APPENDIX 4

CID - LOCAL WATER MANAGEMENT STRATEGY

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SUBDIVISION LOT 15 & 17 BRAND HIGHWAY, RUDDS GULLY

LOCAL WATER MANAGEMENT STRATEGY

PROJECT No. 14001

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AUSTRALIAN MINERALS INVESTORS PTY LTD

OCHREWEST
CONSULTING ENGINEERS

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SUMMARY

Ochre West Consulting Engineers Pty Ltd. has been commissioned by Australian Minerals Investors Pty. Ltd. to provide engineering consultancy services to support Structure planning for the proposed urban development of Lot 15 & 17 Brand Highway, Rudds Gully. The plan is to facilitate the development for residential use. This Local Water Management Strategy (LWMS) for the site will need to ensure that disturbance to the environment is kept to a minimum.

This document details the LWMS for the proposed subdivision plan. The LWMS has been prepared consistent with the guidelines from Better Urban Water Management (DPI, 2008) and is based on requirements of the City of Greater Geraldton and Main Roads WA. This LWMS has been prepared to support the Local Structure Plan (LSP) and to provide guide for the Urban Water Management Plan (UWMP) required at higher stages of planning

Key LWMS/UWMP Elements	Design and Compliance to Objectives
Stormwater Management	• Structural and Non Structural Best Management Practice's (BMP's) will be used to improve water quality by reducing its exposure to pollutants and restricting water velocities within the boundary. • Soakwells or basins and swales are to be designed to capture and infiltrate Lot runoff of each lot property for the one year ARI event for storm duration of one hour. • A Pipe network will be sized to convey stormwater up to the 1 in 5 years ARI event. For larger events, stormwater will be conveyed by the roads. • Rainfall up to the 1 in 100 years ARI event will be retained within the lot boundaries and allowed to infiltrate into the ground via infiltration
Groundwater Management	• Proposed Lot pads will have a vertical clearance of at least 1.5m from the Annual Average Maximum Groundwater Level (AAMGL) to the lot levels. • Minimum set back distances from building footings to infiltration systems is 1m. • Ensure predevelopment groundwater conditions and quality are maintained at predevelopment levels with maximum infiltration of stormwater runoff to recharge the groundwater.
Water Quality Management	• BMP's will be maintained to improve water quality which applies to principles of Water Sensitive Urban Design (WSUD). • Ensure development does not have adverse effects on existing groundwater and surface water quality.
Vegetation and POS management	• A landscape architect will be engaged for management of vegetation within POS as part of the future UWMP. Focus will be on water saving and local species suitable for nutrient stripping.
Subdivision Management	• Management of subdivision works will ensure potential impacts to the surrounding environment and conservation areas are minimised.

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Subdivision Management	• Management of subdivision works will ensure potential impacts to the surrounding environment and conservation areas are minimised.

Key LWMS/UWMP Elements	Design and Compliance to Objectives
Monitoring	• Monitoring at the post development stage will need to be ongoing for 3 years after the final stage of construction.
Implementation	• Roles and responsibilities involved in the implementation of the UWMP are identified

FIGURES

APPENDICES

1 INTRODUCTION

Ochre West Consulting Engineers have been commissioned by Australian Minerals Investors Pty Ltd to prepare a Local Water Management Strategy (LWMS) to support the Structure Plan (SP) for Lots 15 & 17 Brand Highway, Rudds Gully.

1.1 BACKGROUND

Lot 15 & 17 Brand Highway, Rudds Gully is owned by Australian Minerals Investors Pty. Ltd. and is located approximately 5 km south of the City of Geraldton. The areas of both sites are 31.52 hectare (ha) and 35.57 ha for Lot 15 and Lot 17 respectively. The project location is shown in Figure 1 (Site Location).

1.2 PURPOSE AND SCOPE

This document details the Local Water Management Strategy (LWMS) to support the Structure Plan (SP) for Lot 15 & 17 Rudds Gully. This LWMS will provide necessary water management planning to guide a future Urban Water Management Plan (UWMP) for subdivision within the project. The drainage strategies will ensure that the requirements specified by the City of Geraldton and Department of Water are met.

This LWMS provides a proof of concept design, guideline controls and management measures for:

Water Quality	maintain or improve surface and ground water quality.
Water Quantity	maintain the total water cycle balance within development areas relative to the pre-development conditions.
Water conservation	maximise the reuse of stormwater
Public Health and protection of property	minimise public risk, including risk of injury or loss of life and protect the built environment from flooding and water logging.
Ecosystem Health	retain natural drainage systems and protect ecosystem health.
Economic viability	implement long term economically viable stormwater management systems.
Development	deliver best practice stormwater management taking due cognisance of sustainability and precautionary principles.

The document has been prepared In accordance with Better Urban Water Management (DPI, 2008).

This LWMS has been developed therefore to be consistent with the framework and process detailed in the guideline *Better Urban Water Management* (WAPC, 2008a) which sets the level of investigations, key principles and objectives, and documentation required at various decision points in the planning process.

Additionally, there are a number of published guidelines and standards which provide direction or guidance to achieve sustainable environmental and urban development and that define key principles and objectives:

- Better Urban Water Management (WAPC, 2008a).
- Developing a Local Water Management Strategy (DoW, 2008).
- Stormwater Management Manual for Western Australia (DoW, 2004-2007).
- Proposed Model for Integrating Urban Water Management and Land Use Planning (Essential Environment Services, 2005).
- Decision Process for Stormwater Management in Western Australia (DEC and SRT, 2005).
- National Water Quality Management Strategy (ANZECC, 2000).

- City of Greater Geraldton:
  - City of Geraldton Local Planning Scheme No. 1 (Local Scheme).
  - City of Greater Geraldton Land Development Specifications.

This document takes due cognisance and has been prepared and compiled consistent with these polices and their requirements.

1.3 PREVIOUS LOCAL AND REGIONAL STUDIES

This report takes due cognisance of the following documents:

- Geraldton Region Plan Final (WAPC, 1999);
- Geraldton Structure Plan (WAPC, 2011);
- Land Development Guidelines (City of Geraldton, 2011); and
- Geraldton Regional Flora and Vegetation Survey (WAPC, 2010).
- Stormwater Management Manual of Western Australia (DoW 2004-2007)
- Developing a Local Water Management Strategy (DoW 2008)
- Better Urban Water Management (DPI, 2008).

1.4 PLANNING BACKGROUND

The Structure Plan (SP) for Lots 15 and 17 provides a framework for future development and establishes a connect for its subdivision. This LWMS will guide future subdivision to ensure the land is developed in a sustainable manner, fulfill the objectives of the WAPC, and in accordance with objectives of the Department of Water and City of Geraldton. As such it will provide the necessary water management strategies to guide the subsequent Urban Water Management Plan (UWMP) required for subdivision.

2 PROPOSED DEVELOPMENT

2.1 ZONING, STRUCTRAL PLAN AND LAND USE

Australian Minerals Investors Pty. Ltd. are proposing to develop the site into a subdivision development as illustrated in Figure 3 (Structure Plan).

The proposed subdivision development includes the following work:

- construction of new roads;
- installation of new drainage; and
- creation of public open space reserves, for recreation and drainage purposes.

The subject land is zoned “urban development” in City of Geraldton Local Planning Scheme No. 1.

The site-zoning plan for the area is shown in Figure 2a (Site Zoning Plan).

2.2 LANDSCAPE

The landscape concept is to be developed during the UWMP to take due cognisance of water conservation and treatment strategies outlined in this LWMS and will take into account vegetation to be retained in addition to landscaping required for drainage infrastructure.

Irrigation management plans are to be included in the UWMP. Groundwater abstraction for irrigation purposes by suitably located bores may be a source for the POS. Applications to secure such a water supply are to be lodged with the DoW prior to onset of UWMP investigations.

2.3 DESIGN OBJECTIVES

The objectives of the LWMS and subsequent UWMP are to be based on the requirements set out in the Water Sensitive Urban Design manual, which was obtained from the Department of Water (DoW) and should also conform to the City of Greater Geraldton requirements. The objectives of this report are outlined below:

- Maintain the surface water and groundwater quality and quantity within the development areas to predevelopment conditions.
- Maintain or improve surface and groundwater quality at or above pre-development levels.
- Manage and infiltrate catchment runoff up to the 1 in 100 years ARI events within the development area
- Prevent adverse impacts to the natural environment that may be sensitive to changes in the natural hydrological cycle (Liveable Neighbourhoods).
- Minimise the public risk of injury or loss of life by protecting the built environment from flooding.
- Ensure that the best practice in stormwater management is delivered through planning and the development of high quality areas that are consistent with sustainability and ensuring that the long term viability of the stormwater management system is maintained.

The design criteria for the requirements of this development are controlled by the City of Geraldton and are outlined as:

Ecological protection:	retain and treat the 1-yr ARI event for a duration of 1 hour .
Flood management:	Drainage pipes (minimum diameter 300mm with a minimum grade of 1 in 200) shall be designed to convey the 5-year ARI event (minimum). Retain and infiltrate runoff from the 100-year ARI event to ensure no runoff exits the site.

The coefficient of runoff for all lots shall be as detailed in Table 4.1 of the City of Geraldton Land Development Specification.

Infiltration basins shall accommodate the 100-year ARI critical event.

Side slopes shall not exceed a grade of 1 in 6, have a maximum water depth of 1.2m for the 100-year ARI event, and shall not retain water for more than 96 hours.

Finished floor levels are to be a minimum of 0.3m above the 100-year flood level.

3 PRE-DEVELOPMENT ENVIRONMENT

3.1 CURRENT AND PAST LANDUSE

Lots 15 and 17 Brand Hwy are approximately 31.52 ha and 35.57 ha each respectively, located approximately 5km south of Geraldton as indicated in Figure 1.

Data obtained from the Australian Soil Resources Information System (ASRIS) shows that the land use was categorised for grazing of natural vegetation between 1992 to 1993 and by 2009 it was categorised as land used for dryland cropping.

The subject land is currently unoccupied and from the aerial photography obtained from Landgate, the majority of the area seems to have been cleared or grazed.

3.2 GEOLOGY, SOILS AND GEOTECHNICAL INFORMATION

The project site lies within Greenough Province, which covers almost the entire northern half of Northern Agricultural Region. Both of the lots are located in the Geraldton Coastal soil landscape zone and the ground is described to have low hills of; Tamala limestone, recent calcareous and siliceous dunes with alluvial plains and sand sheets. The types of soils that are found within this zone are mainly shallow and deep sands with some loamy and sandy earth (Technical Report 268, Department of Agriculture 2005). Soil types of the region are shown in Figure 4 (Surface Geology Map).

Acid Sulphate Soils

Information retrieved from the ASRIS website indicated that both lots have extremely low probability of containing Acid Sulphate Soils. However, this information is considered to have a very low confidence level which means that the data for this area was inferred from surrogate data with no on ground verification. A more detailed study/survey on Acid Sulphate Soils (ASS) within these Lots, may need to be carried out, however it is not envisioned to be a problem at these sites.

Map of the ASS is shown in Figure 7 (Acid Sulphate Soil Risk Mapping).

3.3 ENVIRONMENTAL ASSETS

Vegetation

The site has been extensively cleared; the uncleared vegetation on the subject land belongs to the Near Coastal – Acacia Rostellifera Shrubland plant community, which is within the Geraldton Regional Flora and Vegetation Survey (GRFVS). This type of community plant usually occurs on taller secondary dunes and along higher river banks where there is often some exposed limestone and sandplain soil to the east, where this community plant is often a result of disturbance (GRFVS, WAPC, 2010). Vegetation types of the region are shown in Figure 5 (Vegetation Mapping).

Wetlands and Waterways

Information gathered from the WA Atlas indicates that there are no Conservation Category Wetlands (CCW) within the vicinity of the project site.

There is a creek located about 800m south of Lot 17. The creek is running in a north-west to south-east direction and discharges into Greenough River. Location of waterways are shown in Figure 6 (Rudds Gully Waterways).

Contaminated Sites

There are no contaminated sites registered in the Contaminated Sites Database from the Department of Environment and Conservation, for the Lots in question.

3.4 SURFACE WATER

Contour data has been provided by HTD surveyors & planners and based on this data, the following were observed:

- For Lot 15:
  - there is a depressed area located east within the lot and about 25% of the catchment area is grading down towards the depressed area; and
  - the remaining catchment area grades in a south westerly direction towards Brand Highway.
- For Lot 17:
  - it is observed that about 65% of the catchment area grades towards Brand Highway in a westerly direction;
  - about 15% of the catchment grades in a south direction towards neighbouring lots (i.e. Lot 477 and 500); and
  - the remaining catchment grades in a south east and northertly direction towards neighbouring Lots (i.e. Lot 30, 117 & 717).

The surface water on Brand Highway is collected in roadside swale drains and is directed towards an existing creek, which is located about 800m south of Lot 17 and eventually discharges into the Greenough River.

Pre-development flow catchments are shown in Figure 8a and pre-development flows are summarised in Table 1 Pre-Development Flow Rates.

Table 1: Pre-Development Flow Rates

		CATCHMENT LOT 15				CATCHMENT LOT 17			
	Catchment	A	B	C	D	A	B	C	D
ARI	Area (ha)	23.64	0.53	7.15	0.2	23.00	2.89	75.07	4.69
1	Q (m^3/s)	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
	C	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.144
5	Q (m^3/s)	0.52	0.52	0.52	0.52	0.53	0.53	0.53	0.53
	C	0.171	0.171	0.171	0.171	0.171	0.171	0.171	0.171
100	Q (m^3/s)	1.28	1.28	1.28	1.28	1.31	1.31	1.31	1.31
	C	0.216	0.216	0.216	0.216	0.216	0.216	0.216	0.216

The pre-development surface water flow paths of both Lots are presented in Figure 8b (Surface Water Flow).

3.5 GROUND WATER

Investigation and ground water levels

There were no on sites monitoring bores established at the time of this report. Therefore, an initial desktop study of the groundwater levels for the area was carried out. The data was obtained from the DoW's monitoring bore, which is located approximately 5 km from the project site.

Figure 9 shows the location of the monitoring bore, in relation to Lots 15 & 17.

The monitoring bore, which is located within 5 km of the site, was used to determine the Average Annual Maximum Groundwater Levels (AAMGL) and the Maximum Groundwater Levels (MGL). This will be used to give some indication on possible groundwater levels at the project site.

The results of the AAMGL analysis are provided in Table 1 below.

Table 2: AAMGL and MGL observation

WIN ID	Bore Site	Bore Location		Sample Dates	AAMGL	95% UCL	MGL
		Easting	Northing				
		MGA -50	MGA -50		mAHD	mAHD	mAHD
11354626	70118304	273424	6808575	04/05/1994 to 30/03/2011	4.41	4.62	5.05

The data indicates that in comparison with existing and proposed site levels, groundwater is not expected to be an issue for the devleopment of the proposed lots due to the significant depth.

Groundwater Quality

At the time of writing this report, groundwater quality monitoring within the sites has not yet been completed or determined.

3.6 SUMMARY OF OPPORTUNITIES AND CONSTRAINTS

- Ground water: Given the natural surface elevation and surface geology, Lots 15 and 17 provide opportunities for infiltration from stormwater both at a local (soakwells) and regional (basin) scale and minimising any fill requirements to increase clearance to groundwater.
- Surface water: Given the natural surface levels, Lots 15 and 17 are well above existing flood levels of regional drainage systems in the area.
- Water supply: Potential use of groundwater bores for POS irrigation
- Possible impact on water source imposed by the change of land use and thus, opportunity to apply sustainability principles etc.
- Soil: Absence of acid sulphate soils.

4 WATER SUSTAINABILITY INITIATIVES

4.1 WATER CONSERVATION OBJECTIVES

The proposed development for lot 15 and 17 will significantly increase the demand for water as there will be an increase in the number of residents. Water conservation management is therefore needed to make sure that use of water is minimised. The objectives for water conservation management are to minimise the net use of water by maximising surface infiltration/recharge in addition to minimising the irrigation water requirements for establishing and maintaining gardens and public open spaces by utilising waterwise principles such as low water requirement plants and species.

The State government identified demand reduction for potable water use and consideration include the use of alternative, fit-for-purpose and water supplies in new residential developments. The initiatives include:

- The BCA 5 Star Plus initiative, by Government of Western Australia, requires that new homes will have water efficient hot water systems, showerheads, taps and toilets; stage 2 of the initiative require alternative water supply for flushing toilets and for washing machines where single dwellings are located on larger lots.

- The Water Corporation's waterwise Rebate Program which include swimming pool covers, rain sensors, subsurface irrigation system, grey water re-use, rainwater tanks, and garden bores.

- The DoW has developed a waterwise Communities Toolkit that provides access to information on wise water use, availability of sources for recycling, shallow ground water, alternative solutions and streamlined application and approval processes.

4.2 DESIGN CRITERIA AND MANAGEMENT MEASURES

Design Criteria

The criteria of water efficiency initiatives for households include:

- Consumption target of water of 100kL/per/year including not more than 40-60kL/person/year of scheme water.
- Meeting 5 Star Plus provisions for all new dwellings.
- Use of rainwater tanks to be promoted to achieve water consumption targets.
- Use alternative water resources for irrigation.

Management Measures

At the development stage, a water conservation could be achieved by implementation of the following management measures:

- Encouraging at-source surface recharge where possible using soakwells, vegetated retention basins, swales,
- Retention of native trees within POS where possible to reduce demand for water during POS area establishment.
- Use of non-potable groundwater for irrigation of POS areas.
- Manage irrigation within POS areas to minimise losses to evaporation.

It will be the responsibility of the local Council to ensure that the building licence applicant details how they expect to manage stormwater with the view to conserving water and to maximise the reuse of this water.

4.3 WASTE WATER MANAGEMENT

The development lots for lots 15 and 17 Brand Highway will be connected to the City of Geraldton, Water Corporation Sewer infrastructure that is currently in the Water Corporations planning and will run along Brand Hwy.

5 STORMWATER MANAGEMENT PLAN

5.1 STORMWATER MANAGEMENT

Surface water runoff needs to be managed at both lot level and development scale. To manage the stormwater runoff at the post development stage, a preliminary earthwork site level and drainage system is proposed to manage minor and major events up to the 1 in 100-yrARI event based on maintaining existing hydrology by infiltrating surface water as close to the source as possible.

The principle drainage system of the development will be based on the Better Urban Water Management (BUWM) guideline and also local government subdivision development guidelines as directed by the City of Geraldton, and the DoW. The principle design will also take into account the decision made by Main Roads WA, that stormwater collected within the lots cannot discharge onto Brand Hwy as there is a flooding issue on the road and subdivision development should make sure that all run off at post development stage should be contained within both lots for up to 1 in 100-yrARI event.

Preliminary site finished levels and associated post development catchments and stormwater measures are illustrated in Figure 10a &11a (Lot 15) and 10b &11b (Lot 17):

The stormwater management system for Lot 15 and 17 is dependent on and includes the following design concepts.

- To maintain the stormwater runoff at post development stage up to the 1 in 100-yr ARI event, which is to be retained within the subdivision boundary; storm-water is conveyed to the POS for further infiltration within the development boundaries.
- Stormwater runoff from the roof of each residential Lot will be retained in soakwells or basins/swale drains on site for up to the 1 in 1-yr ARI event for a one hour duration.
- A gravity piped system, which is sized to accommodate flow up to the 1 in 5-yrARI event. As an alternative an open trench drainage system with shallow, vegetated swales is also feasible, depending on the proposed width of the road reserve and the proposed sizes of the Lots. A combination of both systems is optional.
- The proposed road reserve in conjunction with the 1 in 5-yr ARI system is designed to convey the 1 in 100-yrARI event towards infiltration basins located within Public Open Spaces.
- The pipe network will be designed with leaky manholes that low flows can infiltrate at source.
- Basins will retain and infiltrate site runoff. Events upto the 1 in 100-yr ARI will infiltrate within the vegetated portion of the basin.
- Basins are sized to cater for the 1 in 100-yr ARI event, having a maximum grade of 1 in 6 and a maximum water depth of 1200mm.
- Minimum Lot levels to be 300mm above the 1 in 100-yrflood level.

5.2 ASSESSMENT OF STORMWATER MANAGEMENT STRATEGY

A summary of management strategy is outlined below:

For 1 in 1 year ARI event

The 1 in 1 year ARI event for a storm duration of one hour will be retained within each property boundary through the installation of soakwells, basins or swales on site. These systems will retain roof runoff and water will infiltrate into the ground.

For 1 in 5 years ARI events

The gravity pipe drainage system designed to cater for the stormwater up to 1 in 5 years ARI storm event, fully within the system. The stormwater runoff from the road reserves at this event will be directed to the designated detention basin within the development.

For 1 in 100 years ARI events

For events exceeding the 1 in 5 years ARI event, stormwater will be conveyed through both 1 in 5 years ARI drainage system and the road reserve network into the detention basin. The extent of the localised flow on the site will be limited to the road reserve. The road reserve is designed to provide a pathway for stormwater runoff to the designated detention basins. The detention basins are intended to cater for a stormwater event up to the 1 in 100 years ARI storm event.

For rare rainfall events in excess of the 100-yr ARI, overflow will be directed to road reserves as shown on concept drawings 1400-C-150-162.

5.3 STORMWATER CALCULATION METHODOLOGY

5.3.1 Pre - development Flows

XP-SWMM was used to calculate the flow at pre development stage of the project site. The C10 was calculated using Australian Rainfall & Runoff (ARR, 2003) and was found to be 0.181; the C coefficient for 1, 5, and 100 years ARI events are shown in Table 2 below and are used in XP-SWMM.

Table 3: C Coefficient of Predevelopment Flow

ARI years	Frequency Factors, Fy	Coefficient C
C_1	0.8	0.144
C_5	0.95	0.171
C_{10}	1	0.181
C_{100}	1.2	0.216

The pre development flow of Lot 15 and 17 are shown in Table 3 and Table 4 respectively.

Table 4: Predevelopment Flow for Lot 15

LOT 15	Area (ha)	Q for 1 in n years ARI (m^3/sec)		
		1	5	100
Catchment A	23.64	0.24	0.52	1.28
Catchment B	0.53	0.01	0.02	0.05
Catchment C	7.15	0.11	0.25	0.59
Catchment D	0.2	0.05	0.01	0.02

Table 5: Predevelopment Flow for Lot 17

LOT 17	Area (ha)	Q for 1 in n years ARI (m3/sec)		
		1	5	100
Catchment A	23	0.24	0.53	1.31
Catchment B	2.89	0.05	0.105	0.25
Catchment C	5.07	0.07	0.146	0.35
Catchment D	4.59	0.08	0.161	0.39

Catchment A of both Lot 15 and 17, which have a total area of 46.64 ha, contribute to the flooding on Brand Hwy, the flow from these catchments will be contained on site at post development stage thus mitigating flows to the road and help reduce flooding at the Brand Hwy.

5.3.2 Preliminary Finished Site Levels

Preliminary site earthwork levels have been estimated for future development to ensure containment of surface runoff in accordance with the City of Geraldton design criteria as shown on Figure 11a (Lot15) and Figure 11b (Lot 17).

5.3.3 Post Development Drainage Catchments

Four post development drainage catchments A,B,C and D have been nominated for Lot 15 and eight drainage catchments E, F, G, H, I, J, K and L nominated for Lot 17 as shown in Figure 10a(lot 15) and 10b(lot 17).

Areas for each Catchment is shown in Table 6

Table 6 Post Development Catchment Area

CATCHMENT	A	B	C	D	E	F	G	H	I	J	K	L
AREA (ha)	10.17	3.79	9.65	10.17	3.95	5.60	3.89	5.89	0.79	2.31	4.81	4.85

5.3.4 Infiltration Basin & POS

The City of Geraldton requires that the designated detention basins to be able to store water up to the 1 in 100 years ARI event.

The soil type within Geraldton is mainly covered by sandy soil, and as such, will have a high-saturated hydraulic conductivity.
Parameters used for the basin design, are as follows:

- Saturated hydraulic conductivity (ku) = 180mm/hour (5. x 10-5m/s)
- Soil Moderation Factor (U) = 0.5

The preliminary storage volume calculation is based on the Stormwater Management Manual Chapter 9; all calculations are shown in Appendix A.

