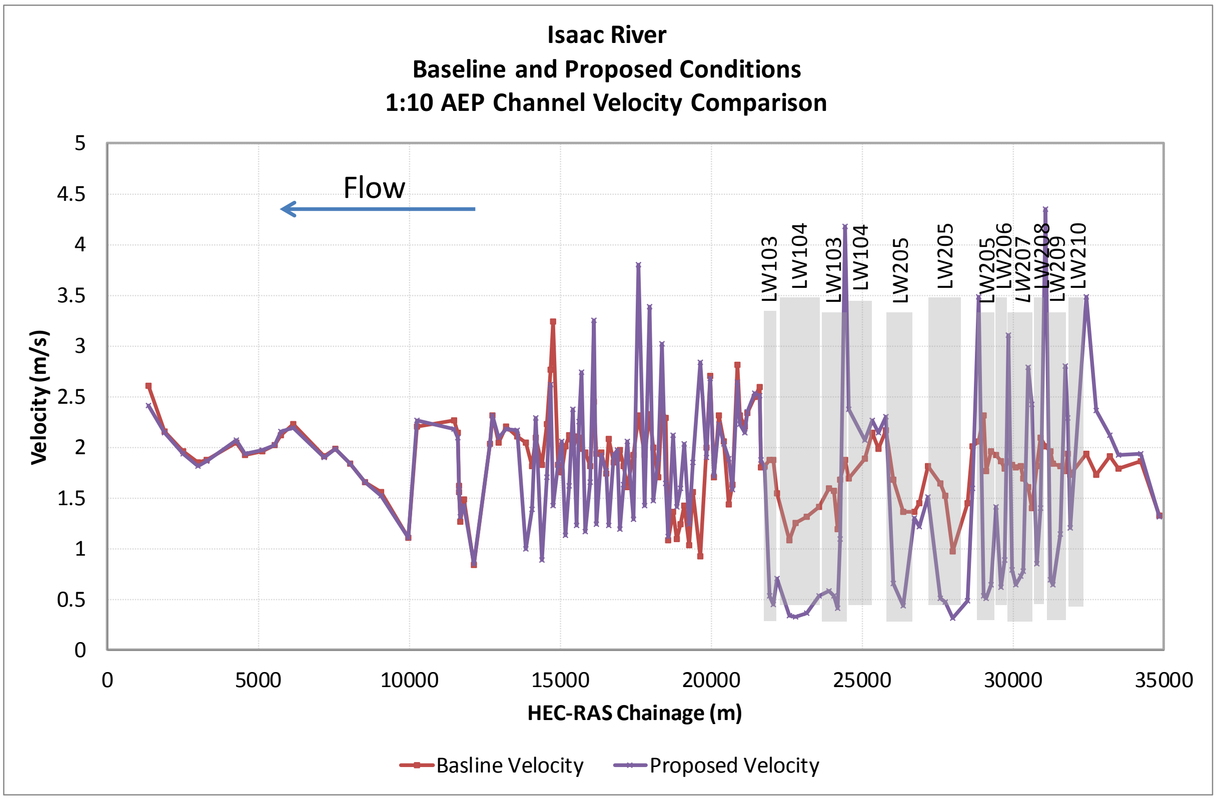
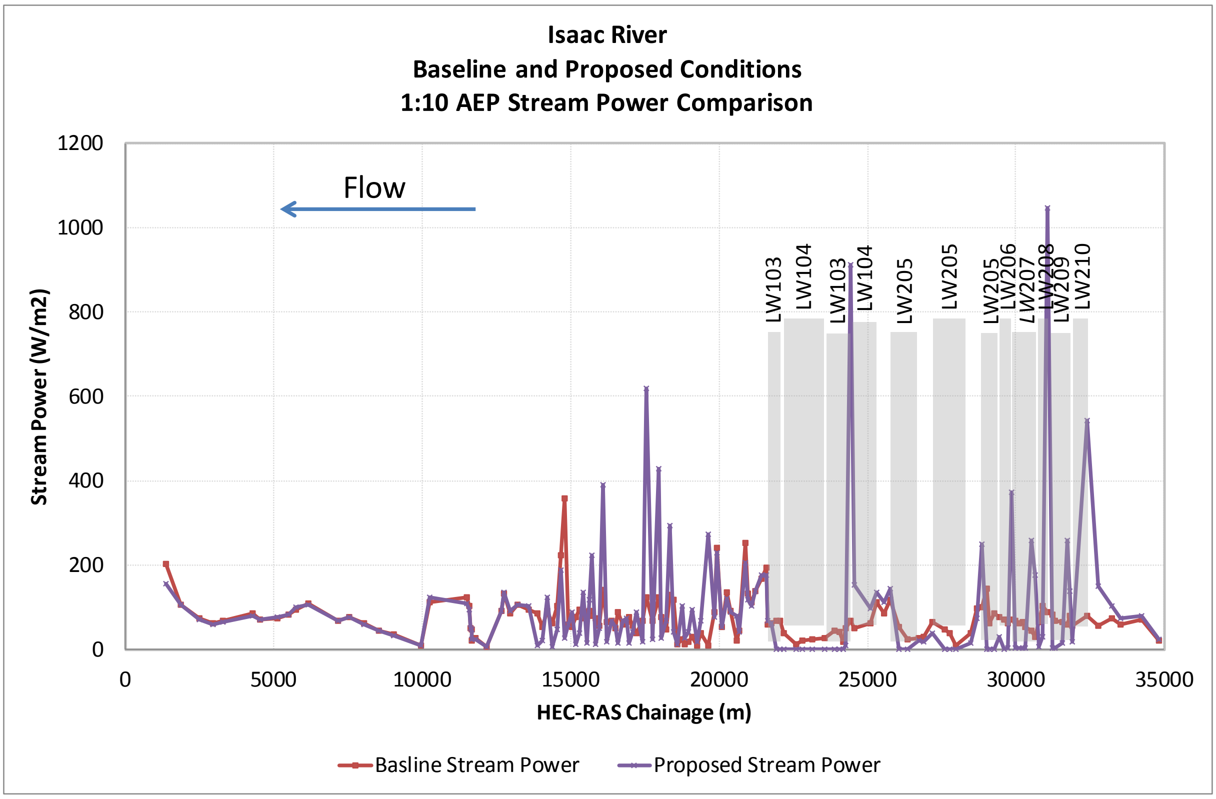
Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

Figure Appendix C 2 Longitudinal Plot of Isaac River Stream Velocity Comparison 1 in 10 AEP



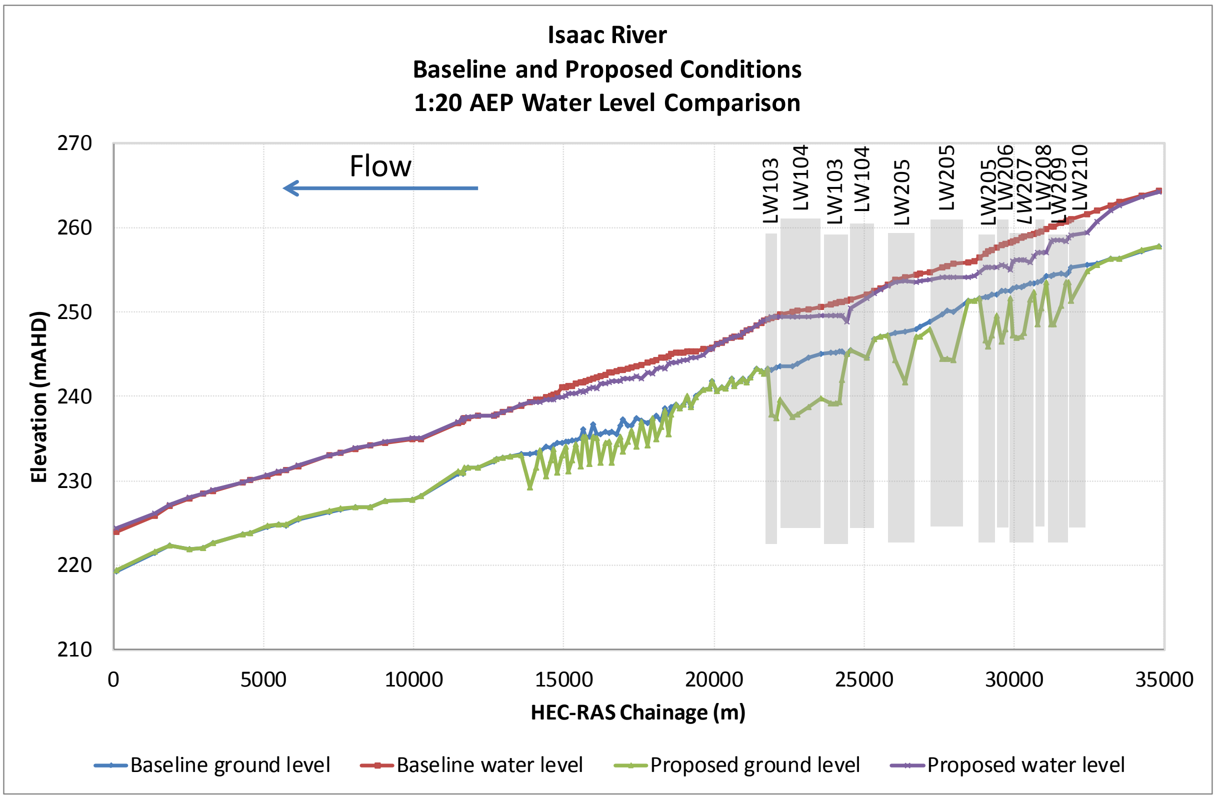
Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

Figure Appendix C 3 Longitudinal Plot of Isaac River Stream Power Comparison 1 in 10 AEP



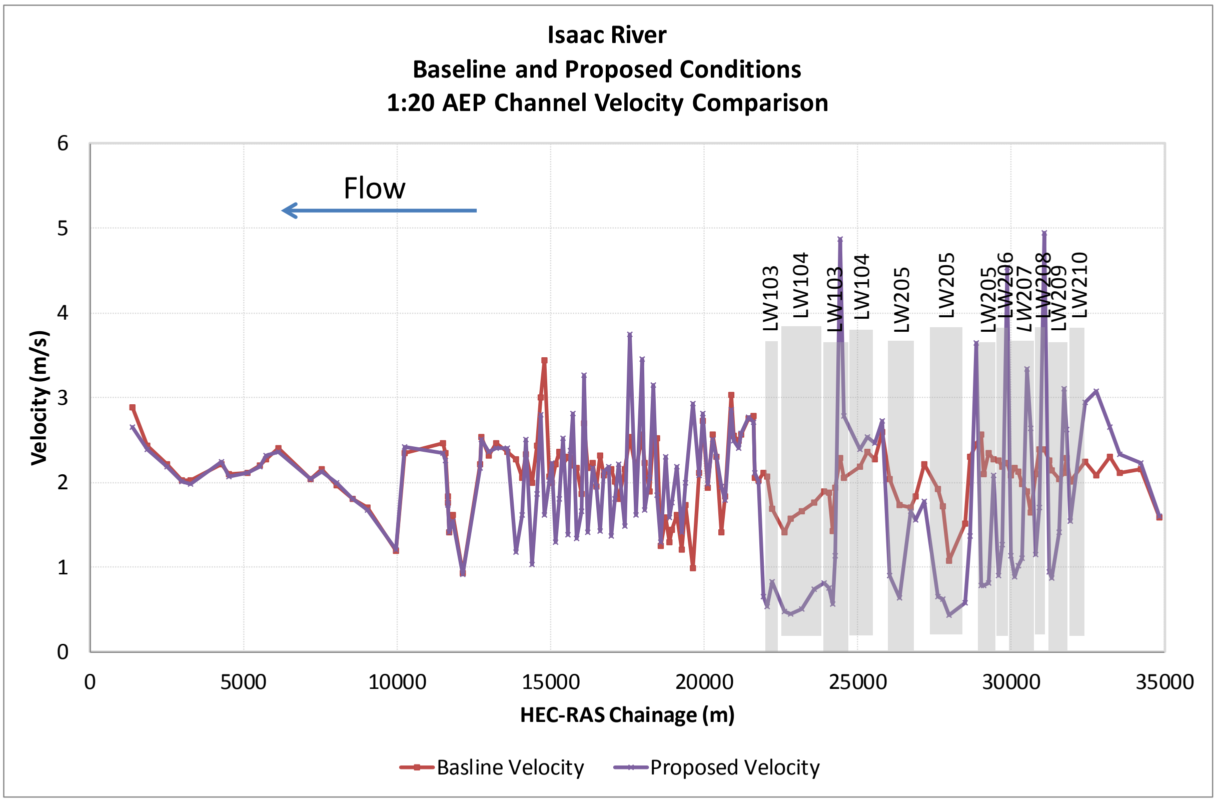
Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

Figure Appendix C 4 Longitudinal Plot of Isaac River Water Surface Elevation Comparison 1 in 20 AEP



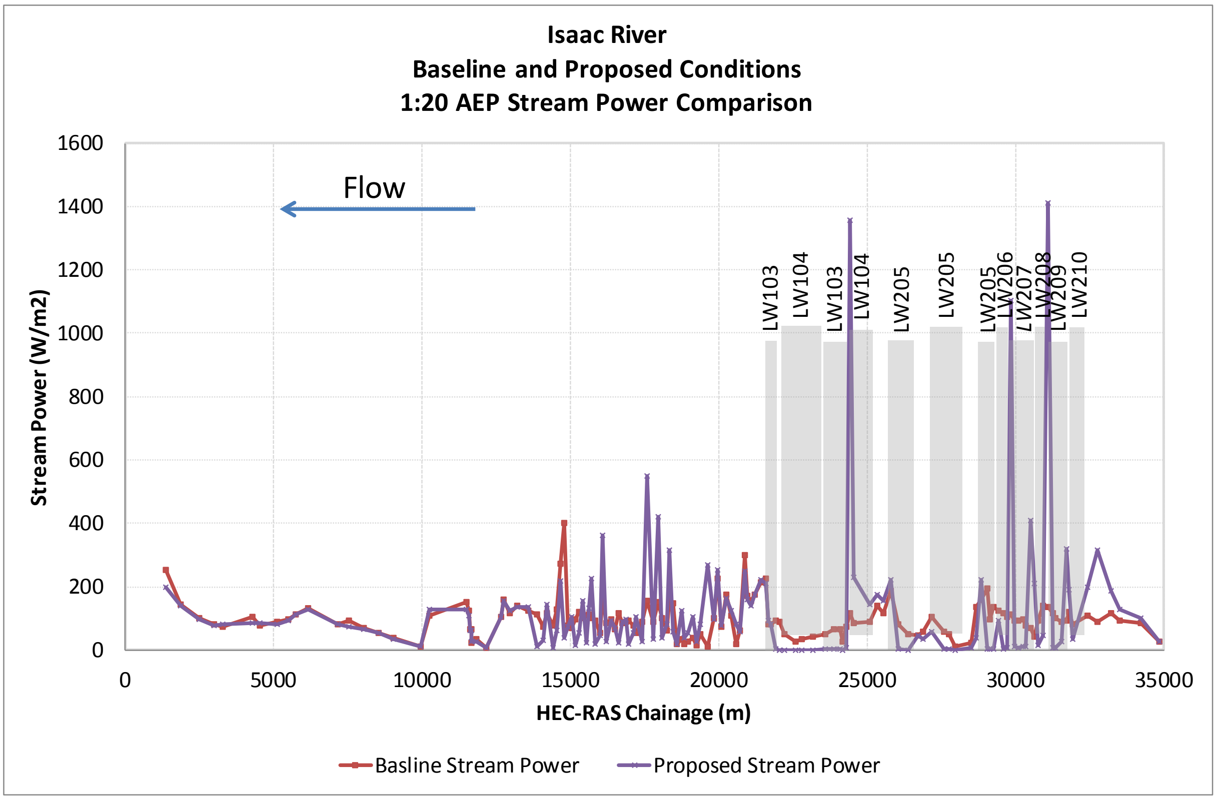
Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

Figure Appendix C 5 Longitudinal Plot of Isaac River Stream Velocity Comparison 1 in 20 AEP



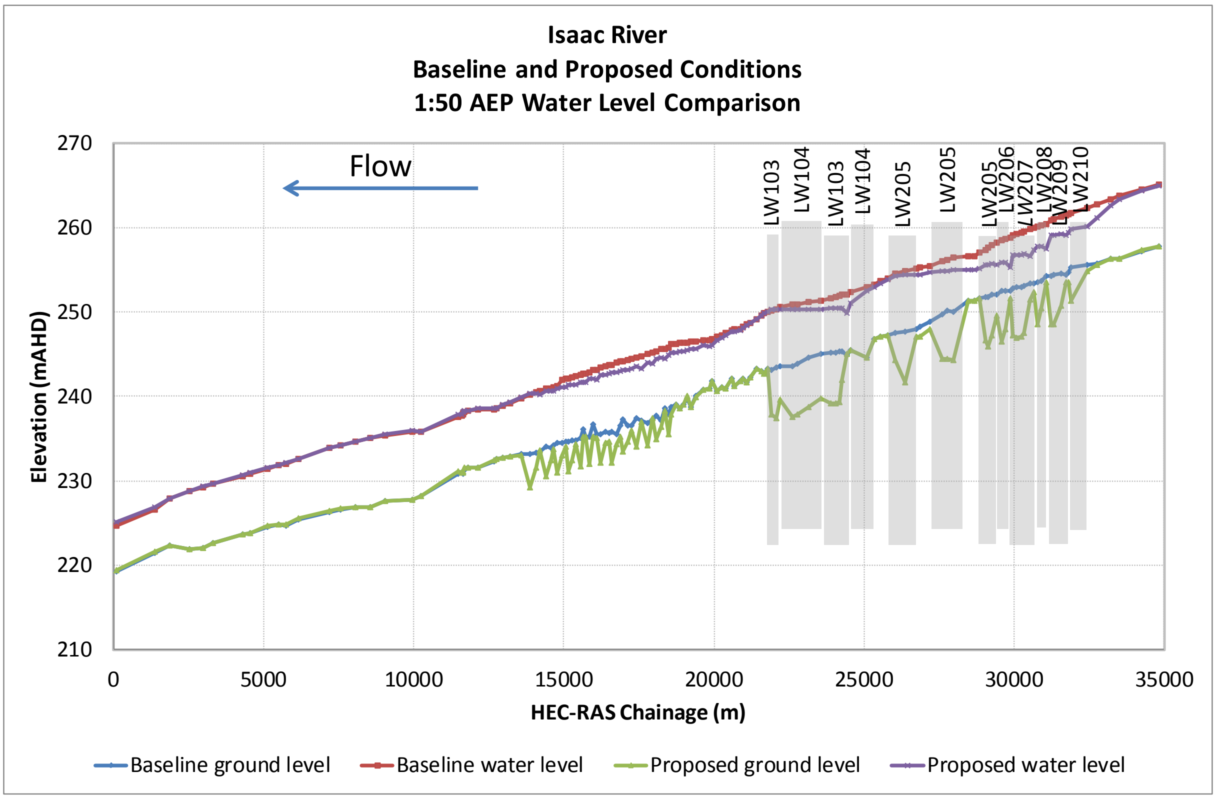
Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

Figure Appendix C 6 Longitudinal Plot of Isaac River Stream Power Comparison 1 in 20 AEP



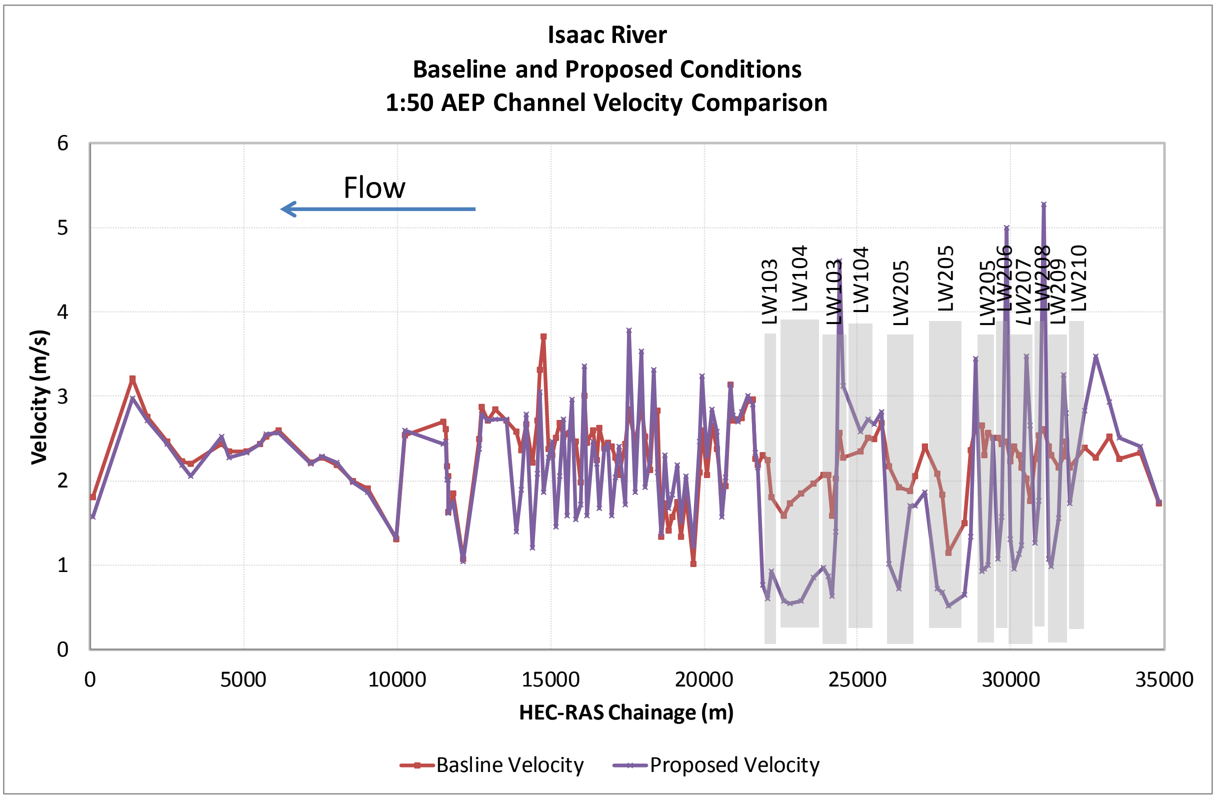
Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

Figure Appendix C 7 Longitudinal Plot of Isaac River Water Surface Elevation Comparison 1 in 50 AEP



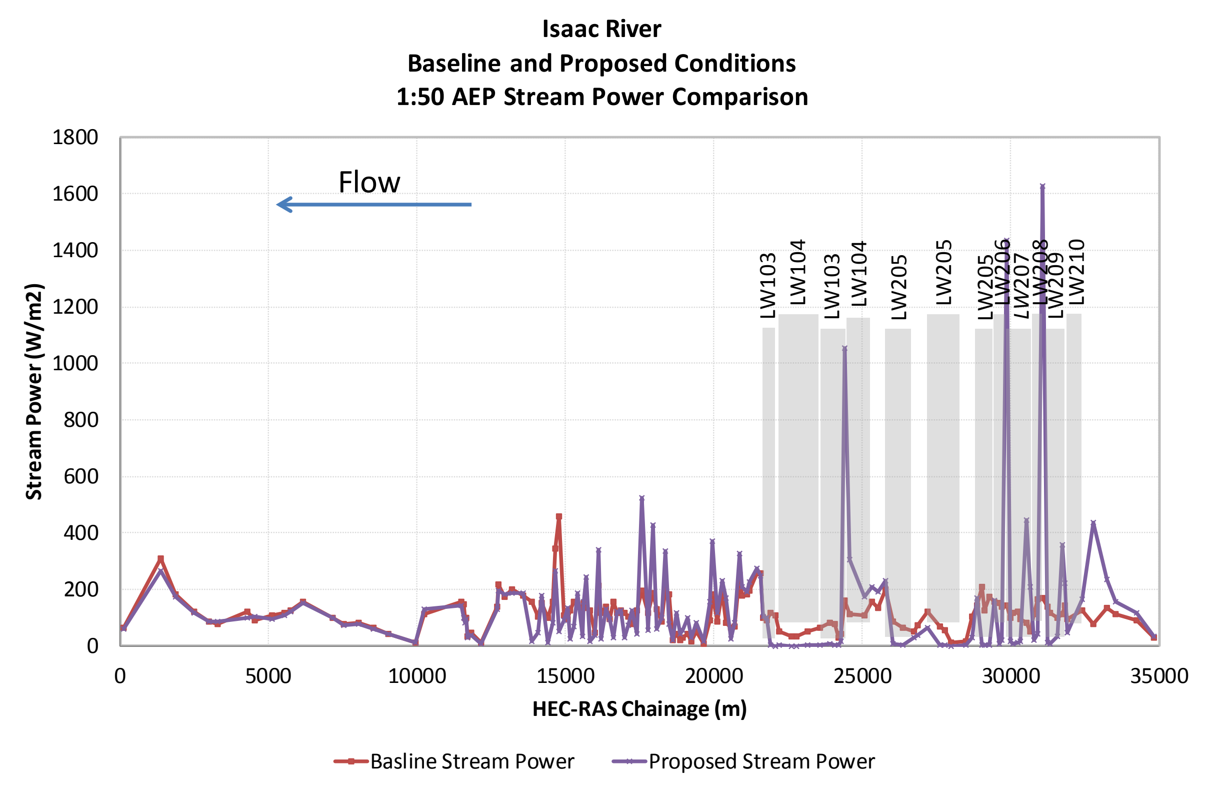
Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

Figure Appendix C 8 Longitudinal Plot of Isaac River Stream Velocity Comparison 1 in 50 AEP



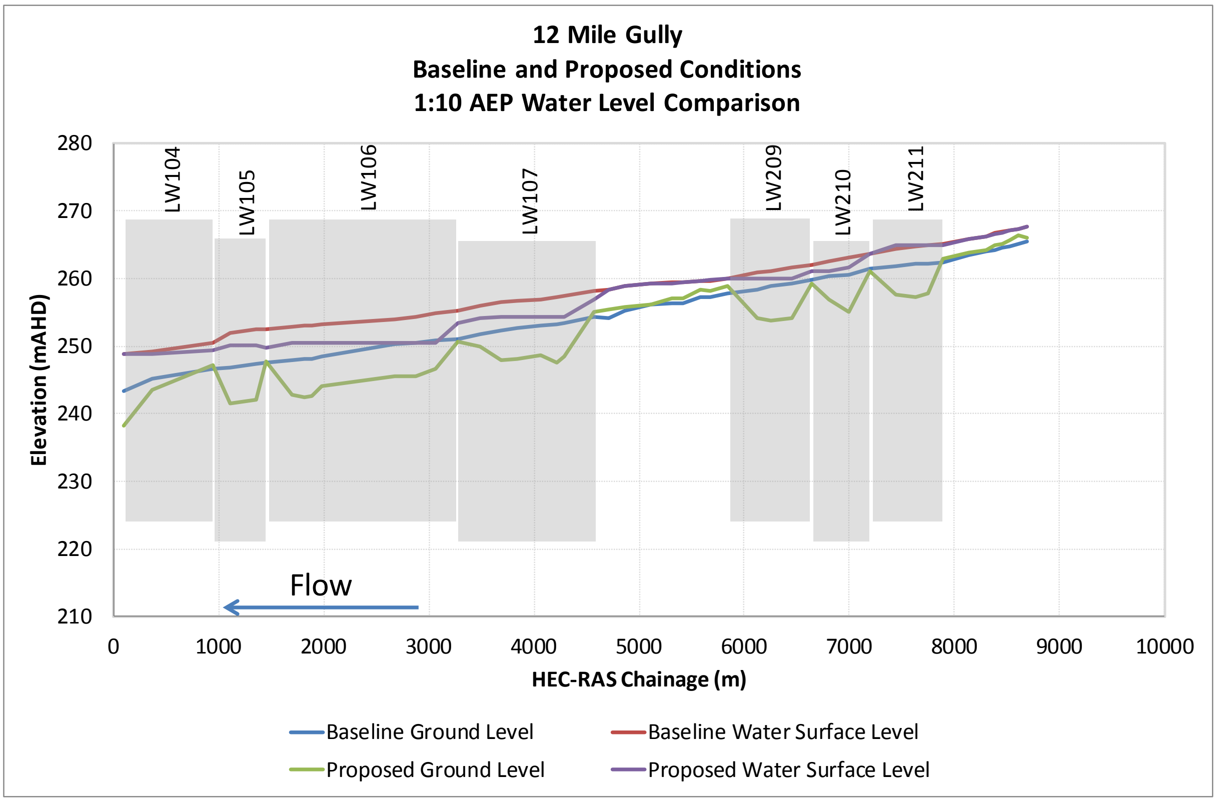
Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

Figure Appendix C 9 Longitudinal Plot of Isaac River Stream Power Comparison 1 in 50 AEP



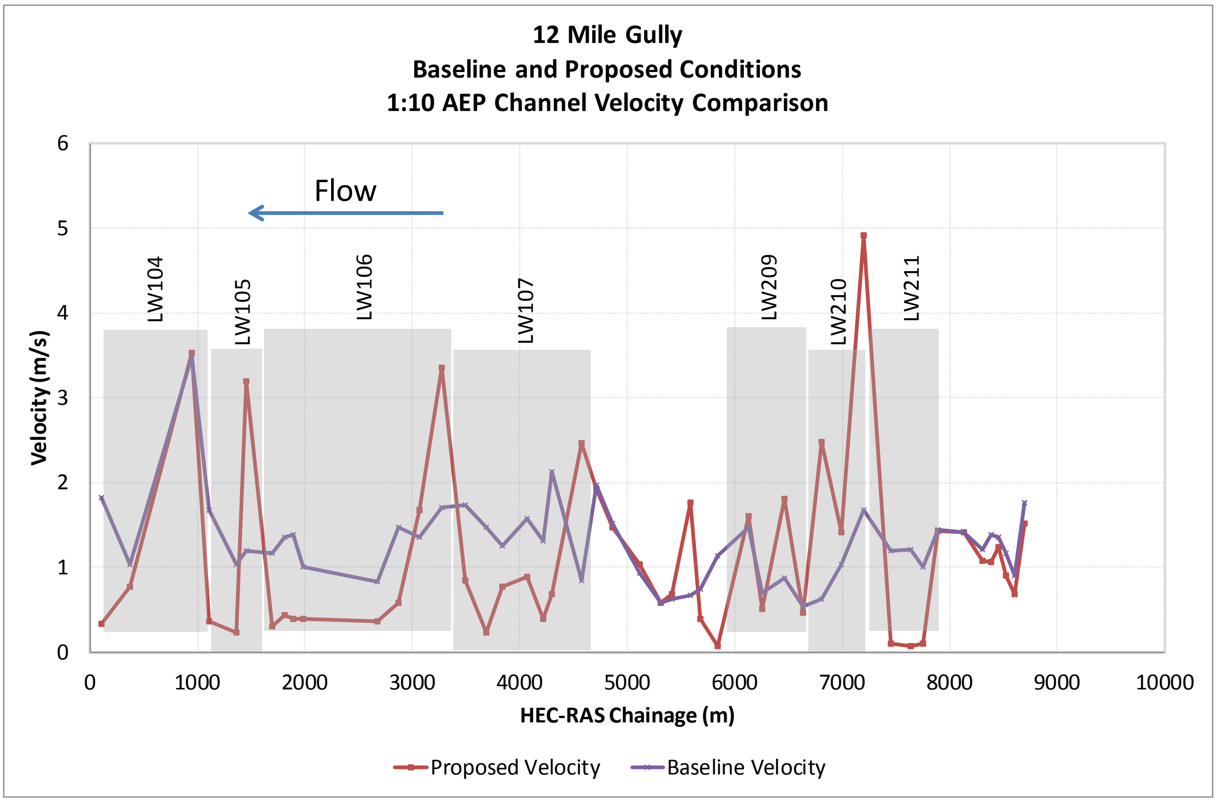
Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

Figure Appendix C 10 Longitudinal Plot of 12 Mile Gully Water Surface Elevation Comparison 1 in 10 AEP



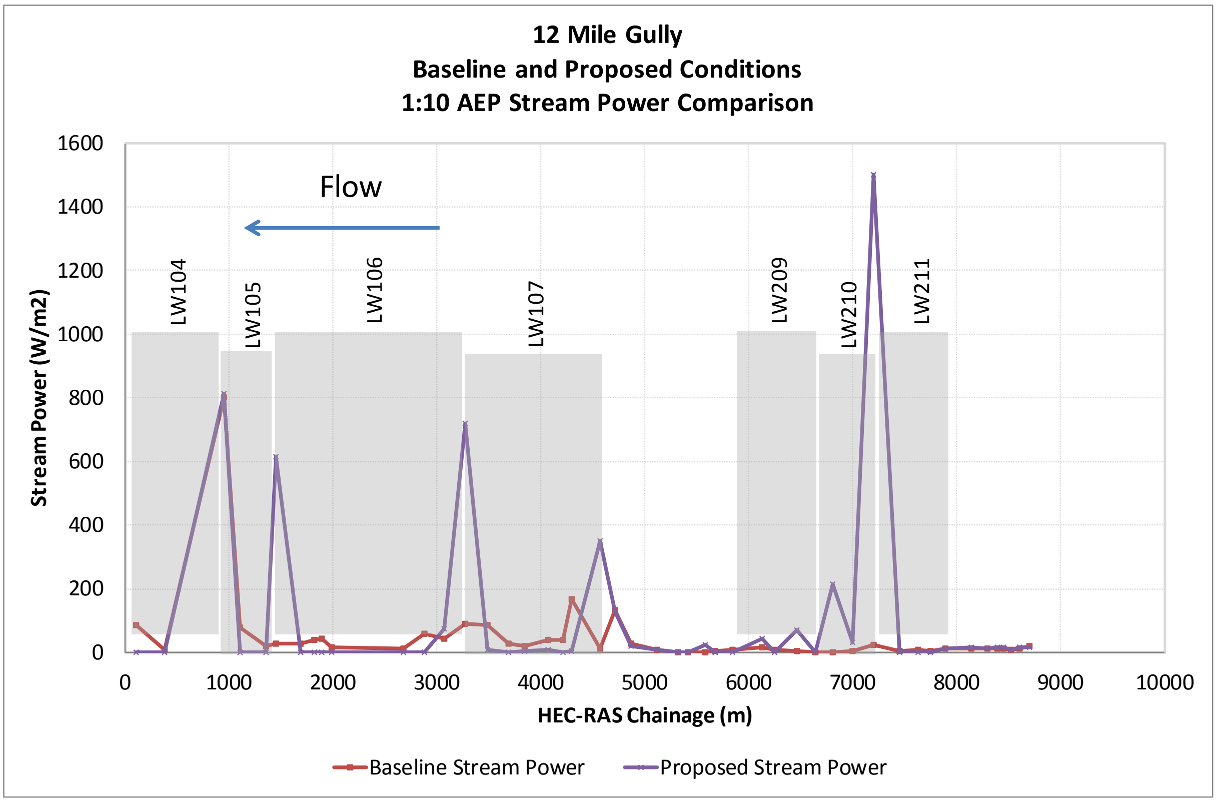
Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

Figure Appendix C 11 Longitudinal Plot of 12 Mile Gully Stream Velocity Comparison 1 in 10 AEP



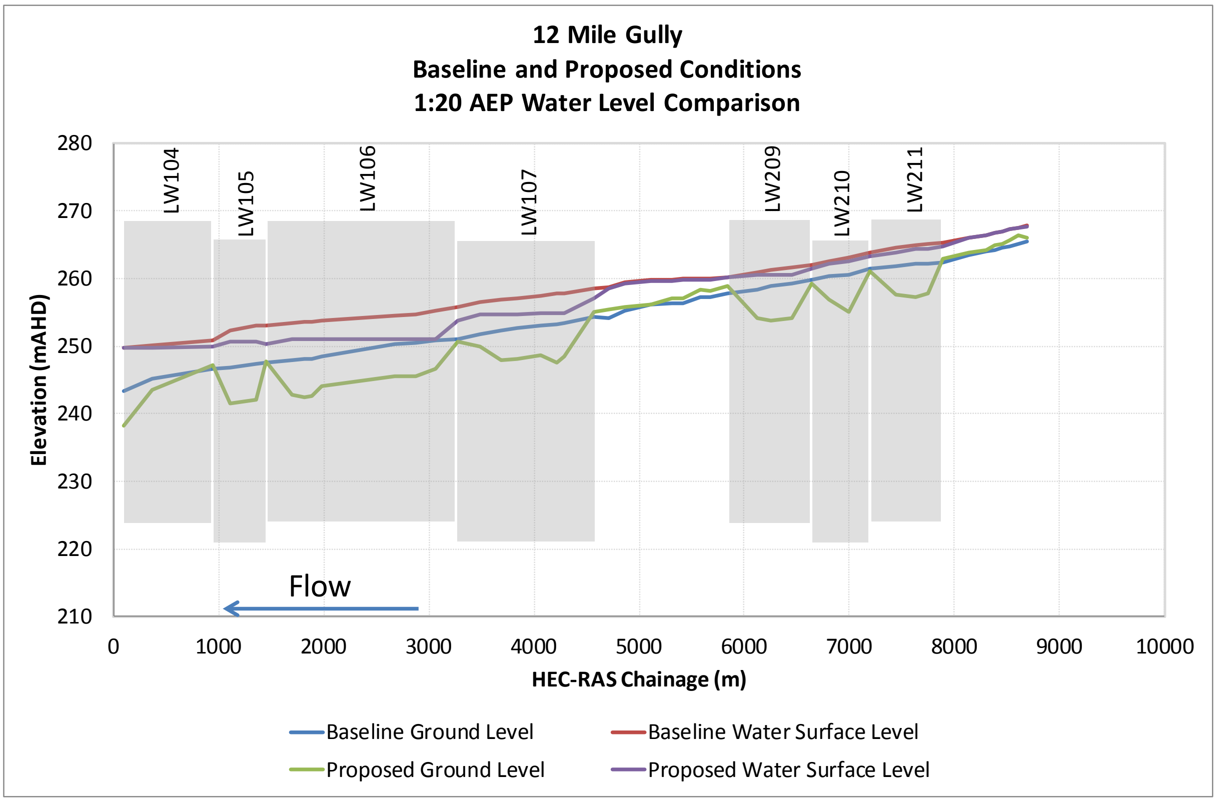
Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

Figure Appendix C 12 Longitudinal Plot of 12 Mile Gully Stream Power Comparison 1 in 10 AEP



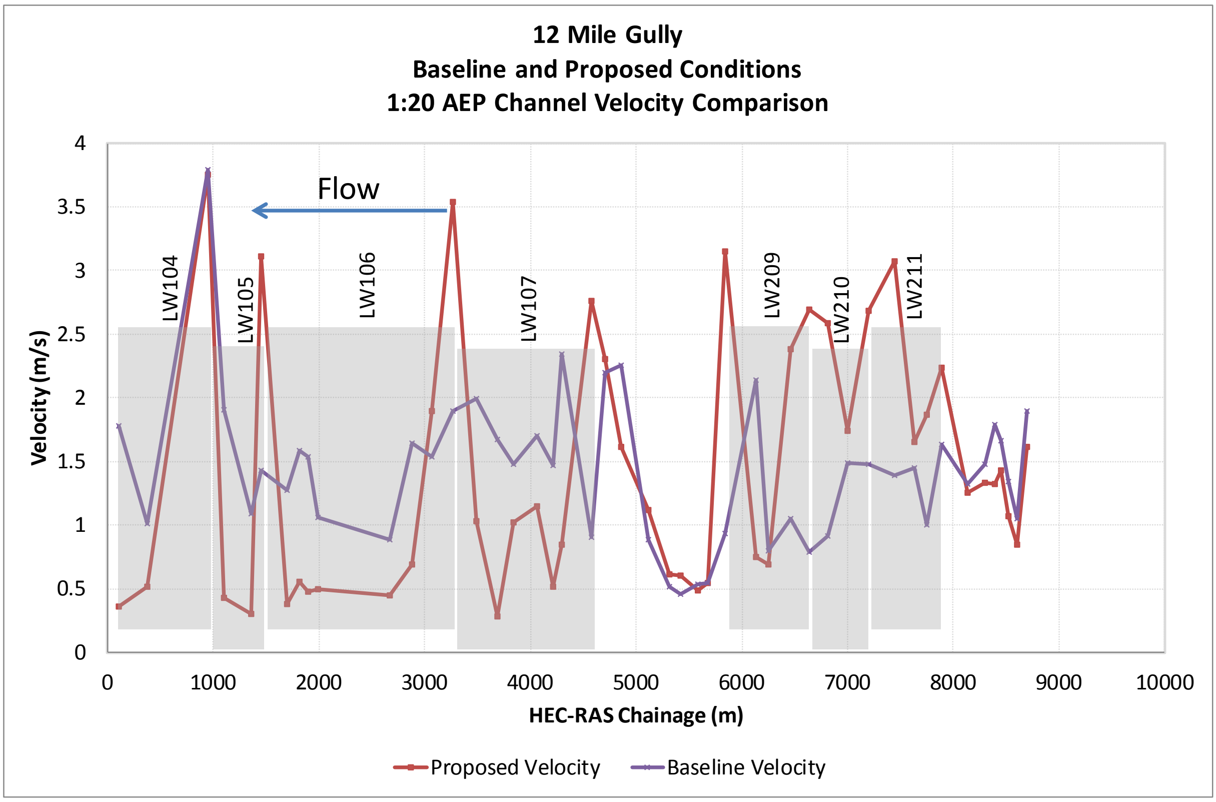
Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

Figure Appendix C 13 Longitudinal Plot of 12 Mile Gully Water Surface Elevation Comparison 1 in 20 AEP



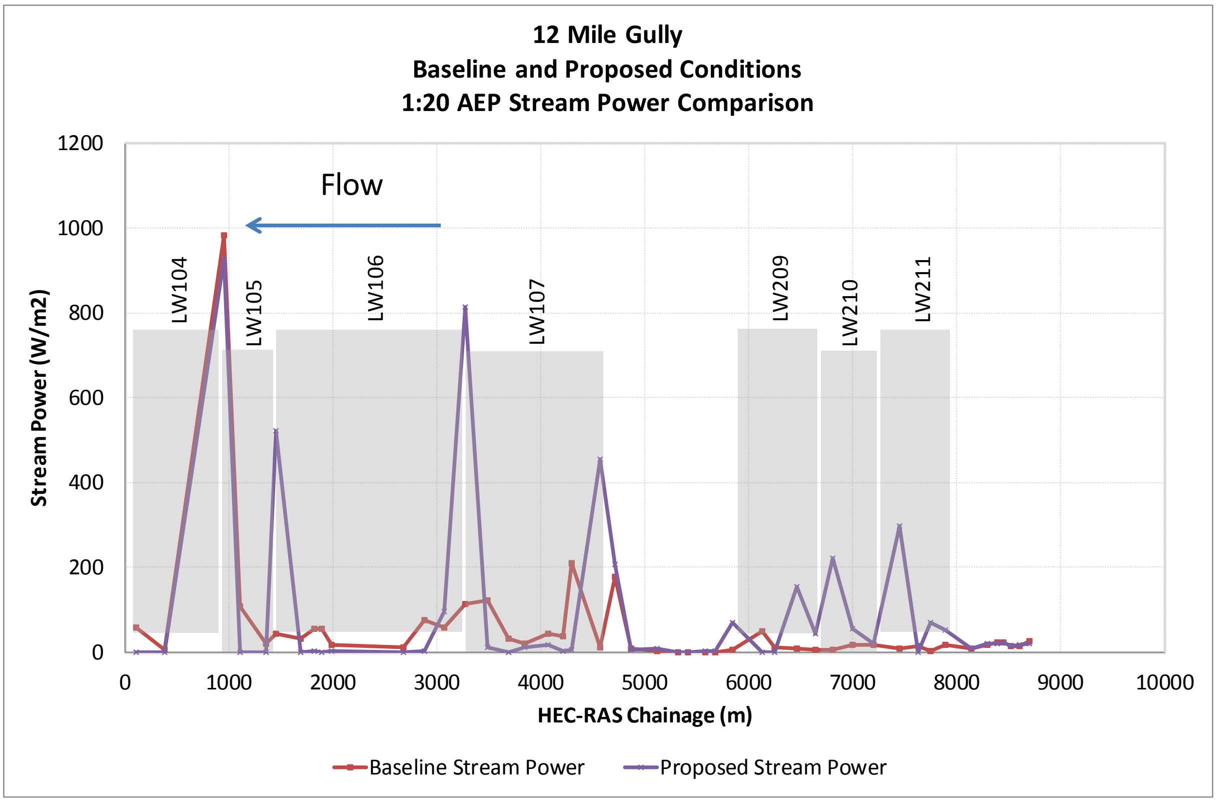
Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

Figure Appendix C 14 Longitudinal Plot of 12 Mile Gully Stream Velocity Comparison 1 in 20 AEP



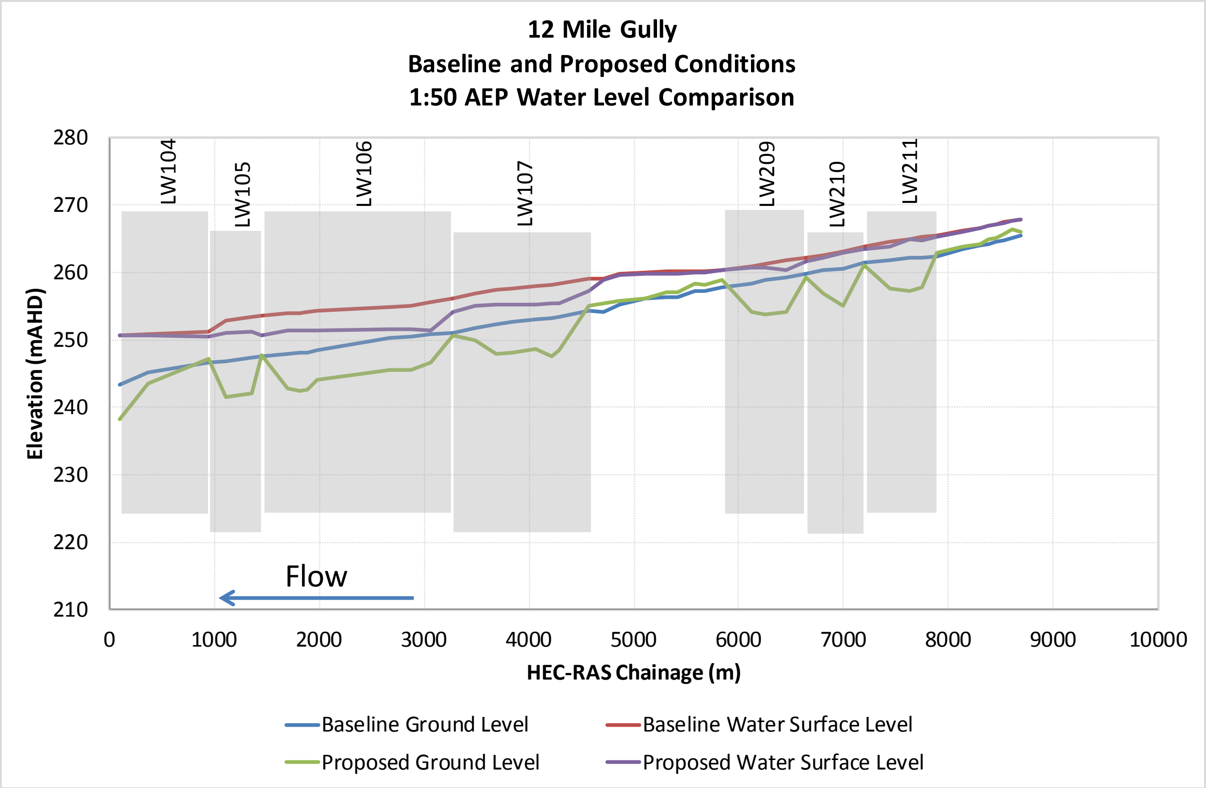
Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

Figure Appendix C 15 Longitudinal Plot of 12 Mile Gully Stream Power Comparison 1 in 20 AEP



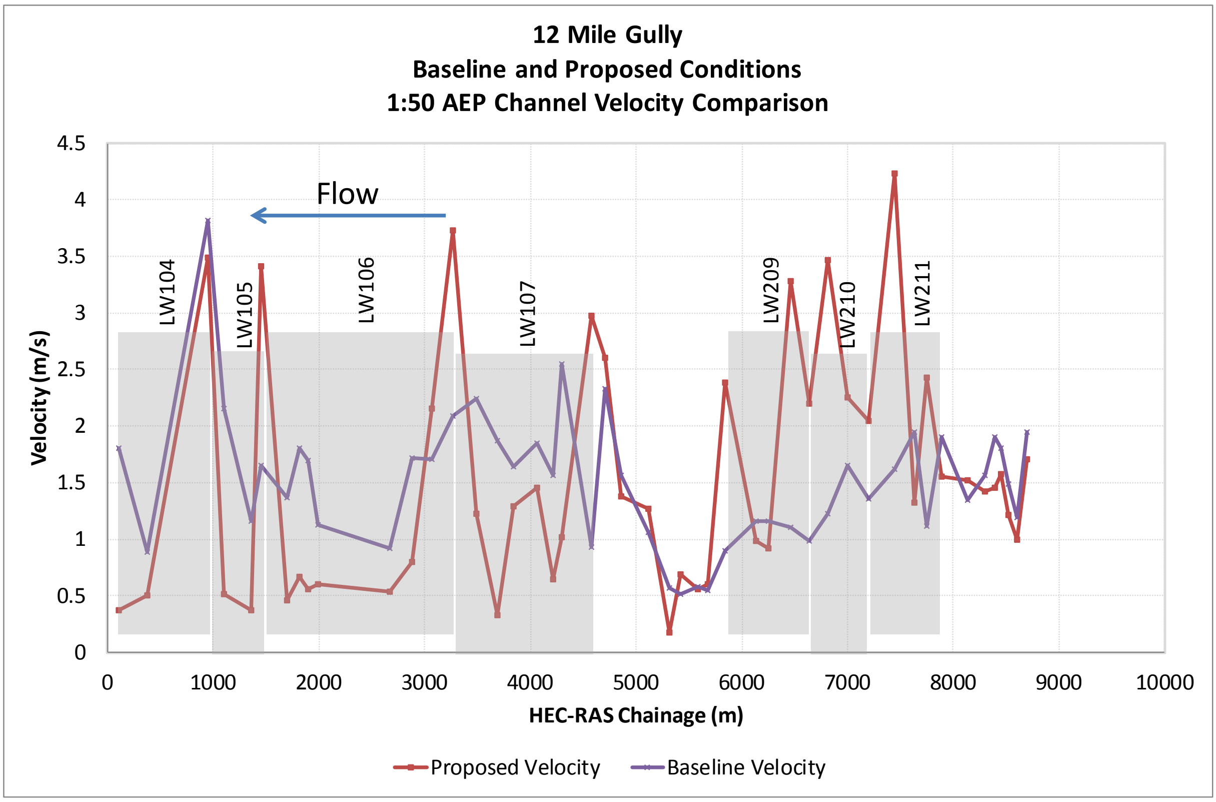
Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

Figure Appendix C 16 Longitudinal Plot of 12 Mile Gully Water Surface Elevation Comparison 1 in 50 AEP



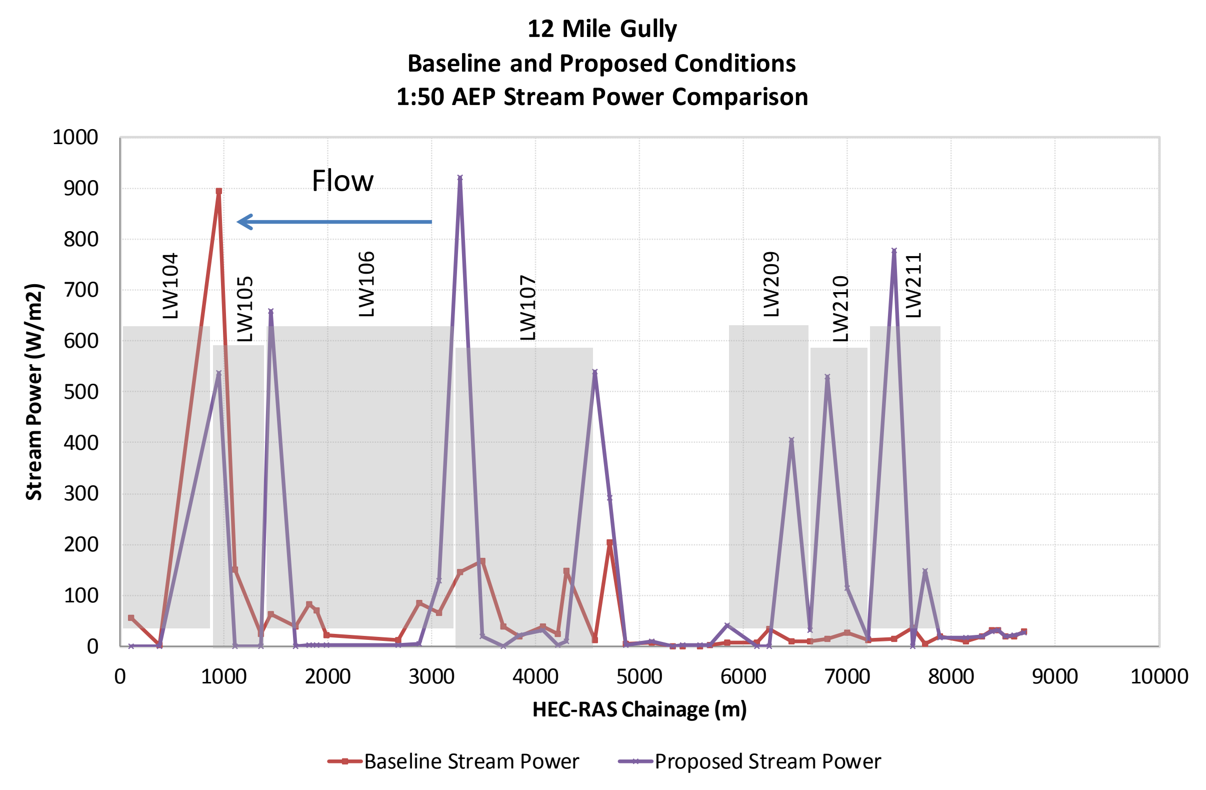
Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

Figure Appendix C 17 Longitudinal Plot of 12 Mile Gully Stream Velocity Comparison 1 in 50 AEP



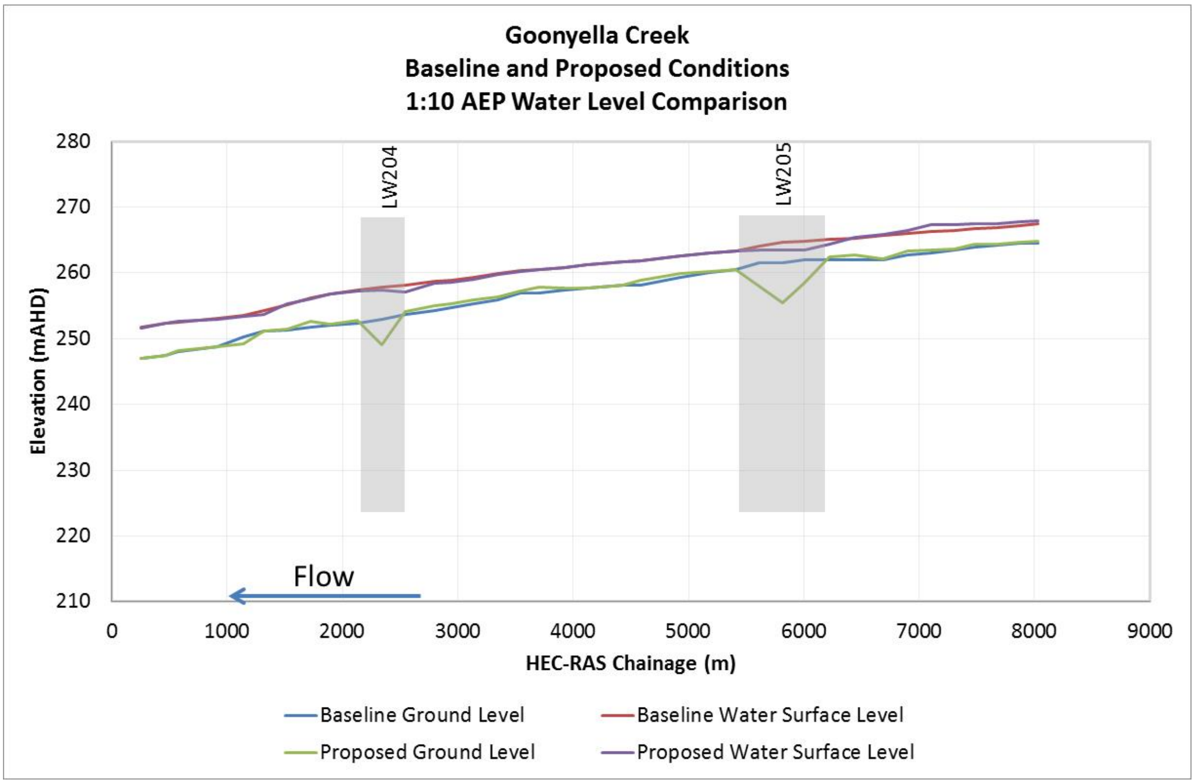
Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

Figure Appendix C 18 Longitudinal Plot of 12 Mile Gully Stream Power Comparison 1 in 50 AEP



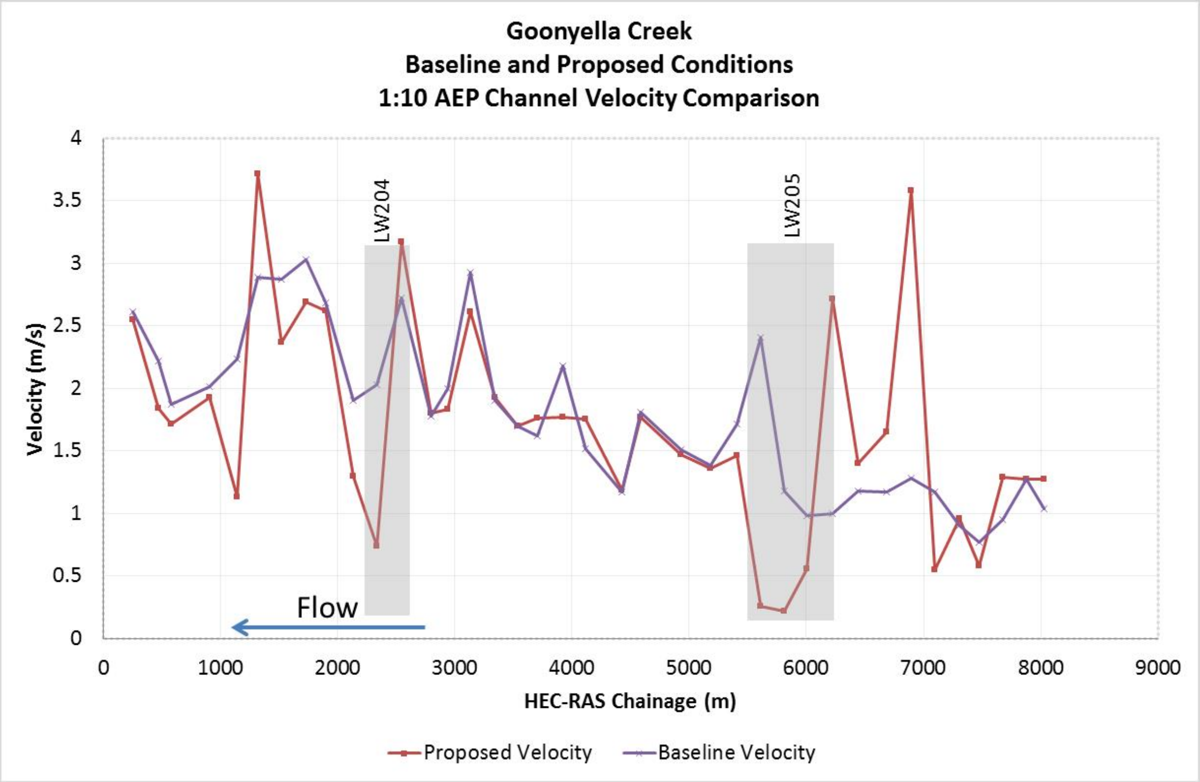
Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

Figure Appendix C 19 Longitudinal Plot of Goonyella Creek Water Surface Elevation Comparison 1 in 10 AEP



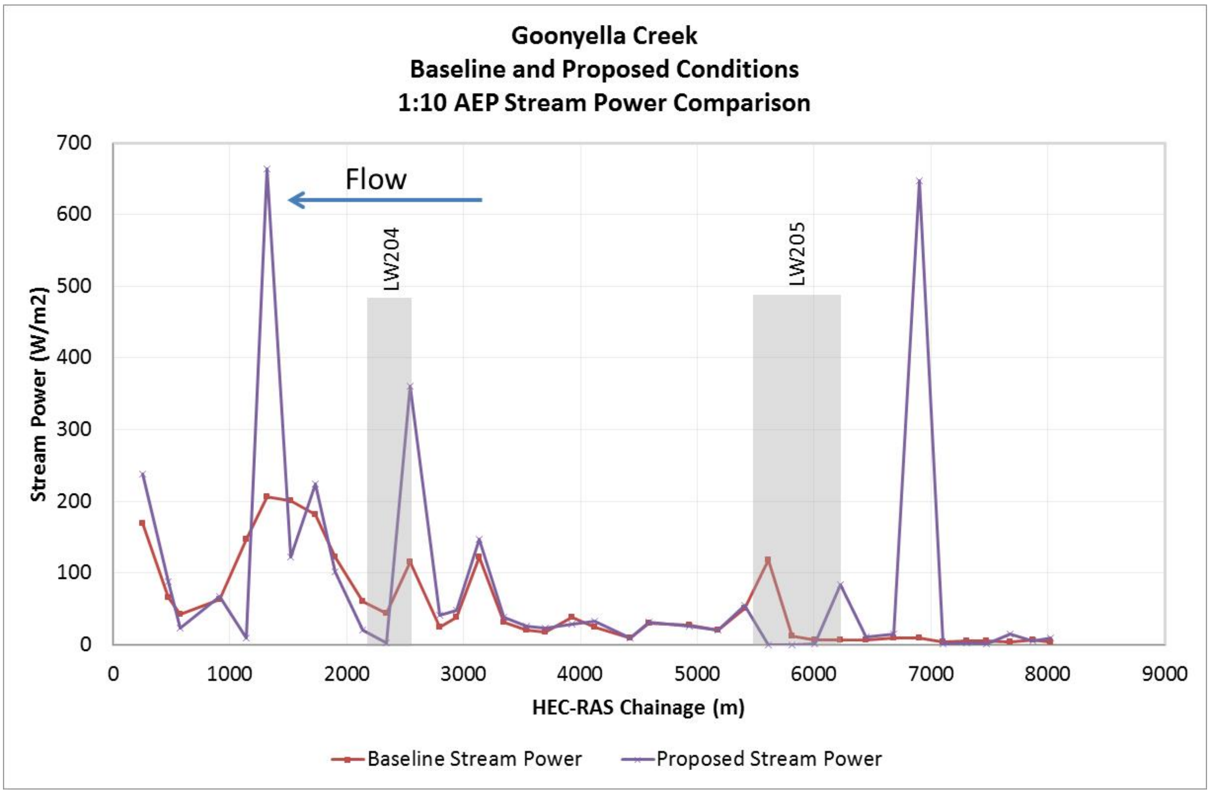
Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

Figure Appendix C 20 Longitudinal Plot of Goonyella Creek Stream Velocity Comparison 1 in 10 AEP



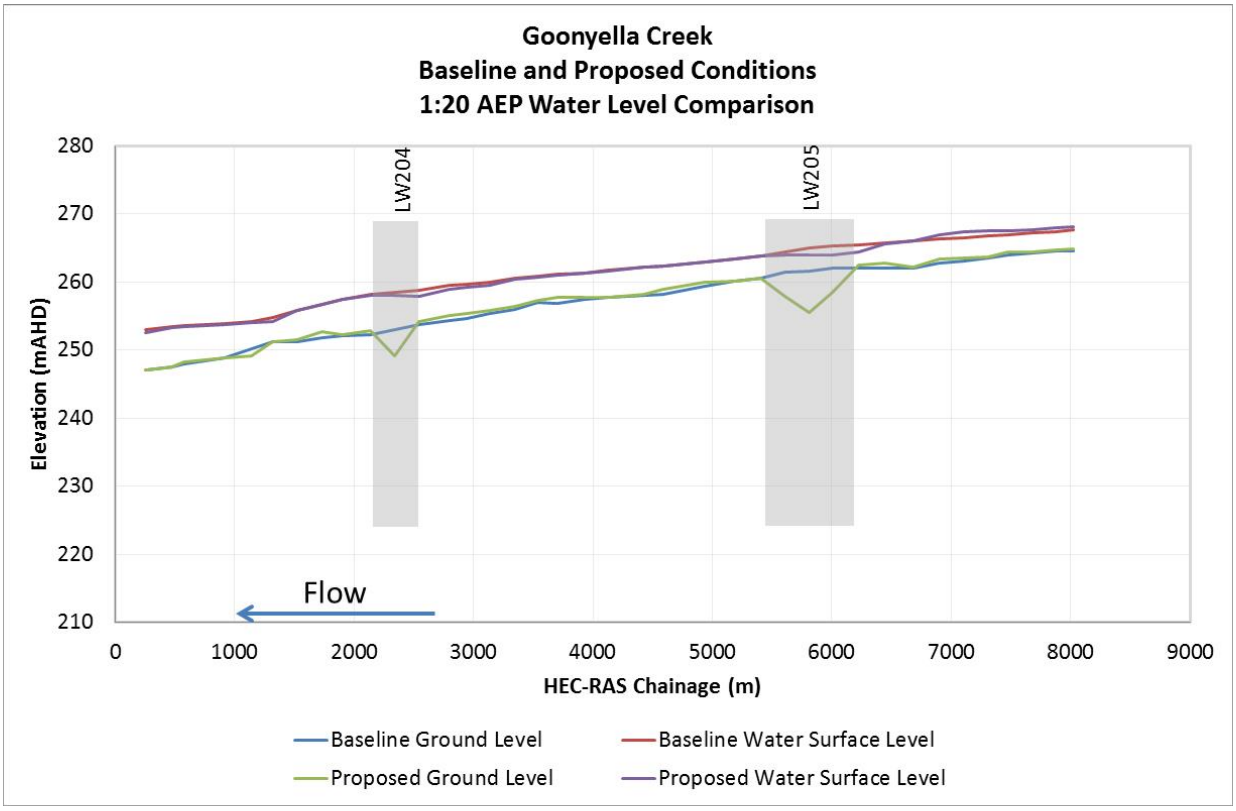
Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

Figure Appendix C 21 Longitudinal Plot of Goonyella Creek Stream Power Comparison 1 in 10 AEP



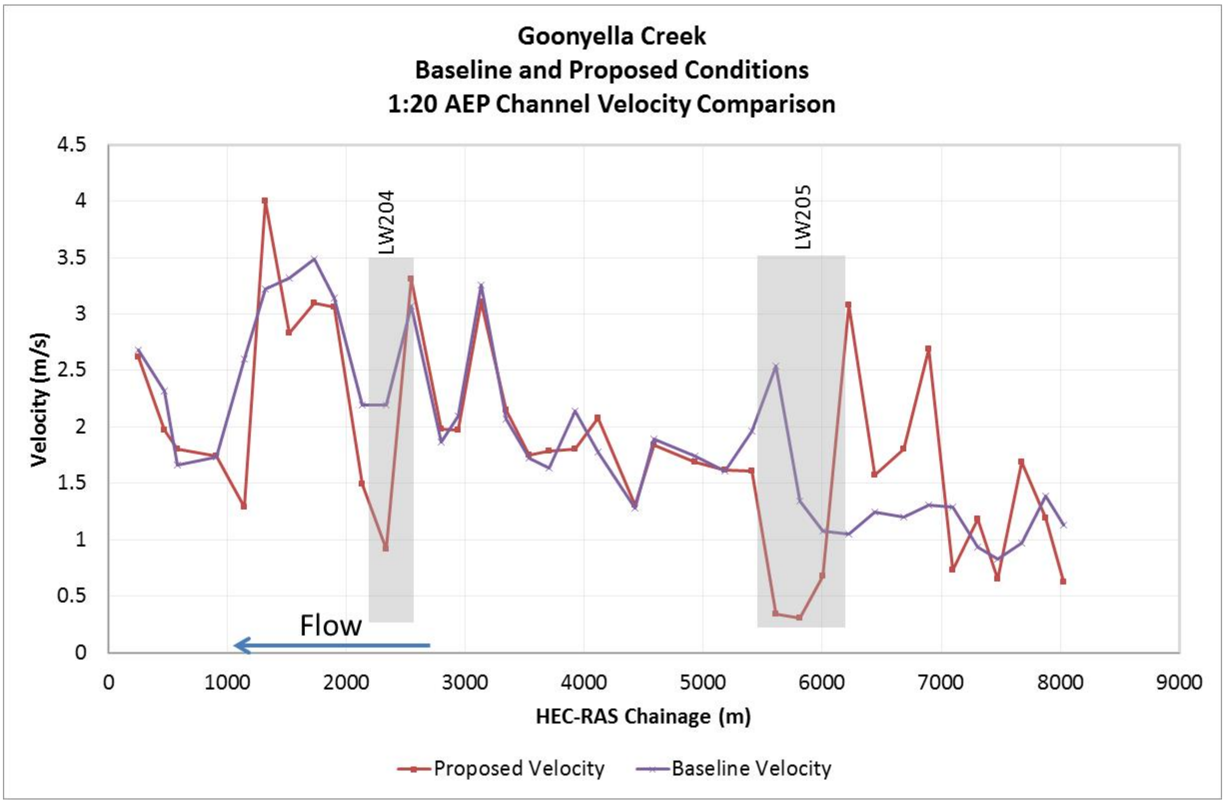
Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

Figure Appendix C 22 Longitudinal Plot of Goonyella Creek Water Surface Elevation Comparison 1 in 20 AEP



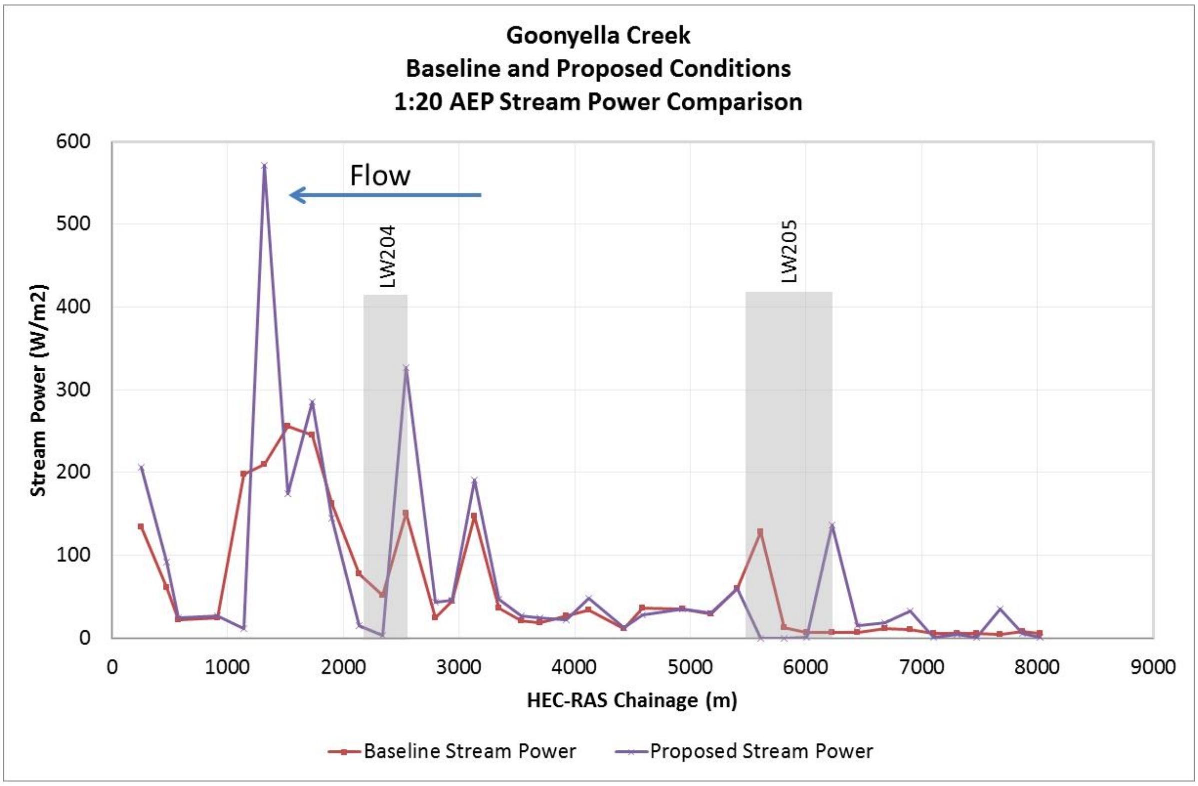
Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

Figure Appendix C 23 Longitudinal Plot of Goonyella Creek Stream Velocity Comparison 1 in 20 AEP



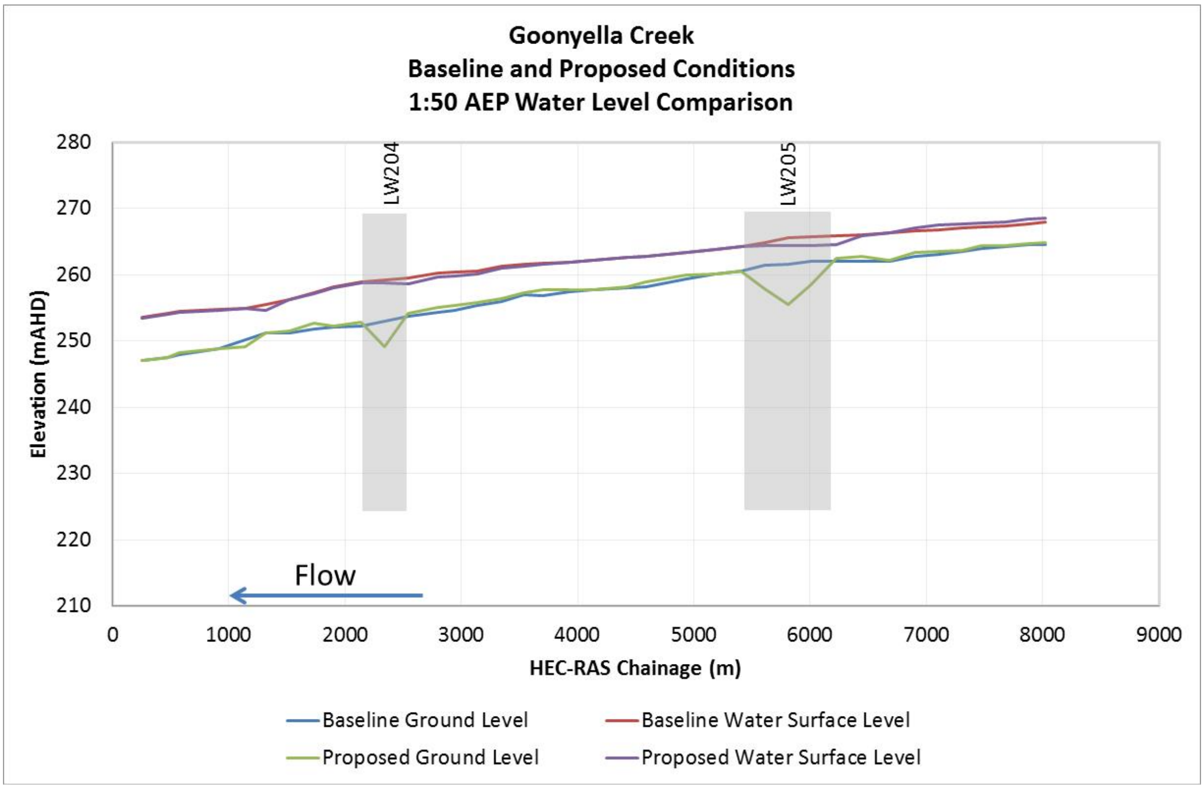
Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

Figure Appendix C 24 Longitudinal Plot of Goonyella Creek Stream Power Comparison 1 in 20 AEP



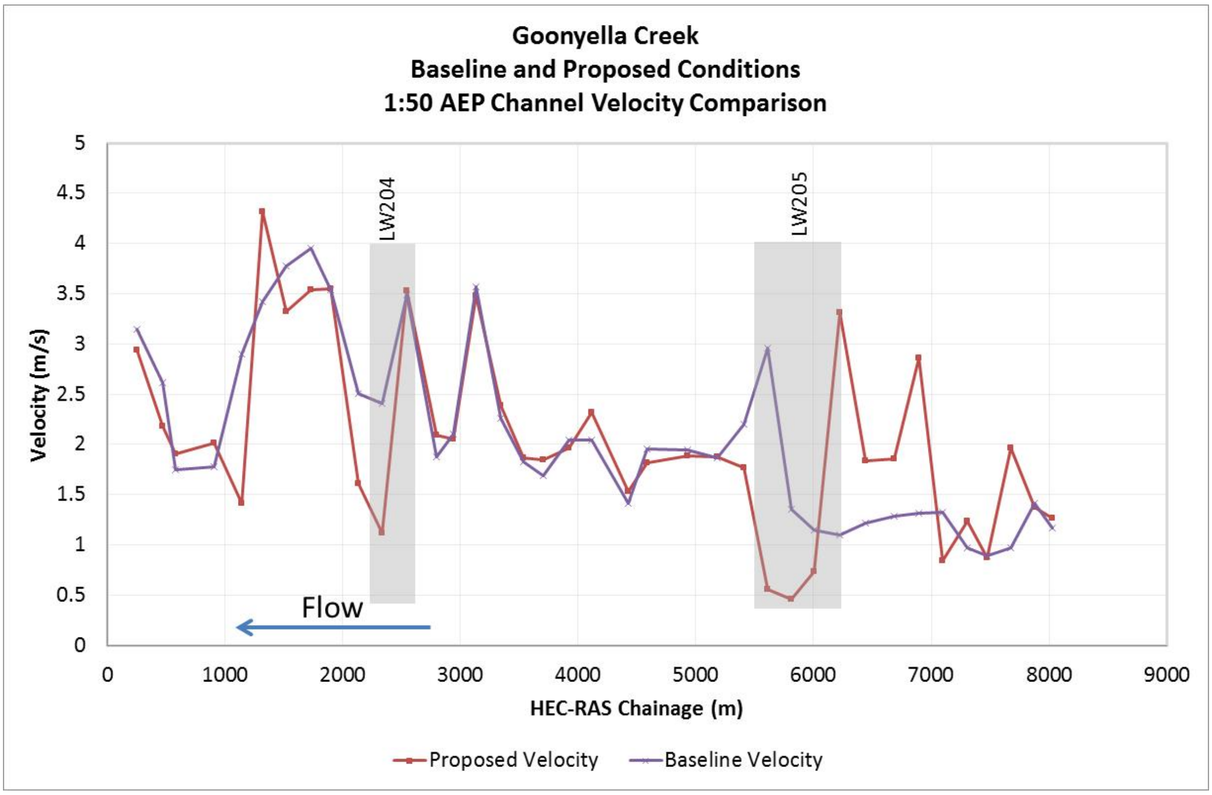
Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

Figure Appendix C 25 Longitudinal Plot of Goonyella Creek Water Surface Elevation Comparison 1 in 50 AEP



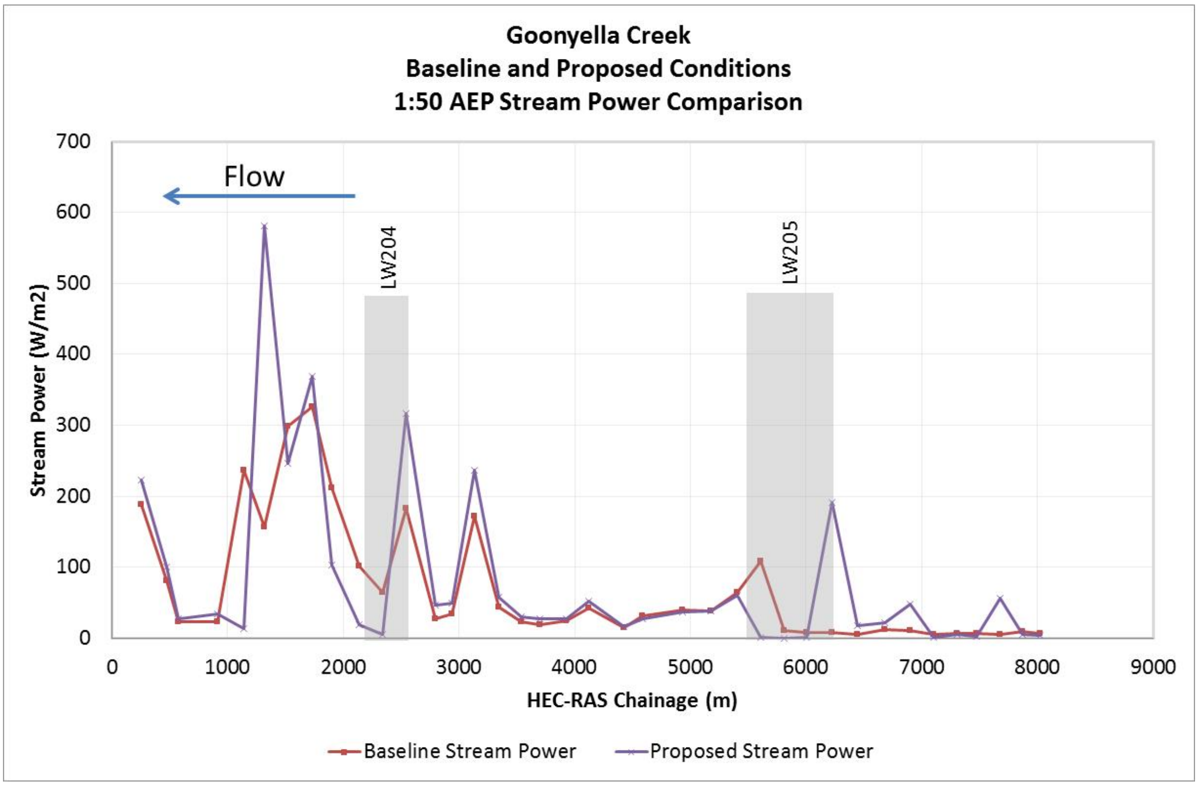
Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

Figure Appendix C 26 Longitudinal Plot of Goonyella Creek Stream Velocity Comparison 1 in 50 AEP



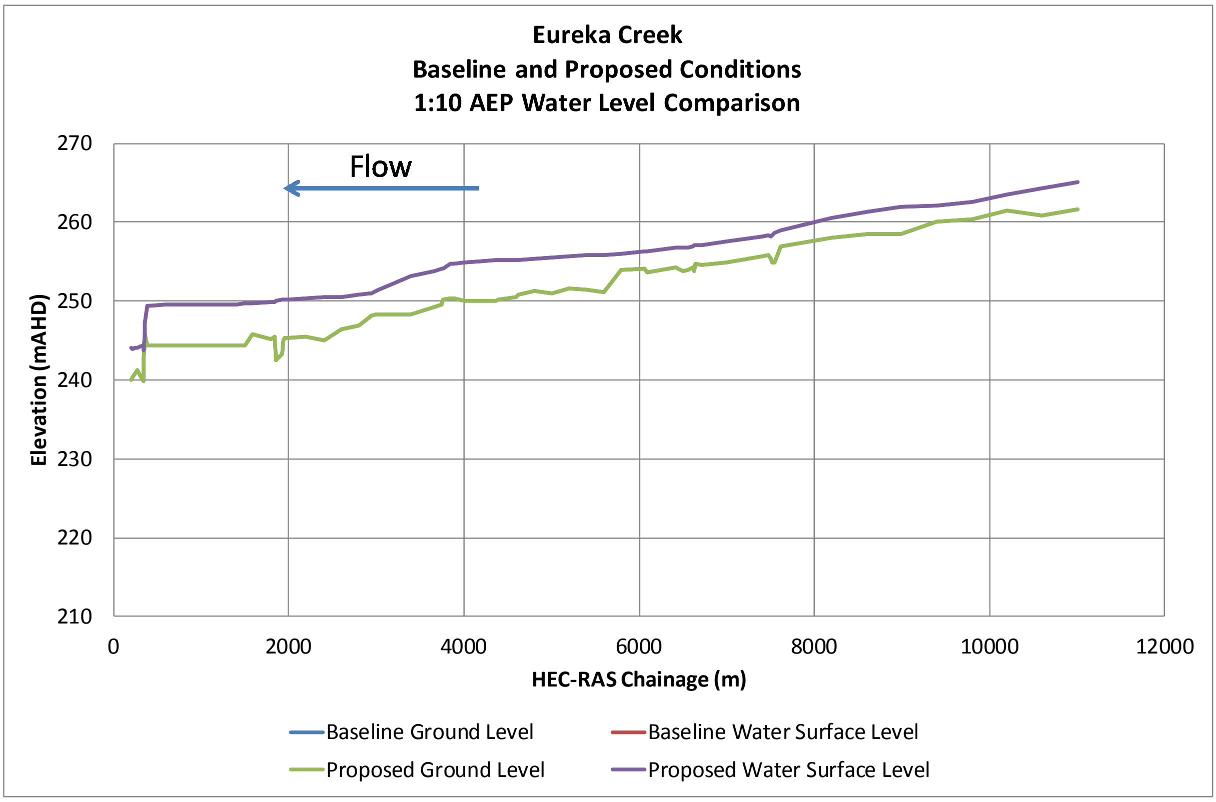
Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

Figure Appendix C 27 Longitudinal Plot of Goonyella Creek Stream Power Comparison 1 in 50 AEP



Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

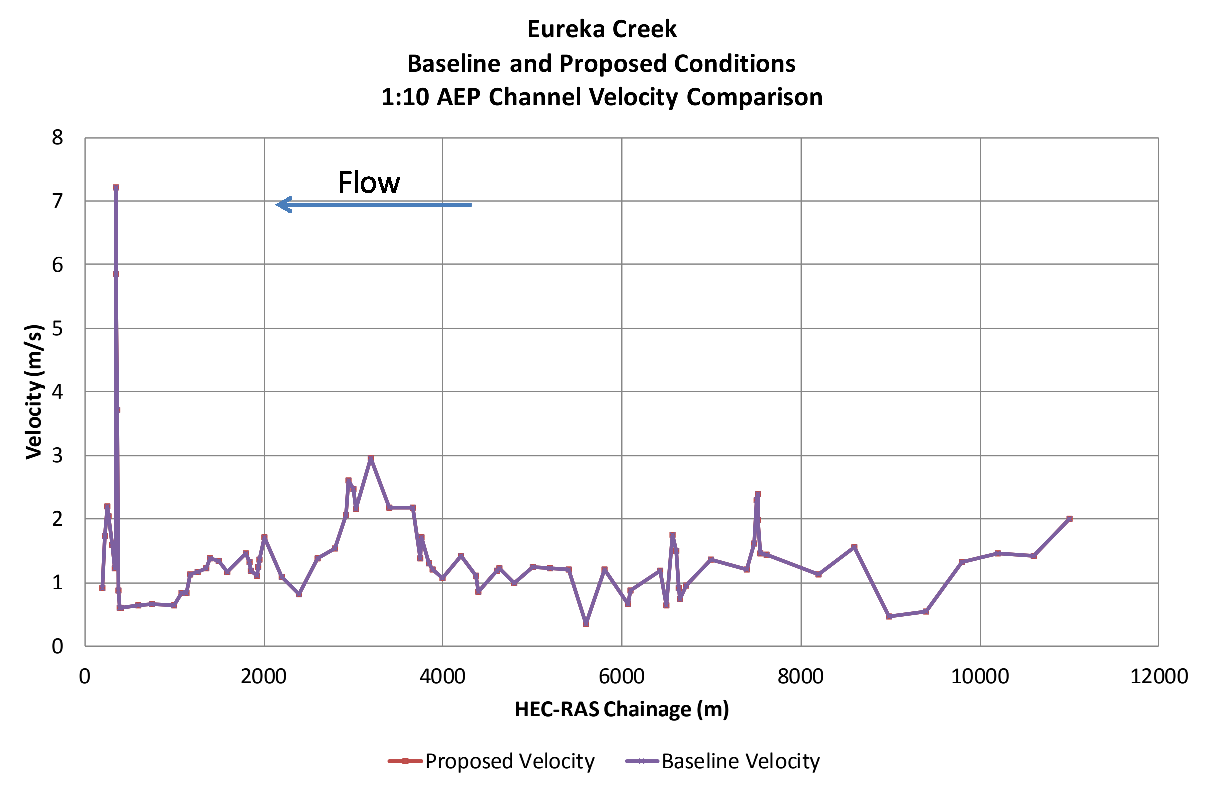
Figure Appendix C 28 Longitudinal Plot of Eureka Creek Water Surface Elevation Comparison 1 in 10 AEP



Note: Baseline and proposed levels coincide.

Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

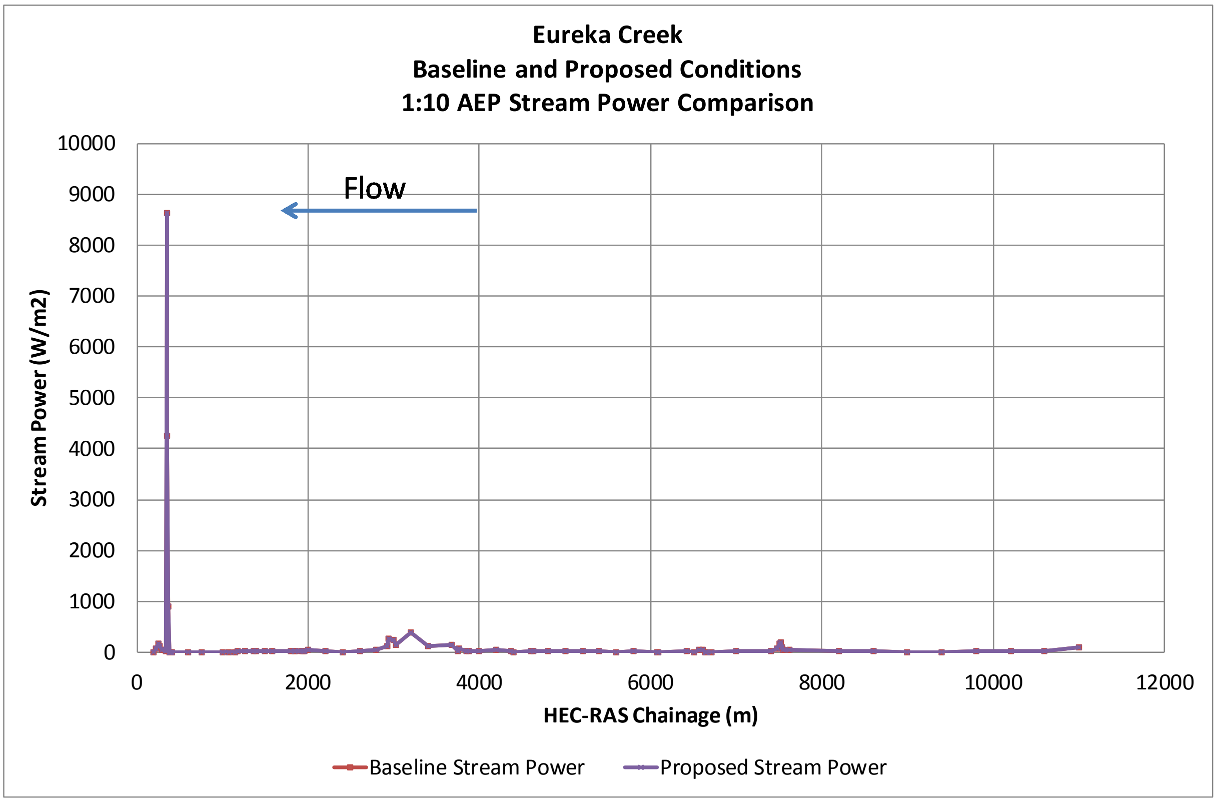
Figure Appendix C 29 Longitudinal Plot of Eureka Creek Stream Velocity Comparison 1 in 10 AEP



Note: Baseline and proposed velocity conditions coincide.

Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

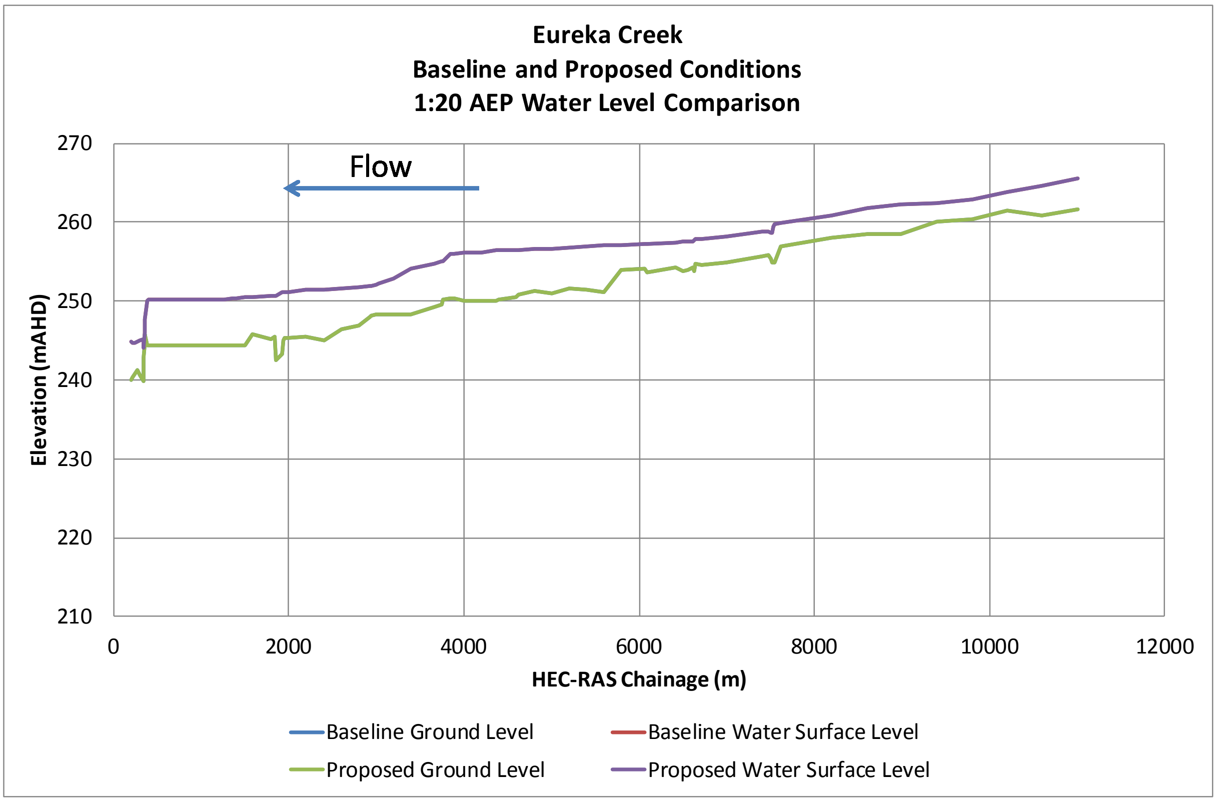
Figure Appendix C 30 Longitudinal Plot of Eureka Creek Stream Power Comparison 1 in 10 AEP



Note: Baseline and proposed stream power conditions coincide.

Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

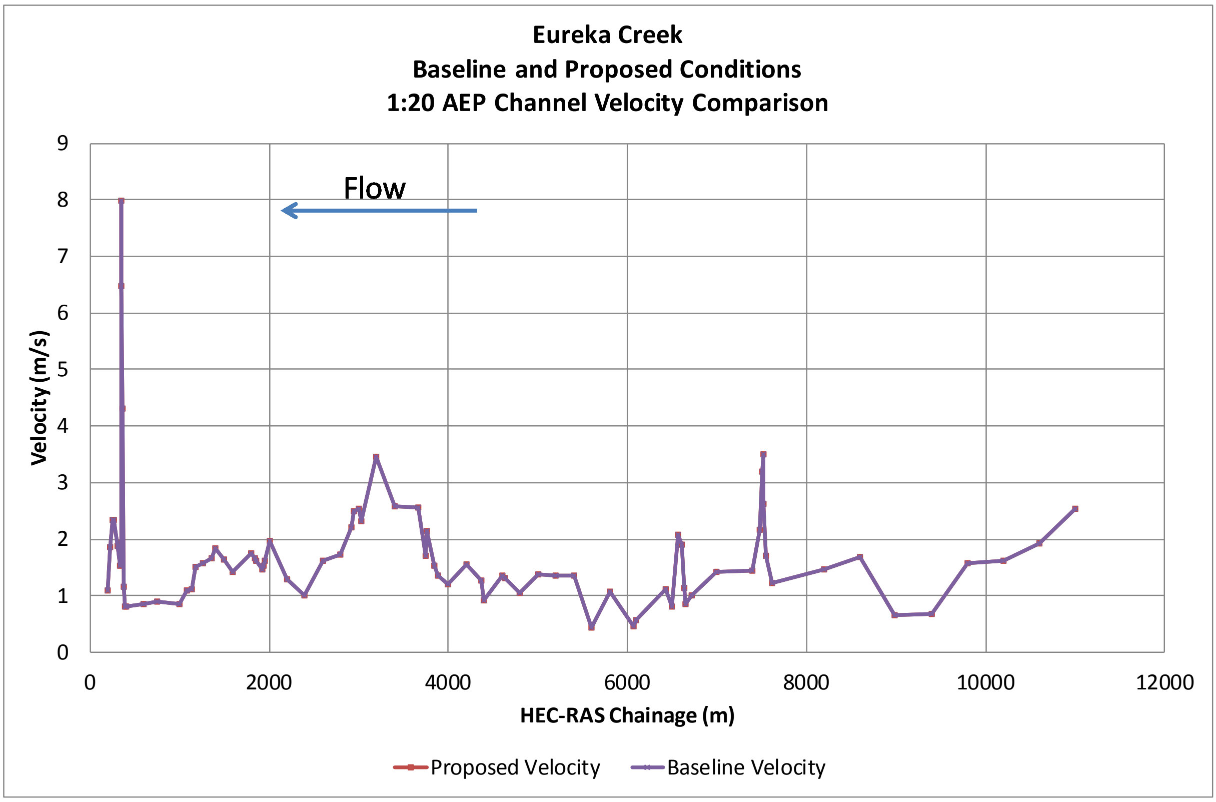
Figure Appendix C 31 Longitudinal Plot of Eureka Creek Water Surface Elevation Comparison 1 in 20 AEP



Note: Baseline and proposed levels coincide.

Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

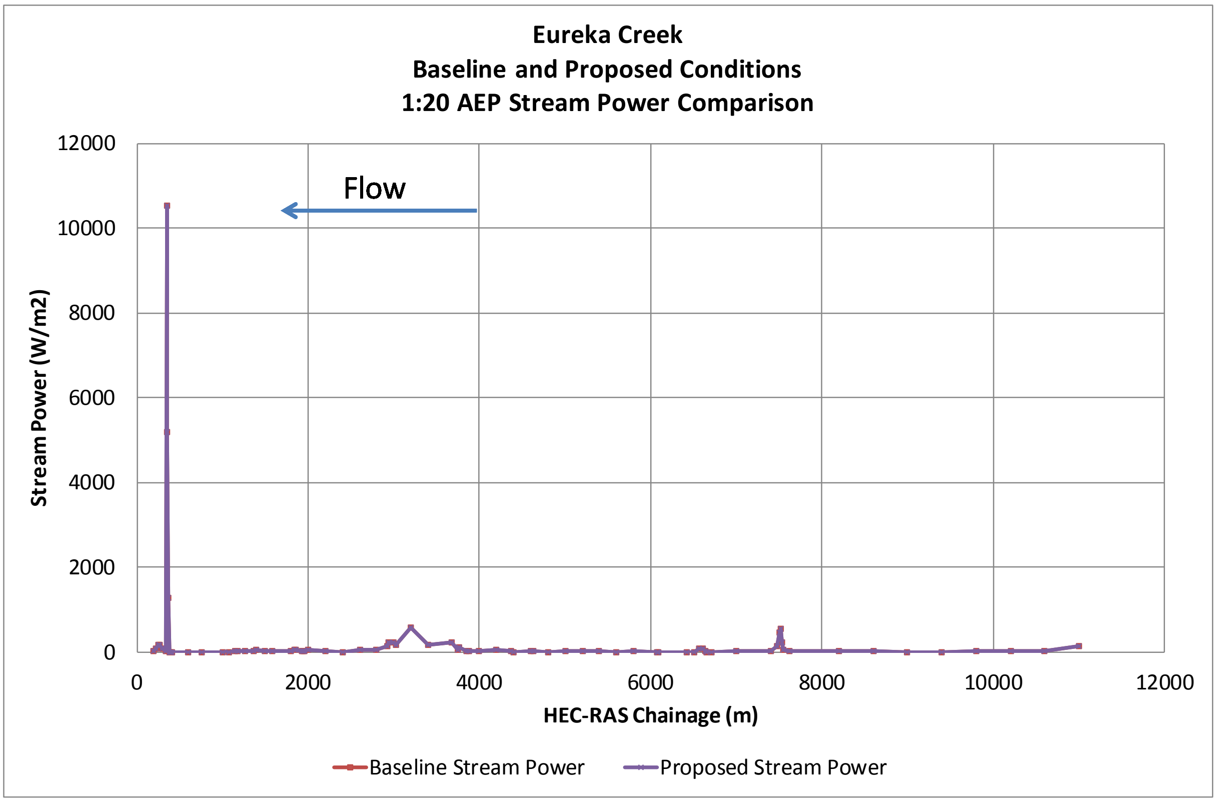
Figure Appendix C 32 Longitudinal Plot of Eureka Creek Stream Velocity Comparison 1 in 20 AEP



Note: Baseline and proposed velocity conditions coincide.

Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

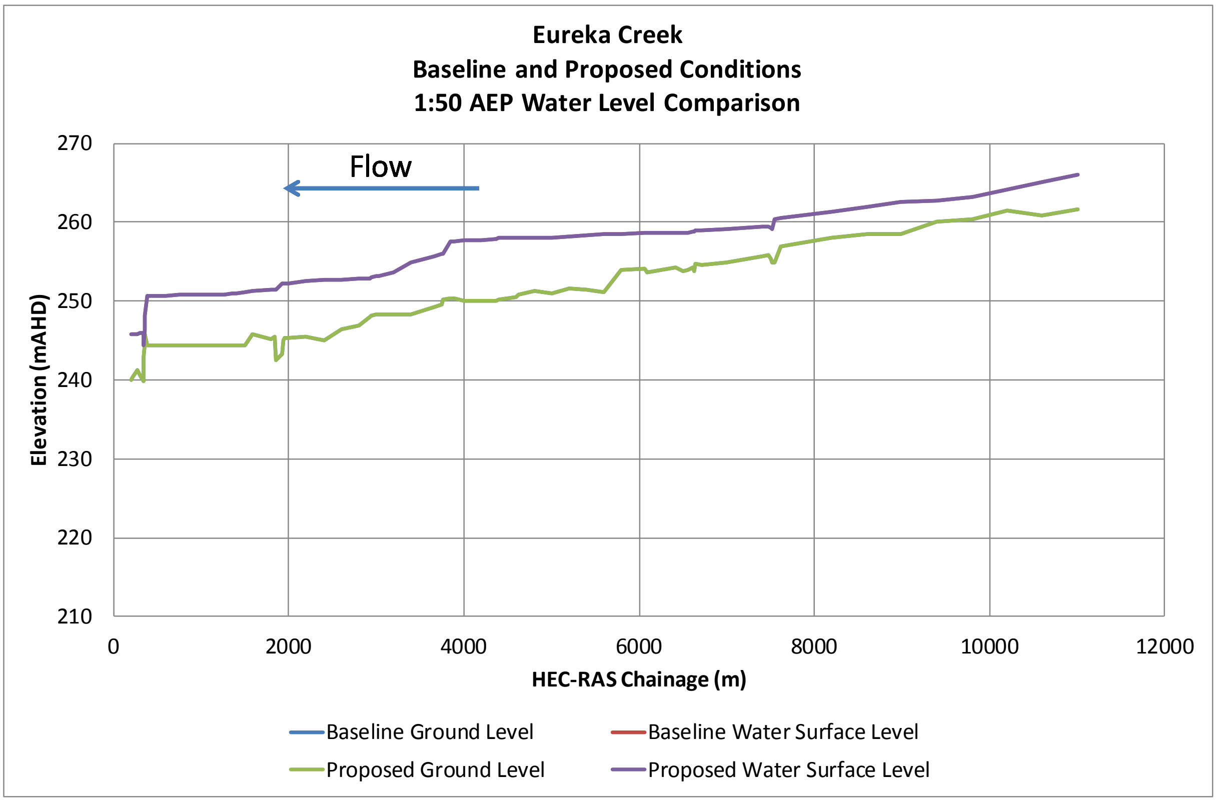
Figure Appendix C 33 Longitudinal Plot of Eureka Creek Stream Power Comparison 1 in 20 AEP



Note: Baseline and proposed stream power conditions coincide.

Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

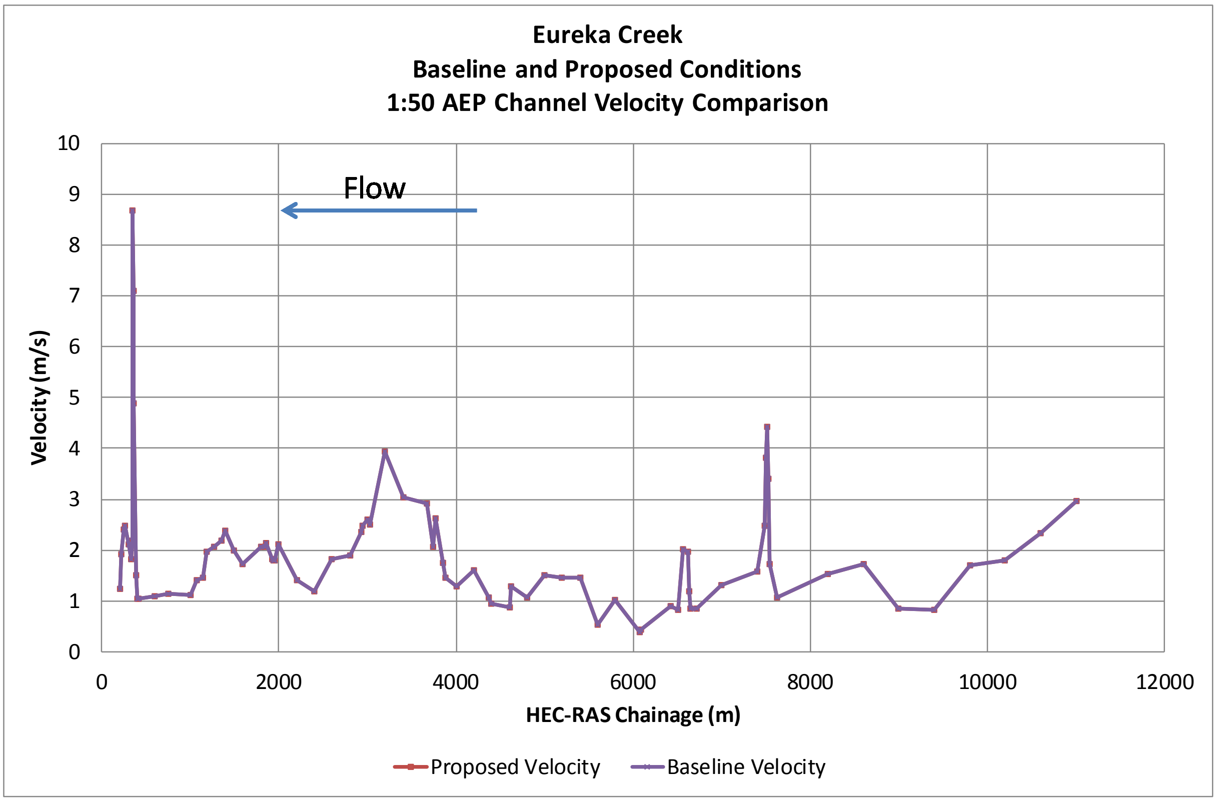
Figure Appendix C 34 Longitudinal Plot of Eureka Creek Water Surface Elevation Comparison 1 in 50 AEP



Note: Baseline and proposed levels coincide.

Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

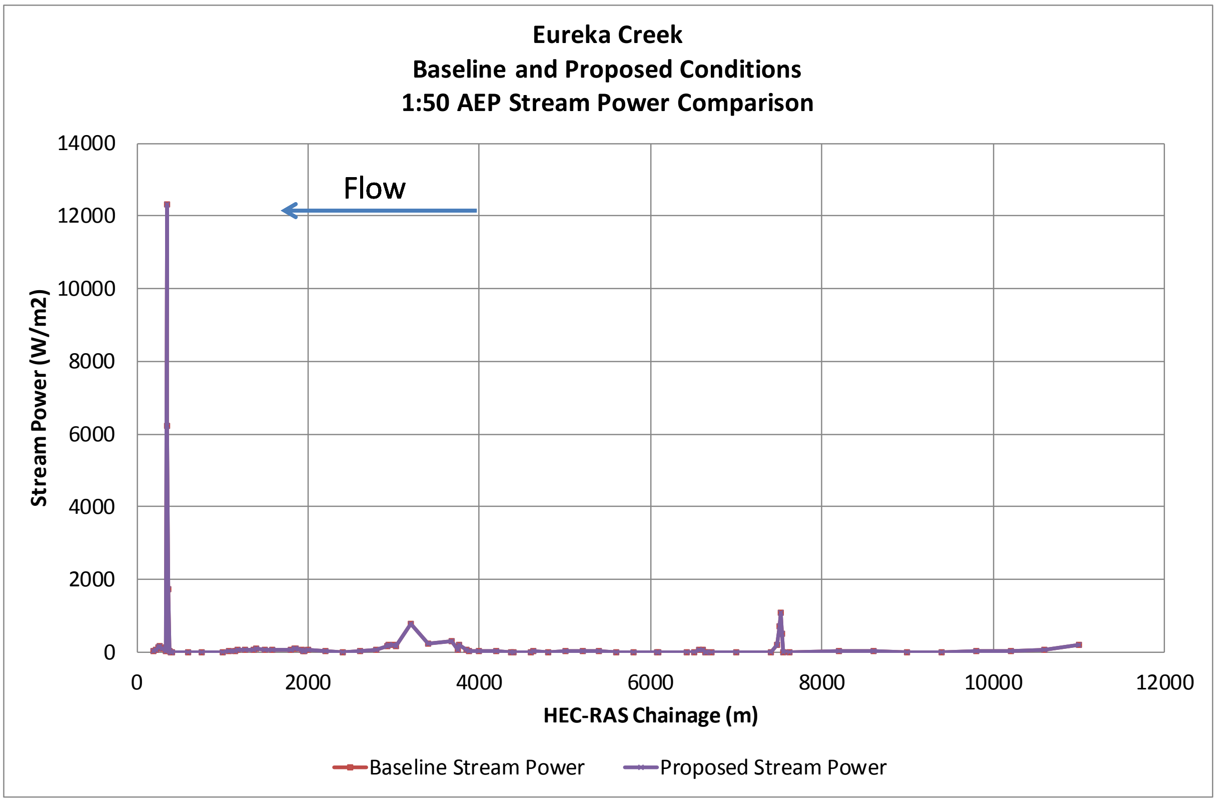
Figure Appendix C 35 Longitudinal Plot of Eureka Creek Stream Velocity Comparison 1 in 50 AEP



Note: Baseline and proposed velocity conditions coincide.

Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

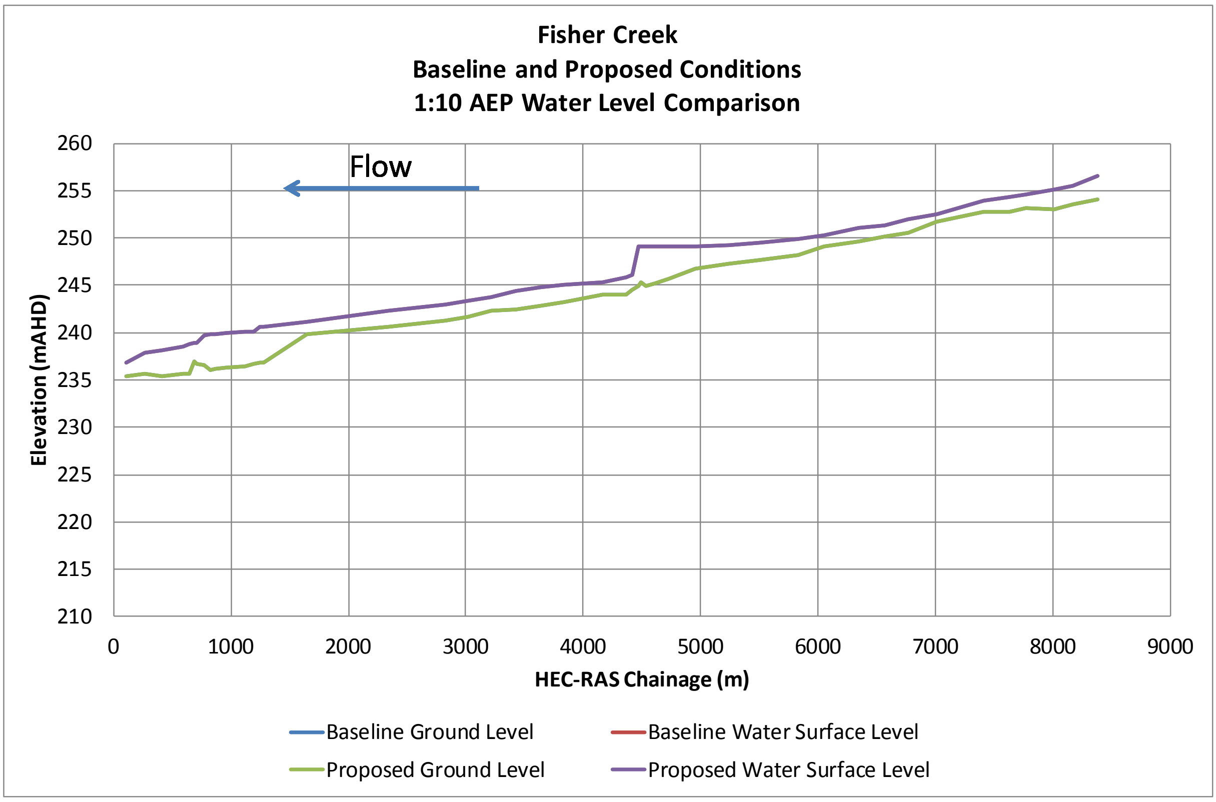
Figure Appendix C 36 Longitudinal Plot of Eureka Creek Stream Power Comparison 1 in 50 AEP



Note: Baseline and proposed stream power conditions coincide.

Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

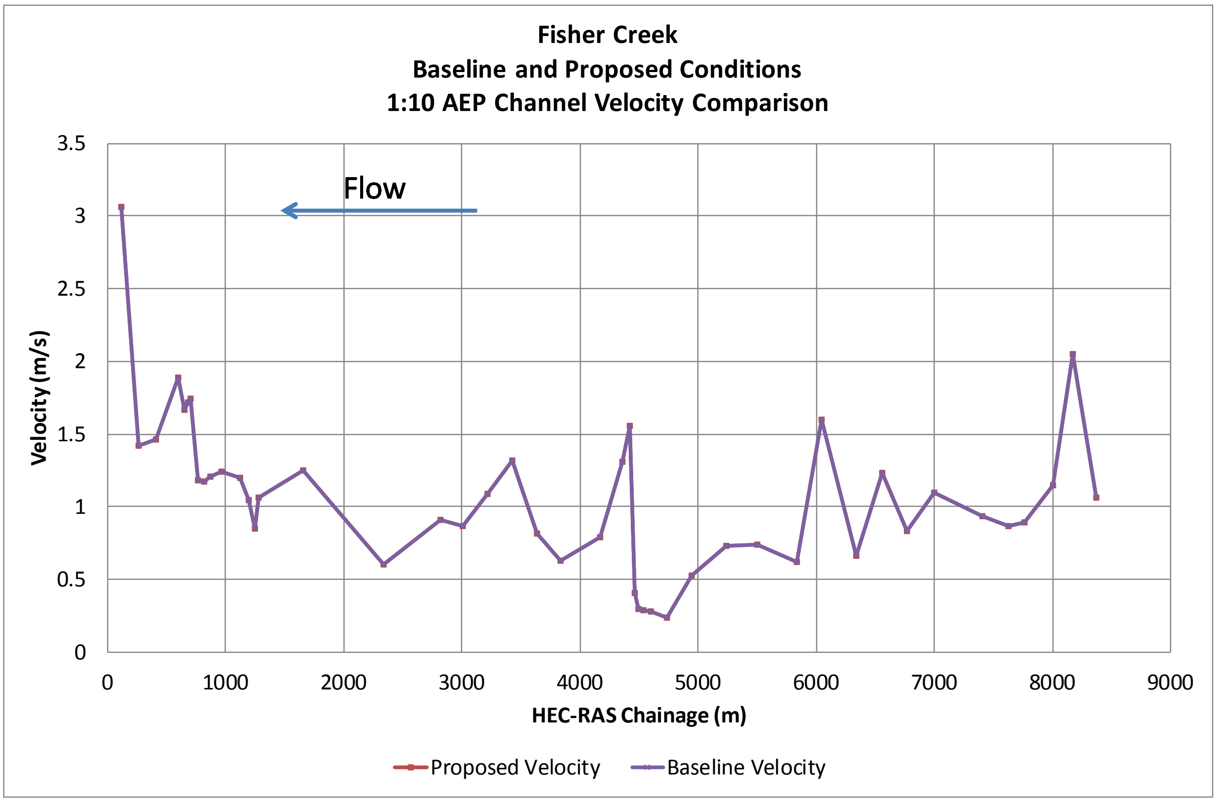
Figure Appendix C 37 Longitudinal Plot of Fisher Creek Water Surface Elevation Comparison 1 in 10 AEP



Note: Baseline and proposed levels coincide.

Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

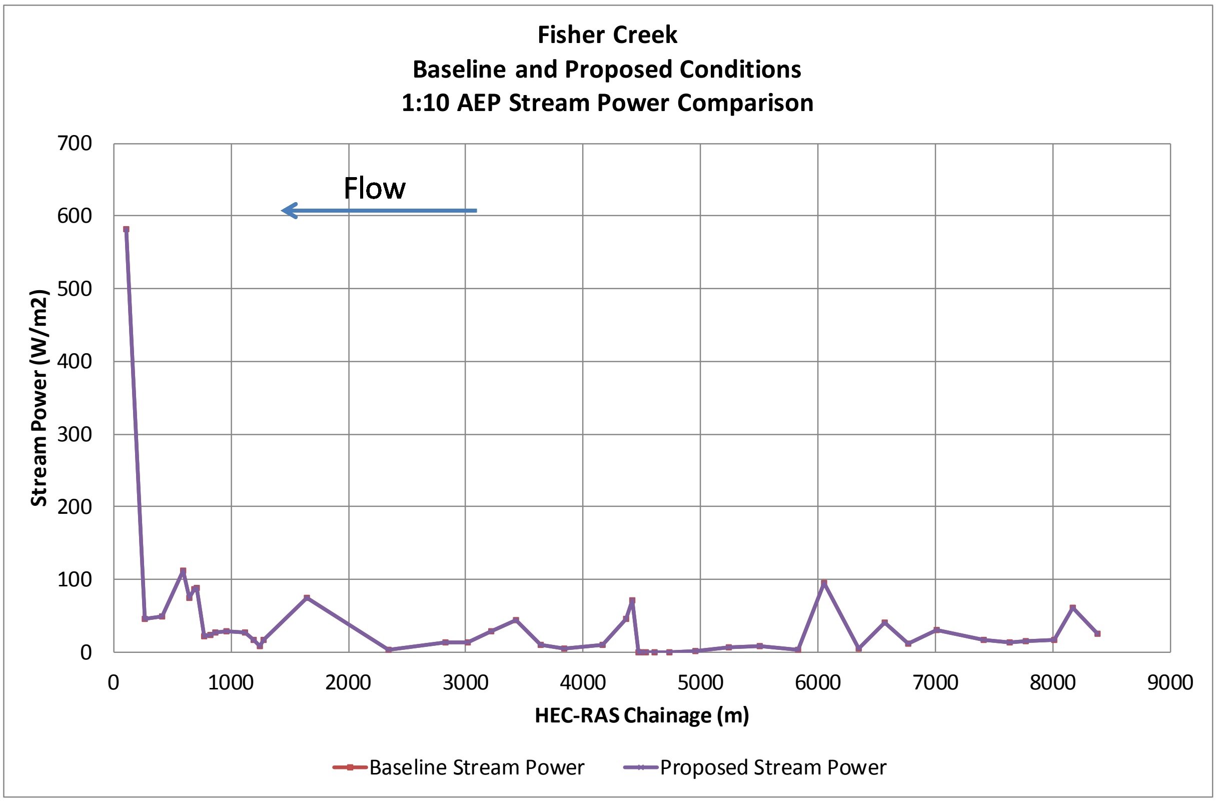
Figure Appendix C 38 Longitudinal Plot of Fisher Creek Stream Velocity Comparison 1 in 10 AEP



Note: Baseline and proposed velocity conditions coincide.

Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

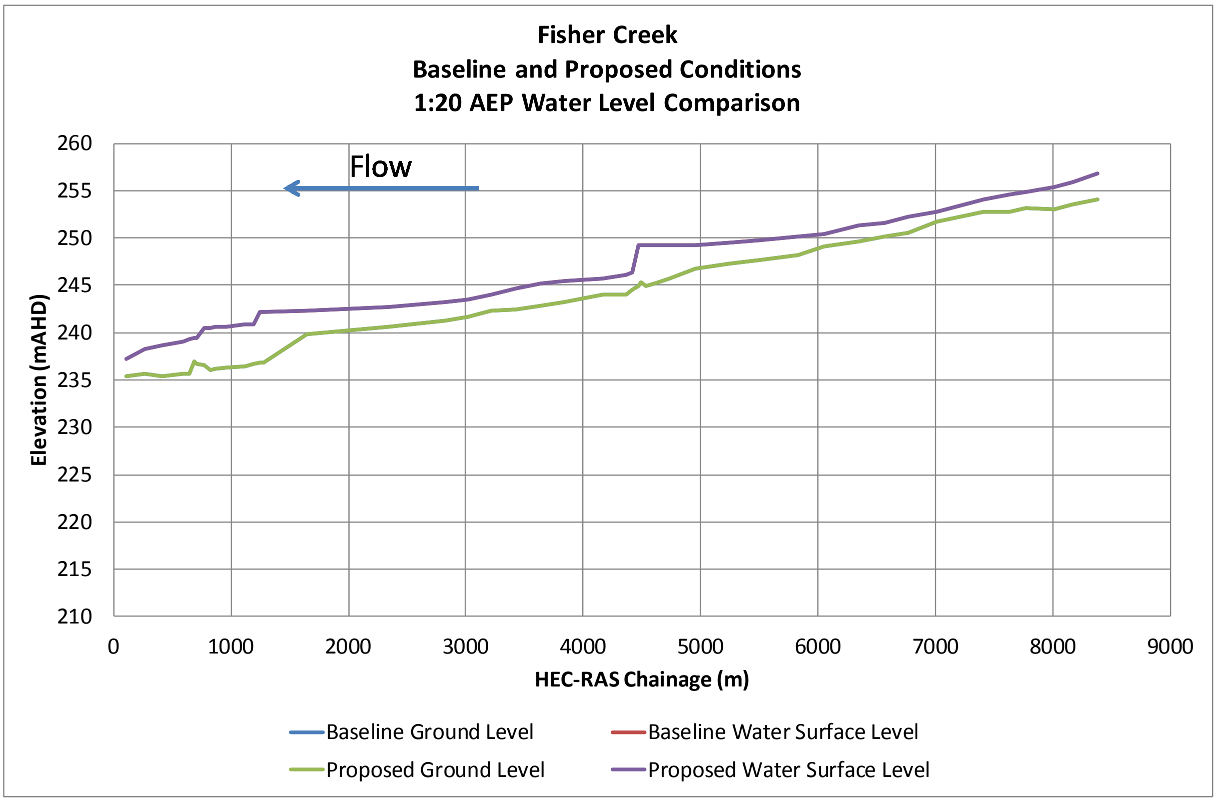
Figure Appendix C 39 Longitudinal Plot of Fisher Creek Stream Power Comparison 1 in 10 AEP



Note: Baseline and proposed stream power conditions coincide.

Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

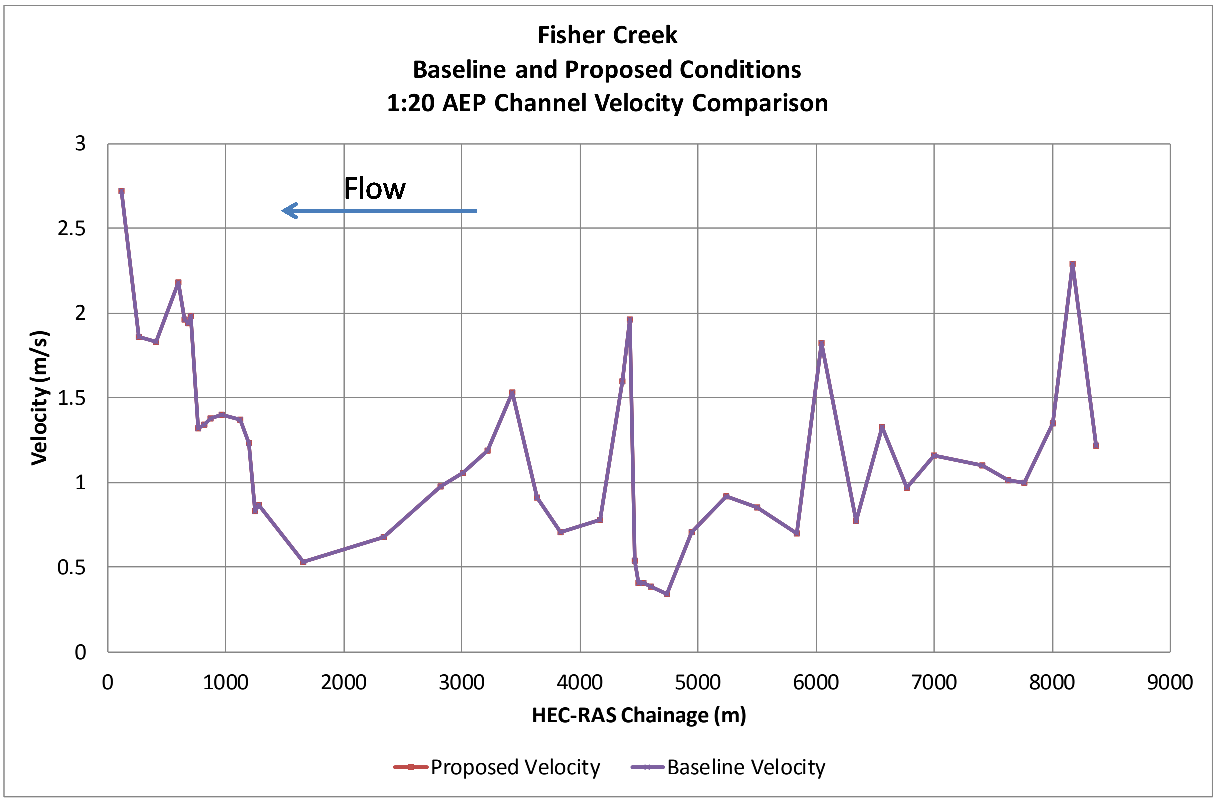
Figure Appendix C 40 Longitudinal Plot of Fisher Creek Water Surface Elevation Comparison 1 in 20 AEP



Note: Baseline and proposed levels coincide.

Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

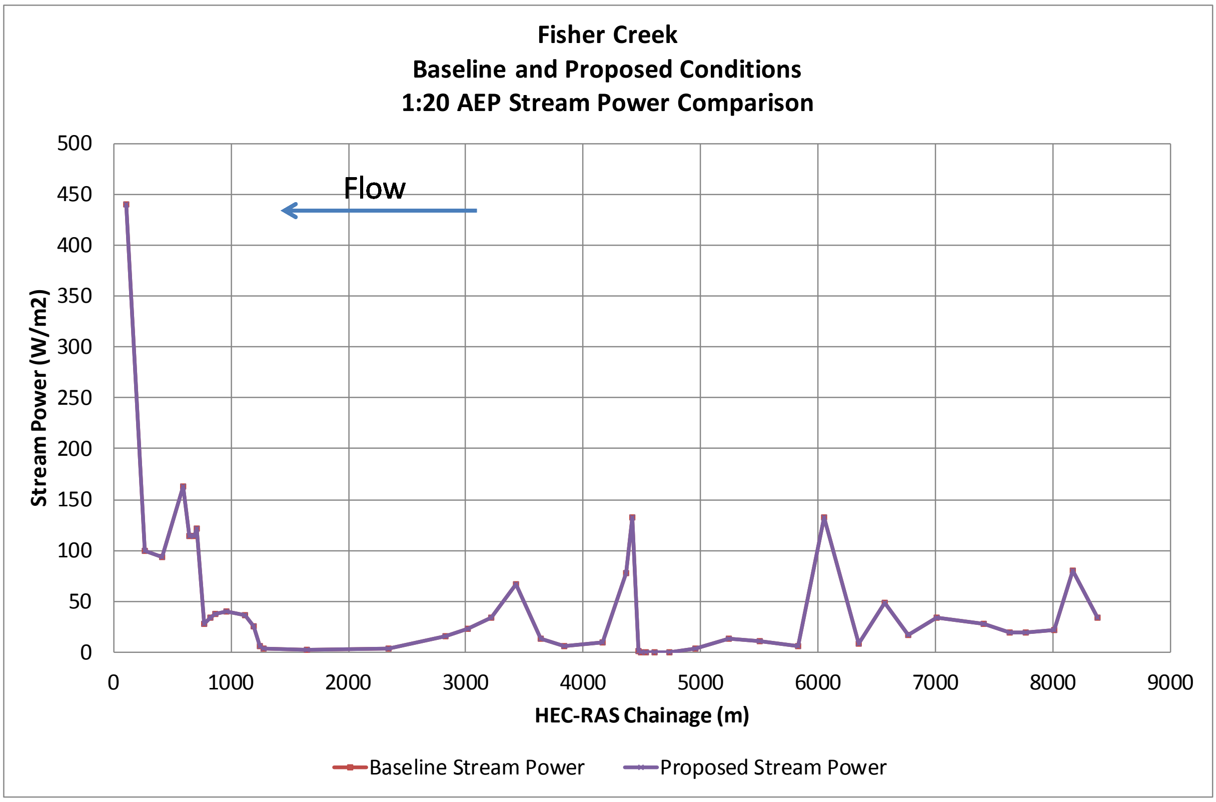
Figure Appendix C 41 Longitudinal Plot of Fisher Creek Stream Velocity Comparison 1 in 20 AEP



Note: Baseline and proposed velocity conditions coincide.

Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

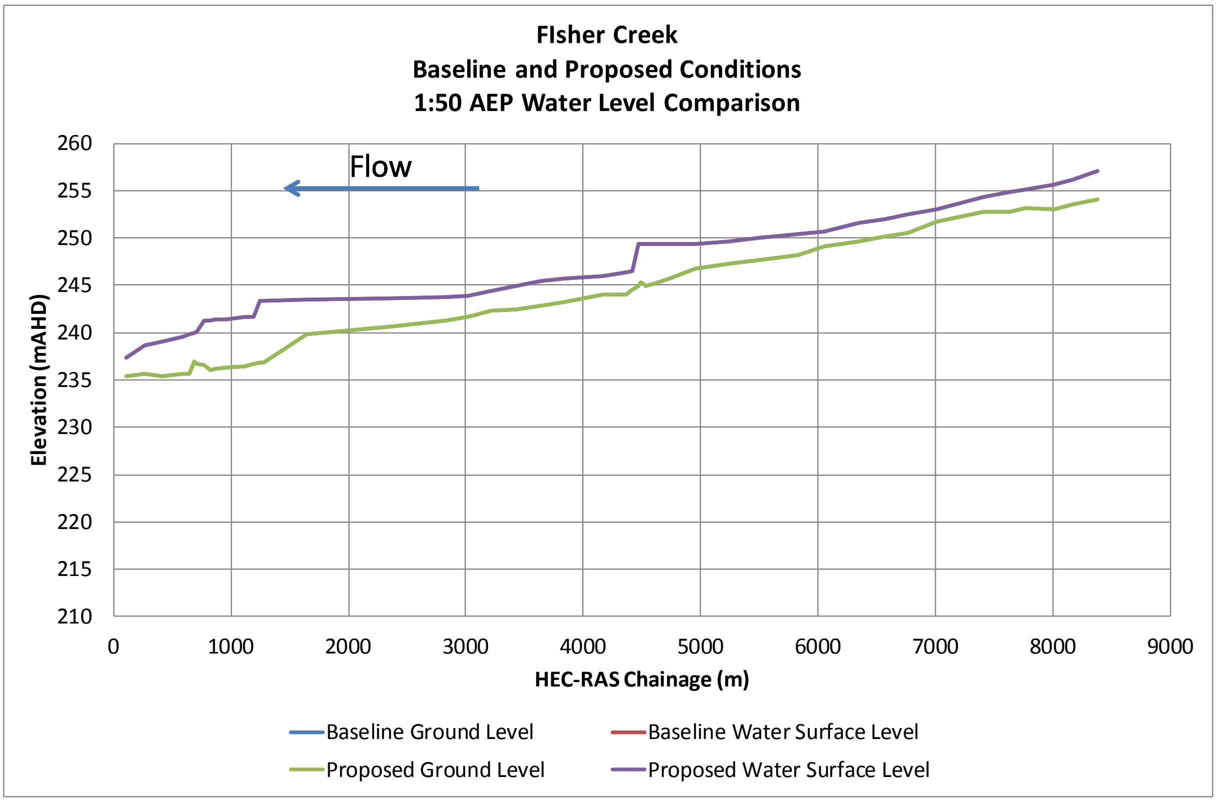
Figure Appendix C 42 Longitudinal Plot of Fisher Creek Stream Power Comparison 1 in 20 AEP



Note: Baseline and proposed stream power conditions coincide.

Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

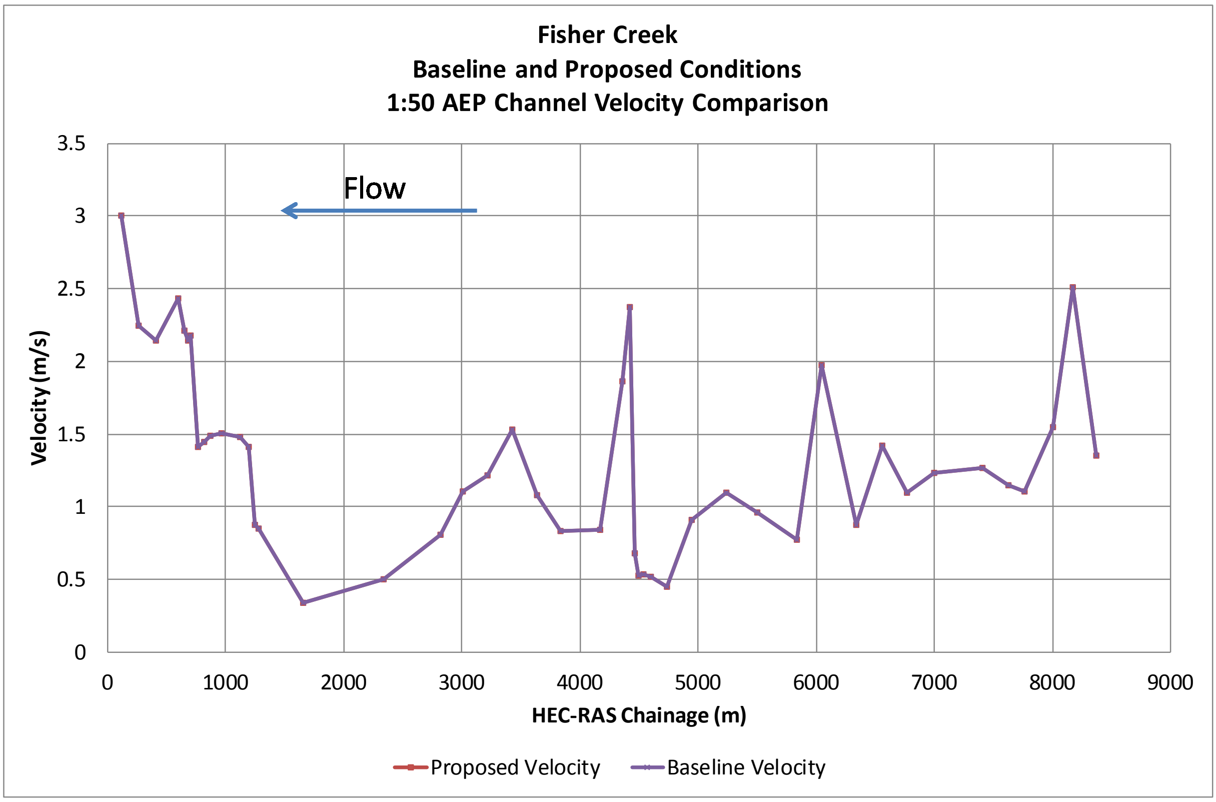
Figure Appendix C 43 Longitudinal Plot of Fisher Creek Water Surface Elevation Comparison 1 in 50 AEP



Note: Baseline and proposed levels coincide.

Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

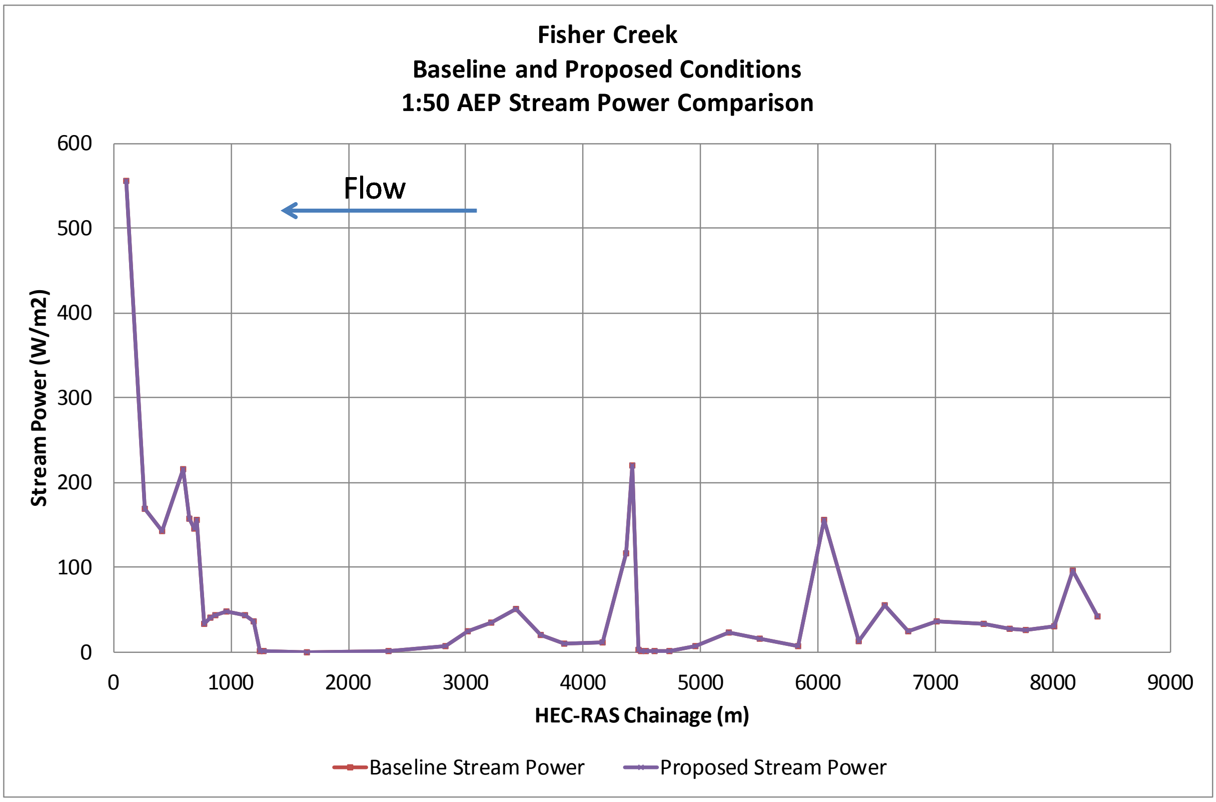
Figure Appendix C 44 Longitudinal Plot of Fisher Creek Stream Velocity Comparison 1 in 50 AEP



Note: Baseline and proposed velocity conditions coincide.

Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

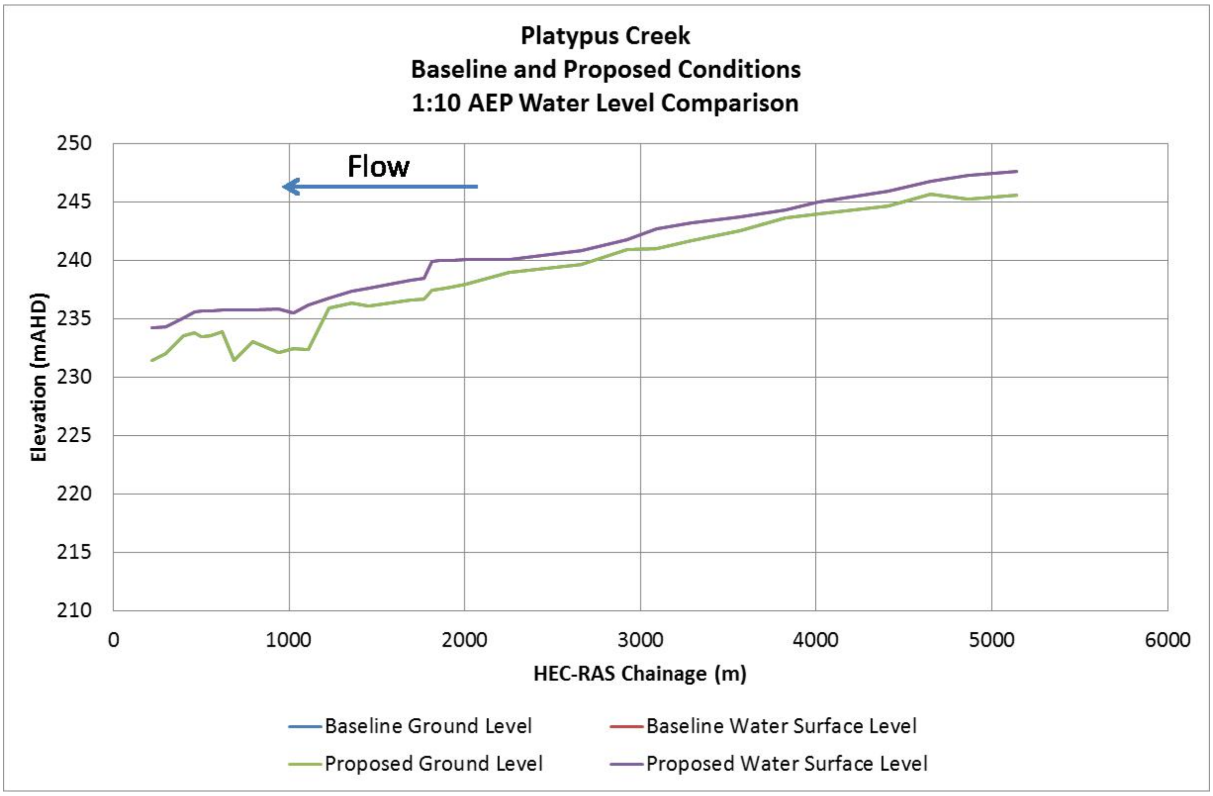
Figure Appendix C 45 Longitudinal Plot of Fisher Creek Stream Power Comparison 1 in 50 AEP



Note: Baseline and proposed stream power conditions coincide.

Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

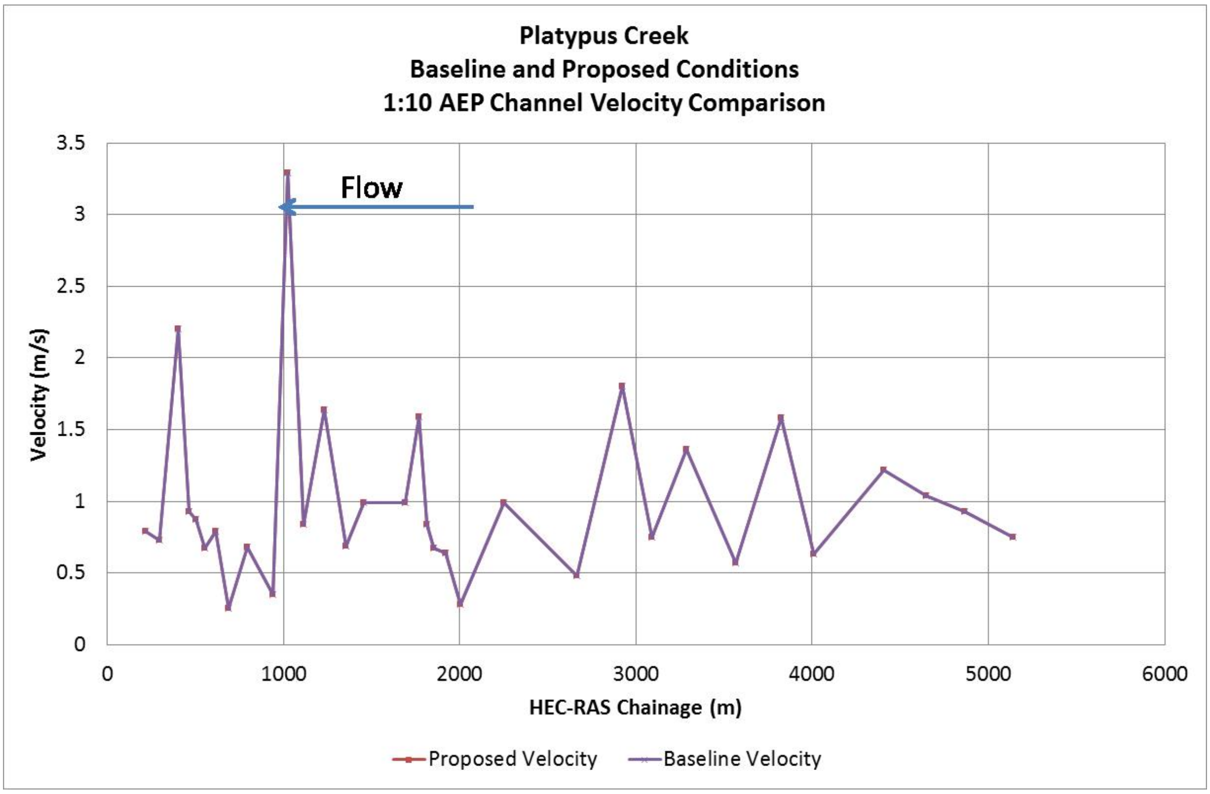
Figure Appendix C 46 Longitudinal Plot of Platypus Creek Water Surface Elevation Comparison 1 in 10 AEP



Note: Baseline and proposed levels coincide.

Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

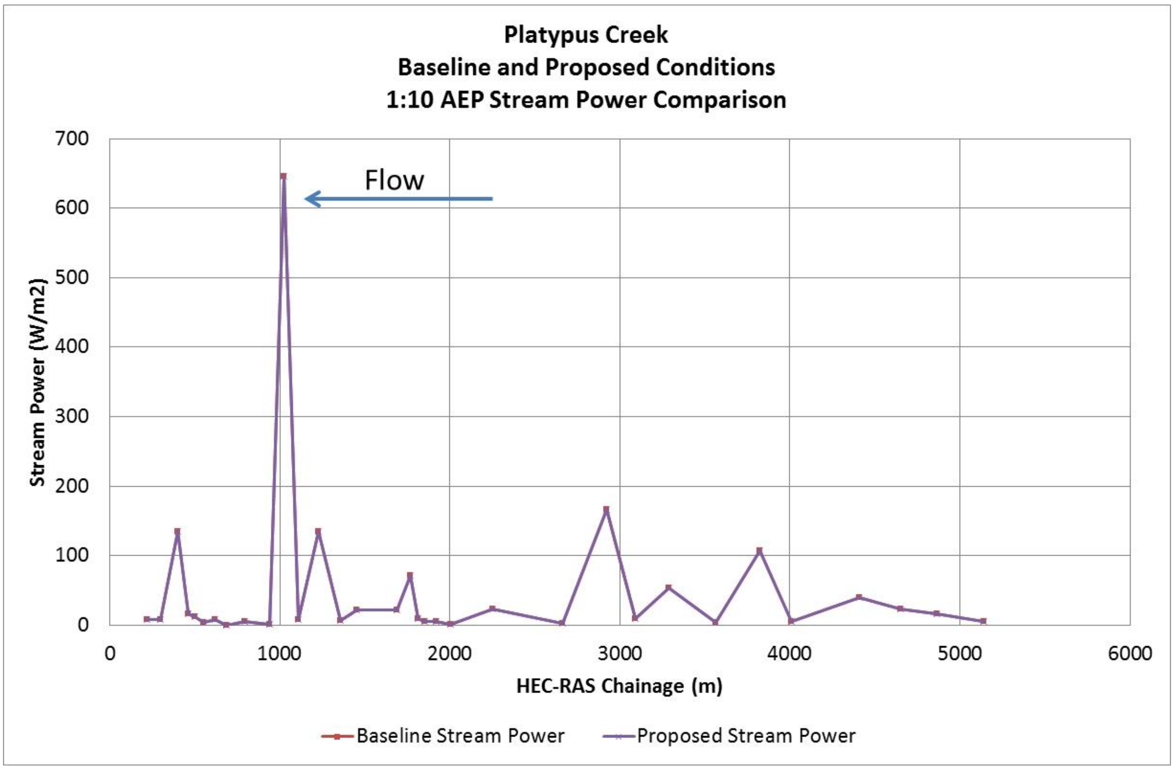
Figure Appendix C 47 Longitudinal Plot of Platypus Creek Stream Velocity Comparison 1 in 10 AEP



Note: Baseline and proposed velocity conditions coincide.

Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

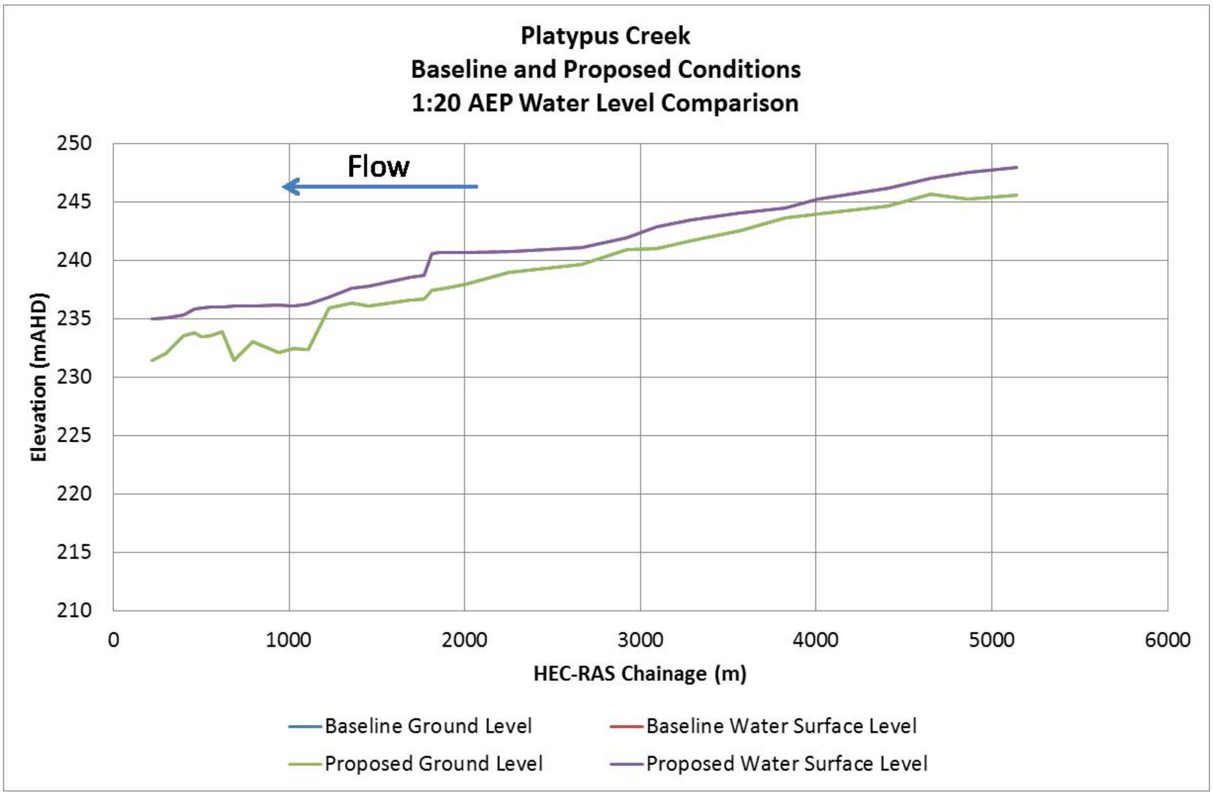
Figure Appendix C 48 Longitudinal Plot of Platypus Creek Stream Power Comparison 1 in 10 AEP



Note: Baseline and proposed stream power conditions coincide.

Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

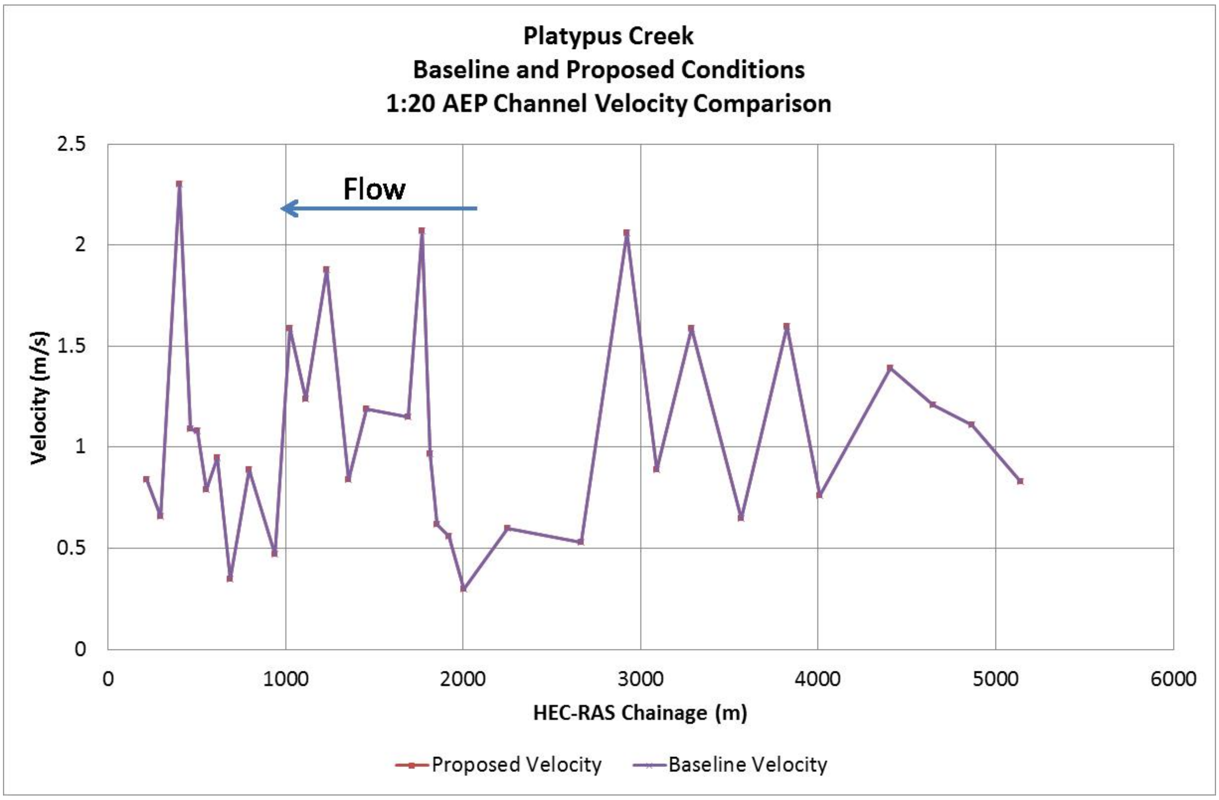
Figure Appendix C 49 Longitudinal Plot of Platypus Creek Water Surface Elevation Comparison 1 in 20 AEP



Note: Baseline and proposed levels coincide.

Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

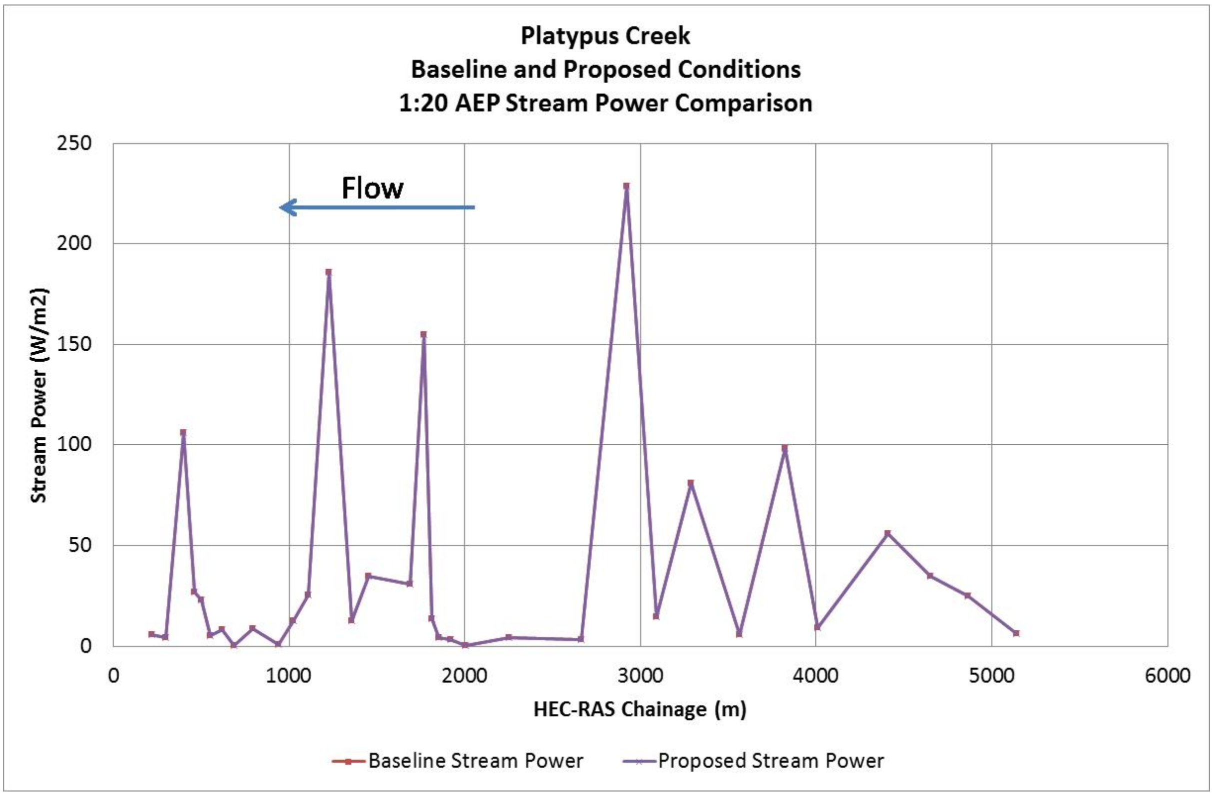
Figure Appendix C 50 Longitudinal Plot of Platypus Creek Stream Velocity Comparison 1 in 20 AEP



Note: Baseline and proposed velocity conditions coincide.

Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

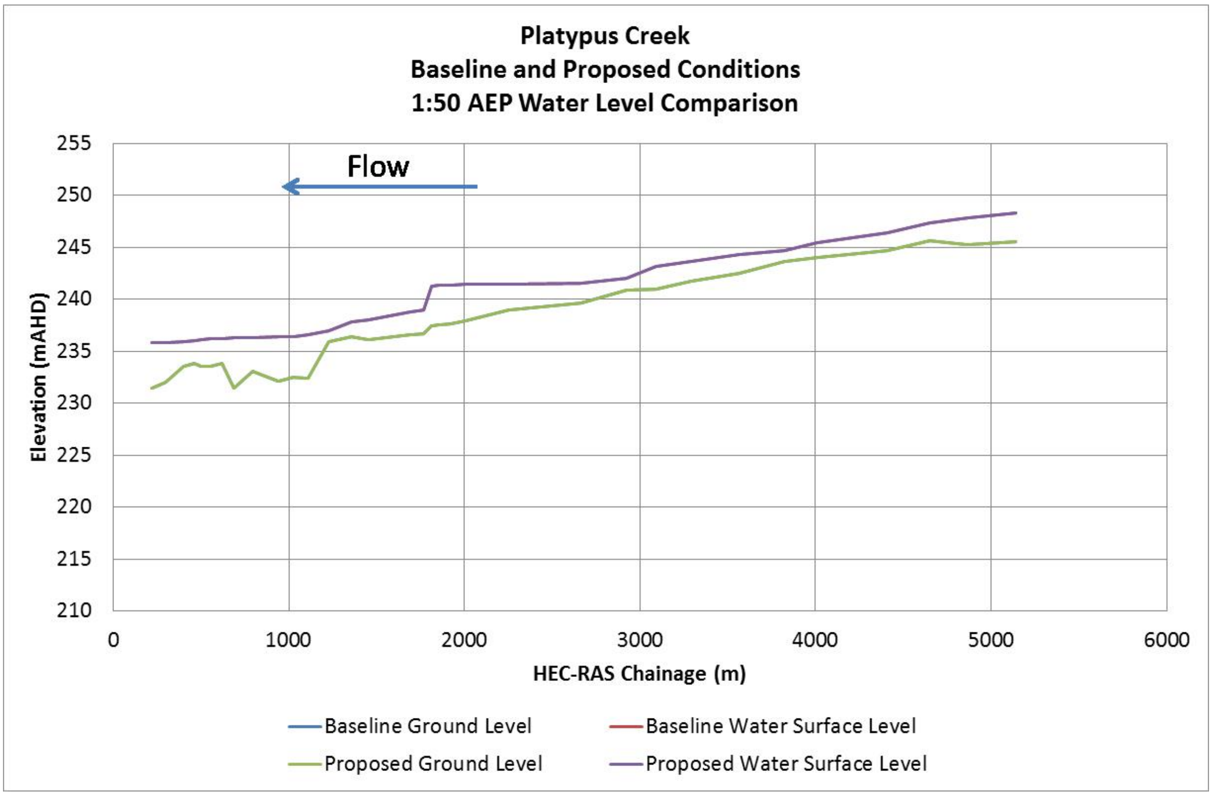
Figure Appendix C 51 Longitudinal Plot of Platypus Creek Stream Power Comparison 1 in 20 AEP



Note: Baseline and proposed stream power conditions coincide.

Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

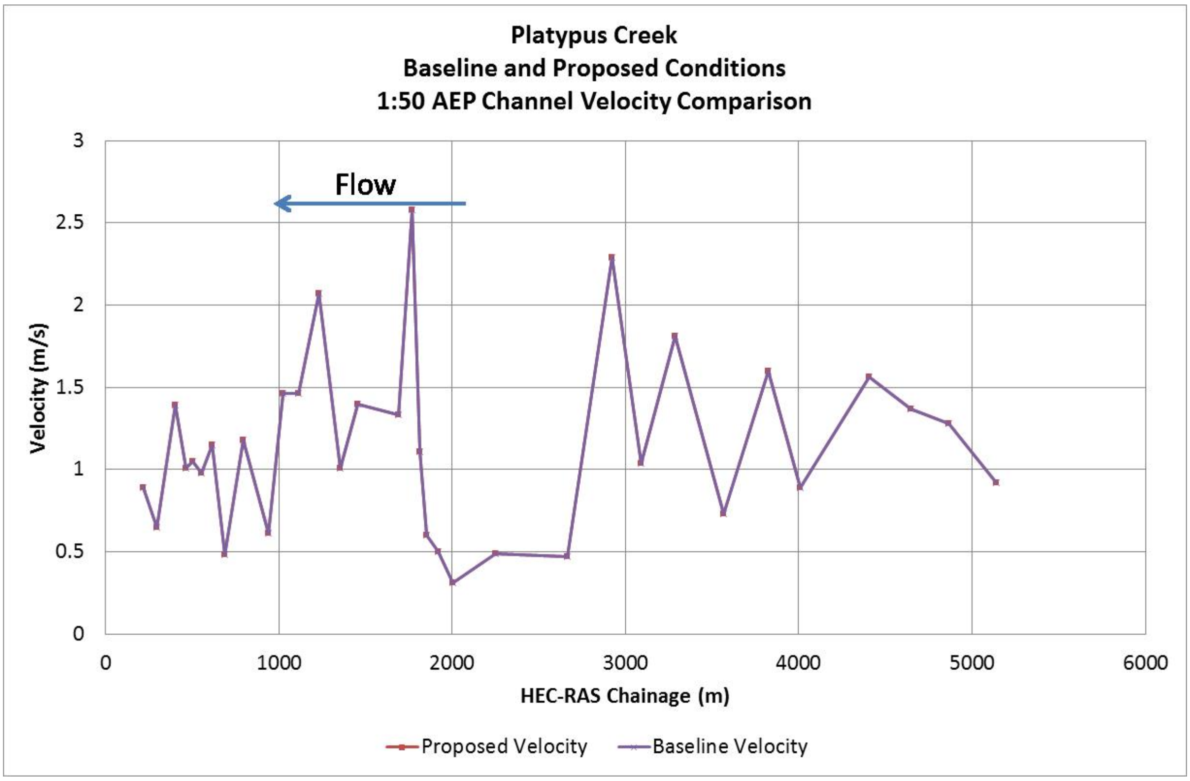
Figure Appendix C 52 Longitudinal Plot of Platypus Creek Water Surface Elevation Comparison 1 in 50 AEP



Note: Baseline and proposed levels coincide.

Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

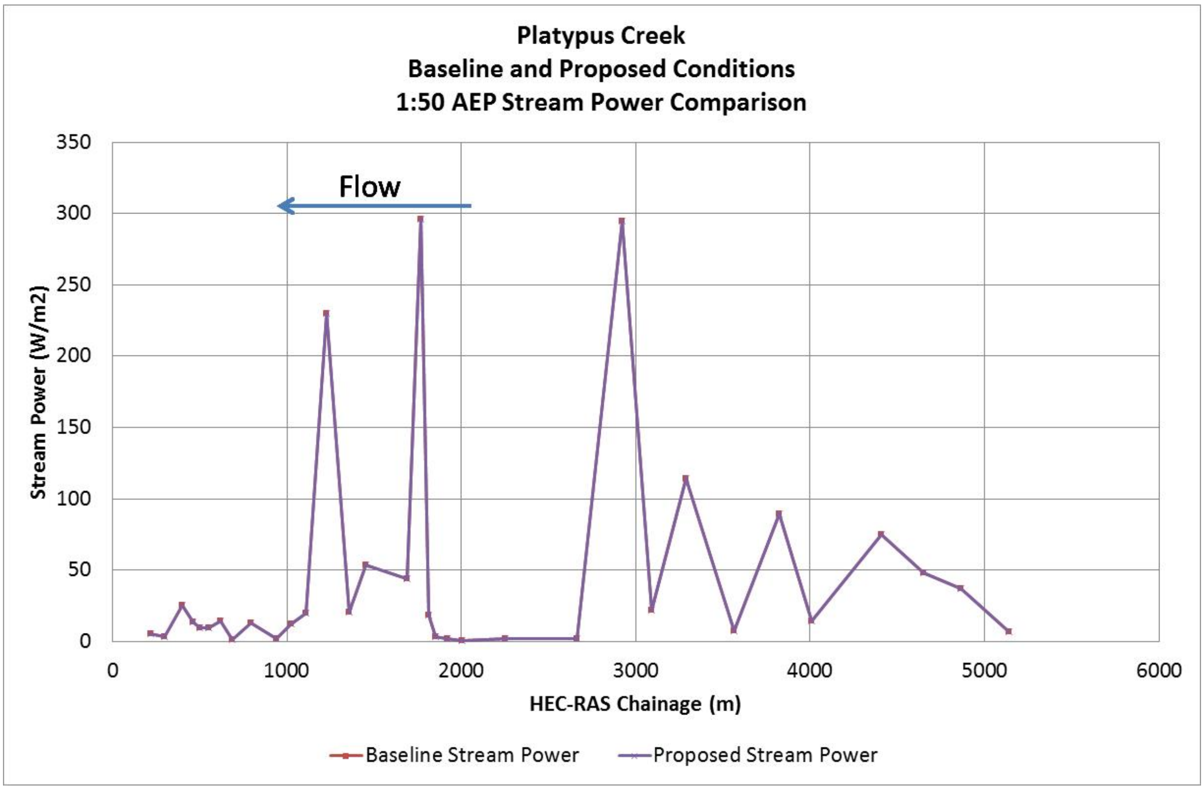
Figure Appendix C 53 Longitudinal Plot of Platypus Creek Stream Velocity Comparison 1 in 50 AEP



Note: Baseline and proposed velocity conditions coincide.

Appendix C - Longitudinal Plots of Basecase and Project HECRAS modelling results (1 in 10 to 1 in 50 AEP)

Figure Appendix C 54 Longitudinal Plot of Platypus Creek Stream Power Comparison 1 in 50 AEP



Note: Baseline and proposed stream power conditions coincide.

D

Appendix D Proposed HECRAS Modelling Results (1 in 2 to 1 in 50 AEP)

Table Appendix D 1 Summary of Proposed Case Stream Power Results (1 in 2 to 1 in 50 AEP)

Creek	Stream Power (W/m2)				
	1 in 2 AEP	1 in 5 AEP	1 in 10 AEP	1 in 20 AEP	1 in 50 AEP
Isaac River to Goonyella confluence	Na	Na	0.3 – 1046	0.7 – 1412	1.1 – 1628
Isaac River between Goonyella confluence and 12 Mile Gully confluence	Na	Na	0.2 – 911	0.5 – 1357	1.0 – 1056
Isaac River between confluence of 12 Mile Gully and Eureka Creek	Na	Na	0.8 – 273	0.9 – 270	1.4 – 370
Isaac River from Eureka Creek confluence to DS model boundary	Na	Na	6.0 – 618	7.6 – 551	10.2 – 524
12 Mile Gully	0.0 – 598	0.0 – 890	0.0 – 1501	0.1 – 929	0.1 – 922
Goonyella Creek	0.01 – 551	0.02 – 671	0.1 – 664	0.1 - 571	0.2 – 580
Eureka Creek	0.2 – 5591	0.4 – 7634	0.5 – 8628	0.7 – 10538	0.5 – 12316
Fisher Creek	0.1 – 360	0.1 – 504	0.1 – 581	0.4 – 440	0.4 – 555
Platypus Creek	0.1 – 348	0.1 – 646	0.4 – 229	0.4 – 296	0.1 – 347

Table Appendix D 2 Summary of Proposed Case Stream Velocity Results (1 in 2 to 1 in 50 AEP)

Creek	Velocity (m/s)				
	1 in 2 AEP	1 in 5 AEP	1 in 10 AEP	1 in 20 AEP	1 in 50 AEP
Isaac River to Goonyella confluence	Na	Na	0.32 – 4.35	0.44 – 4.95	0.51 – 5.27
Isaac River between Goonyella confluence and 12 Mile Gully confluence	Na	Na	0.33 – 4.18	0.45 – 4.87	0.54 – 4.6
Isaac River between confluence of 12 Mile Gully and Eureka Creek	Na	Na	0.45 – 2.84	0.54 – 2.93	0.61 – 3.24
Isaac River from Eureka Creek confluence to DS model boundary	Na	Na	0.85 – 3.8	0.92 – 3.74	1.05 – 3.78
12 Mile Gully	0.04 – 3.32	0.06 – 3.96	0.08 – 4.92	0.28 – 3.75	0.18 – 4.23
Goonyella Creek	0.11 – 3.00	0.16 – 3.42	0.22 – 3.71	0.31 – 4.00	0.46 – 4.32
Eureka Creek	0.29 – 5.93	0.31 – 6.81	0.35 – 7.21	0.43 – 7.99	0.38 – 8.68
Fisher Creek	0.19 – 2.50	0.22 – 2.88	0.24 – 3.06	0.34 – 2.72	0.34 – 3.00
Platypus Creek	0.13 – 2.41	0.21 – 2.68	0.25 – 3.29	0.30 – 2.30	0.31 – 2.58

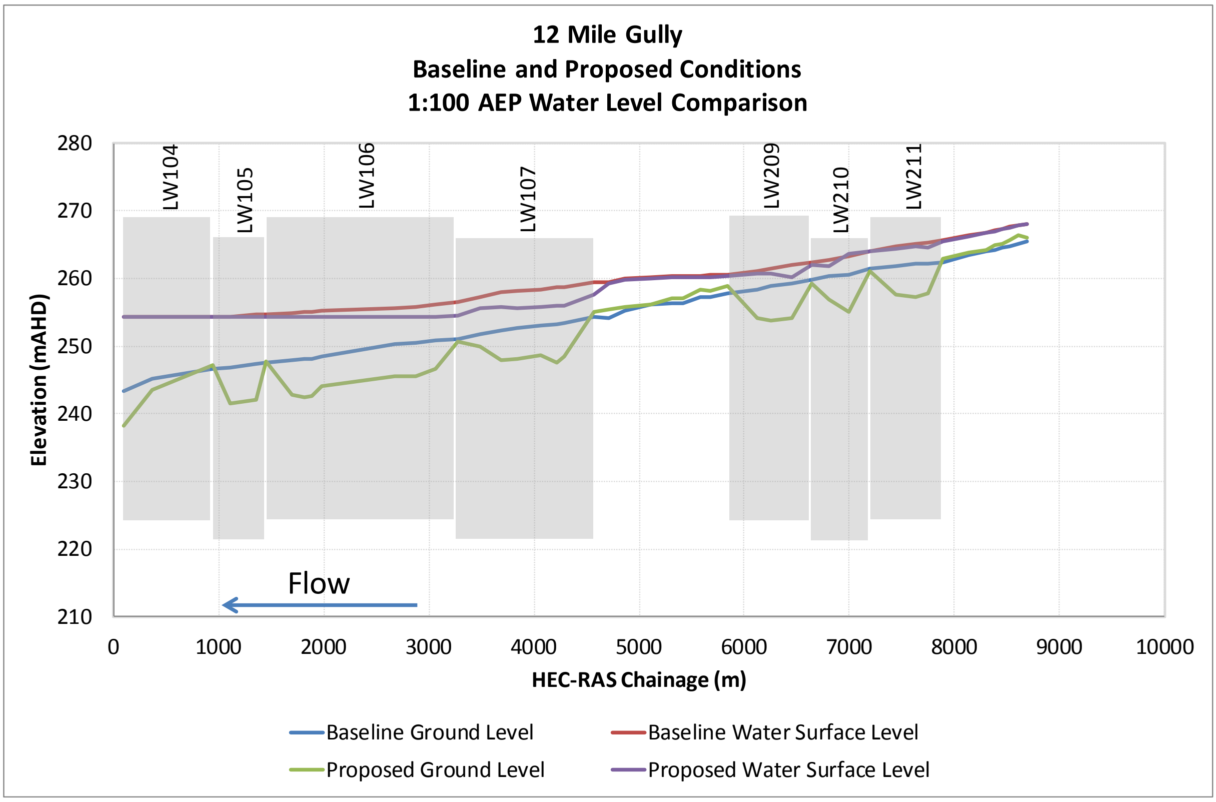
Appendix D - Proposed HECRAS Modelling Results (1 in 2 to 1 in 50 AEP)

Table Appendix D 3 Summary of Proposed Case Maximum Water Depths in Channel (1 in 2 to 1 in 50 AEP)

Creek	Maximum Flow Depth (m)				
	1 in 2 AEP	1 in 5 AEP	1 in 10 AEP	1 in 20 AEP	1 in 50 AEP
Isaac River to Goonyella confluence	Na	Na	1.6 – 10.7	2.9 – 11.9	3.4 – 12.7
Isaac River between Goonyella confluence and 12 Mile Gully confluence	Na	Na	3.2 – 11.0	3.9 – 11.9	4.8 – 12.7
Isaac River between confluence of 12 Mile Gully and Eureka Creek	Na	Na	3.1 – 11.1	3.8 – 12.0	4.2 – 12.8
Isaac River from Eureka Creek confluence to DS model boundary	Na	Na	3.9 – 9.3	4.5 – 10.0	5.2 – 11.0
12 Mile Gully	1.0 – 8.1	1.0 – 8.6	0.9 – 10.7	1.1 – 11.6	1.3 – 12.4
Goonyella Creek	1.7 – 7.0	1.4 – 7.5	1.9 – 8.2	2.0 – 8.9	2.1 – 9.7
Eureka Creek	0.6 – 6.1	0.8 – 7.0	1.0 – 7.4	1.2 – 8.2	1.5 – 9.0
Fisher Creek	0.5 – 3.2	0.7 – 3.8	0.8 – 4.1	1.1 – 5.4	1.3 – 6.6
Platypus Creek	0.3 – 3.9	0.6 – 4.3	0.6 – 4.4	0.8 – 4.7	1.1 – 4.9

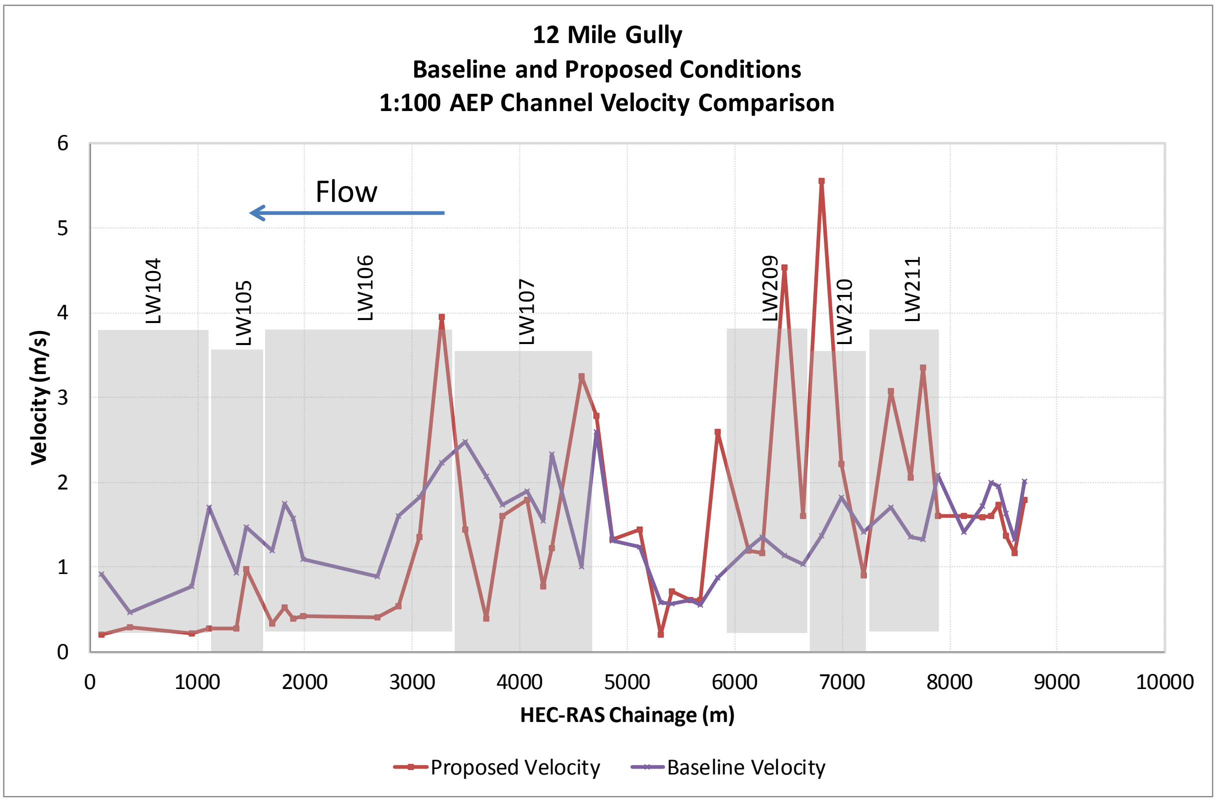
Appendix E Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

Figure Appendix E 1 Longitudinal Plot of 12 Mile Gully Water Surface Elevation Comparison 1 in 100 AEP



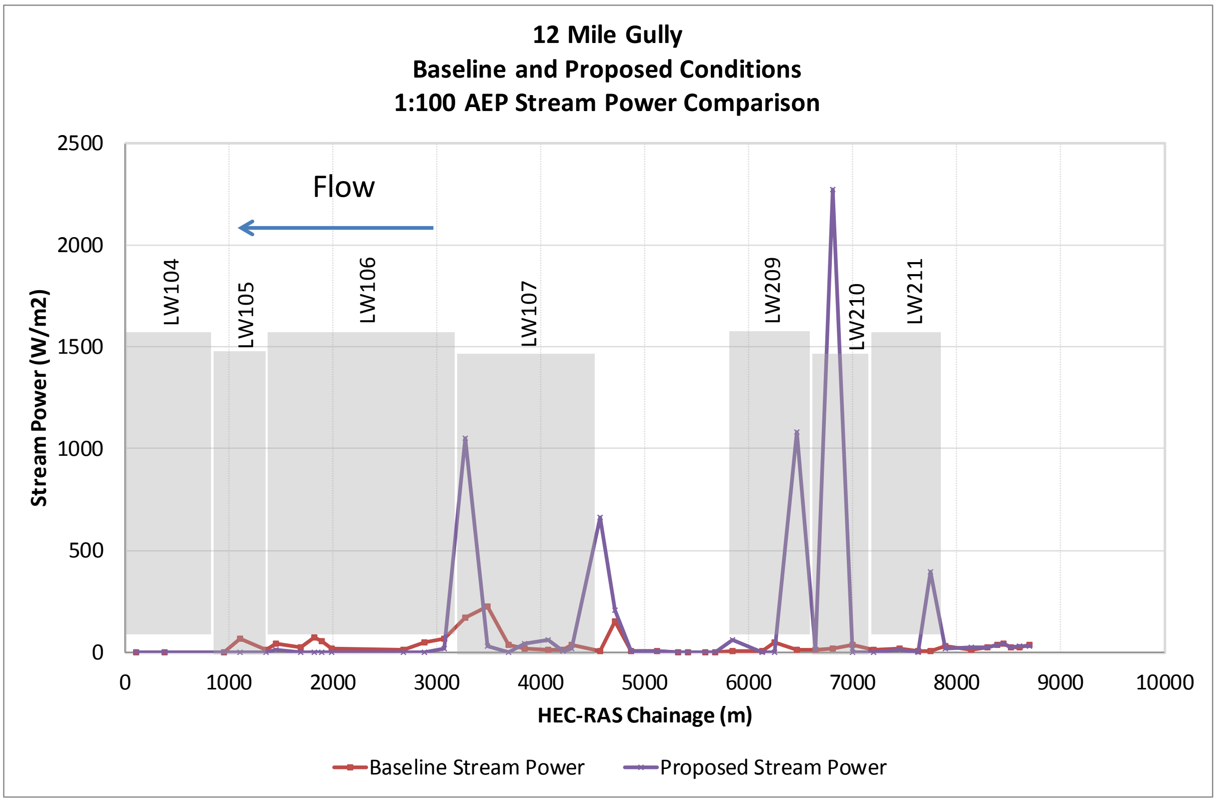
Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

Figure Appendix E 2 Longitudinal Plot of 12 Mile Gully Stream Velocity Comparison 1 in 100 AEP



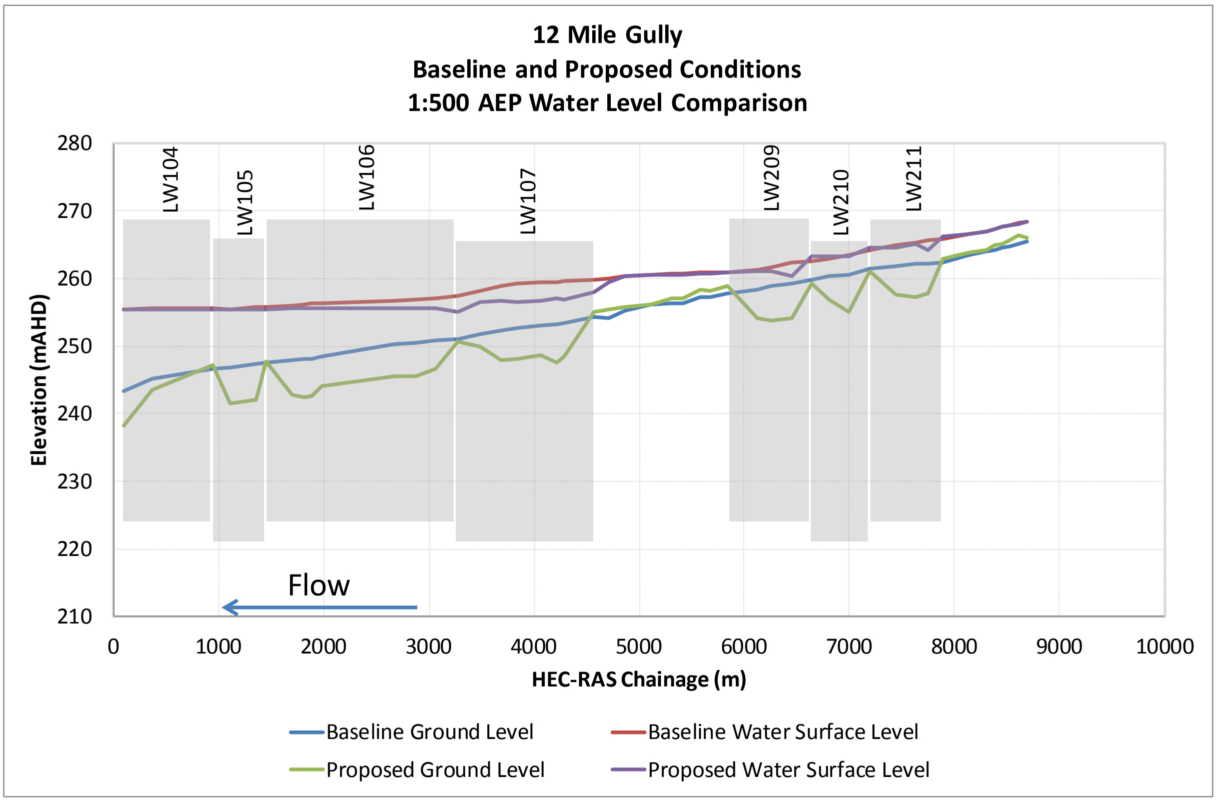
Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

Figure Appendix E 3 Longitudinal Plot of 12 Mile Gully Stream Power Comparison 1 in 100 AEP



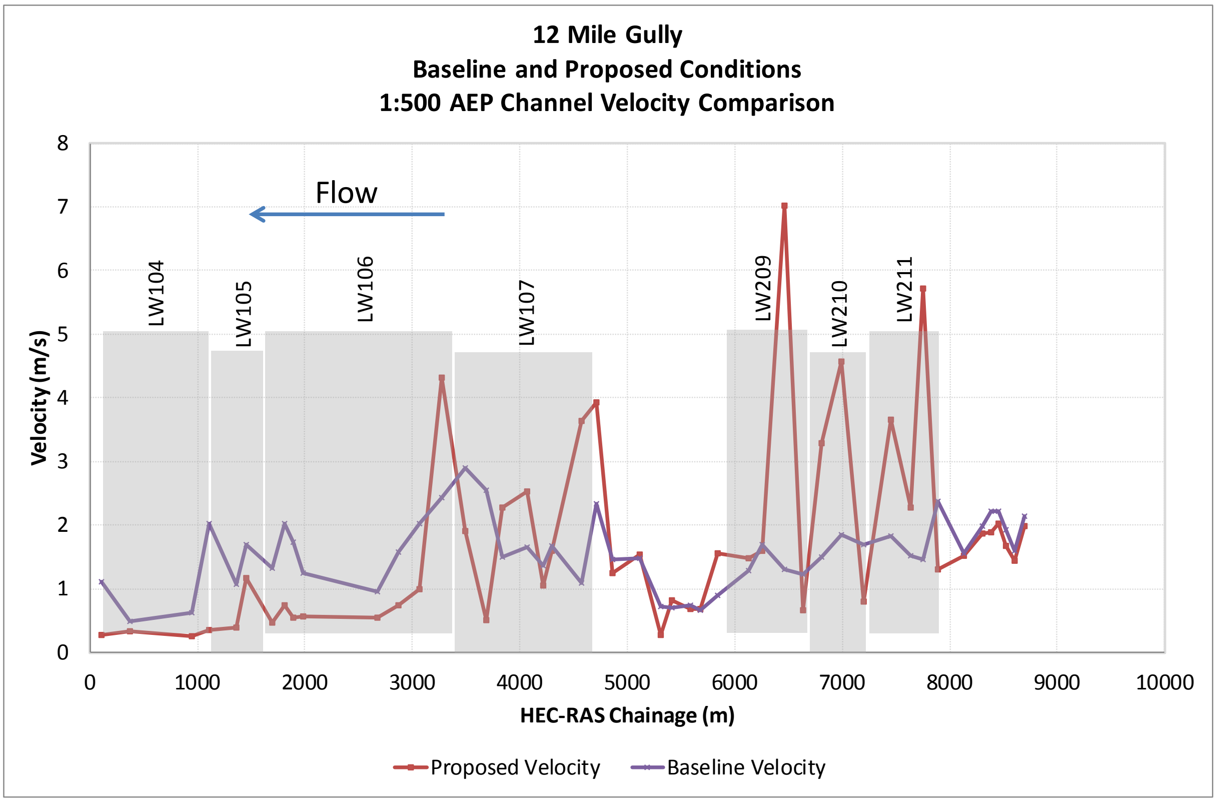
Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

Figure Appendix E 4 Longitudinal Plot of 12 Mile Gully Water Surface Elevation Comparison 1 in 500 AEP



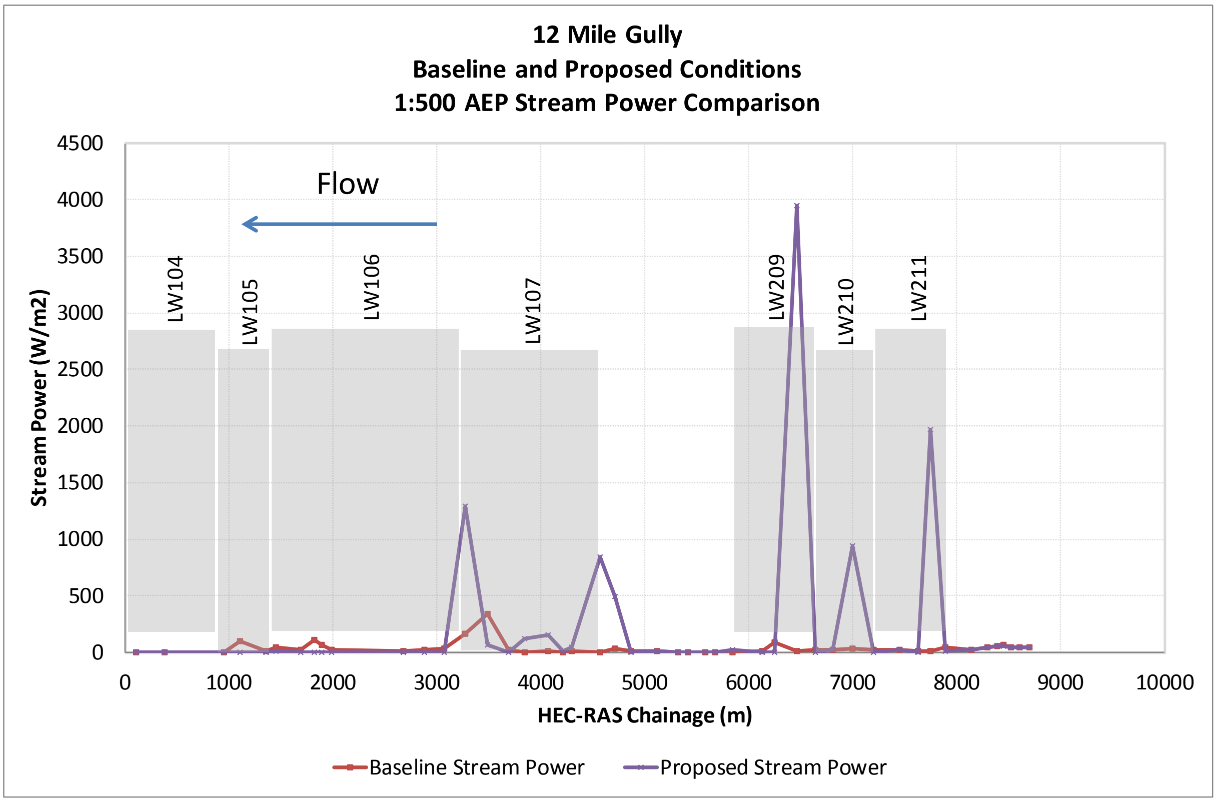
Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

Figure Appendix E 5 Longitudinal Plot of 12 Mile Gully Stream Velocity Comparison 1 in 500 AEP



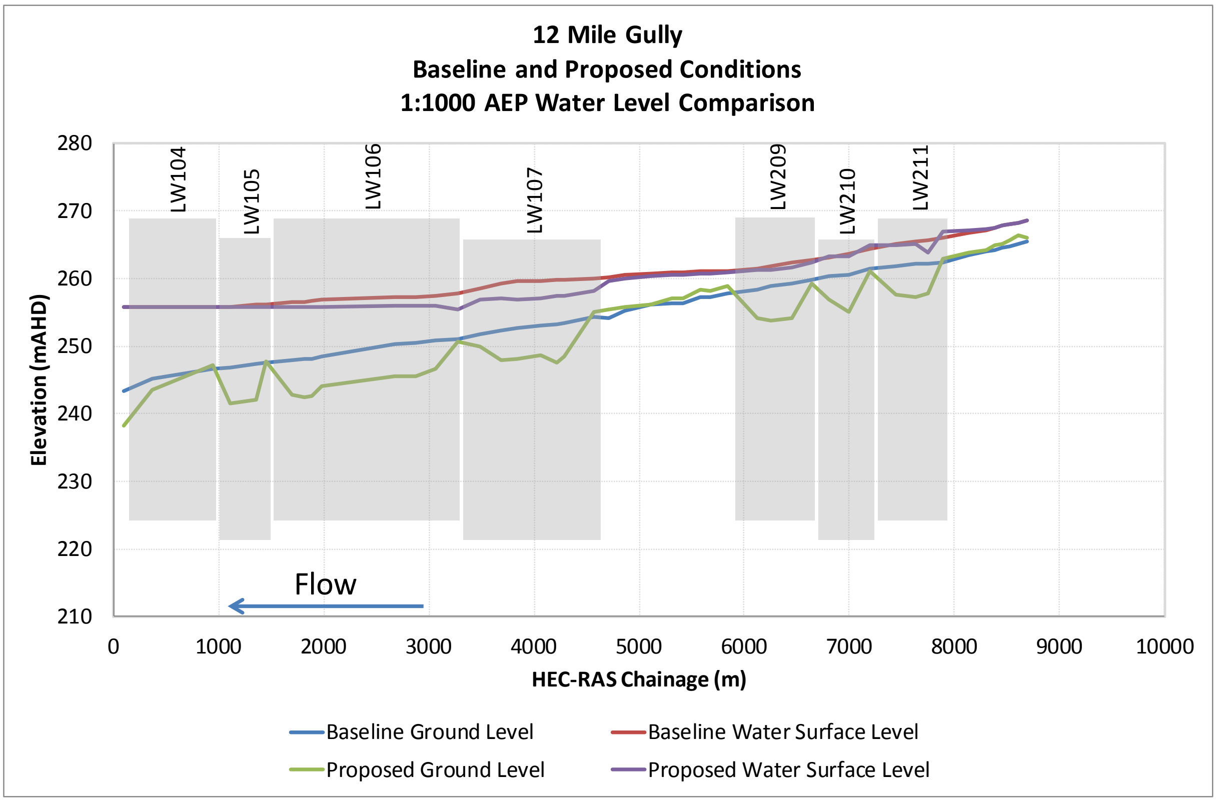
Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

Figure Appendix E 6 Longitudinal Plot of 12 Mile Gully Stream Power Comparison 1 in 500 AEP



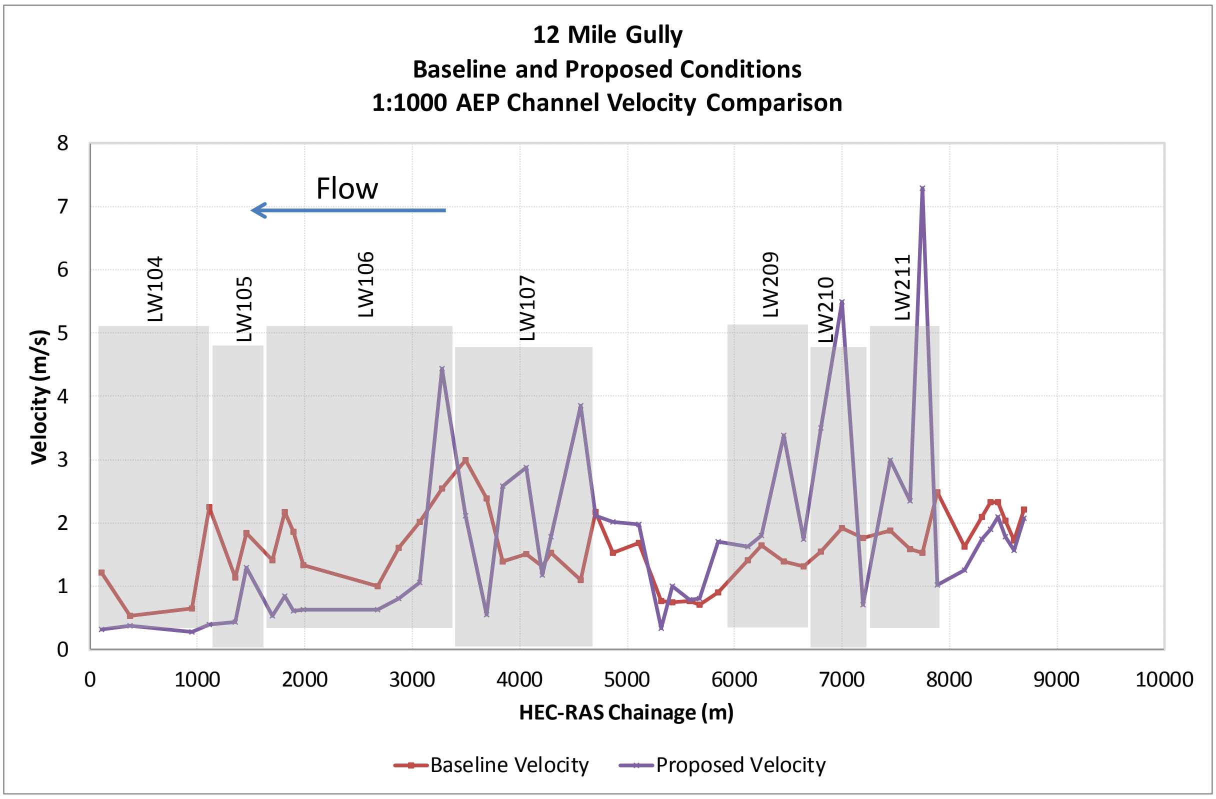
Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

Figure Appendix E 7 Longitudinal Plot of 12 Mile Gully Water Surface Elevation Comparison 1 in 1000 AEP



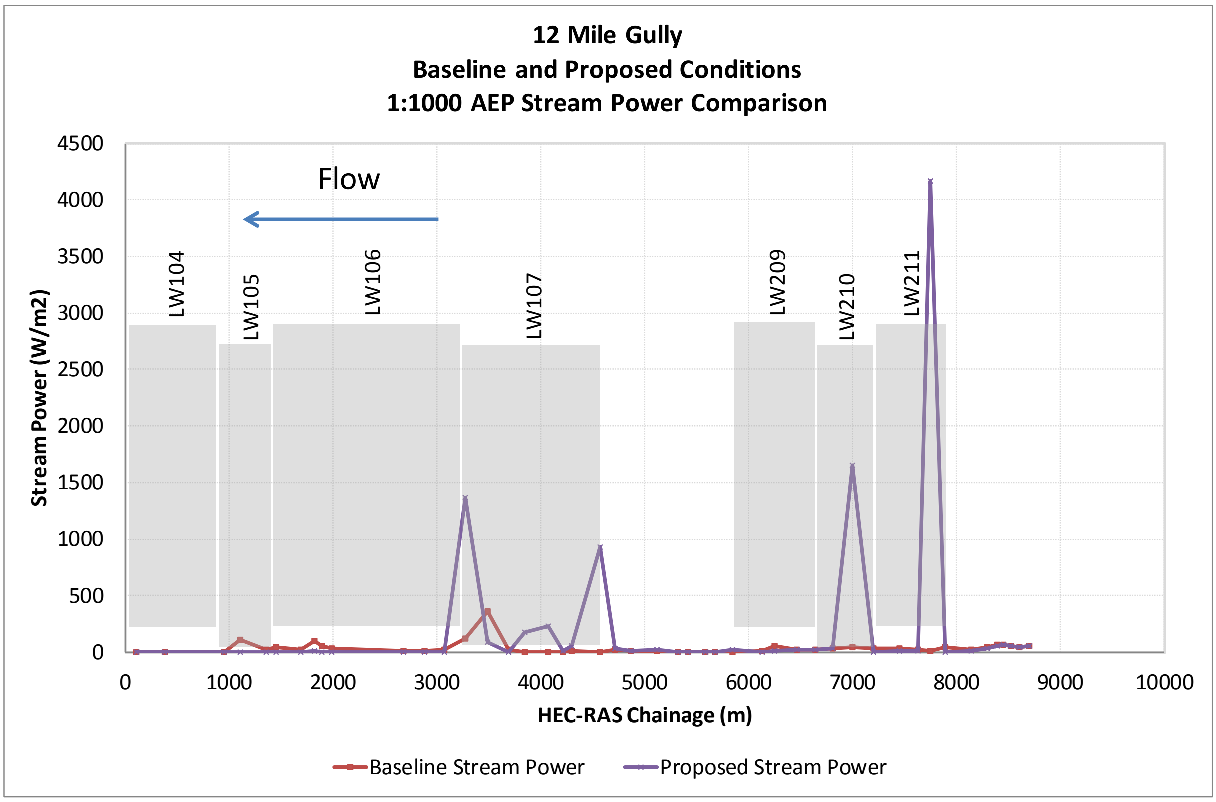
Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

Figure Appendix E 8 Longitudinal Plot of 12 Mile Gully Stream Velocity Comparison 1 in 1000 AEP



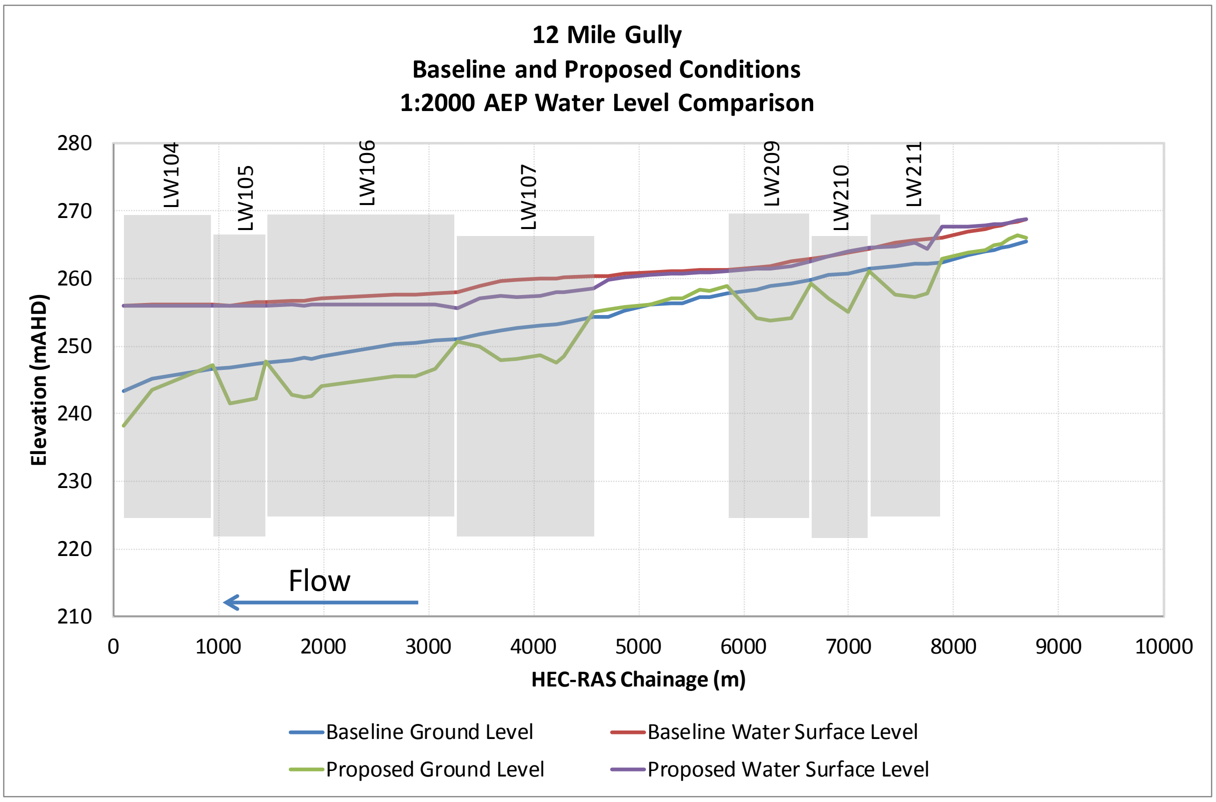
Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

Figure Appendix E 9 Longitudinal Plot of 12 Mile Gully Stream Power Comparison 1 in 1000 AEP



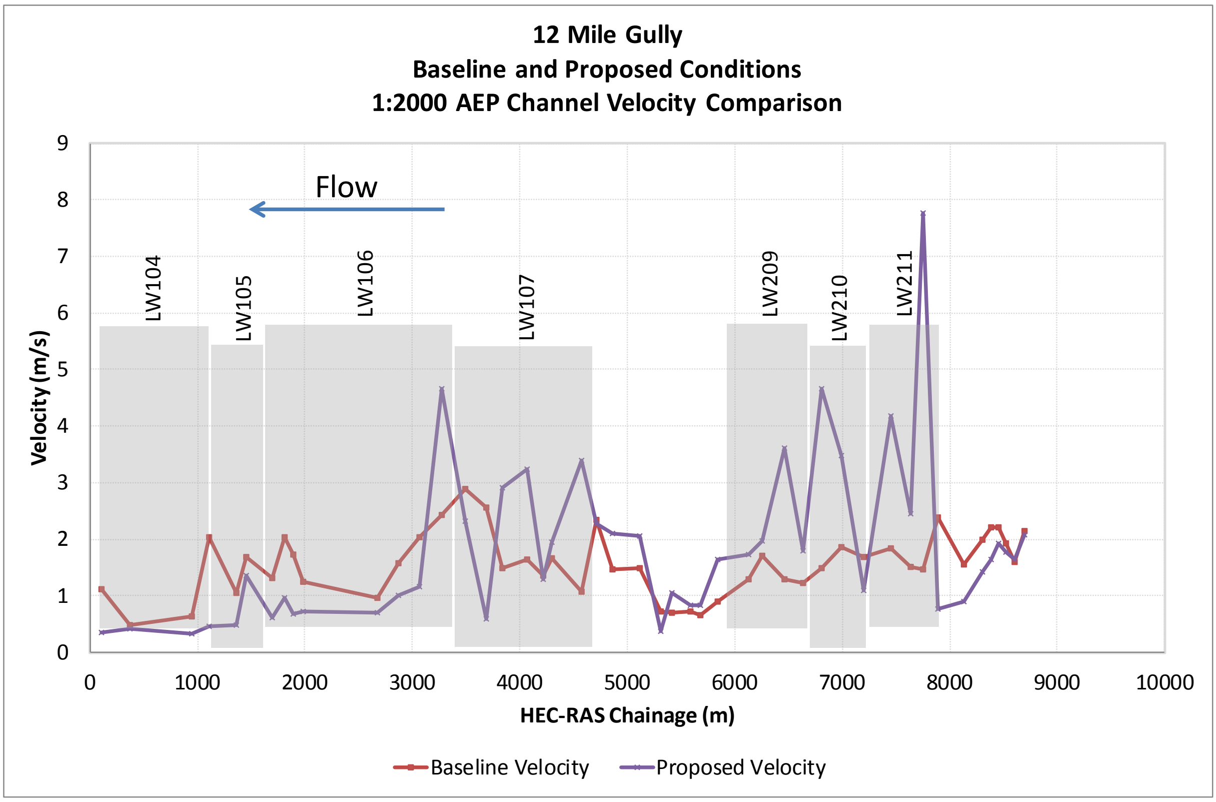
Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

Figure Appendix E 10 Longitudinal Plot of 12 Mile Gully Water Surface Elevation Comparison 1 in 2000 AEP



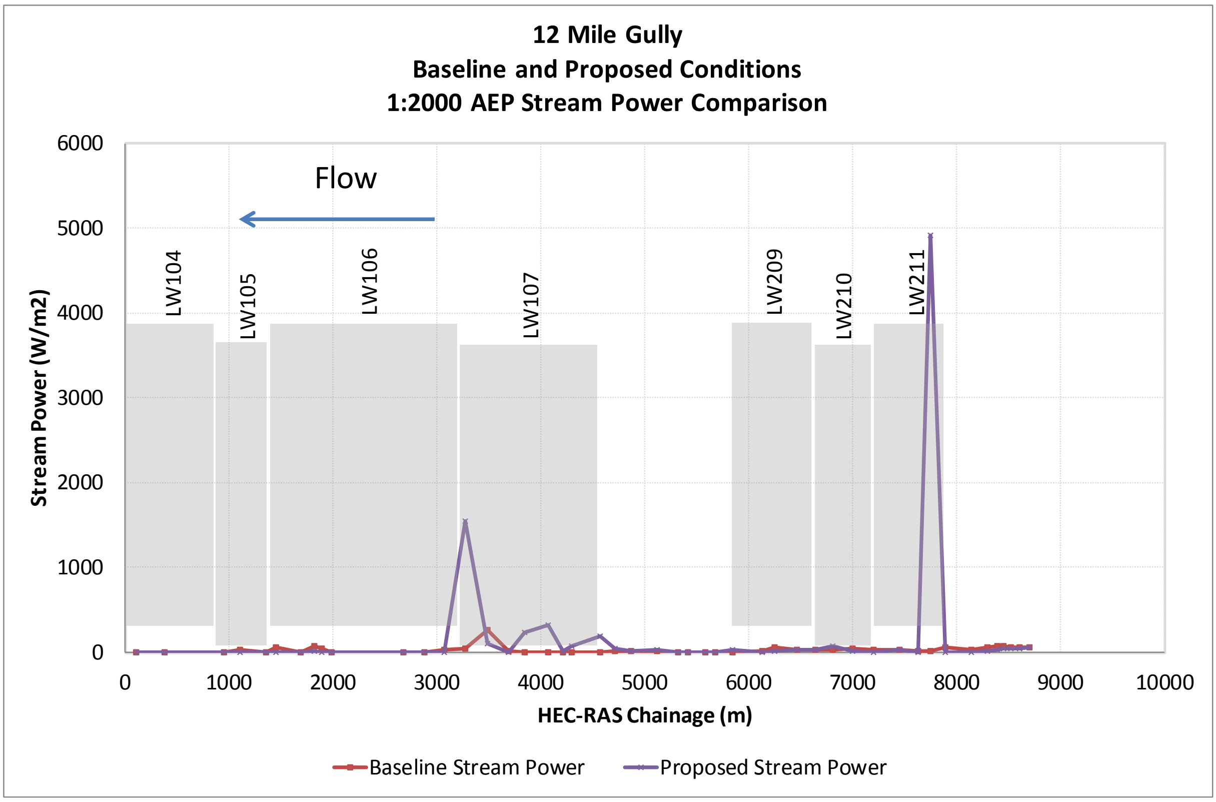
Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

Figure Appendix E 11 Longitudinal Plot of 12 Mile Gully Stream Velocity Comparison 1 in 2000 AEP



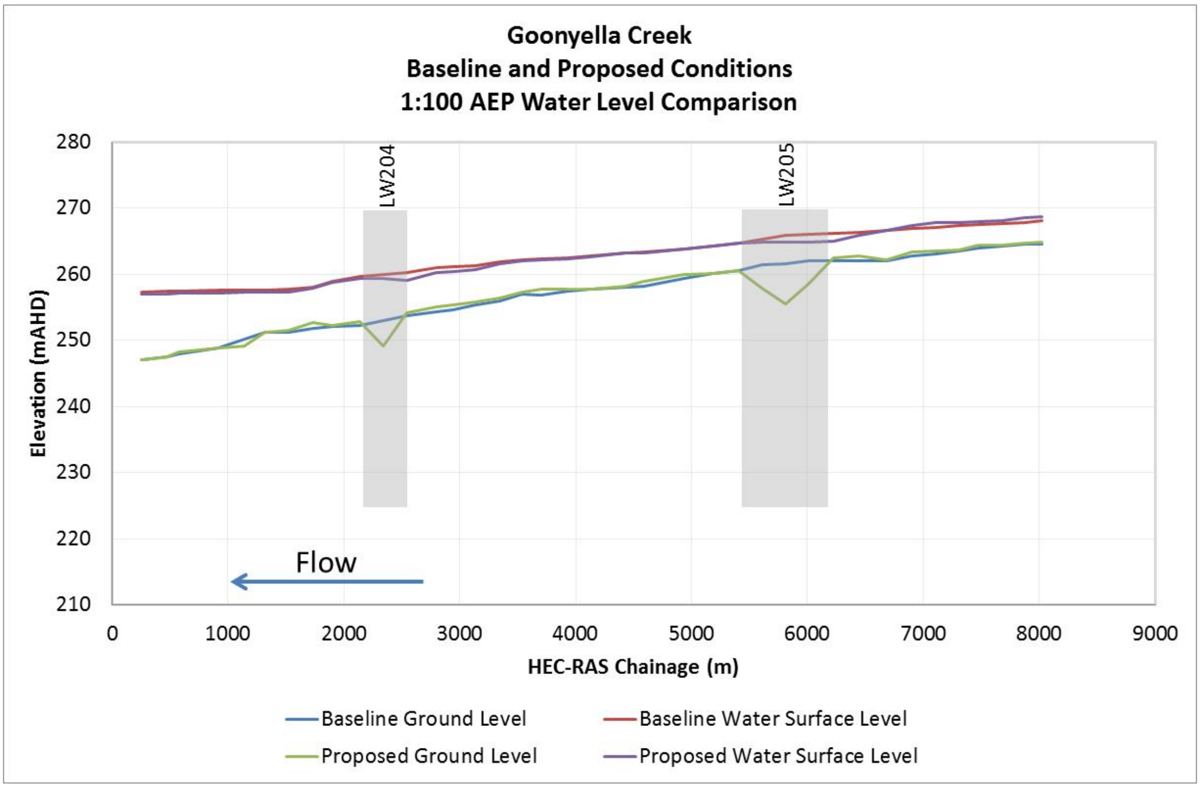
Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

Figure Appendix E 12 Longitudinal Plot of 12 Mile Gully Stream Power Comparison 1 in 2000 AEP



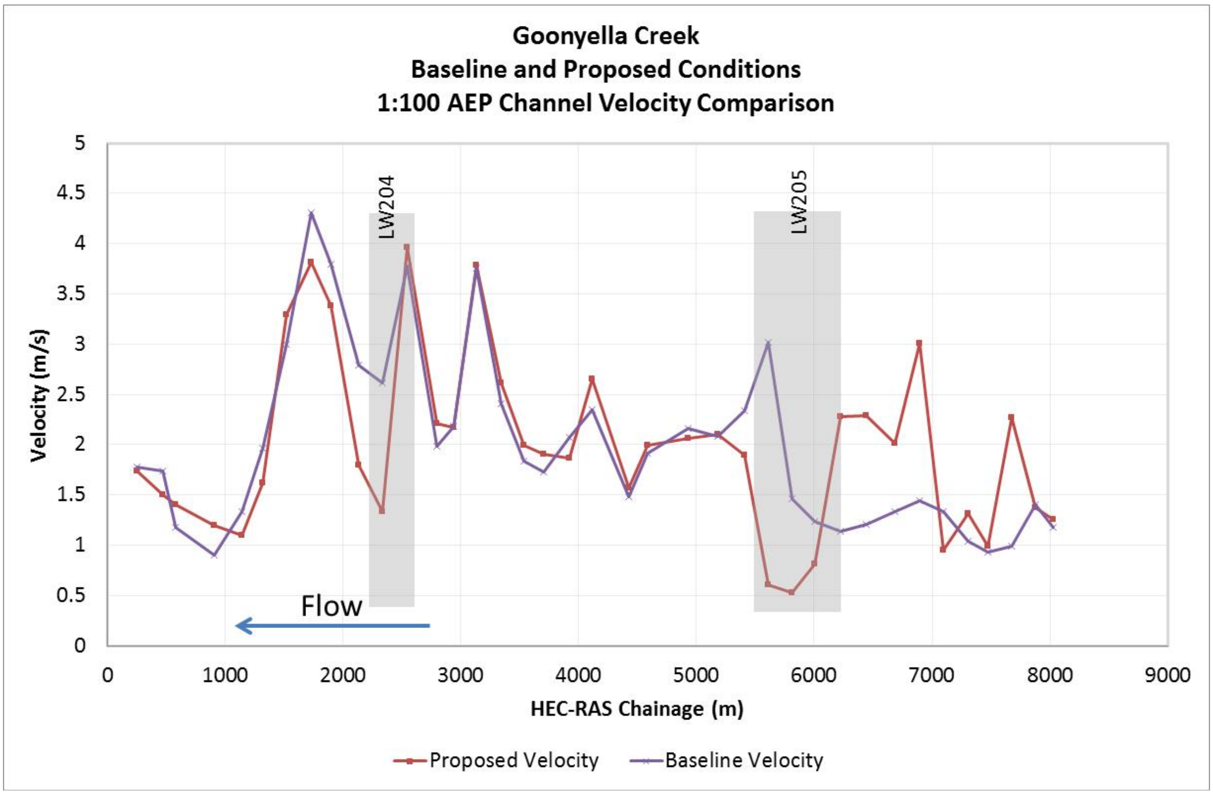
Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

Figure Appendix E 13 Longitudinal Plot of Goonyella Creek Water Surface Elevation Comparison 1 in 100 AEP



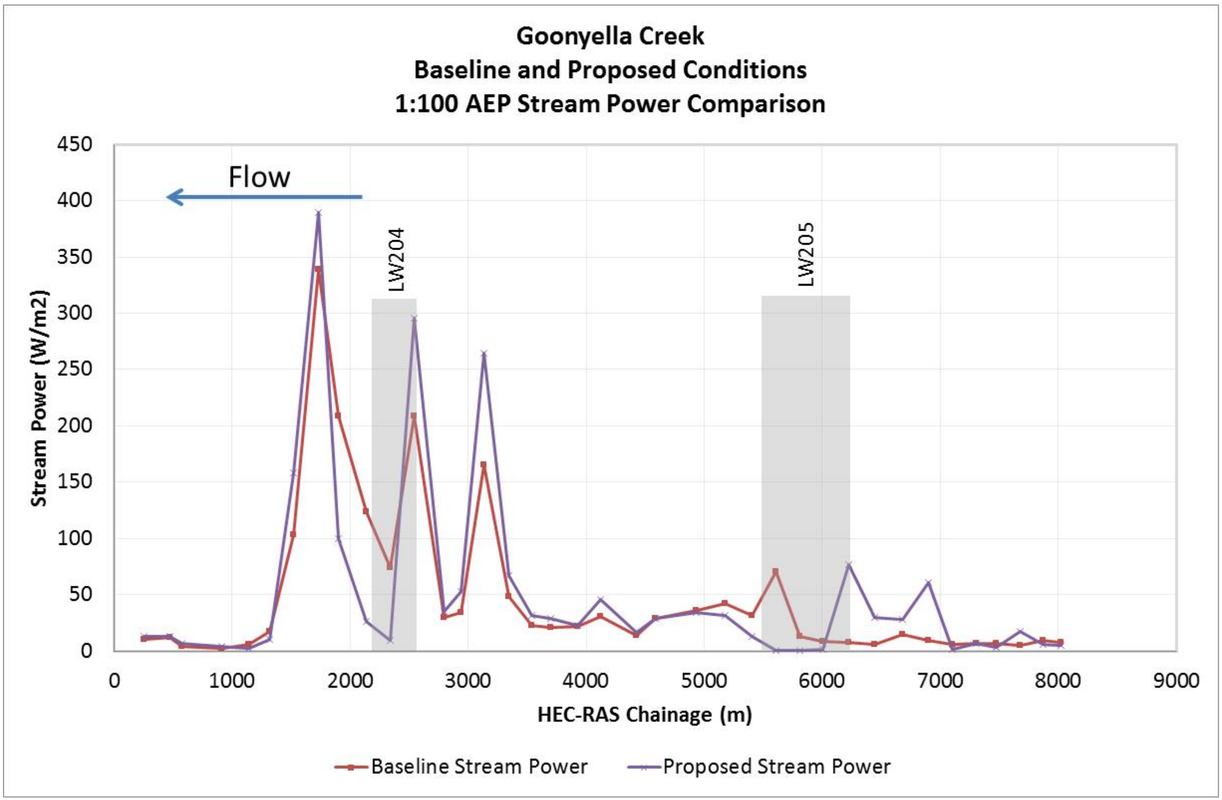
Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

Figure Appendix E 14 Longitudinal Plot of Goonyella Creek Stream Velocity Comparison 1 in 100 AEP



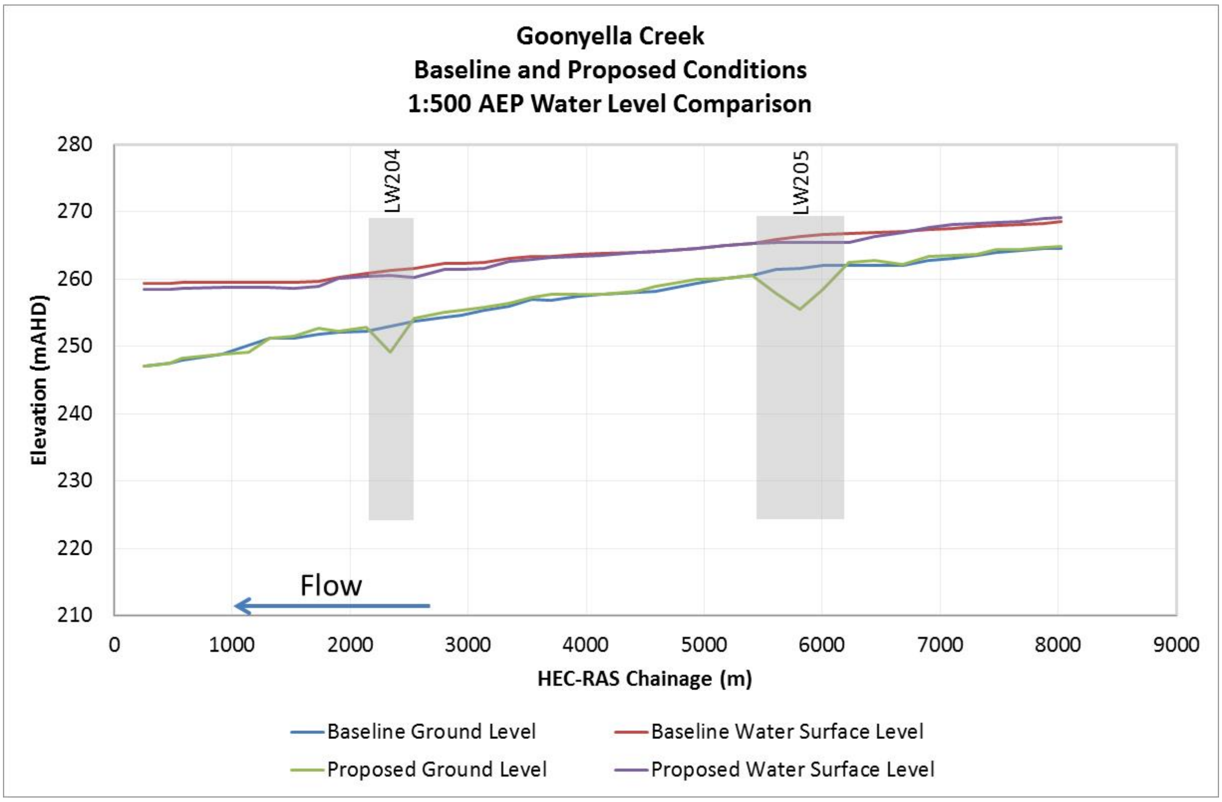
Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

Figure Appendix E 15 Longitudinal Plot of Goonyella Creek Stream Power Comparison 1 in 100 AEP



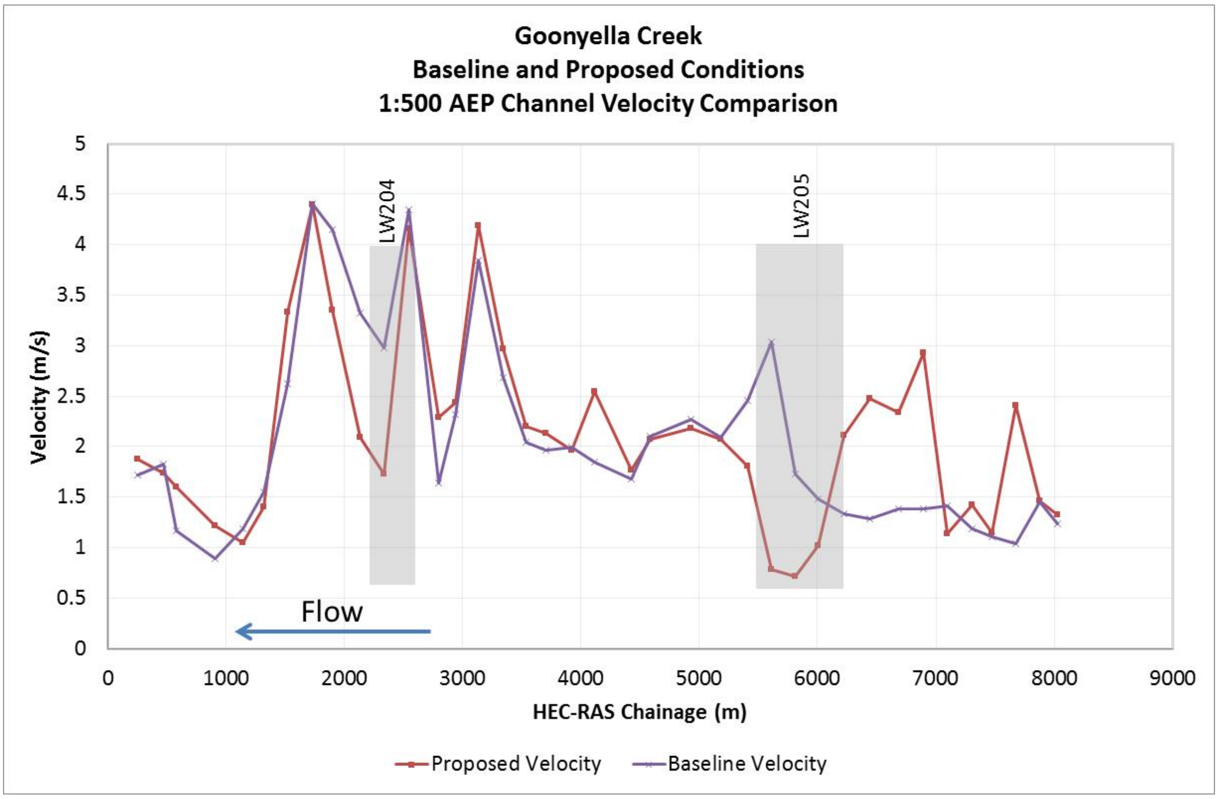
Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

Figure Appendix E 16 Longitudinal Plot of Goonyella Creek Water Surface Elevation Comparison 1 in 500 AEP



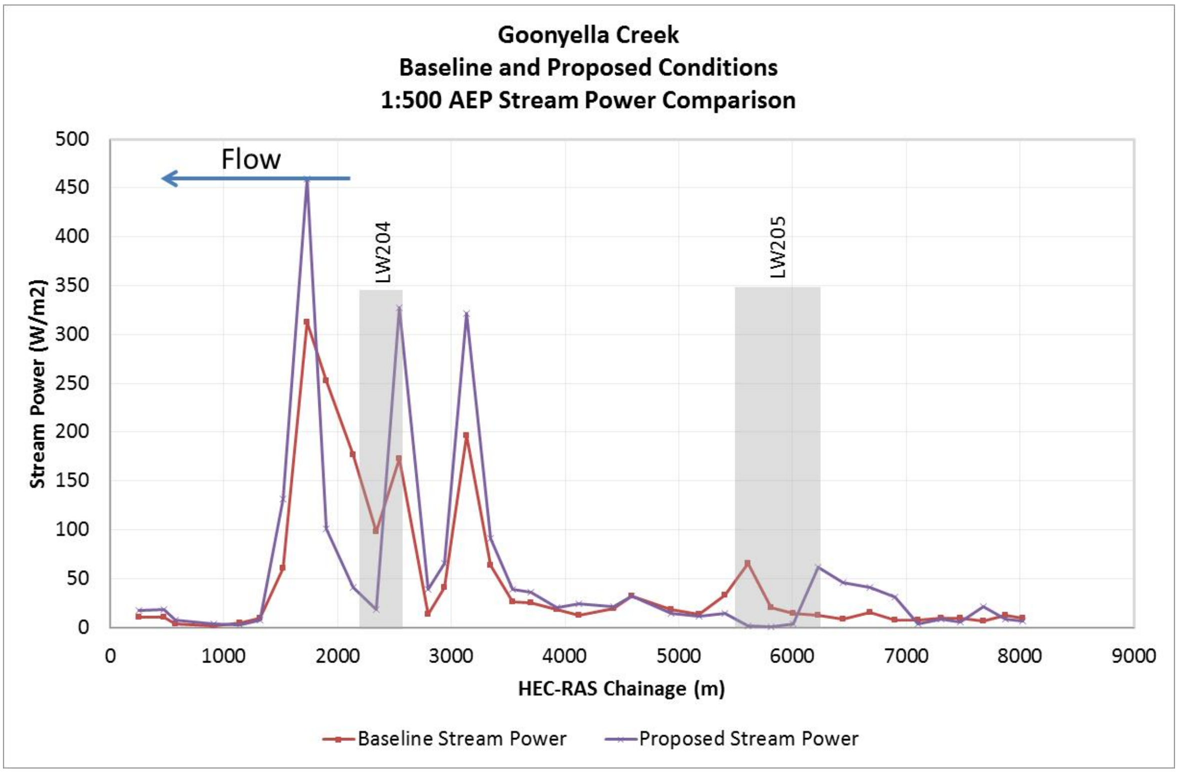
Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

Figure Appendix E 17 Longitudinal Plot of Goonyella Creek Stream Velocity Comparison 1 in 500 AEP



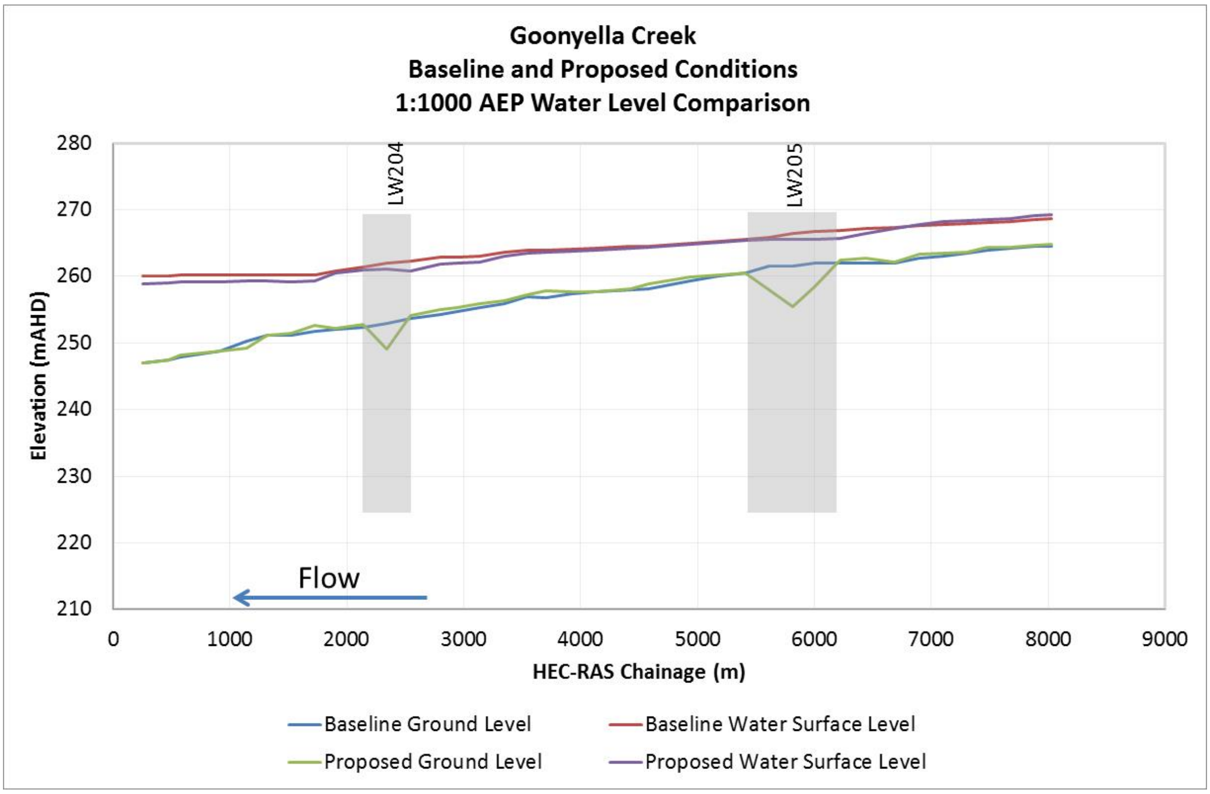
Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

Figure Appendix E 18 Longitudinal Plot of Goonyella Creek Stream Power Comparison 1 in 500 AEP



