

Stormwater Management Report
Lot 7, River Road
Redbank
Ipswich

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1.0 INTRODUCTION

This report has been prepared in relation to a Development Application for a site located at River Road Road, Redbank, described as lot 7 on SP133329 (refer to Figure 1.1). The proposal involves a Reconfiguration of Lot over the site for the purposes of subdividing the industrial land into nineteen (19) separate parcels with associated industrial amenities, driveways, parking, and landscaped areas as shown in the Plans of Development included in Appendix A.

This report addresses all stormwater management issues relating to water quality and the hydraulic impact on local drainage capacity.

It is intended that the level of detail provided within this report will satisfy Council that sufficient detail has been provided to facilitate Council's approval of the current Reconfiguration of Lot (RoL) Application; subject to appropriate conditions requiring that further detail shall be provided prior to any future Building and/or Operational Works application.



Figure 1.1: Locality of Site (source: Google Earth)

2.0 DESCRIPTION OF SITE AND PROPOSAL

2.1 Characteristics of Site

The site is described as 61 River Road, Redbank. The Brisbane River flows along the west boundary of the site. The western portion of the site comprises of river bank and park area, and falls with a slope of approximately 8%. The southern part of the site (proposed lot 9) falls further southward with a grade ranging from 6-12%. The remaining area is almost flat and falls partly towards the west and partly towards the south. The southern corner of the site is subject to local flooding where the Council's designated 100 year flood level is around 15.8m AHD, (refer Figure 2.1). The site is currently mainly vacant, as shown in the aerial photo below (Figure 2.2).