5.3.5 Flow Assessment at Legal Points of Discharge (Post –Mitigated Development Flows)

It is highlighted that all site runoff is retained and infiltrated on site in the post-development scenario for all events upto and including the 100-yr ARI event. There will be no runoff exiting the site.

5.3.6 Lot Drainage System

Where possible, runoff from roofs within the catchments will be retained and infiltrated in soakwells. The UWMP must ensure that basins are designed to cater for the co-efficient of runoff as nominated by the City of Geraldton Land Development Specification in accordance with the proposed site level design based on the current layout and soil conditions at the site.

5.3.7 Development Drainage System

Drainage of road reserves within the catchments will be achieved through an interconnected pipe network discharging to the basins. Events up to the 100-yr ARI will infiltrate within the vegetated portion of the basin i.e. there will be no discharge from the site for events less than or equal to the 100-yr ARI event.

The pipe network will be designed with leaky manholes such that low flows can infiltrate at source.

The basins will retain and infiltrate site runoff. Basins are expected to have sandy floors to facilitate infiltration.

All rainfall events upto and including the 110-yr ARI will be contained within the POS basin areas. For rare rainfall events in excess of the 100-yr ARI, they shall also be partially contained within the POS/basin areas with overflow paths identified within road reserves as shown in Figure 12A and 12B.

5.3.8 Lot 15 Brand Highway

Lot 15 is proposed to manage runoff into 4 separate catchments A, B, C, and D within POS areas.

Preliminary earthworks level have been proposed which direct surplus lot flow and road reserve runoff to nominated basins located within planned POS areas.

The catchment areas for each designated infiltration basin within Lot 15 are shown in Figure 10a. Each catchment area is labelled and the drainage area is then determined for each catchment.

Conceptual basin layouts located within POS areas have been prepared and are attached as Appendix B. Summary of basin detail calculations are summarised in Table 7 below:

Table 7 – Lot 15 Post-development Catchments

.

Basin	ARI	Level (mAHD)	Volume (m^3)	Surface Area (m^3)	Property soakwell storage (1 in1-yr ARI)	Basin Size			
						Top Water Area (m2)	Base Area (m2)	Top Volume (m3)	Side Slope 1:
A	1-yr	32.75	187.00	188.00	903.00	3,945.00	3,500.00	1,958.00	6
	5-yr	33.40	842.00	883.00					
	100 yr	33.70	2,845.00	3,954.00					
B	1-yr	35.74	86.00	87.00	463.00	1,968.00	1,650.00	1,041.00	6
	5-yr	36.40	542.00	848.00					
	100 yr	36.70	1,475.00	1,968.00					
C	1-yr	34.73	217.00	218.00	1,166.00	5,160.00	4,500.00	2,574.00	6
	5-yr	35.40	1,126.00	1,690.00					
	100 yr	35.70	3,713.00	5,160.00					
D	1-yr	47.85	195.00	196.00	1,229.00	5,812.00	5,265.00	2,625.00	6
	5-yr	47.40	965.00	1,663.00					
	100 yr	47.70	3,815.00	5,812.00					

5.3.9 Lot 17 Brand Highway

Lot 17 is to be managed as 8 separate catchments E, F, G, H, I, J, K and L within POS areas as shown in Figure 10b.

Preliminary earthworks level have been proposed which direct surplus lot flow and road reserve runoff to nominated basins located within planned POS areas.

The catchment areas for each designated infiltration basin within Lot 17 are shown in Figure 10b. Each catchment area is labelled and the drainage area is then determined for each catchment.

Conceptual basin layouts located within POS areas have been prepared and are attached as Appendix B. Summary of basin detail calculations are summarised in Table 8 below:

Table 8 – Lot 17 Post-development Catchments

Basin	ARI	Level (mAHD)	Volume (m^3)	Surface Area (m^3)	Property soakwell storage (1 in1-yr ARI)	Basin Size			
						Top Water Area (m2)	Base Area (m2)	Volume (m3)	Side Slope 1:
E	1-yr	32.83	103.00	406.00	482.00	2,169.00	260.00	1,024.00	6
	5-yr	33.40	429.00	733.00					
	100 yr	33.70	1,501.00	2,169.00					
F	1-yr	27.83	103.00	406.00	684.00	3,252.00	448.00	1,574.00	6
	5-yr	28.40	662.00	1,061.00					
	100 yr	28.70	2,083.00	3,252.00					
G	1-yr	34.65	86.00	87.00	386.00	5,160.00	300.00	1,405.00	6
	5-yr	35.40	407.00	1,690.00					
	100 yr	35.60	1,245.00	5,160.00					
H	1-yr	46.27	142.00	616.00	711.00	2,820.00	440.00	1,658.00	6
	5-yr	46.90	522.00	980.00					
	100 yr	47.20	2,349.00	2,820.00					
I	1-yr	43.25	16.00	91.00	95.00	606.00	40.00	345.00	6
	5-yr	43.90	65.00	193.00					
	100 yr	44.20	247.00	606.00					
J	1-yr	26.82	57.00	235.00	279.00	758.00	128.00	473.00	6
	5-yr	26.40	197.00	425.00					
	100 yr	26.70	431.00	758.00					
K	1-yr	27.25	114.00	528.00	581.00	2,184.00	390.00	1,371.00	6
	5-yr	27.90	416.00	821.00					
	100 yr	28.20	1,950.00	2,184.00					
L	1-yr	41.95	183.00	641.00	586.00	2,514.00	280.00	1,323.00	6
	5-yr	42.40	414.00	785.00					
	100 yr	42.70	1,884.00	2,514.00					

5.4 SURFACE WATER QUALITY

To achieve water conservation and efficiency, the project will need to ensure that the use of Best Management Practices (BMP's) will be adapted so as to manage the stormwater at the pre-development conditions, as well as nutrient and sediment management of the stormwater. The primary strategy is utilise devices to maintain and/or improve the water quality for minor 1 in 1 year event runoff.

This will be implemented where possible through the use of unconnected property soakwells, however the ability to do so for road reserve runoff is restricted in this case by soil types and steep grades of the natural surface of the site. The implementation of vegetated biorentention basins within POS areas strategically located throughout the development structure plan is proposed to meet the quality objectives and set-out by the Stormwater Management Manual of Western Australia regarding bioretention system areas and non structural measures. The bioretention./detention basin areas are to be vegetated with local native species selected for their ability to take up nutrients. A detailed list of species will be provided in the UWMP phase of the planning process.

Where the presence of limestone is an issue the implementation of soakage pits into the road piped system will aid the infiltration at source for road reserve runoff for minor events.

Implementation of at source measures and any potential constraints will be investigated during the UWMP phase when geotechnical and other details are known such as the presence and clearance to limestone.

In order to maintain a conservative approach the infiltration in soakwells has not been included in preliminary concept calculations for stormwater runoff in this phase of planning.

5.5 STRUCTURAL BEST MANAGEMENT PRACTICES (BMPS)

The key structural BMP's implemented as part of this development, are summarised in Table 7 below.

Table 1 – Key Structural BMP's

Scale	Ownership & Maintenance	BMP
Lot	Lot Owner	Infiltration System: • Reduced impervious areas • Soakwells, Water Efficiency Devices
Street	Local Authority	Conveyance System: • Gravity piped drainage system designed for the 1 in 5 years event or and equally designed open trench drainage system. Pollutant Control System: • Vegetated sedimentation basins and Gross Water Pollutant Traps
Precinct	Local Authority	Infiltration System: • Vegetated detention basin designed to cater for the 1 in 100 years ARI event.

Requirements for the Lot owners will be required to be enforced at the building stage as part of building application.

5.5.1 Separation System

The street drainage system is designed to cater for the 1 in 5 years ARI event, within a suitable system. All drainage networks are proposed to be directed to a separation system such as sedimentation basin.

Up to 1 in 5 years ARI events will discharge into the 1 in 5 years ARI drainage system which direct the flow into the sedimentation control basins or other approved structures. Overland flows higher than 1 in 5 years event ARI which will have a higher quality of water will be allowed to bypass the designated pollution control systems flowing directly into the detention basin.

Incorporating a sediment and pollution control component within the system provides additional water quality treatment for water sensitive urban design purposes.

5.6 NON-STRUCTURAL BMP'S

Non-structural BMP's are recommended with the view to provide additional stormwater quality management and can include; public awareness, community education, establishing operation, maintenance activities and management of land use.

The following are considered most relevant to the development of Lot 15 and Lot 17 Brand Highway, Rudds Gully:

- Implementation of sediment and erosion control measures at construction phase.
- Ensure all structural BMP's are maintained according to relevant maintenance plans.
- Maintenance shall include regular vegetation trimming and removal to promote growth and nutrient take-up, as well as removal of sedimentation.
- Sweeping to capture pollutants such as litter, organic matter and other sediments so that they are not collected by the drainage system.

6 GROUNDWATER MANAGEMENT

6.1 GROUNDWATER LEVEL

The maximum groundwater level is expected to be more than 15 metres below development level and will not impact on study on groundwater level for the project.

The construction of infiltration of basins, soakwells within the project site will not be impacted by groundwater level and other groundwater control measures such as subsoil drains or other measures will not berequired.

Infiltration basins shall not intersect groundwater and emptying of the basins within 72 hours will occur.

Infiltration both at source and form the POS/Drainage areas will ensure groundwater levels should be maintained close to Pre-developmentlevels.

Further investigation during the UWMP phase will assess whether groundwater bores are possible for POS irrigation as is the preferred option of both the City of Geraldton and Department of Water.

6.2 GROUNDWATER QUALITY MEASURES

The Lot areas typically have high permeability sand, which allows high amount of soakage from the post development flows, to infiltrate into the ground. Sediment and gross pollution control systems have been included in this design, thus preventing pollutants from entering the aquifers and therefore improving the water quality of the stormwater before infiltration at the detention basin takes place.

6.2.1 Infiltration Basins

Infiltration basins will also be vegetated with local species to encourage stripping of nutrients before being infiltrated into the ground, thus increasing the water quality before being recharged into the ground. It is also possible to combine all measurements to control the sediment and gross pollution movements with one arrangement, i.e. a vegetated bio-retention basin. Although this does not limit the installation to only one basin per catchment, it is also possible to create more than one basin conveniently located at different Public Open Spaces. This would also help reducing the stormwater volumes discharging through the 1 in 5-yr ARI event drainage system and the road reserve in major events.

6.3 GROUNDWATER ALLOCATIONS

In the absence of existing Water licenses that can be transferred to the development, DoW is to be approached upon approval of this document to ascertain current allocation of groundwater in the region to secure licenses for groundwater as a source of irrigation water.

7 SUBDIVISIONS AND UWMP

A UWMP containing a more detailed water management plans will be required to be submitted as a condition of subdivision; the areas that will need to be investigated further at UWMP stage include and not limited to the following:

- Design of water management strategy which demonstrate compliance to the satisfaction of the City of Geraldton and Department of Water design criteria and this document.
- Detailed methodology for implementation of water conservation strategies.
- A further detailed study which include:
  - hydrogeological Investigation to determine depth of groundwater and infiltration capacity of soil;
  - detailed surveying to investigate flooding of Brand Hwy;
  - detailed earthworks design and stormwater drainage management design and calculation and modelling to determine drainage strategy and flood storage requirements; and
  - detailed Monitoring of Surface and Groundwater targets for water quality, flows and levels that are to be maintained at post development
- The landscape concept ensuring that the concept promotes the water conservation strategy and stormwater management.
- Department of Water allocation and licensing to take groundwater for irrigation purposes
- Construction management of subdivisional works to ensure minimum disturbance to environment.
- Maintenance strategy including roles and responsibilities of each stakeholder.
- Implementation of UWMP including roles, responsibilities, funding, and maintenance arrangements.
- Advice from the City is that diagonal road crossings are not recommended for drainage.

8 MONITORING PROGRAM

Monitoring requirements in this section were determined by the DoW's Natural Resource Management Officer; the requirement is in accordance with DoW's Draft "Water monitoring guidelines for better urban water management strategies/plans").

8.1 PRE-DEVELOPMENT MONITORING

There are no permanent surface water features on Lots 15 and 17, but some of the surface drainage of the land in larger events will flow to Rudds Gully, tributary to the Greenough River and Estuary which are recognised as having ecological and recreational value. Groundwater is likely to be at a depth of more than 10m and will be brackish to saline.

Section 2.2 of the DoW guidelines specifies that where no district or local water management strategies have been previously prepared, a minimum of at least 18 months of site specific ecological, surface water and groundwater monitoring must occur before the land is developed. Pre-development monitoring of surface flows will not be required, however if opportunistic sampling can occur at property boundaries, this will enhance evaluation of post-development data, and so is recommended by Department of Water.

8.2 POST DEVELOPMENT MONITORING

There is a need for detailed hydrogeological investigations to ascertain the depth to groundwater and the capacity of bores (within basins) to infiltrate on-site retained stormwater up to and including the 100 yr ARI event.

Geotechnical assessment of infiltration capacity for the proposed design will determine if this approach is justified and/or suitable for Lots 15 & 17. Given the lots may be on soil type, with a caprock limestone, the construction of infiltration bores may be required.

If bores are needed to enhance infiltration, pre and post-development groundwater monitoring will also be required, in accordance with the DoW guidelines.

A post development monitoring program will be implemented with activities pertaining to the following:

- biannual water quality monitoring for nutrients, total suspended solids and other physical parameters at the outlet of the stormwater treatment swale. This will be opportunistic based on flow.
- Nutrients should be measured on a quarterly basis with some initial first flush monitoring for heavy metals and pesticides. Groundwater levels and field parameters should be measured every two months.

8.2.1 Surface Water Monitoring

Surface water flows should be monitored at drainage controls (Basin inlets) on a quarterly basis and on the first flush.

The following parameters are to be analysed for:

- In-situ pH, electrical conductivity, turbidity, dissolved oxygen, and oxidation reduction potential
- Laboratory
- Heavy metals: aluminium, arsenic, cadmium, chromium, copper, iron, lead mercury, nickel, zinc
- Total suspended solids
- Nutrients: ammonia, nitrate and nitrite, total nitrogen and total phosphorous
- Total titratable acidicity, and total alkalinity
- Major cations (calcium, magnesium, sodium, and potassium) and anions (chloride and sulphate)

8.2.2 Groundwater

Groundwater monitoring of infiltration and irrigation bores should be undertaken if applicable under the same reporting and duration guidelines detailed in 8.2.3 and 8.2.4, and the same parameters as for Surface water monitoring.

8.2.3 Duration

Monitoring should continue for 3 years post development, with biannual reporting to the City of Geraldton to ensure baseline conditions are not worsened.

8.3 CONTINGENCY RESPONSE

Minimum Trigger values has been set in the LWMS for in accordance with the Healthy Rivers Action Plan (SRT, 2008) and Australian Drinking Water Guidelines (ANZECC,2000) and are shown in Table 9:

Table 9: Trigger Values

Parameter	Trigger Value
Nutrients	Surface Water: - Total Suspended Solids: measured as Turbidity: <5NTU. - Total Phosphorous: 0.1 mg/L - Total Nitrogen: 1.0 mg/L Groundwater: - Total Phosphorus: 0.1 mg/L - Nitrate: 1.0mg/L Trigger values for all remaining determinants are to be set at ambient concentrations taking due cognisance of the short and long term triggers of the Healthy Rivers Action Plan (SRT, 2008) and ANZECC 2000

Where initial trigger value is exceeded, monitoring will be repeated to determine if there are any sampling errors; where exceeding trigger values are found to be accurate, the following will be implemented:

- Determination of whether the breach:
  - is genuine, outside natural variability of the parameter and signifies a real decline;
  - may have caused by external events;
  - caused by failure of structural BMP's provided during sub-division works; and
  - caused an impact on local or downstream receiving environment.

- Contingency measures, in consultation with relevant authority, will address majority of physical deteriorations that may occur, they are as follow:
  - identify the source of water quality deterioration and remove/replace as appropriate;
  - prevent continuing deterioration with temporary controls; and
  - if required, remove/replace/repair existing structural control, provide/construct additional controls or modify controls/procedures to prevent further deterioration in water quality.

- If measures above has been done and breaches still occur, the following are advised:
  - construction/operation management and maintenance plans and practices should be revised and modified if required; and
  - revision of trigger values may be sought with consultation with City of Greater Geraldton, and Department of Water in consideration of all data collected and actions taken.

9 IMPLEMENTATION PLAN

9.1 DEVELOPER COMMITMENTS

The developer is committed to implement this LWMS, in consultation with the City of Geraldton and the Department of Water, and to subsequently develop an UWMP and detailed engineering design to support an application for subdivision.

9.2 ROLES/RESPONSIBILTIES AND FUNDING

The following key stakeholders and their roles, responsibilities and funding to the operation and maintenance program is proposed and is shown in Table 9 below:

Table 2 - Roles and Responsibilities for Implementation

Organisation	Role/Responsibility	Funding
City of Geraldton	Approval of this document and provide guidance during development of an UWMP	Rates
Water Corporation	Assumes responsibility for the potable and non-potable water supply and sewerage infrastructure constructed, including ongoing operations and maintenance.	Rates
Developer: Australian Minerals Investors Pty Ltd	Satisfy WAPC Conditions including preparation of LWMS and implement a UWMP in consultation with DoW and City of Greater Geraldton Demonstrated that UWMP for subdivision proposal comply with LWMS and achieve water quantity and quality objectives and criteria set by this document. Design and construct water supply and sewerage infrastructure to Water Corporation standards. Apply fo water use license. Contribute for sampling and analysis of post development monitoring activities for submission to the regulatory authorities.	Developer
Lot Owner	Construction and management, consistent with City of Geraldton requirements	Lot Owner

10 REFERENCES

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Department of Agriculture, 2005, Resource Management Technical Report 268, Greenough Region Catchment Appraisal.

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Western Australian Planning Commission (WAPC), 2006a: Statement of Planning Policy No 3 Urban Growth and Settlement.

Western Australian Planning Commission (WAPC), 2006a: State Planning Policy 2.9.

FIGURES

Figure 1 – Site Location

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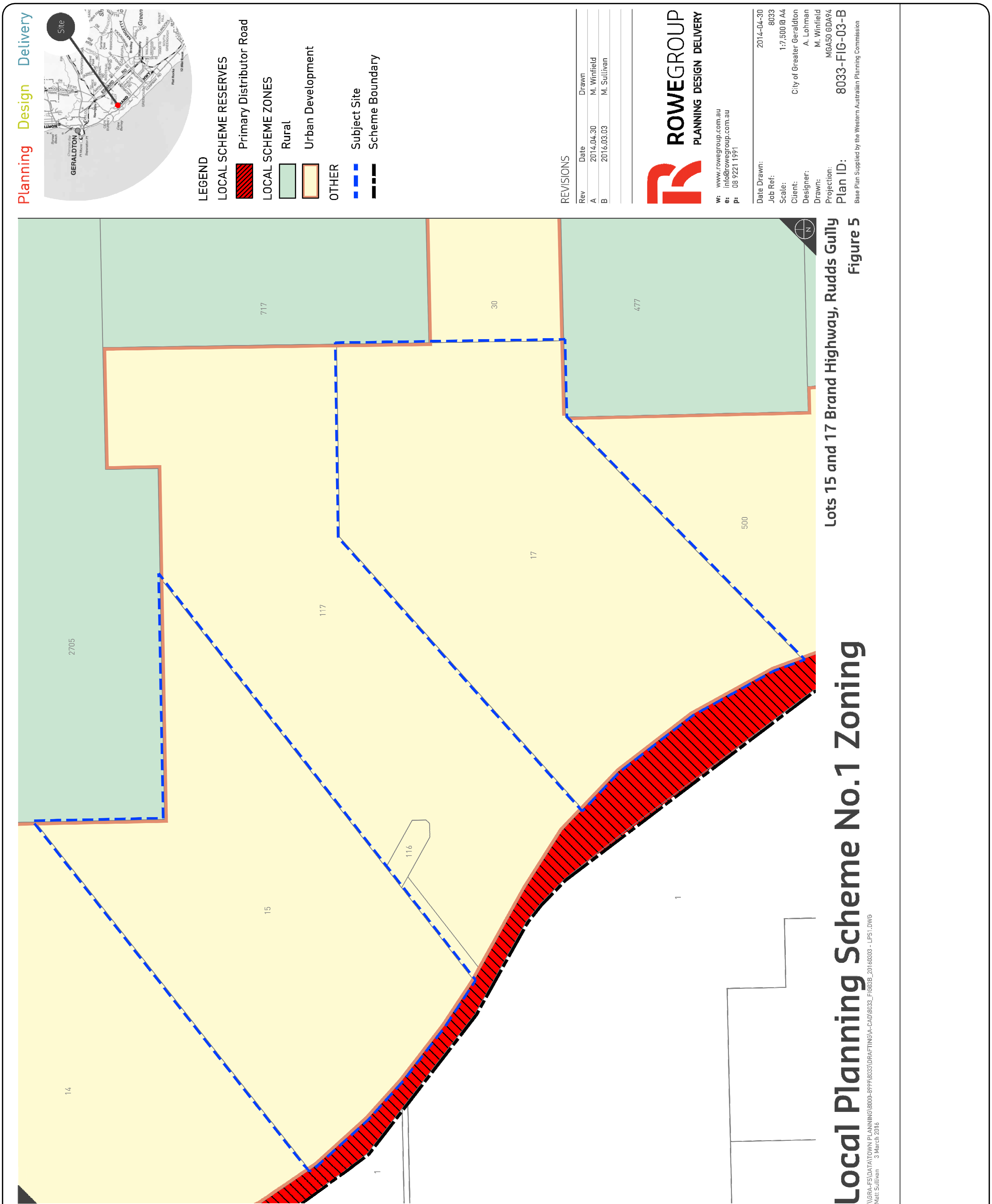
PROJECT
PROPOSED SUBDIVISION LOT 15 & 17 BRAND HWY, RUDDS GULLY

CLIENT
Australian Minerals Investors Pty Ltd

TITLE
SITE LOCATION

SCALE	SIZE	DRAWING No	REV
N/A	A4	14001 – FIGURE 1	A

Figure 2A – Site Zoning Plan



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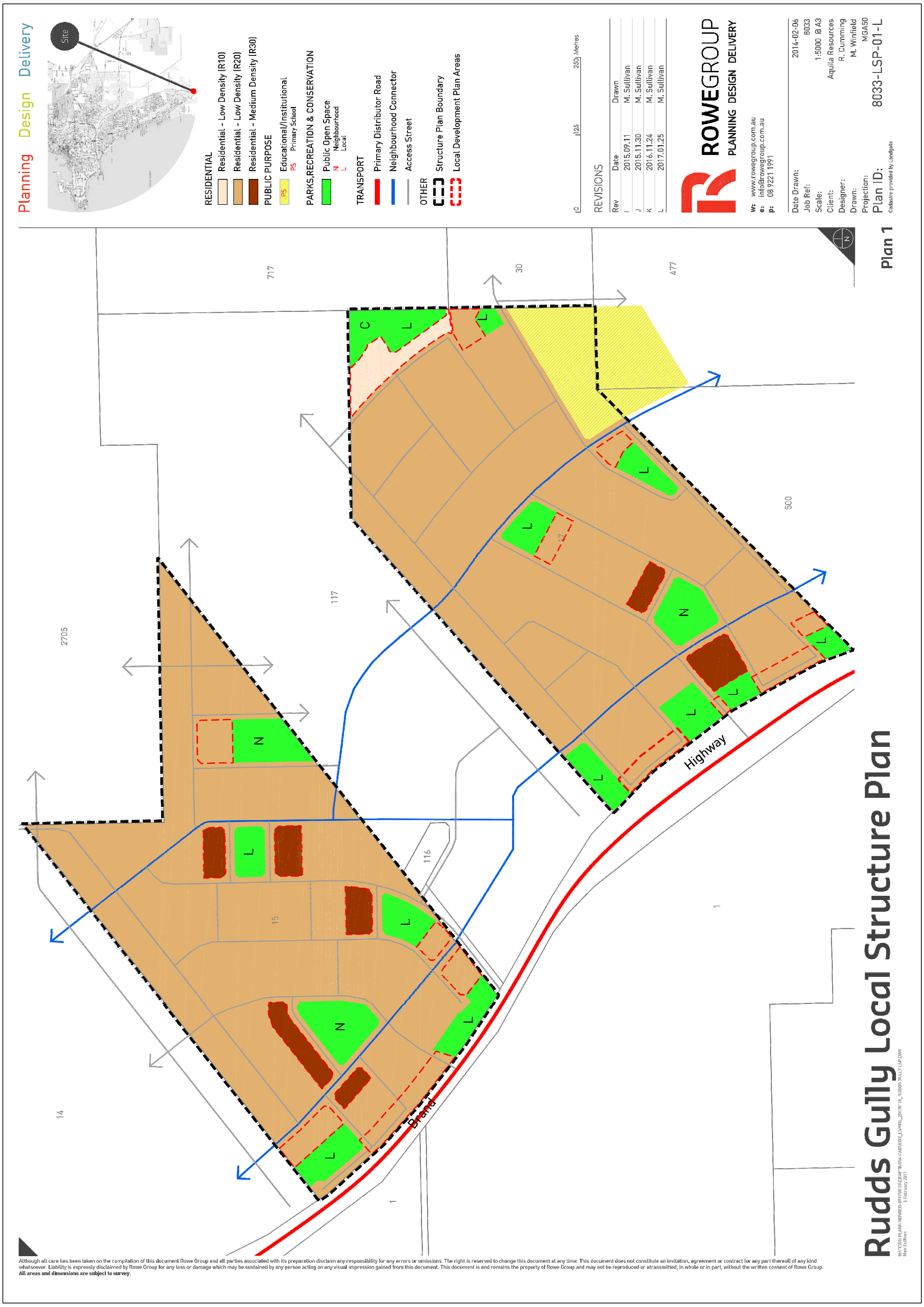
PROJECT	TITLE
PROPOSED SUBDIVISION LOT 15 & 17 BRAND HWY, RUDDS GULLY	SITE ZONING PLAN