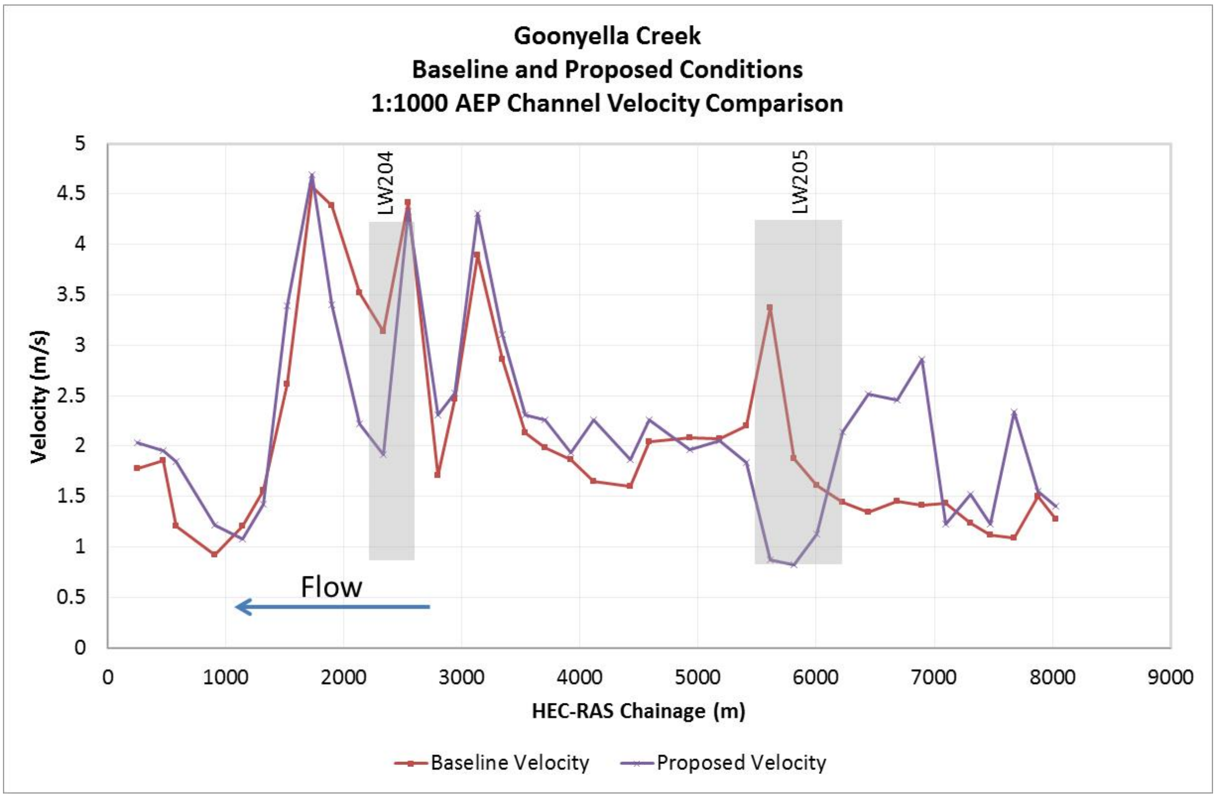
Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

Figure Appendix E 19 Longitudinal Plot of Goonyella Creek Water Surface Elevation Comparison 1 in 1000 AEP



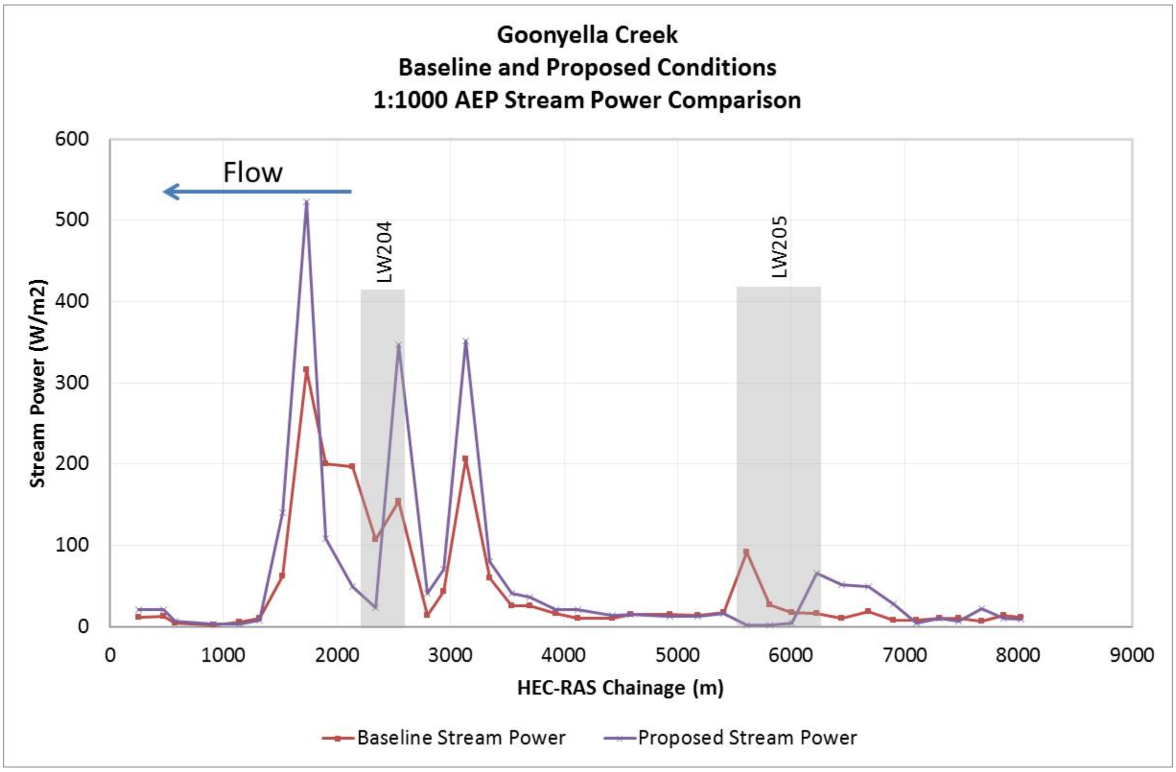
Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

Figure Appendix E 20 Longitudinal Plot of Goonyella Creek Stream Velocity Comparison 1 in 1000 AEP



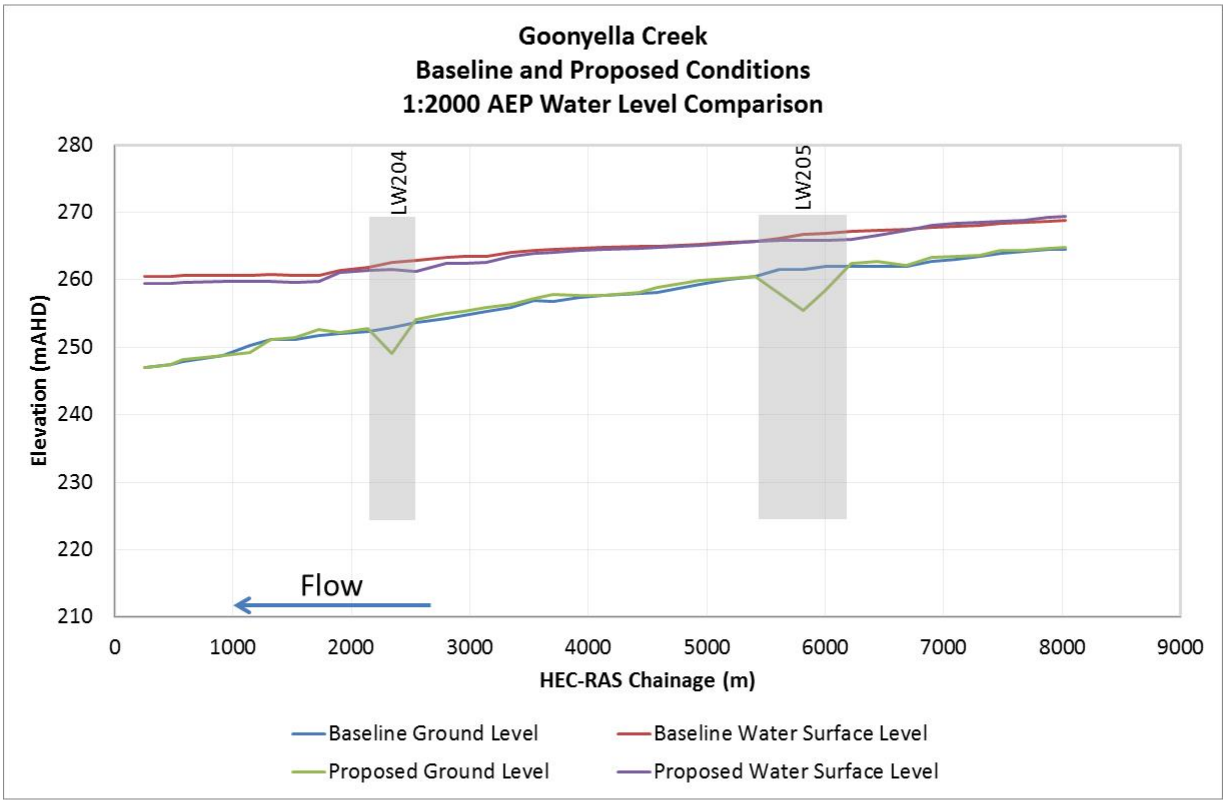
Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

Figure Appendix E 21 Longitudinal Plot of Goonyella Creek Stream Power Comparison 1 in 1000 AEP



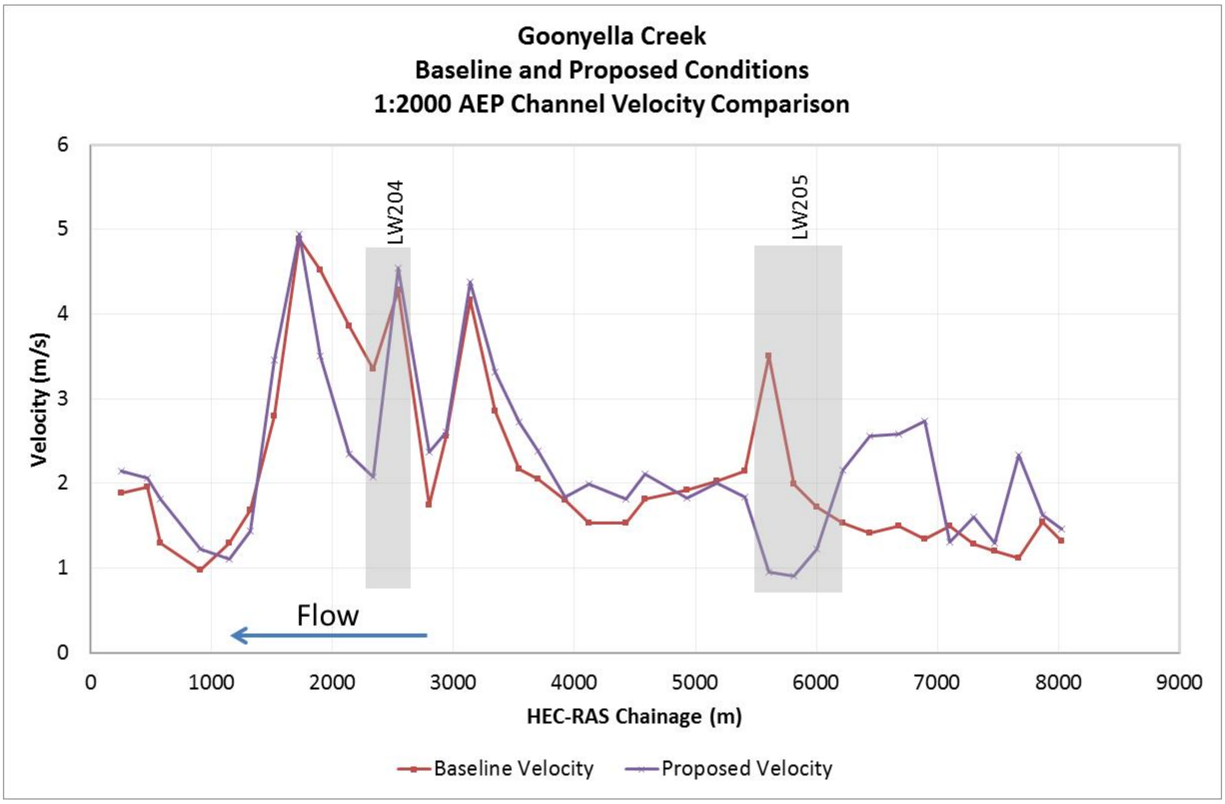
Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

Figure Appendix E 22 Longitudinal Plot of Goonyella Creek Water Surface Elevation Comparison 1 in 2000 AEP



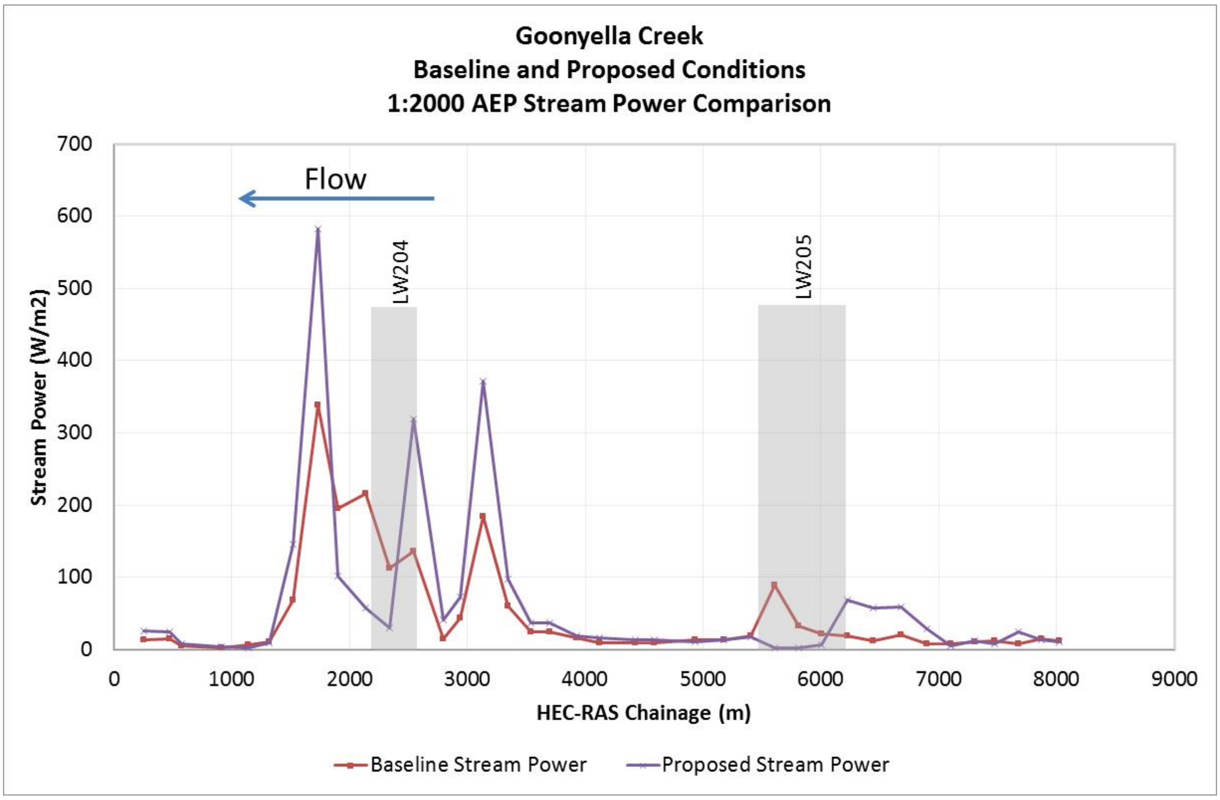
Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

Figure Appendix E 23 Longitudinal Plot of Goonyella Creek Stream Velocity Comparison 1 in 2000 AEP



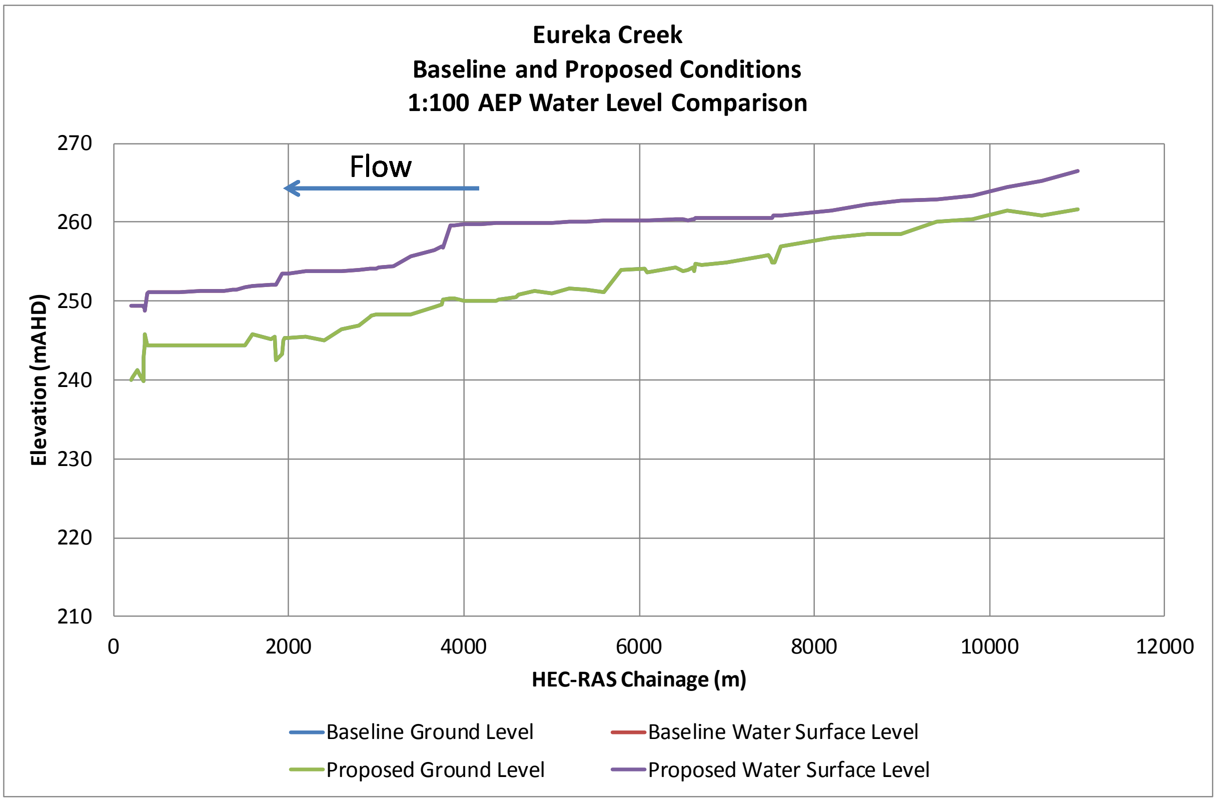
Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

Figure Appendix E 24 Longitudinal Plot of Goonyella Creek Stream Power Comparison 1 in 2000 AEP



Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

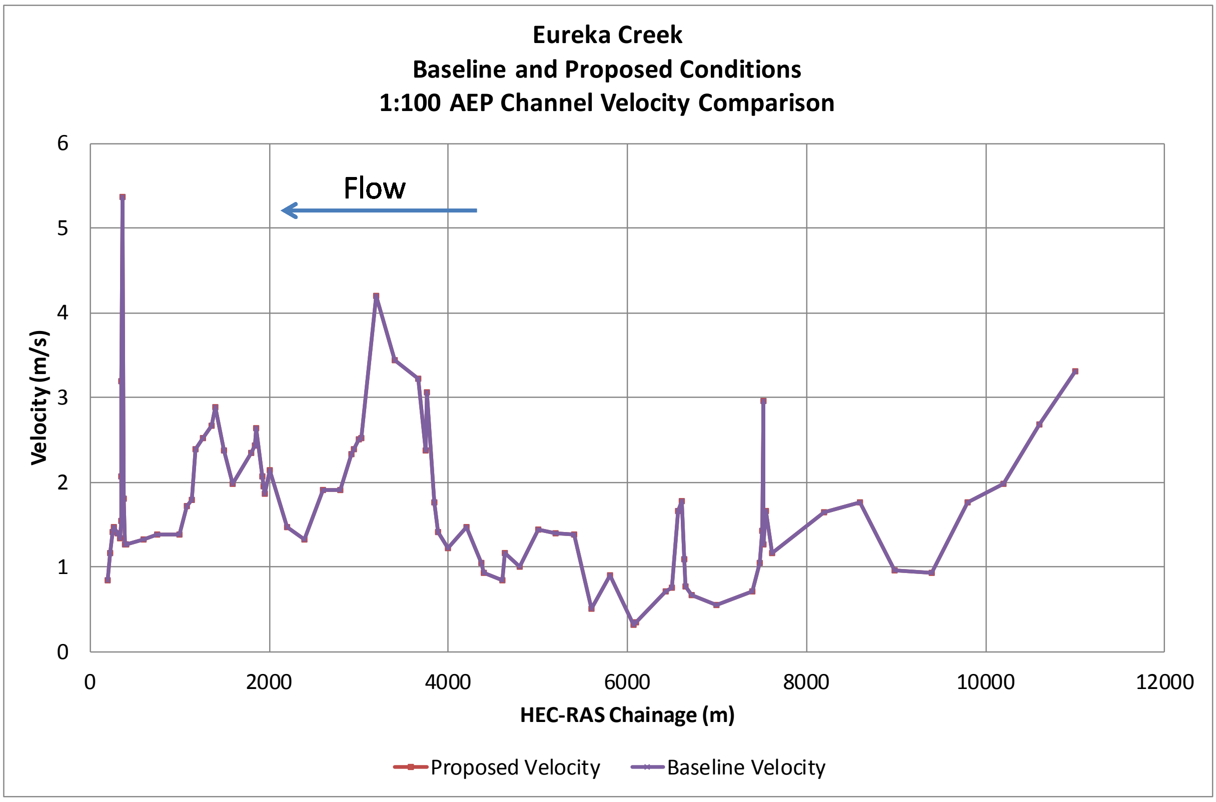
Figure Appendix E 25 Longitudinal Plot of Eureka Creek Water Surface Elevation Comparison 1 in 100 AEP



Note: Baseline and proposed levels coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

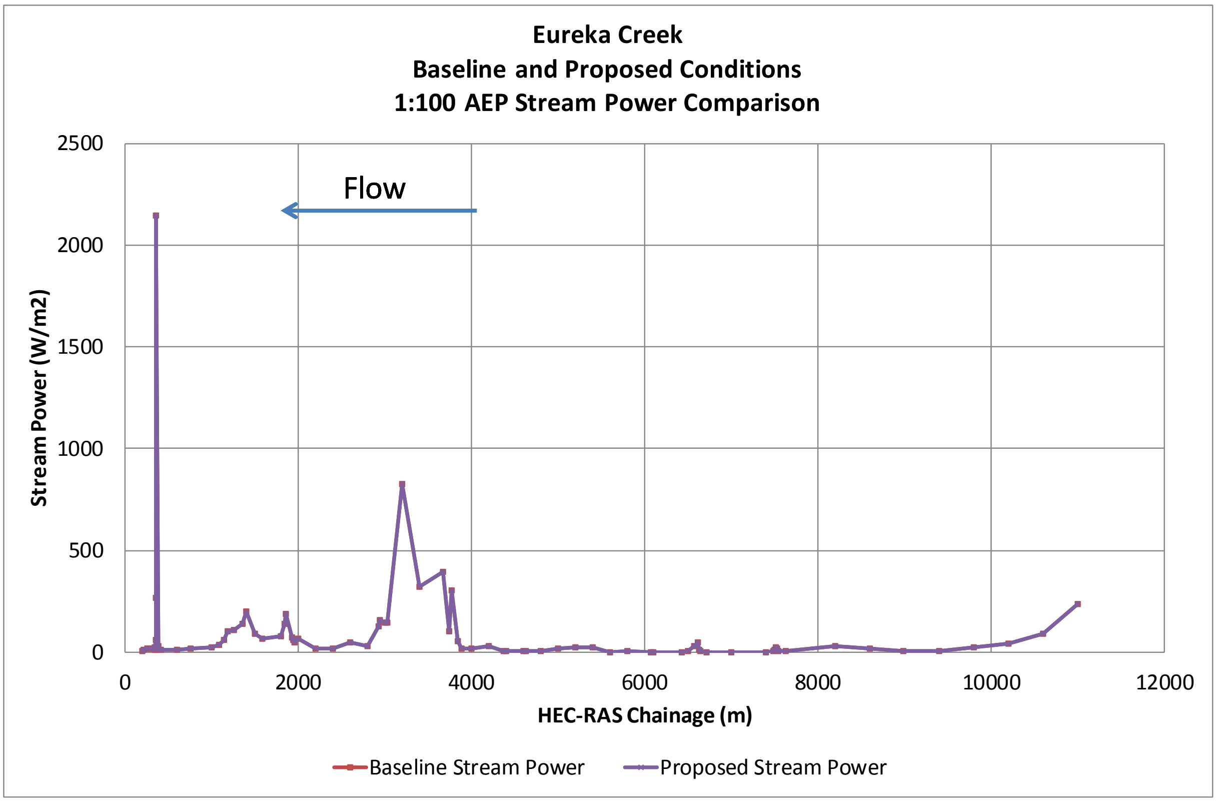
Figure Appendix E 26 Longitudinal Plot of Eureka Creek Stream Velocity Comparison 1 in 100 AEP



Note: Baseline and proposed velocity conditions coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

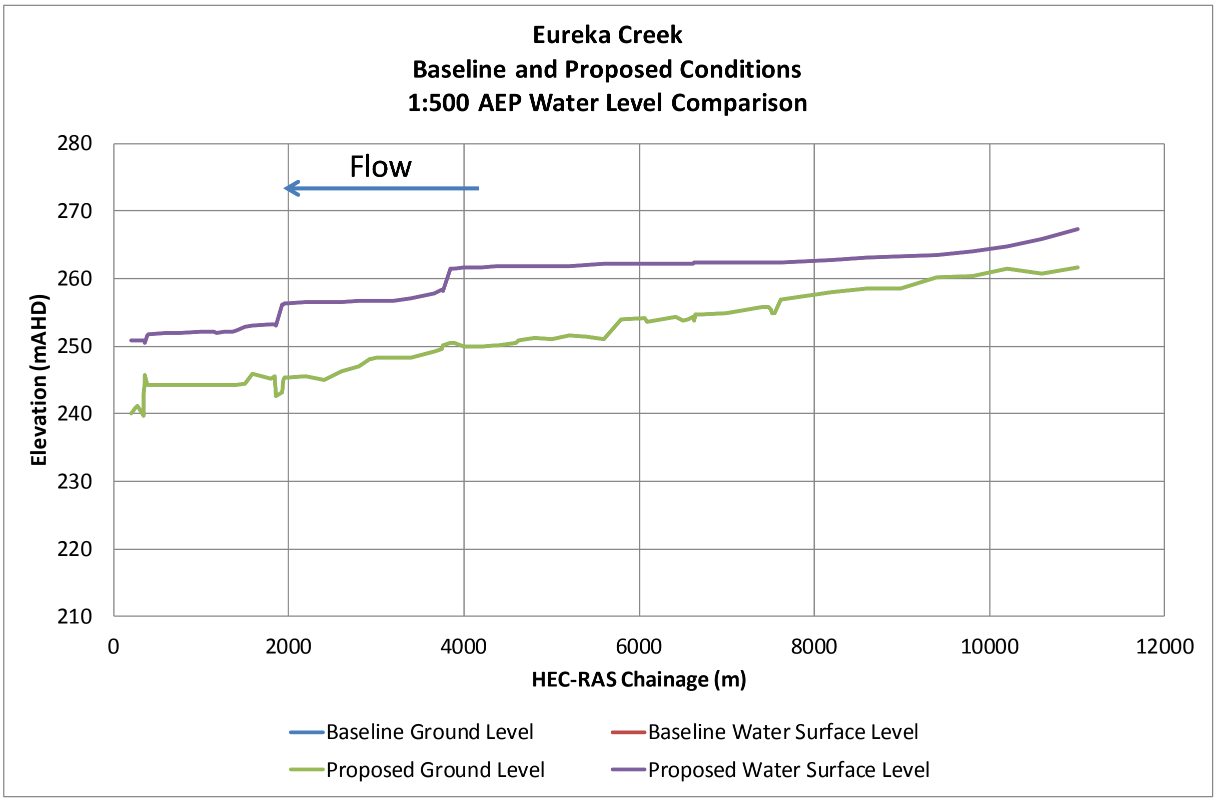
Figure Appendix E 27 Longitudinal Plot of Eureka Creek Stream Power Comparison 1 in 100 AEP



Note: Baseline and proposed stream power conditions coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

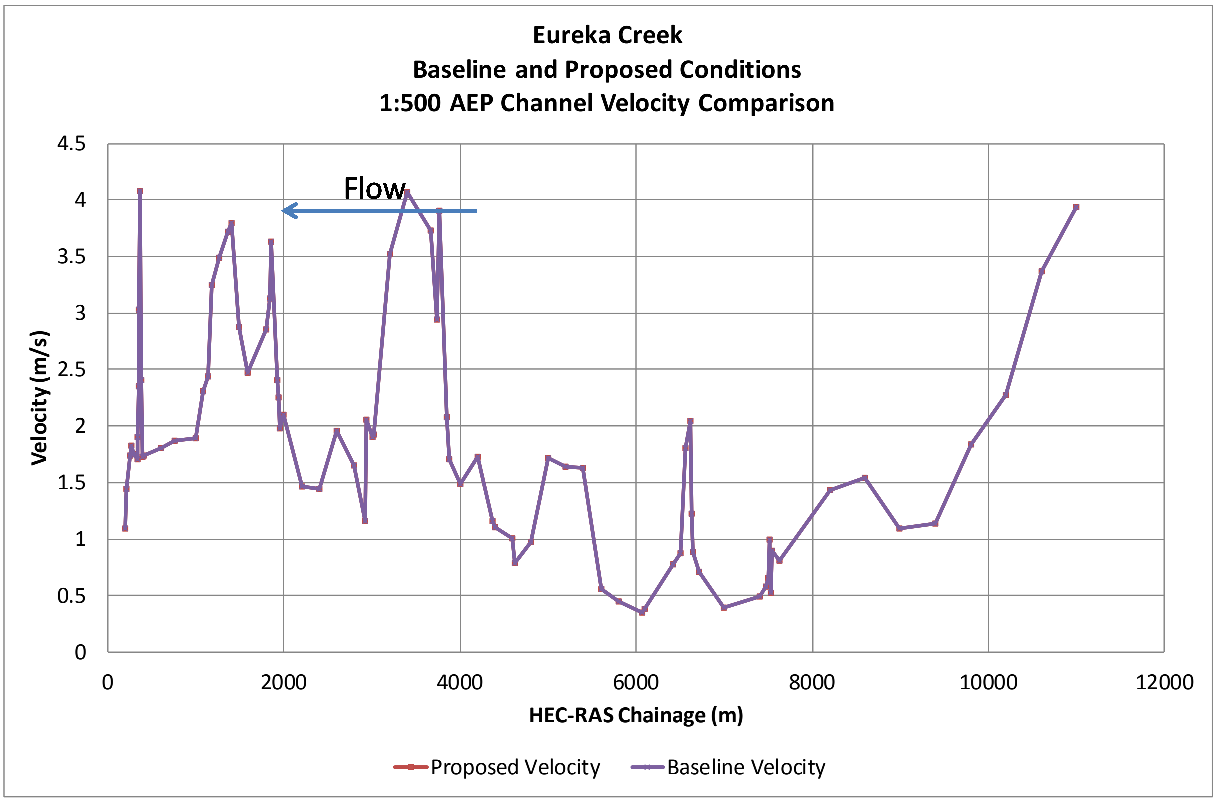
Figure Appendix E 28 Longitudinal Plot of Eureka Creek Water Surface Elevation Comparison 1 in 500 AEP



Note: Baseline and proposed levels coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

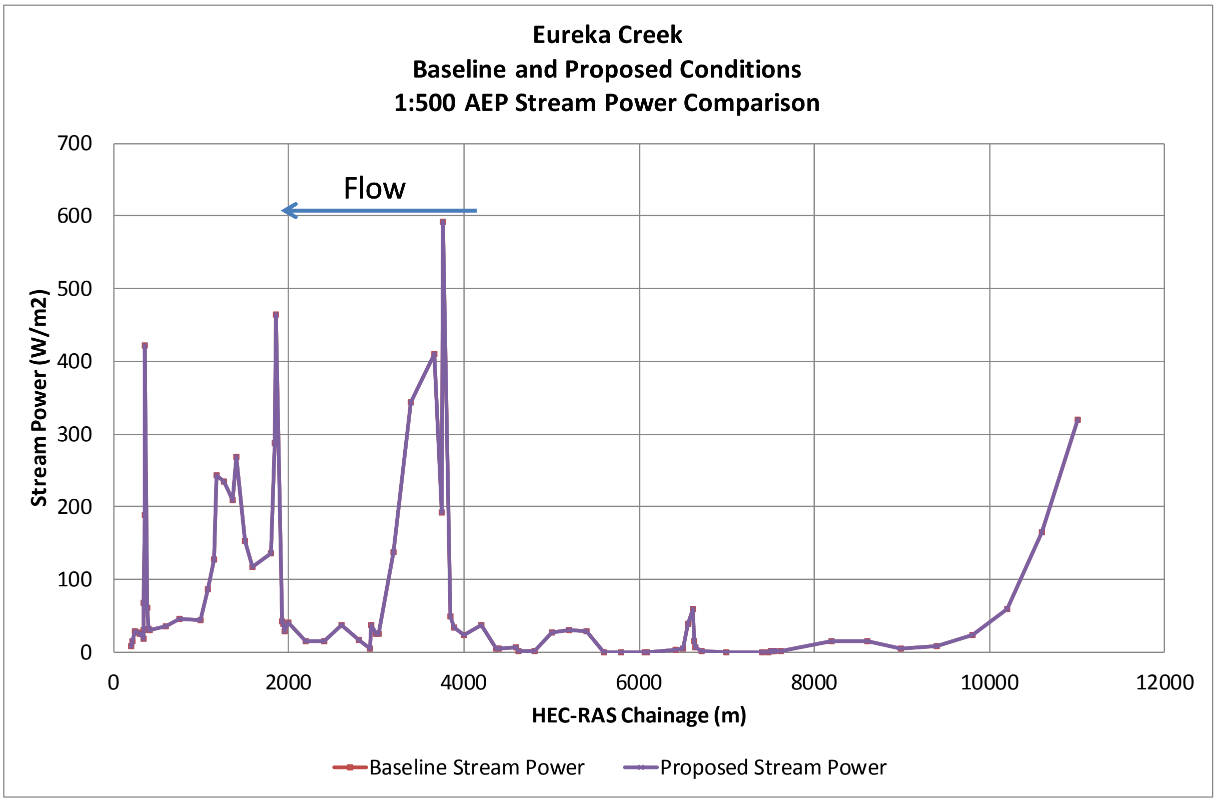
Figure Appendix E 29 Longitudinal Plot of Eureka Creek Stream Velocity Comparison 1 in 500 AEP



Note: Baseline and proposed velocity conditions coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

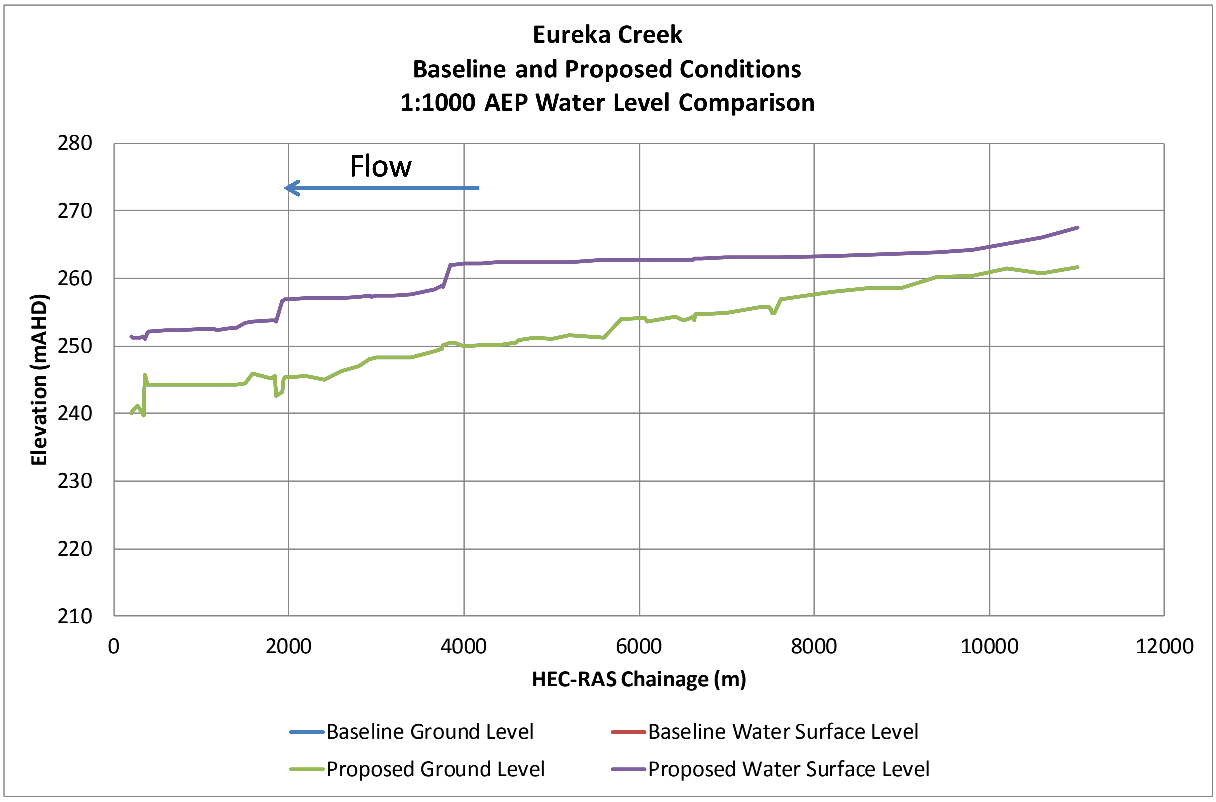
Figure Appendix E 30 Longitudinal Plot of Eureka Creek Stream Power Comparison 1 in 500 AEP



Note: Baseline and proposed stream power conditions coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

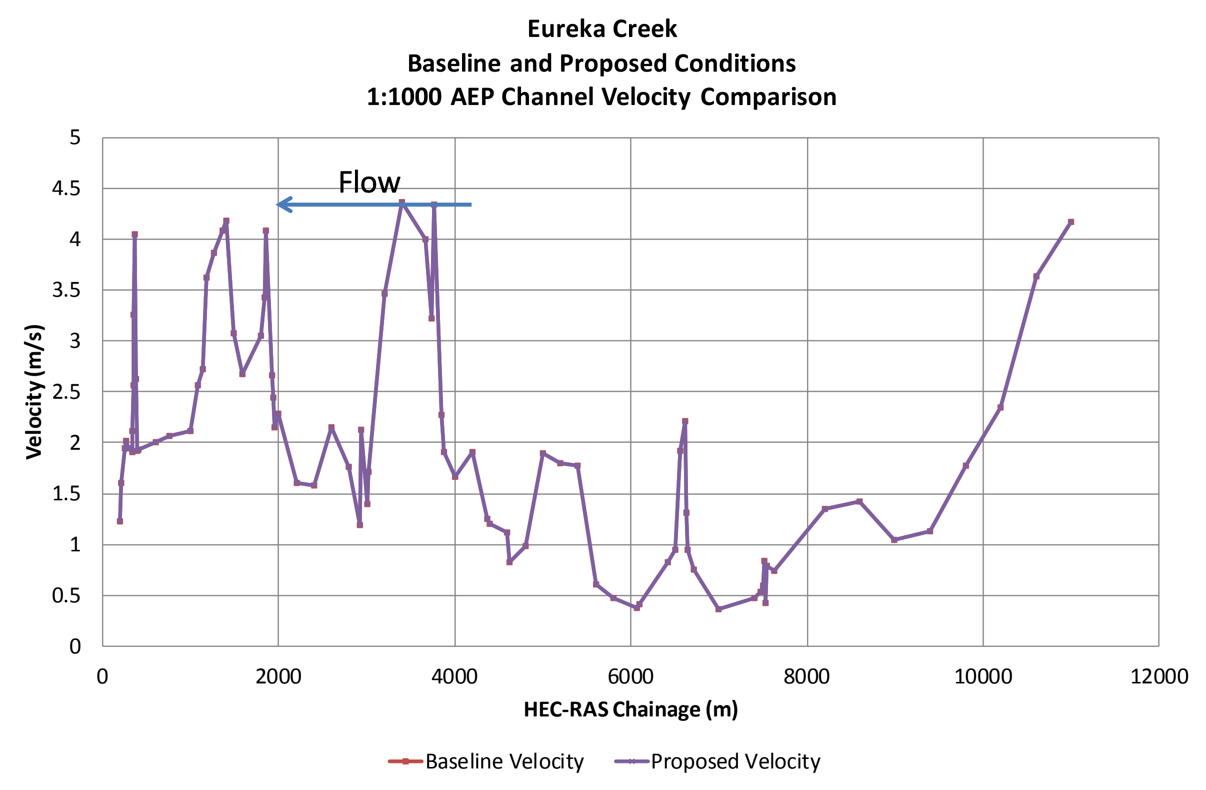
Figure Appendix E 31 Longitudinal Plot of Eureka Creek Water Surface Elevation Comparison 1 in 1000 AEP



Note: Baseline and proposed levels coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

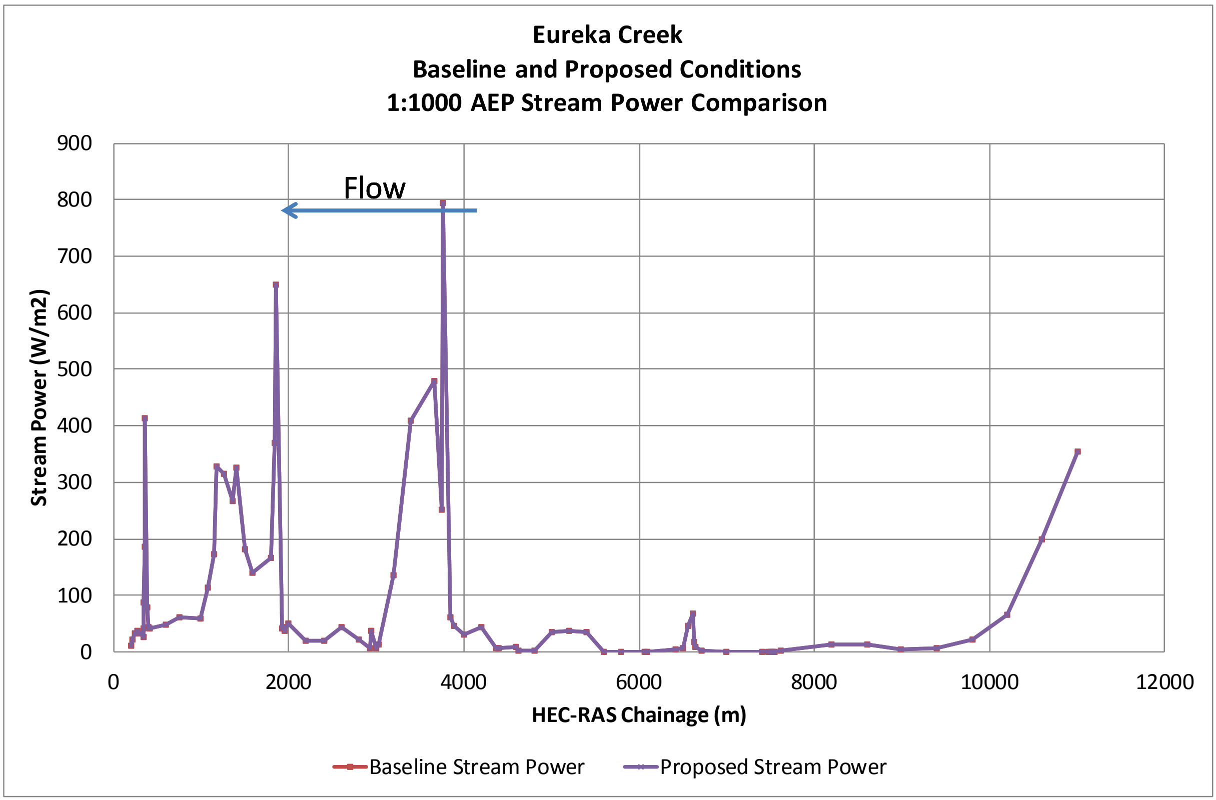
Figure Appendix E 32 Longitudinal Plot of Eureka Creek Stream Velocity Comparison 1 in 1000 AEP



Note: Baseline and proposed velocity conditions coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

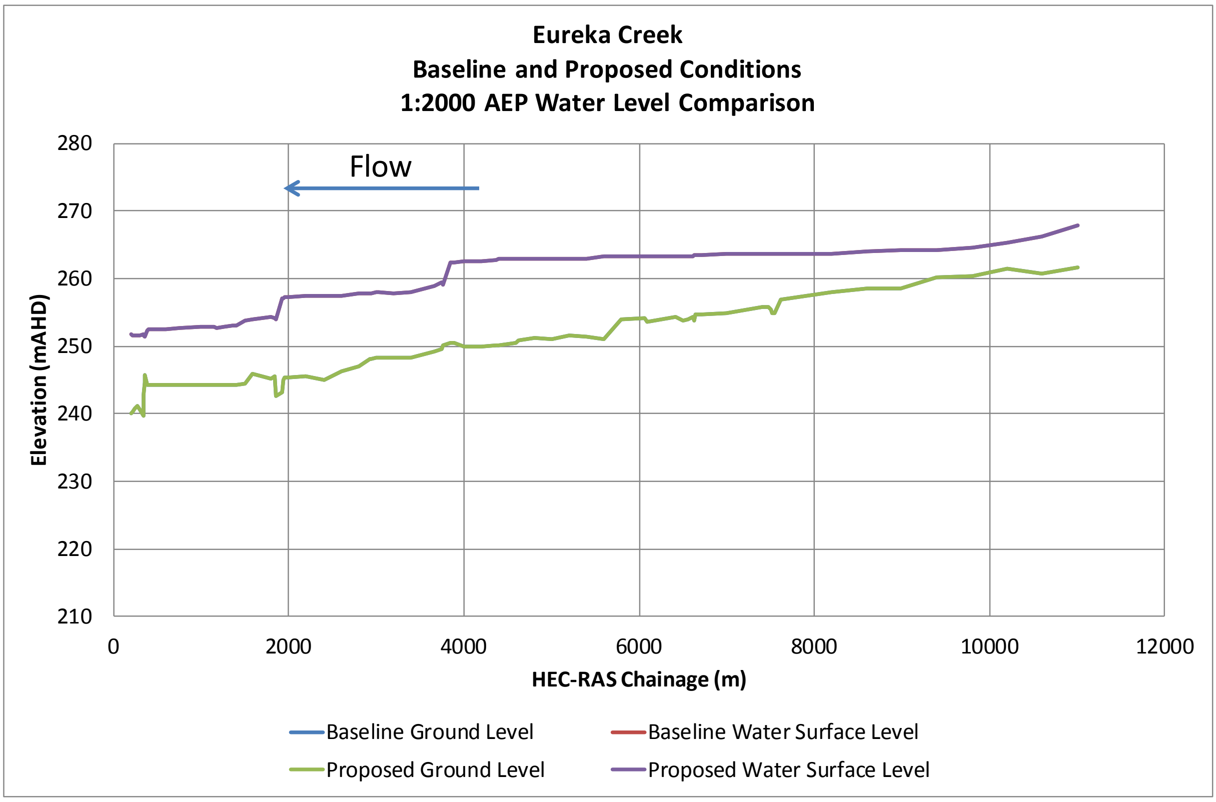
Figure Appendix E 33 Longitudinal Plot of Eureka Creek Stream Power Comparison 1 in 1000 AEP



Note: Baseline and proposed stream power conditions coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

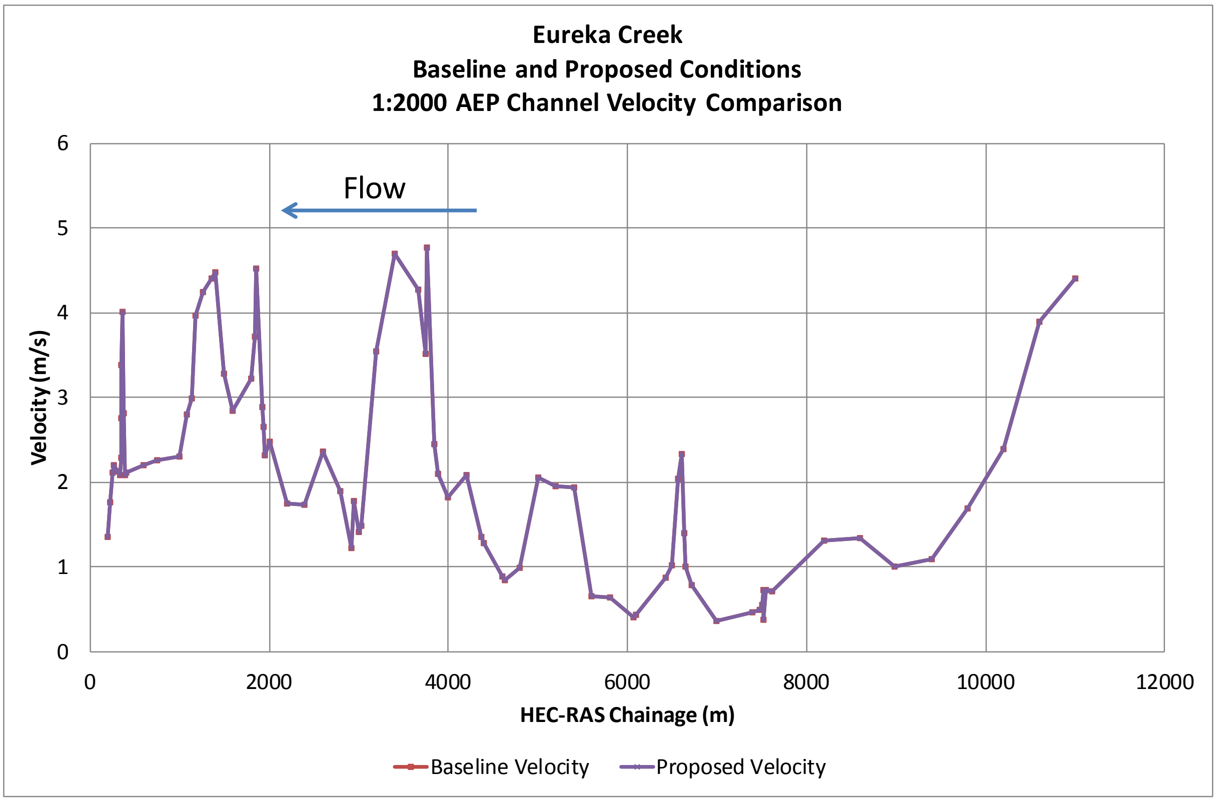
Figure Appendix E 34 Longitudinal Plot of Eureka Creek Water Surface Elevation Comparison 1 in 2000 AEP



Note: Baseline and proposed levels coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

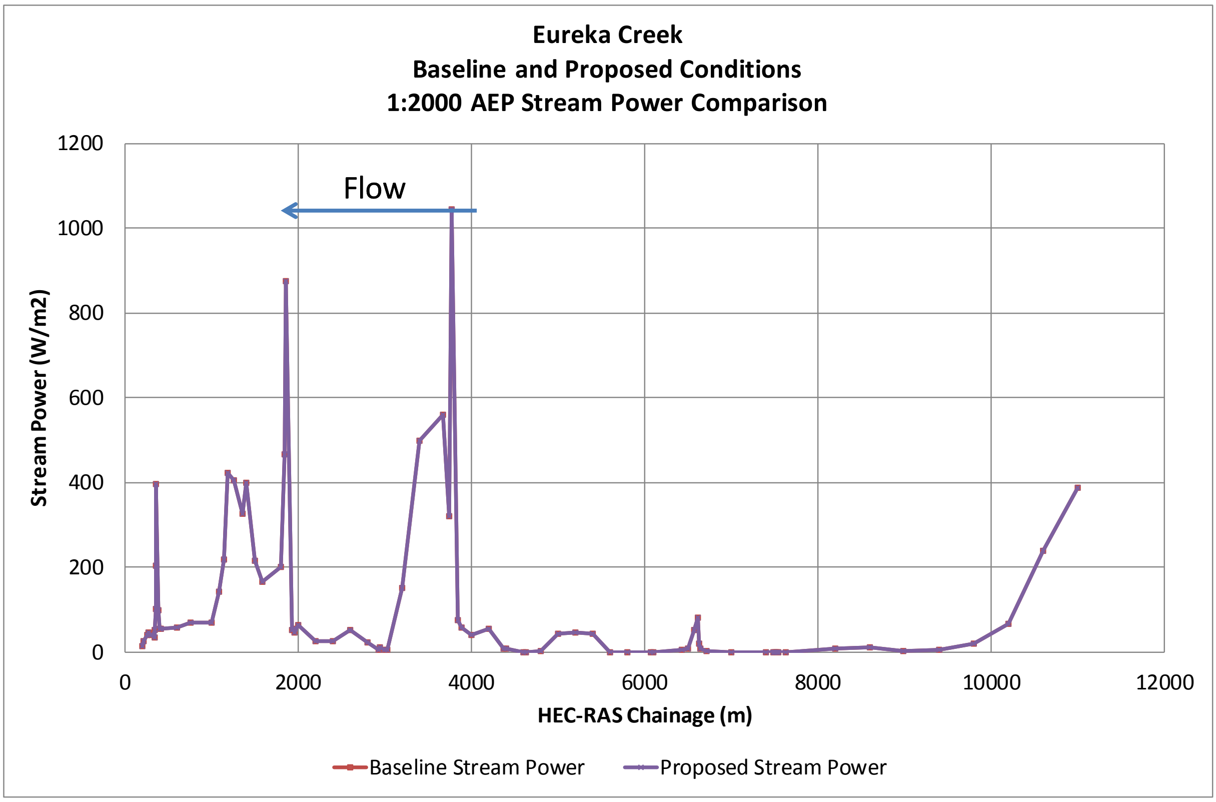
Figure Appendix E 35 Longitudinal Plot of Eureka Creek Stream Velocity Comparison 1 in 2000 AEP



Note: Baseline and proposed velocity conditions coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

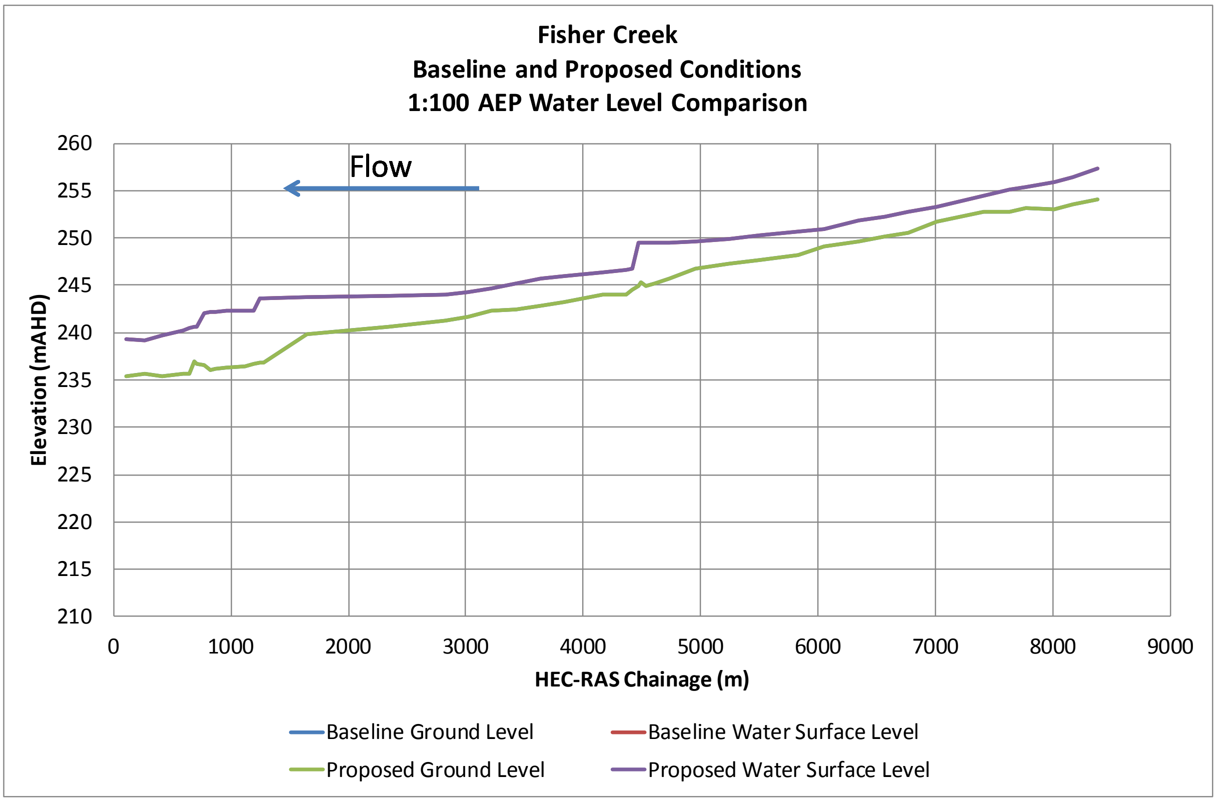
Figure Appendix E 36 Longitudinal Plot of Eureka Creek Stream Power Comparison 1 in 2000 AEP



Note: Baseline and proposed stream power conditions coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

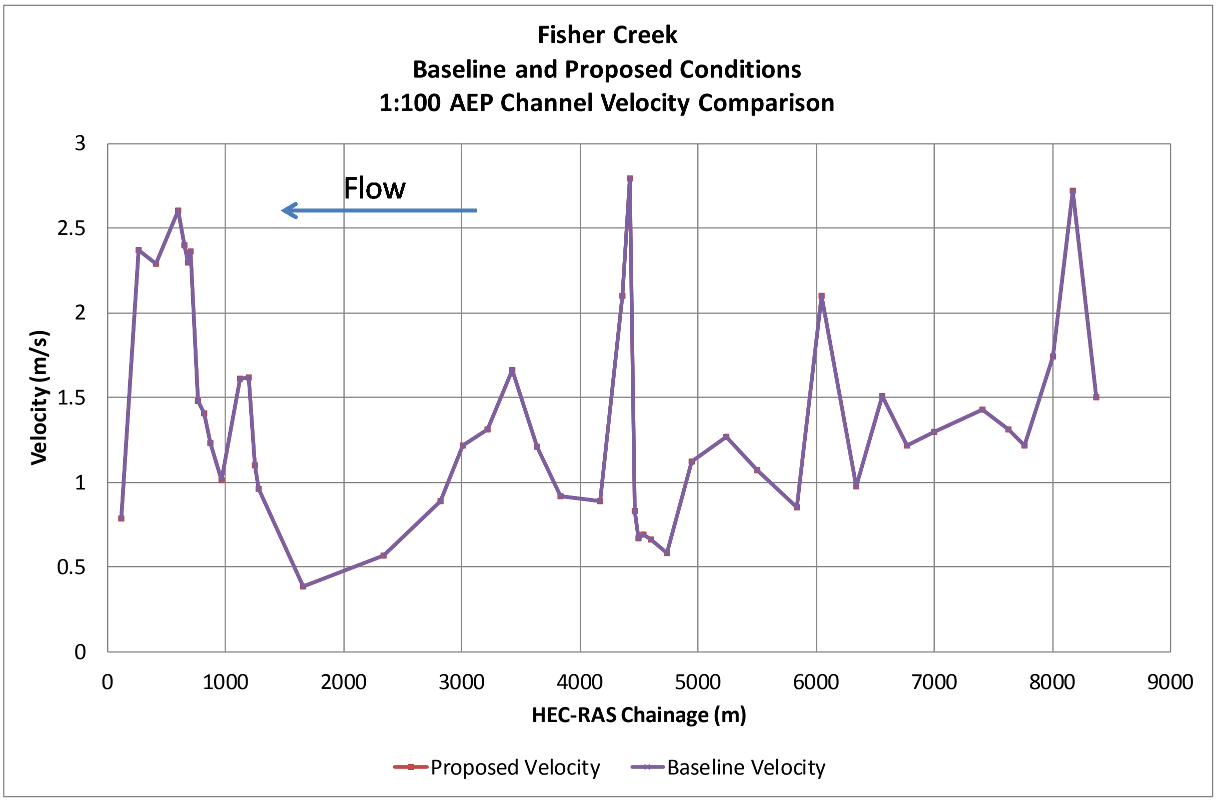
Figure Appendix E 37 Longitudinal Plot of Fisher Creek Water Surface Elevation Comparison 1 in 100 AEP



Note: Baseline and proposed levels coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

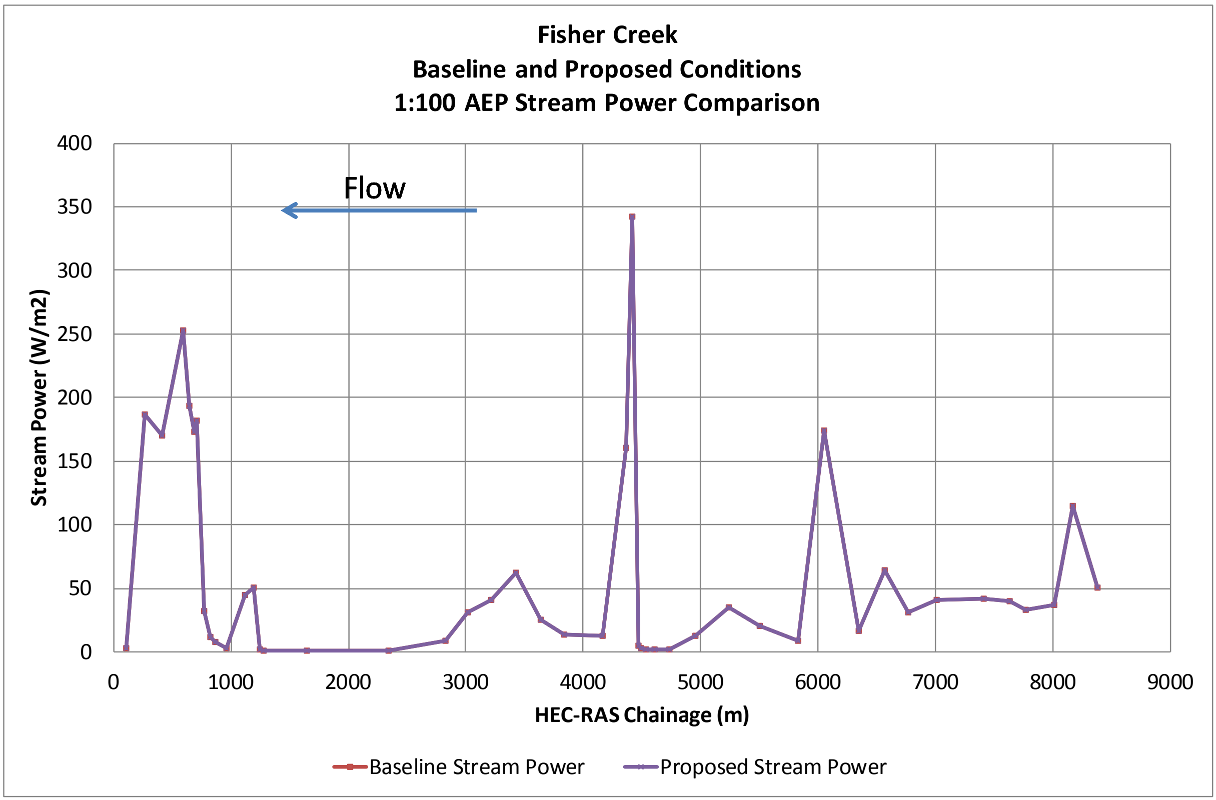
Figure Appendix E 38 Longitudinal Plot of Fisher Creek Stream Velocity Comparison 1 in 100 AEP



Note: Baseline and proposed velocity conditions coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

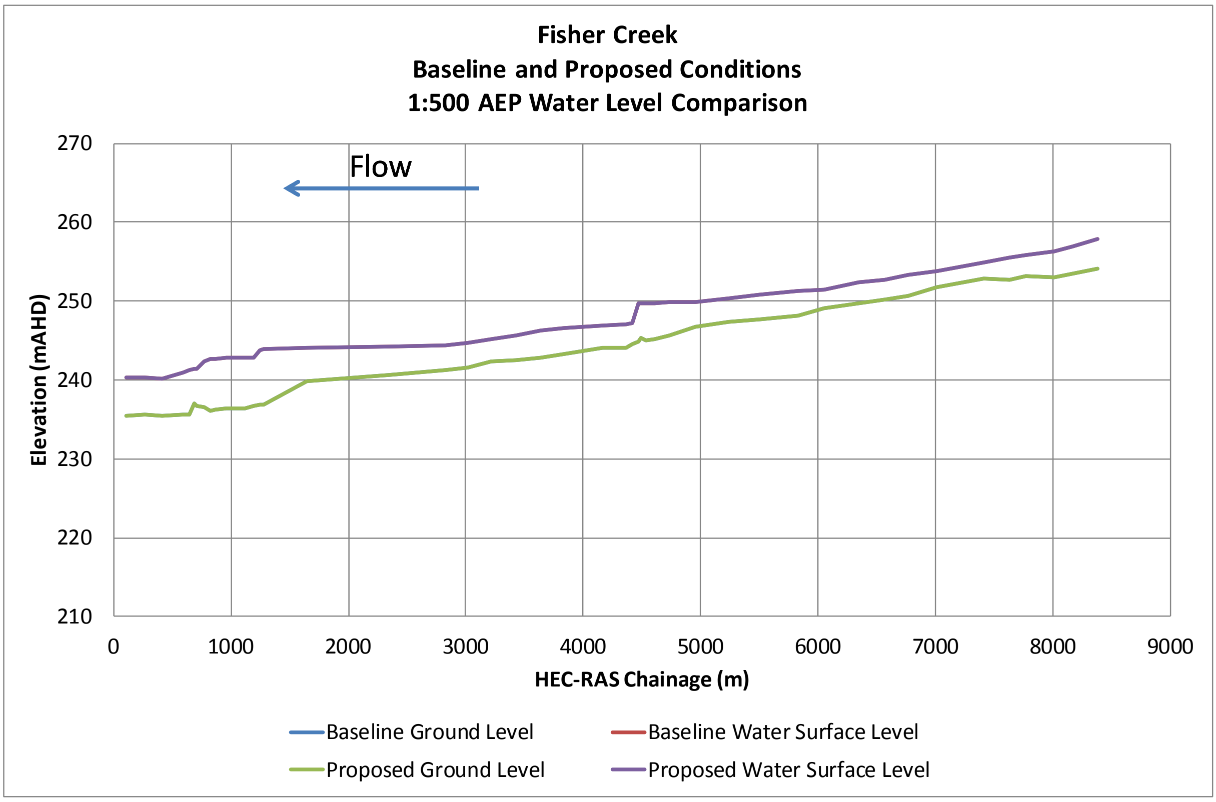
Figure Appendix E 39 Longitudinal Plot of Fisher Creek Stream Power Comparison 1 in 100 AEP



Note: Baseline and proposed stream power conditions coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

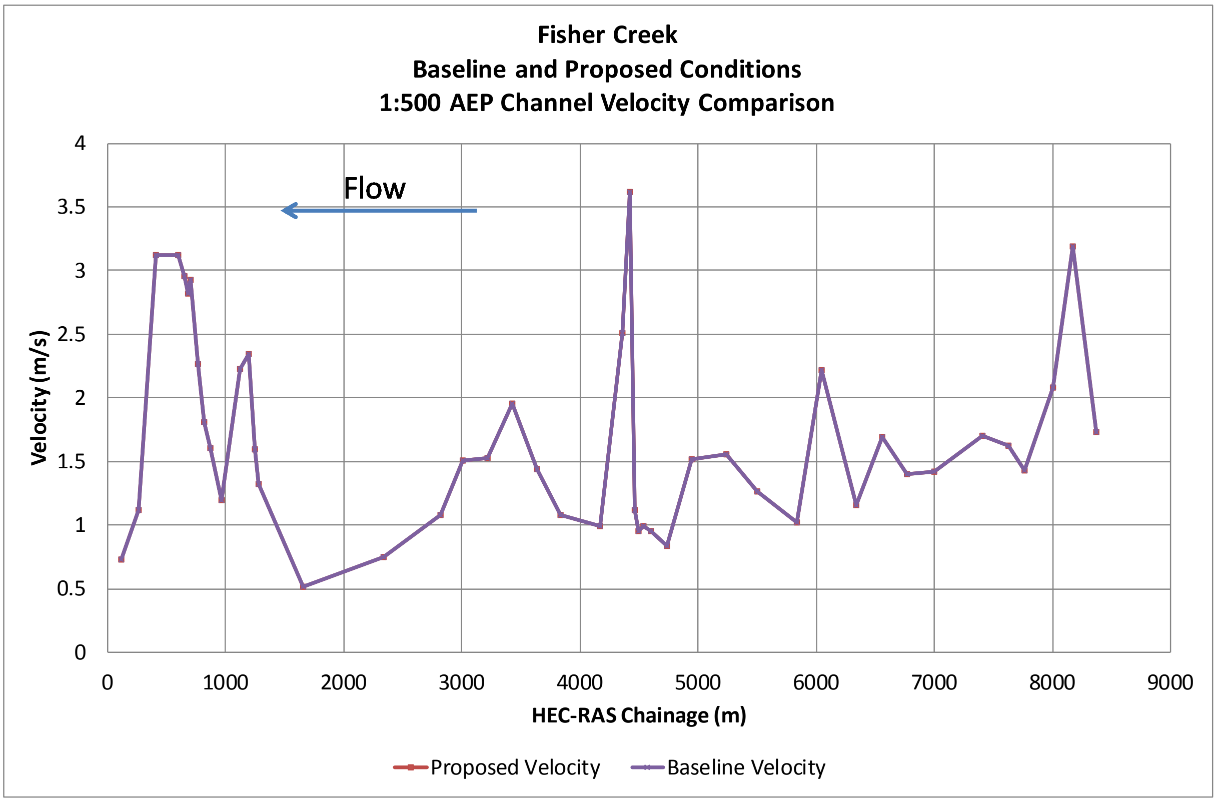
Figure Appendix E 40 Longitudinal Plot of Fisher Creek Water Surface Elevation Comparison 1 in 500 AEP



Note: Baseline and proposed levels coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

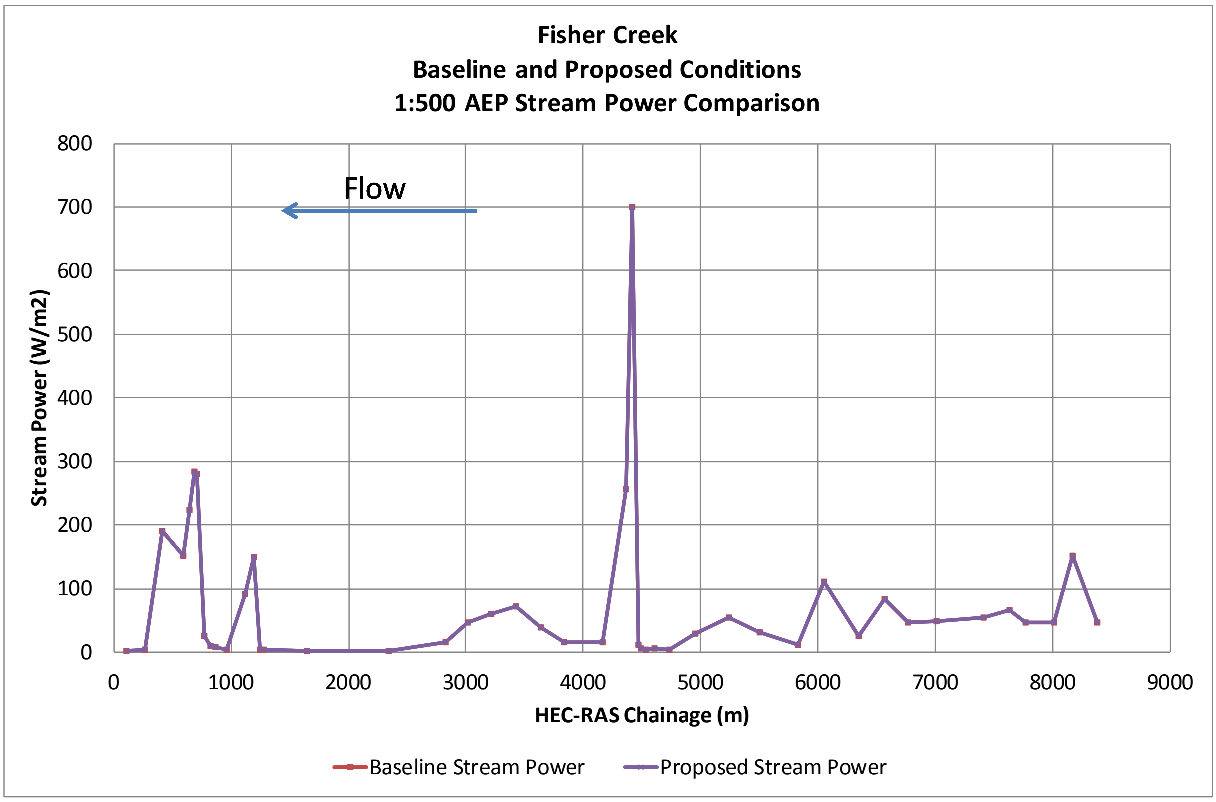
Figure Appendix E 41 Longitudinal Plot of Fisher Creek Stream Velocity Comparison 1 in 500 AEP



Note: Baseline and proposed velocity conditions coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

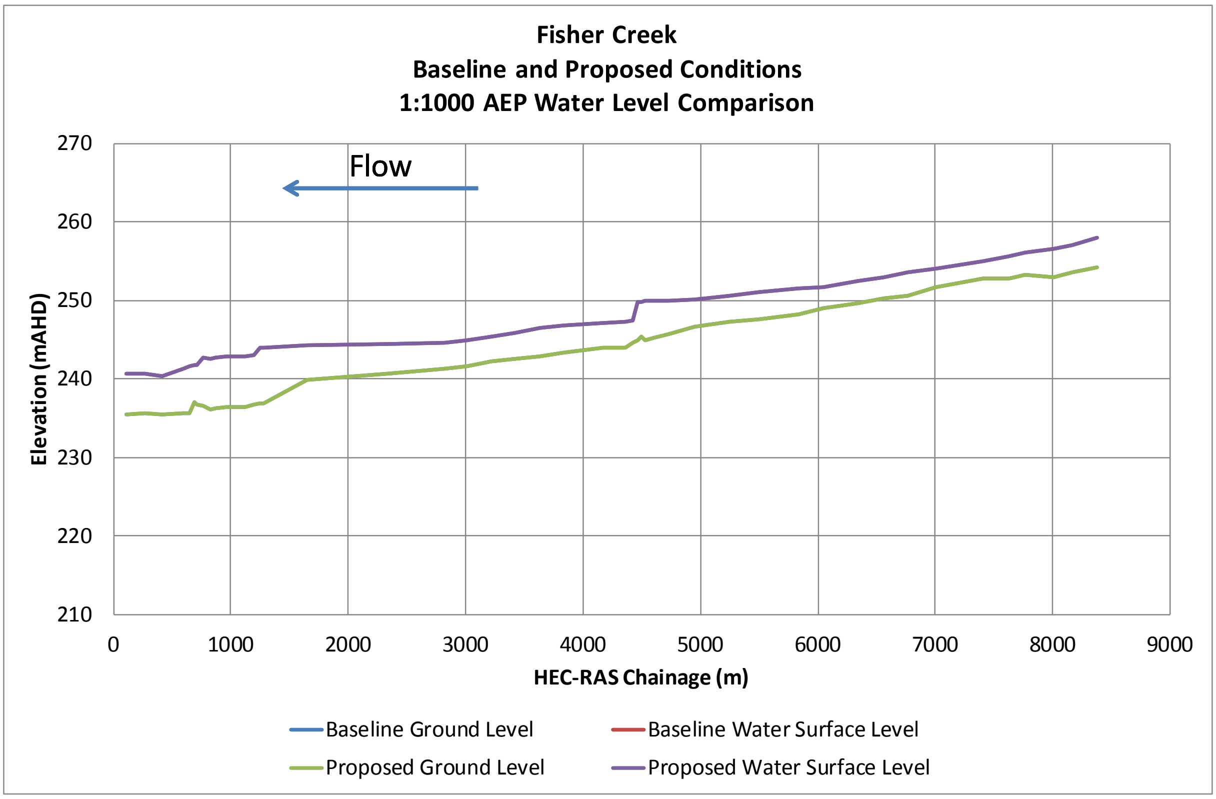
Figure Appendix E 42 Longitudinal Plot of Fisher Creek Stream Power Comparison 1 in 500 AEP



Note: Baseline and proposed stream power conditions coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