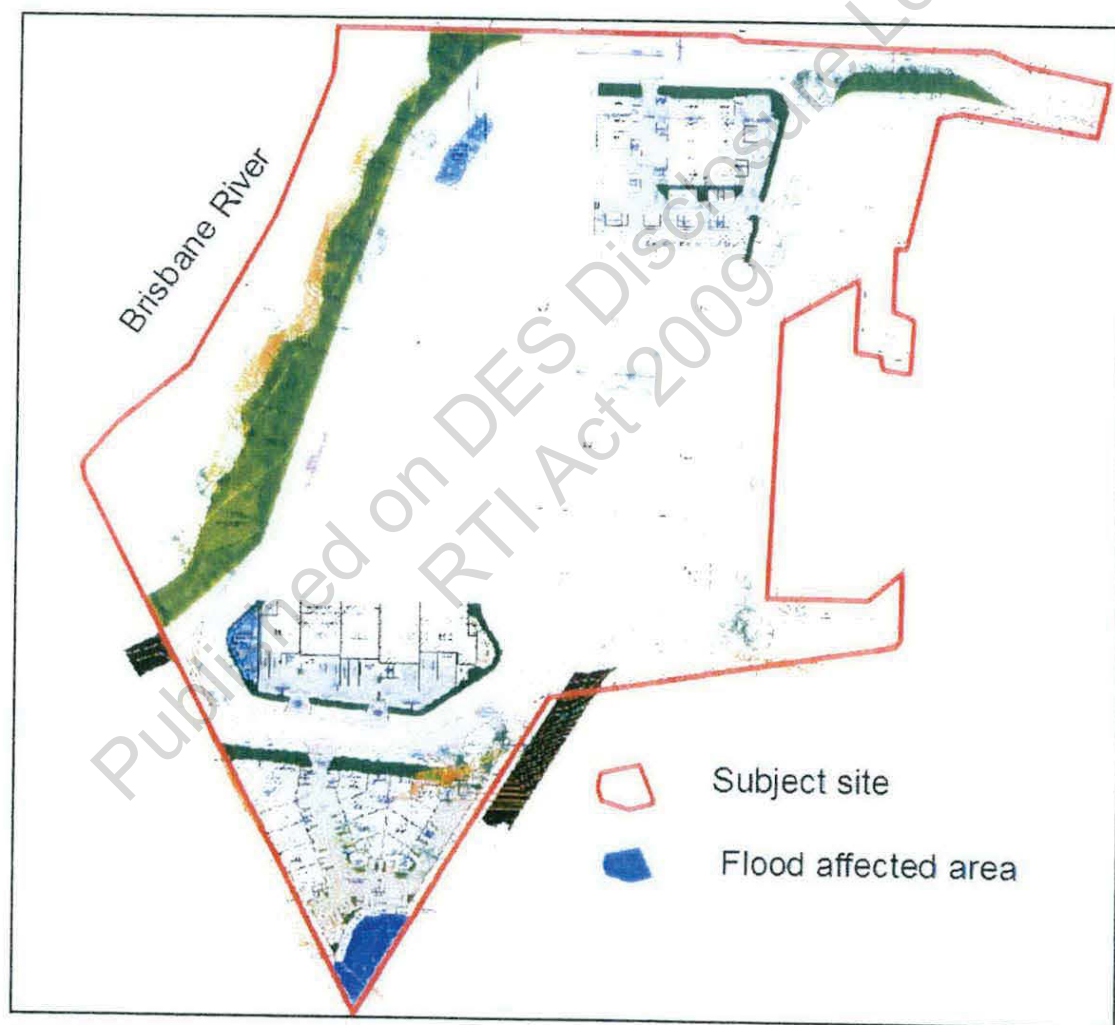


Figure 2.1: Subject site boundary and flood affected area (sources: Rehabilitation Plan prepared for C-Change Investments by OROGEN)



Figure 2.2: Aerial Photo of Site (source: Google Earth)

2.2 Development Proposal

It is proposed for Reconfiguration of the Lot into nineteen smaller parcels and a Material Change of Use for General Industry over proposed lots 1, 8 and 9 and Business & Caretakers Resident over proposed lot 3. The layout of the development is shown in the concept plan included as Appendix A. The conceptual stormwater quality management strategy will involve the use of individual as well as regional bioretention devices, individual rainwater tanks and gross pollutant traps, described further in Section 3.0. The stormwater quantity management aspect of the development proposal involves additional ponding on the bioretention basins and temporary storage within the adjacent landscape area described further in Section 4.0.

The summary of the water management (quality and quantity) devices with corresponding dimensions are presented in Section 5.1.

3.0 STORMWATER QUALITY MANAGEMENT

3.1 Stormwater Management Strategy

3.1.1 Objectives

The City of Ipswich Planning Scheme Policy 3 – General Works, Part 2 Division 3 – Water Quality Control states that *"The Local Government is committed to minimising erosion and sedimentation, and the degradation of surface and groundwater quality which can result from development, both during and after construction. Effective water quality control involves –*

- a. implementation of Stormwater Quality Best Management Practices;*
- b. integration of water quantity, water quality and waterway corridor issues into the design of both permanent and temporary water quality control measures;*
- c. programming of works to minimise erosion potentials; and*
- d. a commitment to the monitoring and maintenance of water quality control measures.*

Water Quality Control measures can be divided into two categories-

1. Temporary Water Quality Control (Off Stream)-
 - a. These measures are required to control and filter the runoff from areas disturbed during construction.*
 - b. These are typically erosion and sediment control measures and should preferably be the first items constructed when work begins.*
2. Permanent Water Quality Control (On Stream)-
 - a. These works are to be implemented to control runoff water quality beyond the initial construction and maintenance stages.*

Stormwater Quality Management Strategy:

1. Development that is likely to have a significant adverse impact on water quality is to compile and submit a Water Quality Management Plan that details the temporary and permanent methods of water quality control that are to be included in the development.
2. For developments which are likely to have a significant adverse impact on water quality, relevant water Quality Objectives as outlined in Table 2.3.1 are to be nominated and the temporary and permanent methods for water quality control to ensure that these objectives will be satisfied are to be identified on the Water Quality Management Plan.
3. Water Quality Objectives are the "standards" that describe the quality of stormwater that is required to be achieved prior to its discharge from a development site."

The Acceptable Solutions to this are:

A Stormwater Management Plan which is prepared for the site in accordance with the Stormwater Management and Water Quality Guidelines demonstrates that:

- (a) Stormwater is treated prior to discharge into the wetland or waterway;
- (b) Stormwater is discharged at appropriate areas of the waterway;
- (c) The velocity and quality of stormwater to be discharged into the wetland or waterway does not degrade the environmental values of the wetland or waterway;
- (d) The development will not impact on the geo-hydrology affecting the wetland or waterway.