CLIENT: Australian Minerals Investors Pty Ltd

SCALE	SIZE	DRAWING No	REV
N/A	A4	14001 - FIGURE 2A	B

Figure 3 – Development Layout



PROJECT

PROPOSED SUBDIVISION LOT
15 & 17 BRAND HWY, RUDDS GULLY

CLIENT

Australian Minerals Investors Pty Ltd

TITLE

STRUCTURE PLAN

SCALE	SIZE	DRAWING No	REV
N/A	A4	14001 - FIGURE 3	C

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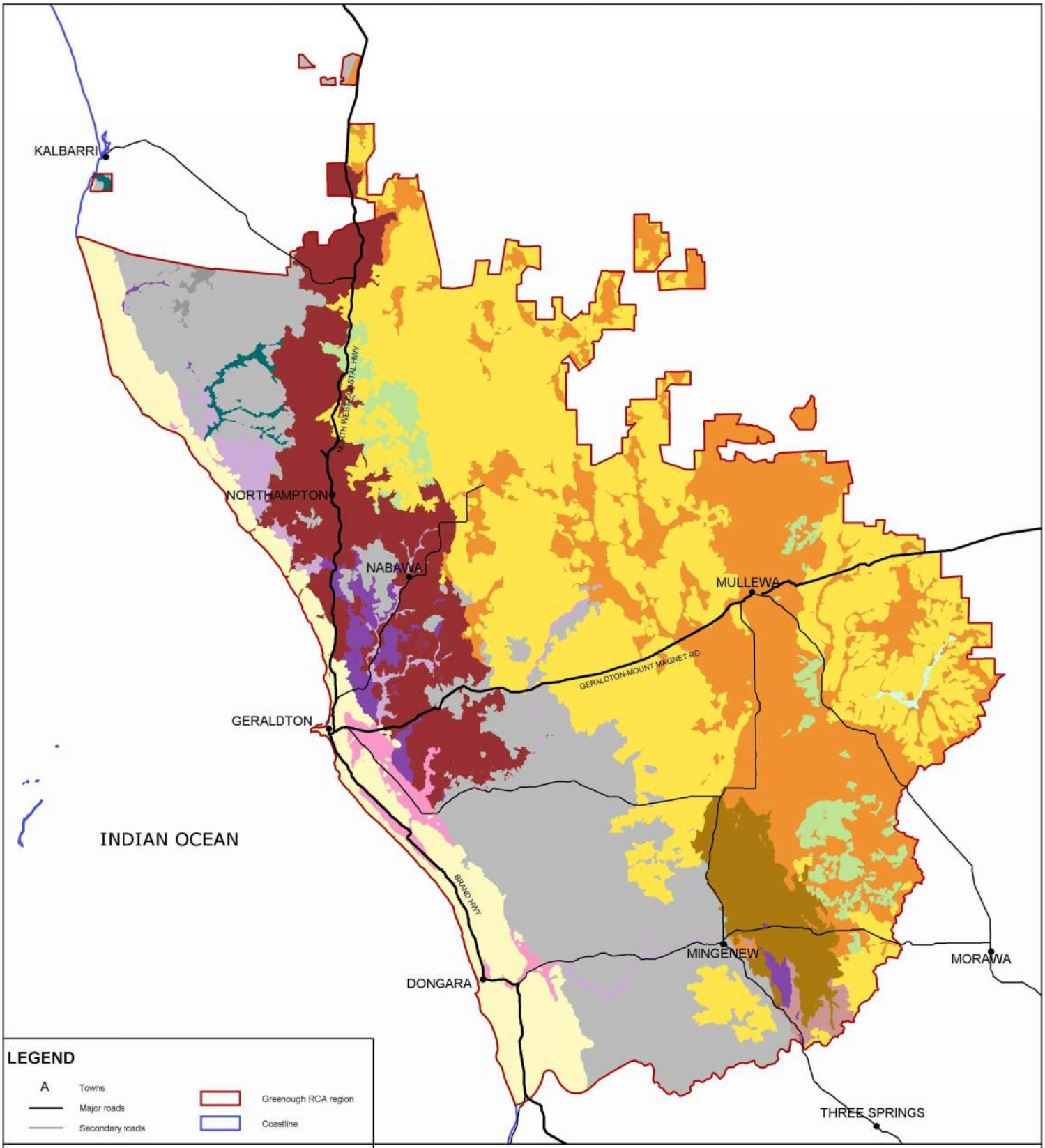
Figure 4 – Surface Geology Map



LEGEND

- A — Towns
- Major roads
- Secondary roads
- Greenough RCA region
- Coastline

SOIL SUPERGROUPS

WET AND WATERLOGGED SOILS	Saline soils and salt lake soils
ROCKY OR STONY SOILS	Rocky or stony soils
CLAYEY SOILS	Clays with red and calcareous earths and red duplexes
DEEP SANDS	Yellow deep sands, yellow and brown sandy earths
	Calcareous deep sands and sands over limestone
	Pale deep sands and sand over gravel
	Deep alluvial sands
IRONSTONE GRAVELLY SOILS	Shallow and sandy gravels
LOAMY EARTHS	Calcareous loamy earths
	Brown to red loamy earths and clays
	Red shallow loams and red-brown hardpan soils
DUPLEX SOILS	Red loamy duplexes
	Sandy and loamy duplexes - Non-alkaline subsoils
	Sandy duplexes - non-alkaline subsoils

Title: **Greenough RCA region soil supergroups**

Compiled by: John Bruce
CRIS Research Officer, Geraldton

Date: 1st April, 2005

File Name: Greenough_soils_GDA94.gws

Projection: Universal Transverse Mercator, Zone 50

Datum: Geocentric Datum of Australia 1994

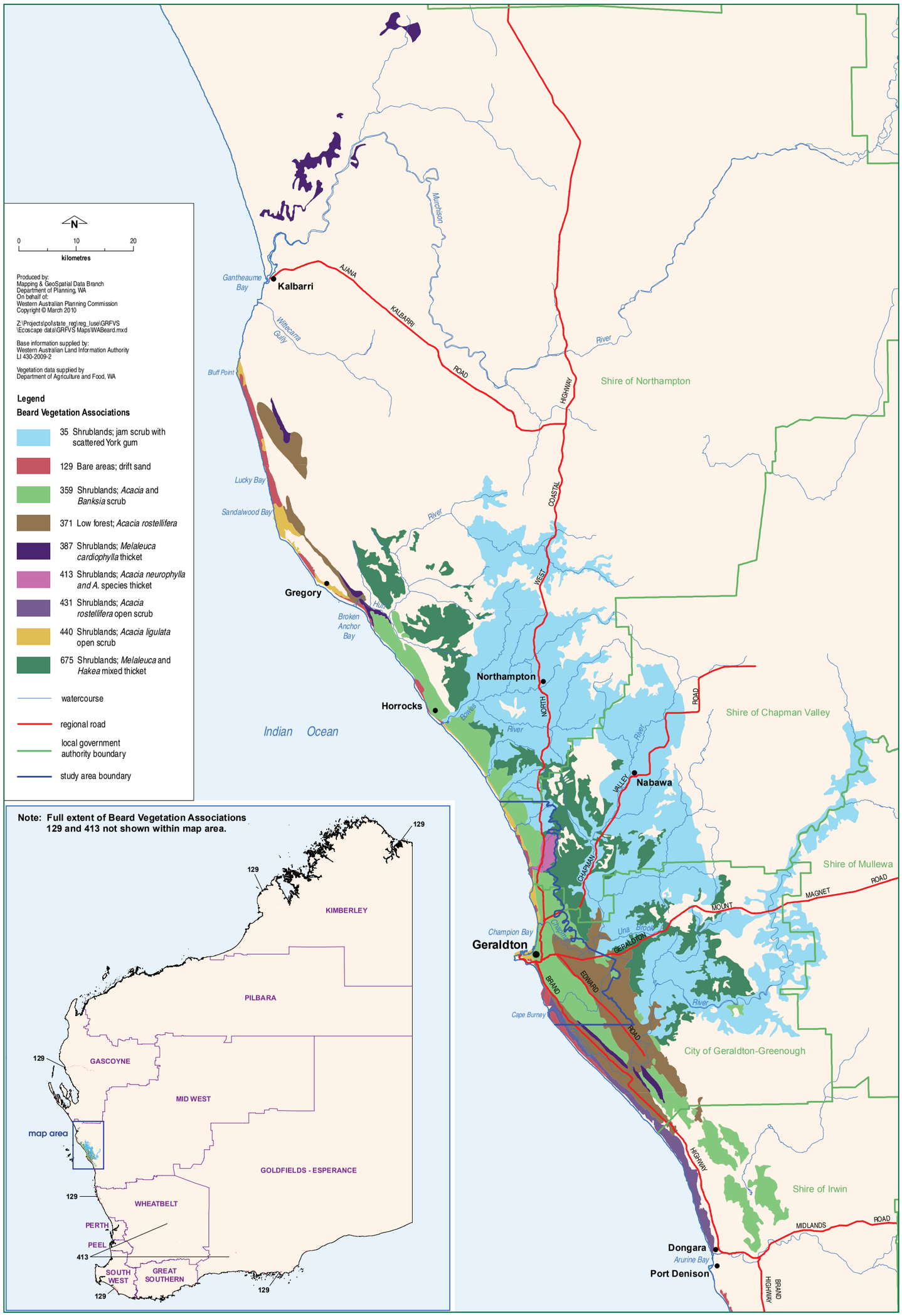
GDA

Department of Agriculture
Government of Western Australia

N

0 10 20 30 40 50
Kilometers

Figure 5 – Vegetation Mapping



Map 3: Original WA extent of GRFVS Beard vegetation associations

Figure 6 – Rudds Gully Waterways

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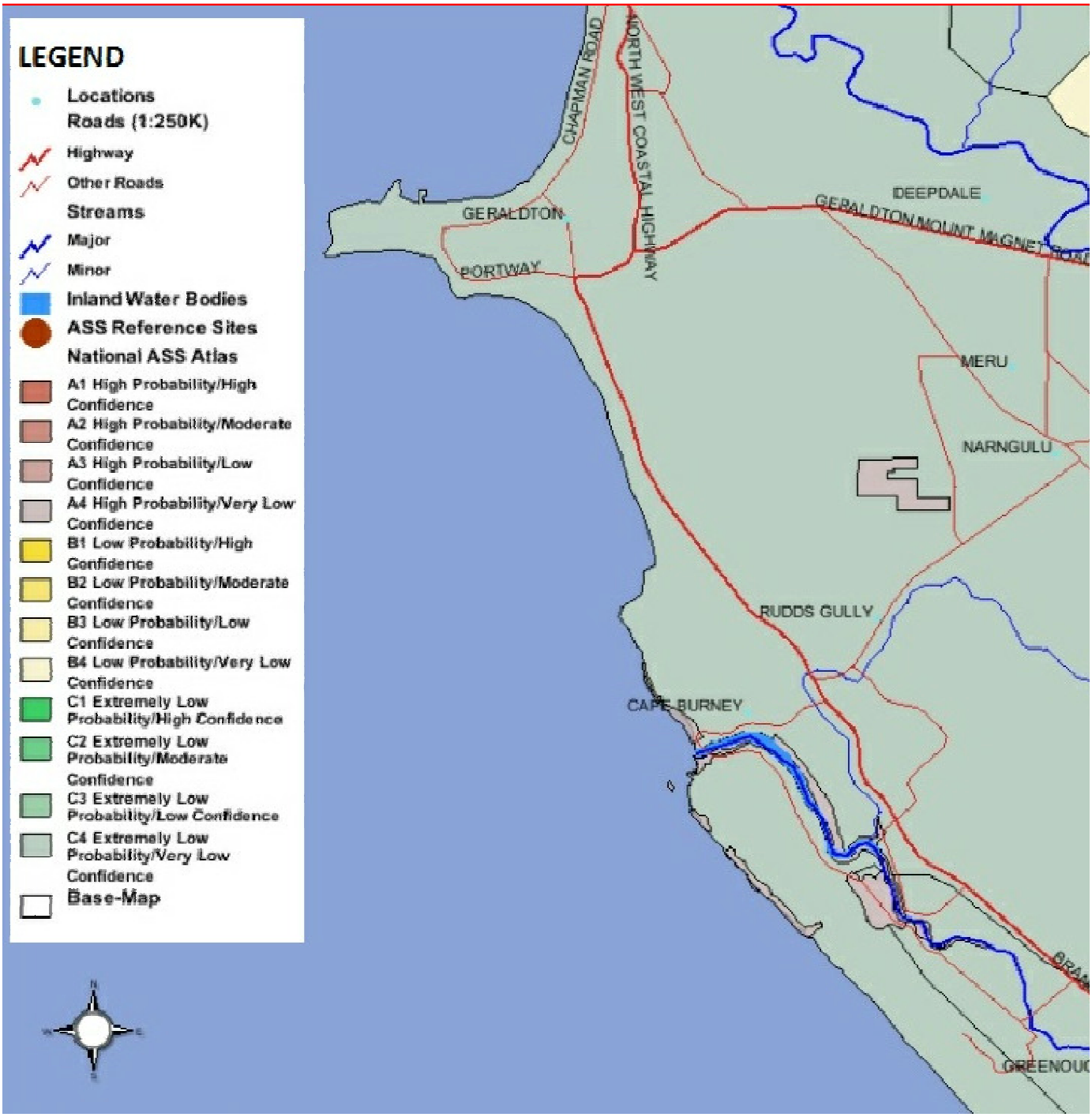
PROPOSED SUBDIVISION LOT
15 & 17 BRAND HWY, RUDDS GULLY

CLIENT
Australian Minerals Investors Pty Ltd

TITLE
RUDDS GULLY WATERWAYS

SCALE	SIZE	DRAWING No	REV
N/A	A4	14001 – FIGURE 6	A

Figure 7 – Acid Sulphate Soil Mapping



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PROPOSED SUBDIVISION LOT
15 & 17 BRAND HWY, RUDDS GULLY

CLIENT
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TITLE
ACID SULPHATE SOIL MAPPING

SCALE	SIZE	DRAWING No	REV
N/A	A4	14001 – FIGURE 7	A

Figure 8A – Pre-Development Catchment Area

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PROPOSED SUBDIVISION LOT 15 & 17 BRAND HWY, RUDDS GULLY

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TITLE
PRE-DEVELOPMENT CATCHMENT AREA

SCALE	SIZE	DRAWING No	REV
N/A	A4	14001 - FIGURE 8A	A

Figure 8B – Surface Water Flow

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PROPOSED SUBDIVISION LOT
15 & 17 BRAND HWY, RUDDS GULLY

CLIENT
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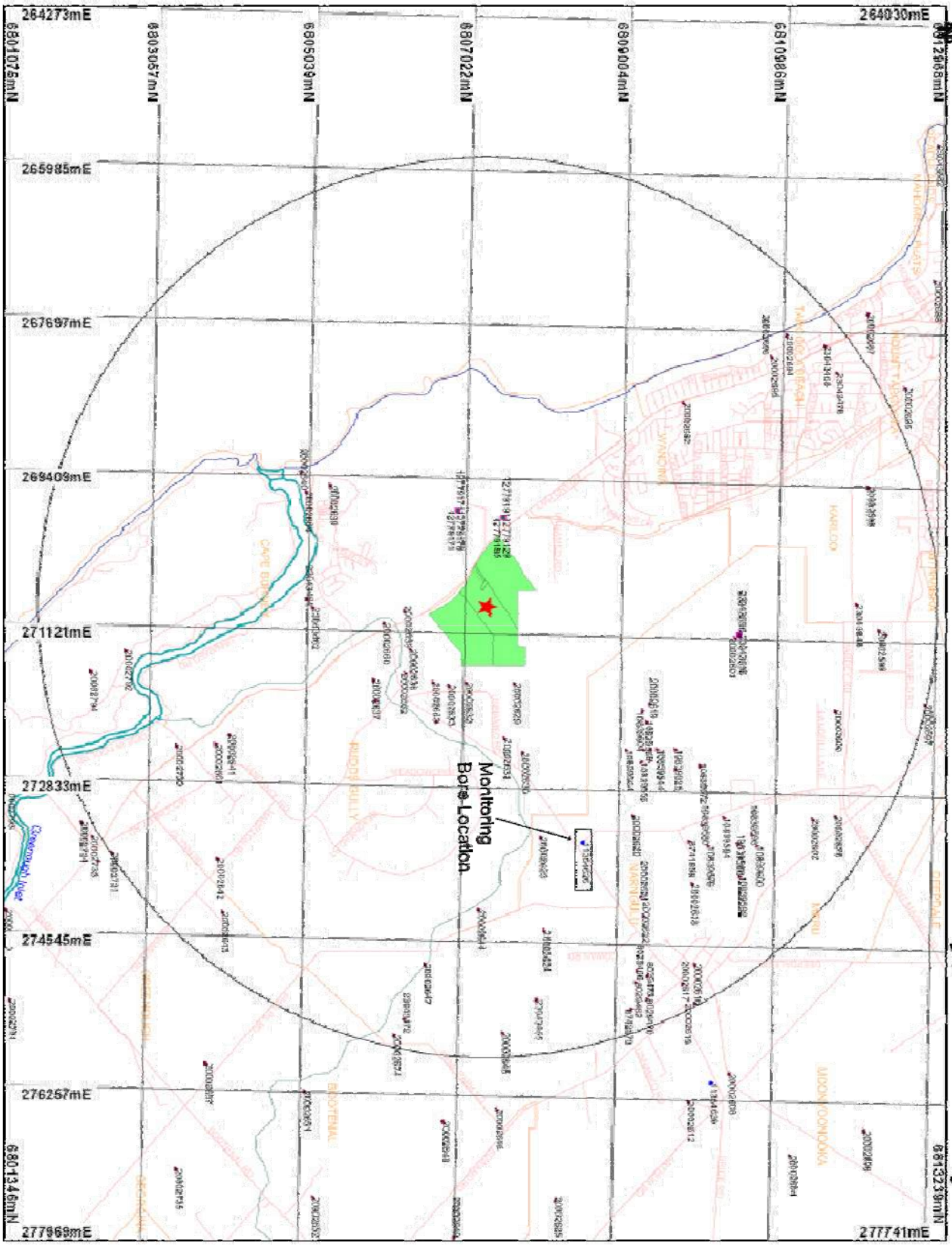
TITLE
SURFACE WATER FLOW

SCALE	SIZE	DRAWING No	REV
N/A	A4	14001 - FIGURE 8B	A

Figure 9 – Monitoring Bores Location

Bores Within a 5km Radius of Lot 15 & 17 Brand Hwy, Rudds Gully



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PROPOSED SUBDIVISION LOT 15 & 17 BRAND HWY, RUDDS GULLY

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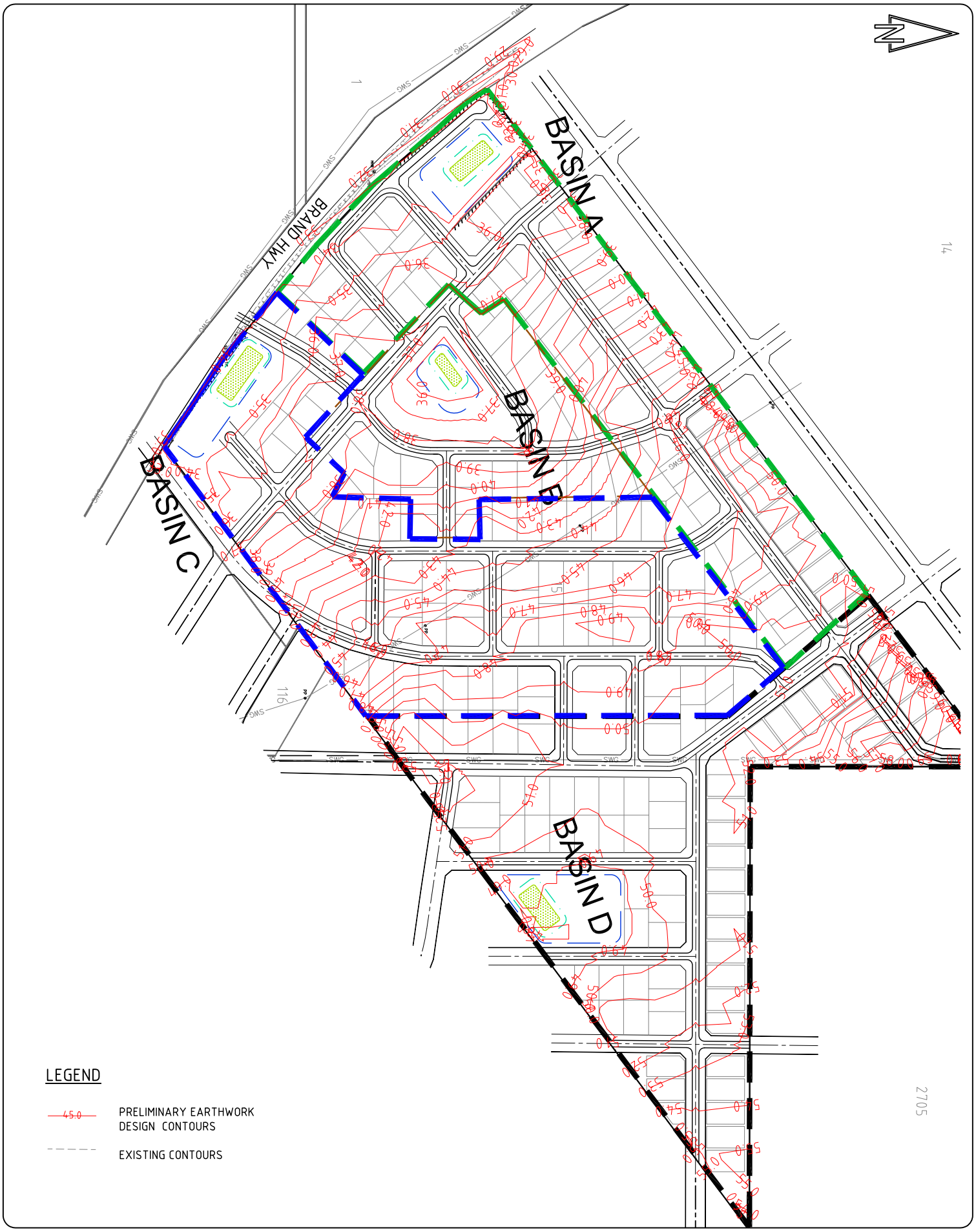
TITLE
MONITORING BORES LOCATION PLAN