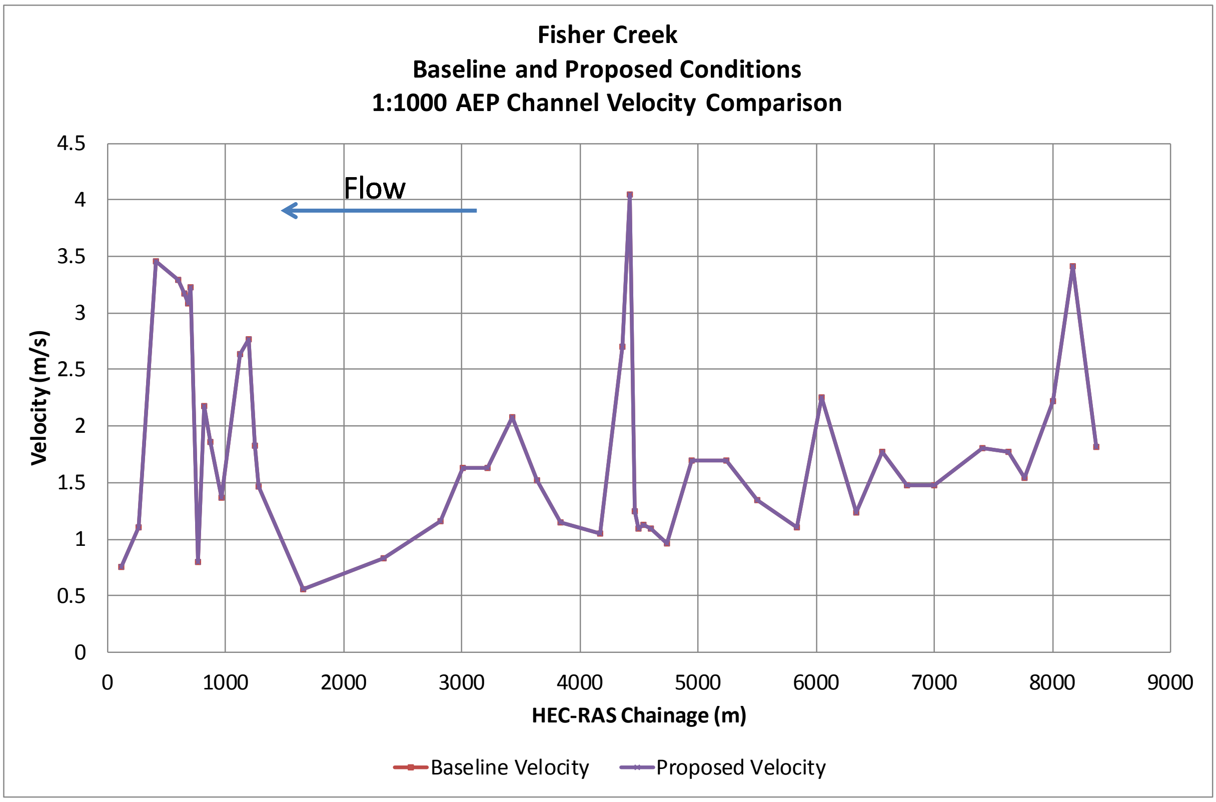
Figure Appendix E 43 Longitudinal Plot of Fisher Creek Water Surface Elevation Comparison 1 in 1000 AEP



Note: Baseline and proposed levels coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

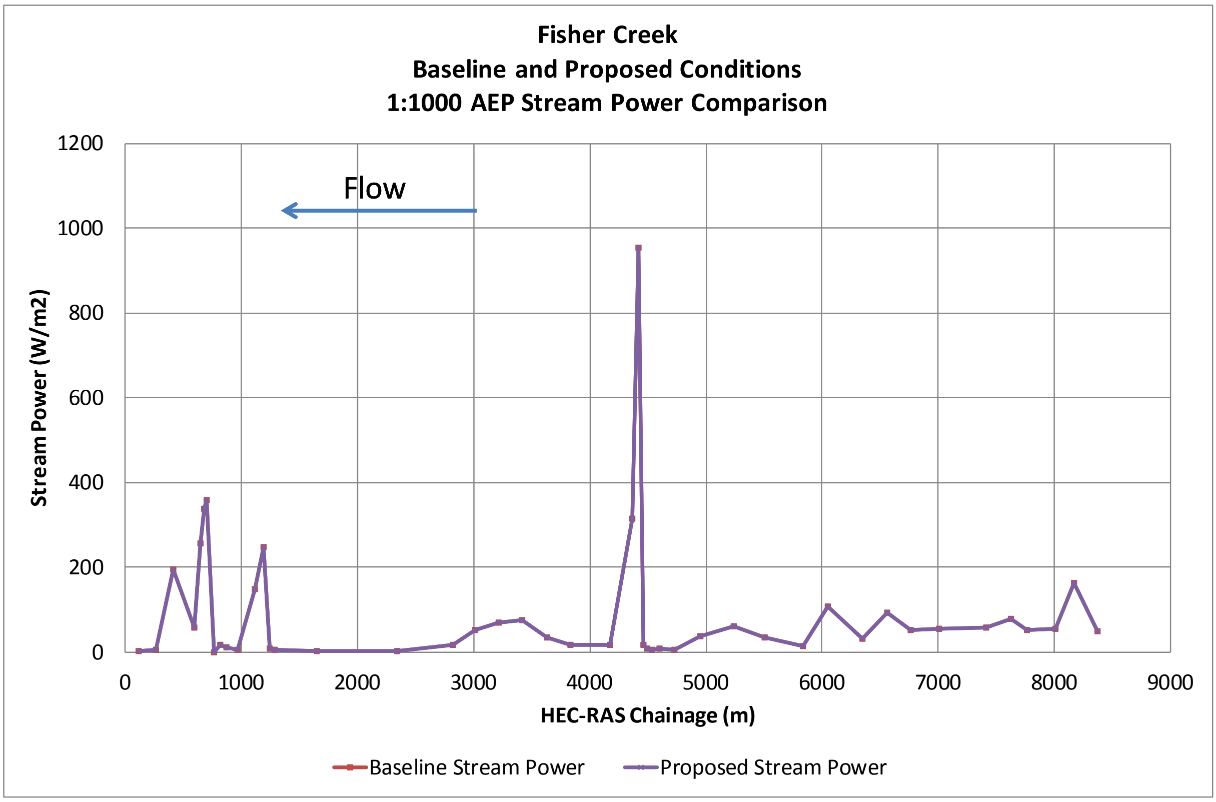
Figure Appendix E 44 Longitudinal Plot of Fisher Creek Stream Velocity Comparison 1 in 1000 AEP



Note: Baseline and proposed velocity conditions coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

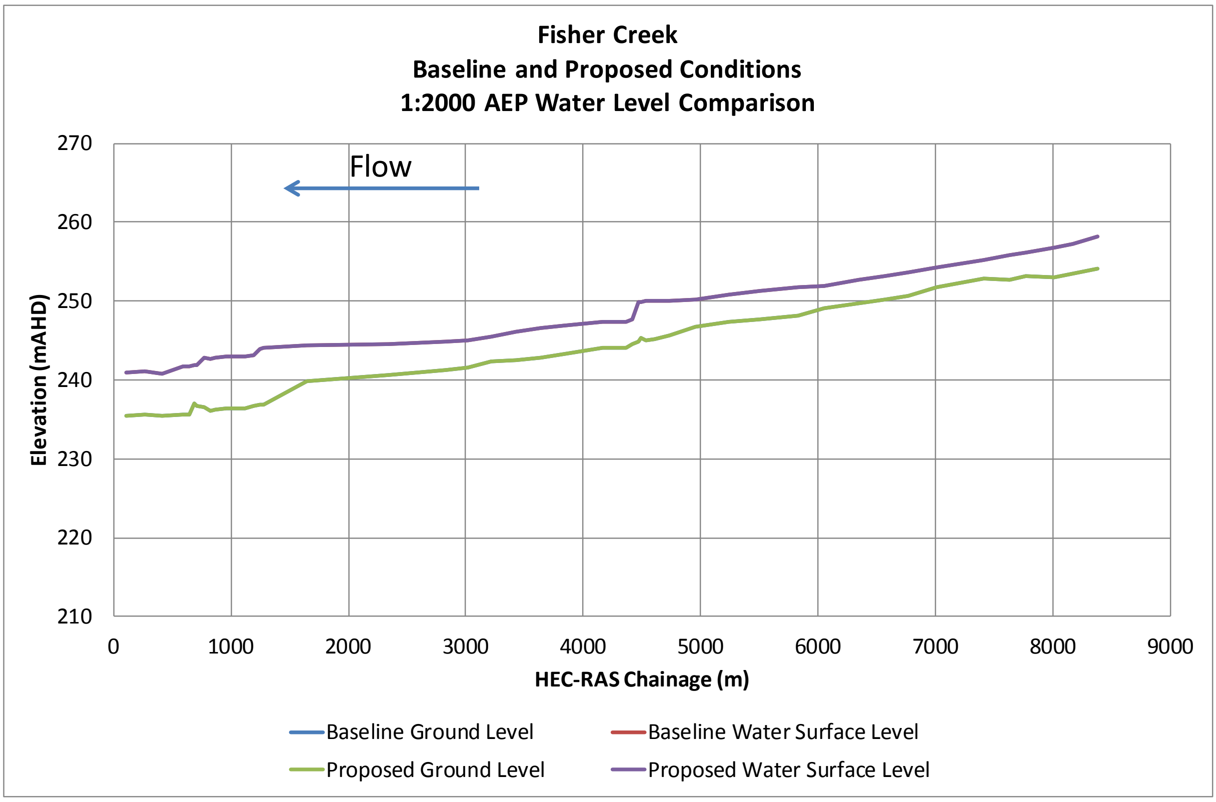
Figure Appendix E 45 Longitudinal Plot of Fisher Creek Stream Power Comparison 1 in 1000 AEP



Note: Baseline and proposed stream power conditions coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

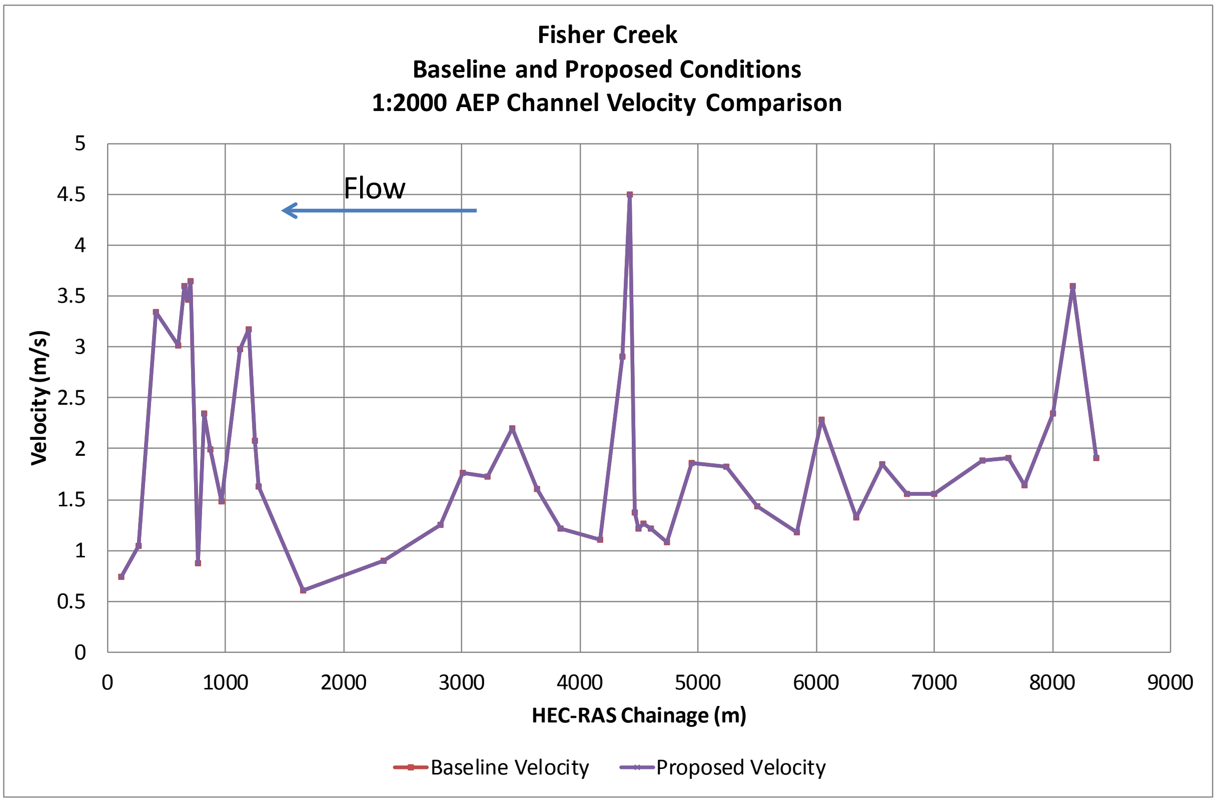
Figure Appendix E 46 Longitudinal Plot of Fisher Creek Water Surface Elevation Comparison 1 in 2000 AEP



Note: Baseline and proposed levels coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

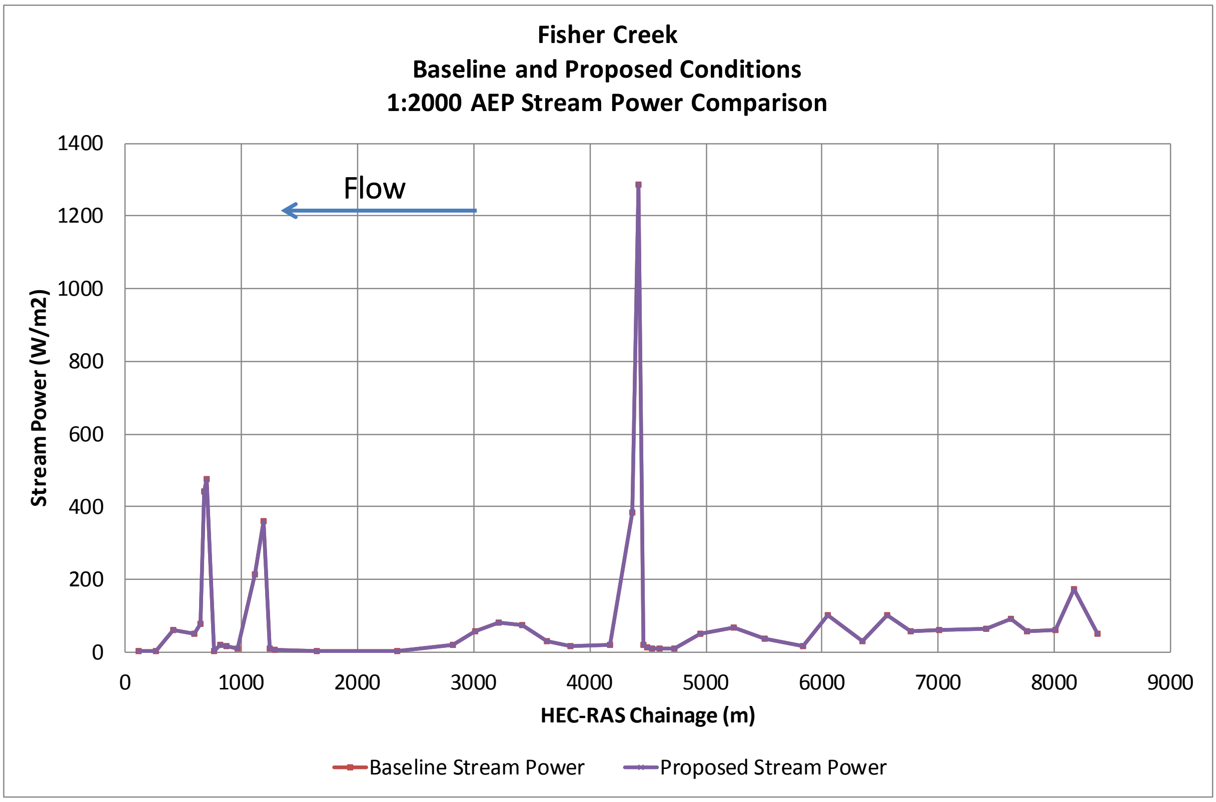
Figure Appendix E 47 Longitudinal Plot of Fisher Creek Stream Velocity Comparison 1 in 2000 AEP



Note: Baseline and proposed velocity conditions coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

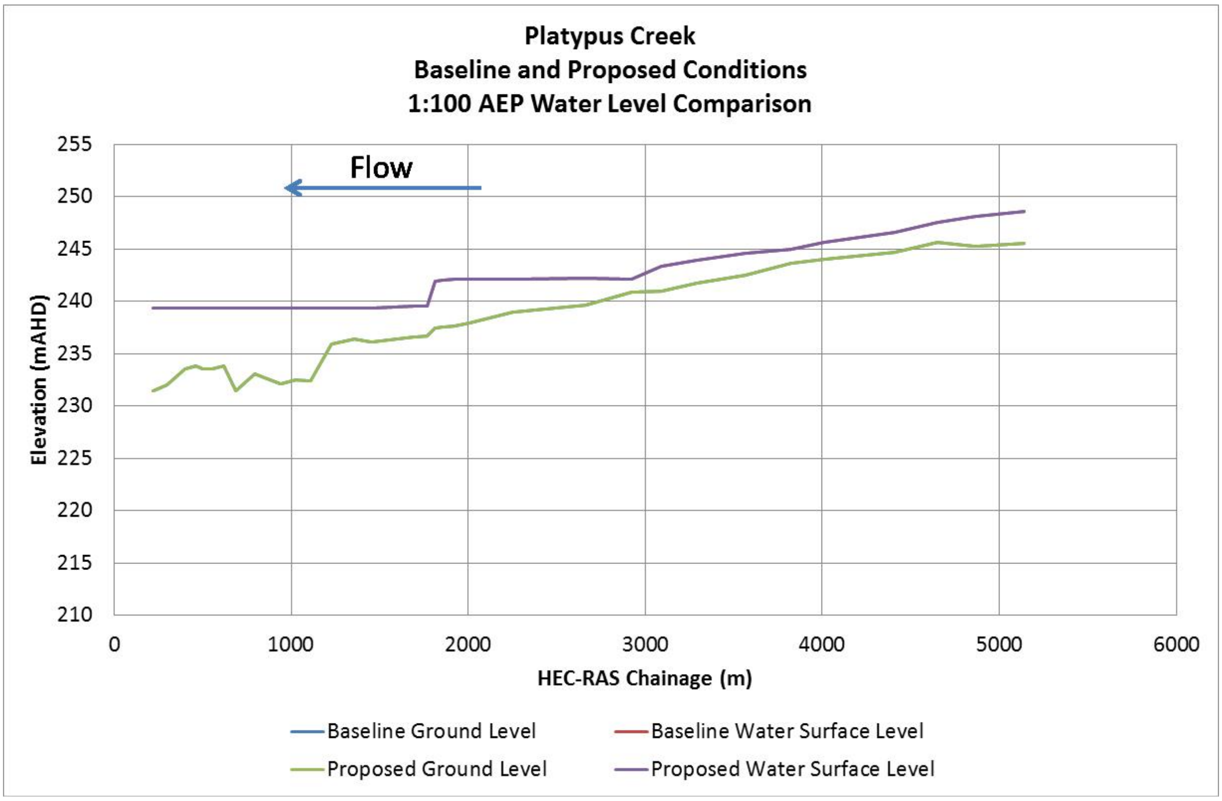
Figure Appendix E 48 Longitudinal Plot of Fisher Creek Stream Power Comparison 1 in 2000 AEP



Note: Baseline and proposed stream power conditions coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

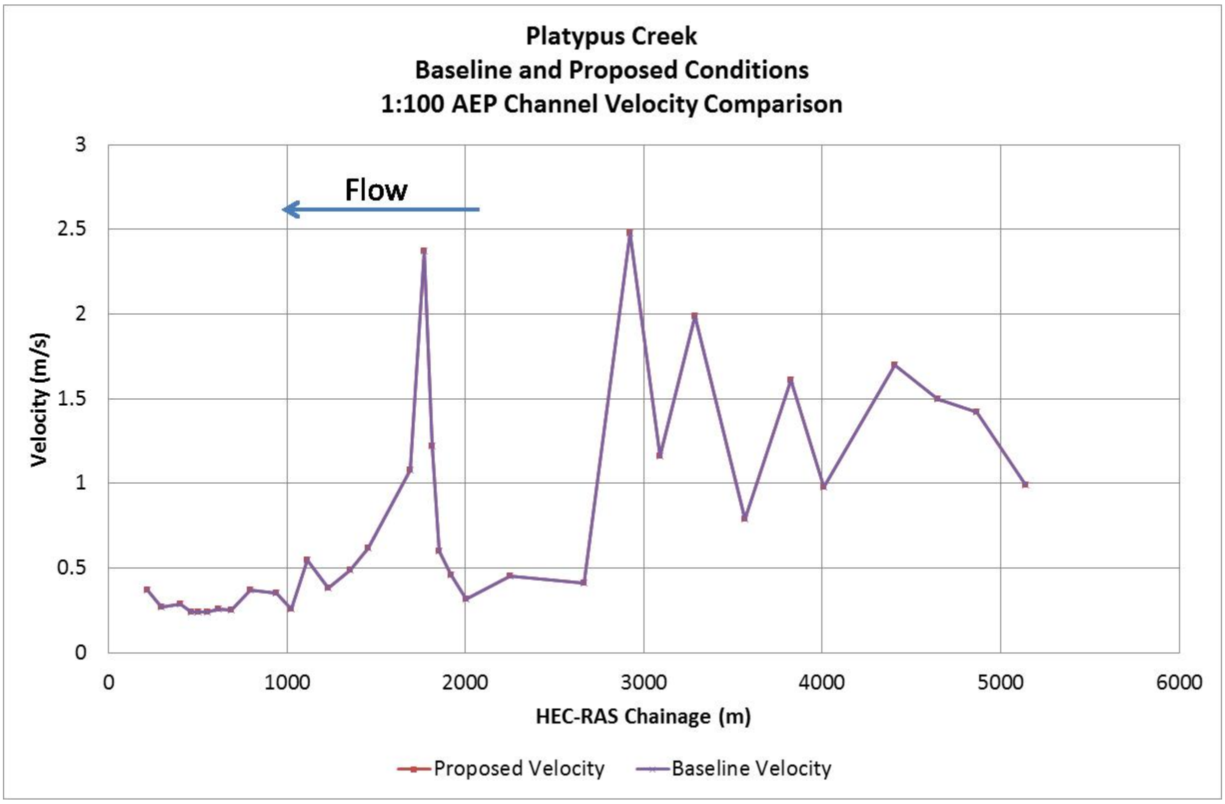
Figure Appendix E 49 Longitudinal Plot of Platypus Creek Water Surface Elevation Comparison 1 in 100 AEP



Note: Baseline and proposed levels coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

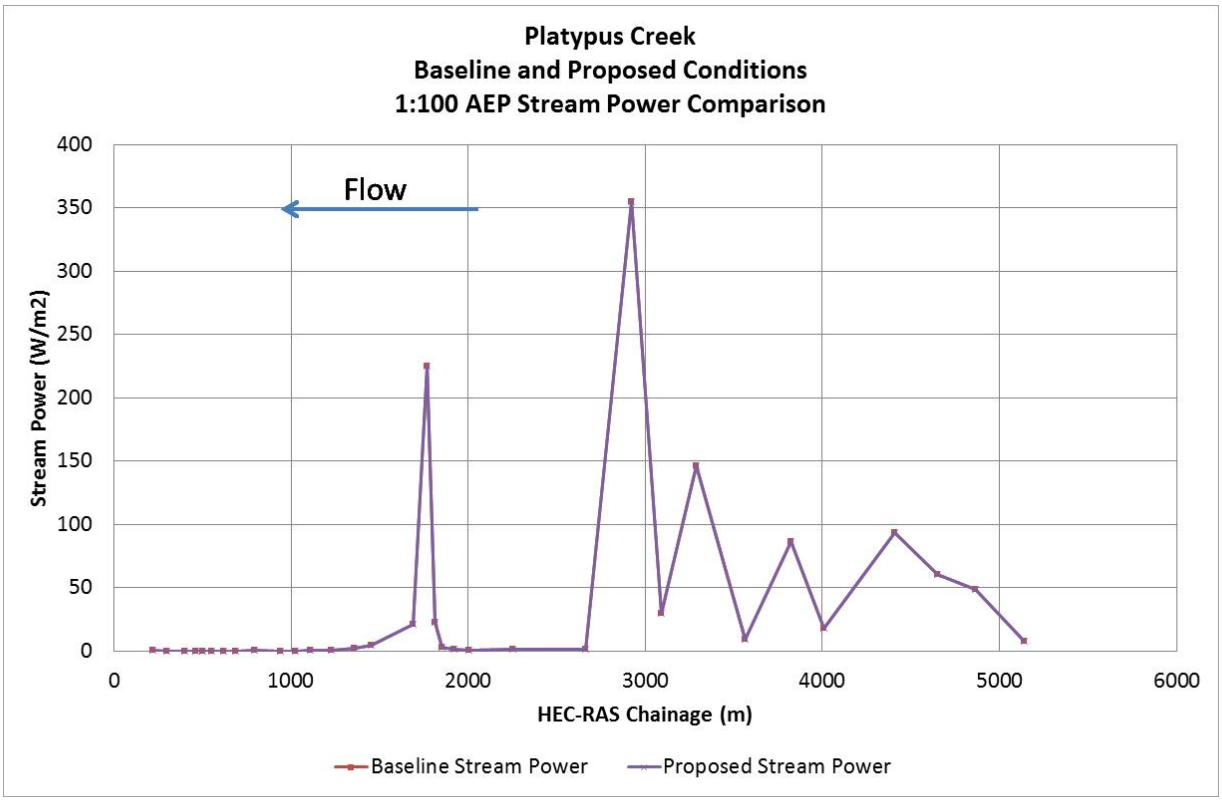
Figure Appendix E 50 Longitudinal Plot of Platypus Creek Stream Velocity Comparison 1 in 100 AEP



Note: Baseline and proposed velocity conditions coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

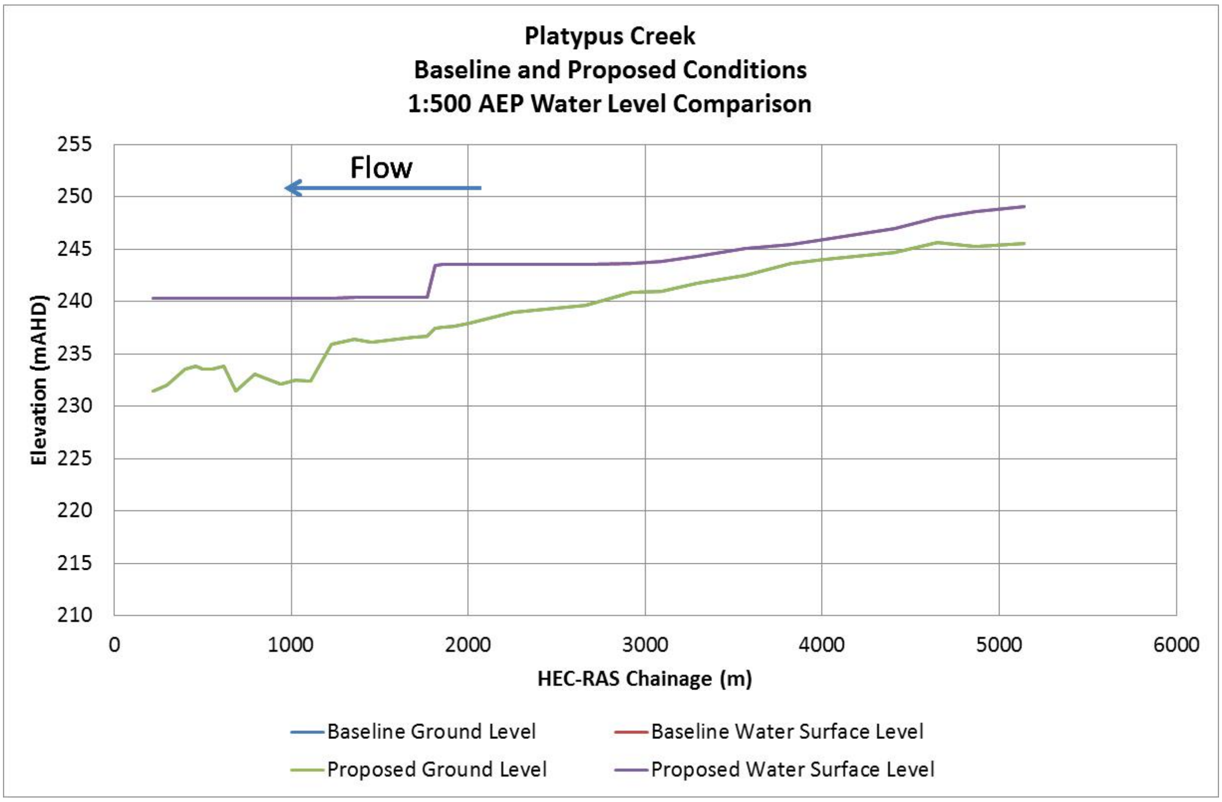
Figure Appendix E 51 Longitudinal Plot of Platypus Creek Stream Power Comparison 1 in 100 AEP



Note: Baseline and proposed stream power conditions coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

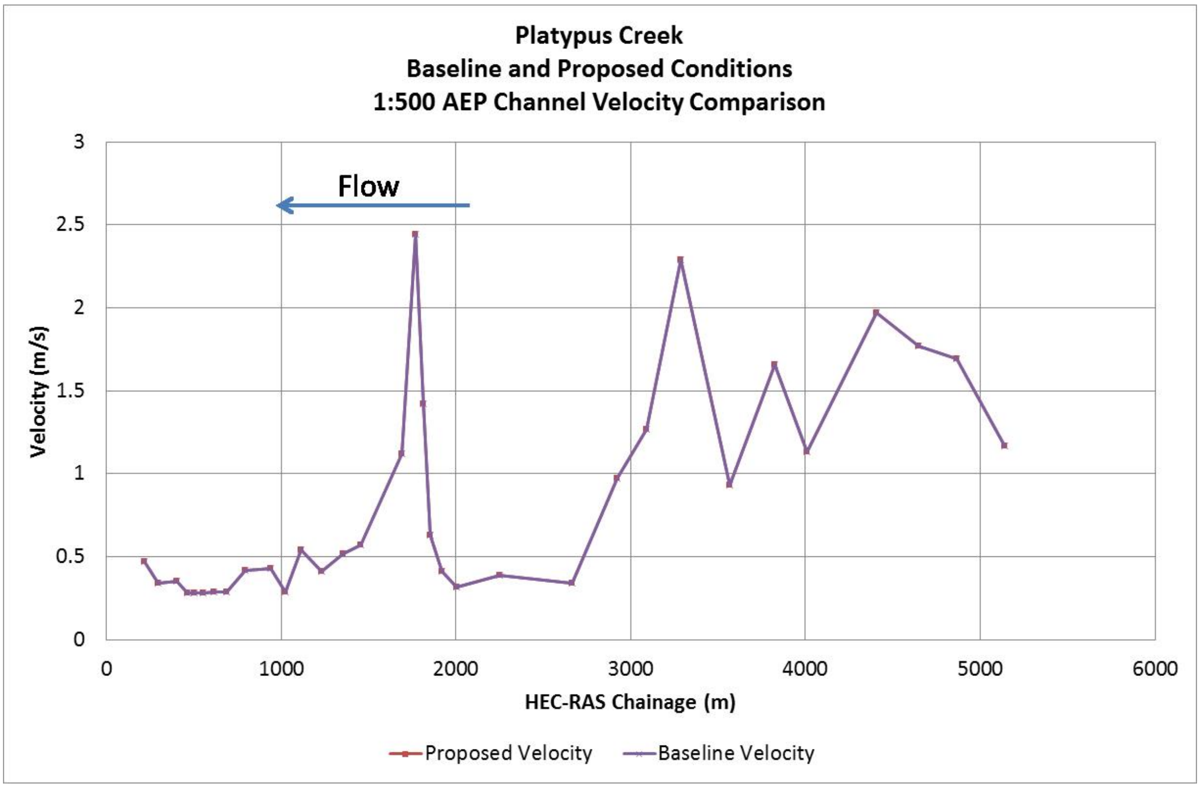
Figure Appendix E 52 Longitudinal Plot of Platypus Creek Water Surface Elevation Comparison 1 in 500 AEP



Note: Baseline and proposed levels coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

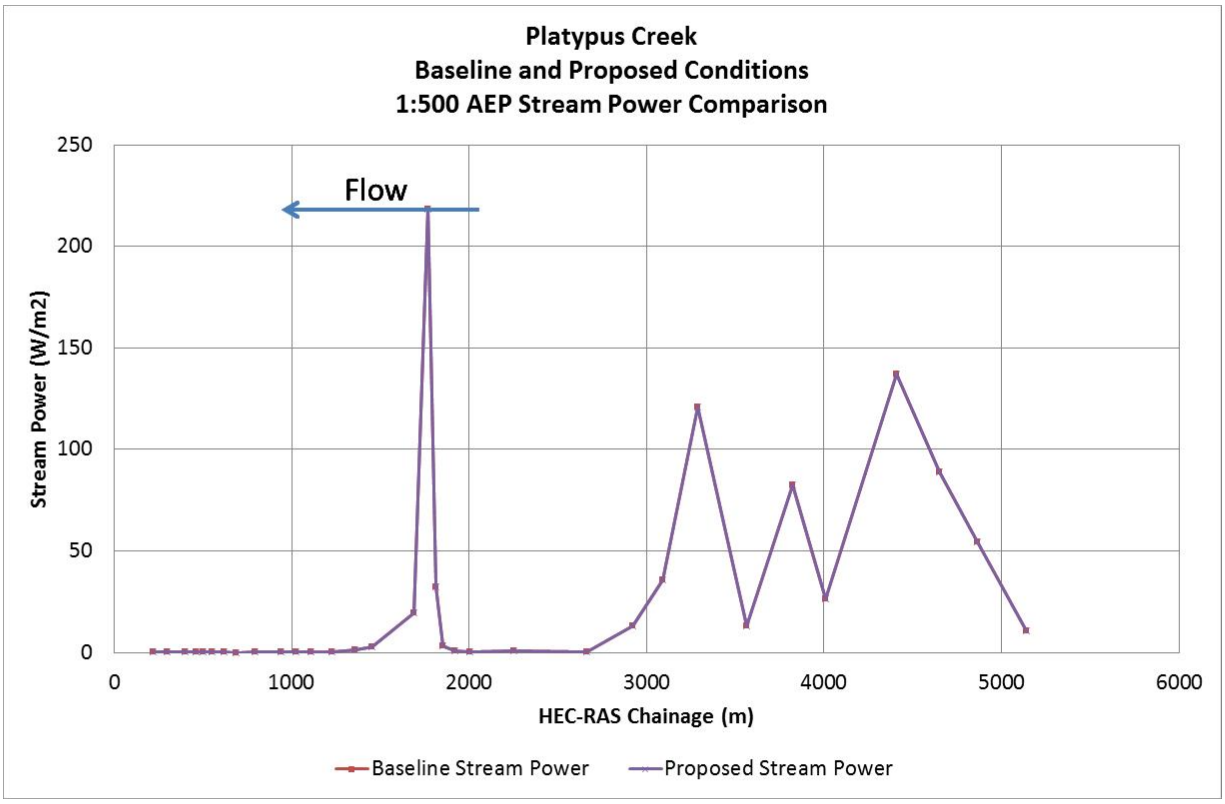
Figure Appendix E 53 Longitudinal Plot of Platypus Creek Stream Velocity Comparison 1 in 500 AEP



Note: Baseline and proposed velocity conditions coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

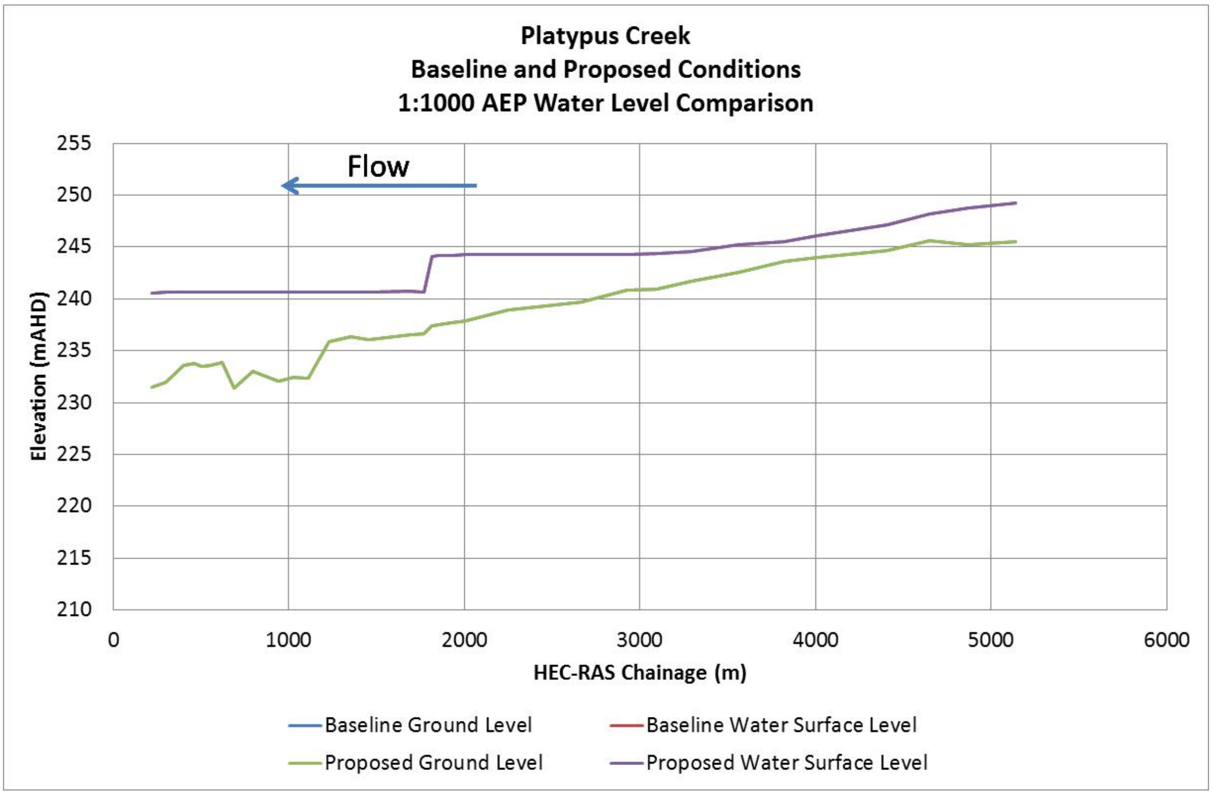
Figure Appendix E 54 Longitudinal Plot of Platypus Creek Stream Power Comparison 1 in 500 AEP



Note: Baseline and proposed stream power conditions coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

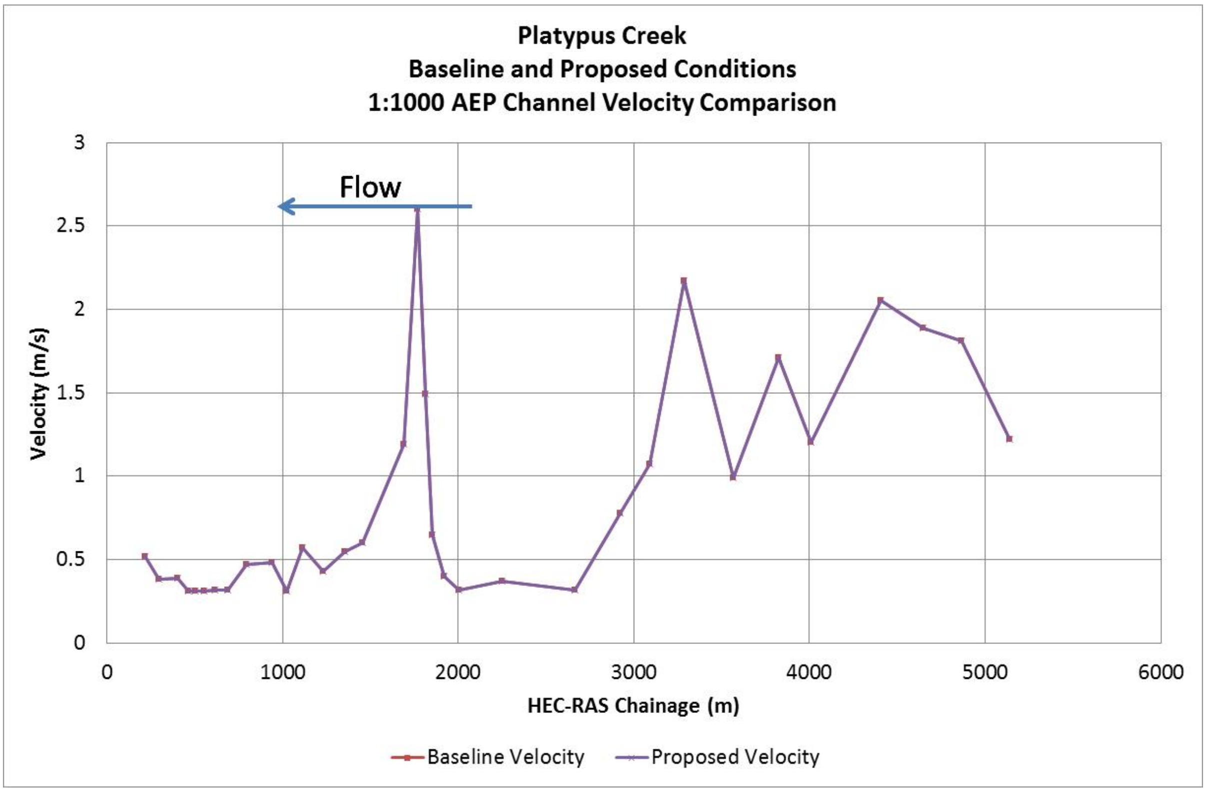
Figure Appendix E 55 Longitudinal Plot of Platypus Creek Water Surface Elevation Comparison 1 in 1000 AEP



Note: Baseline and proposed levels coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

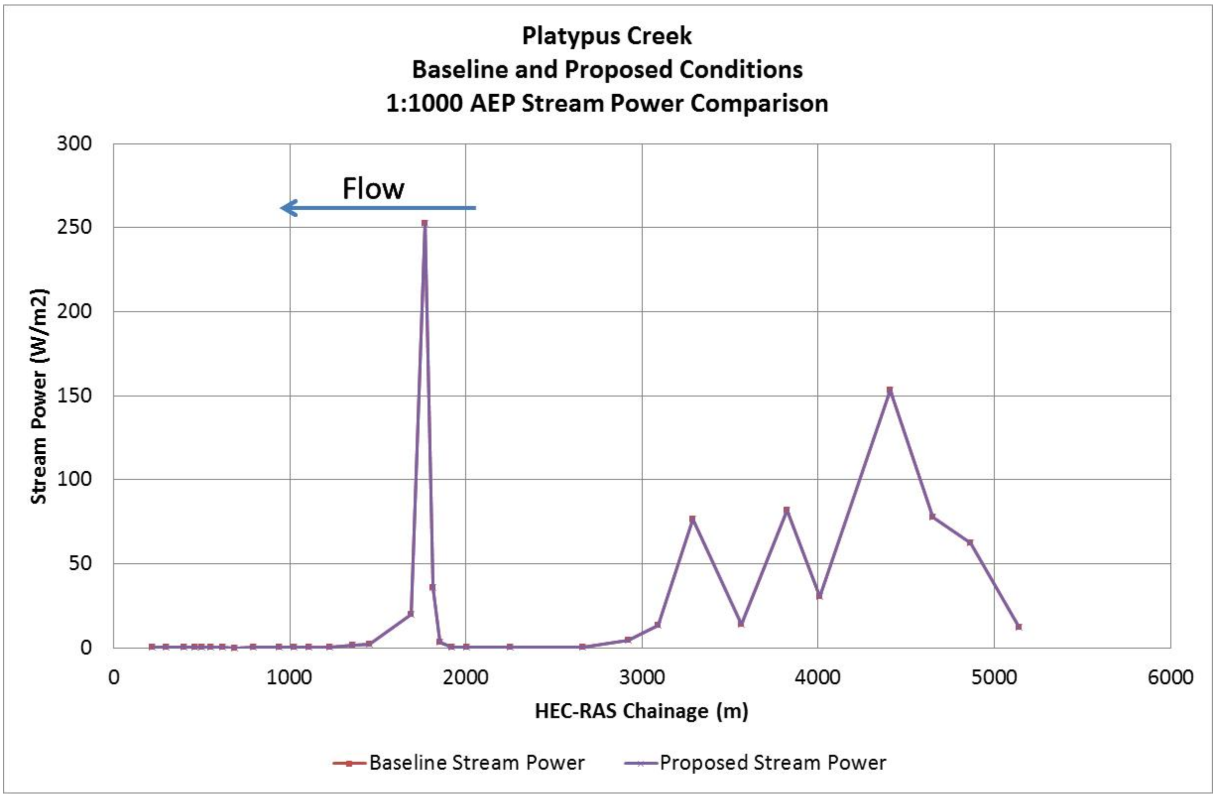
Figure Appendix E 56 Longitudinal Plot of Platypus Creek Stream Velocity Comparison 1 in 1000 AEP



Note: Baseline and proposed velocity conditions coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

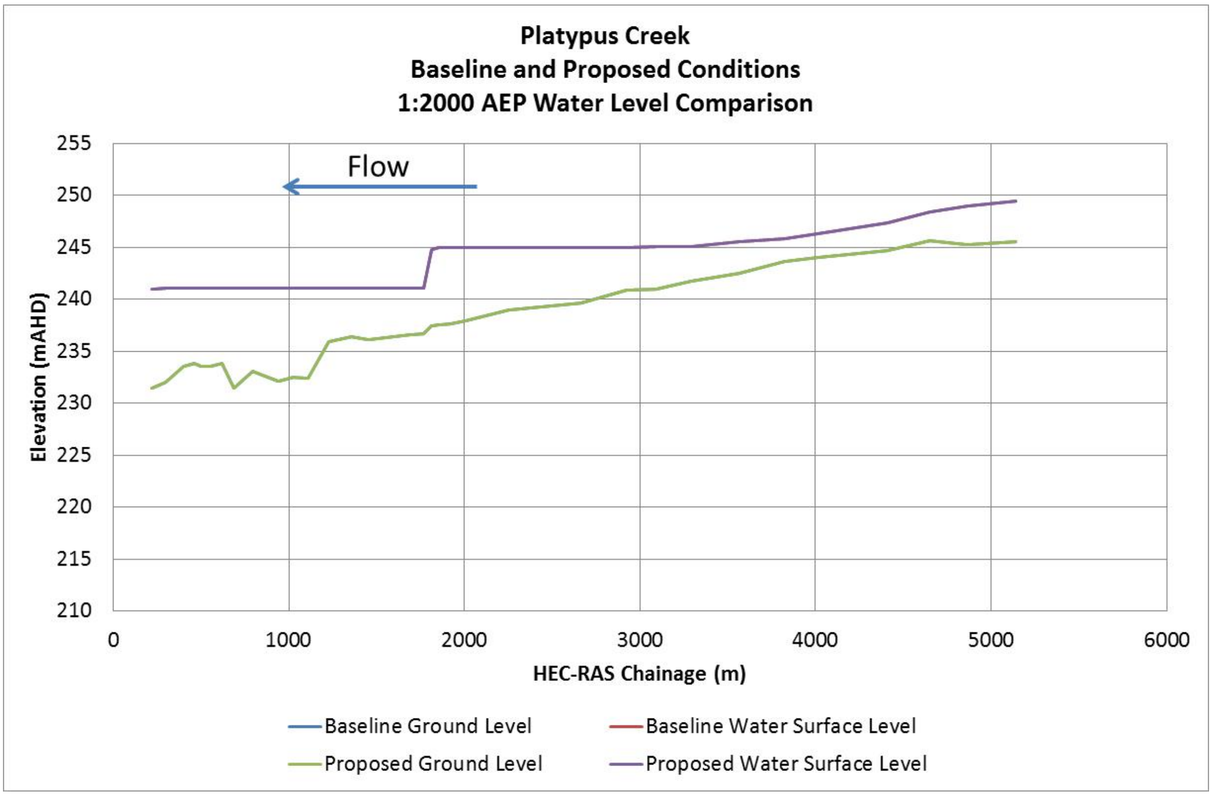
Figure Appendix E 57 Longitudinal Plot of Platypus Creek Stream Power Comparison 1 in 1000 AEP



Note: Baseline and proposed stream power conditions coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

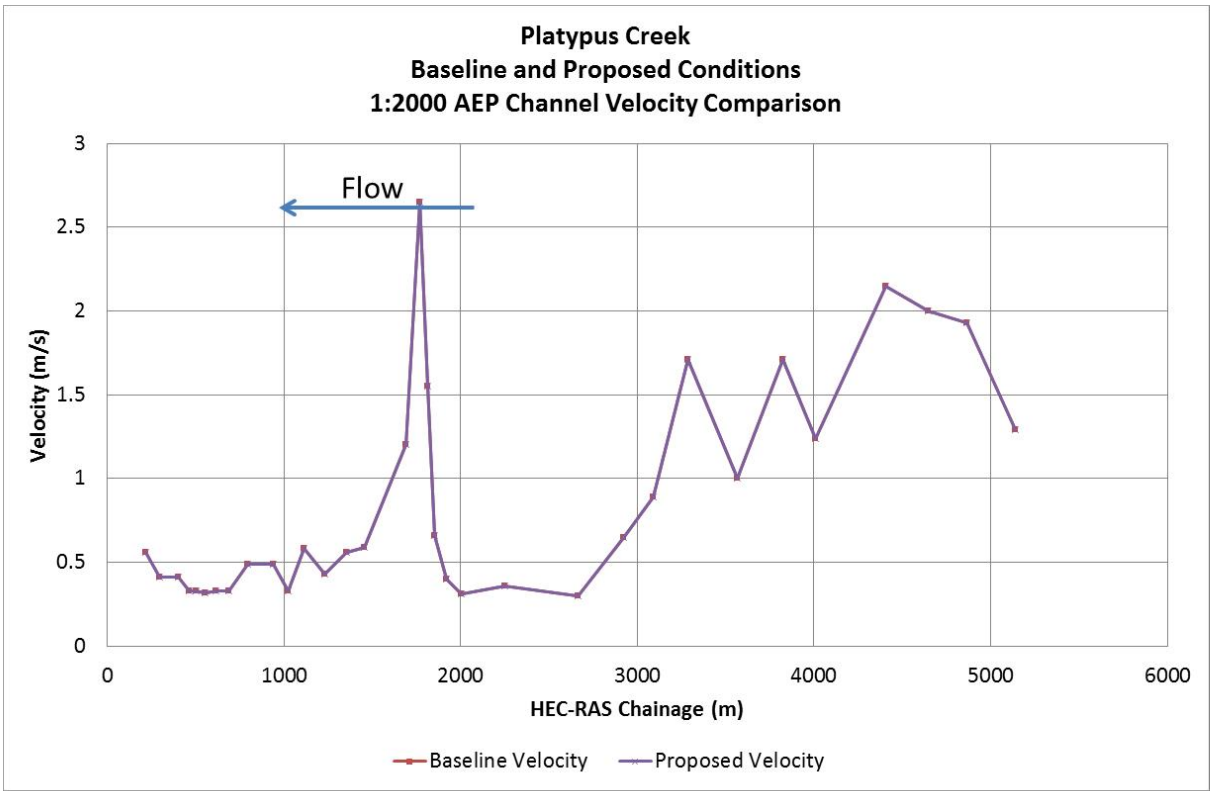
Figure Appendix E 58 Longitudinal Plot of Platypus Creek Water Surface Elevation Comparison 1 in 2000 AEP



Note: Baseline and proposed levels coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

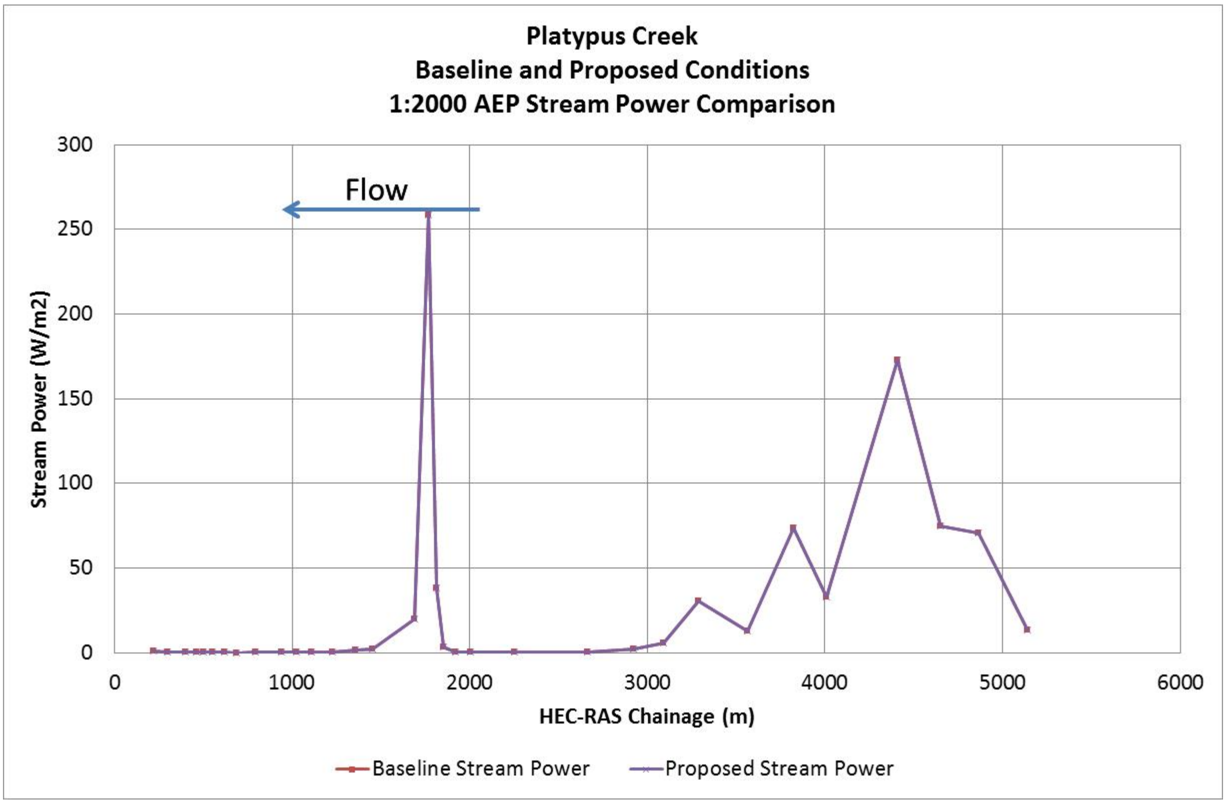
Figure Appendix E 59 Longitudinal Plot of Platypus Creek Stream Velocity Comparison 1 in 2000 AEP



Note: Baseline and proposed velocity conditions coincide.

Appendix E - Longitudinal Plots of baseline and proposed HECRAS modelling results (1 in 100 to 1 in 2000 AEP)

Figure Appendix E 60 Longitudinal Plot of Platypus Creek Stream Power Comparison 1 in 2000 AEP



Note: Baseline and proposed stream power conditions coincide.

Appendix F Proposed HECRAS Modelling Results (1 in 100 to 1 in 2000 AEP)

Table Appendix F 1 Summary of Proposed Case Stream Power Results (1 in 100 to 1 in 2000 AEP)

Creek	Stream Power (W/m2)			
	1 in 100 AEP	1 in 500 AEP	1 in 1000 AEP	1 in 2000 AEP
12 Mile Gully	0.02 – 2273	0.1 – 3945	0.1 – 4170	0.1 – 4913
Goonyella Creek	0.4 – 390	1.0 – 459	1.4 – 523	2.0 – 582
Eureka Creek	0.3 – 2145	0.2 – 592	0.2 – 795	0.2 – 1043
Fisher Creek	0.6 – 343	1.2 – 700	1.3 – 953	1.7 – 1285
Platypus Creek	0.1 – 218	0.1 – 252	0.1 – 258	0.1 – 218

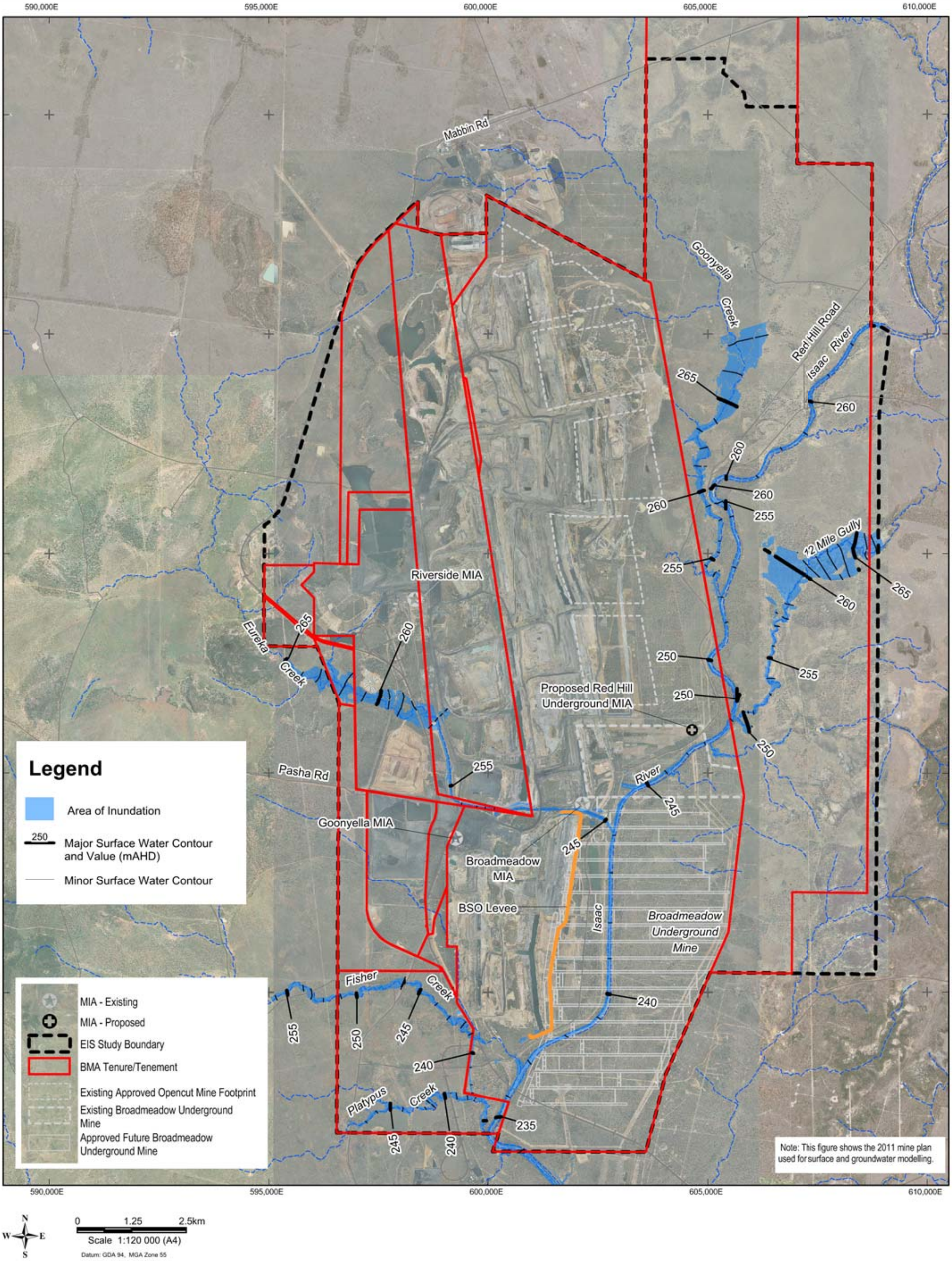
Table Appendix F 2 Summary of Proposed Case Stream Velocity Results (1 in 100 to 1 in 2000 AEP)

Creek	Velocity (m/s)			
	1 in 100 AEP	1 in 500 AEP	1 in 1000 AEP	1 in 2000 AEP
12 Mile Gully	0.20 – 5.56	0.26 – 7.01	0.28 – 7.29	0.32 – 7.77
Goonyella Creek	0.53 – 3.96	0.72 – 4.40	0.82 – 4.69	0.91 – 4.94
Eureka Creek	0.32 – 5.37	0.35 – 4.08	0.37 – 4.36	0.37 – 4.77
Fisher Creek	0.39 – 2.79	0.52 – 3.62	0.56 – 4.05	0.61 – 4.50
Platypus Creek	0.24 – 2.48	0.28 – 2.44	0.31 – 2.60	0.30 – 2.65

Table Appendix F 3 Summary of Proposed Case Maximum Water Depths in Channel (1 in 100 to 1 in 2000 AEP)

Creek	Maximum Flow Depth (m)			
	1 in 100 AEP	1 in 500 AEP	1 in 1000 AEP	1 in 2000 AEP
12 Mile Gully	1.5 – 16.2	1.8 – 17.3	2.0 – 17.6	2.2 – 17.8
Goonyella Creek	2.5 – 10.3	3.1	3.3 – 11.9	3.5 – 12.4
Eureka Creek	2.8 – 10.2	3.3 – 12.9	3.5 – 13.4	3.7 – 13.8
Fisher Creek	1.6 – 6.8	2.1 – 7.1	2.2 – 7.2	2.4 – 7.3
Platypus Creek	1.3 – 7.9	1.8 – 8.9	1.9 – 9.2	2.1 – 9.6

Appendix G TUFLOW Model Results - Base Case Maps



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HYDRAULICS TECHNICAL REPORT

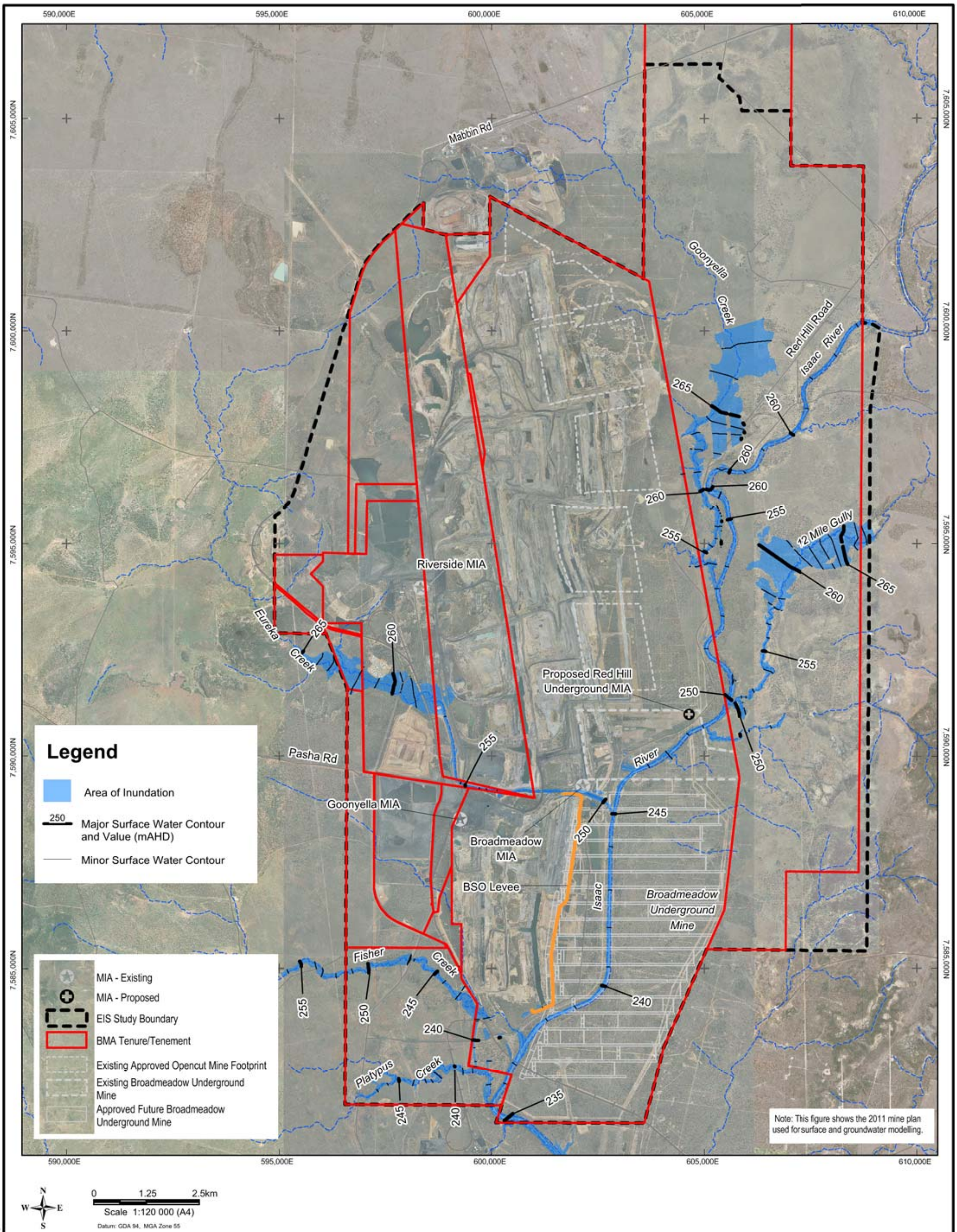
BASECASE 1:10 AEP WATER SURFACE ELEVATION

URS

SURFACE WATER

Appendix G-01

File No: **42627136-g-2111b.wor** Drawn: **VH** Approved: **CT** Date: **03-10-2013** Rev. **B** A4



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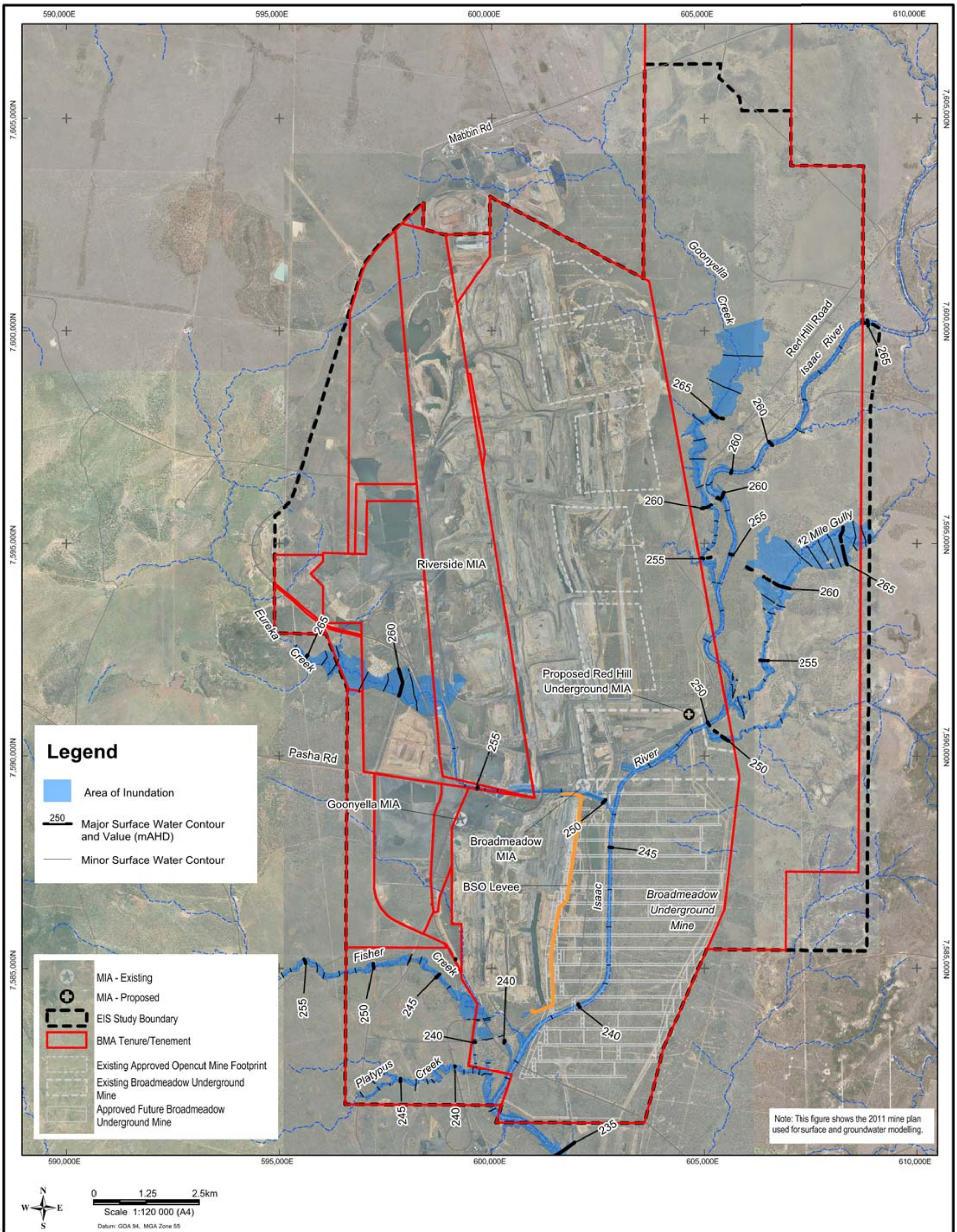
BASECASE 1:20 AEP WATER SURFACE ELEVATION

SURFACE WATER

Appendix G-02

File No: **42627136-g-2112b.wor** Drawn: **VH** Approved: **CT** Date: **03-10-2013** Rev. **B** A4



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HYDRAULICS TECHNICAL REPORT

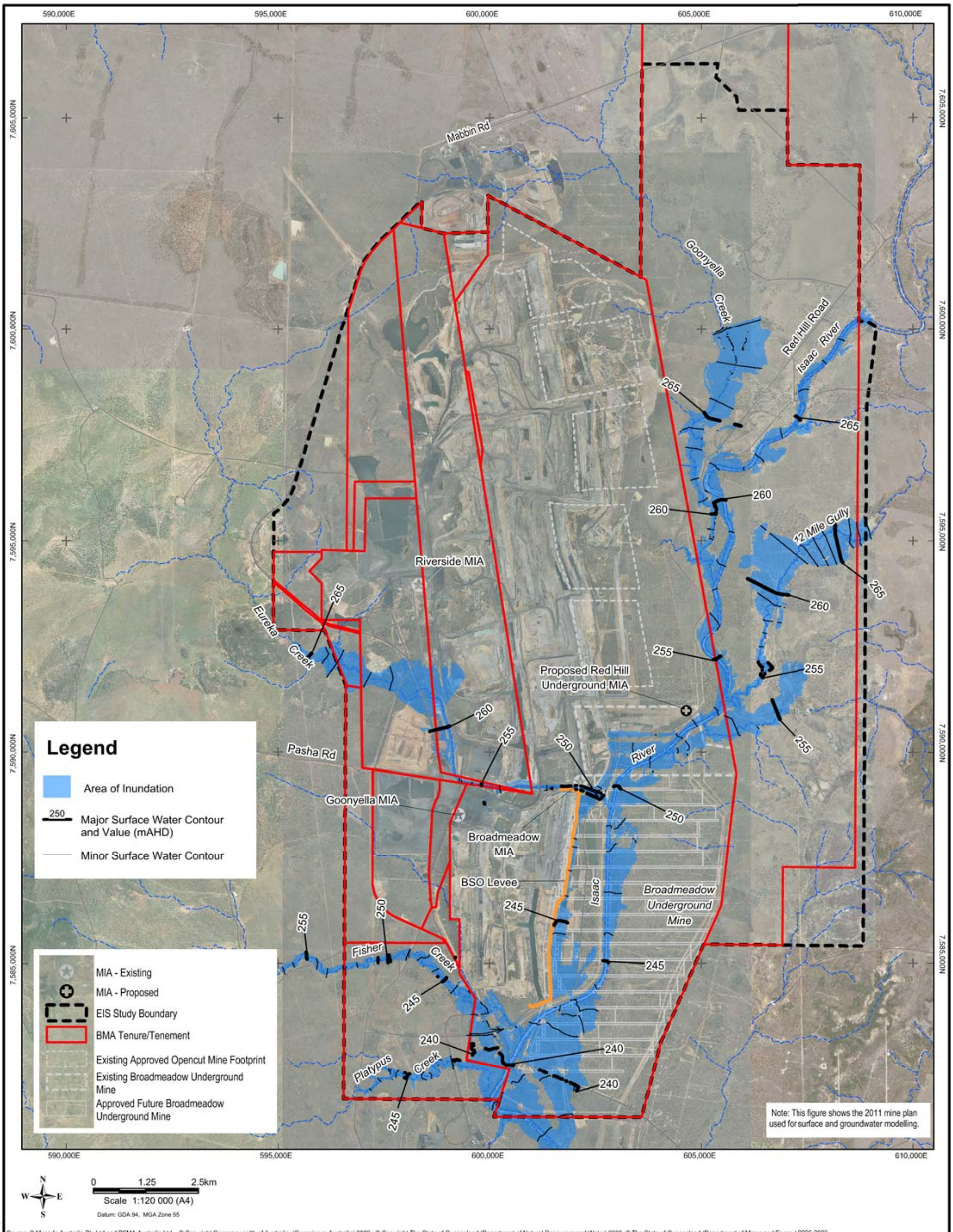
BASECASE 1:50 AEP WATER SURFACE ELEVATION

URS

SURFACE WATER

Appendix G-03

File No: **42627136-g-2113b.wor** Drawn: **VH** Approved: **CT** Date: **03-10-2013** Rev.**B** A4



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HYDRAULICS TECHNICAL REPORT

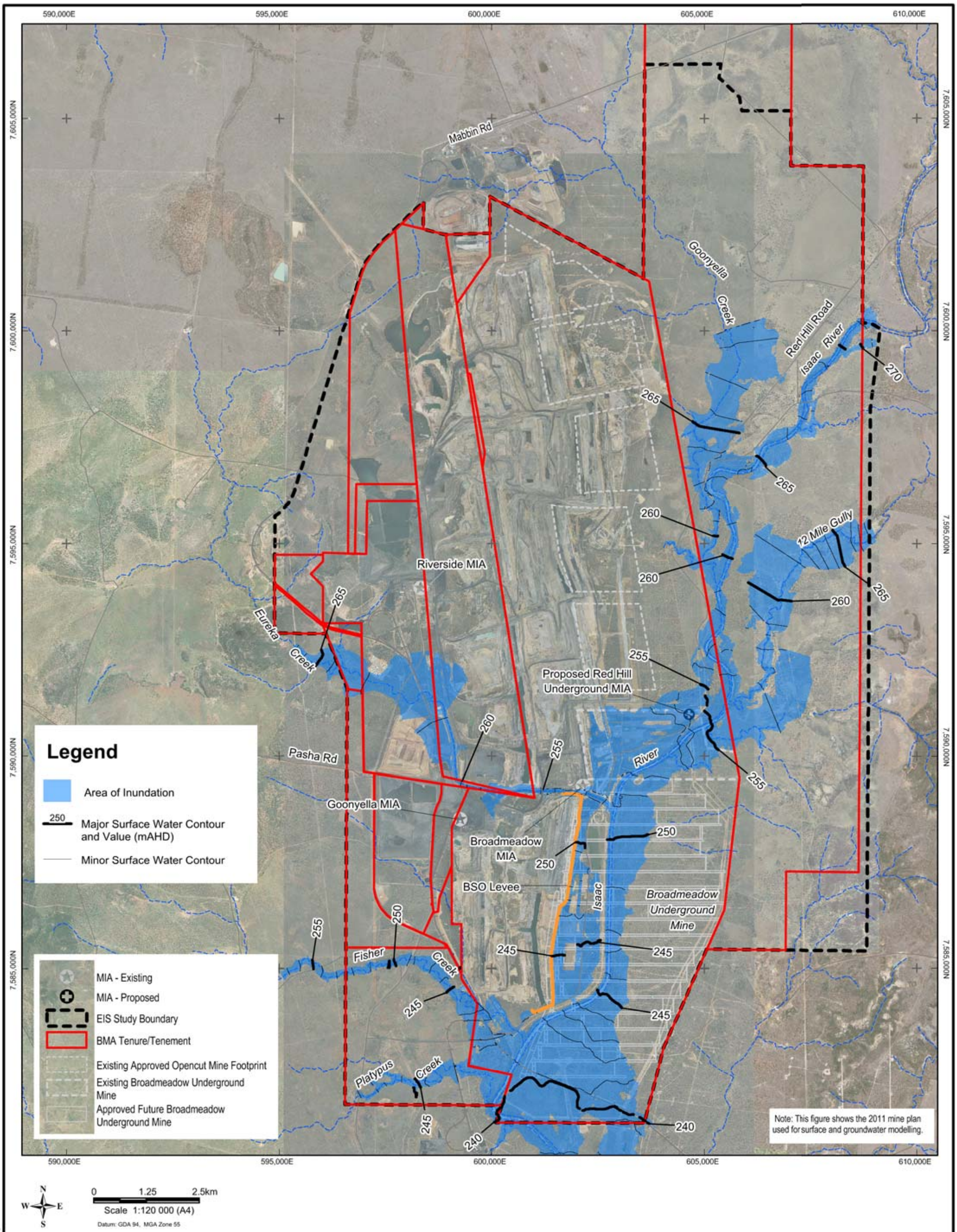
BASECASE 1:100 AEP WATER SURFACE ELEVATION

URS

SURFACE WATER

Appendix G-04

File No: **42627136-g-2052b.wor** Drawn: **VH** Approved: **CT** Date: **03-10-2013** Rev.**B** A4



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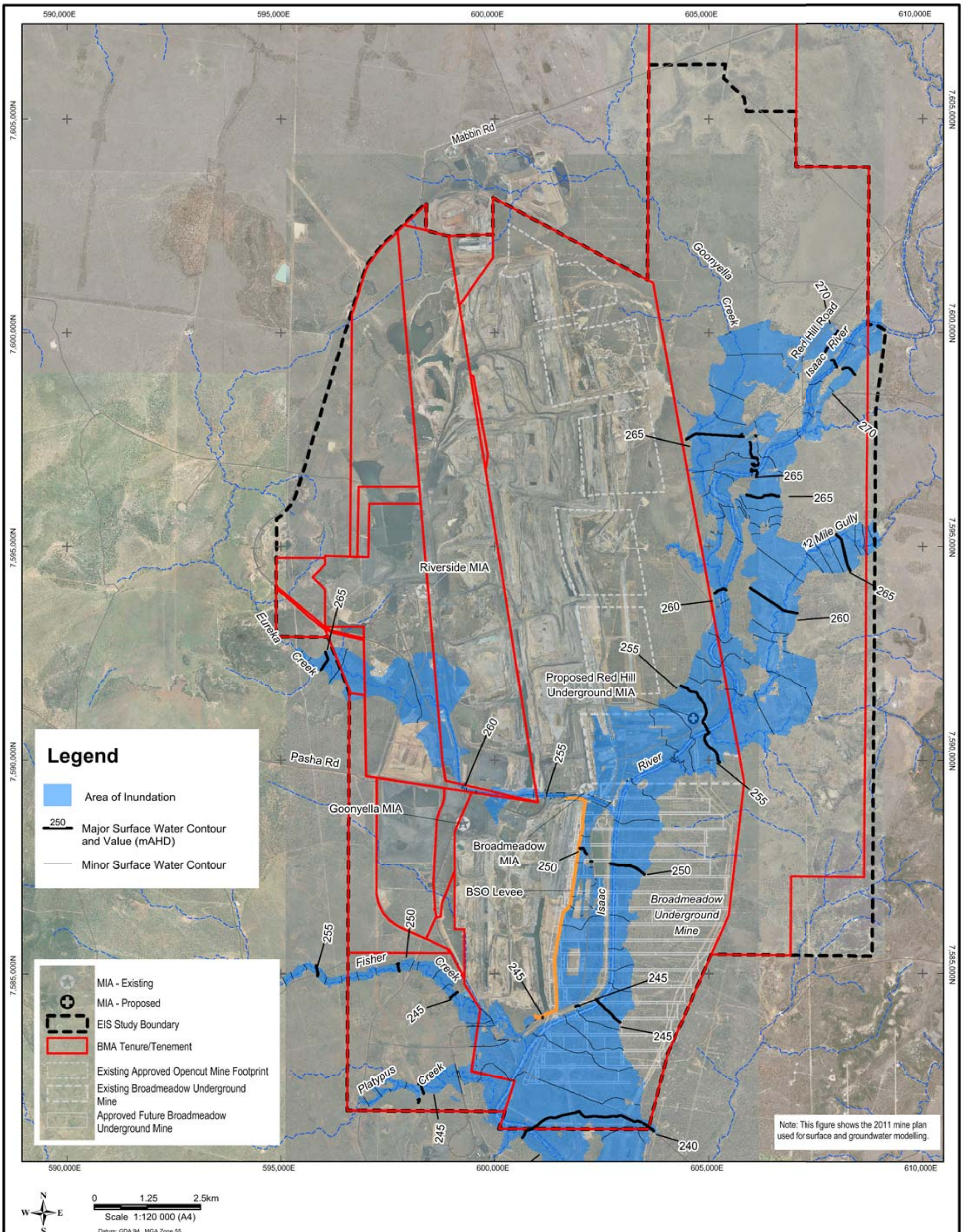
BASECASE 1:500 AEP WATER SURFACE ELEVATION