SCALE	SIZE	DRAWING No	REV
N/A	A4	14001 – FIGURE 9	A

Figure 10A – Catchment Plan for Lot 15



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PROPOSED SUBDIVISION LOT 15 & 17 BRAND HWY, RUDDS GULLY

CLIENT
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TITLE
DRAINAGE CATCHMENT BOUNDARY LOT 15

SCALE	SIZE	DRAWING No	REV
N/A	A4	14001 - FIGURE 10A	A

Figure 10B – Catchment Plan for Lot 17

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PROJECT
PROPOSED SUBDIVISION LOT
15 & 17 BRAND HWY, RUDDS GULLY

CLIENT
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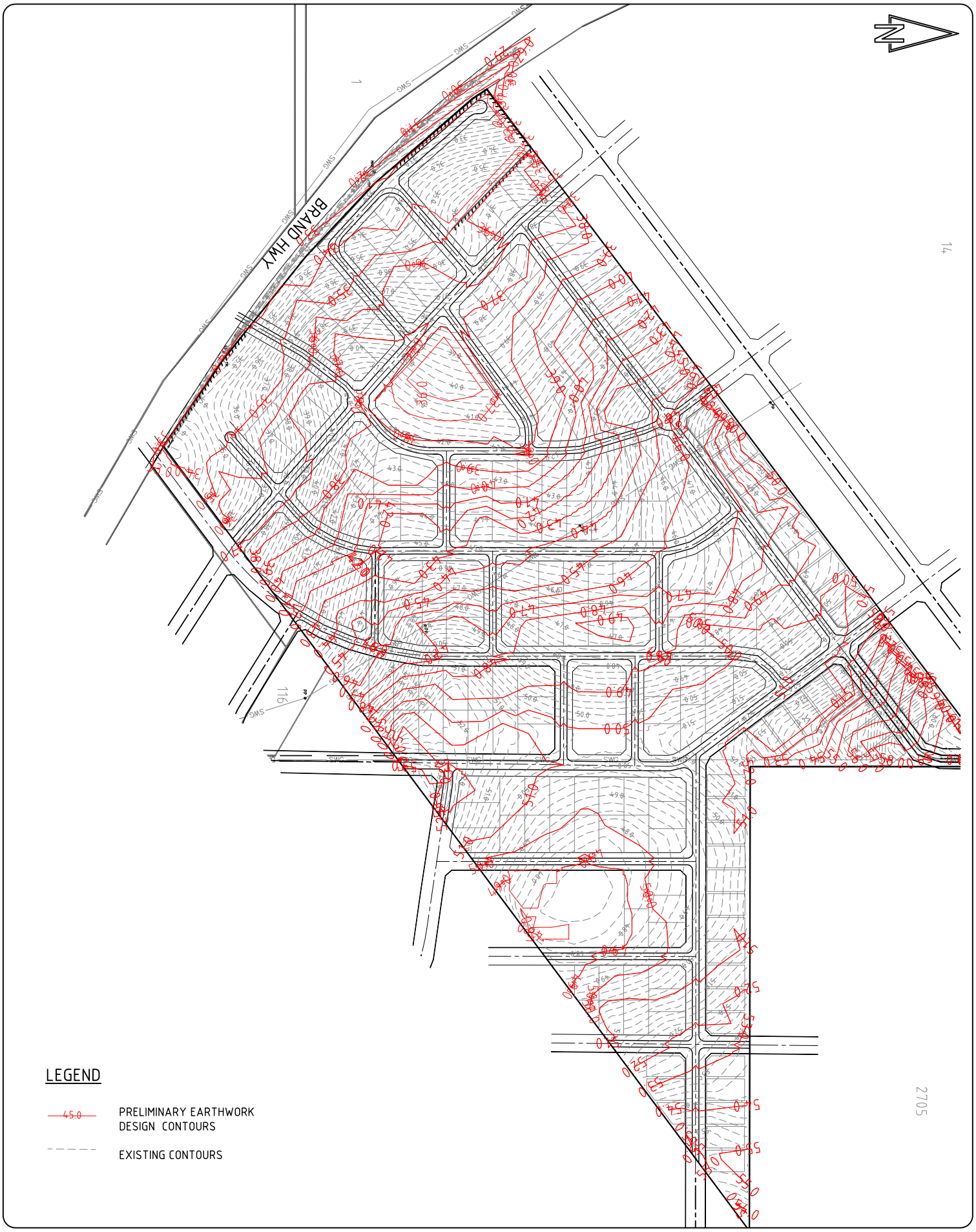
TITLE
DRAINAGE CATCHMENT
BOUNDARY LOT 17

SCALE	SIZE	DRAWING No	REV
N/A	A4	14001 - FIGURE 10B	A

Figure 11A - Preliminary Earthworks Lot 15



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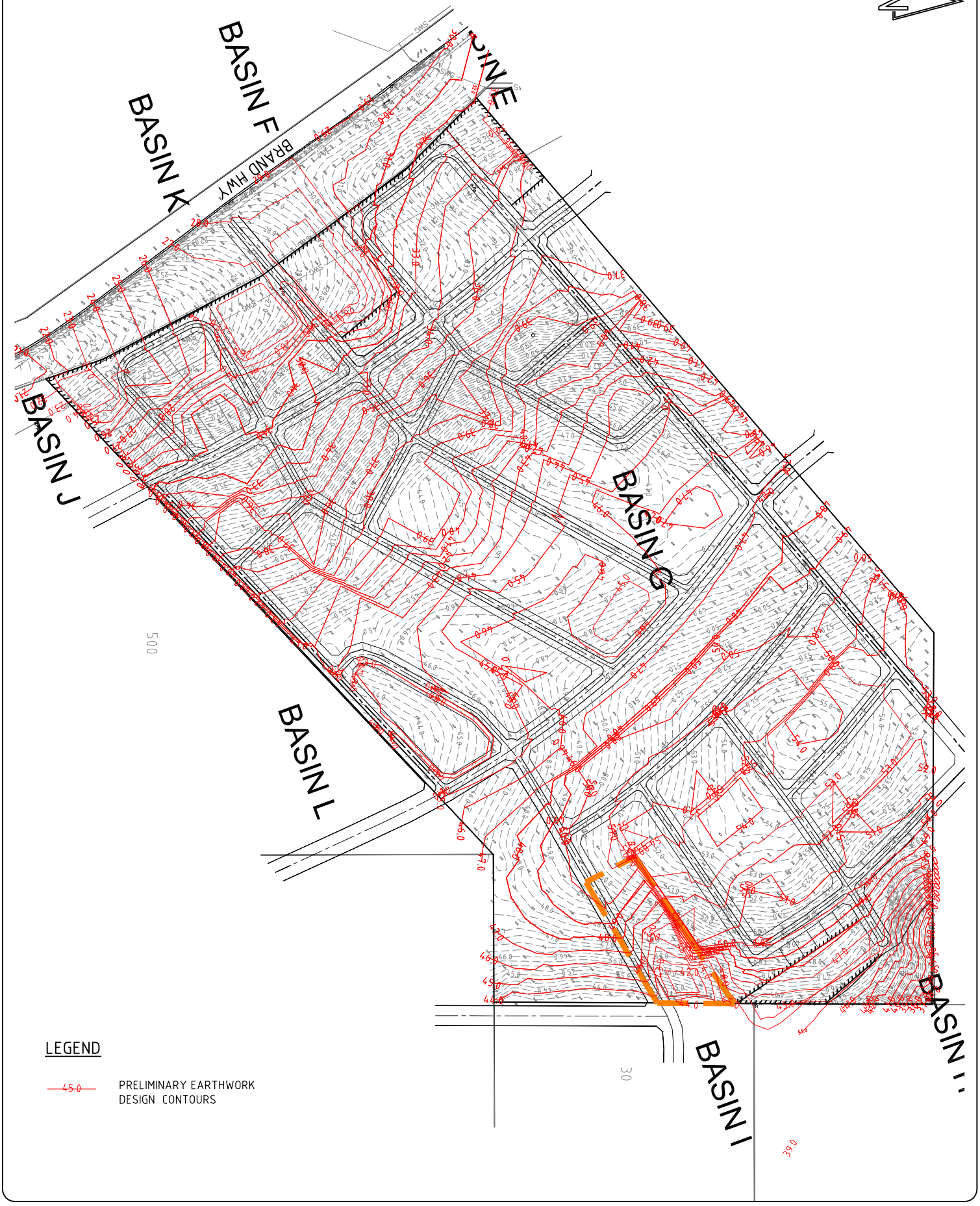
PROJECT
PROPOSED SUBDIVISION LOT 15 & 17 BRAND HWY, RUDDS GULLY

CLIENT
Australian Minerals Investors Pty Ltd

TITLE
PRELIMINARY EARTHWORKS LOT 15

SCALE	SIZE	DRAWING No	REV
N/A	A4	14001 - FIGURE 11A	A

Figure 11B - Preliminary Earthworks Lot 17



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CONSULTING ENGINEERS

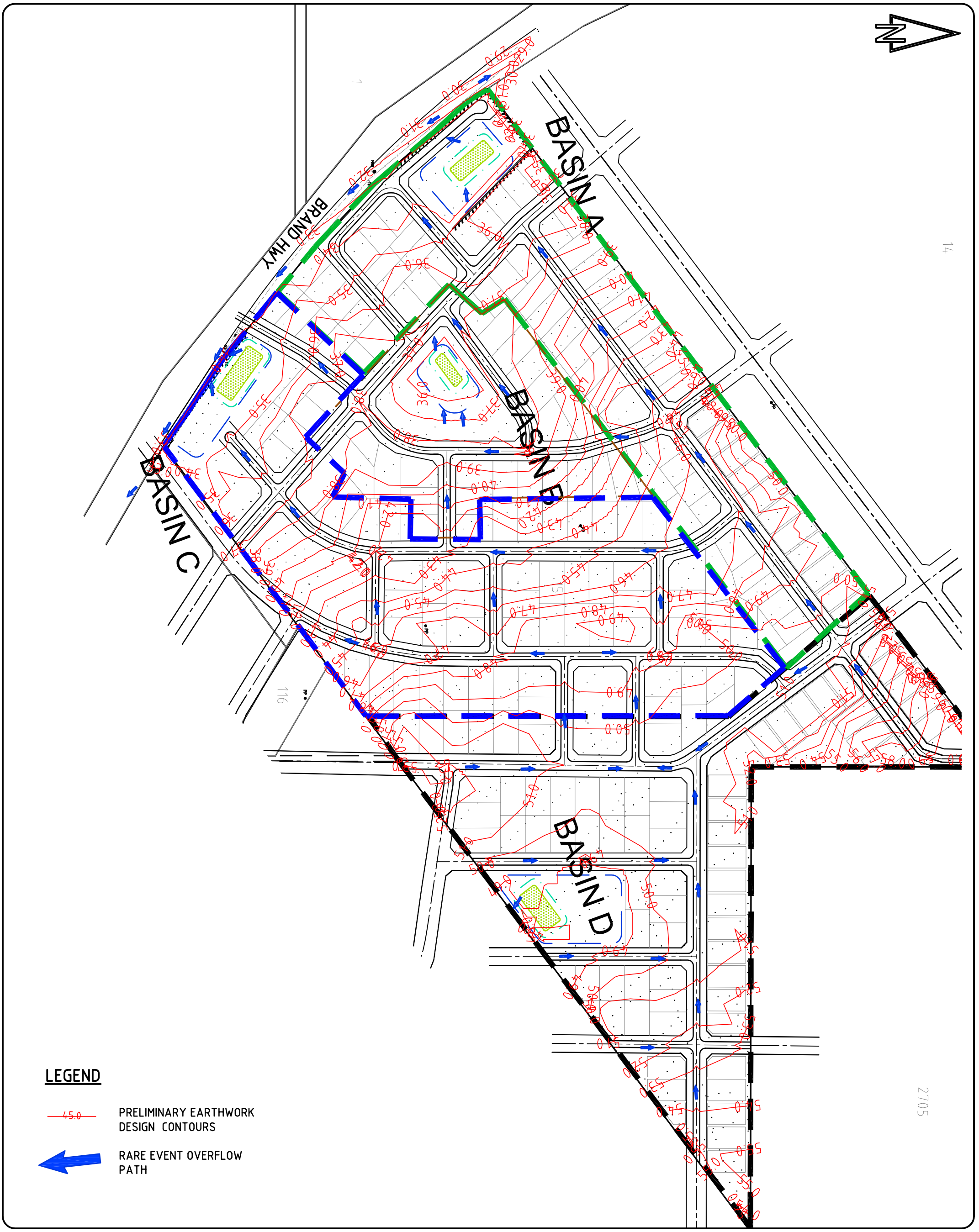
PROJECT
PROPOSED SUBDIVISION LOT
15 & 17 BRAND HWY, RUDDS GULLY

CLIENT
Australian Minerals Investors Pty Ltd

TITLE
PRELIMINARY EARTHWORKS
LOT 17

SCALE	SIZE	DRAWING No	REV
N/A	A4	14001 - FIGURE 11B	B

Figure 12A – Rare Event Overflow Path Lot 15



OCHREWEST
CONSULTING ENGINEERS

PROJECT
PROPOSED SUBDIVISION LOT
15 & 17 BRAND HWY, RUDDS GULLY

CLIENT
Australian Minerals Investors Pty Ltd

TITLE
RAREEVENT OVERFLOW PATH
LOT 15

SCALE	SIZE	DRAWING No	REV
N/A	A4	14001 - FIGURE 12A	A

Figure 12B – Rare Event Overflow Path Lot 17

OCHREWEST
CONSULTING ENGINEERS

PROJECT
PROPOSED SUBDIVISION LOT
15 & 17 BRAND HWY, RUDDS GULLY

CLIENT
Australian Minerals Investors Pty Ltd

TITLE
RARE EVENT OVERFLOW PATH
LOT 17

SCALE	SIZE	DRAWING No	REV
N/A	A4	14001 - FIGURE 12B	B

Appendix A – Storage Calculation

RUNOFF COEFFICIENT

Runoff Coefficient C were determined using a typical Runoff coefficient table combined with AR&R 1987 book VIII section 1.5.5 part iii.

For average sandy soil, C_{10} is assumed to be 0.14 and for impervious area, C_{10} is assumed to be 0.86.

For 1 in 100 years ARI,

- Pervious C = 0.15 x 1.2 = 0.17

- Impervious C = 0.86 x 1.2 = 1.035

IMPERVIOUS AREA

The City of Greater Geraldton Land development Specification table 4.1 requires a generalised impervious area per lot be included in storage calculations.

Area of storage required for both Lots will depend on the total catchment areas within the boundaries. For getting

Impervious areas have been calculated based on the following assumptions

i. the road reserve is 20% of the total catchment area and road reserve is 80% impervious
ii. 64% of the total catchment area will be zoned R15/R20 which will have 80% impervious
iii. 16% of the total catchment area will be zoned R30 and therefore will have a 90%
iv. impervious area on lots will be drained by on site soakwells

Impervious area for each catchment has been calculated as follows:

Impervious Area =

(Catchment Area x 20%(road Reserve)x80%Imp + Catchment Area x 64%(R15/20)x80%Imp + Catchment Area x 16%(R30)x90%Imp**)** x 1.03

DETENTION BASIN REQUIREMENT

The assumptions for calculating the basin size are as follow (Stormwater Management Manual, DoW 2008):

• The subject land will be filled with sandy soil type

• Saturated hydraulic conductivity (k_u) is 180mm/hour (5 x 10^{-5}m/s)

• Soil Moderation Factors (U) of 0.5 is used

• Slope is 1 in 6

• Catchment Runoff and basin storage requirements have been calculated for various storms to identify the critical event with a maximum depth allowed to be 1.2m.

The infiltration outflow from has been calculated based on

$$\text{Infiltration} = \frac{[A_{inf}+(Pd/2)]U.k_h.D}{1000}$$

K_h =point saturated hydraulic conductivity (mm/hr)

A_{inf} =infiltration area (m_2)

P = perimeter length of the infiltration area (m)

d = depth of the infiltration system (m)

U = point soil hydraulic conductivity moderating factor

D = storm duration (hours)

Infiltration capability is dependent on the storage size, therefore, total volume required within the storage will vary for the various basins.

Calculation tabulations follow for 1 in 100 year rainfall events for all basins A to L

Lot 15 Catchment A
Detention Basin for 1 in 100 year ARI

	Area	"C"	SAND	
Pervious	19345.376	0.184	U	0.5
Impervious	54654.624	1.035	kh	180 mm/hr
CA_{100}		**60127**		

hrs	I 100 yr	CA Total	Inflow Volume (m3)	Outflow Volume (m3) (INFILTRATION)	Detention Storage Required
0.08	173.67	60127	835.39	28.68	806.71
0.1	161.52	60127	971.15	35.85	935.30
0.16	128.79	60127	1238.96	57.36	1181.61
0.33	90.05	60127	1786.71	118.30	1668.41
0.5	71.26	60127	2142.42	179.24	1963.18
1	46.22	60127	2779.30	358.48	2420.82
2	28.85	60127	3469.78	716.96	2752.81
3	**21.76**	**60127**	**3925.48**	**1075.44**	**2850.04**
6	13.40	60127	4833.74	2150.88	2682.86
12	8.28	60127	5972.66	4301.77	1670.89
24	5.31	60127	7666.99	8603.54	-936.55
48	3.32	60127	9594.07	17207.08	-7613.01
72	2.46	60127	10634.63	25810.62	-15175.98

ON SITE SOAKWELLS

Impervious Area
CA_{100} Lots only 45149 sqm
Volume in soakwells provided
CA_{100}/50 903 cum

BASIN SIZE

VOLUME = A h^3 + Bh^2 + C h

A	48		A	144		Width (m)	50.00
B	720		B	1440		Length (m)	70
C	3500		C	3500		Slope	6
			Top Width	53.6	m		
Height	0.3		Top Length	73.6	m	Perimeter	254.4 m
Volume	1116		Top Area	3944.96	m^2	Base Area	3500 m^2

For Freeboard of	0	m
Total Height	0.3	m
Top Width	53.6	m
Top Length	73.6	m
NO FREEBOARD	3944.96	
Top Area	3944.96	m^2

Note: The width and length of the calculation is applicable only for basin of rectangular shape; when other shapes are used, only area, height, and slope can be used in the design

Max Detention required	2850.04
Less 1 in 1 yr soakwell storage	903
Less in 5 yr storage	842
STORAGE REQUIRED	**1104.76**

Lot 15 Catchment B
Detention Basin for 1 in 100 year ARI

	Area	"C"	SAND	
Pervious	9926.26928	0.184	U	0.5
Impervious	28043.73072	1.035	kh	180 mm/hr
CA_{100}		**30852**		

hrs	I 100 yr	CA Total	Inflow Volume (m3)	Outflow Volume (m3) (INFILTRATION)	Detention Storage Required
0.08	173.67	30852	428.64	14.38	414.27
0.1	161.52	30852	498.30	17.97	480.33
0.16	128.79	30852	635.72	28.75	606.97
0.33	90.05	30852	916.78	59.30	857.48
0.5	71.26	30852	1099.29	89.85	1009.44
1	46.22	30852	1426.08	179.70	1246.39
2	28.85	30852	1780.37	359.39	1420.98
3	**21.76**	**30852**	**2014.20**	**539.09**	**1475.11**
6	13.40	30852	2480.23	1078.17	1402.06
12	8.28	30852	3064.62	2156.35	908.27
24	5.31	30852	3934.00	4312.70	-378.70
48	3.32	30852	4922.79	8625.40	-3702.60
72	2.46	30852	5456.72	12938.10	-7481.38

ON SITE SOAKWELLS

Impervious Area
CA_{100} Lots only 23167 sqm
Volume in soakwells provided
CA_{100}/50 463 cum

BASIN SIZE

VOLUME = A h^3 + Bh^2 + C h

A	48	A	144	Width (m)	30.00
B	510	B	1020	Length (m)	55
C	1650	C	1650	Slope	6
		Top Width	33.6 m		
Height	0.3	Top Length	58.6 m	Perimeter	184.4 m
Volume	542	Top Area	1968.96 m^2	Base Area	1650 m^2

For Freeboard of	0 m
Total Height	0.3 m
Top Width	33.6 m
Top Length	58.6 m
Top Area	1968.96 m^2

Note: The width and length of the calculation is applicable only for basin of rectangular shape; when other shapes are used, only area, height, and slope can be used in the design

Max Detention required	1475.11
Less 1 in 1 yr soakwell storage	463
Less in 5 yr storage	499
STORAGE REQUIRED	**512.39**

STORAGE PROVIDED	**542.20**

Lot 15 Catchment C
Detention Basin for 1 in 100 year ARI

	Area	"C"	SAND	
Pervious	25242.57859	0.184	U	0.5
Impervious	71315.42141	1.035	kh	180 mm/hr
CA_{100}		**78456**		

hrs	I 100 yr	CA Total	Inflow Volume (m3)	Outflow Volume (m3) (INFILTRATION)	Detention Storage Required
0.08	173.67	78456	1090.05	37.56	1052.48
0.1	161.52	78456	1267.19	46.95	1220.23
0.16	128.79	78456	1616.64	75.13	1541.52
0.33	90.05	78456	2331.37	154.95	2176.42
0.5	71.26	78456	2795.51	234.77	2560.74
1	46.22	78456	3626.54	469.54	3156.99
2	28.85	78456	4527.49	939.08	3588.41
3	**21.76**	**78456**	**5122.12**	**1408.62**	**3713.50**
6	13.40	78456	6307.25	2817.24	3490.00
12	8.28	78456	7793.35	5634.49	2158.86
24	5.31	78456	10004.18	11268.98	-1264.80
48	3.32	78456	12518.70	22537.96	-10019.26
72	2.46	78456	13876.47	33806.94	-19930.47

ON SITE SOAKWELLS

Impervious Area
CA_{100} Lots only 58295 sqm
Volume in soakwells provided
CA_{100}/50 1166 cum

BASIN SIZE

VOLUME = A h^3 + Bh^2 + C h

A	48	A	144	Width (m)	30.00
B	1080	B	2160	Length (m)	150
C	4500	C	4500	Slope	6
		Top Width	33.6 m		
Height	0.3	Top Length	153.6 m	Perimeter	374.4 m
Volume	1448	Top Area	5160.96 m^2	Base Area	4500 m^2

For Freeboard of	0	m
Total Height	0.3	m
Top Width	33.6	m
Top Length	153.6	m
Top Area	5160.96	m^2

Note: The width and length of the calculation is applicable only for basin of rectangular shape; when other shapes are used, only area, height, and slope can be used in the design

Max Detention required	3713.50
Less 1 in 1 yr soakwell storage	1166
Less in 5 yr storage	1126
STORAGE REQUIRED	**1421.99**

STORAGE PROVIDED	**1448.50**

Lot 15 Catchment D
Detention Basin for 1 in 100 year ARI

	Area	"C"	SAND	
Pervious	26601.46054	0.184	U	0.5
Impervious	75154.53946	1.035	kh	180 mm/hr
CA_{100}		**82680**		

hrs	I 100 yr	CA Total	Inflow Volume (m3)	Outflow Volume (m3) (INFILTRATION)	Detention Storage Required
0.08	173.67	82680	1148.73	42.19	1106.54
0.1	161.52	82680	1335.40	52.73	1282.67
0.16	128.79	82680	1703.67	84.37	1619.30
0.33	90.05	82680	2456.87	174.02	2282.85
0.5	71.26	82680	2946.00	263.67	2682.33
1	46.22	82680	3821.76	527.33	3294.43
2	28.85	82680	4771.22	1054.67	3716.55
3	**21.76**	**82680**	**5397.86**	**1582.00**	**3815.85**
6	13.40	82680	6646.79	3164.01	3482.78
12	8.28	82680	8212.89	6328.01	1884.88
24	5.31	82680	10542.73	12656.02	-2113.29
48	3.32	82680	13192.62	25312.05	-12119.43
72	2.46	82680	14623.48	37968.07	-23344.59