URS

SURFACE WATER

Appendix G-05

File No: 42627136-g-2053b.wor Drawn: VH Approved: CT Date: 03-10-2013 Rev.B A4



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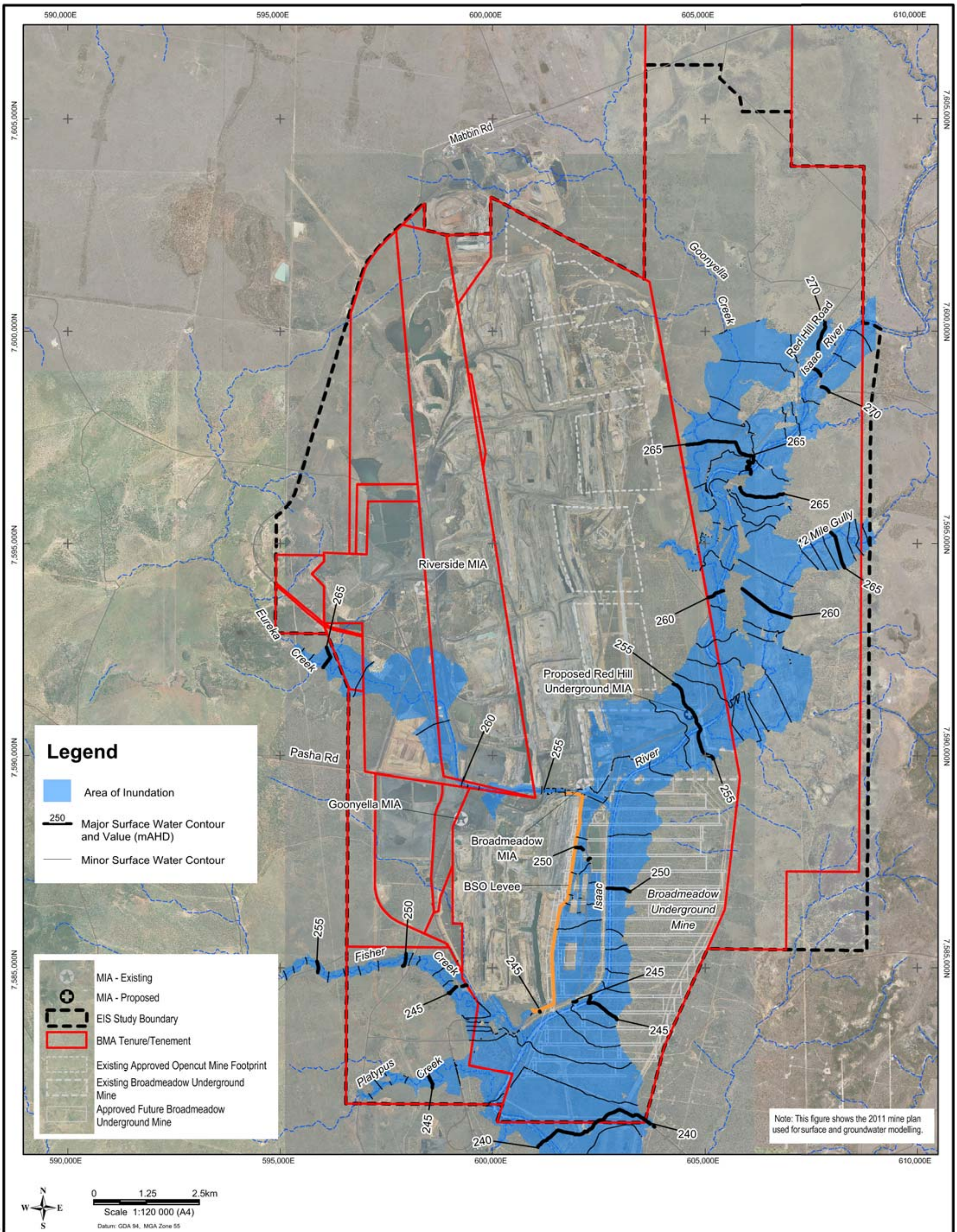
BASECASE 1:1000 AEP WATER SURFACE ELEVATION

URS

SURFACE WATER

Appendix G-06

File No: **42627136-g-2054b.wor** Drawn: **VH** Approved: **CT** Date: **03-10-2013** Rev.**B** A4



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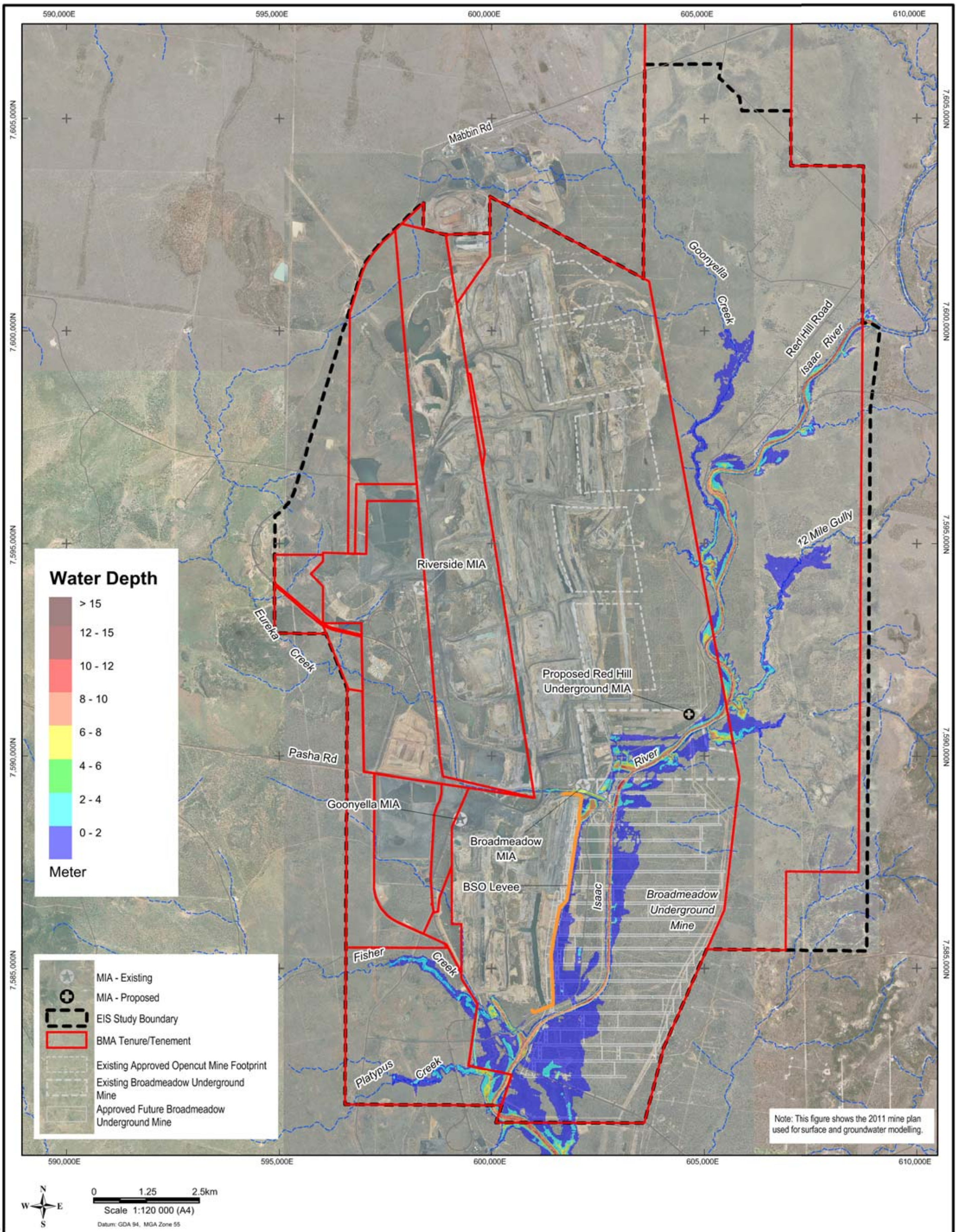
BASECASE 1:2000 AEP WATER SURFACE ELEVATION

URS

SURFACE WATER

Appendix G-07

File No: **42627136-g-2055b.wor** | Drawn: **VH** | Approved: **CT** | Date: **03-10-2013** | Rev. **B** | A4



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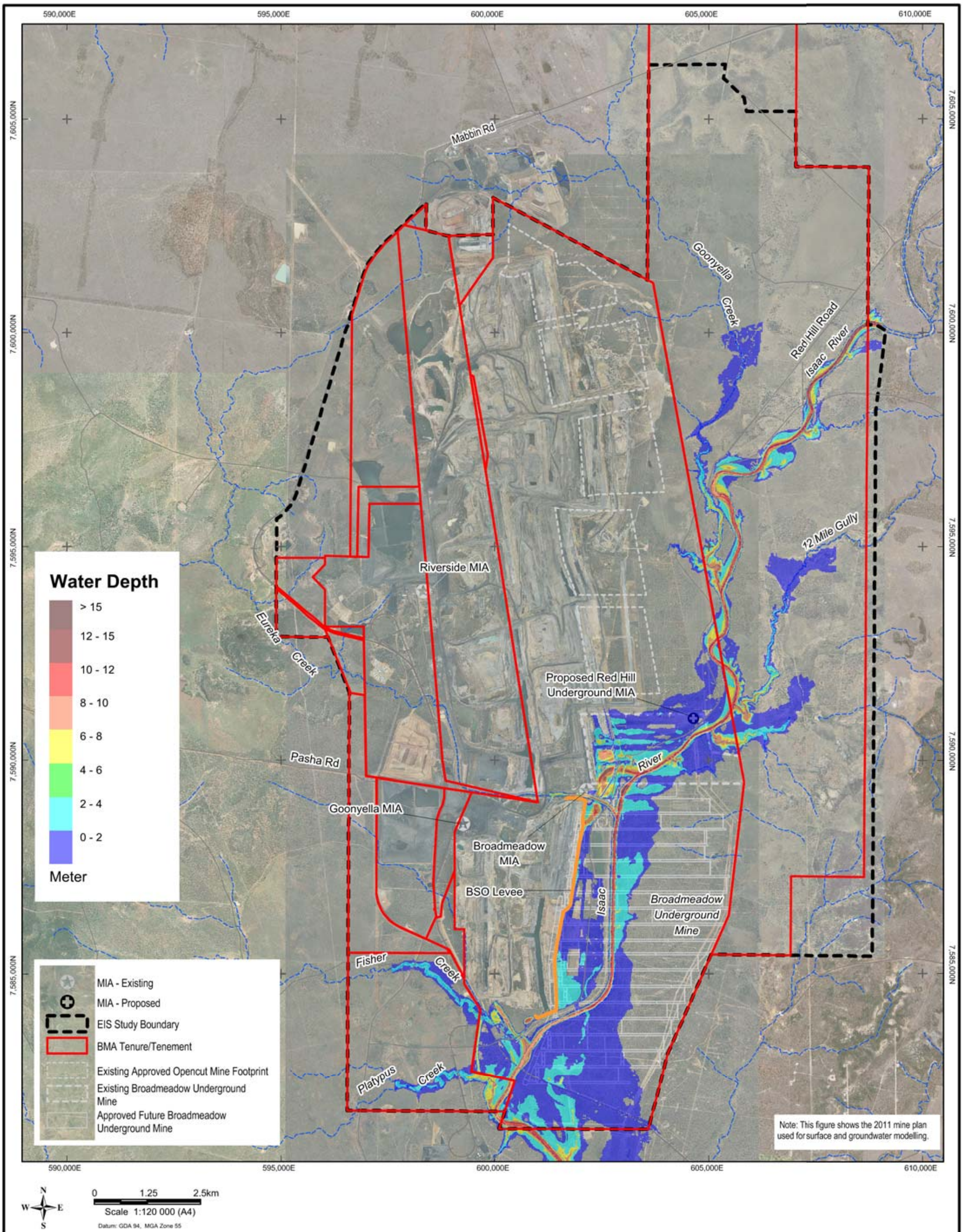
BASECASE 1:100 AEP
WATER DEPTH

URS

SURFACE WATER

Appendix G-08

File No: **42627136-g-2048b.wor** Drawn: **VH** Approved: **CP** Date: **03-10-2013** Rev.**B** A4



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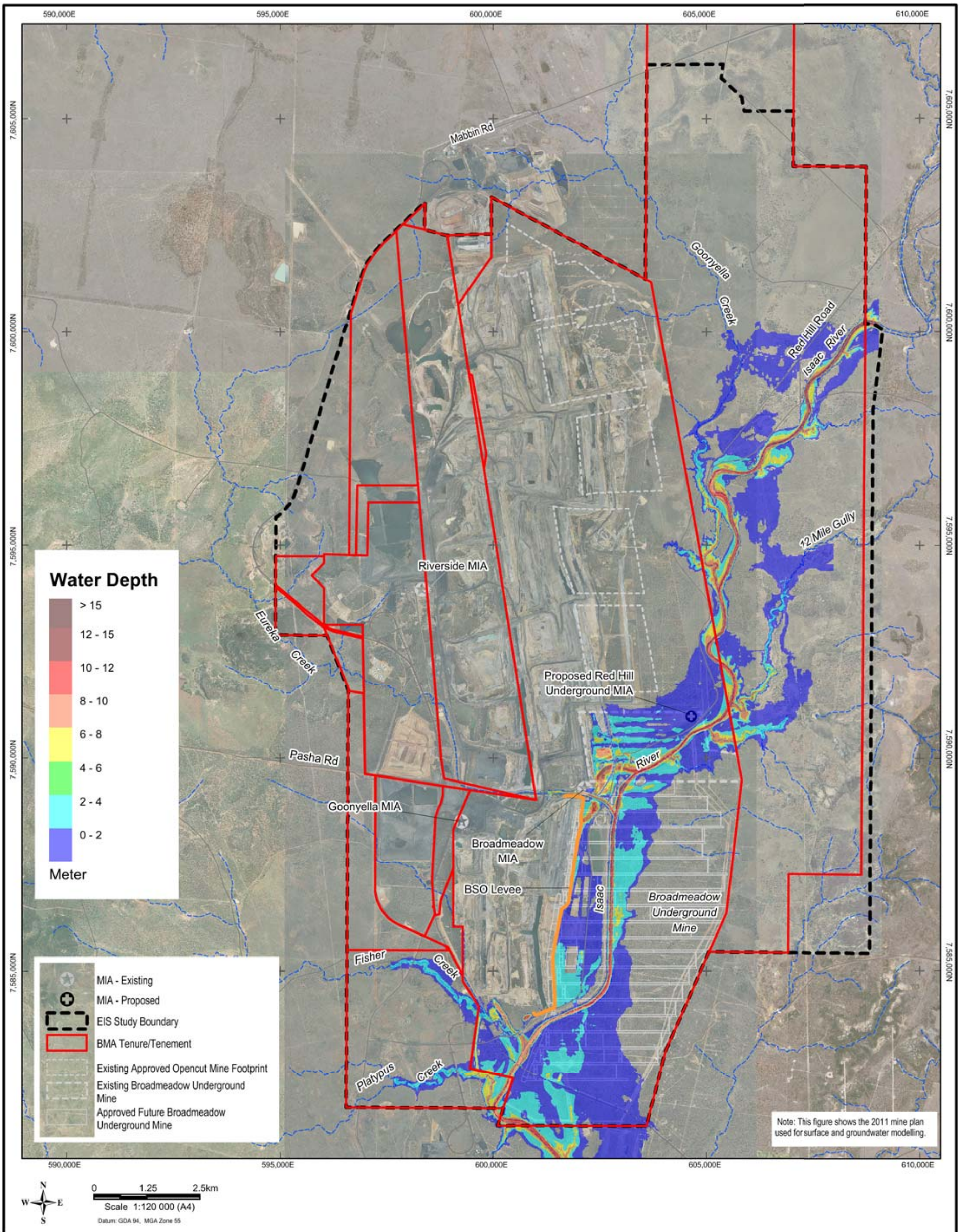
HYDRAULICS TECHNICAL REPORT

BASECASE 1:500 AEP WATER DEPTH

SURFACE WATER

Appendix G-09

File No: **42627136-g-2049b.wor** Drawn: **VH** Approved: **CT** Date: **03-10-2013** Rev.**B** A4



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HYDRAULICS TECHNICAL REPORT

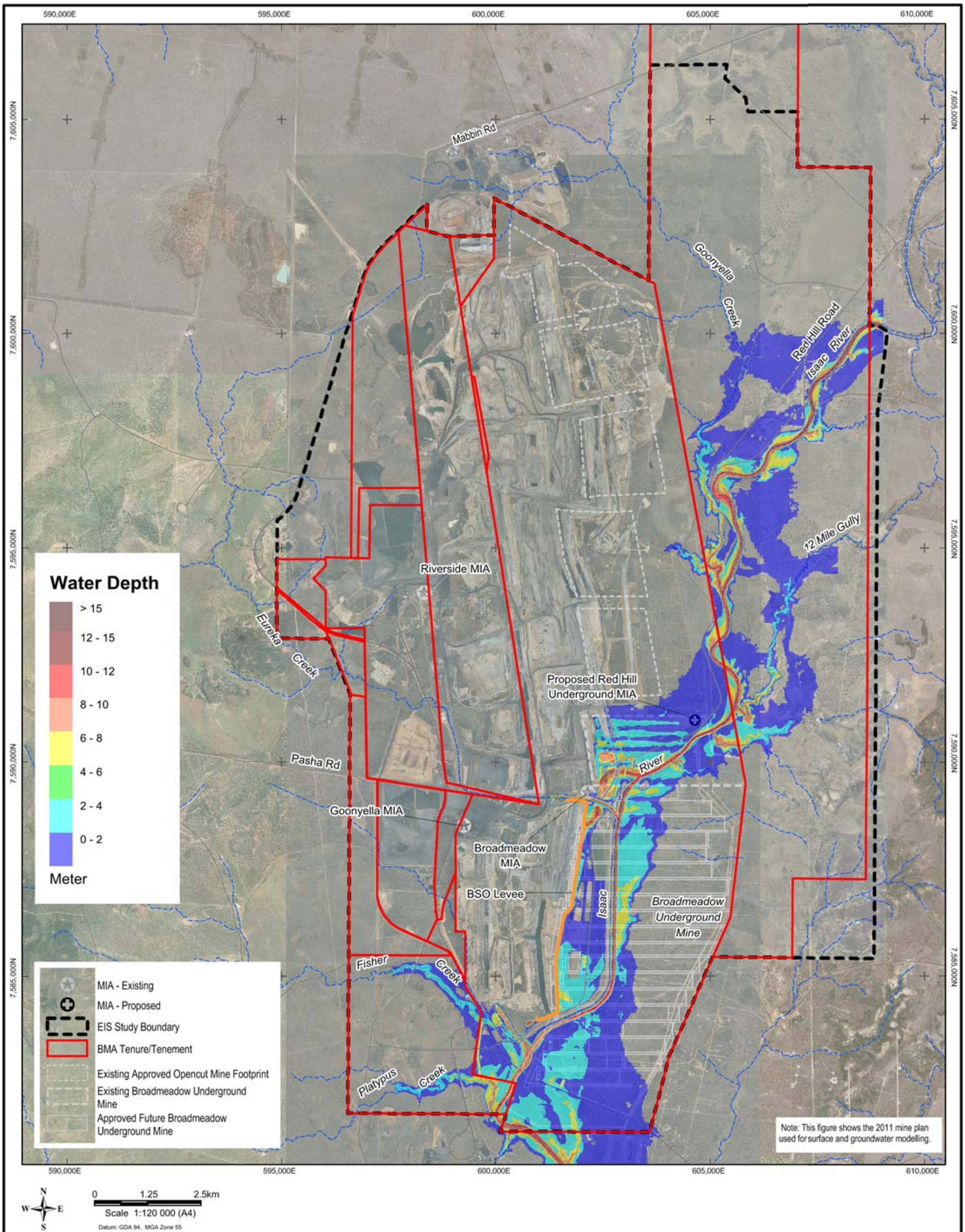
BASECASE 1:1000 AEP WATER DEPTH

URS

SURFACE WATER

Appendix G-10

File No: **42627136-g-2050b.wor** Drawn: **VH** Approved: **CT** Date: **03-10-2013** Rev. **B** A4



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HYDRAULICS TECHNICAL REPORT

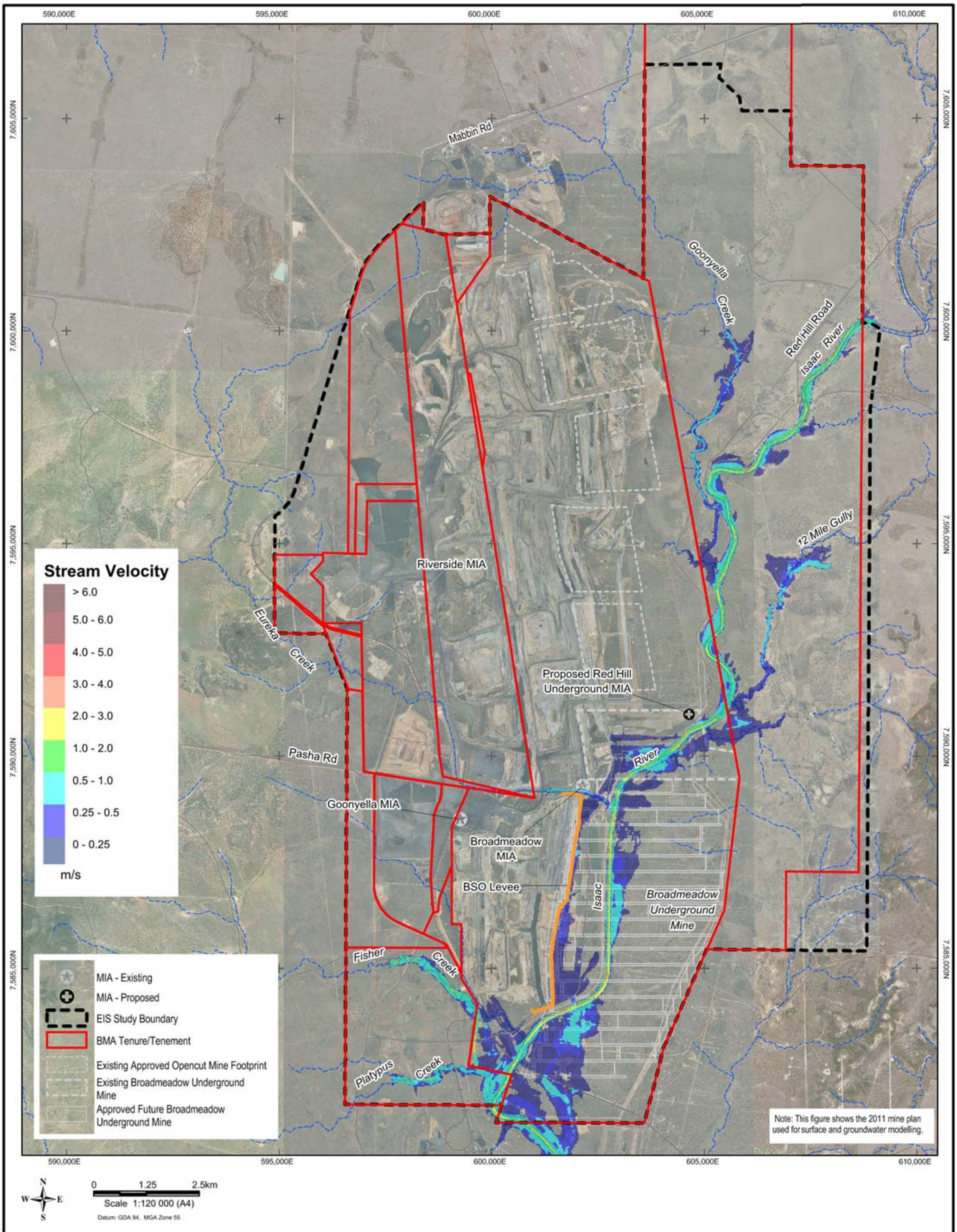
BASECASE 1:2000 AEP
WATER DEPTH

URS

SURFACE WATER

Appendix G-11

File No: **42627136-g-2051b.wor** Drawn: **VH** Approved: **CT** Date: **03-10-2013** Rev.**B** A4



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HYDRAULICS TECHNICAL REPORT

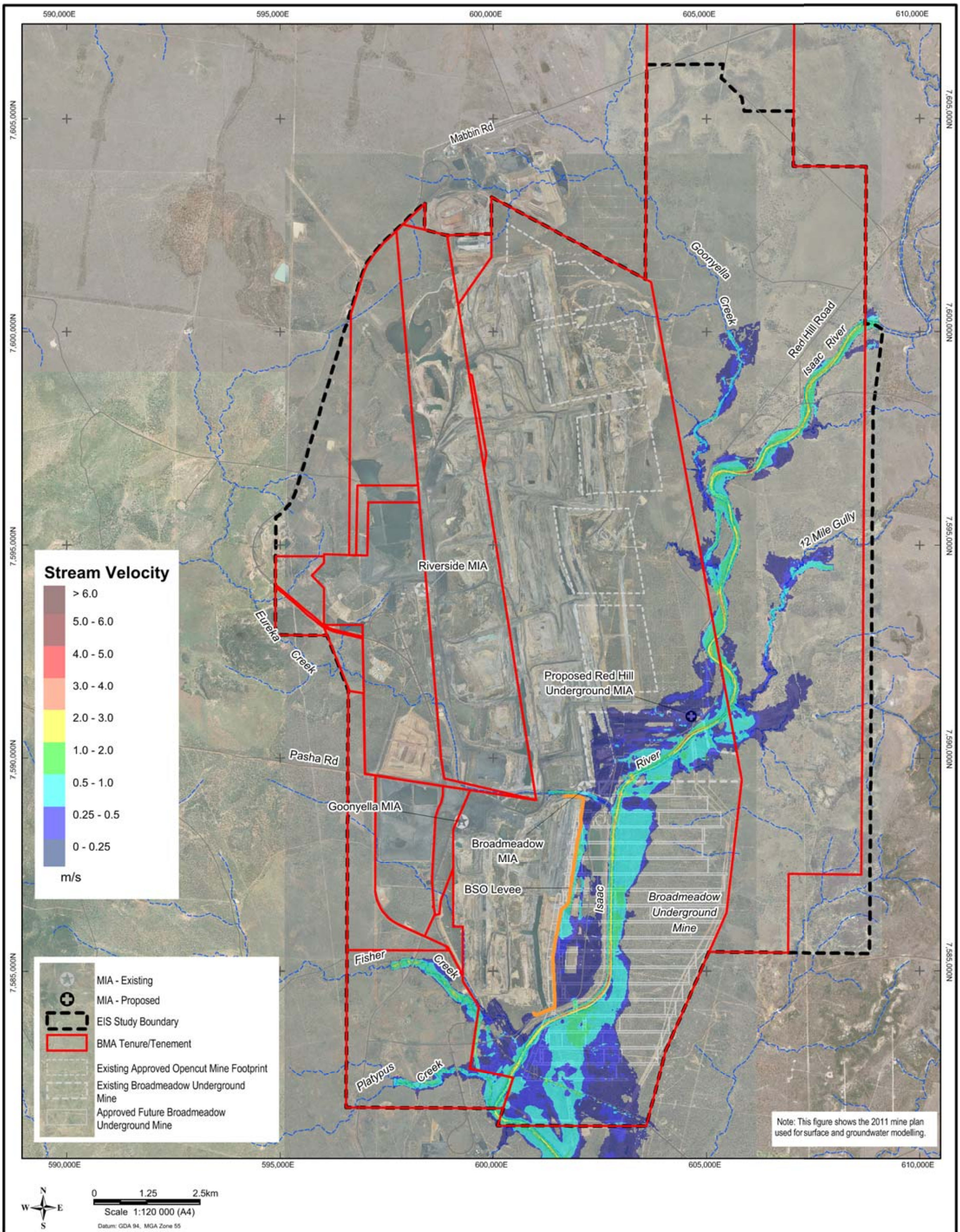
BASECASE 1:100 AEP STREAM VELOCITY

URS

SURFACE WATER

Appendix G-12

File No: **42627136-g-2056b.wor** Drawn: **VH** Approved: **CT** Date: **03-10-2013** Rev.**B** A4



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HYDRAULICS TECHNICAL REPORT

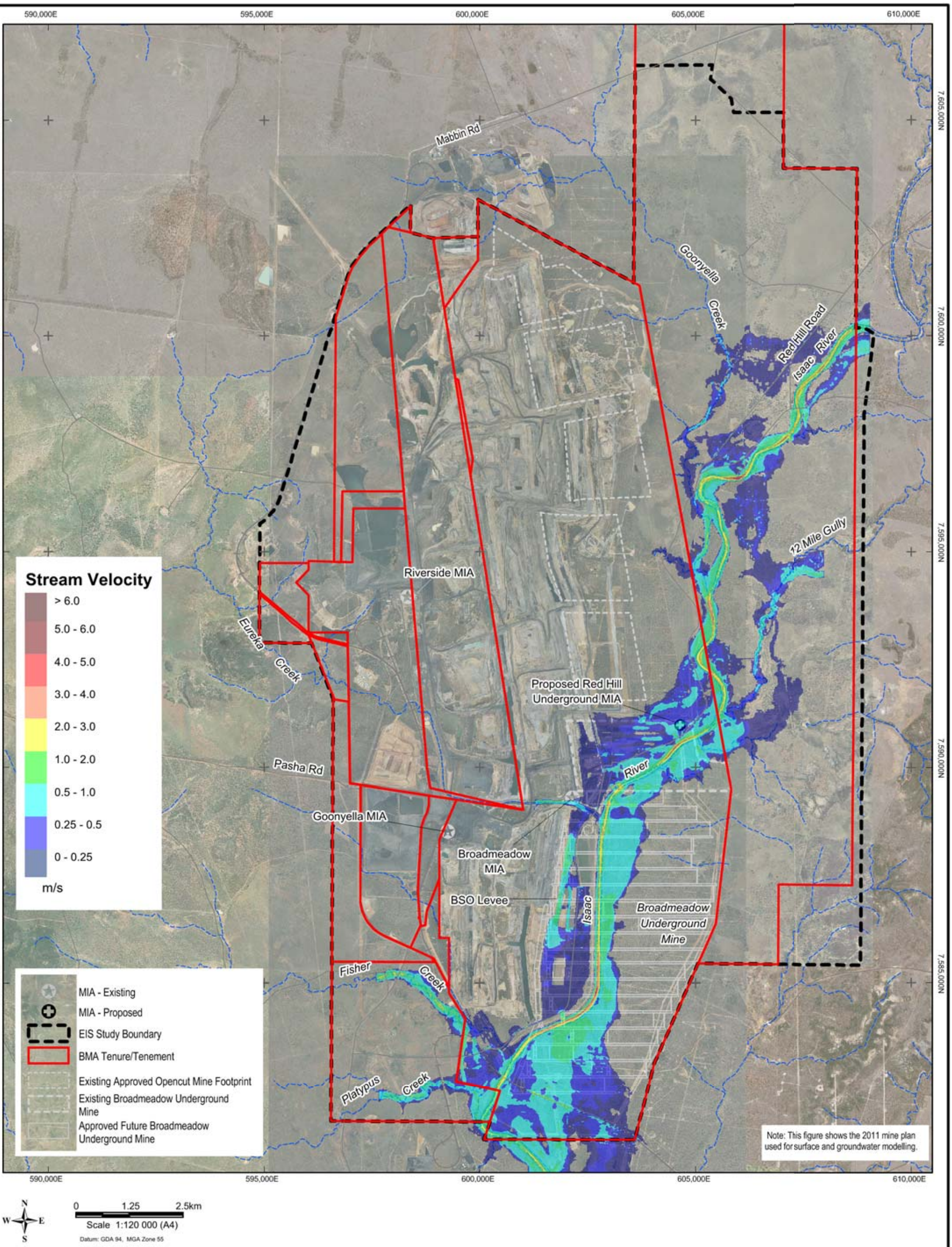
BASECASE 1:500 AEP STREAM VELOCITY

URS

SURFACE WATER

Appendix G-13

File No: **42627136-g-2057b.wor** Drawn: **VH** Approved: **CT** Date: **03-10-2013** Rev. **B** A4



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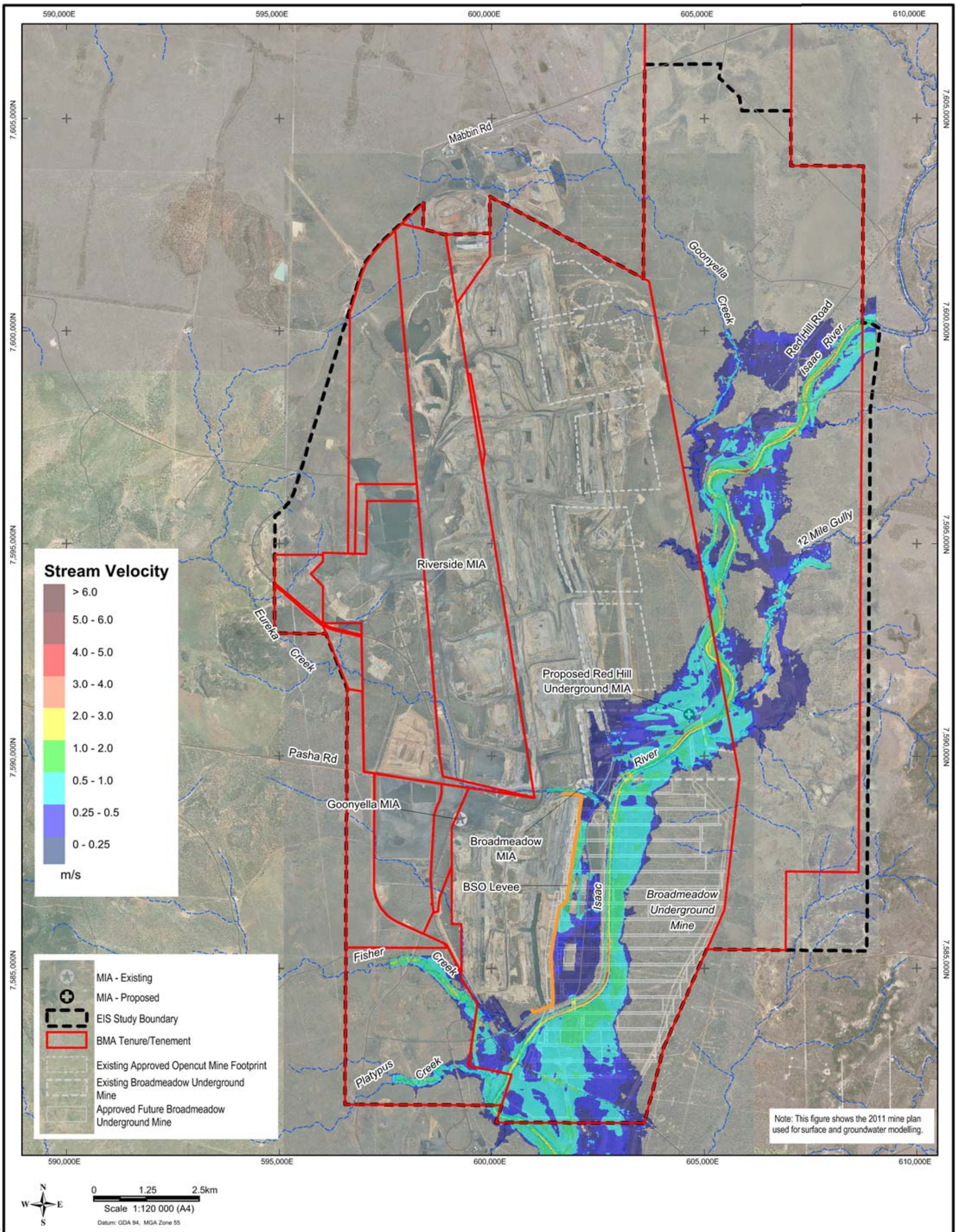
HYDRAULICS TECHNICAL REPORT

BASECASE 1:1000 AEP
STREAM VELOCITY

SURFACE WATER

Appendix G-14

File No: **42627136-g-2058b.wor** Drawn: **VH** Approved: **CT** Date: **03-10-2013** Rev. **B** A4



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HYDRAULICS TECHNICAL REPORT

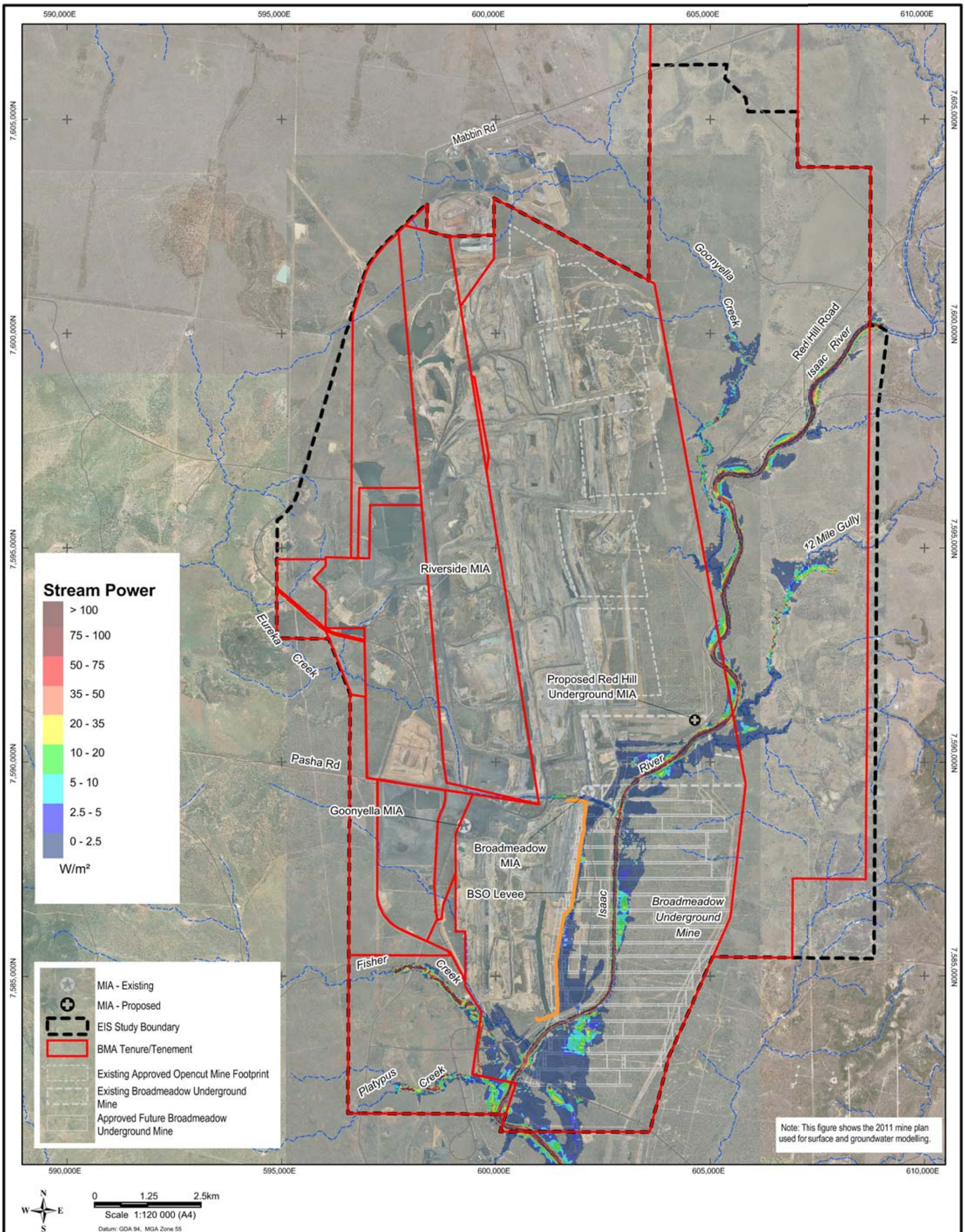
BASECASE 1:2000 AEP
STREAM VELOCITY

URS

SURFACE WATER

Appendix G-15

File No: **42627136-g-2059b.wor** Drawn: **VH** Approved: **CT** Date: **03-10-2013** Rev.**B** A4



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HYDRAULICS TECHNICAL REPORT

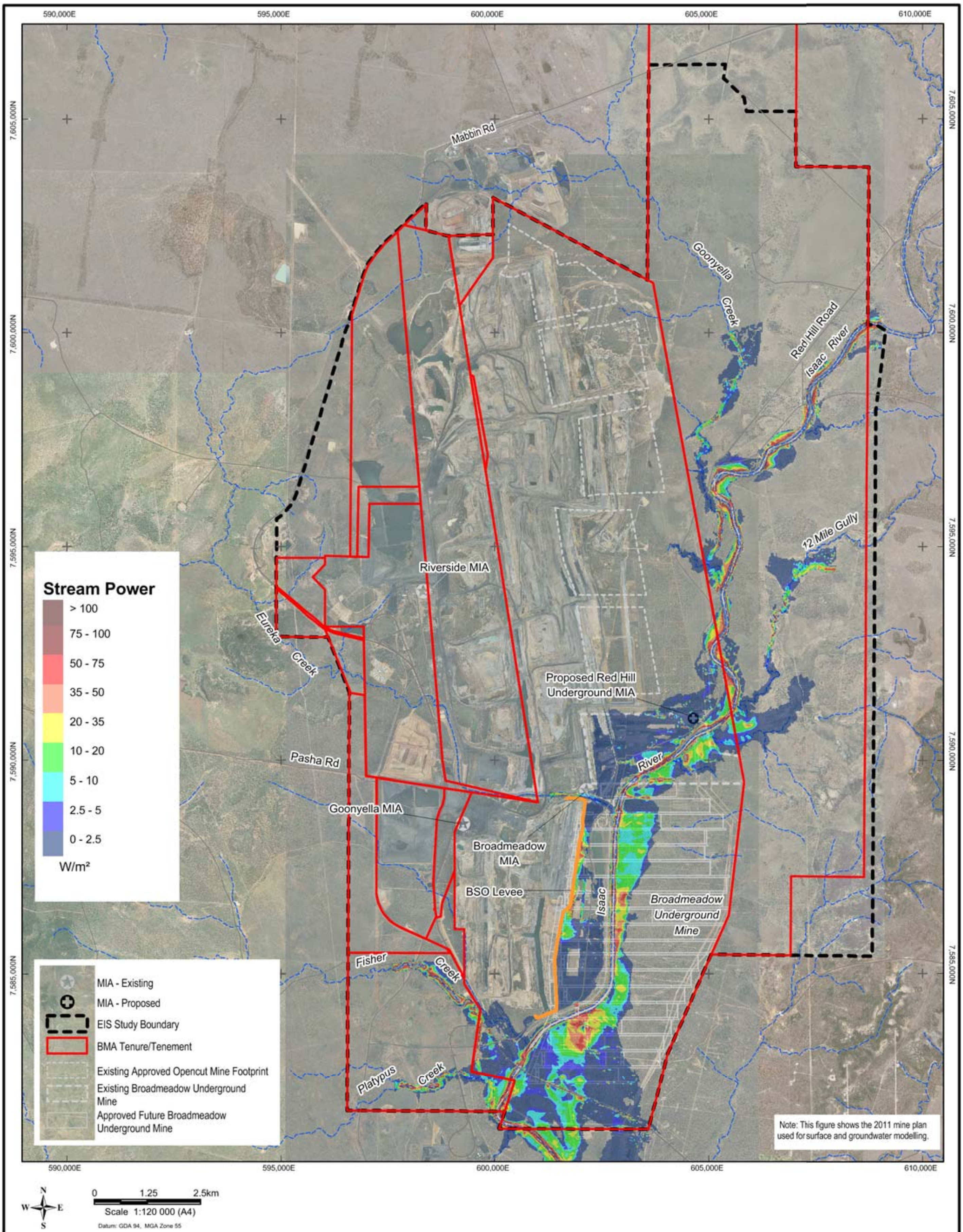
BASECASE 1:100 AEP STREAM POWER

URS

SURFACE WATER

Appendix G-16

File No: **42627136-g-2060b.wor** Drawn: **VH** Approved: **CT** Date: **03-10-2013** Rev.**B** A4



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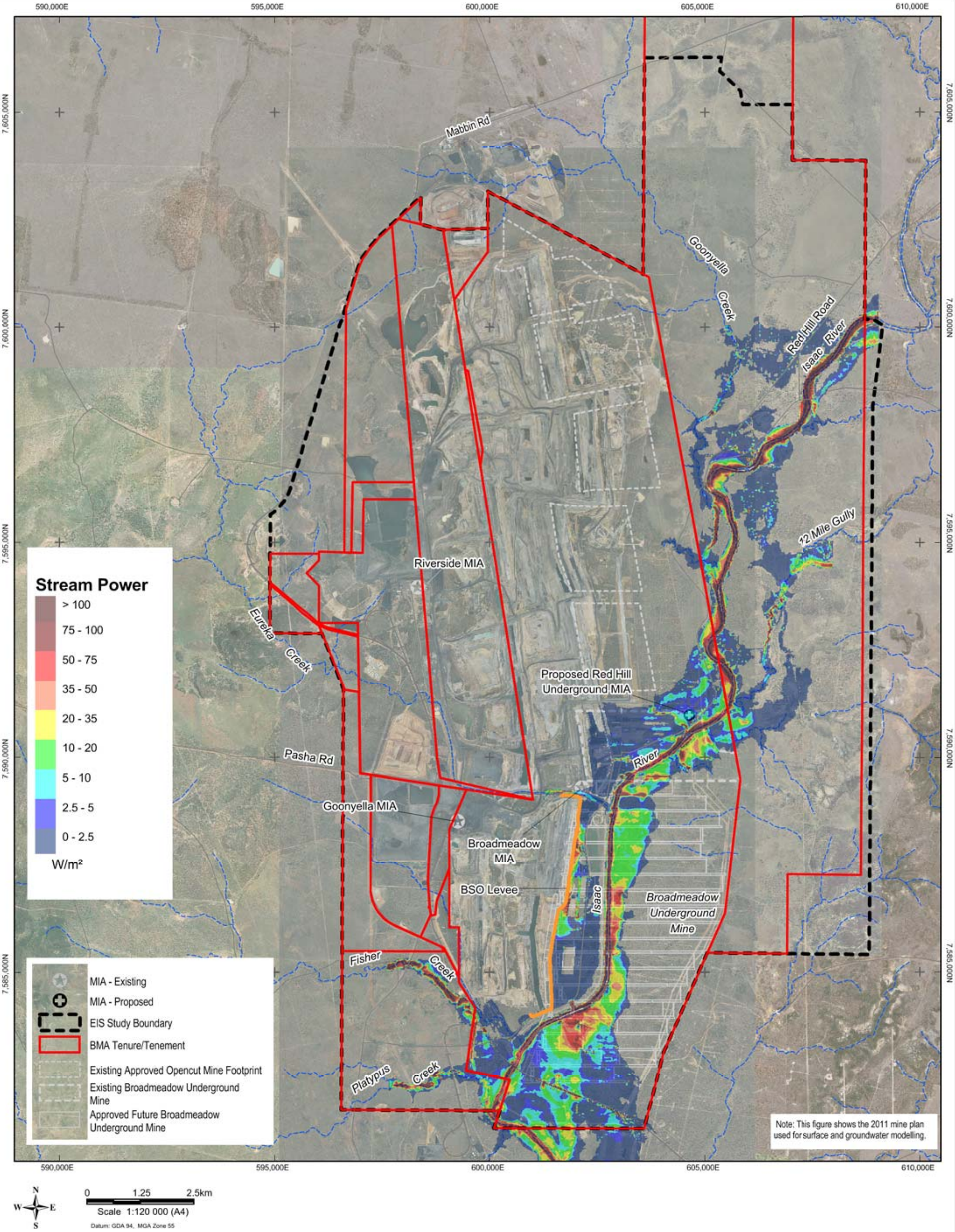
HYDRAULICS TECHNICAL REPORT

BASECASE 1:500 AEP STREAM POWER



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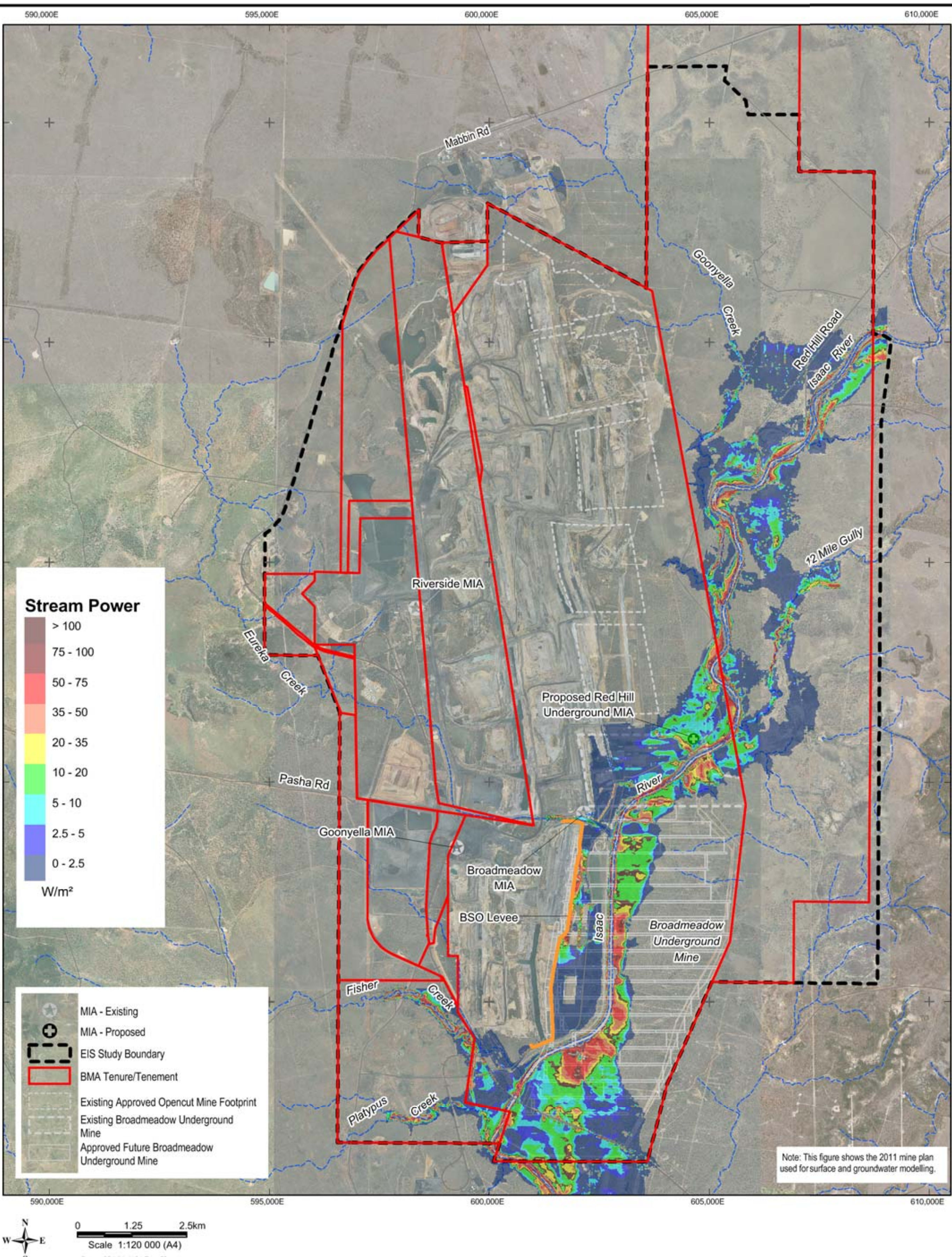
HYDRAULICS TECHNICAL REPORT

BASECASE 1:1000 AEP
STREAM POWER

SURFACE WATER

Appendix G-18

File No: **42627136-g-2062.wor** Drawn: **VH** Approved: **CT** Date: **24-06-2013** Rev. **A** A4



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HYDRAULICS TECHNICAL REPORT

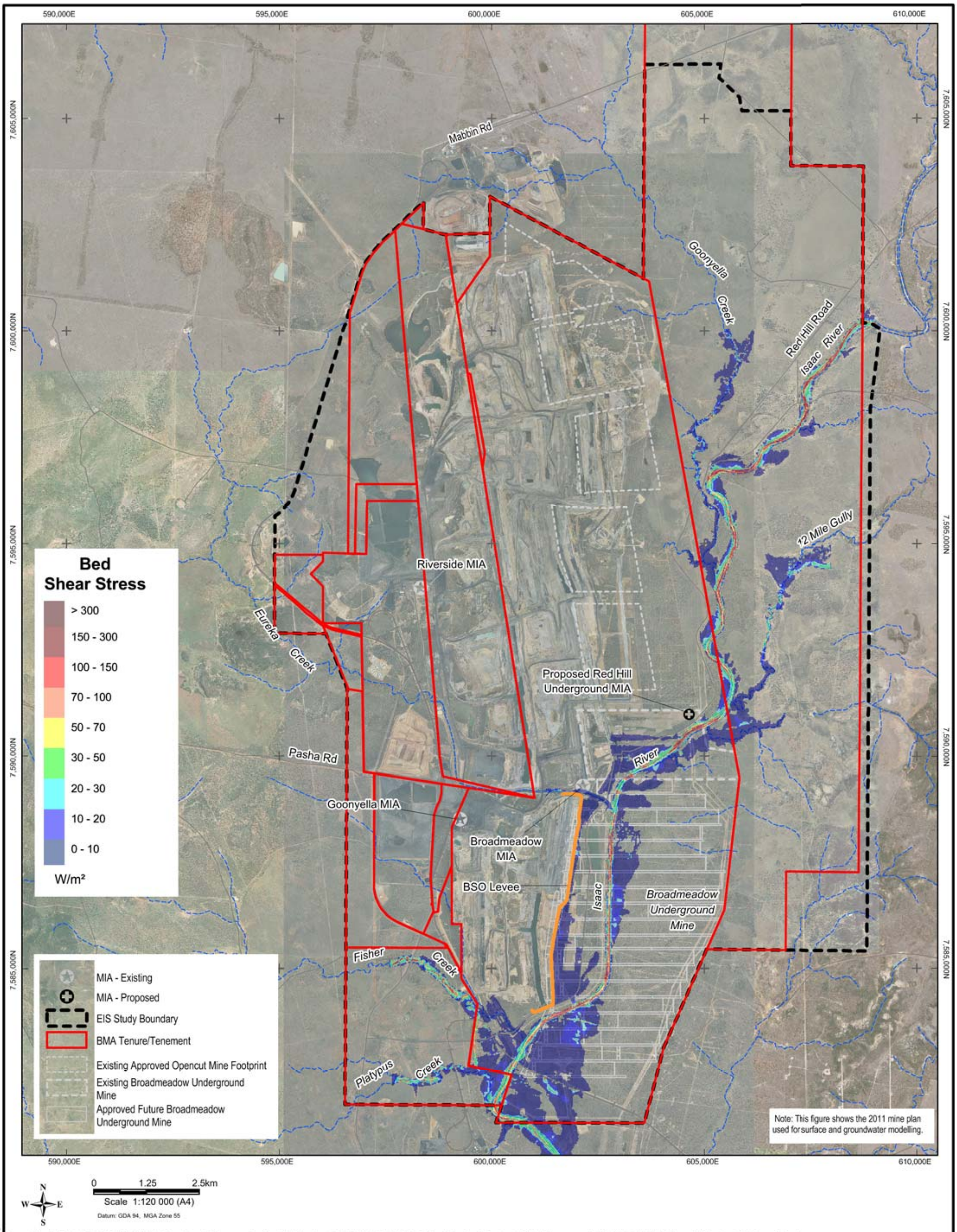
BASECASE 1:2000 AEP
STREAM POWER

URS

SURFACE WATER

Appendix G-19

File No: **42627136-g-2063b.wor** Drawn: **VH** Approved: **CT** Date: **03-10-2013** Rev.**B** A4



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HYDRAULICS TECHNICAL REPORT

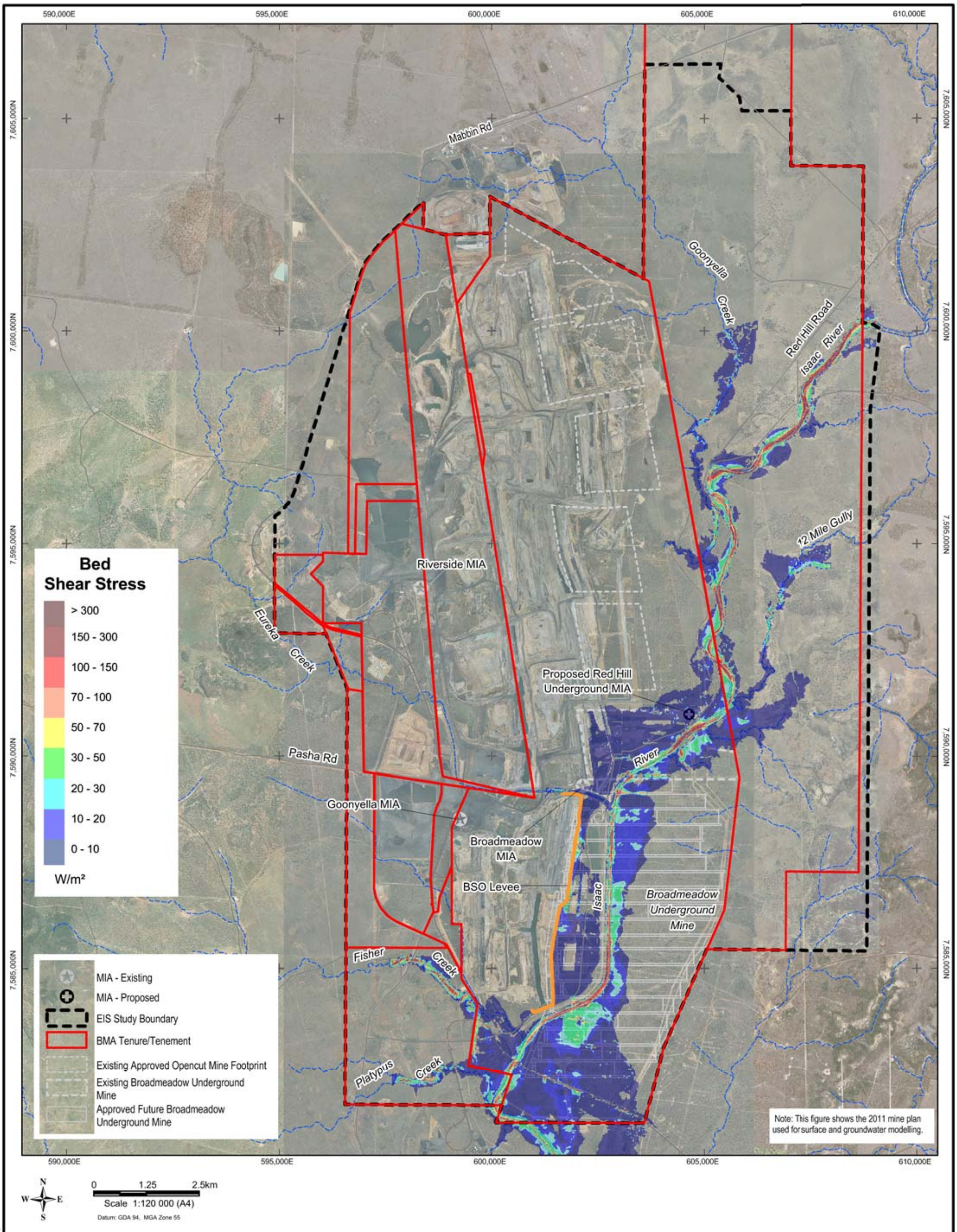
BASECASE 1:100 AEP
BED SHEAR STRESS

URS

SURFACE WATER

Appendix G-20

File No: **42627136-g-2064b.wor** Drawn: **VH** Approved: **CT** Date: **03-10-2013** Rev.**B** A4



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HYDRAULICS TECHNICAL REPORT

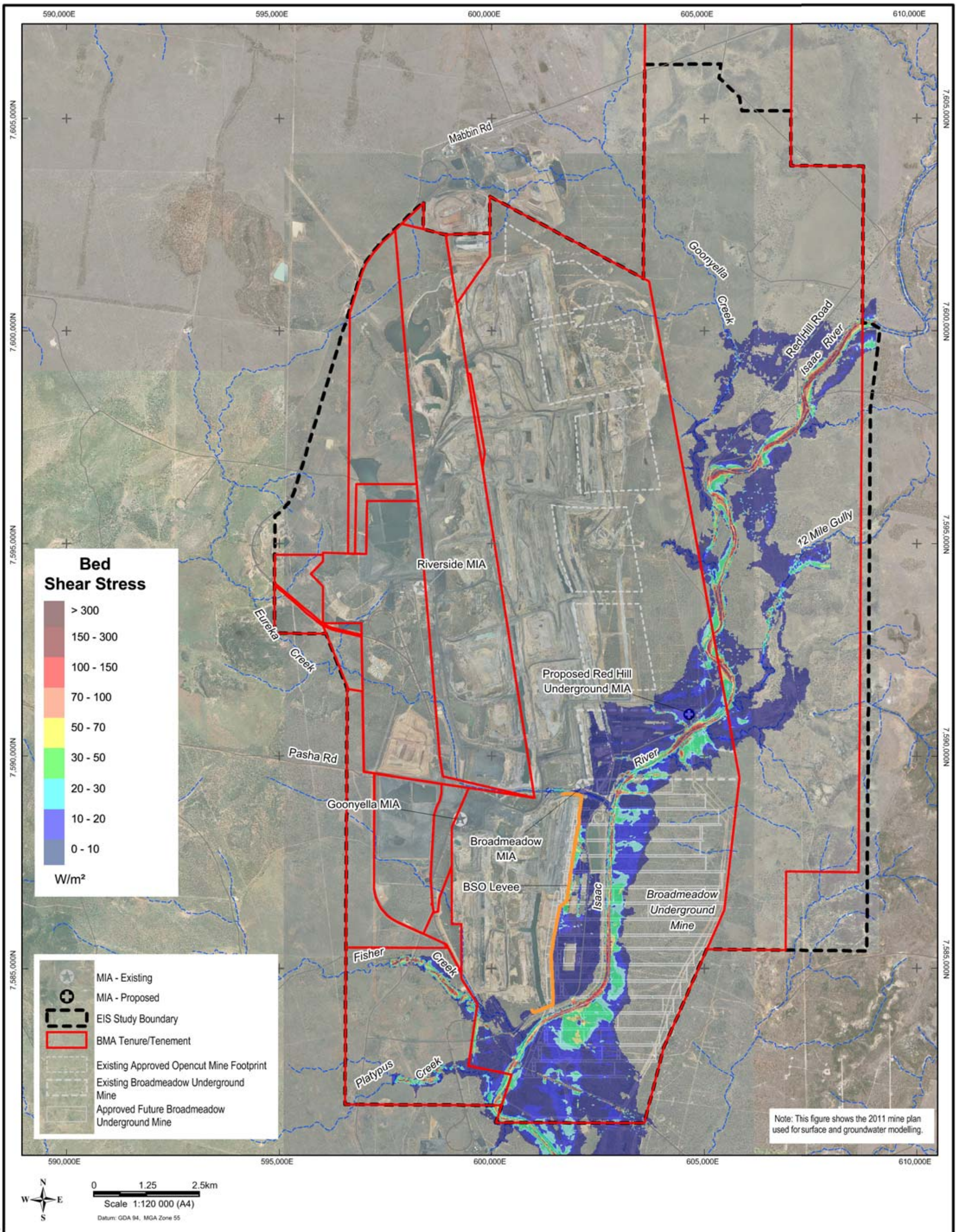
BASECASE 1:500 AEP
BED SHEAR STRESS

URS

SURFACE WATER

Appendix G-21

File No: **42627136-g-2065b.wor** Drawn: **VH** Approved: **CT** Date: **03-10-2013** Rev. **B** A4



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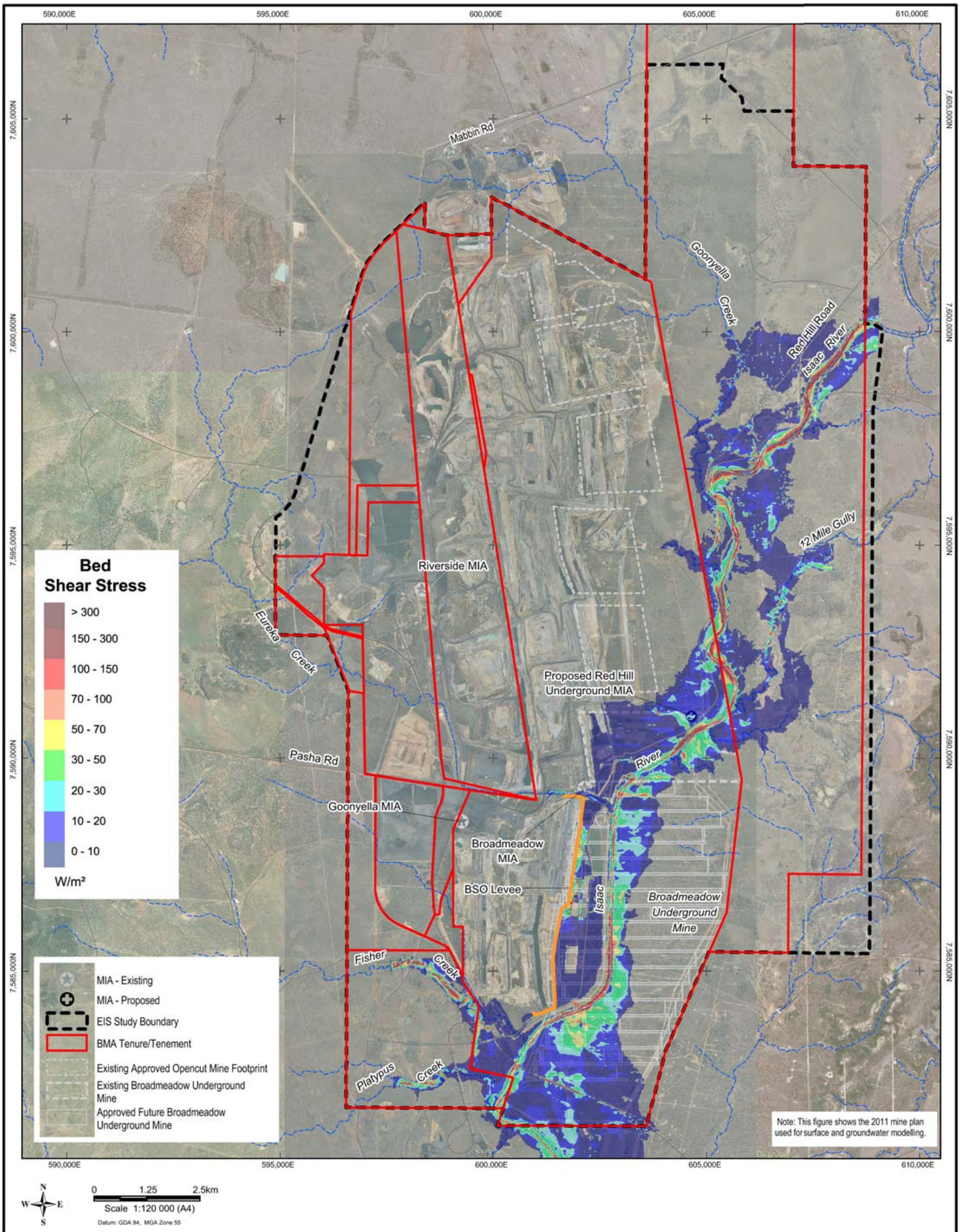
BASECASE 1:1000 AEP
BED SHEAR STRESS

SURFACE WATER

Appendix G-22

File No: **42627136-g-2066b.wor** Drawn: **VH** Approved: **CT** Date: **03-10-2013** Rev. **B** A4



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HYDRAULICS TECHNICAL REPORT

BASECASE 1:2000 AEP
BED SHEAR STRESS

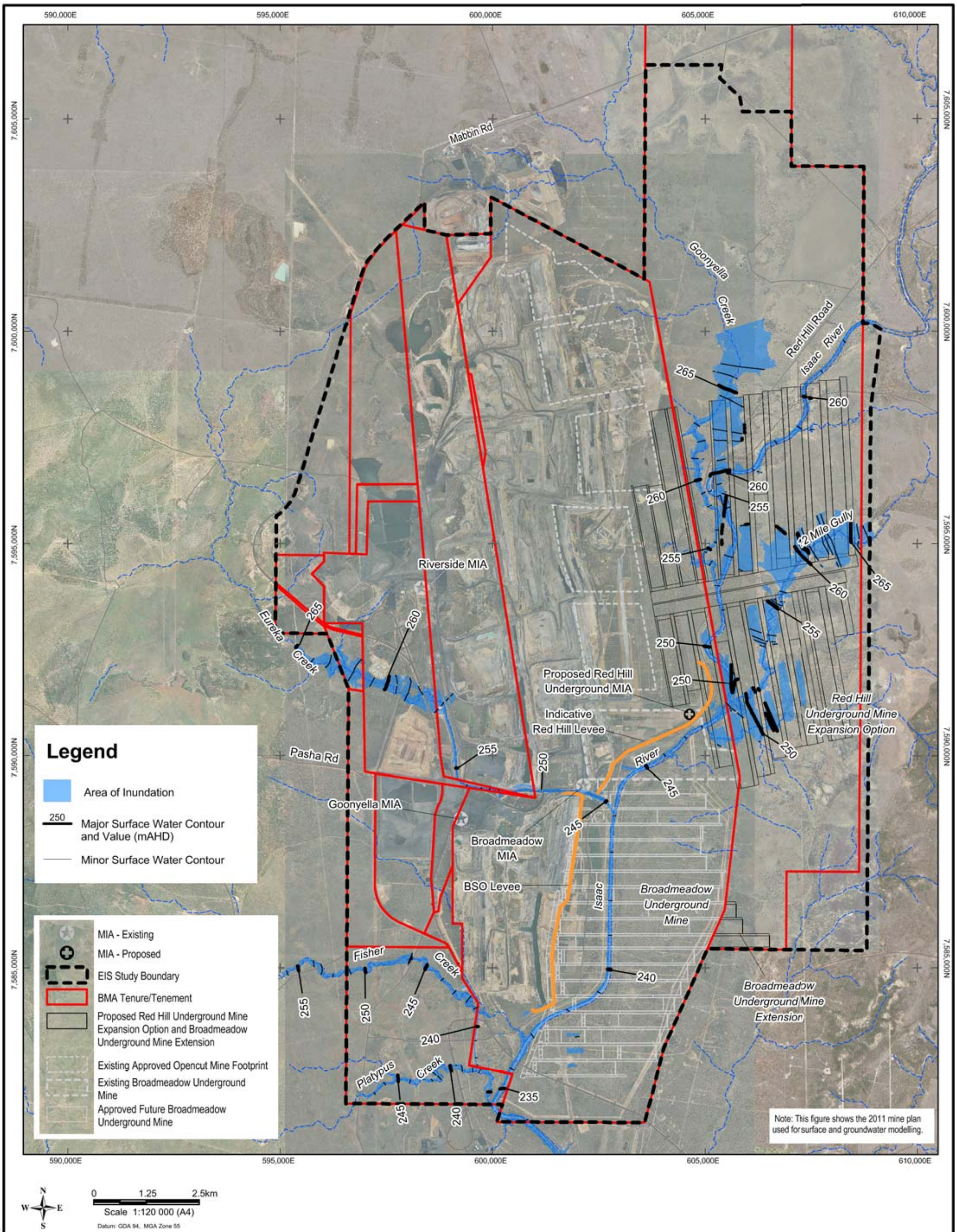
URS

SURFACE WATER

Appendix G-23

File No: **42627136-g-2067b.wor** Drawn: **VH** Approved: **CT** Date: **03-10-2013** Rev. **B** A4

Appendix H TUFLOW Model Results - Proposed Scenario Maps



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HYDRAULICS TECHNICAL REPORT

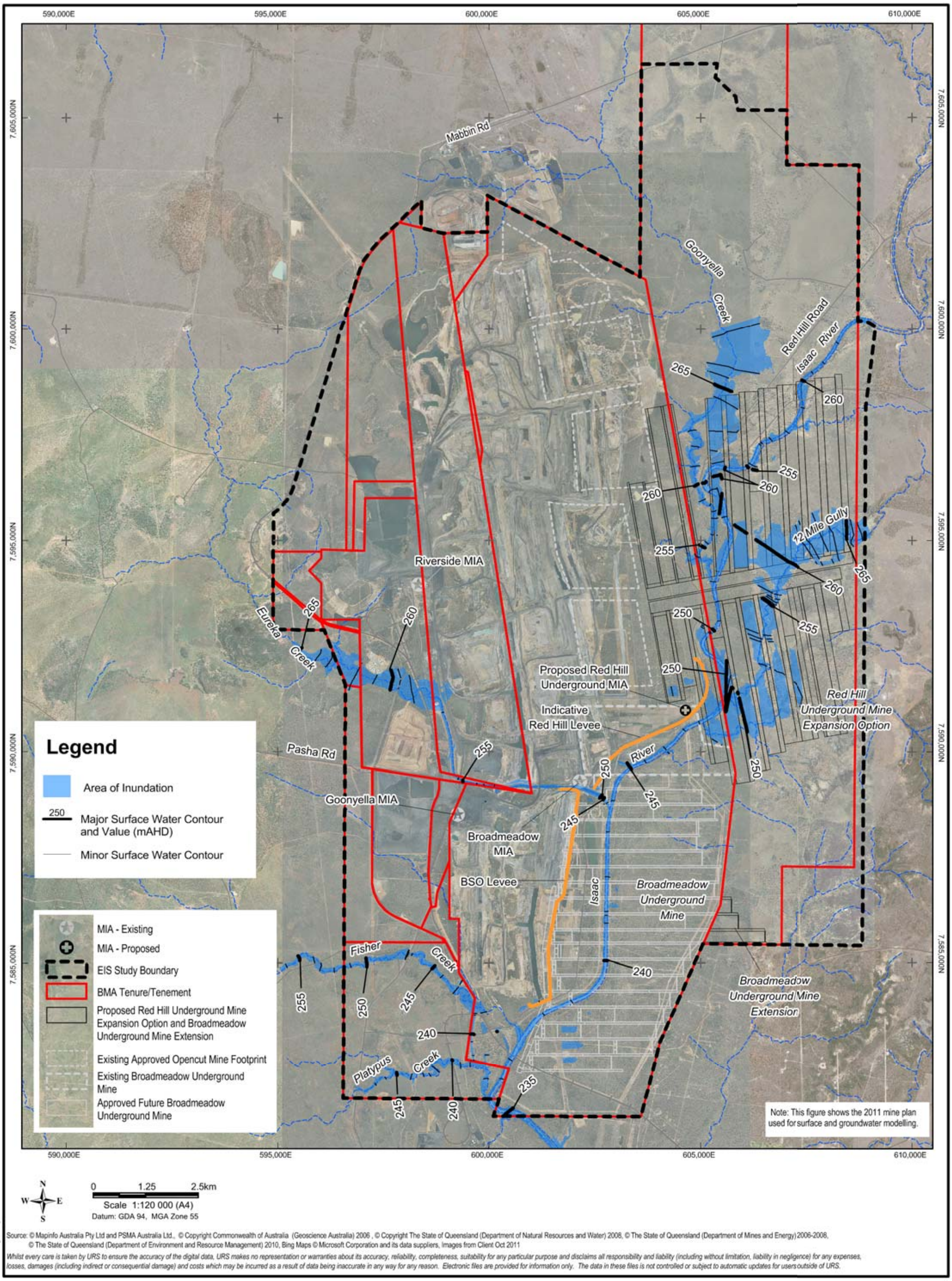
PROPOSED 1:10 AEP WATER SURFACE ELEVATION

URS

SURFACE WATER

Appendix H-01

File No: **42627136-g-2114b.wor** Drawn: **VH** Approved: **CT** Date: **03-10-2013** Rev. **B** A4