ON SITE SOAKWELLS

Impervious Area

CA_{100} Lots only 61433 sqm

Volume in soakwells provided

CA_{100}/50 1229 cum

BASIN SIZE

VOLUME = A h^3 + Bh^2 + C h

A	48	A	144	Width (m)	58.50
B	891	B	1782	Length (m)	90
C	5265	C	5265	Slope	6
		Top Width	62.1 m		
Height	0.3	Top Length	93.6 m	Perimeter	311.4 m
Volume	1661	Top Area	5812.56 m^2	Base Area	5265 m^2

For Freeboard of	0	m
Total Height	0.3	m
Top Width	62.1	m
Top Length	93.6	m
Top Area	5812.56	m^2

Note: The width and length of the calculation is applicable only for basin of rectangular shape; when other shapes are used, only area, height, and slope can be used in the design

Max Detention required	3815.85
Less 1 in 1 yr soakwell storage	1229
Less in 5 yr storage	965
STORAGE REQUIRED	**1622.32**

STORAGE PROVIDED	**1660.99**

Lot 17 Catchment E
Detention Basin for 1 in 100 year ARI

	Area	"C"	SAND	
Pervious	10326.248	0.184	U	0.5
Impervious	29173.752	1.035	kh	180 mm/hr
CA_{100}		**32095**		

hrs	I 100 yr	CA Total	Inflow Volume (m3)	Outflow Volume (m3) (INFILTRATION)	Detention Storage Required
0.08	173.67	32095	445.92	15.85	430.07
0.1	161.52	32095	518.38	19.81	498.57
0.16	128.79	32095	661.34	31.70	629.64
0.33	90.05	32095	953.72	65.38	888.34
0.5	71.26	32095	1143.59	99.05	1044.53
1	46.22	32095	1483.55	198.11	1285.44
2	28.85	32095	1852.11	396.22	1455.89
3	21.76	32095	2095.36	594.33	1501.03
6	**13.40**	**32095**	**2580.17**	**1188.66**	**1391.51**
12	8.28	32095	3188.11	2377.32	810.79
24	5.31	32095	4092.52	4754.64	-662.12
48	3.32	32095	5121.16	9509.27	-4388.11
72	2.46	32095	5676.59	14263.91	-8587.31

ON SITE SOAKWELLS

Impervious Area
CA_{100} Lots only 24100 sqm
Volume in soakwells provided
CA_{100}/50 482 cum

BASIN SIZE

VOLUME = A h^3 + Bh^2 + C h

A	48	A	144			Width (m)	24.00
B	594	B	1188			Length (m)	75
C	1800	C	1800			Slope	6
		Top Width	27.6	m			
Height	0.3	Top Length	78.6	m		Perimeter	212.4 m
Volume	595	Top Area	2169.36	m^2		Base Area	1800 m^2

For Freeboard of	0	m
Total Height	0.3	m
Top Width	27.6	m
Top Length	78.6	m
NO FREEBOARD	2169.36	
Top Area	2169.36	m^2

Note: The width and length of the calculation is applicable only for basin of rectangular shape; when other shapes are used, only area, height, and slope can be used in the design

Max Detention required	1501.03
Less 1 in 1 yr soakwell storage	482
Less in 5 yr storage	429
STORAGE REQUIRED	**589.66**
STORAGE PROVIDED	**594.76**

Lot 17 Catchment F
Detention Basin for 1 in 100 year ARI

	Area	"C"	SAND	
Pervious	14644.18821	0.184	U	0.5
Impervious	41372.81179	1.035	kh	180 mm/hr
CA_{100}		**45515**		

hrs	I 100 yr	CA Total	Inflow Volume (m3)	Outflow Volume (m3) (INFILTRATION)	Detention Storage Required
0.08	173.67	45515	632.38	23.67	608.70
0.1	161.52	45515	735.14	29.59	705.55
0.16	128.79	45515	937.88	47.35	890.53
0.33	90.05	45515	1352.52	97.65	1254.86
0.5	71.26	45515	1621.78	147.96	1473.82
1	46.22	45515	2103.89	295.92	1807.97
2	28.85	45515	2626.57	591.84	2034.73
3	**21.76**	**45515**	**2971.54**	**887.77**	**2083.77**
6	13.40	45515	3659.08	1775.53	1883.55
12	8.28	45515	4521.22	3551.06	970.16
24	5.31	45515	5803.81	7102.12	-1298.31
48	3.32	45515	7262.58	14204.25	-6941.67
72	2.46	45515	8050.27	21306.37	-13256.10

ON SITE SOAKWELLS

Impervious Area
CA_{100} Lots only 34178 sqm
Volume in soakwells provided
CA_{100}/50 684 cum

BASIN SIZE

VOLUME = A h^3 + Bh^2 + C h

A	48	A	144	Width (m)	40.00
B	666	B	1332	Length (m)	71
C	2840	C	2840	Slope	6
		Top Width	43.6 m		
Height	0.3	Top Length	74.6 m	Perimeter	236.4 m
Volume	913	Top Area	3252.56 m^2	Base Area	2840 m^2

For Freeboard of 0 m
Total Height 0.3 m
Top Width 43.6 m
Top Length 74.6 m
Top Area 3252.56 m^2

Note: The width and length of the calculation is applicable only for basin of rectangular shape; when other shapes are used, only area, height, and slope can be used in the design

Max Detention required	2083.77
Less 1 in 1 yr soakwell storage	684
Less in 5 yr storage	662
STORAGE REQUIRED	**738.47**

STORAGE PROVIDED	**913.24**

Lot 17 Catchment G
Detention Basin for 1 in 100 year ARI

	Area	"C"	SAND	
Pervious	10182.72622	0.15	U	0.5
Impervious	28768.27378	0.9	kh	180 mm/hr
CA_{100}		**27419**		

hrs	I 100 yr	CA Total	Inflow Volume (m3)	Outflow Volume (m3) (INFILTRATION)	Detention Storage Required
0.08	173.67	27419	380.95	14.53	366.42
0.1	161.52	27419	442.86	18.16	424.70
0.16	128.79	27419	564.99	29.06	535.93
0.33	90.05	27419	814.77	59.93	754.84
0.5	71.26	27419	976.97	90.80	886.17
1	46.22	27419	1267.40	181.61	1085.79
2	28.85	27419	1582.27	363.22	1219.05
3	**21.76**	**27419**	**1790.08**	**544.83**	**1245.25**
6	13.40	27419	2204.26	1089.66	1114.60
12	8.28	27419	2723.62	2179.31	544.31
24	5.31	27419	3496.26	4358.62	-862.36
48	3.32	27419	4375.04	8717.24	-4342.20
72	2.46	27419	4849.55	13075.86	-8226.31

ON SITE SOAKWELLS

Impervious Area
CA_{100} Lots only 19286 sqm
Volume in soakwells provided
CA_{100}/50 386 cum

BASIN SIZE

VOLUME = A h^3 + Bh^2 + C h

A	48	A	144	Width (m)	35.00
B	480	B	960	Length (m)	45
C	1575	C	1575	Slope	6
		Top Width	39.8 m		
Height	0.4	Top Length	49.8 m	Perimeter	179.2 m
Volume	710	Top Area	1982.04 m^2	Base Area	1575 m^2

For Freeboard of	0	m
Total Height	0.4	m
Top Width	39.8	m
Top Length	49.8	m
Top Area	1982.04	m^2

Note: The width and length of the calculation is applicable only for basin of rectangular shape; when other shapes are used, only area, height, and slope can be used in the design

Max Detention required	1245.25
Less 1 in 1 yr soakwell storage	386
Less in 5 yr storage	407
STORAGE REQUIRED	**452.88**

STORAGE PROVIDED	**709.87**

Lot 17 Catchment H
Detention Basin for 1 in 100 year ARI

	Area	"C"	SAND	
Pervious	15396.30506	0.184	U	0.5
Impervious	43497.69494	1.035	kh	180 mm/hr
CA_{100}		**47853**		

hrs	I 100 yr	CA Total	Inflow Volume (m3)	Outflow Volume (m3) (INFILTRATION)	Detention Storage Required
0.08	173.67	47853	664.86	20.67	644.19
0.1	161.52	47853	772.90	25.84	747.06
0.16	128.79	47853	986.05	41.34	944.71
0.33	90.05	47853	1421.98	85.26	1336.72
0.5	71.26	47853	1705.07	129.18	1575.89
1	46.22	47853	2211.95	258.36	1953.58
2	28.85	47853	2761.47	516.73	2244.74
3	**21.76**	**47853**	**3124.15**	**775.09**	**2349.06**
6	13.40	47853	3847.00	1550.19	2296.82
12	8.28	47853	4753.43	3100.38	1653.05
24	5.31	47853	6101.89	6200.76	-98.87
48	3.32	47853	7635.58	12401.51	-4765.93
72	2.46	47853	8463.73	18602.27	-10138.53

ON SITE SOAKWELLS

Impervious Area
CA_{100} Lots only 35556 sqm
Volume in soakwells provided
CA_{100}/50 711 cum

BASIN SIZE

VOLUME = A h^3 + Bh^2 + C h

A	48	A	144	Width (m)	32.00
B	612	B	1224	Length (m)	70
C	2240	C	2240	Slope	6
		Top Width	37.4 m		
Height	0.45	Top Length	75.4 m	Perimeter	225.6 m
Volume	1136	Top Area	2819.96 m^2	Base Area	2240 m^2

For Freeboard of	0	m
Total Height	0.45	m
Top Width	37.4	m
Top Length	75.4	m
Top Area	2819.96	m^2

Note: The width and length of the calculation is applicable only for basin of rectangular shape; when other shapes are used, only area, height, and slope can be used in the design

Max Detention required	2349.06
Less 1 in 1 yr soakwell storage	711
Less in 5 yr storage	522
STORAGE REQUIRED	**1115.56**

STORAGE PROVIDED	**1136.30**

Lot 17 Catchment I
Detention Basin for 1 in 100 year ARI

	Area	"C"	SAND	
Pervious	2067.340992	0.184	U	0.5
Impervious	5840.659008	1.035	kh	180 mm/hr
CA_{100}		**6425**		

hrs	I 100 yr	CA Total	Inflow Volume (m3)	Outflow Volume (m3) (INFILTRATION)	Detention Storage Required
0.08	173.67	6425	89.27	4.60	84.68
0.1	161.52	6425	103.78	5.74	98.04
0.16	128.79	6425	132.40	9.19	123.21
0.33	90.05	6425	190.94	18.96	171.98
0.5	71.26	6425	228.95	28.72	200.23
1	46.22	6425	297.01	57.45	239.56
2	**28.85**	**6425**	**370.80**	**114.89**	**255.91**
3	21.76	6425	419.50	172.34	247.16
6	13.40	6425	516.56	344.67	171.89
12	8.28	6425	638.27	689.34	-51.08
24	5.31	6425	819.33	1378.68	-559.35
48	3.32	6425	1025.27	2757.37	-1732.10
72	2.46	6425	1136.47	4136.05	-2999.59

ON SITE SOAKWELLS

Impervious Area
CA_{100} Lots only 4774 sqm
Volume in soakwells provided
CA_{100}/50 95 cum

BASIN SIZE

VOLUME = A h^3 + Bh^2 + C h

A	48	A	144	Width (m)	14.00
B	204	B	408	Length (m)	20
C	280	C	280	Slope	6
		Top Width	21.8 m		
Height	0.65	Top Length	27.8 m	Perimeter	99.2 m
Volume	281	Top Area	606.04 m^2	Base Area	280 m^2

For Freeboard of 0 m
Total Height 0.65 m
Top Width 21.8 m
Top Length 27.8 m
Top Area 606.04 m^2

Note: The width and length of the calculation is applicable only for basin of rectangular shape; when other shapes are used, only area, height, and slope can be used in the design

Max Detention required	247.16
Less 1 in 1 yr soakwell storage	95
Less in 5 yr storage	65
STORAGE REQUIRED	**87.07**

STORAGE PROVIDED	**281.37**

Lot 17 Catchment J
Detention Basin for 1 in 100 year ARI

	Area	"C"	SAND	
Pervious	6032.097376	0.184	U	0.5
Impervious	17041.90262	1.035	kh	180 mm/hr
CA_{100}		**18748**		

hrs	I 100 yr	CA Total	Inflow Volume (m3)	Outflow Volume (m3) (INFILTRATION)	Detention Storage Required
0.08	173.67	18748	260.48	5.64	254.84
0.1	161.52	18748	302.81	7.05	295.77
0.16	128.79	18748	386.32	11.28	375.04
0.33	90.05	18748	557.12	23.26	533.86
0.5	71.26	18748	668.03	35.24	632.79
1	46.22	18748	866.62	70.48	796.13
2	28.85	18748	1081.91	140.96	940.95
3	21.76	18748	1224.01	211.44	1012.57
6	**13.40**	**18748**	**1507.21**	**422.88**	**1084.33**
12	8.28	18748	1862.34	845.77	1016.57
24	5.31	18748	2390.65	1691.54	699.11
48	3.32	18748	2991.53	3383.08	-391.54
72	2.46	18748	3315.99	5074.62	-1758.62

ON SITE SOAKWELLS

Impervious Area
CA_{100} Lots only 13930 sqm
Volume in soakwells provided
CA_{100}/50 279 cum

BASIN SIZE

VOLUME = A h^3 + Bh^2 + C h

A	48	A	144	Width (m)	16.00
B	276	B	552	Length (m)	30
C	480	C	480	Slope	6
		Top Width	21.4 m		
Height	0.45	Top Length	35.4 m	Perimeter	113.6 m
Volume	276	Top Area	757.56 m^2	Base Area	480 m^2

For Freeboard of	0	m
Total Height	0.45	m
Top Width	21.4	m
Top Length	35.4	m
Top Area	757.56	m^2

Note: The width and length of the calculation is applicable only for basin of rectangular shape; when other shapes are used, only area, height, and slope can be used in the design

Max Detention required	699.11
Less 1 in 1 yr soakwell storage	279
Less in 5 yr storage	197
STORAGE REQUIRED	**223.25**

STORAGE PROVIDED	**276.26**

Lot 17 Catchment K
Detention Basin for 1 in 100 year ARI

	Area	"C"	SAND	
Pervious	12579.46146	0.184	U	0.5
Impervious	35539.53854	1.035	kh	180 mm/hr
CA_{100}		**39098**		

hrs	I 100 yr	CA Total	Inflow Volume (m3)	Outflow Volume (m3) (INFILTRATION)	Detention Storage Required
0.08	173.67	39098	543.22	16.07	527.15
0.1	161.52	39098	631.49	20.08	611.41
0.16	128.79	39098	805.64	32.13	773.51
0.33	90.05	39098	1161.82	66.28	1095.55
0.5	71.26	39098	1393.12	100.42	1292.70
1	46.22	39098	1807.26	200.84	1606.42
2	28.85	39098	2256.25	401.67	1854.58
3	**21.76**	**39098**	**2552.57**	**602.51**	**1950.07**
6	13.40	39098	3143.17	1205.01	1938.16
12	8.28	39098	3883.76	2410.02	1473.74
24	5.31	39098	4985.51	4820.04	165.47
48	3.32	39098	6238.61	9640.08	-3401.47
72	2.46	39098	6915.24	14460.12	-7544.88

ON SITE SOAKWELLS

Impervious Area
CA_{100} Lots only 29051 sqm
Volume in soakwells provided
CA_{100}/50 581 cum

BASIN SIZE

VOLUME = A h^3 + Bh^2 + C h

A	48	A	144	Width (m)	33.00
B	498	B	996	Length (m)	50
C	1650	C	1650	Slope	6
		Top Width	39 m		
Height	0.5	Top Length	56 m	Perimeter	190 m
Volume	956	Top Area	2184 m^2	Base Area	1650 m^2

For Freeboard of	0 m
Total Height	0.5 m
Top Width	39 m
Top Length	56 m
Top Area	2184 m^2

Note: The width and length of the calculation is applicable only for basin of rectangular shape; when other shapes are used, only area, height, and slope can be used in the design

Max Detention required	1950.07
Less 1 in 1 yr soakwell storage	581
Less in 5 yr storage	416
STORAGE REQUIRED	**953.17**

STORAGE PROVIDED	**955.50**

Lot 17 Catchment L
Detention Basin for 1 in 100 year ARI

	Area	"C"	SAND	
Pervious	12685.5996	0.184	U	0.5
Impervious	35839.4004	1.035	kh	180 mm/hr
CA_{100}		**39428**		

hrs	I 100 yr	CA Total	Inflow Volume (m3)	Outflow Volume (m3) (INFILTRATION)	Detention Storage Required
0.08	173.67	39428	547.80	18.40	529.40
0.1	161.52	39428	636.82	23.00	613.82
0.16	128.79	39428	812.44	36.80	775.64
0.33	90.05	39428	1171.62	75.90	1095.72
0.5	71.26	39428	1404.88	115.01	1289.87
1	46.22	39428	1822.51	230.01	1592.50
2	28.85	39428	2275.28	460.02	1815.26
3	**21.76**	**39428**	**2574.11**	**690.03**	**1884.07**
6	13.40	39428	3169.69	1380.07	1789.63
12	8.28	39428	3916.53	2760.13	1156.40
24	5.31	39428	5027.58	5520.27	-492.69
48	3.32	39428	6291.24	11040.54	-4749.29
72	2.46	39428	6973.59	16560.81	-9587.22

ON SITE SOAKWELLS

Impervious Area
CA_{100} Lots only 29296 sqm
Volume in soakwells provided
CA_{100}/50 586 cum

BASIN SIZE

VOLUME = A h^3 + Bh^2 + C h

A	48	A	144	Width (m)	34.00
B	564	B	1128	Length (m)	60
C	2040	C	2040	Slope	6
		Top Width	38.8 m		
Height	0.4	Top Length	64.8 m	Perimeter	207.2 m
Volume	909	Top Area	2514.24 m^2	Base Area	2040 m^2

For Freeboard of	0 m
Total Height	0.4 m
Top Width	38.8 m
Top Length	64.8 m
Top Area	2514.24 m^2

Note: The width and length of the calculation is applicable only for basin of rectangular shape; when other shapes are used, only area, height, and slope can be used in the design

Max Detention required	1884.07
Less 1 in 1 yr soakwell storage	586
Less in 5 yr storage	414
STORAGE REQUIRED	**884.46**

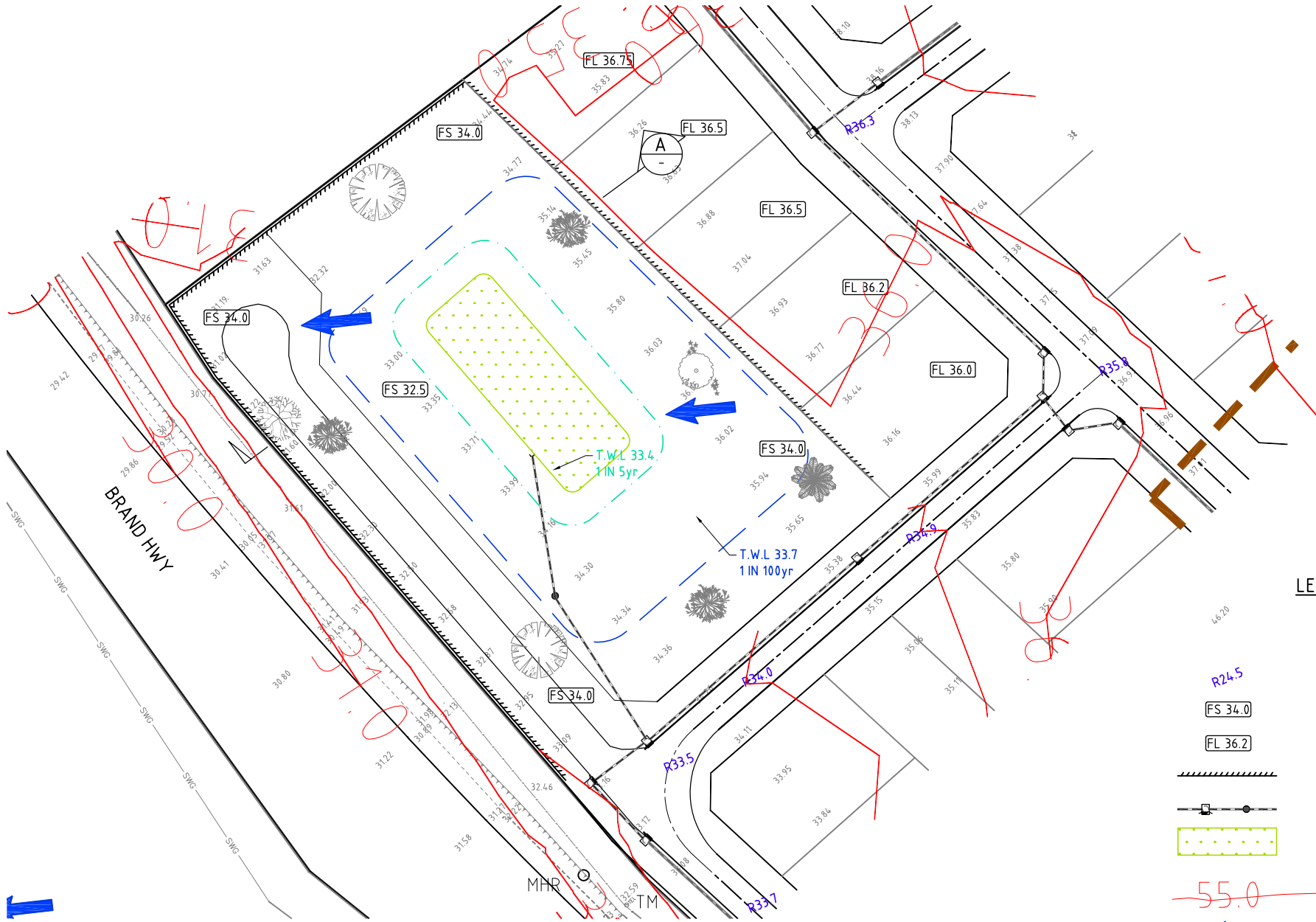
STORAGE PROVIDED	**909.31**

Appendix B – Ochre West Drawings

Appendix B – Ochre West Drawings

BASIN A DETAILS

TOTAL IMPERVIOUS AREA	6.3 Ha
100 YEAR STORAGE REQUIRED	2540 m^3
AREA AT T.W.L (100 yr)	3944 m^2
RL T.W.L (100 yr)	33.7 m
5 YEAR STORAGE REQUIRED	825 m^3
AREA AT T.W.L (5 yr)	1304 m^2
RL T.W.L (5 yr)	33.4 m
AREA AT T.W.L (1 YR)	610 m^2
RL T.W.L (1 YR)	32.77 m
PEAK OUTFLOW (100 YR)	0 l/s
BASE LEVEL	32.5 m



PLAN
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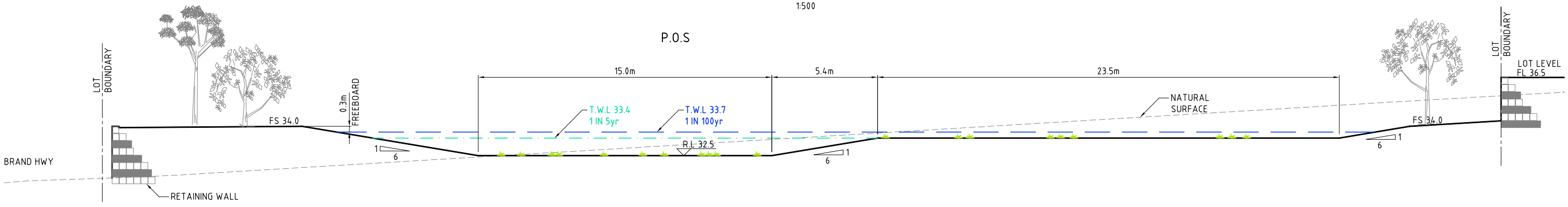

SECTION A
1:100

LEGEND

- EXISTING SPOT LEVEL
- PRELIMINARY DESIGN CONTOURS
- PRELIMINARY ROAD LEVELS
- PRELIMINARY EARTHWORK LEVELS
- PRELIMINARY LOT LEVELS
- RETAINING WALL
- RCP DRAINAGE PIPE & PITS
- 1 IN 1 YEAR INFILTRATION BASE
- PRELIMINARY EARTHWORK CONTOURS
- RARE EVENT OVERFLOW PATH >1 IN1 00 YR

PRELIMINARY
NOT FOR CONSTRUCTION

SCALE 1:100

SCALE 1:500

Rev.	Date	Drn.	Des.	Issue Description
C	11.12.2016	CF	CF	REISSUED AS REQUESTED
B	19.06.2016	CF	CF	RARE EVENT OVERFLOW PATH
A	12.11.2014	NMcD	CF	ISSUED FOR CLIENT REVIEW

CLIENT
AUSTRALIAN MINERALS INVESTORS PTY LTD

OCHREWEST CONSULTING ENGINEERS

PROJECT
LOTS 15 & 17 BRAND HIGHWAY
RUDDS GULLY

DRN	N.McDONALD	REVIEWED	DATE
DESIGN	C.FINGHER	Colin Fingher	12.11.2014
DIRECTOR	C.FINGHER	APPROVED FOR ISSUE: Colin Fingher	DATE: 12.11.2014

TITLE
LOCAL WATER MANAGEMENT STRATEGY
LOT 15 POST DEVELOPMENT DRAINAGE STORAGE CATCHMENT A

SCALE	SIZE	DRAWING No	REV.
AS SHOWN	A1	14001-C-151	C

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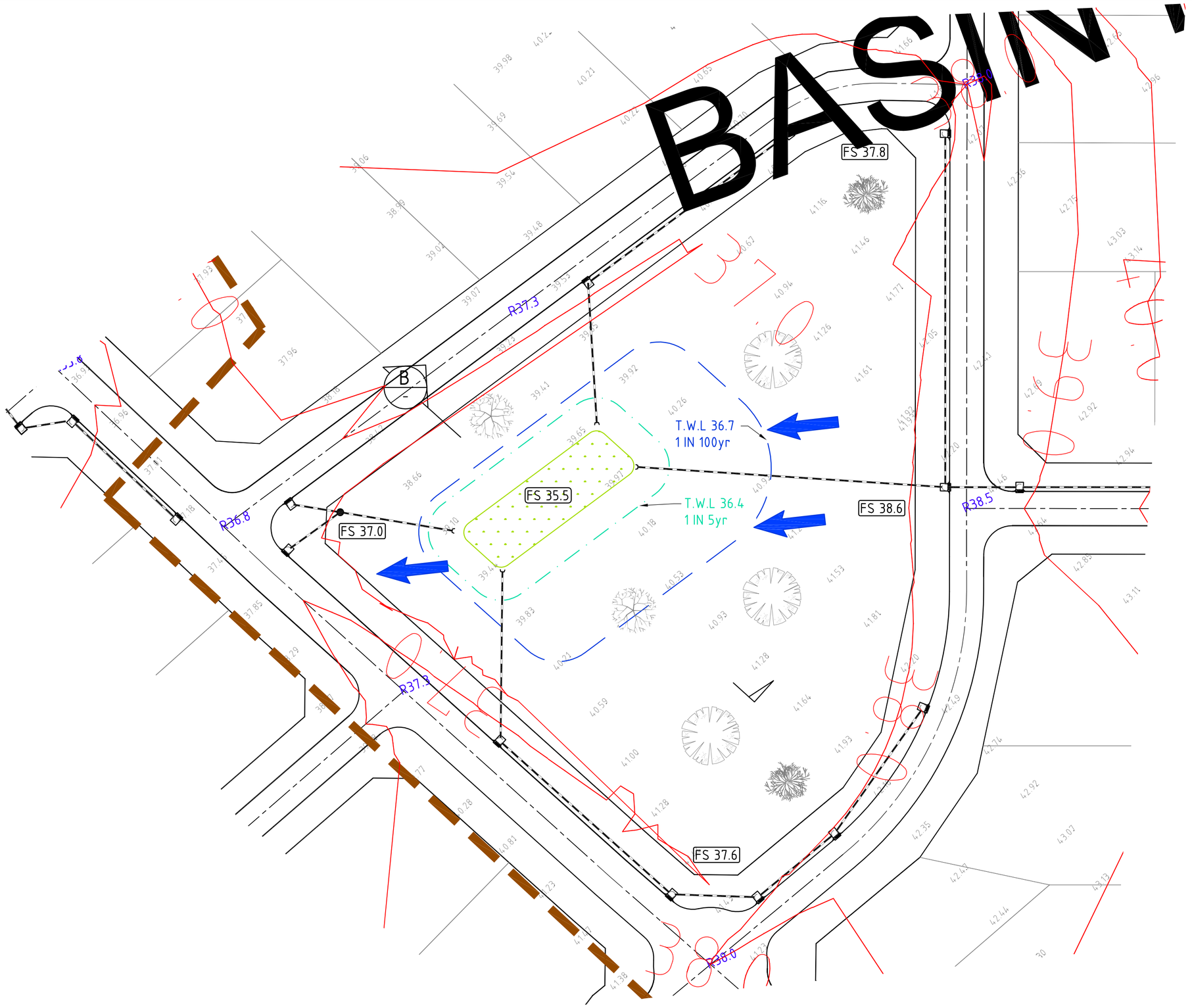
BASIN B DETAILS

TOTAL IMPERVIOUS AREA	3.8 Ha
100 YEAR STORAGE REQUIRED	2540 m^3
AREA AT T.W.L (100 yr)	1914 m^2
RL T.W.L (100 yr)	36.7 m
5 YEAR STORAGE REQUIRED	1485 m^3
AREA AT T.W.L (5 yr)	792 m^2
RL T.W.L (5 yr)	36.4 m
AREA AT T.W.L (1 YR)	825 m^2
RL T.W.L (1 YR)	35.74 m
PEAK OUTFLOW (100 YR)	0 l/s
BASE LEVEL	35.5 m



PLAN
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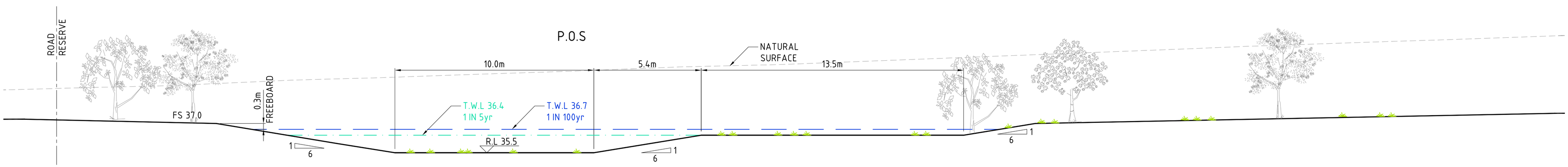
LEGEND

- EXISTING SPOT LEVEL
- PRELIMINARY DESIGN CONTOURS
- R24.5 — PRELIMINARY ROAD LEVELS
- FS 34.0 — PRELIMINARY EARTHWORK LEVELS
- FL 36.2 — PRELIMINARY LOT LEVELS
- RETAINING WALL
- RCP DRAINAGE PIPE & PITS
- 1 IN 1 YEAR INFILTRATION BASE
- 55.0 — PRELIMINARY EARTHWORK CONTOURS
- RARE EVENT OVERFLOW PATH >1 IN1 00 YR



SECTION B
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PRELIMINARY
NOT FOR CONSTRUCTION

SCALE 1:100

SCALE 1:500

Rev.	Date	Drn.	Des.	Issue Description
B	19.06.2016	CF	CF	RARE EVENT OVERFLOW PATH
A	12.11.2014	NMCD	CF	ISSUED FOR CLIENT REVIEW

CLIENT
AUSTRALIAN MINERALS INVESTORS PTY LTD

OCHREWEST
CONSULTING ENGINEERS

PROJECT
LOTS 15 & 17 BRAND HIGHWAY
RUDDS GULLY

DRN	N.McDONALD	REVIEWED	DATE
DESIGN	C.FINGHER	Colin Fingher	12.11.2014
DIRECTOR	C.FINGHER	APPROVED FOR ISSUE: Colin Fingher	DATE: 12.11.2014

TITLE
LOCAL WATER MANAGEMENT STRATEGY
LOT 15 POST DEVELOPMENT DRAINAGE STORAGE CATCHMENT B

SCALE	SIZE	DRAWING No	REV
AS SHOWN	A1	14001-C-152	B

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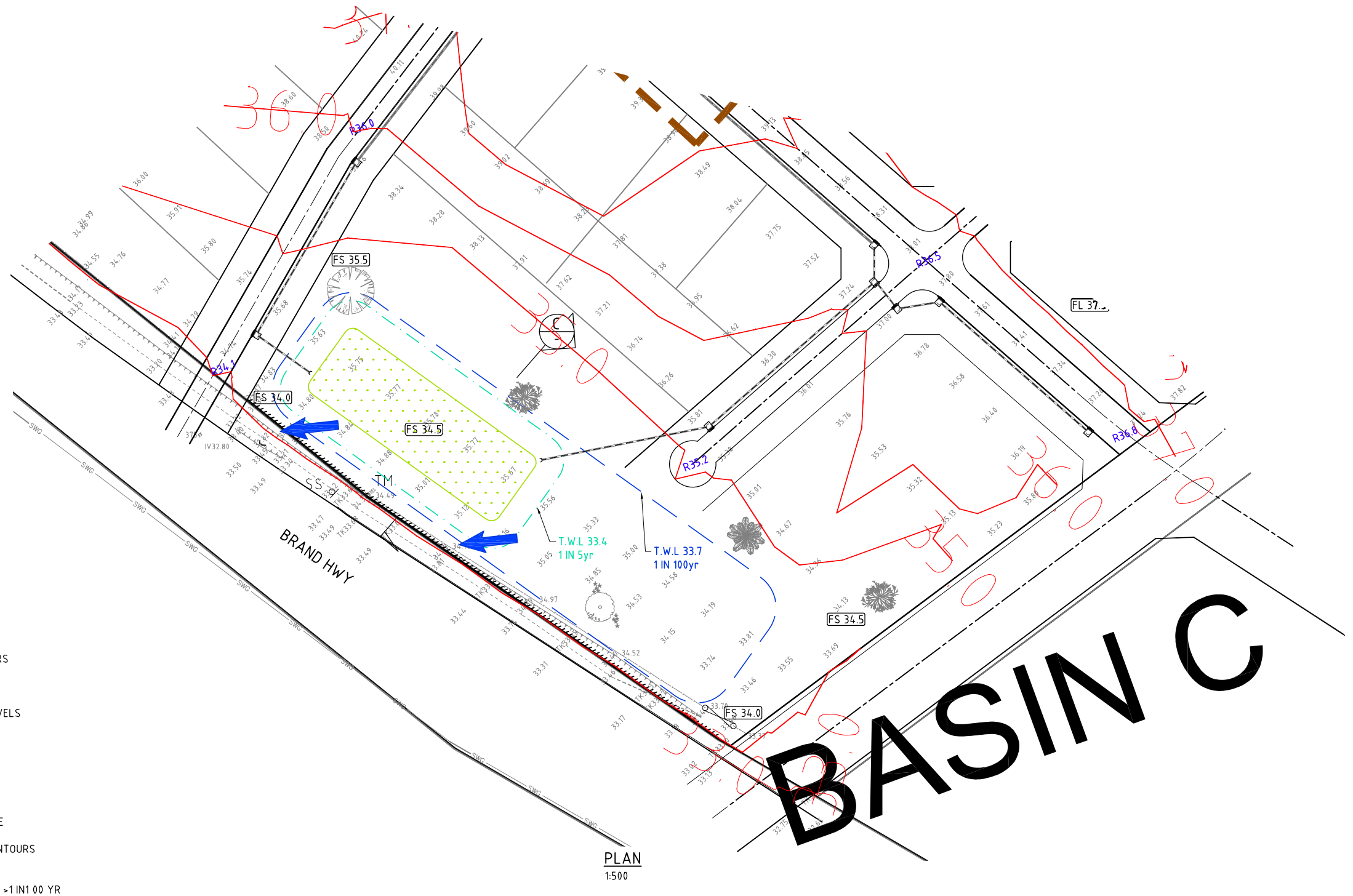
BASIN C DETAILS

TOTAL IMPERVIOUS AREA	9.6 Ha
100 YEAR STORAGE REQUIRED	2540 m^3
AREA AT T.W.L (100 yr)	3658 m^2
RL T.W.L (100 yr)	35.7 m
5 YEAR STORAGE REQUIRED	825 m^3
AREA AT T.W.L (5 yr)	1708 m^2
RL T.W.L (5 yr)	35.4 m
AREA AT T.W.L (1 YR)	1485 m^2
RL T.W.L (1 YR)	34.73 m
PEAK OUTFLOW (100 YR)	0 l/s
BASE LEVEL	34.5 m

LEGEND

- EXISTING SPOT LEVEL
- PRELIMINARY DESIGN CONTOURS
- R24.5 — PRELIMINARY ROAD LEVELS
- FS 34.0 — PRELIMINARY EARTHWORK LEVELS
- FL 36.2 — PRELIMINARY LOT LEVELS
- RETAINING WALL
- RCP DRAINAGE PIPE & PITS
- 1 IN 1 YEAR INFILTRATION BASE
- 55.0 — PRELIMINARY EARTHWORK CONTOURS
- RARE EVENT OVERFLOW PATH >1 IN1 00 YR



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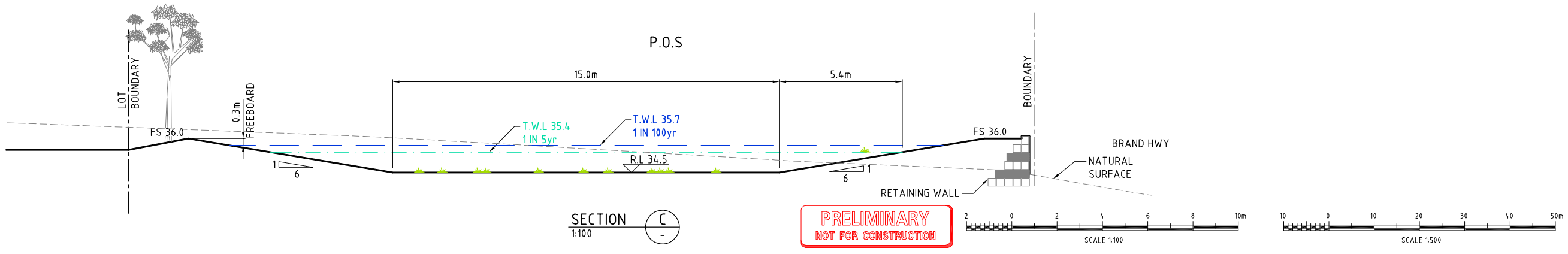

SECTION C
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PRELIMINARY
NOT FOR CONSTRUCTION

SCALE 1:100

SCALE 1:500

Rev.	Date	Drn.	Des.	Issue Description
C	11.12.2016	CF	CF	REISSUED AS REQUESTED
B	19.06.2016	CF	CF	RARE EVENT OVERFLOW PATH
A	12.11.2014	NMCD	CF	ISSUED FOR CLIENT REVIEW

CLIENT
AUSTRALIAN MINERALS INVESTORS PTY LTD

OCHREWEST CONSULTING ENGINEERS

PROJECT
LOTS 15 & 17 BRAND HIGHWAY
RUDDS GULLY

DRN	N.McDONALD	REVIEWED	DATE
DESIGN	C.FINGHER	Colin Fingher	12.11.2014
DIRECTOR	C.FINGHER	APPROVED FOR ISSUE: Colin Fingher	DATE: 12.11.2014

TITLE
LOCAL WATER MANAGEMENT STRATEGY
LOT 15 POST DEVELOPMENT DRAINAGE STORAGE
CATCHMENT C

SCALE	SIZE	DRAWING No	REV
AS SHOWN	A1	14001-C-153	C

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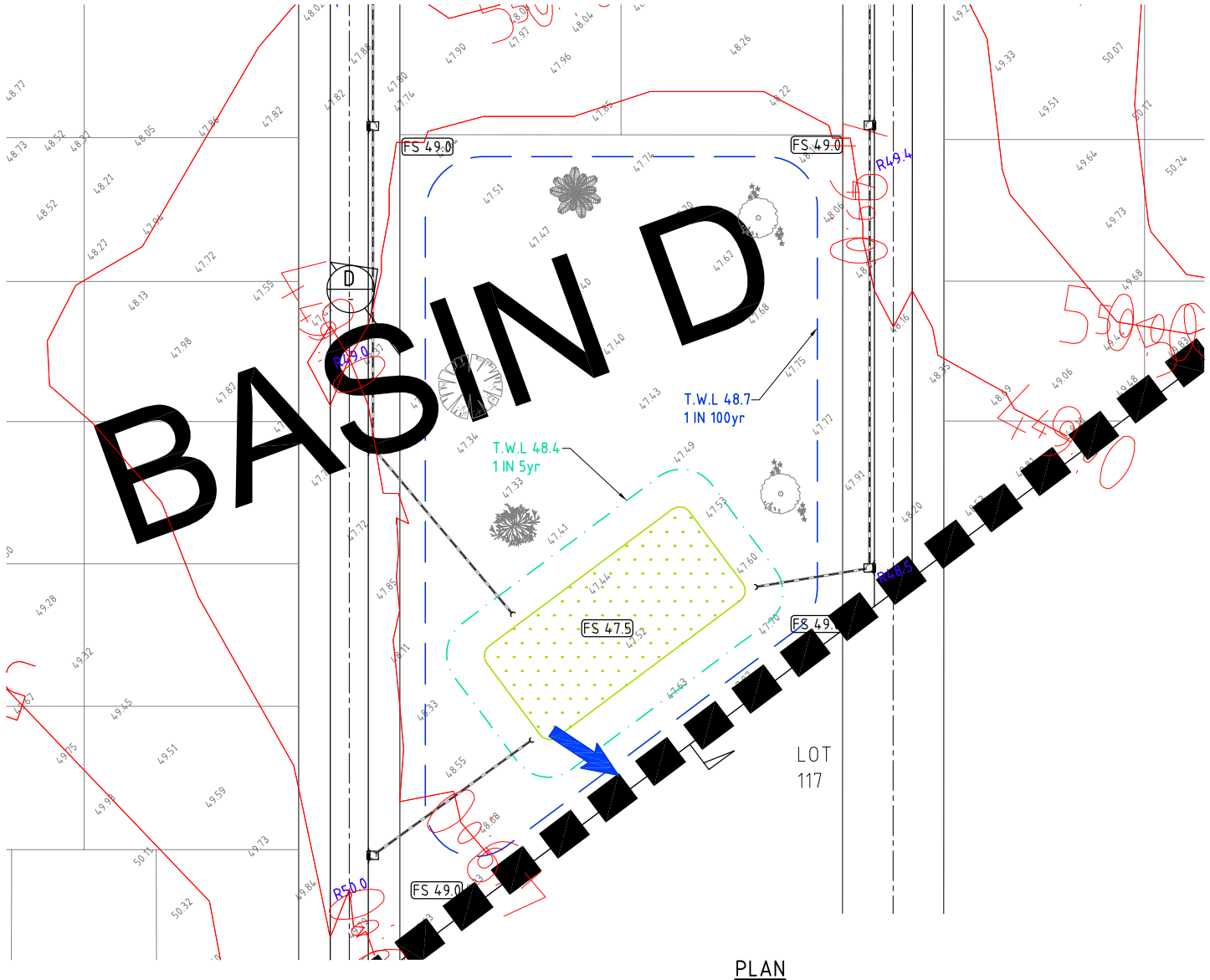
BASIN D DETAILS

TOTAL IMPERVIOUS AREA	10.1 Ha
100 YEAR STORAGE REQUIRED	2540 m^3
AREA AT T.W.L (100 yr)	5823 m^2
RL T.W.L (100 yr)	48.2 m
5 YEAR STORAGE REQUIRED	825 m^3
AREA AT T.W.L (5 yr)	1432 m^2
RL T.W.L (5 yr)	47.6 m
AREA AT T.W.L (1 YR)	967 m^2
RL T.W.L (1 YR)	47.05 m
PEAK OUTFLOW (100 YR)	0 l/s
BASE LEVEL	46.7 m



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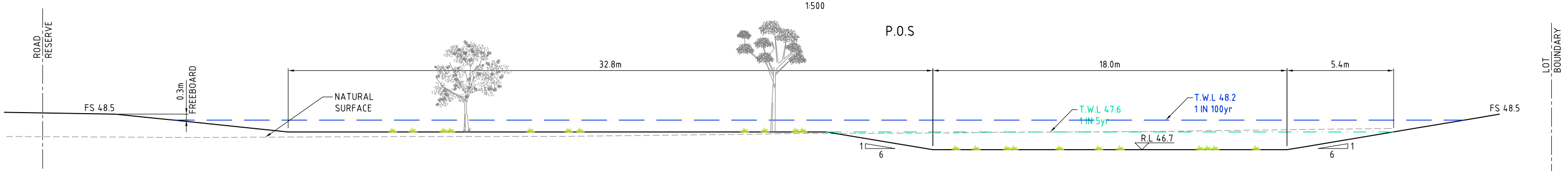

SECTION D
1:100

LEGEND

- EXISTING SPOT LEVEL
- PRELIMINARY DESIGN CONTOURS
- R24.5 PRELIMINARY ROAD LEVELS
- FS 34.0 PRELIMINARY EARTHWORK LEVELS
- FL 36.2 PRELIMINARY LOT LEVELS
- RETAINING WALL
- RCP DRAINAGE PIPE & PITS
- 1 IN 1 YEAR INFILTRATION BASE
- PRELIMINARY EARTHWORK CONTOURS
- RARE EVENT OVERFLOW PATH >1 IN1 00 YR

PRELIMINARY
NOT FOR CONSTRUCTION

2 0 2 4 6 8 10m
SCALE 1:100

10 0 10 20 30 40 50m
SCALE 1:500

Rev.	Date	Drn.	Des.	Issue Description
B	19.06.2016	CF	CF	RARE EVENT OVERFLOW PATH
A	29.10.2014	NMCD	CF	ISSUED FOR CLIENT REVIEW

CLIENT
AUSTRALIAN MINERALS INVESTORS PTY LTD

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CONSULTING ENGINEERS

PROJECT
LOTS 15 & 17 BRAND HIGHWAY
RUDDS GULLY

DRN	N.McDONALD	REVIEWED	DATE
DESIGN	C.FINGHER	Colin Fingher	29.10.2014
DIRECTOR	C.FINGHER	APPROVED FOR ISSUE: Colin Fingher	DATE: 29.10.2014