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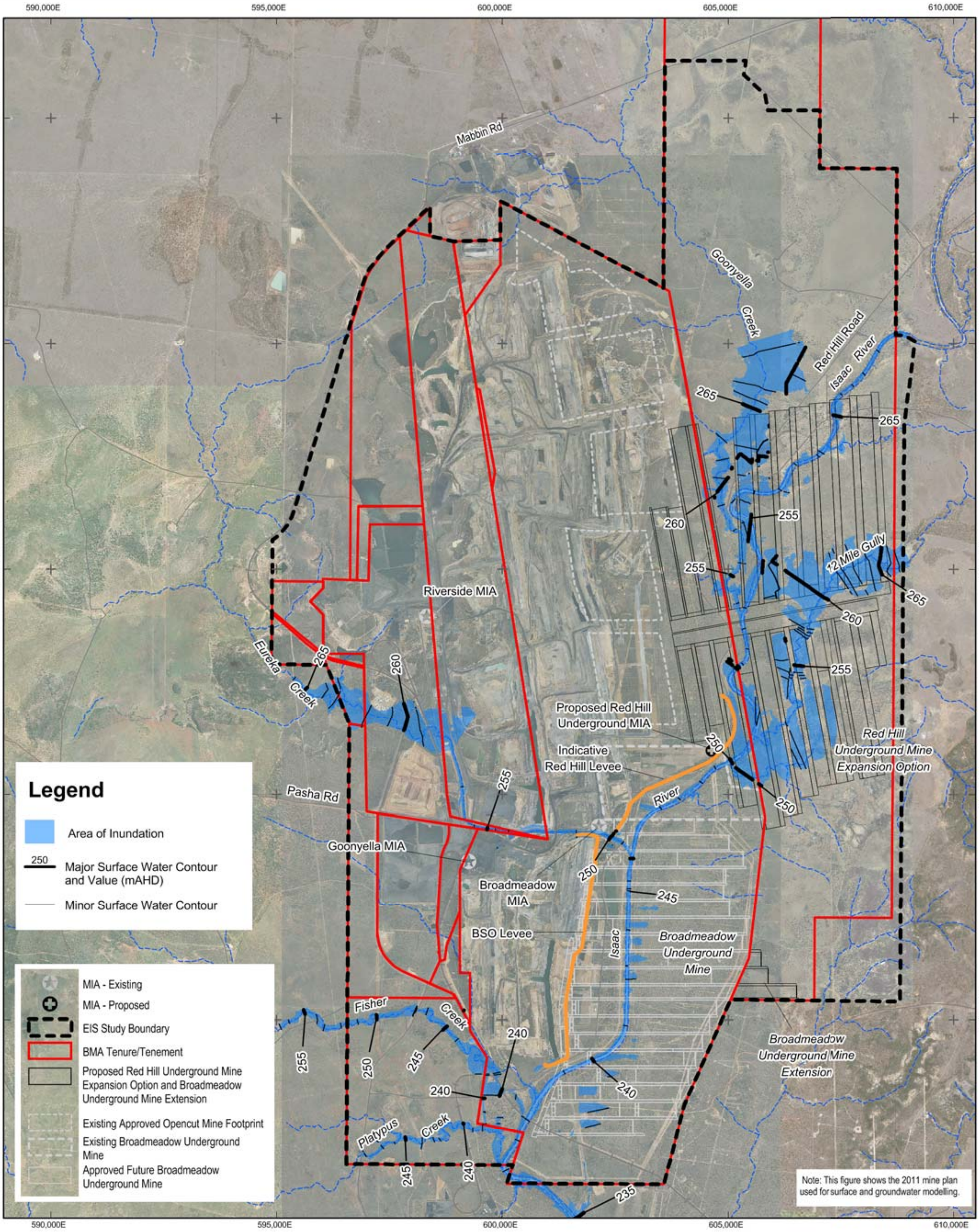
PROPOSED 1:20 AEP WATER SURFACE ELEVATION

URS

SURFACE WATER

Appendix H-02

File No: 42627136-g-2115b.wor Drawn: VH Approved: CT Date: 03-10-2013 Rev.B A4



N W E S

0 1.25 2.5km

Scale 1:120 000 (A4)

Datum: GDA 94, MGA Zone 55

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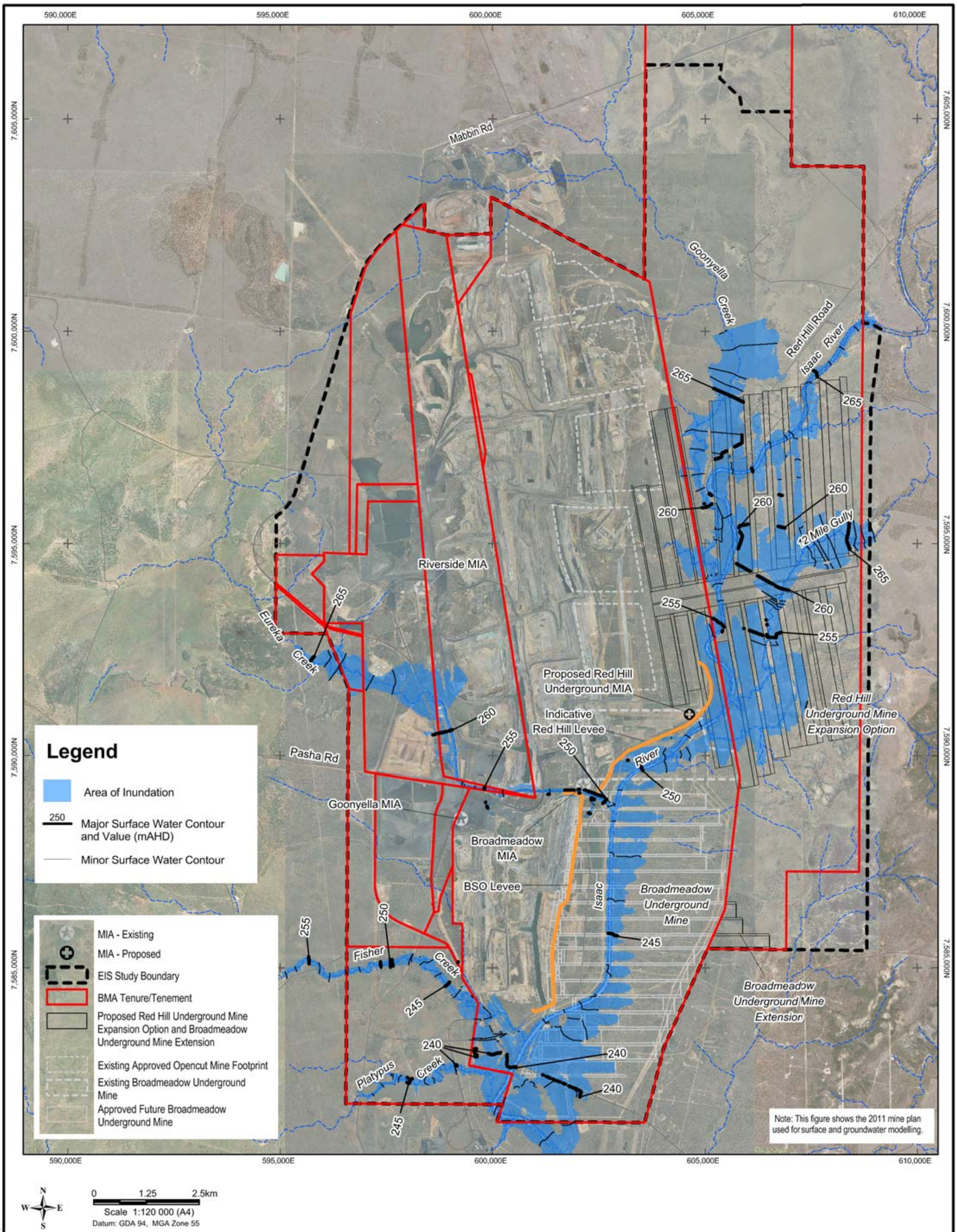
PROPOSED 1:50 AEP WATER SURFACE ELEVATION

URS

SURFACE WATER

Appendix H-03

File No: **42627136-g-2116b.wor** Drawn: **VH** Approved: **CT** Date: **03-10-2013** Rev.**B** A4



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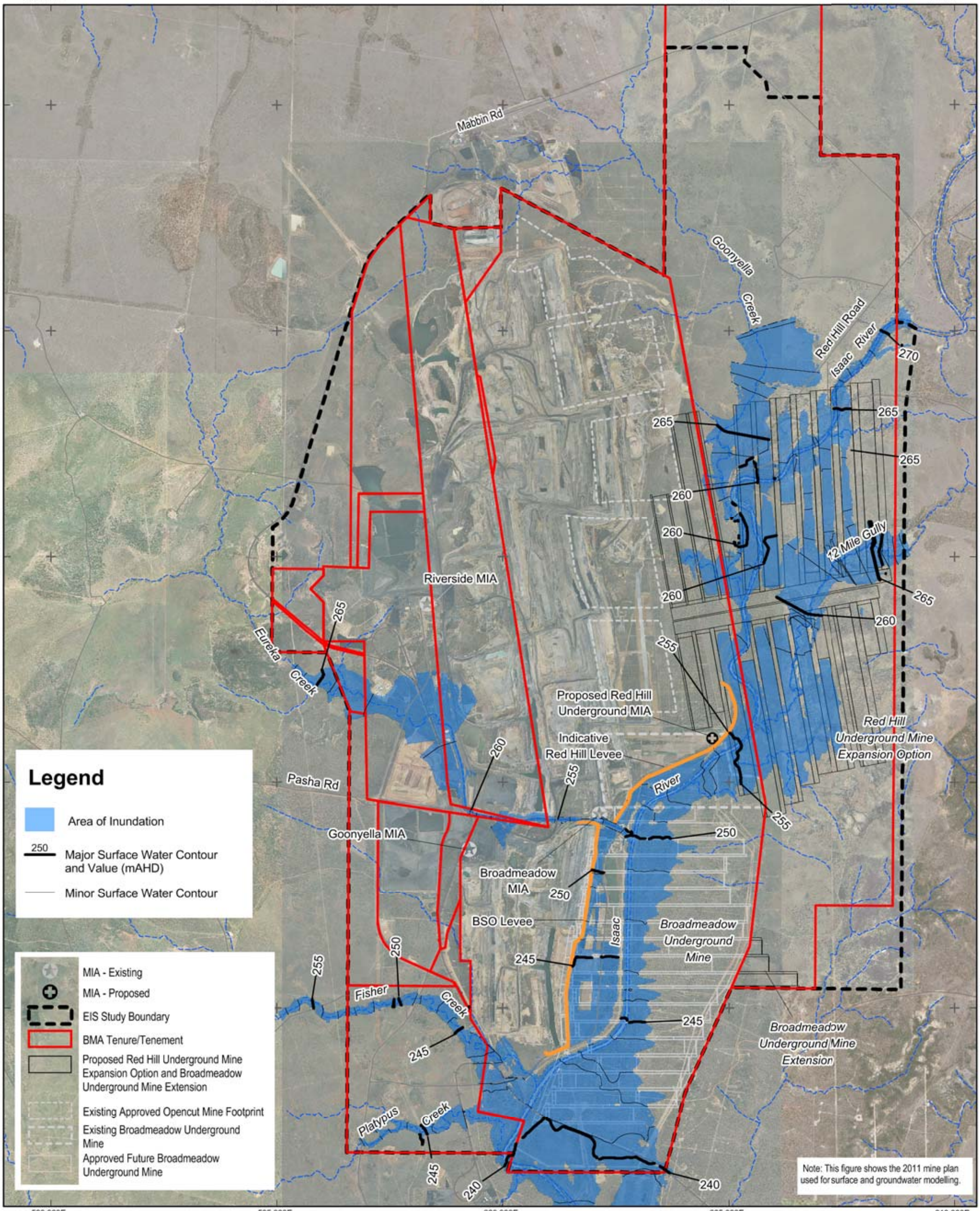
PROPOSED 1:100 AEP WATER SURFACE ELEVATION

URS

SURFACE WATER

Appendix H-04

File No: **42626730-g-2072b.wor** Drawn: **VH** Approved: **MP** Date: **03-10-2013** Rev.**B** A4



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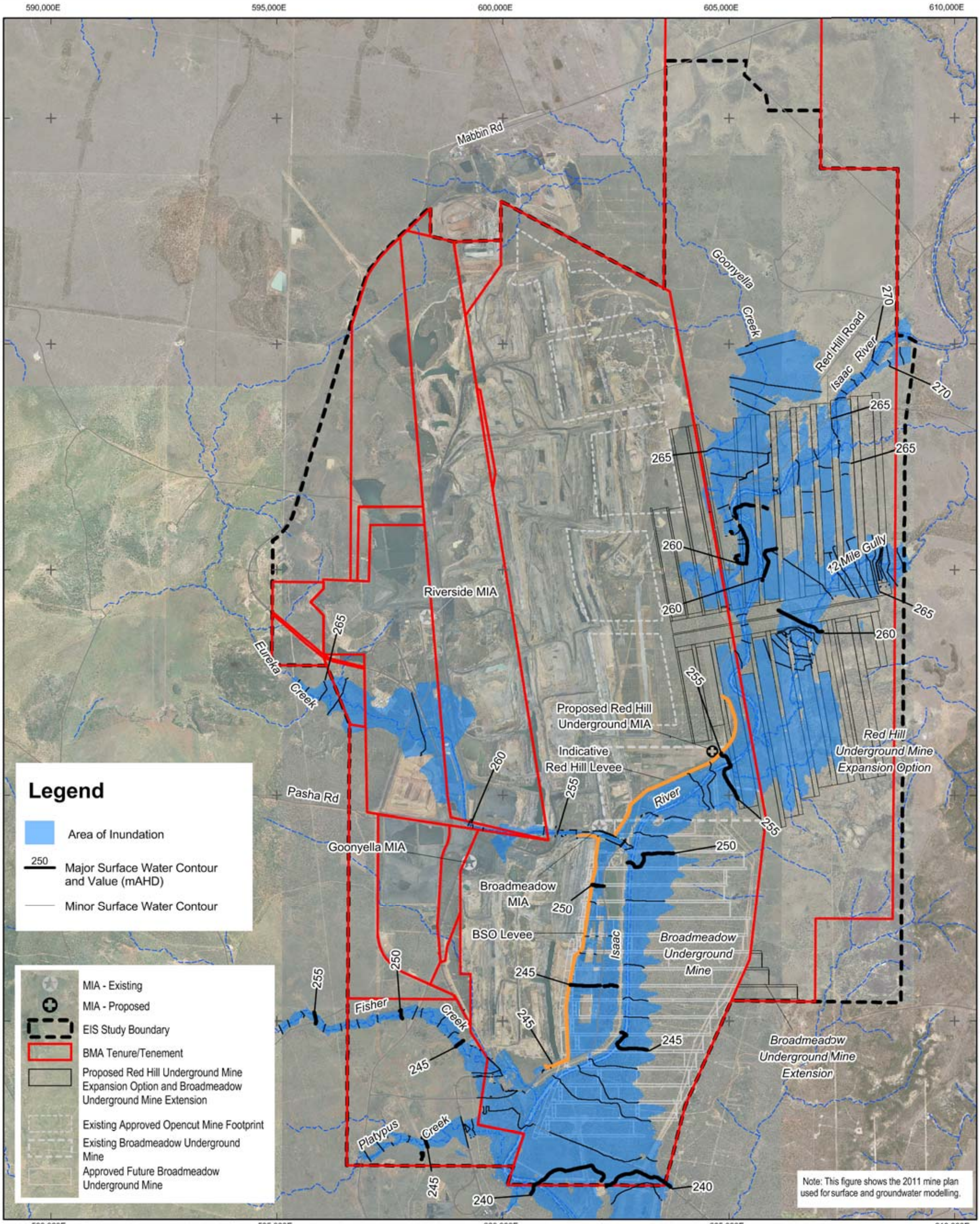
PROPOSED 1:500 AEP WATER SURFACE ELEVATION



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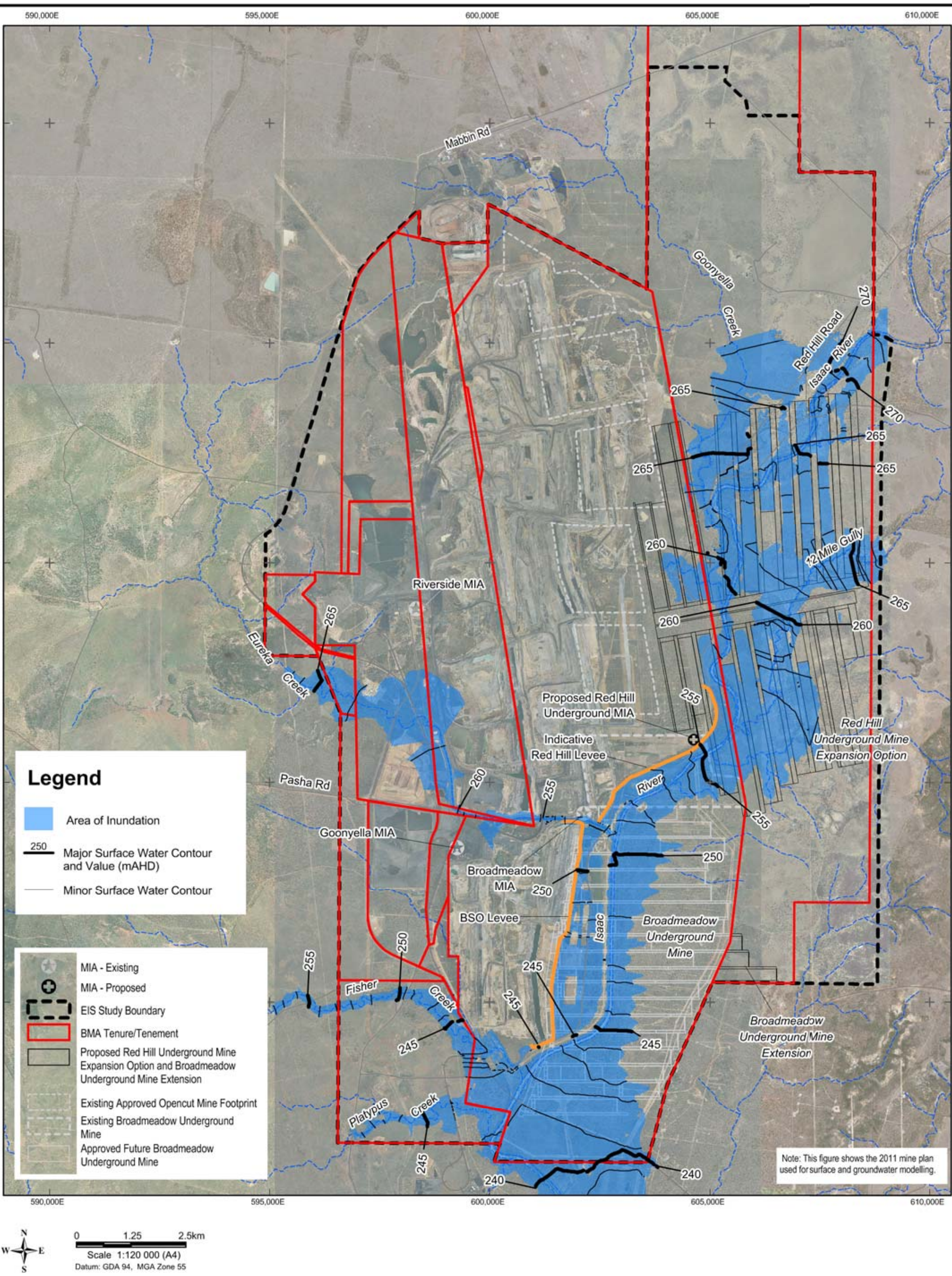
PROPOSED 1:1000 AEP WATER SURFACE ELEVATION

URS

SURFACE WATER

Appendix H-06

File No: **42627136-g-2074b.wor** Drawn: **VH** Approved: **CT** Date: **03-10-2013** Rev.**B** A4



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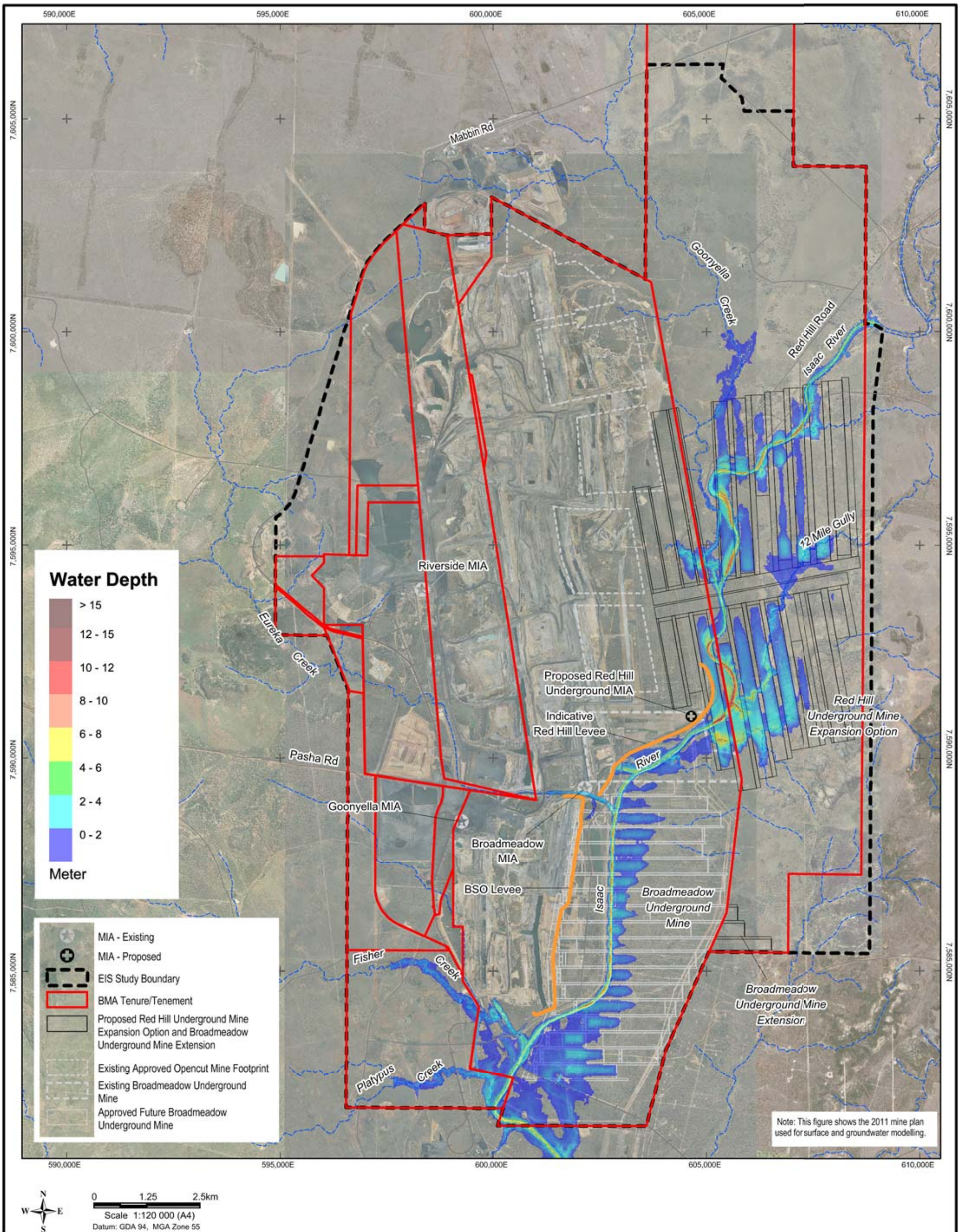
PROPOSED 1:2000 AEP WATER SURFACE ELEVATION

SURFACE WATER

Appendix H-07

File No: 42627136-g-2075b.wor | Drawn: VH | Approved: CT | Date: 03-10-2013 | Rev.B | A4



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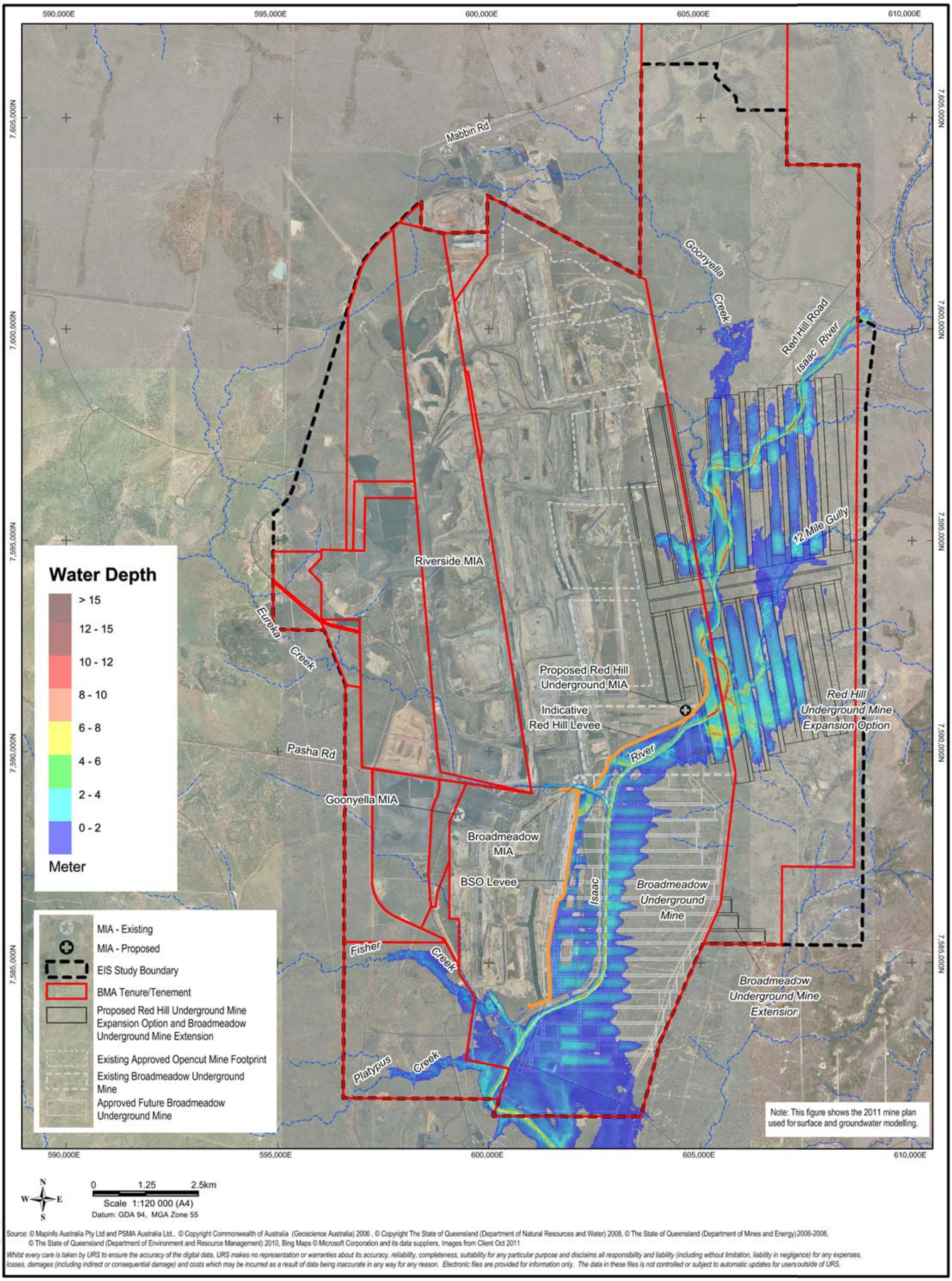
PROPOSED 1:100 AEP WATER DEPTH

SURFACE WATER

Appendix H-08

File No: **42627136-g-2068.wor** Drawn: **VH** Approved: **CT** Date: **24-06-2013** Rev.**A** A4



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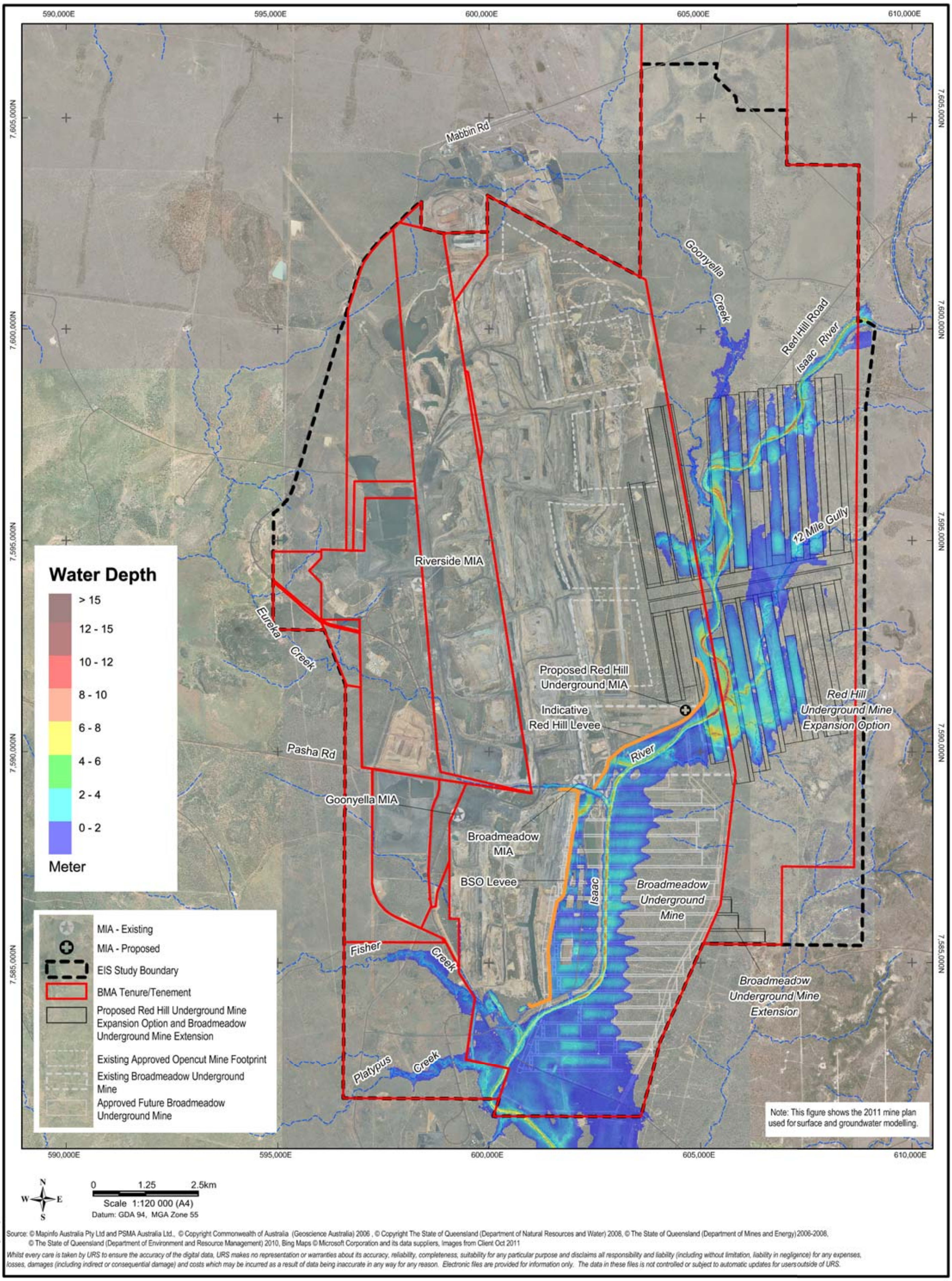
PROPOSED 1:500 AEP WATER DEPTH

URS

SURFACE WATER

Appendix H-09

File No: 42627136-g-2069.wor | Drawn: VH | Approved: CT | Date: 24-06-2013 | Rev. A | A4



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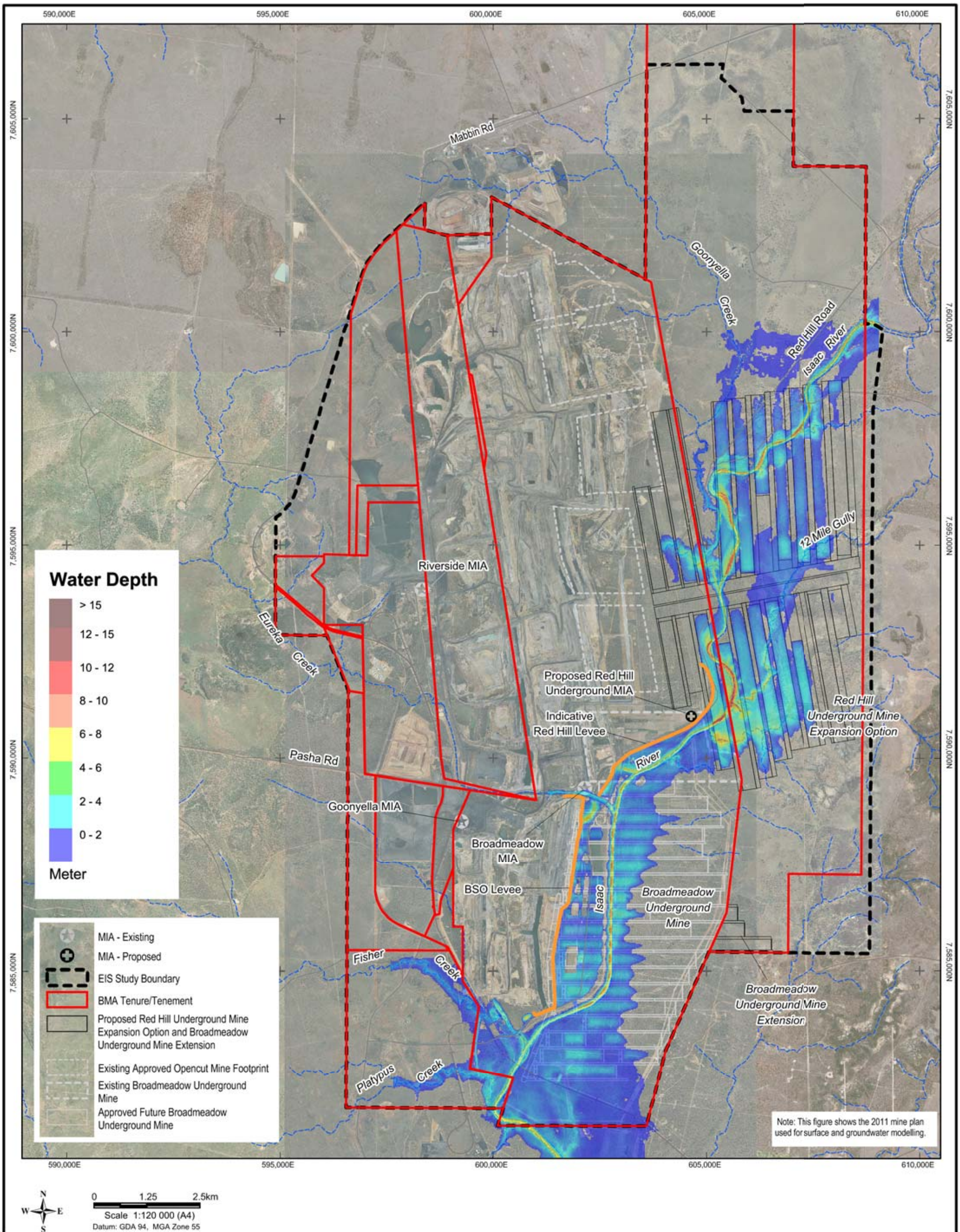
PROPOSED 1:1000 AEP WATER DEPTH

URS

SURFACE WATER

Appendix H-10

File No: **42627136-g-2070.wor** Drawn: **VH** Approved: **CT** Date: **24-06-2013** Rev. **A** A4



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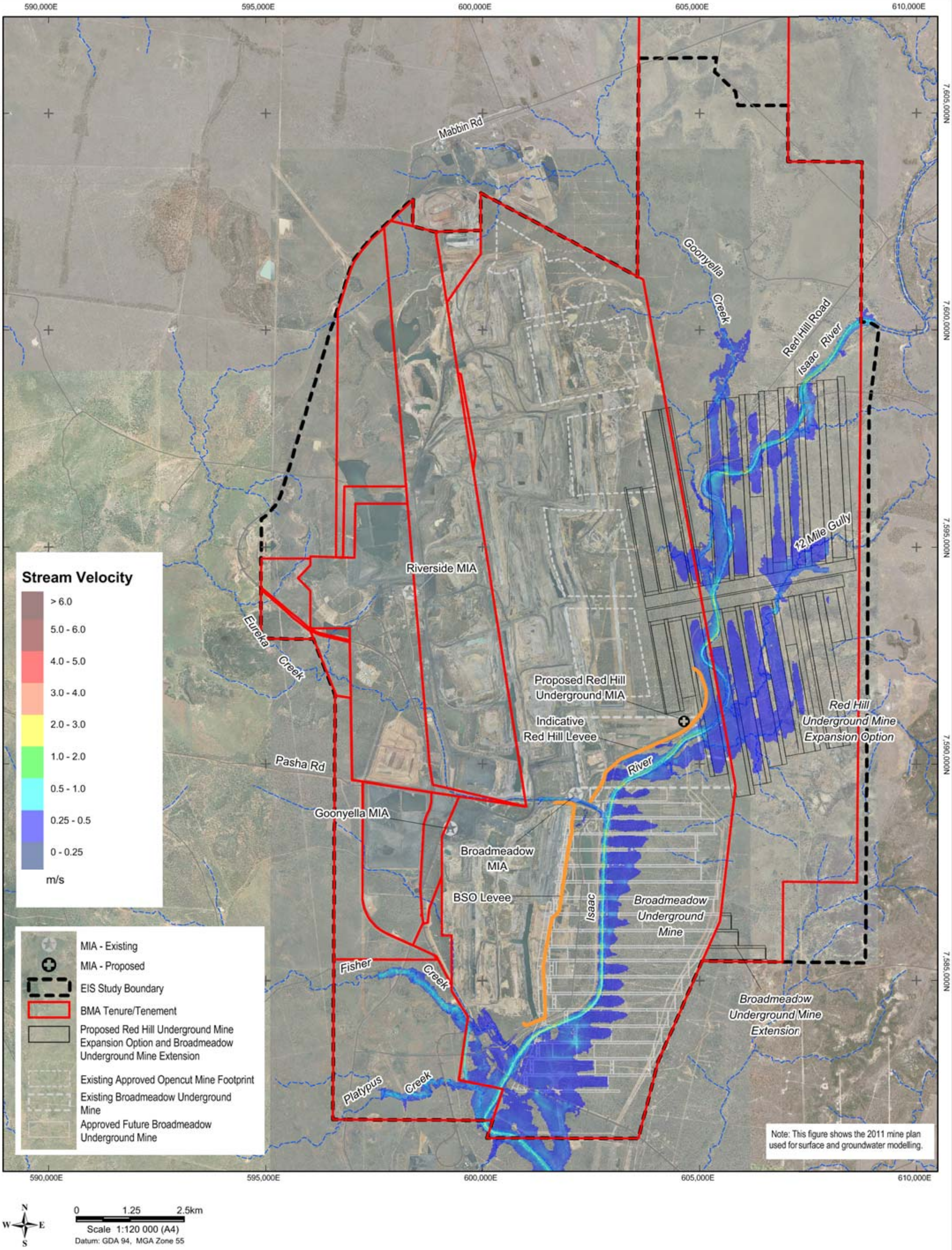
PROPOSED 1:2000 AEP WATER DEPTH

SURFACE WATER — **Appendix H-11**

File No: **42627136-g-2071.wor** Drawn: **VH** Approved: **CT** Date: **24-06-2013** Rev. **A** A4



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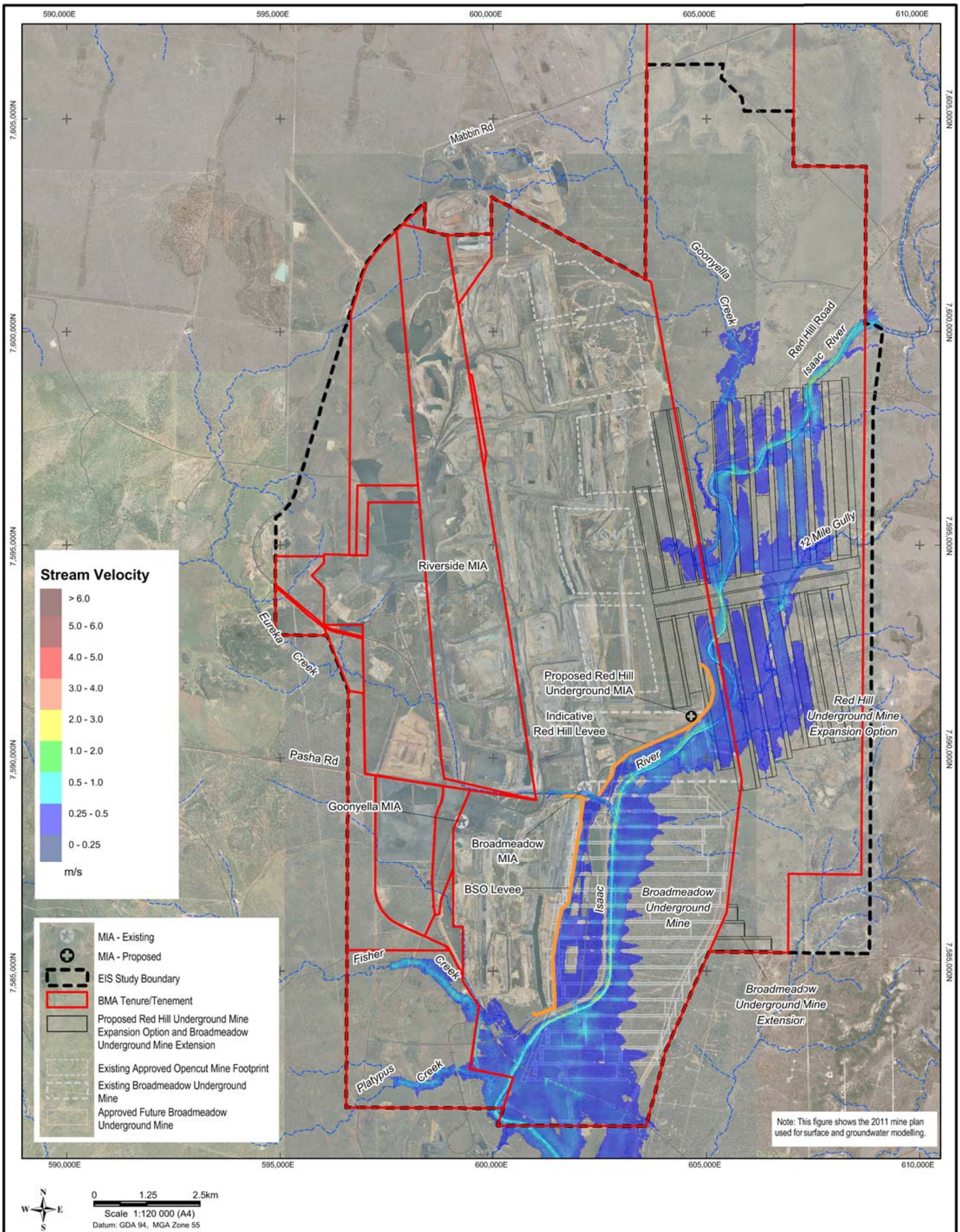
PROPOSED 1:100 AEP STREAM VELOCITY

URS

SURFACE WATER

Appendix H-12

File No: 42627136-g-2076.wor | Drawn: VH | Approved: CT | Date: 24-06-2013 | Rev.A | A4



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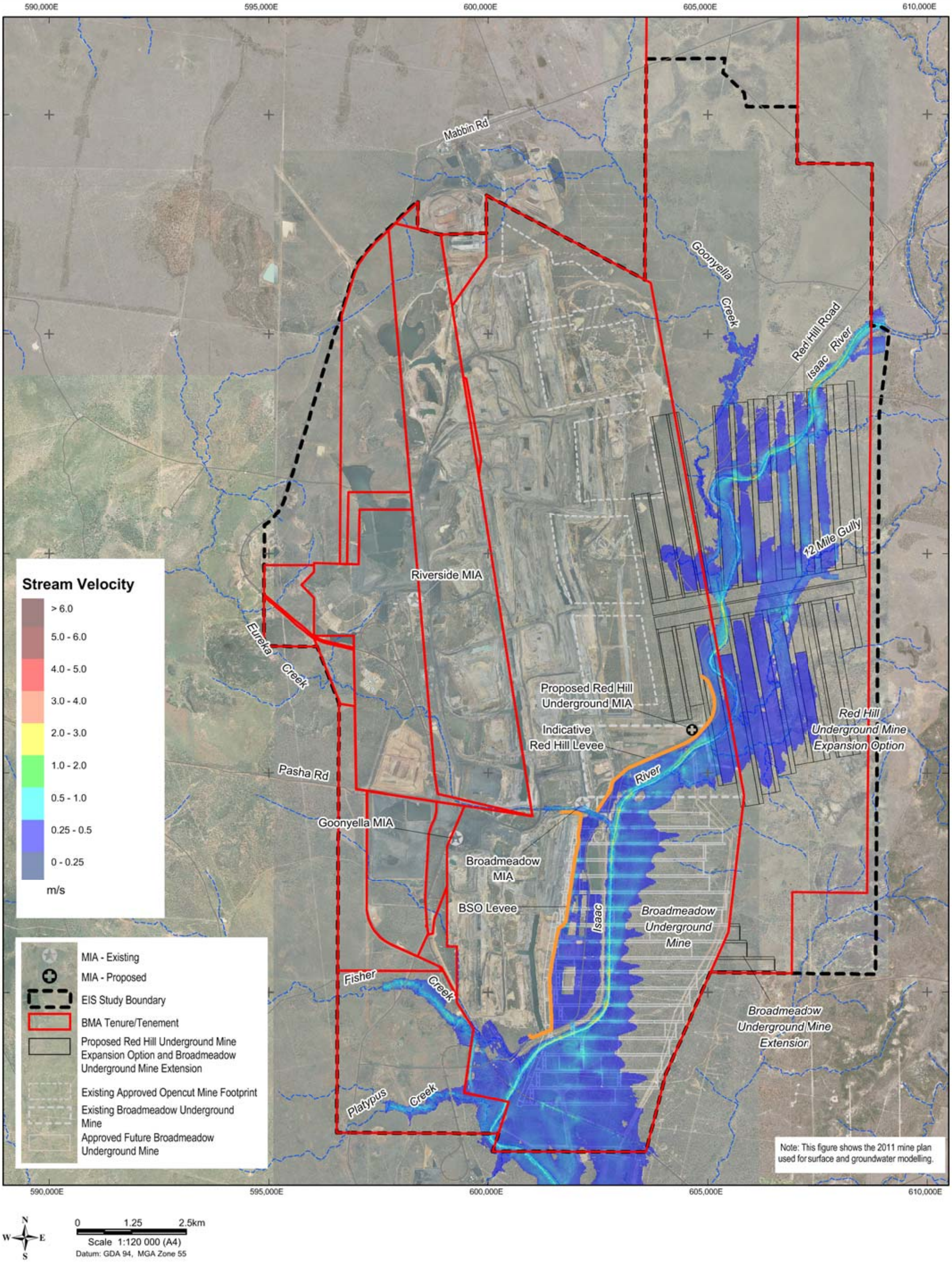
PROPOSED 1:500 AEP STREAM VELOCITY

URS

SURFACE WATER

Appendix H-13

File No: **42627136-g-2077.wor** Drawn: **VH** Approved: **CT** Date: **24-06-2013** Rev. **A** A4



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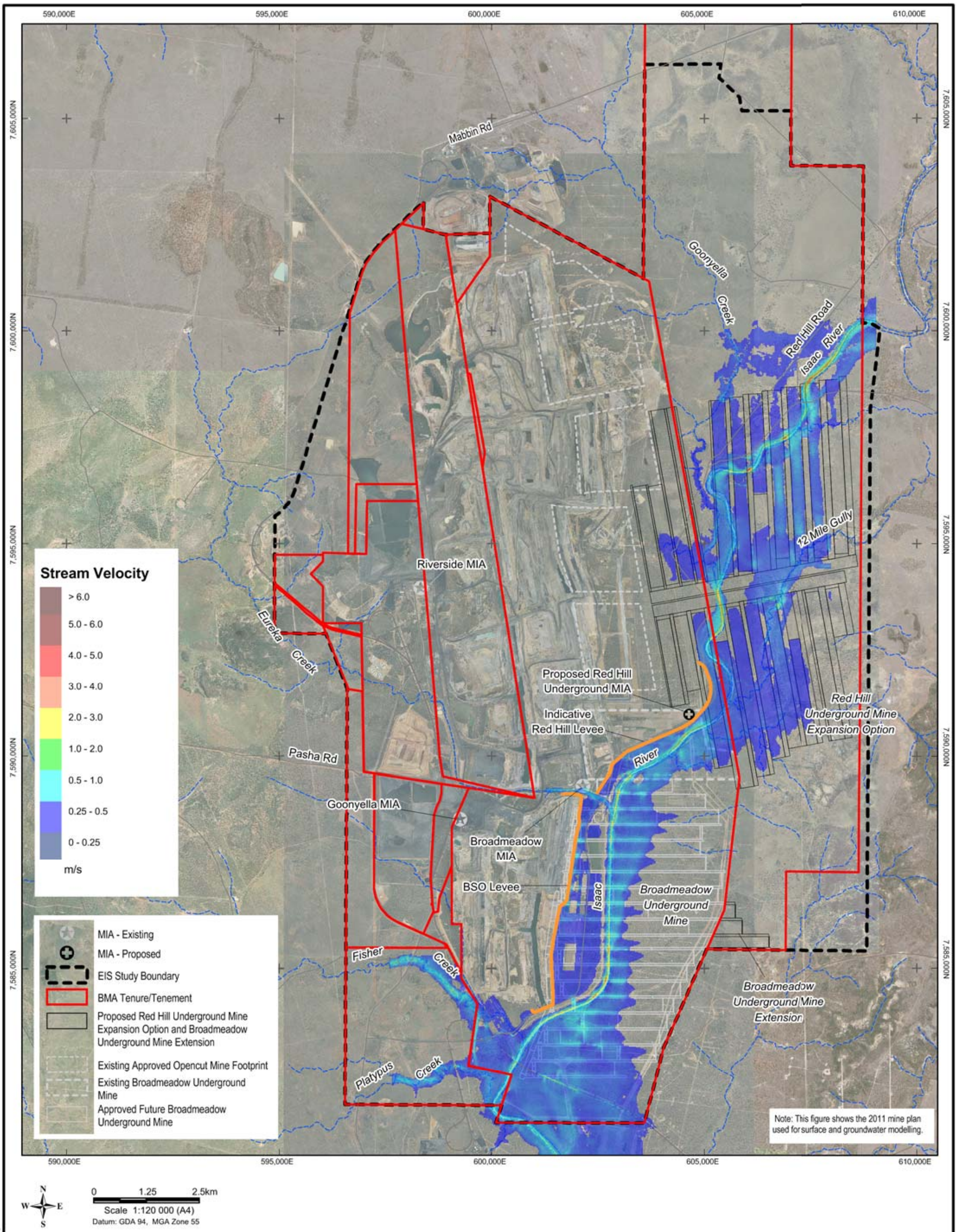
PROPOSED 1:1000 AEP STREAM VELOCITY

URS

SURFACE WATER

Appendix H-14

File No: 42627136-g-2078.wor	Drawn: VH	Approved: CT	Date: 24-06-2013	Rev. A	A4



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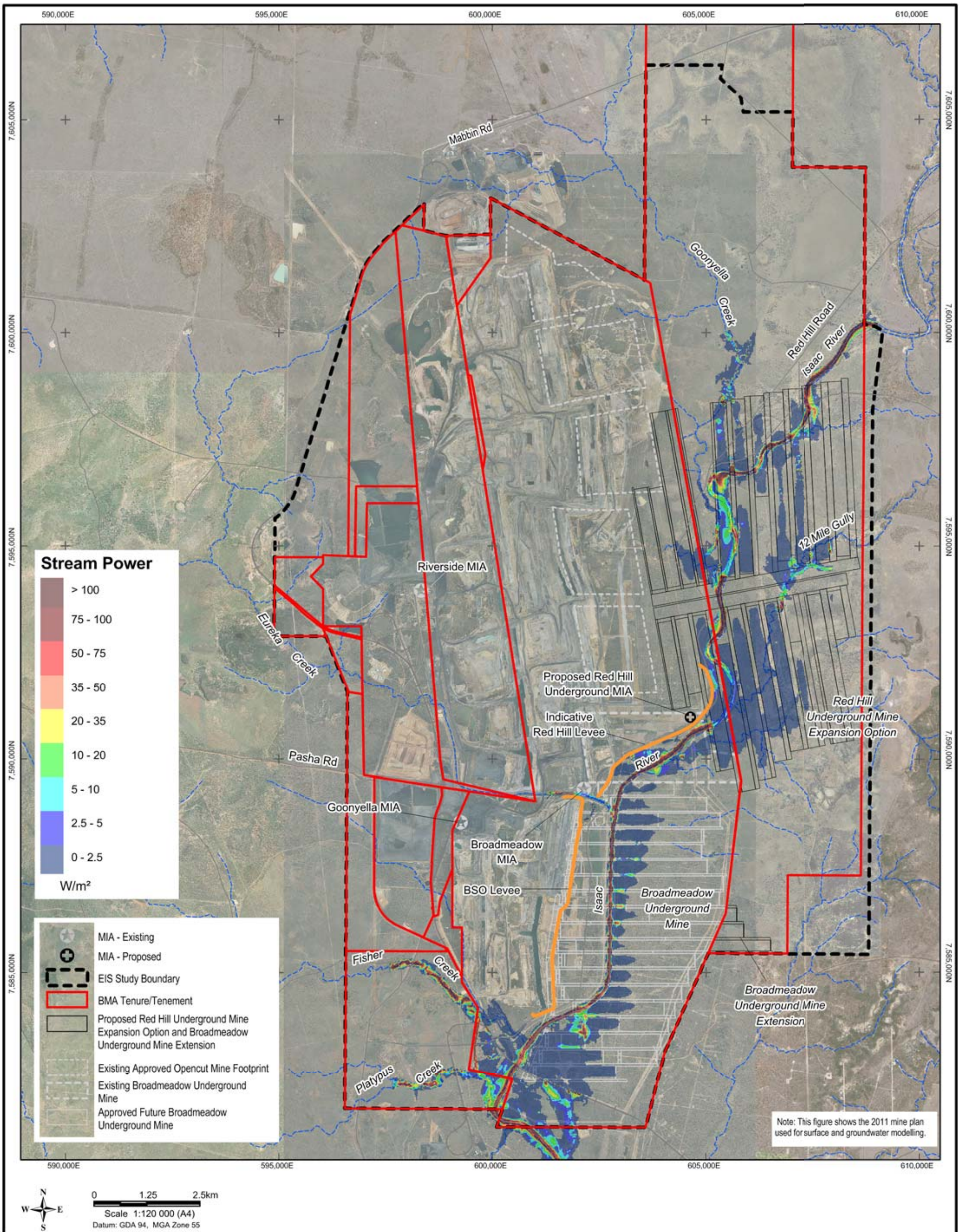
PROPOSED 1:2000 AEP STREAM VELOCITY

URS

SURFACE WATER

Appendix H-15

File No: **42627136-g-2079.wor** Drawn: **VH** Approved: **CT** Date: **24-06-2013** Rev. **A** A4



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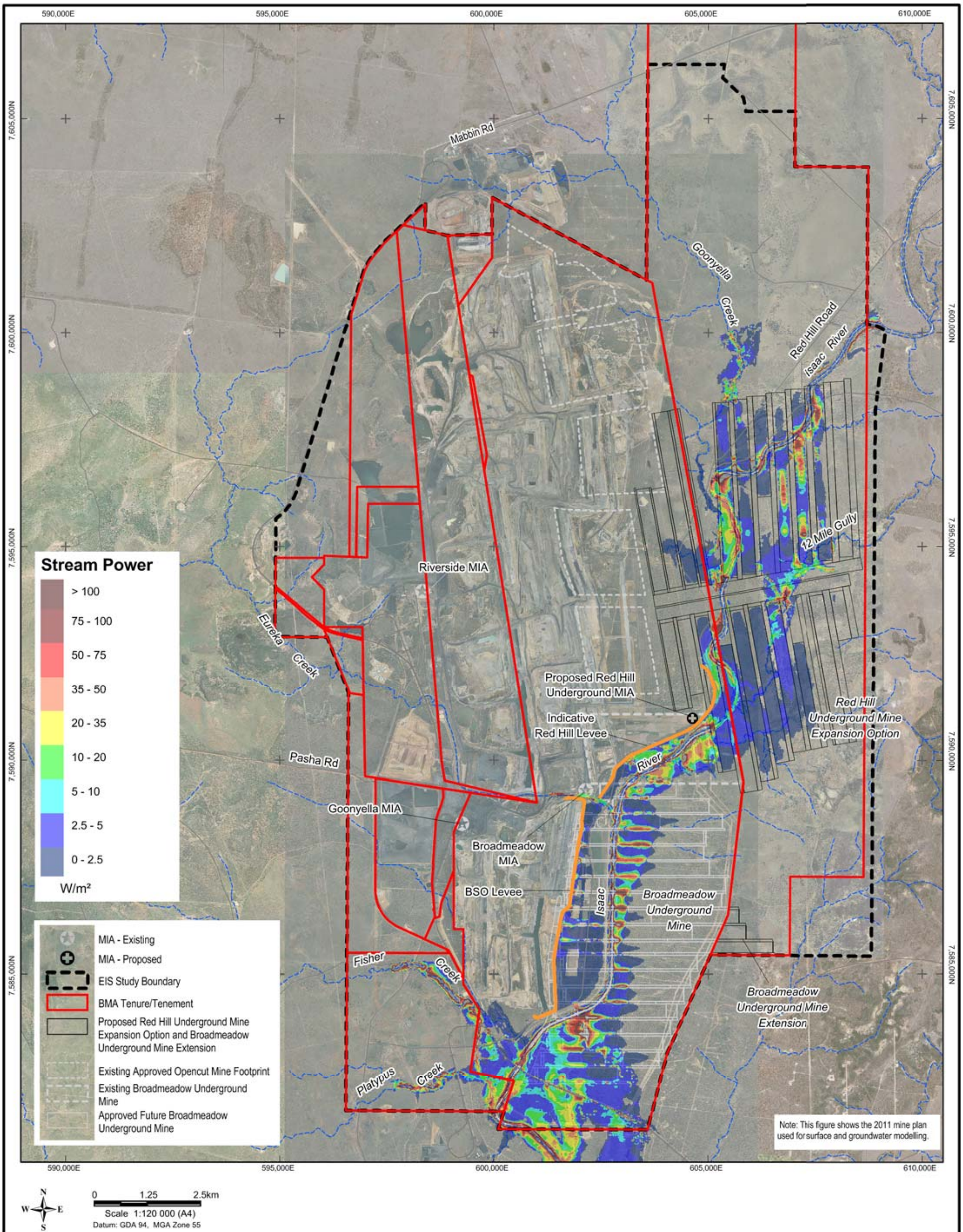
PROPOSED 1:100 AEP STREAM POWER

SURFACE WATER — **Appendix H-16**

File No: 42627136-g-2080.wor | Drawn: VH | Approved: CT | Date: 24-06-2013 | Rev. A | A4



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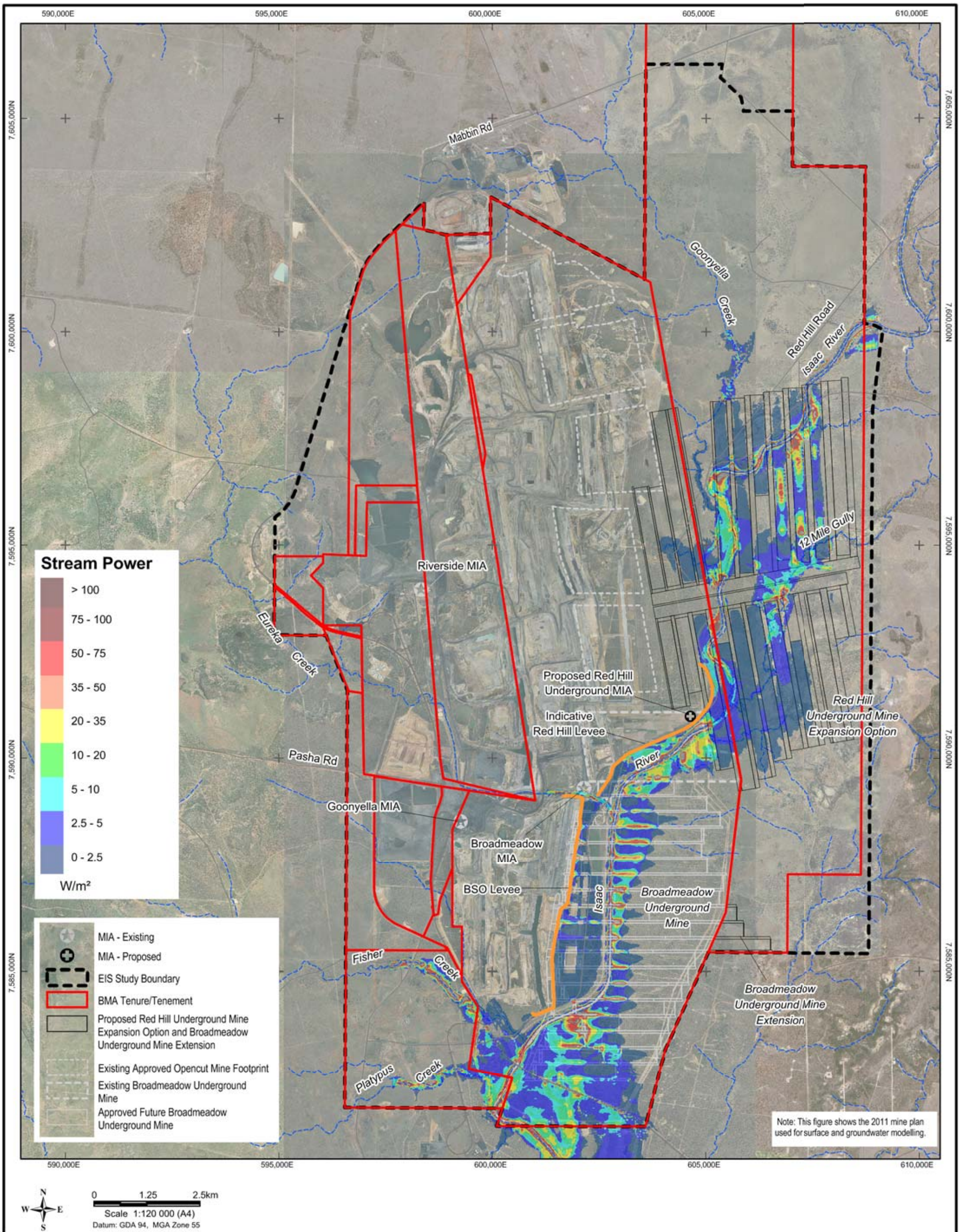
SURFACE WATER

Appendix H-17

File No: **42627136-g-2081.wor** Drawn: **VH** Approved: **CT** Date: **24-06-2013** Rev. **A** A4



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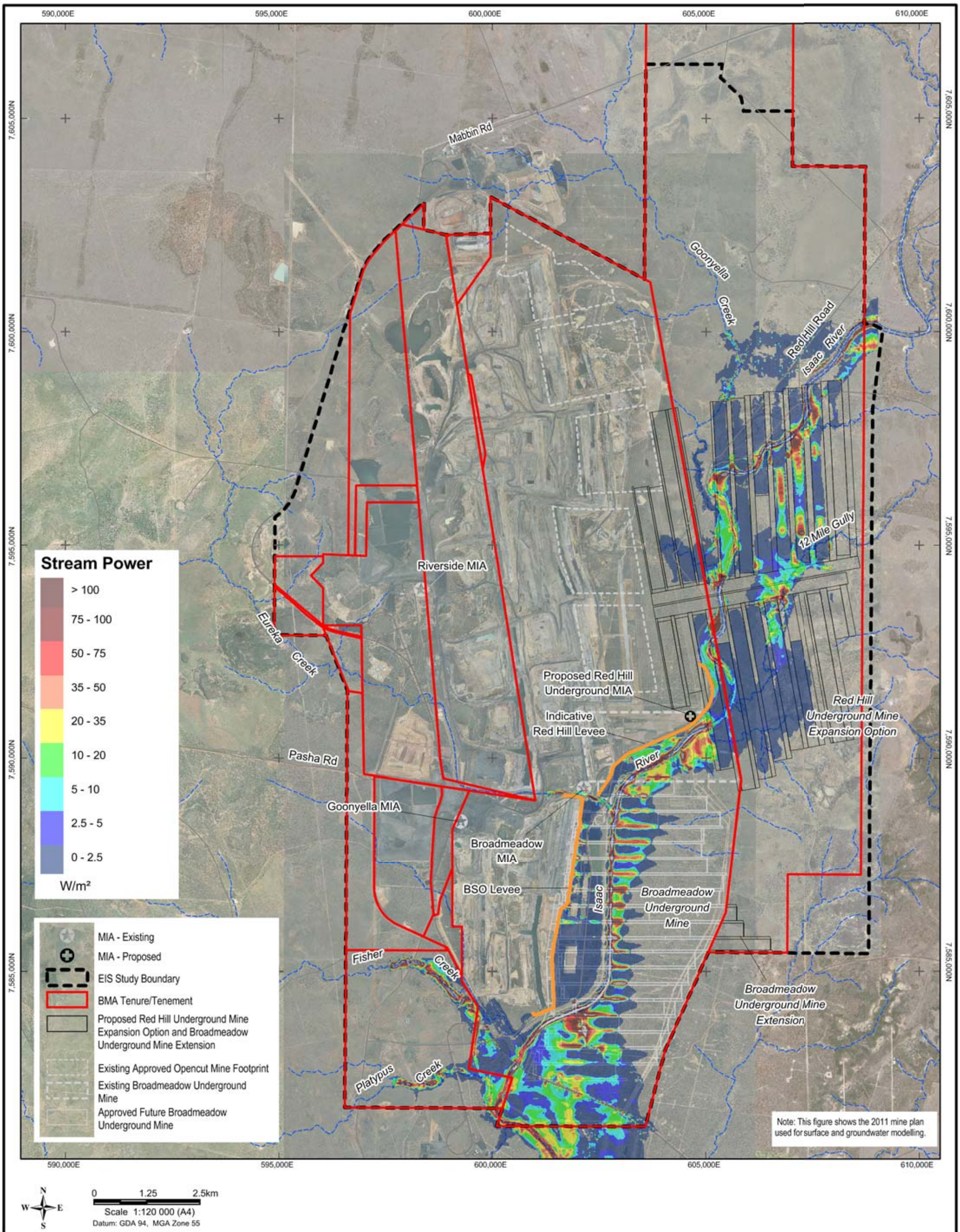
URS

SURFACE WATER

Appendix H-18

File No: 42627136-g-2082.wor | Drawn: VH | Approved: CT | Date: 24-06-2013 | Rev. A | A4



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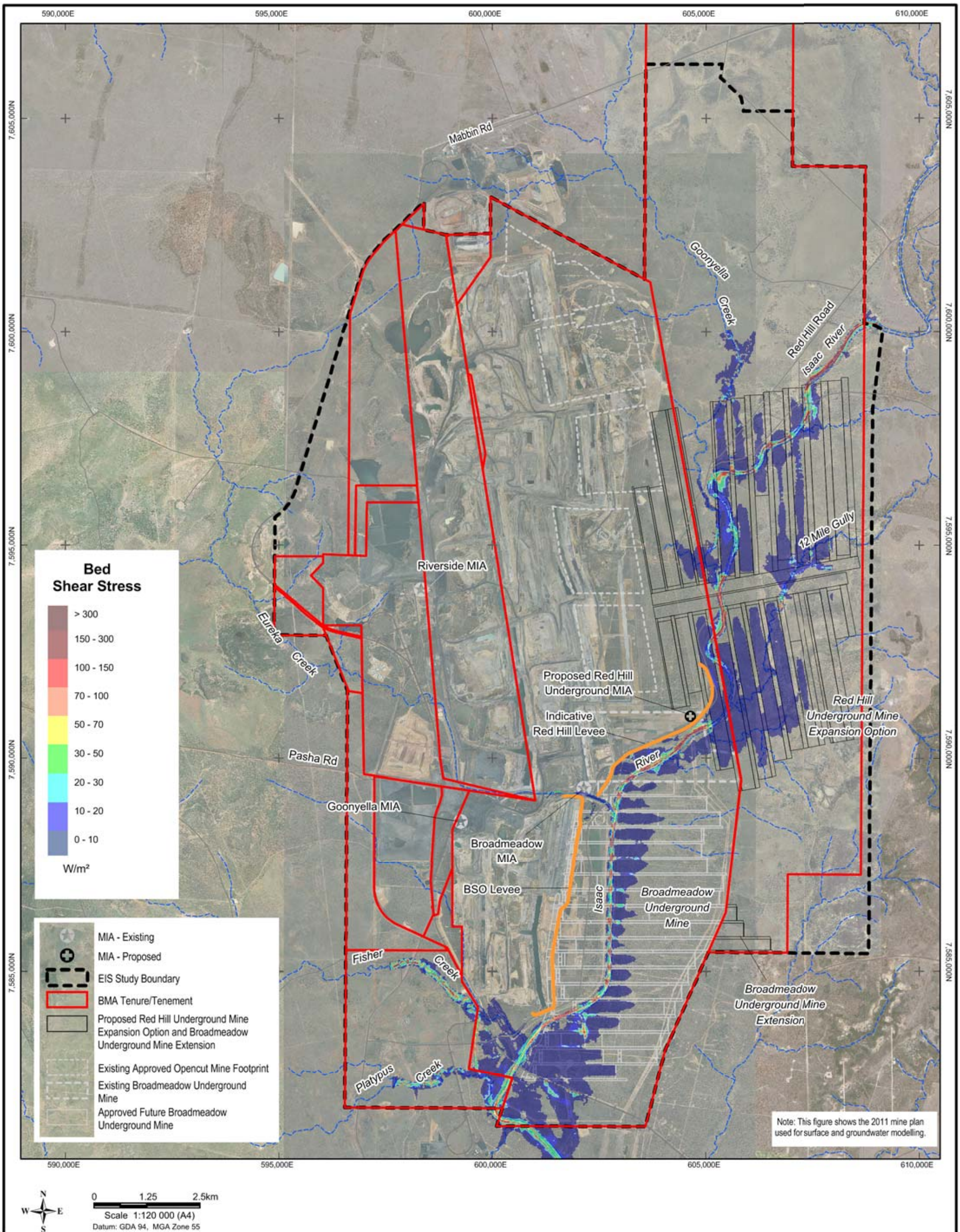
URS

SURFACE WATER

Appendix H-19

File No: **42627136-g-2083.wor** Drawn: **VH** Approved: **CT** Date: **24-06-2013** Rev.**A** A4



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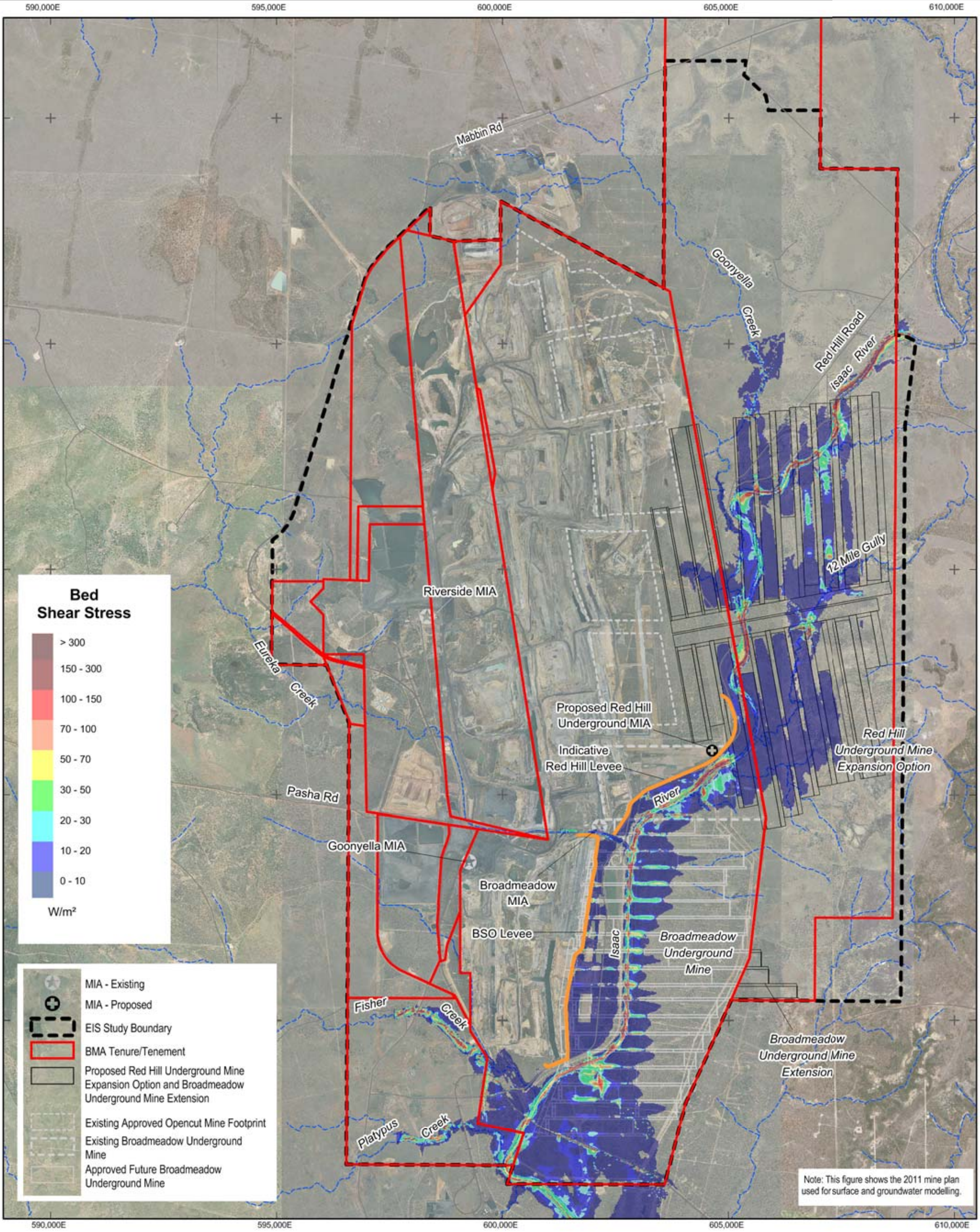
URS

SURFACE WATER

Appendix H-20

File No: **42627136-g-2084.wor** Drawn: **VH** Approved: **CT** Date: **24-06-2013** Rev. **A** A4



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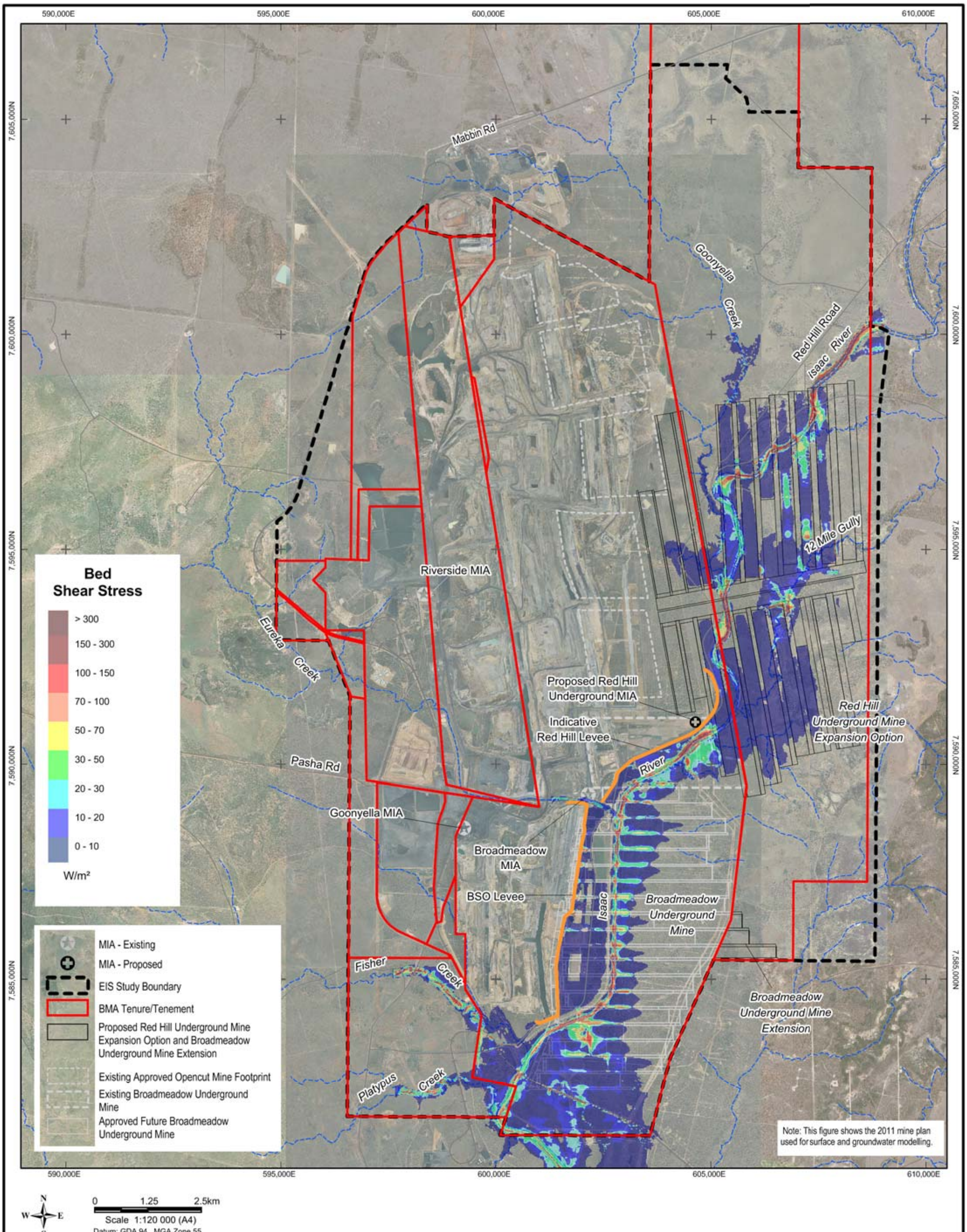
SURFACE WATER

Appendix H-21

File No: **42626730-g-2085c.wor** Drawn: **VH** Approved: **MP** Date: **08-07-2012** Rev.**C** A4