TITLE
LOCAL WATER MANAGEMENT STRATEGY
LOT 15 POST DEVELOPMENT DRAINAGE STORAGE CATCHMENT D

SCALE	SIZE	DRAWING No	REV
AS SHOWN	A1	14001-C-154	B

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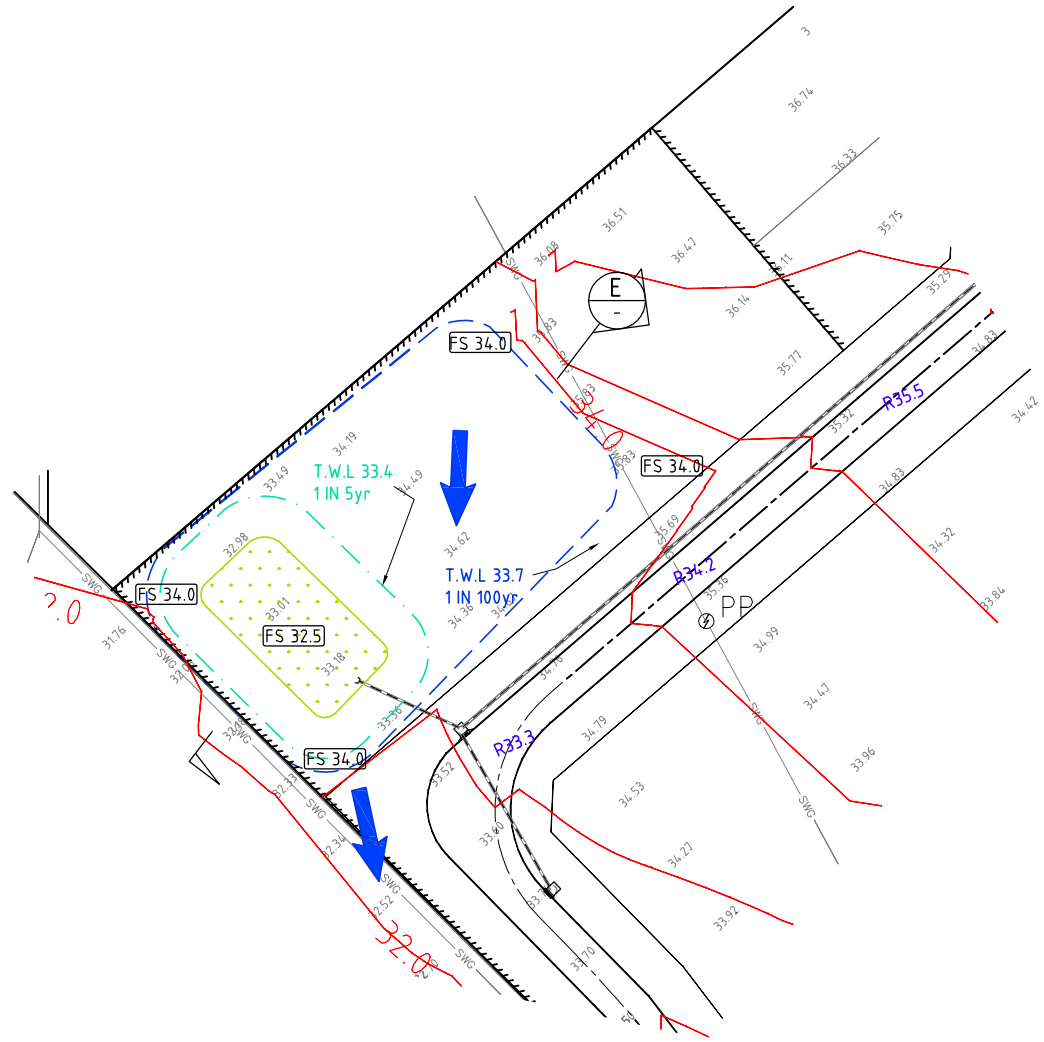
BASIN E DETAILS

TOTAL IMPERVIOUS AREA	3.29 Ha
100 YEAR STORAGE REQUIRED	1024 m^3
AREA AT T.W.L (100 yr)	2169 m^2
RL T.W.L (100 yr)	33.7 m
5 YEAR STORAGE REQUIRED	429 m^3
AREA AT T.W.L (5 yr)	733 m^2
RL T.W.L (5 yr)	33.4 m
AREA AT T.W.L (1 YR)	549 m^2
RL T.W.L (1 YR)	32.8 m
PEAK OUTFLOW (100 YR)	0 l/s
BASE LEVEL	32.5 m



LEGEND

- EXISTING SPOT LEVEL
- PRELIMINARY DESIGN CONTOURS
- PRELIMINARY ROAD LEVELS
- PRELIMINARY EARTHWORK LEVELS
- PRELIMINARY LOT LEVELS
- RETAINING WALL
- RCP DRAINAGE PIPE & PITS
- 1 IN 1 YEAR INFILTRATION BASE
- PRELIMINARY EARTHWORK CONTOURS
- RARE EVENT OVERFLOW PATH >1 IN1 00 YR

PLAN
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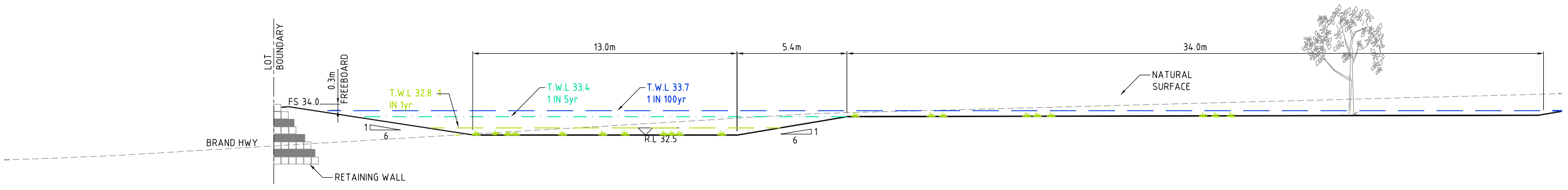

SECTION E
1:100

PRELIMINARY
NOT FOR CONSTRUCTION

SCALE 1:100

SCALE 1:500

Rev.	Date	Drn.	Des.	Issue Description
B	19.06.2016	CF	CF	RARE EVENT OVERFLOW ADDED
A	12.11.2014	NMcD	CF	ISSUED FOR CLIENT REVIEW

CLIENT
AUSTRALIAN MINERALS INVESTORS PTY LTD

OCHREWEST CONSULTING ENGINEERS

PROJECT
LOTS 15 & 17 BRAND HIGHWAY
RUDDS GULLY

DRN	N.McDONALD	REVIEWED	DATE
DESIGN	C.FINGHER	*Colin Fingher*	12.11.2014
DIRECTOR	C.FINGHER	APPROVED FOR ISSUE *Colin Fingher*	DATE 12.11.2014

TITLE
LOCAL WATER MANAGEMENT STRATEGY
LOT 17 POST DEVELOPMENT DRAINAGE STORAGE CATCHMENT E

SCALE	SIZE	DRAWING No	REV
AS SHOWN	A1	14001-C-155	B

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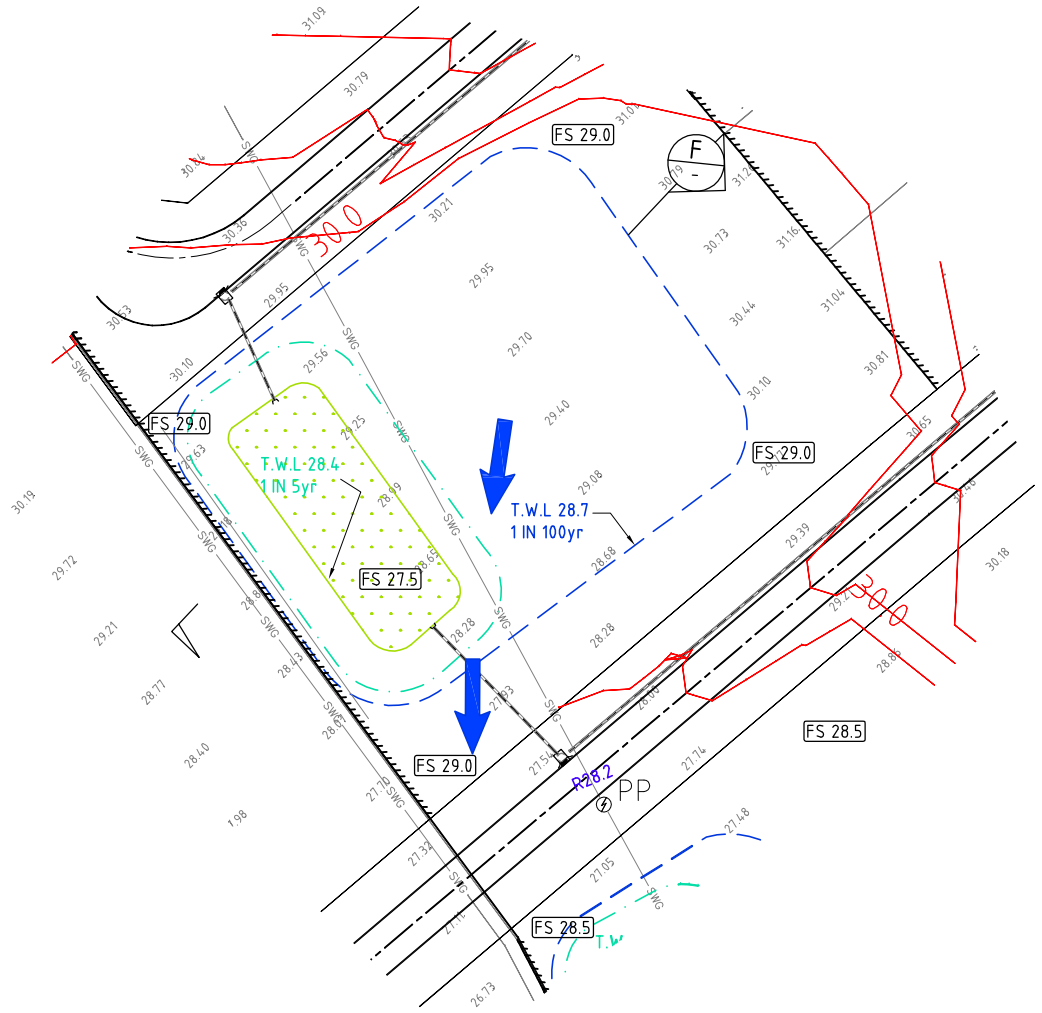
BASIN F DETAILS

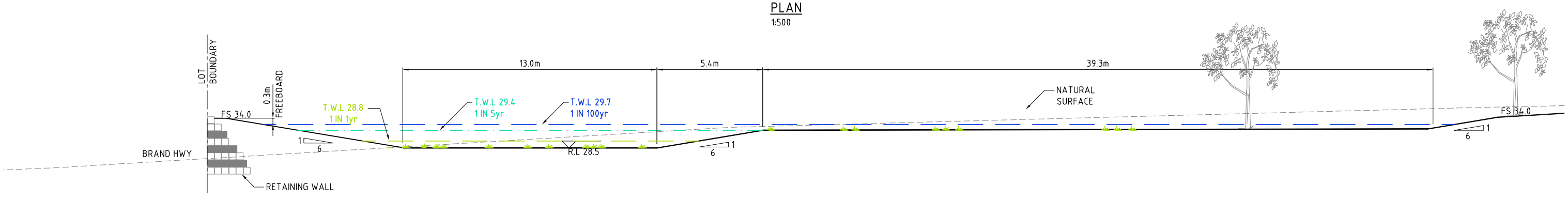
TOTAL IMPERVIOUS AREA	4.57 Ha
100 YEAR STORAGE REQUIRED	1574m^3
AREA AT T.W.L (100 yr)	3252 m^2
RL T.W.L (100 yr)	28.7 m
5 YEAR STORAGE REQUIRED	662 m^3
AREA AT T.W.L (5 yr)	1061 m^2
RL T.W.L (5 yr)	28.4 m
AREA AT T.W.L (1 YR)	423 m^2
RL T.W.L (1 YR)	27.75 m
PEAK OUTFLOW (100 YR)	0 l/s
BASE LEVEL	27.5 m



LEGEND

- 46.20 — EXISTING SPOT LEVEL
- PRELIMINARY DESIGN CONTOURS
- R24.5 — PRELIMINARY ROAD LEVELS
- FS 34.0 — PRELIMINARY EARTHWORK LEVELS
- FL 36.2 — PRELIMINARY LOT LEVELS
- RETAINING WALL
- RCP DRAINAGE PIPE & PITS
- 1 IN 1 YEAR INFILTRATION BASE
- 55.0 — PRELIMINARY EARTHWORK CONTOURS
- RARE EVENT OVERFLOW PATH >1 IN1 00 YR

PLAN
1:500



SECTION F
1:100

PRELIMINARY
NOT FOR CONSTRUCTION

SCALE 1:100

SCALE 1:500

Rev.	Date	Drn.	Des.	Issue Description
B	19.06.2016	CF	CF	RARE EVENT OVERFLOW ADDED
A	12.11.2014	NMCD	CF	ISSUED FOR CLIENT REVIEW

CLIENT

AUSTRALIAN MINERALS
INVESTORS PTY LTD

OCHREWEST
CONSULTING ENGINEERS

PROJECT

LOTS 15 & 17 BRAND HIGHWAY
RUDDS GULLY

DRN	N.McDONALD	REVIEWED	DATE
DESIGN	C.FINGHER	Colin Fingher	12.11.2014
DIRECTOR	C.FINGHER	APPROVED FOR ISSUE: Colin Fingher	DATE: 12.11.2014

TITLE

LOCAL WATER MANAGEMENT STRATEGY
LOT 17 POST DEVELOPMENT DRAINAGE STORAGE
CATCHMENT F

SCALE	SIZE	DRAWING No	REV
AS SHOWN	A1	14001-C-156	B

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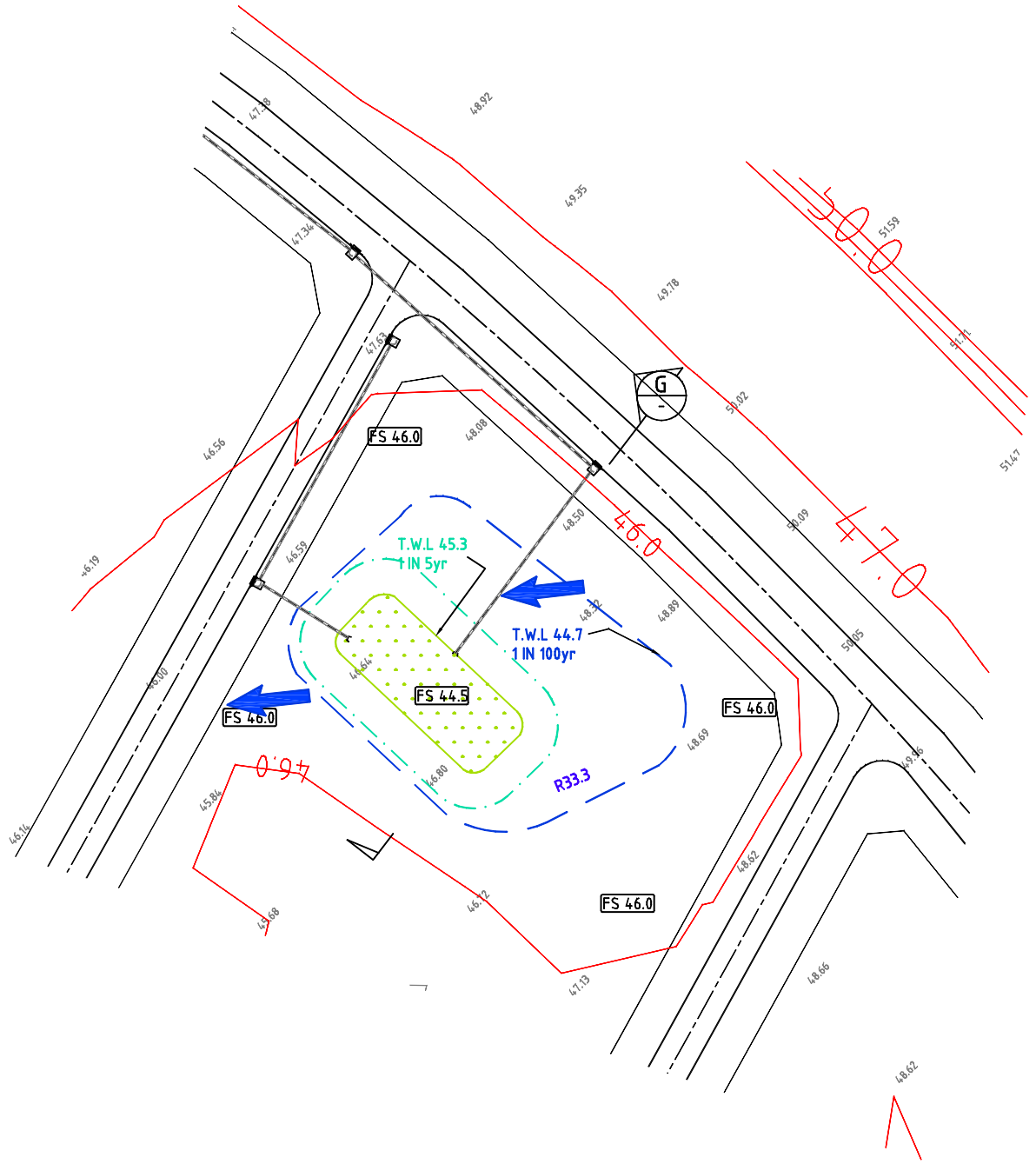
BASIN G DETAILS

TOTAL IMPERVIOUS AREA	3.18 Ha
100 YEAR STORAGE REQUIRED	1116 m^3
AREA AT T.W.L (100 yr)	5160 m^2
RL T.W.L (100 yr)	35.7 m
5 YEAR STORAGE REQUIRED	407 m^3
AREA AT T.W.L (5 yr)	1690 m^2
RL T.W.L (5 yr)	35.4 m
AREA AT T.W.L (1 YR)	1042 m^2
RL T.W.L (1 YR)	34.73 m
PEAK OUTFLOW (100 YR)	0 l/s
BASE LEVEL	34.5 m

LEGEND

- 46.20 — EXISTING SPOT LEVEL
- R24.5 — PRELIMINARY DESIGN CONTOURS
- FS 34.0 — PRELIMINARY ROAD LEVELS
- FL 36.2 — PRELIMINARY EARTHWORK LEVELS
- PRELIMINARY LOT LEVELS
- RETAINING WALL
- RCP DRAINAGE PIPE & PITS
- 1 IN 1 YEAR INFILTRATION BASE
- 55.0 — PRELIMINARY EARTHWORK CONTOURS
- RARE EVENT OVERFLOW PATH >1 IN1 00 YR



PLAN
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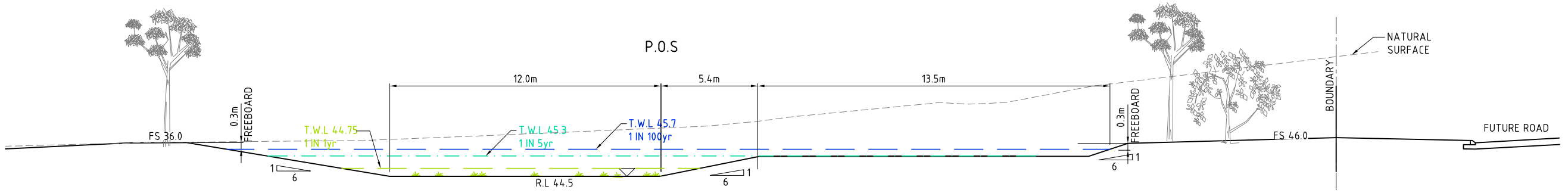

SECTION G
1:100

PRELIMINARY
NOT FOR CONSTRUCTION

SCALE 1:100

SCALE 1:500

Rev.	Date	Drn.	Des.	Issue Description
B	DATE	CF	CF	RARE EVENT OVERFLOW ADDED
A	12.11.2014	NMCD	CF	ISSUED FOR CLIENT REVIEW

CLIENT
AUSTRALIAN MINERALS
INVESTORS PTY LTD

OCHREWEST
CONSULTING ENGINEERS

PROJECT
LOTS 15 & 17 BRAND HIGHWAY
RUDDS GULLY

DRN	N.McDONALD	REVIEWED	DATE
DESIGN	C.FINGHER	Colin Fingher	12.11.2014
DIRECTOR	C.FINGHER	APPROVED FOR ISSUE: Colin Fingher	DATE: 12.11.2014

TITLE
LOCAL WATER MANAGEMENT STRATEGY
LOT 17 POST DEVELOPMENT DRAINAGE STORAGE
CATCHMENT G

SCALE	SIZE	DRAWING No	REV
AS SHOWN	A1	14001-C-157	B

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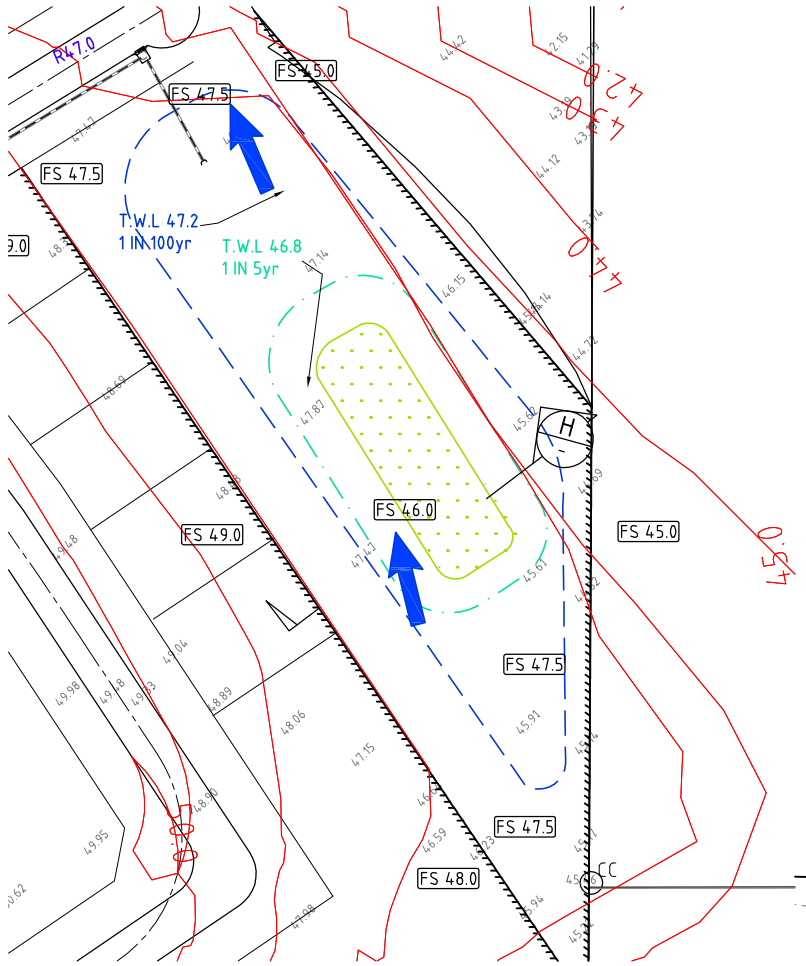
BASIN H DETAILS

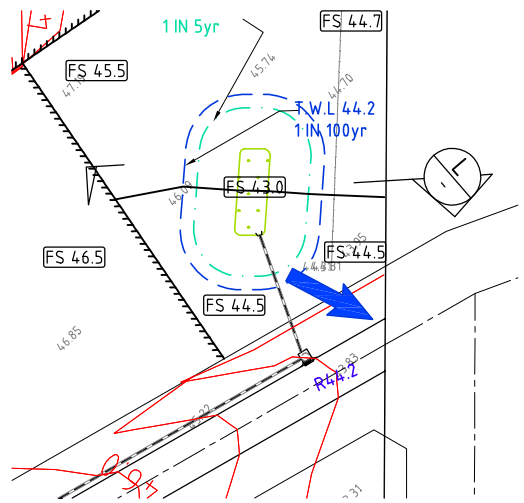
TOTAL IMPERVIOUS AREA	10.1 Ha
100 YEAR STORAGE REQUIRED	1658m^3
AREA AT T.W.L (100 yr)	2820 m^2
RL T.W.L (100 yr)	47.2 m
5 YEAR STORAGE REQUIRED	522 m^3
AREA AT T.W.L (5 yr)	980 m^2
RL T.W.L (5 yr)	46.75 m
AREA AT T.W.L (1 YR)	615 m^2
RL T.W.L (1 YR)	46.27 m
PEAK OUTFLOW (100 YR)	0 l/s
BASE LEVEL	46.0m



CATCHMENT H PLAN
1:500

BASIN I DETAILS

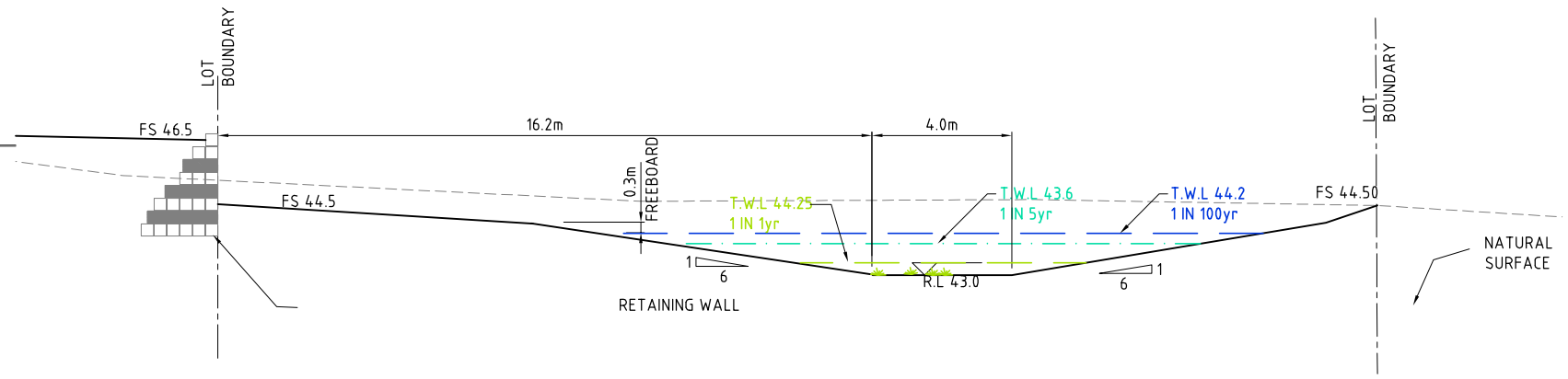
TOTAL IMPERVIOUS AREA	0.64 Ha
100 YEAR STORAGE REQUIRED	345m^3
AREA AT T.W.L (100 yr)	606m^2
RL T.W.L (100 yr)	44.2 m
5 YEAR STORAGE REQUIRED	65 m^3
AREA AT T.W.L (5 yr)	193 m^2
RL T.W.L (5 yr)	43.6 m
AREA AT T.W.L (1 YR)	91 m^2
RL T.W.L (1 YR)	43.25 m
PEAK OUTFLOW (100 YR)	0 l/s
BASE LEVEL	43.0m



CATCHMENT I PLAN
1:500

LEGEND

- EXISTING SPOT LEVEL
- PRELIMINARY DESIGN CONTOURS
- PRELIMINARY ROAD LEVELS
- PRELIMINARY EARTHWORK LEVELS
- PRELIMINARY LOT LEVELS
- RETAINING WALL
- RCP DRAINAGE PIPE & PITS
- 1 IN 1 YEAR INFILTRATION BASE
- PRELIMINARY EARTHWORK CONTOURS
- RARE EVENT OVERFLOW PATH >1 IN1 00 YR



SECTION I
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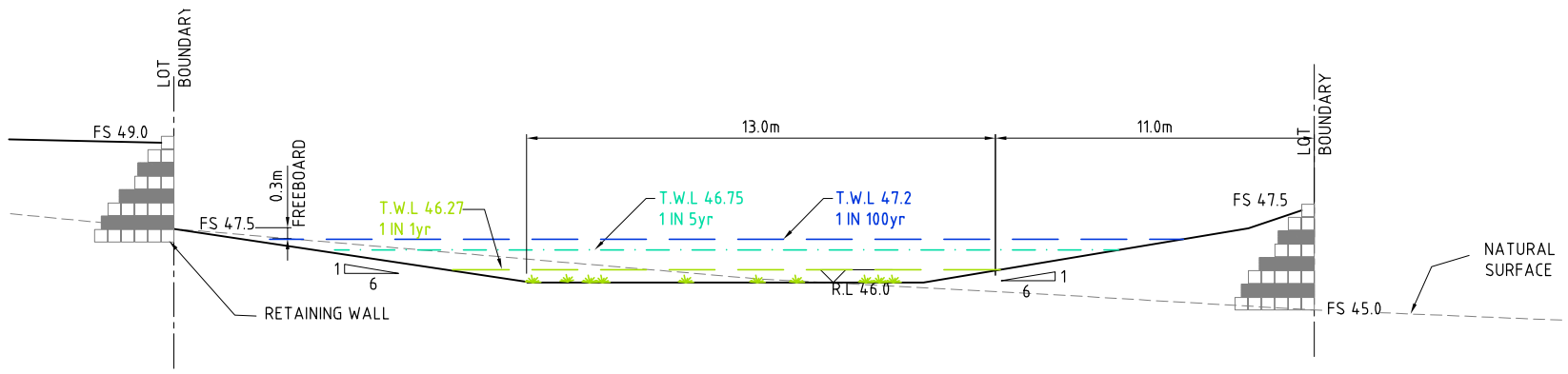

SECTION H
1:100

PRELIMINARY
NOT FOR CONSTRUCTION

SCALE 1:100

SCALE 1:500

Rev.	Date	Drn.	Des.	Issue Description
B	19.06.2016	CF	CF	RARE EVENT OVERFLOW ADDED
A	28.01.15	NMCD	CF	ISSUED FOR CLIENT REVIEW

CLIENT

AUSTRALIAN MINERALS
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CONSULTING ENGINEERS

PROJECT

LOTS 15 & 17 BRAND HIGHWAY
RUDDS GULLY

DRN	N.McDONALD	REVIEWED	DATE
DESIGN	C.FINGHER	Colin Fingher	29.10.2014
DIRECTOR	C.FINGHER	APPROVED FOR ISSUE: Colin Fingher	DATE: 29.10.2014

TITLE

LOCAL WATER MANAGEMENT STRATEGY
LOT 17 POST DEVELOPMENT DRAINAGE STORAGE
CATCHMENT H and I

SCALE	SIZE	DRAWING No	REV
AS SHOWN	A1	14001-C-158	B

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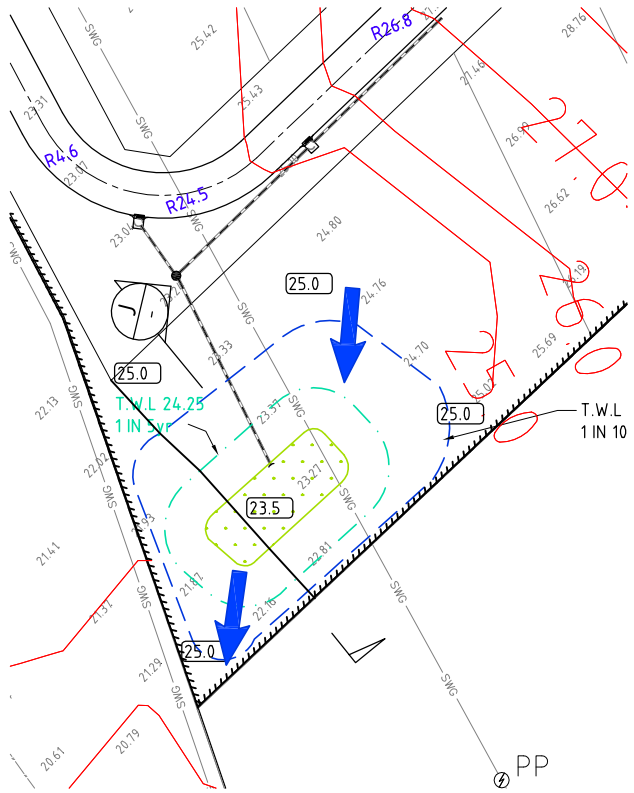
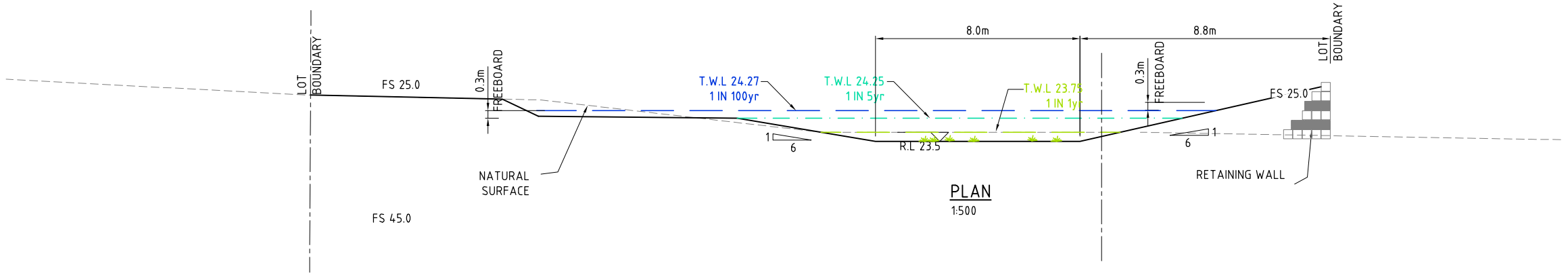
BASIN J DETAILS

TOTAL IMPERVIOUS AREA	1.88Ha
100 YEAR STORAGE REQUIRED	473m³
AREA AT T.W.L (100 yr)	758 m²
RL T.W.L (100 yr)	24.70 m
5 YEAR STORAGE REQUIRED	197 m³
AREA AT T.W.L (5 yr)	425 m²
RL T.W.L (5 yr)	24.25 m
AREA AT T.W.L (1 YR)	234m²
RL T.W.L (1 YR)	23.75 m
PEAK OUTFLOW (100 YR)	0 l/s
BASE LEVEL	25.50 m



LEGEND

- EXISTING SPOT LEVEL
- PRELIMINARY DESIGN CONTOURS
- R24.5 — PRELIMINARY ROAD LEVELS
- FS 34.0 — PRELIMINARY EARTHWORK LEVELS
- FL 36.2 — PRELIMINARY LOT LEVELS
- RETAINING WALL
- RCP DRAINAGE PIPE & PITS
- 1 IN 1 YEAR INFILTRATION BASE
- 55.0 — PRELIMINARY EARTHWORK CONTOURS
- RARE EVENT OVERFLOW PATH >1 IN1 00 YR



PLAN
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J — SECTION
1:100

PRELIMINARY
NOT FOR CONSTRUCTION

SCALE 1:100

SCALE 1:500

Rev.	Date	Drn.	Des.	Issue Description
B	19.06.2016	CF	CF	RARE EVENT OVERFLOW ADDED
A	29.10.2014	NMCD	CF	ISSUED FOR CLIENT REVIEW

CLIENT
AUSTRALIAN MINERALS INVESTORS PTY LTD

OCHREWEST CONSULTING ENGINEERS

PROJECT
LOTS 15 & 17 BRAND HIGHWAY
RUDDS GULLY

DRN	N.McDONALD	REVIEWED	DATE
DESIGN	C.FINGHER	Colin Fingher	29.10.2014
DIRECTOR	C.FINGHER	APPROVED FOR ISSUE: Colin Fingher	DATE: 29.10.2014

TITLE
LOCAL WATER MANAGEMENT STRATEGY
LOT 17 POST DEVELOPMENT DRAINAGE STORAGE CATCHMENT J

SCALE	SIZE	DRAWING No	REV
AS SHOWN	A1	14001-C-159	B

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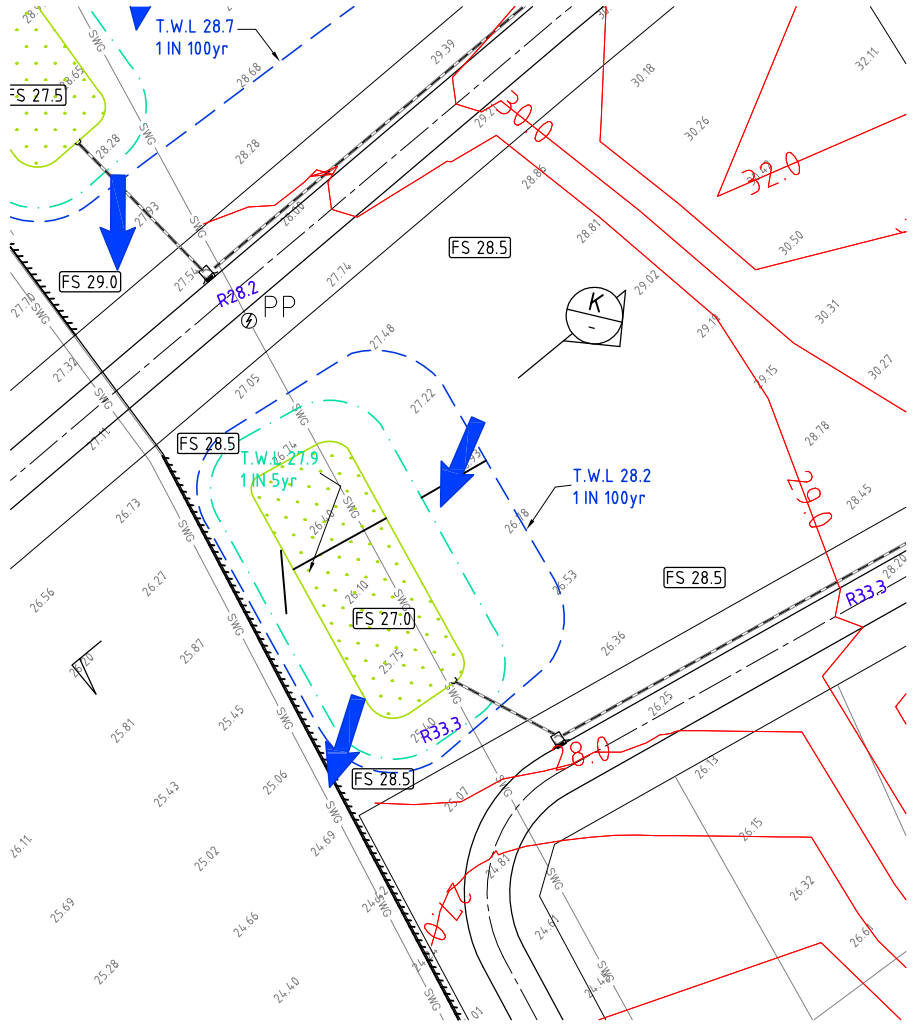
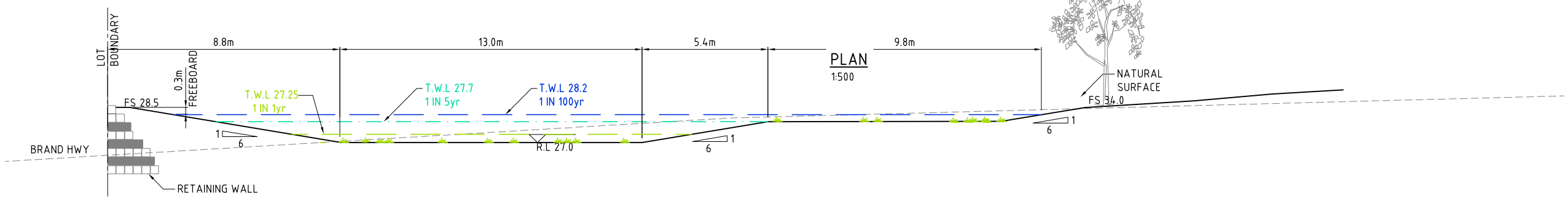
BASIN K DETAILS

TOTAL IMPERVIOUS AREA	3.93 Ha
100 YEAR STORAGE REQUIRED	1371 m^3
AREA AT T.W.L (100 yr)	2184 m^2
RL T.W.L (100 yr)	28.2 m
5 YEAR STORAGE REQUIRED	414 m^3
AREA AT T.W.L (5 yr)	821 m^2
RL T.W.L (5 yr)	27.7 m
AREA AT T.W.L (1 YR)	528 m^2
RL T.W.L (1 YR)	27.25 m
PEAK OUTFLOW (100 YR)	0 l/s
BASE LEVEL	27.0 m



LEGEND

- 46.20 — EXISTING SPOT LEVEL
- PRELIMINARY DESIGN CONTOURS
- R24.5 — PRELIMINARY ROAD LEVELS
- FS 34.0 — PRELIMINARY EARTHWORK LEVELS
- FL 36.2 — PRELIMINARY LOT LEVELS
- RETAINING WALL
- RCP DRAINAGE PIPE & PITS
- 1 IN 1 YEAR INFILTRATION BASE
- 55.0 — PRELIMINARY EARTHWORK CONTOURS
- RARE EVENT OVERFLOW PATH >1 IN1 00 YR



SECTION K
1:100

PLAN
1:500

PRELIMINARY
NOT FOR CONSTRUCTION

SCALE 1:100

SCALE 1:500

Rev.	Date	Drn.	Des.	Issue Description
B	19.06.2016	CF	CF	RARE EVENT OVERFLOW ADDED
A	29.10.2014	NMCD	CF	ISSUED FOR CLIENT REVIEW

CLIENT

AUSTRALIAN MINERALS
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CONSULTING ENGINEERS

PROJECT

LOTS 15 & 17 BRAND HIGHWAY
RUDDS GULLY

DRN	N.McDONALD	REVIEWED	DATE
DESIGN	C.FINGHER	*Colin Fingher*	*29.10.2014*
DIRECTOR	C.FINGHER	APPROVED FOR ISSUE: *Colin Fingher*	DATE: *29.10.2014*

TITLE

LOCAL WATER MANAGEMENT STRATEGY
LOT 17 POST DEVELOPMENT DRAINAGE STORAGE CATCHMENT K

SCALE	SIZE	DRAWING No	REV
AS SHOWN	A1	14001-C-160	B

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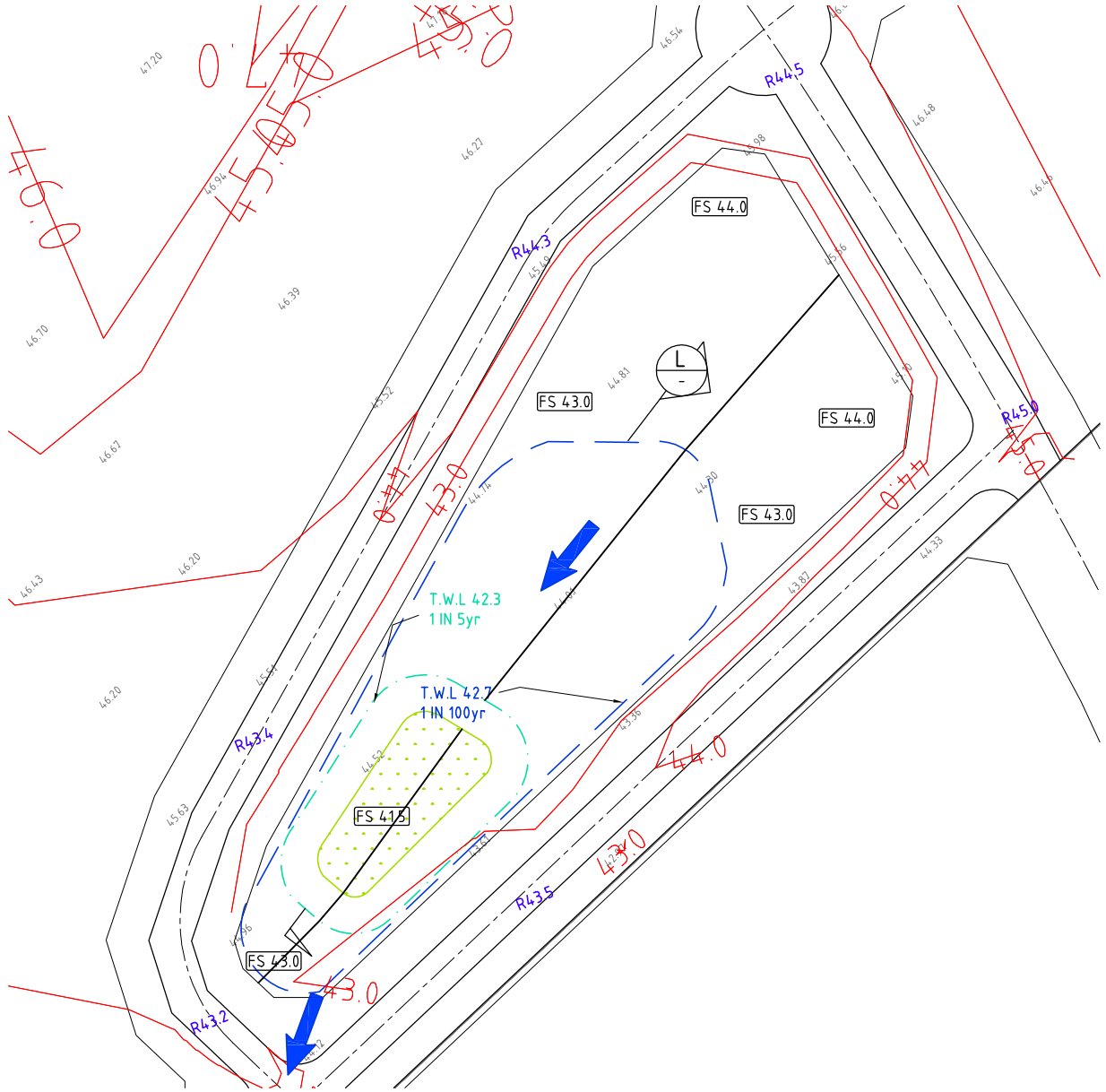
BASIN L DETAILS

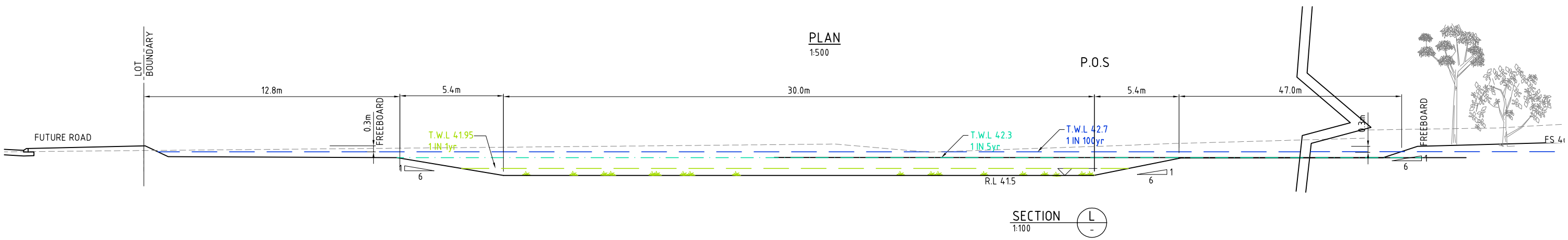
TOTAL IMPERVIOUS AREA	3.96 Ha
100 YEAR STORAGE REQUIRED	1323 m^3
AREA AT T.W.L (100 yr)	2514 m^2
RL T.W.L (100 yr)	42.7 m
5 YEAR STORAGE REQUIRED	412m^3
AREA AT T.W.L (5 yr)	785 m^2
RL T.W.L (5 yr)	42.3 m
AREA AT T.W.L (1 YR)	541 m^2
RL T.W.L (1 YR)	41.95 m
PEAK OUTFLOW (100 YR)	0 l/s
BASE LEVEL	41.5 m



LEGEND

- EXISTING SPOT LEVEL (46.20)
- PRELIMINARY DESIGN CONTOURS
- PRELIMINARY ROAD LEVELS (R24.5)
- PRELIMINARY EARTHWORK LEVELS (FS 34.0)
- PRELIMINARY LOT LEVELS (FL 36.2)
- RETAINING WALL
- RCP DRAINAGE PIPE & PITS
- 1 IN 1 YEAR INFILTRATION BASE
- PRELIMINARY EARTHWORK CONTOURS (55.0)
- RARE EVENT OVERFLOW PATH >1 IN1 00 YR

PLAN
1:500



SECTION L
1:100

PRELIMINARY
NOT FOR CONSTRUCTION

SCALE 1:100

SCALE 1:500

Rev.	Date	Drn.	Des.	Issue Description
B	19.06.2016	CF	CF	RARE EVENT OVERFLOW ADDED
A	29.10.2014	NMCD	CF	ISSUED FOR CLIENT REVIEW

CLIENT

AUSTRALIAN MINERALS
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CONSULTING ENGINEERS

PROJECT

LOTS 15 & 17 BRAND HIGHWAY
RUDDS GULLY

DRN	N.McDONALD	REVIEWED	DATE
DESIGN	C.FINGHER	Colin Fingher	29.10.2014
DIRECTOR	C.FINGHER	APPROVED FOR ISSUE: Colin Fingher	DATE: 29.10.2014

TITLE

LOCAL WATER MANAGEMENT STRATEGY
LOT 17 POST DEVELOPMENT DRAINAGE STORAGE
CATCHMENT L

SCALE	SIZE	DRAWING No	REV
AS SHOWN	A1	14001-C-162	B

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