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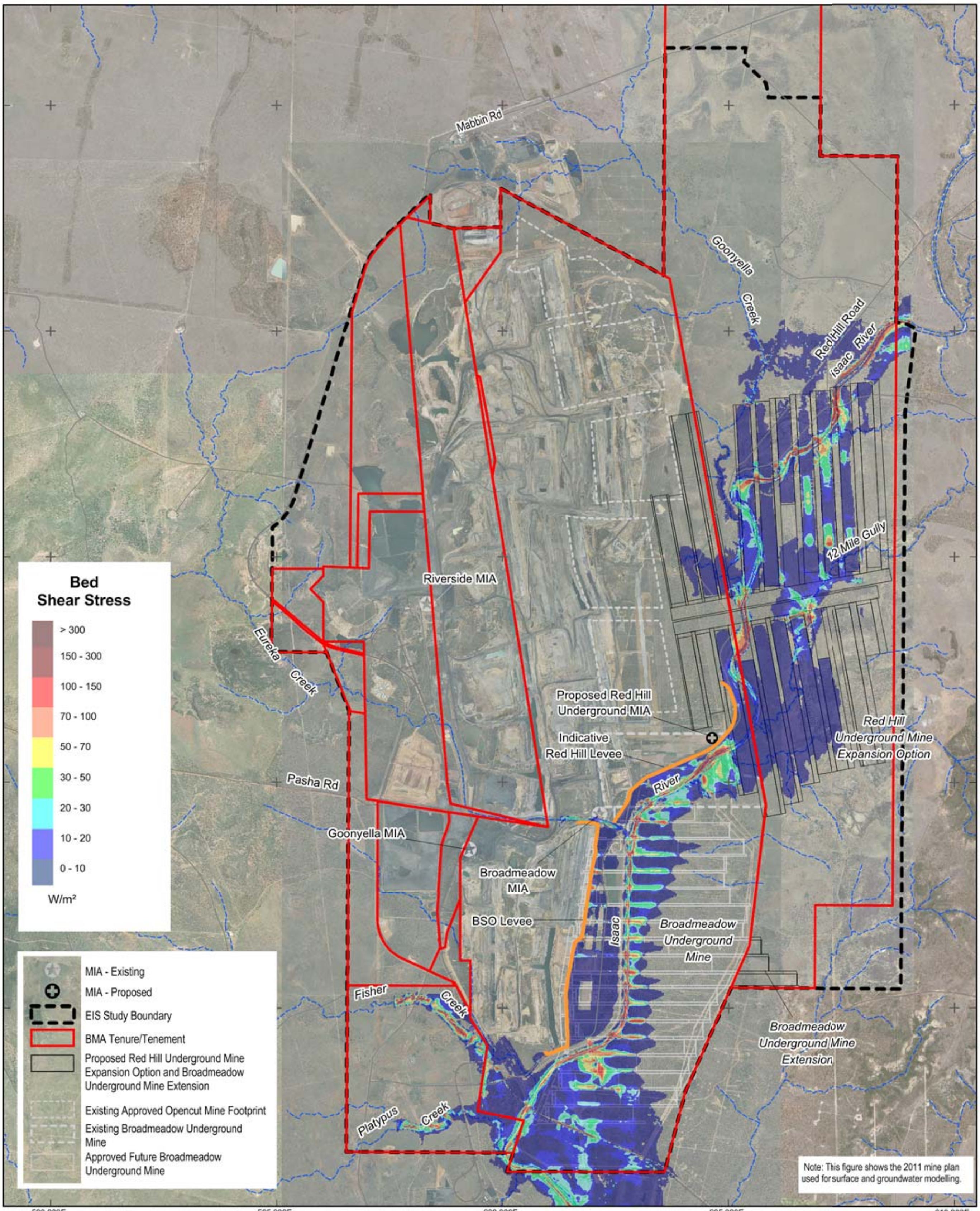
URS

SURFACE WATER

Appendix H-22

File No: 42627136-g-2086.wor Drawn: VH Approved: CP Date: 24-06-2013 Rev. A A4



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PROPOSED 1:2000 AEP BED SHEAR STRESS

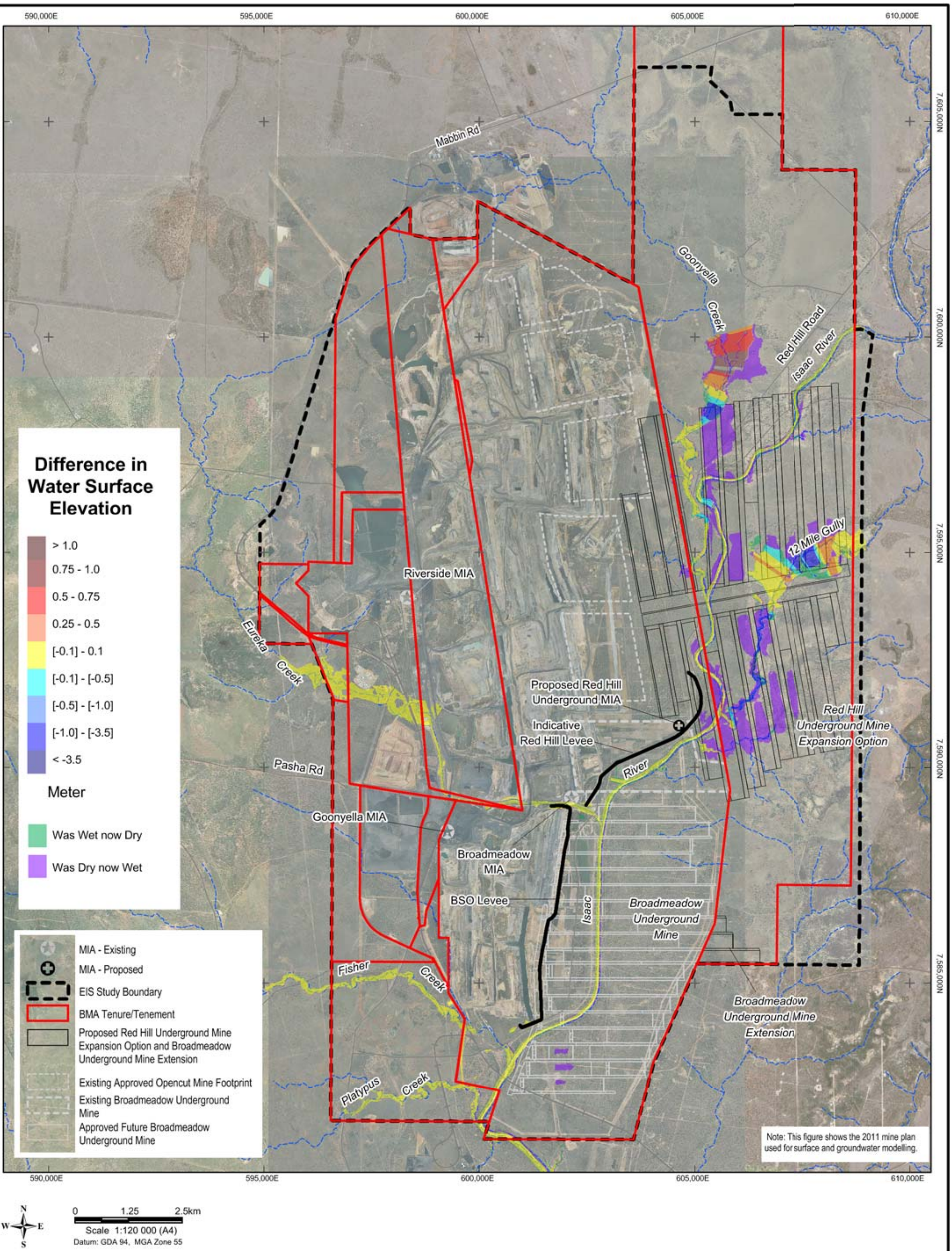
URS

SURFACE WATER

Appendix H-23

File No: **42627136-g-2087.wor** Drawn: **VH** Approved: **CT** Date: **24-06-2013** Rev. **A** A4

Appendix I TUFLOW Model Results - Difference Maps



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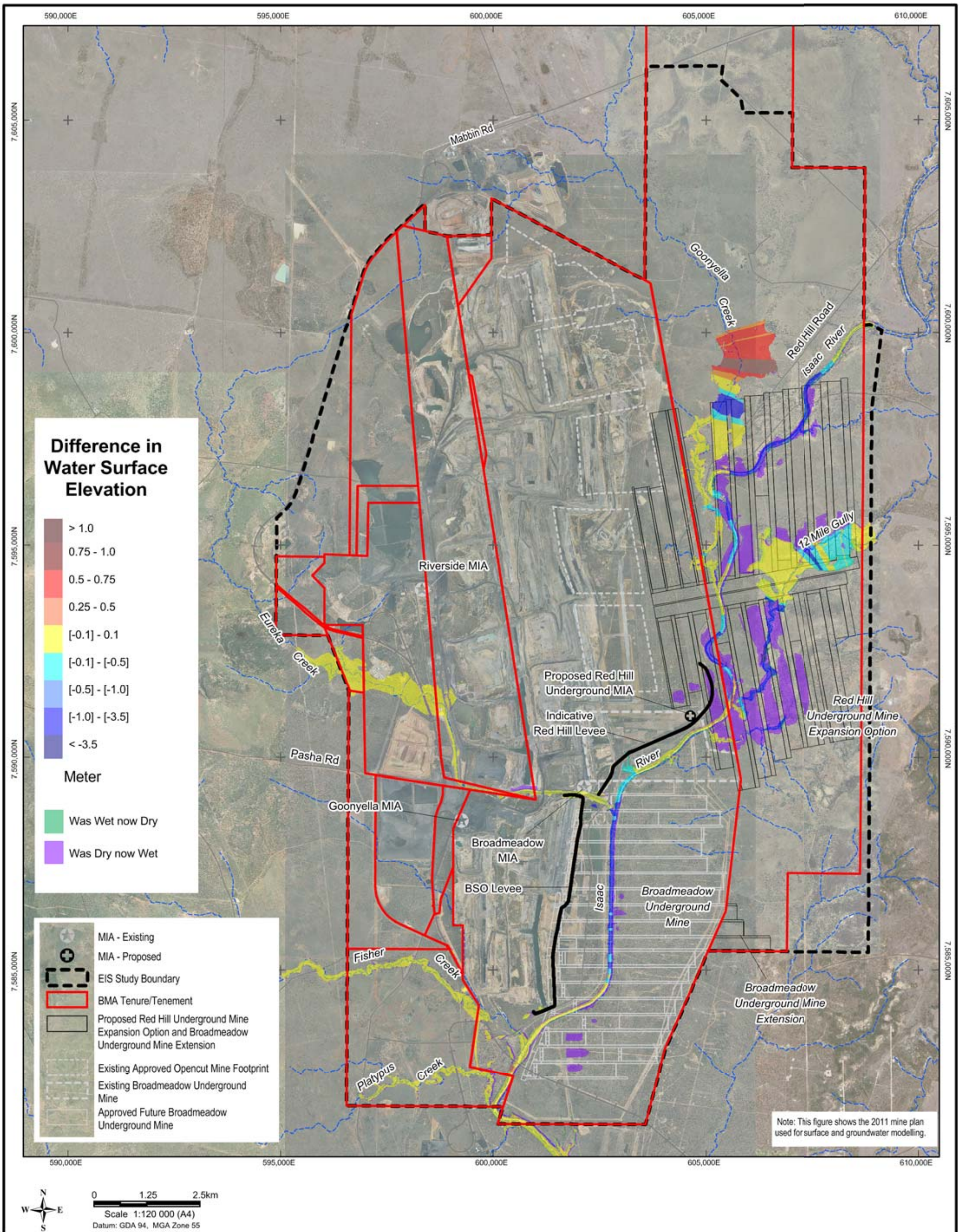
DIFFERENCE 1:10 AEP WATER SURFACE ELEVATION

URS

SURFACE WATER

Appendix I-01

File No: 42627136-g-2117.wor | Drawn: VH | Approved: CT | Date: 24-06-2013 | Rev.A | A4



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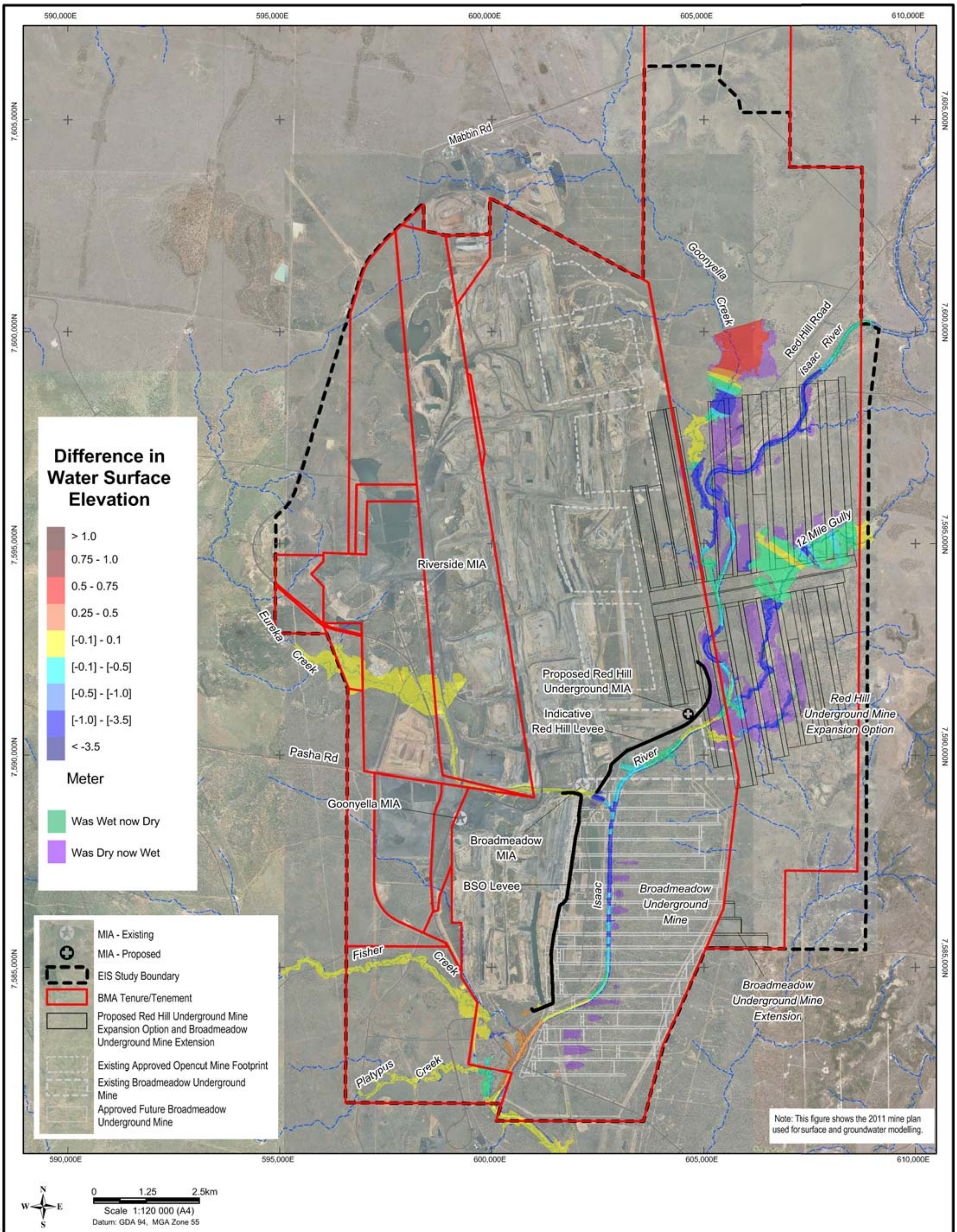
DIFFERENCE 1:20 AEP WATER SURFACE ELEVATION

URS

SURFACE WATER

Appendix I-02

File No: **42627136-g-2118.wor** Drawn: **VH** Approved: **CT** Date: **24-06-2013** Rev. **A** A4



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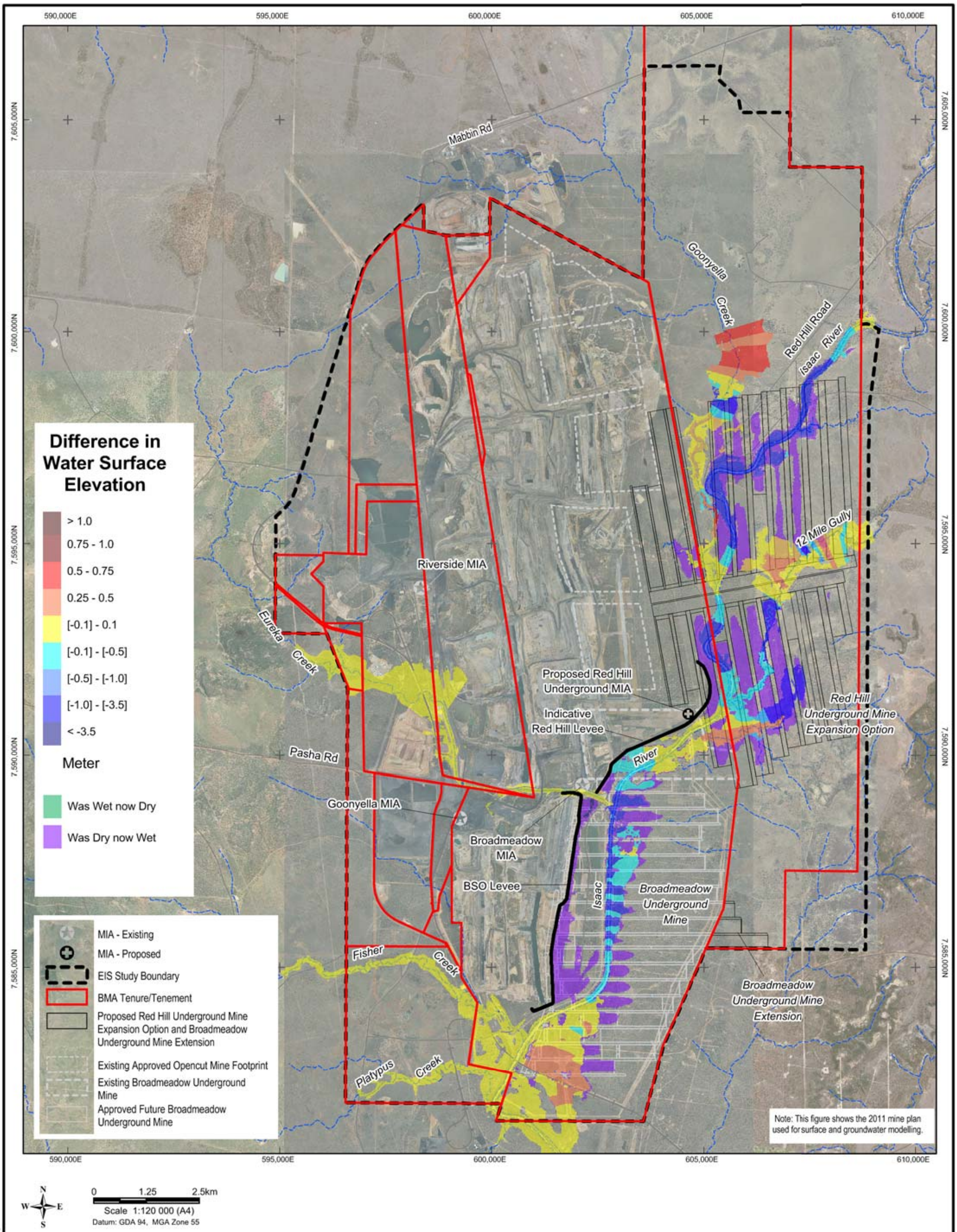
DIFFERENCE 1:50 AEP WATER SURFACE ELEVATION

URS

SURFACE WATER

Appendix I-03

File No: **42627136-g-2119.wor** Drawn: **VH** Approved: **CT** Date: **24-06-2013** Rev.**A** A4



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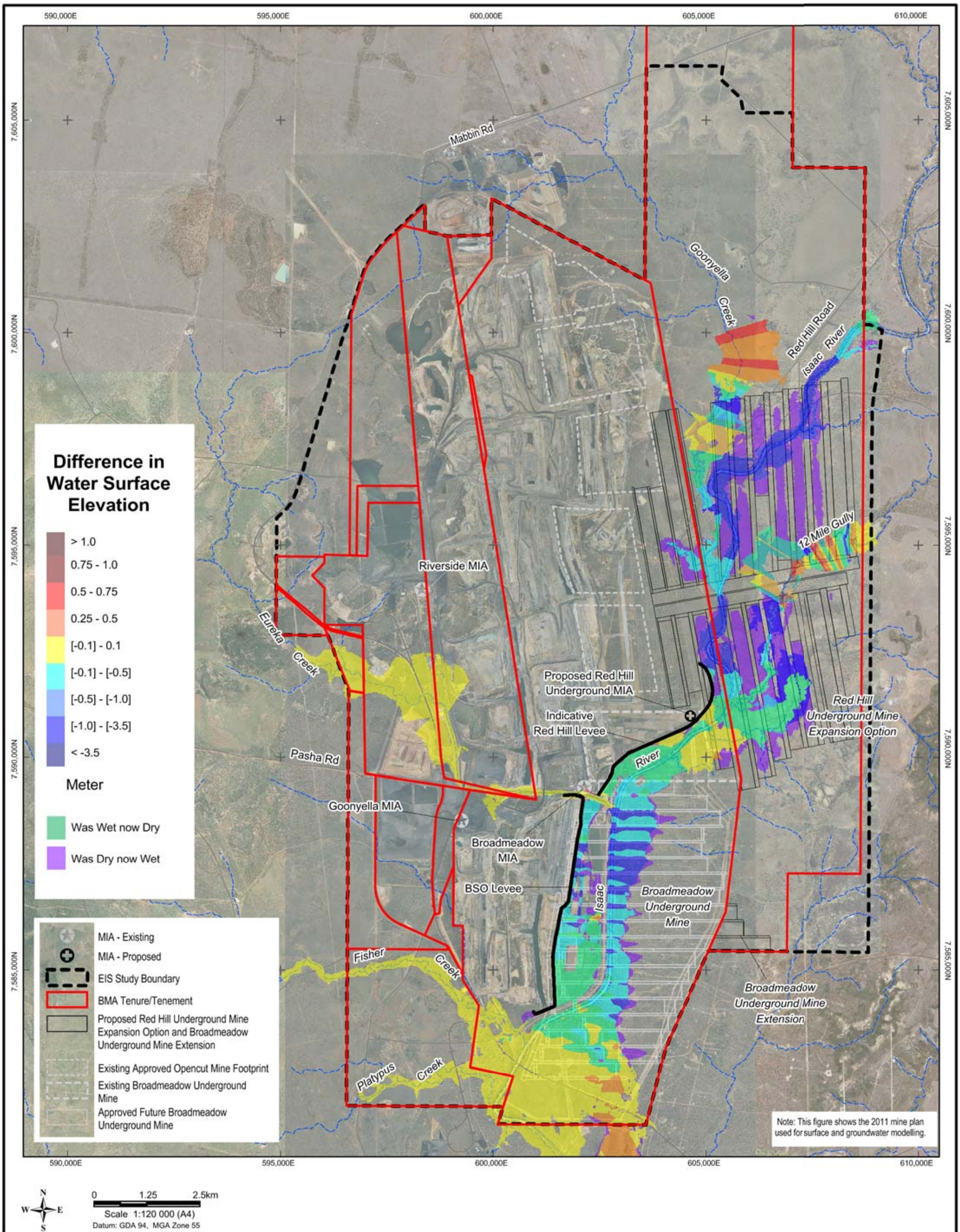
DIFFERENCE 1:100 AEP SURFACE ELEVATION

URS

SURFACE WATER | **Appendix I-04**

File No: **42627136-g-2120.wor** | Drawn: **VH** | Approved: **CT** | Date: **24-06-2013** | Rev. **A** | A4



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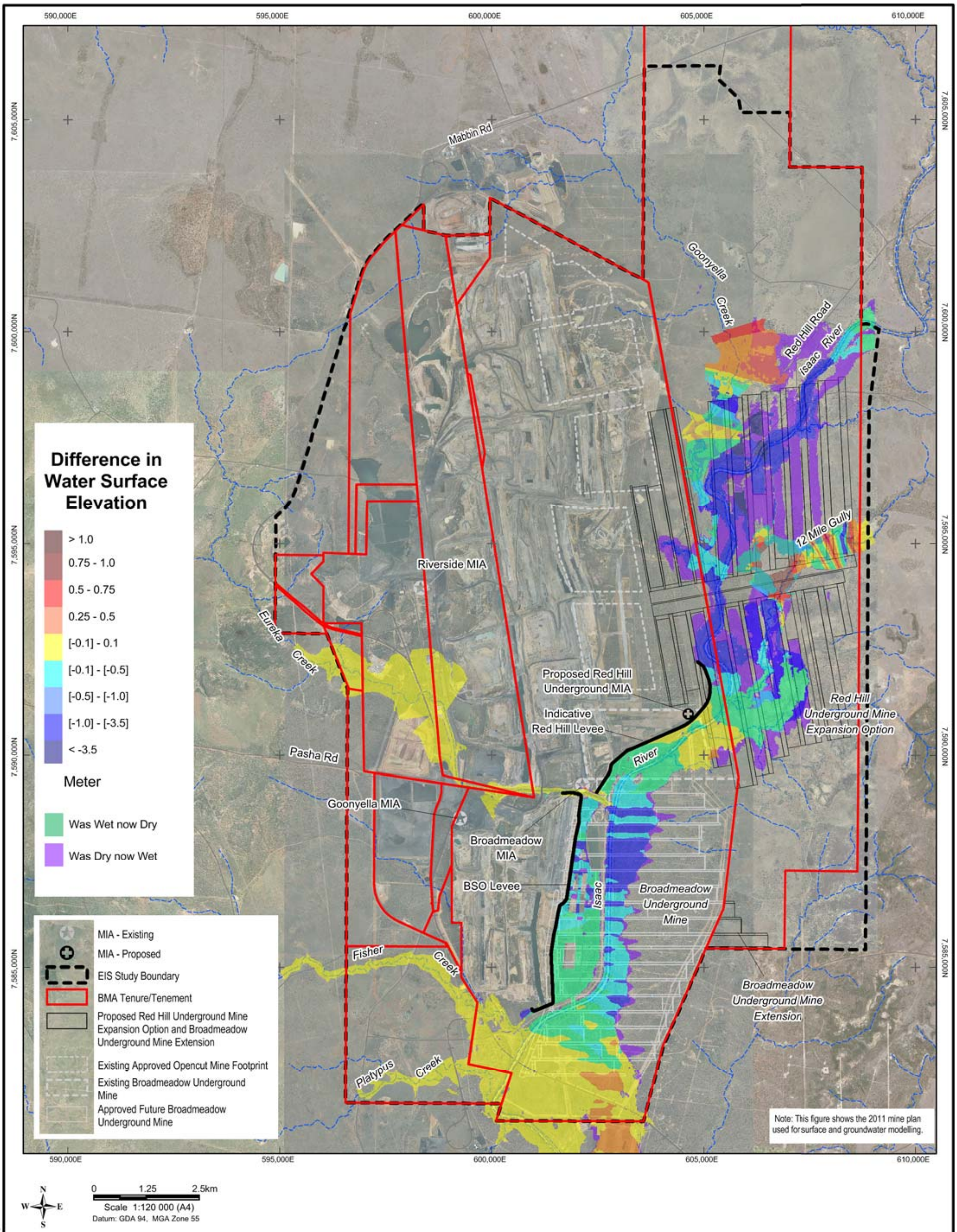
DIFFERENCE 1:500 AEP SURFACE ELEVATION

URS

SURFACE WATER

Appendix I-05

File No: **42627136-g-2121.wor** Drawn: **VH** Approved: **CT** Date: **24-06-2013** Rev.**A** A4



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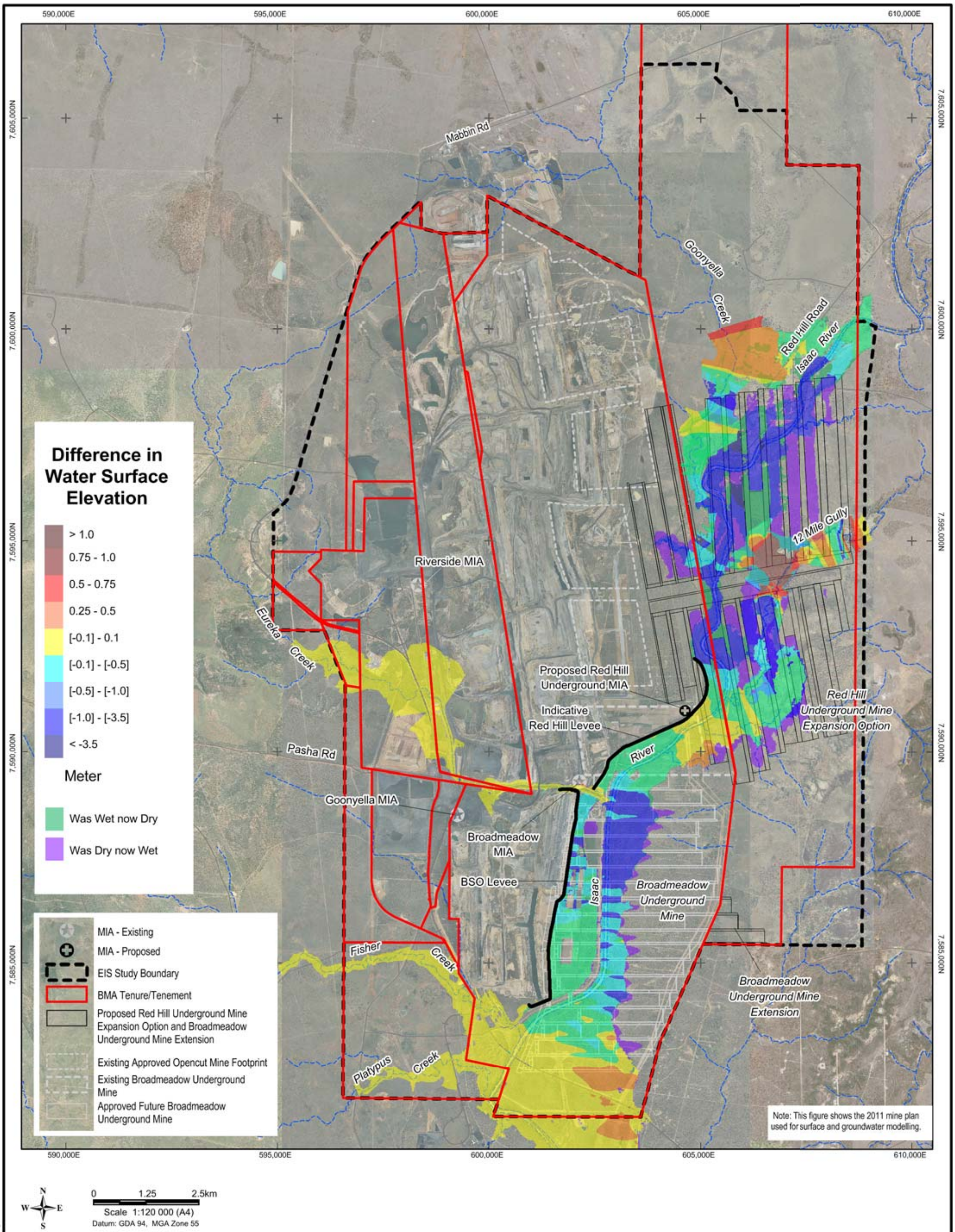
DIFFERENCE 1:1000 AEP SURFACE ELEVATION

URS

SURFACE WATER

Appendix I-06

File No: **42627136-g-2122.wor** Drawn: **VH** Approved: **CT** Date: **24-06-2013** Rev.**A** A4



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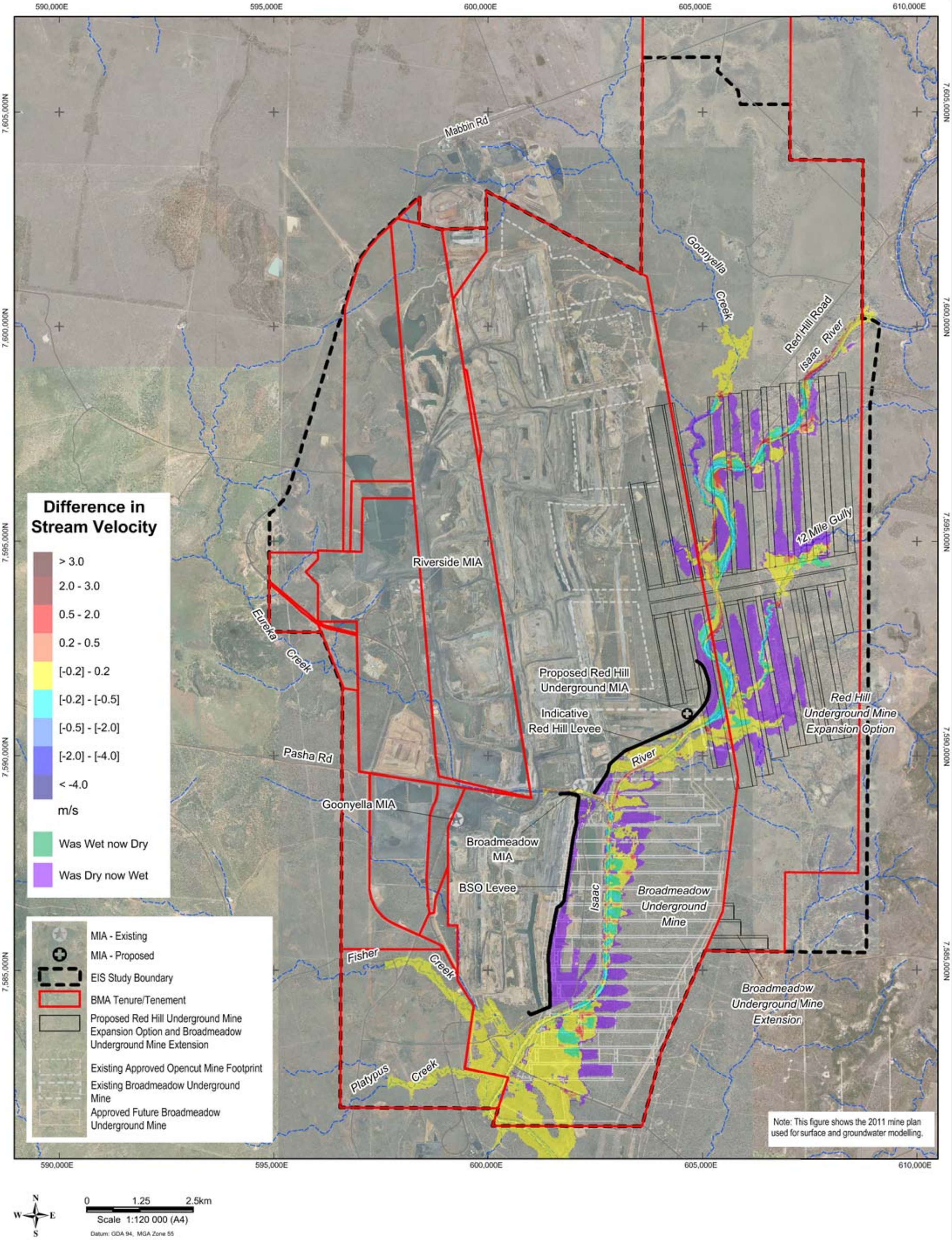
DIFFERENCE 1:2000 AEP SURFACE ELEVATION

URS

SURFACE WATER

Appendix I-07

File No: **42627136-g-2123.wor** Drawn: **VH** Approved: **CT** Date: **24-06-2013** Rev.**A** A4



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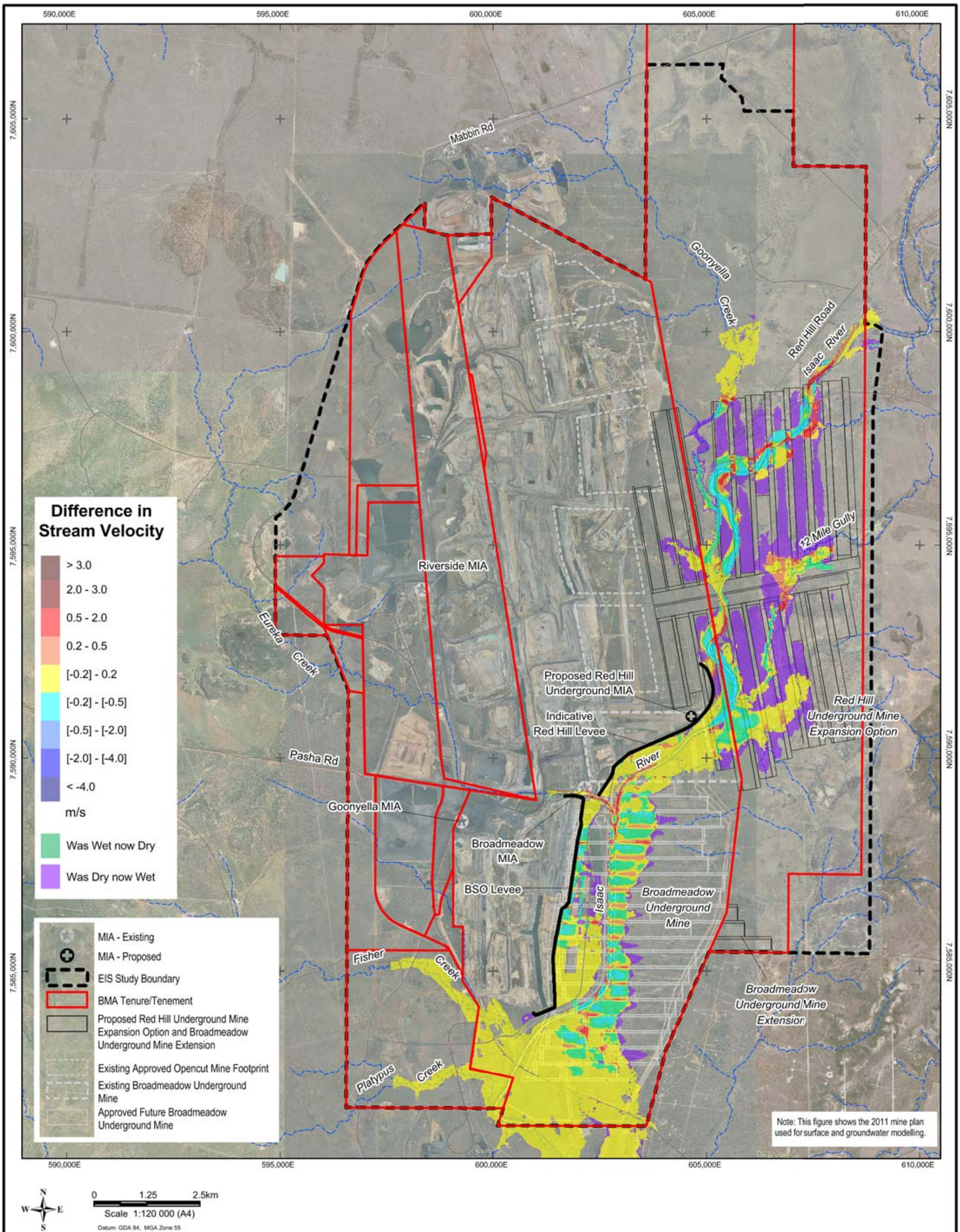
DIFFERENCE 1:100 AEP STREAM VELOCITY

URS

SURFACE WATER

Appendix I-08

File No: **42627136-g-2124.wor** Drawn: **VH** Approved: **CT** Date: **24-06-2013** Rev.**A** A4



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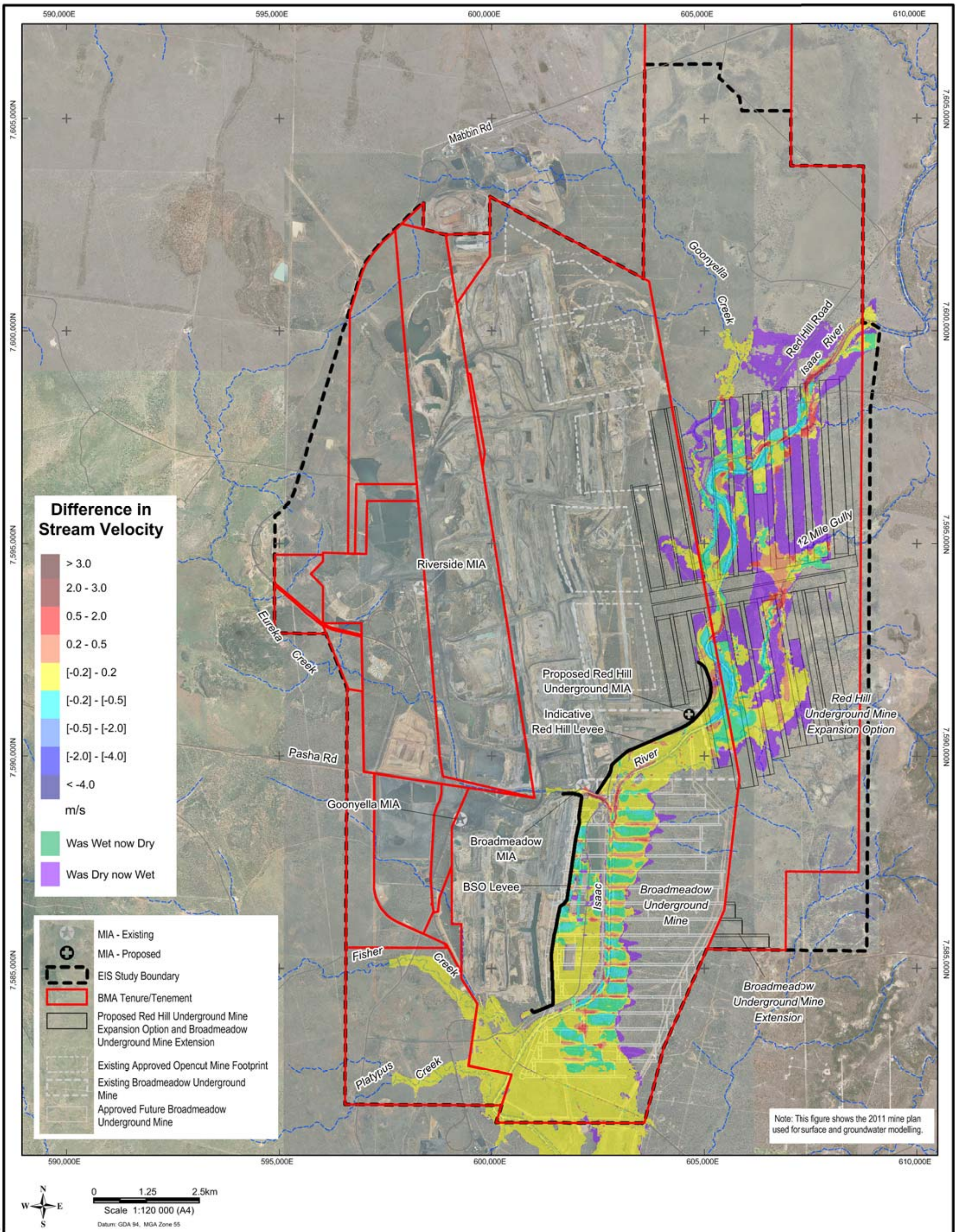
DIFFERENCE 1:500 AEP STREAM VELOCITY

URS

SURFACE WATER

Appendix I-09

File No: **42627136-g-2125.wor** Drawn: **VH** Approved: **CT** Date: **24-06-2013** Rev. **A** A4



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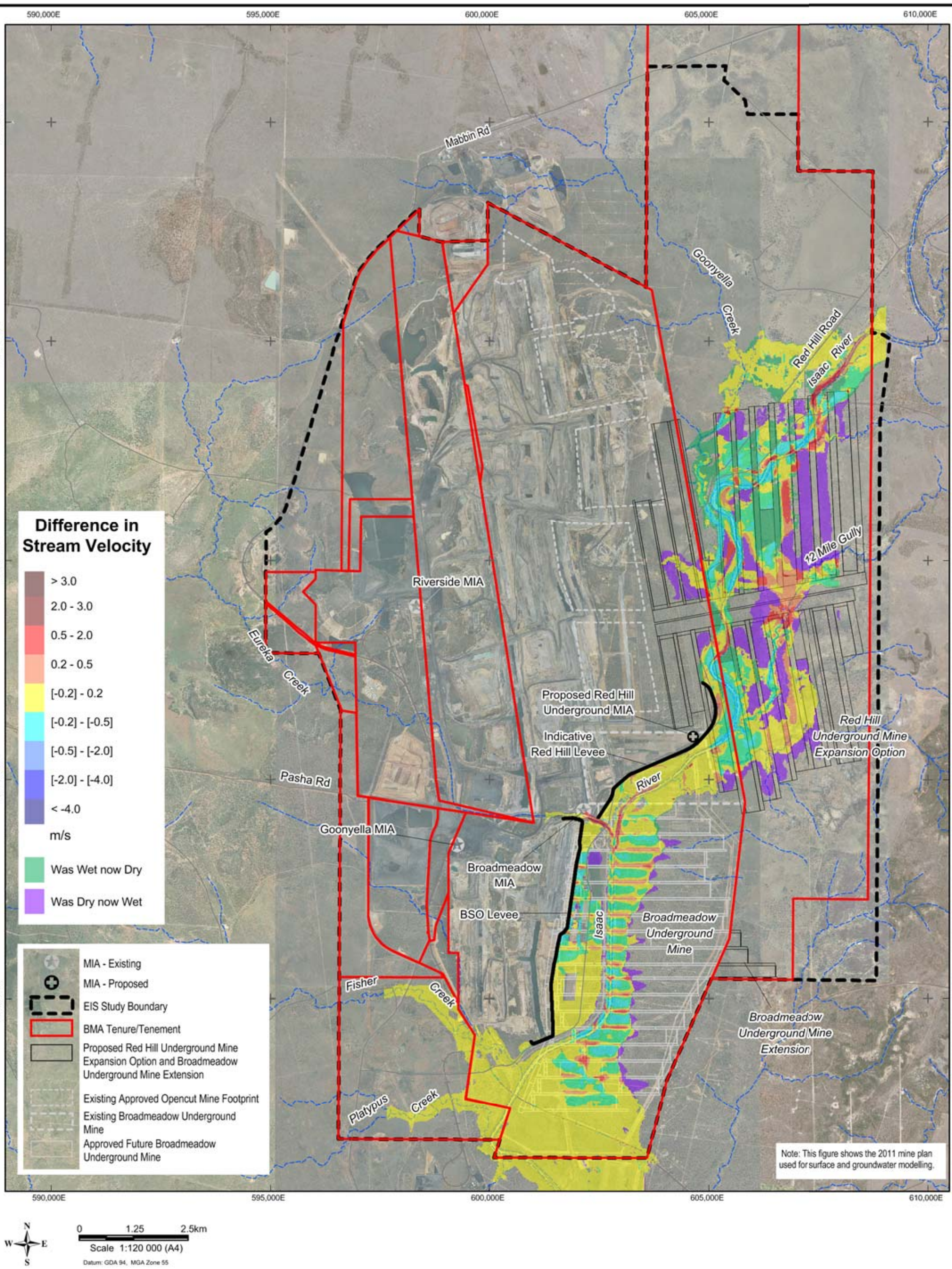
DIFFERENCE 1:1000 AEP STREAM VELOCITY

URS

SURFACE WATER

Appendix I-10

File No: **42627136-g-2126.wor** Drawn: **VH** Approved: **CT** Date: **24-06-2013** Rev. **A** A4



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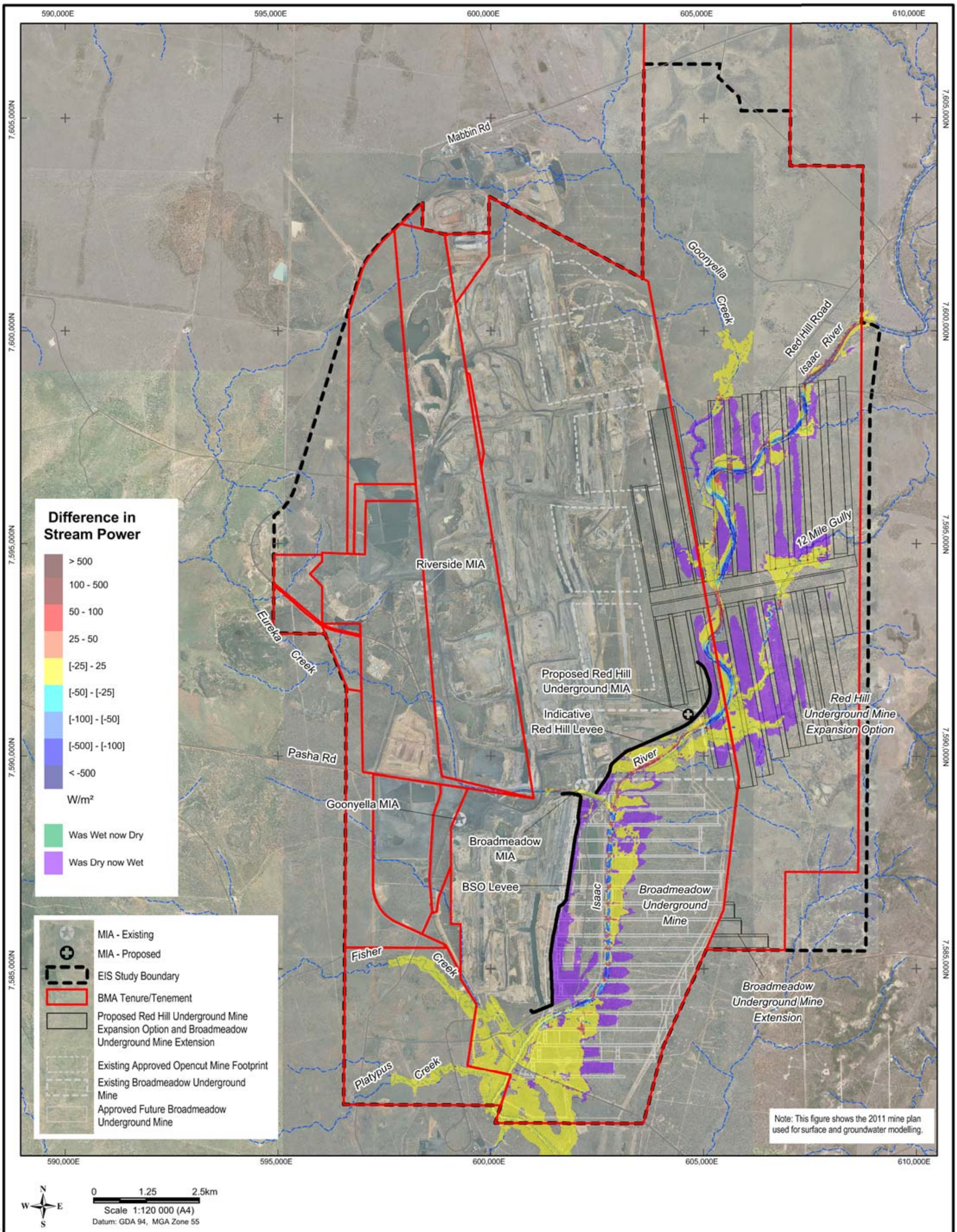
DIFFERENCE 1:2000 AEP STREAM VELOCITY

URS

SURFACE WATER

Appendix I-11

File No: **42627136-g-2126.wor** Drawn: **VH** Approved: **CT** Date: **24-06-2013** Rev.**A** A4



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HYDRAULICS TECHNICAL REPORT

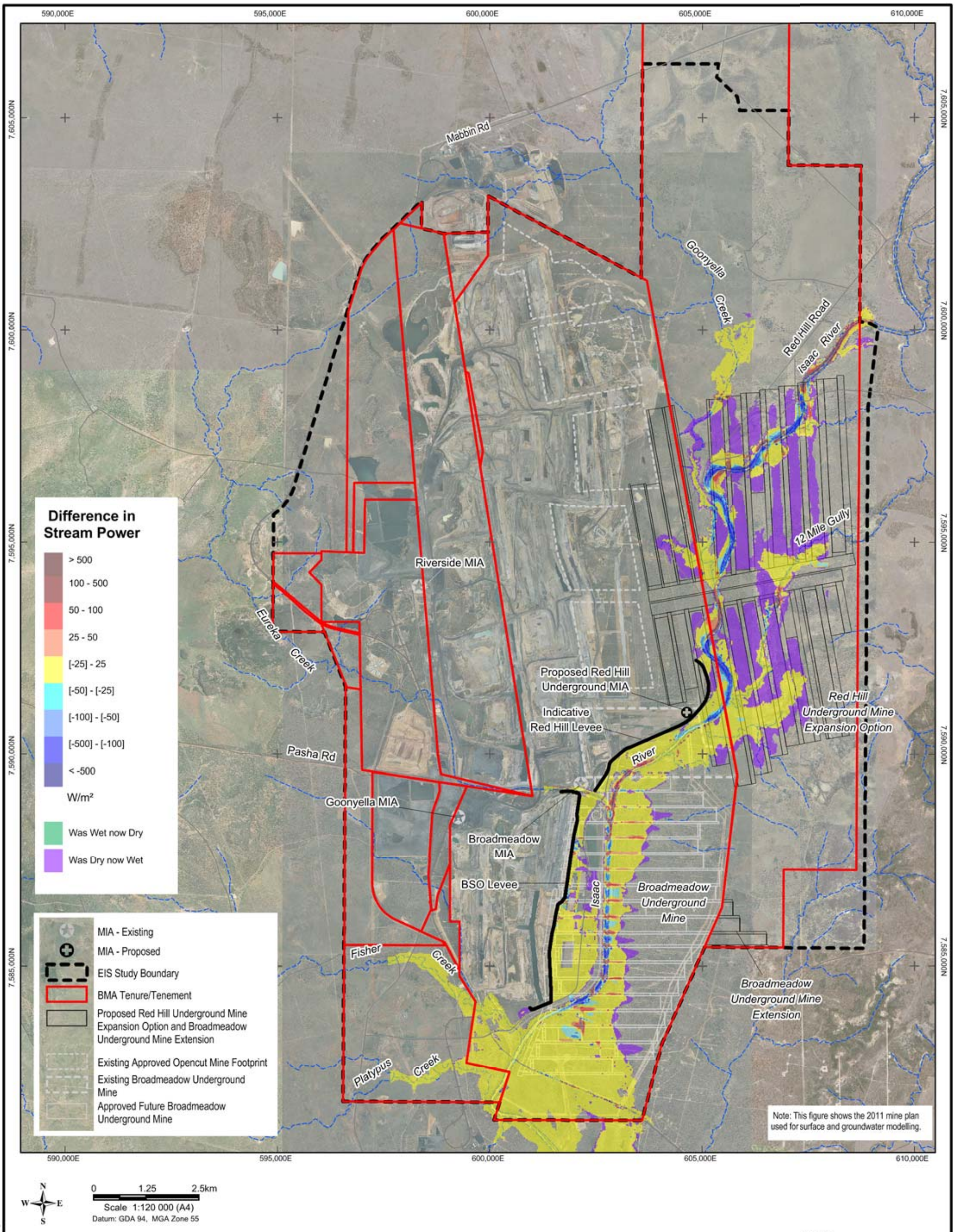
DIFFERENCE 1:100 AEP STREAM POWER

URS

SURFACE WATER

Appendix I-12

File No: **42627136-g-2128.wor** Drawn: **VH** Approved: **CT** Date: **24-06-2013** Rev. **A** A4



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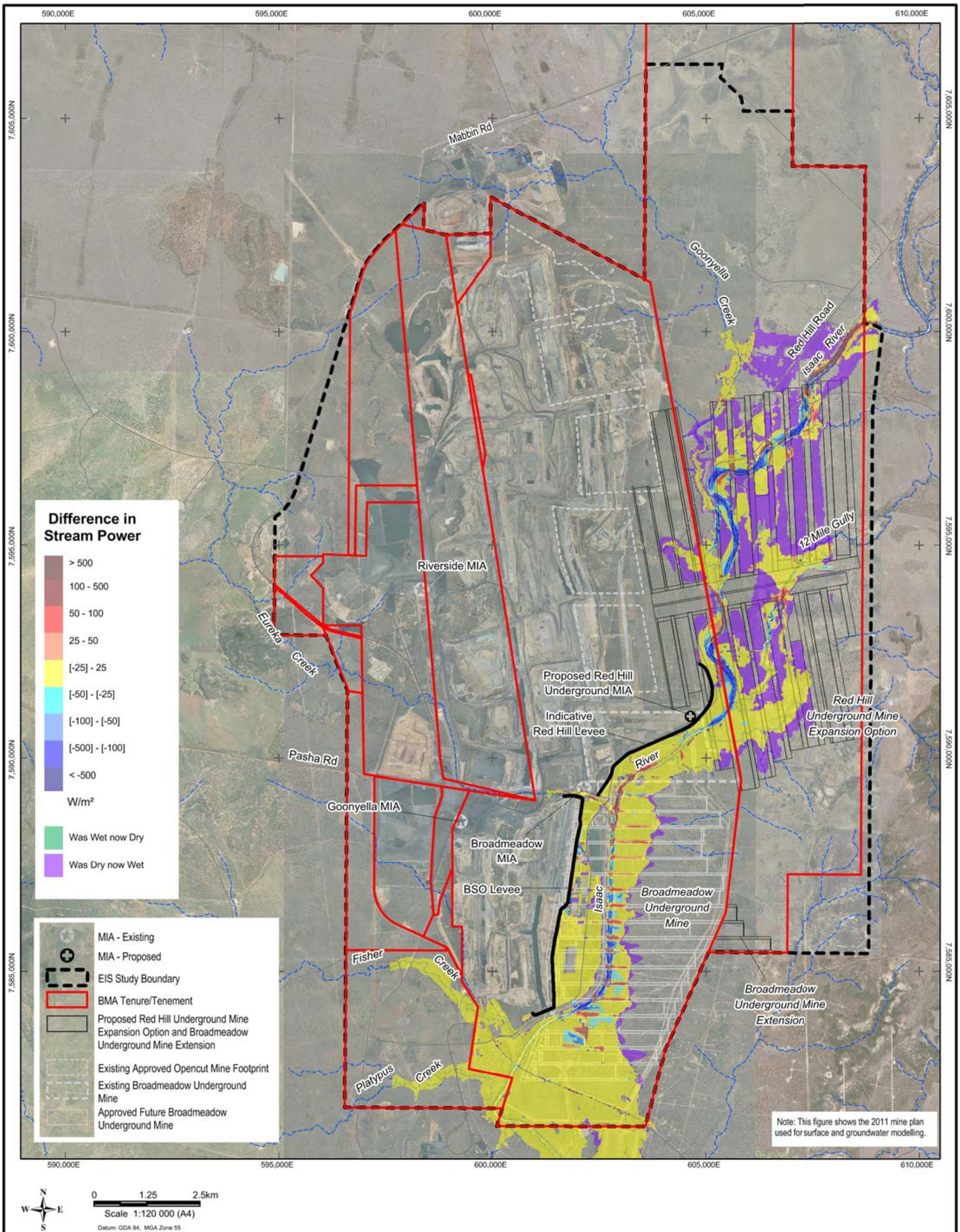
DIFFERENCE 1:500 AEP STREAM POWER

URS

SURFACE WATER

Appendix I-13

File No: 42627136-g-2129.wor Drawn: VH Approved: CT Date: 24-06-2013 Rev.A A4



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DIFFERENCE 1:1000 AEP STREAM POWER

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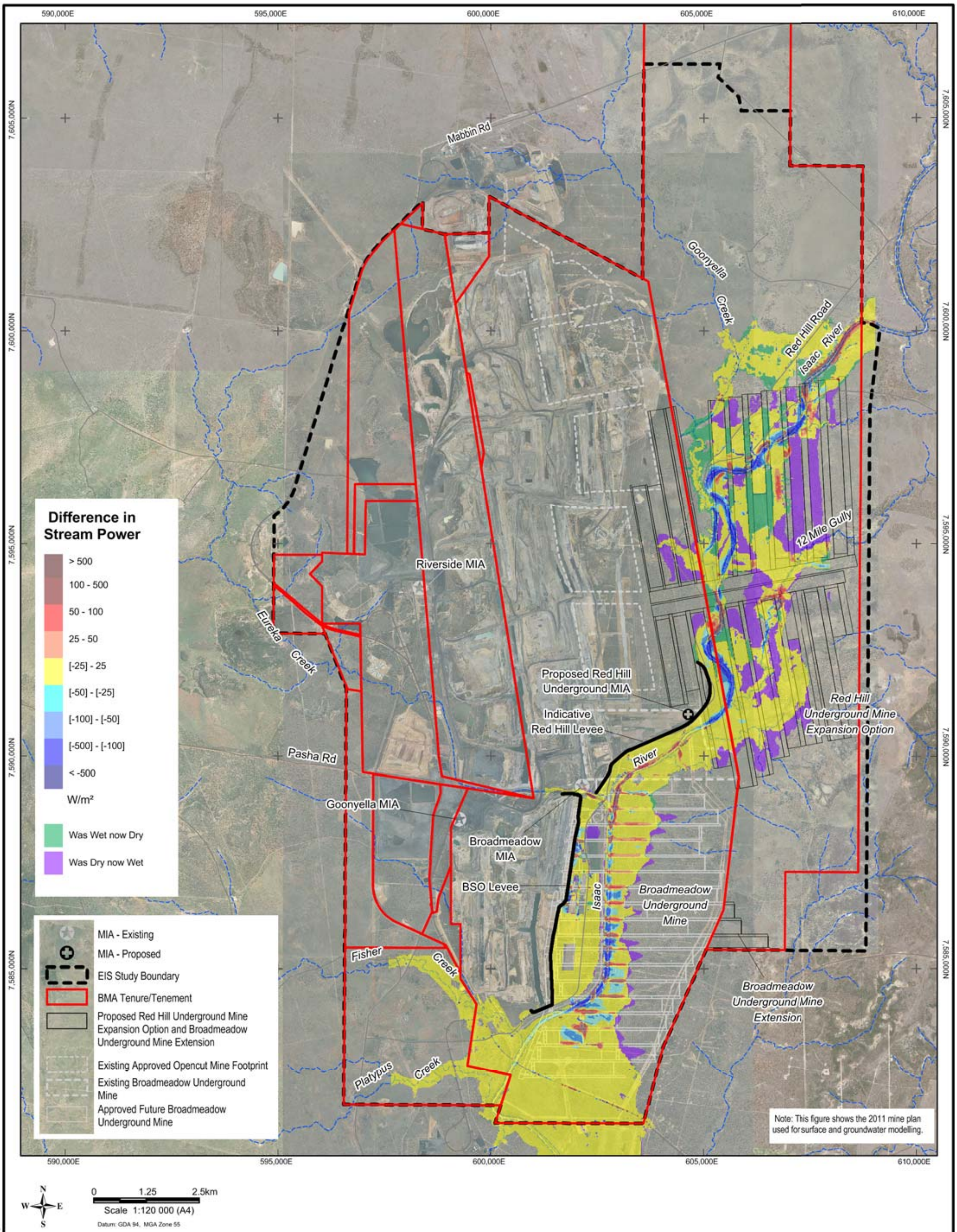
Appendix I-14

File No: **42627136-g-2130.wor** Drawn: **VH** Approved: **CT** Date: **24-06-2013** Rev. **A** A4



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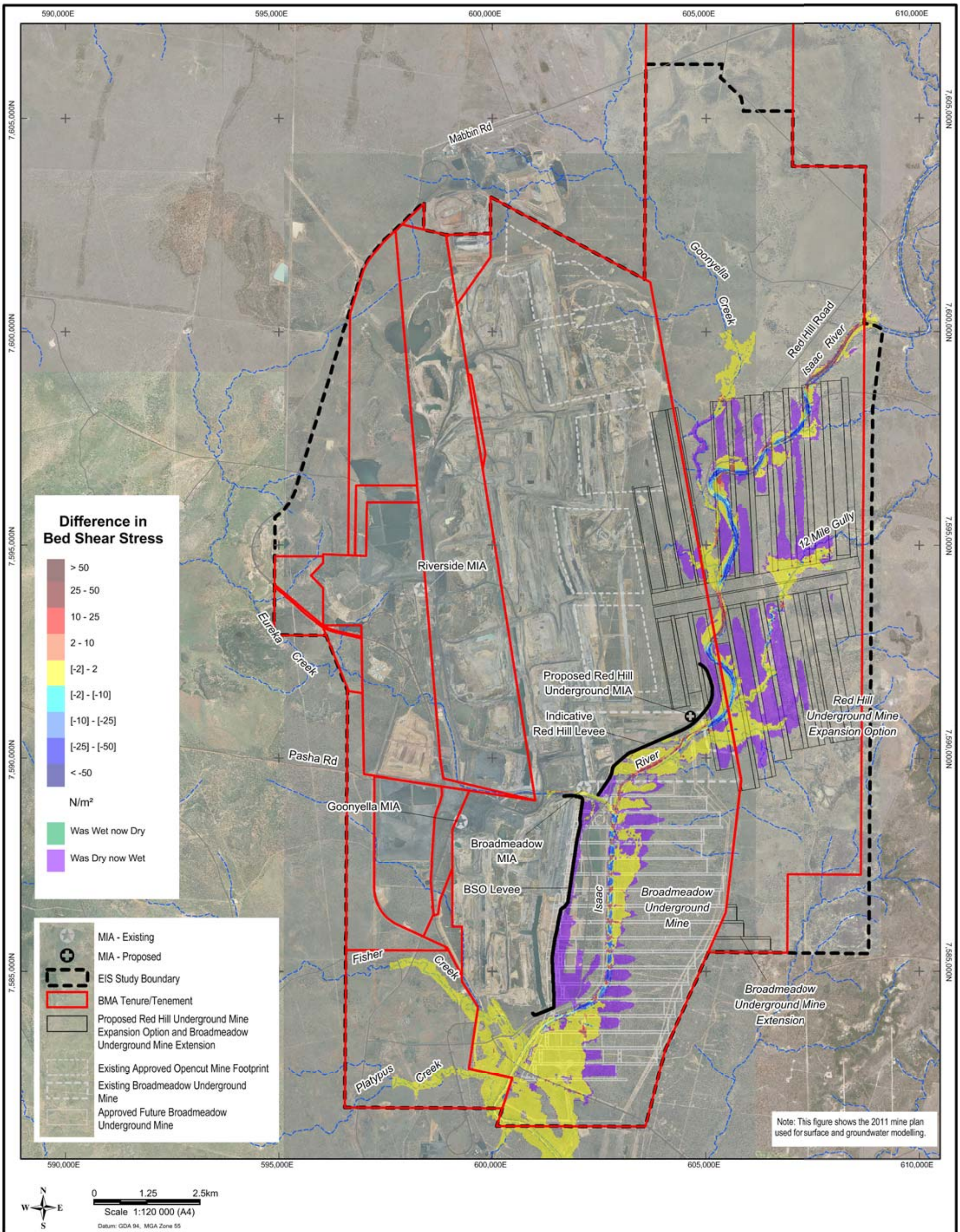
DIFFERENCE 1:2000 AEP STREAM POWER

URS

SURFACE WATER

Appendix I-15

File No: **42627136-g-2131.wor** Drawn: **VH** Approved: **CT** Date: **24-06-2013** Rev. **A** A4



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DIFFERENCE 1:100 AEP BED SHEAR STRESS

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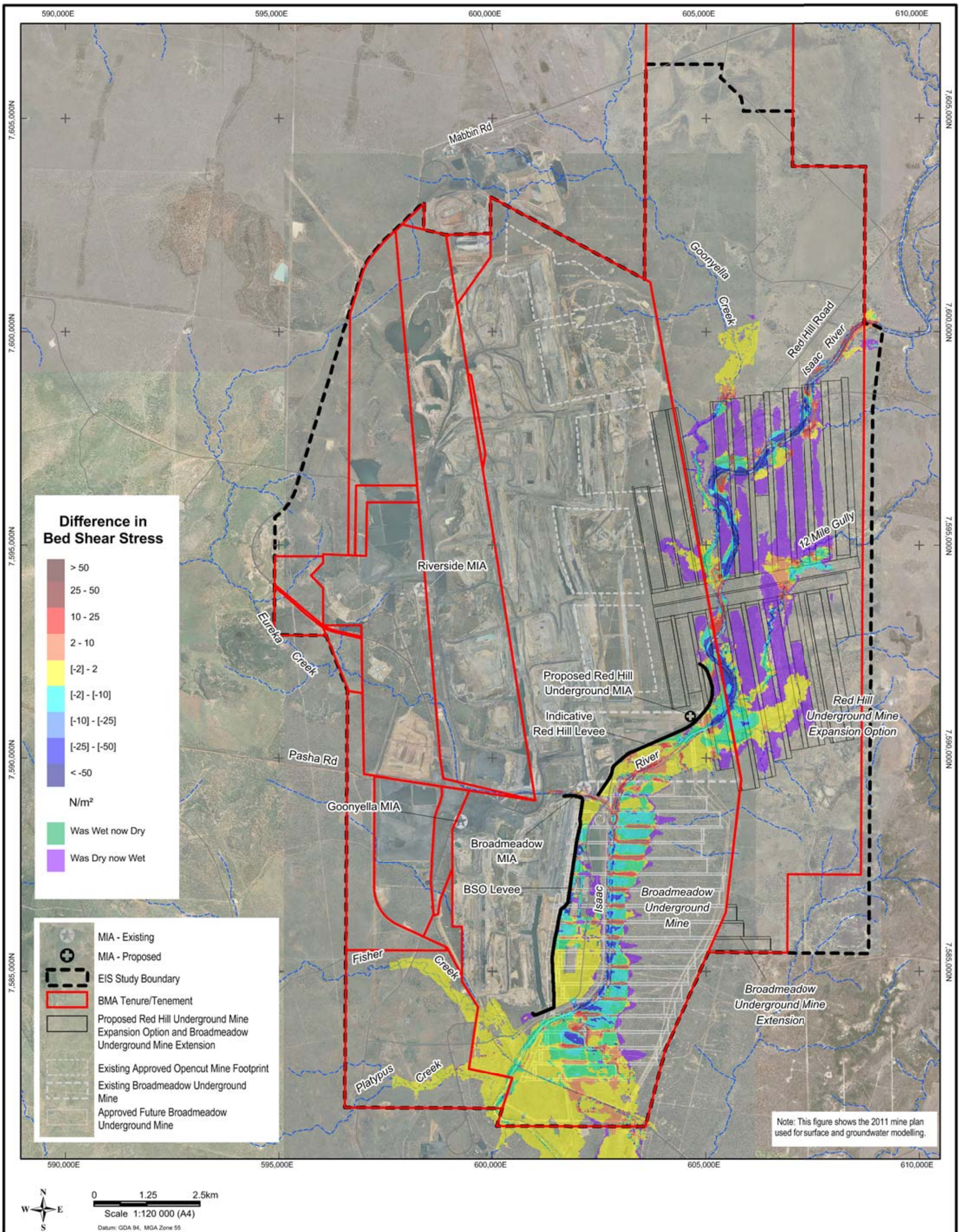
SURFACE WATER

Appendix I-16

File No: **42627136-g-2132.wor** Drawn: **VH** Approved: **CT** Date: **24-06-2013** Rev. **A** A4



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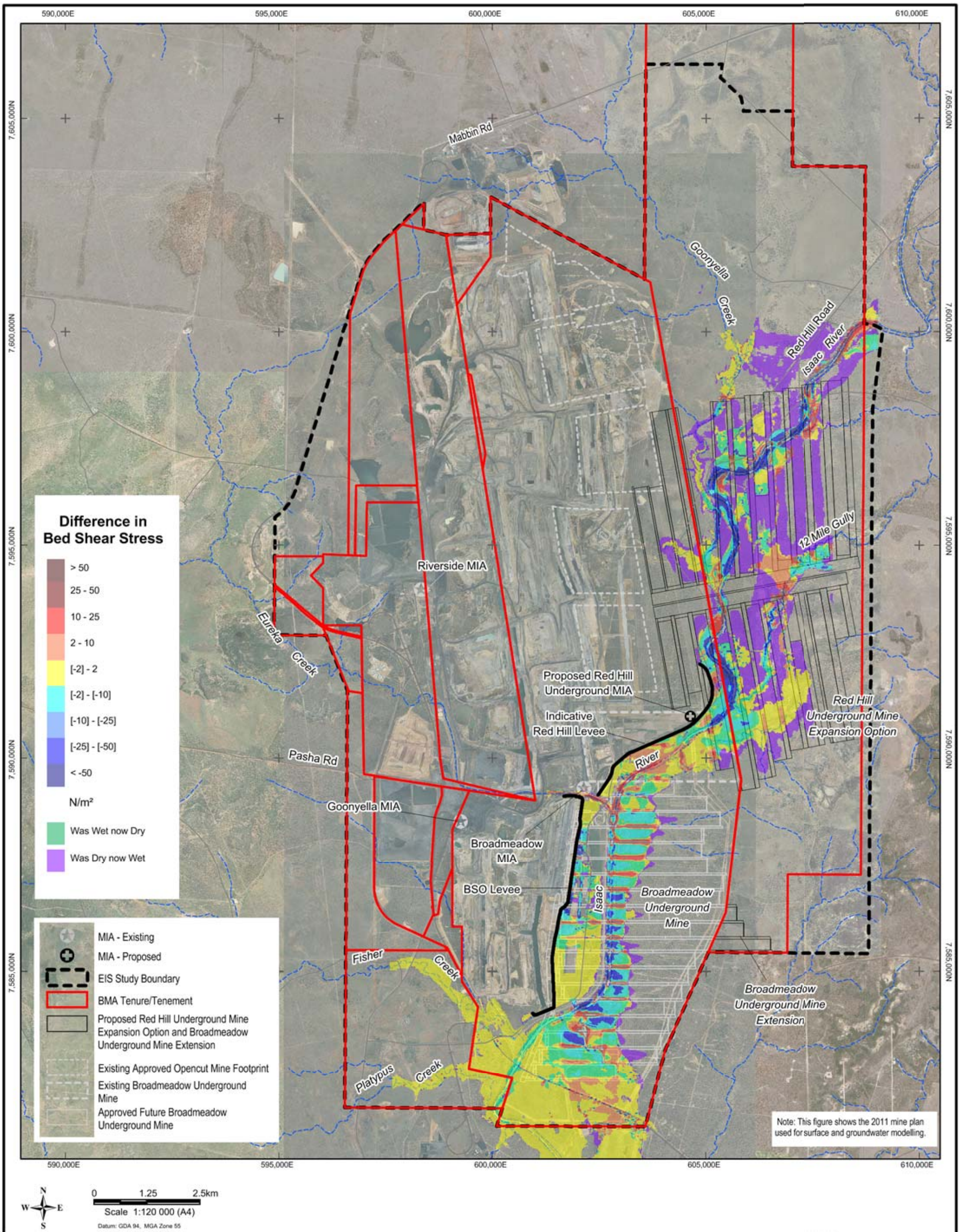
DIFFERENCE 1:500 AEP BED SHEAR STRESS

SURFACE WATER | **Appendix I-17**

File No: **42627136-g-2133.wor** Drawn: **VH** Approved: **CT** Date: **24-06-2013** Rev. **A** A4



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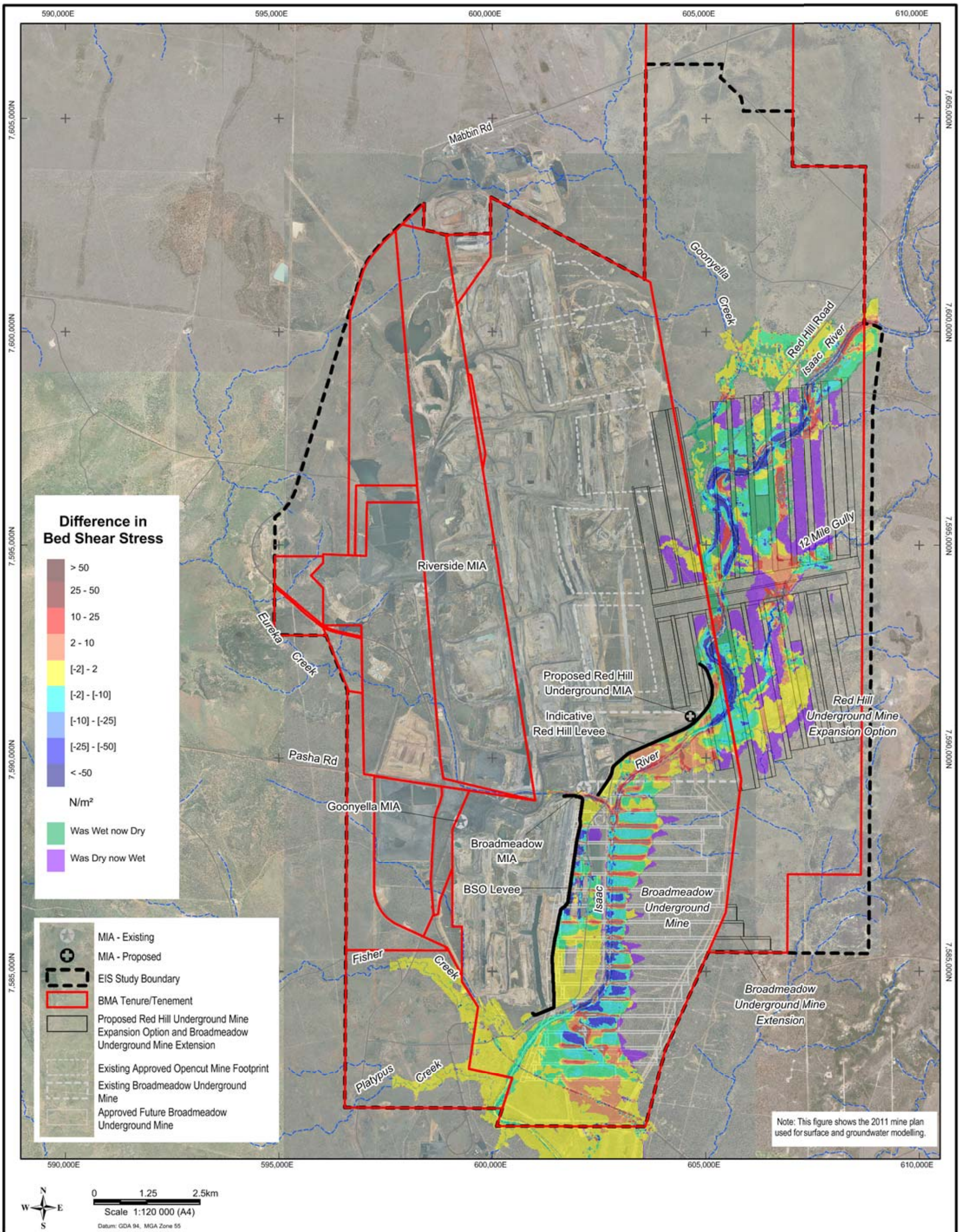
DIFFERENCE 1:1000 AEP BED SHEAR STRESS



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File No: **42627136-g-2135.wor** Drawn: **VH** Approved: **CT** Date: **24-06-2013** Rev. **A** A4

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