The purpose of the Planning Scheme Policy referred to the *Integrated Planning Act* (1997), which seeks to achieve ecological sustainability by managing the effects of development on the environment. This includes ensuring that decision-making processes take account of short and long-term environmental effects of development at local, regional, State and wider levels and apply the *precautionary principle* as stated in Section 1.2.3 of the Act.

The Policy proposes that there are three stages of stormwater & water quality management planning, comprising:

1. Identification of Water Quality Objectives, Performance Criteria and Risk Assessment;
2. Stormwater Management Strategy (SWMS) – estimation of pollutants loads and overall conceptual planning; and
3. Stormwater Management Plan (SWMP) - a detailed management plan addressing major risks, key pollutants and site specific or development specific issues.

The Policy states that it is critical that planning for stormwater management and treatment is conducted in conjunction with the initial planning phases for a development site. Consideration should be given to:

1. Site constraints and opportunities;
2. Required protection of drainage lines, waterway corridors and wetlands;
3. The level of stormwater treatment required;
4. The area of land required to treat stormwater;
5. Water Sensitive Urban Design and stormwater reuse opportunities;
6. The siting and location of treatment measures; and
7. The cost and timing of works.

3.2 Stormwater Quality Management Strategy

3.2.1 Temporary Water Quality Control (Off Stream)

There is no runoff from external catchments flowing through the developed site. Most of the developed lots will fall towards the west and lot 9 will fall towards the south, which allows opportunities for sediment control at the western and southern part of the development. In order to maintain water quality during the construction phase all works shall be conducted in accordance with the following Construction Phase Management Plan.

A sediment basin is normally required where:

- the proposed development area is more than 1 ha;
- soils on the subject site are dispersive; and
- the development site is close to any water course.

Given the proposed development area is greater than 1ha; sediment basin will be required for the catchment. Due to the industrial nature of the proposed development, to control sediment erosion from the proposed development during the construction phase, three separate sediment basins will require to be constructed. The lots at the northern part (roughly lots 1-5, 13-15 & 18-19) of the site will flow towards the basin 3 as indicated in Figure 3.1. All other lots, except lot 9 will flow towards the basin 2 while lot 9 will flow towards basin 1.

The required sediment basin for the construction site has been designed in accordance with the standard approach using Universal Soil Loss Equation (USLE) and the CALM method as described in the IEAust Sediment Erosion Control Guideline for Queensland.

The USLE has been used to calculate average yearly sediment load from the subject site. The USLE is the product of the rainfall erosivity factor (R), the soil-erodibility factor (K), the slope length factor (L), the slope angle factor (S), the soil coverage factor (C), and the erosion control factor (P).

Calculations of predicted sediment load during construction phase, and for sizing of the sediment basin, are presented in Appendix D. The calculations show that the sediment basin 1 with a capacity of 67 m³ and hence an area of 100 m² with 0.6 m depth is required. The sediment basin 2 with a capacity of 385 m³ and hence an area of 577 m² with 0.6 m depth is required. The sediment basin 3 with a capacity of 368 m³ and hence an area of 552 m² with 0.6 m depth is required. The following Table 3.1 includes parameters related to the sediment basins. The sediment basin 1 will be positioned at the location of bioretention basin 9 while sediment basin 2 and 3 will be

positioned at the locations of regional bioretention basin 1 and 2 respectively. Later, after the completion of development phase, the sediment basins will be replaced by the bioretention basins.

Table 3.1: Sediment Basin Parameters

BASIN PARAMETER	SB1	SB2	SB3
SURFACE AREA (M ²)	100	577	552
LENGTH (M)	18	42	43
WIDTH (M)	6	14	14
SETTLING DEPTH (M)	0.6	0.6	0.6
STORAGE DEPTH (M)	0.07	0.07	0.07
TOTAL DEPTH (M)	0.67	0.67	0.67

To settle the suspended sediment it is proposed that artificial flocculation will be needed by applying gypsum within 24 hour of a storm event before pumping out water from the basins. Gypsum will be spread by hand at a rate of 32 kg per 100 m³ of stored water.

The following measures will also be undertaken to mitigate water quality impacts during the construction phase:

- i) Placement of sediment fences at the base of all batters and soil stockpiles to prevent any discharge outside the proposed development site.
- ii) Placement of grass filter strips along the road verges.
- iii) Regular inspection of sediment basin and sediment fences immediately after any rain event.
- iv) Remove sediments from the sediment basins when they are about 50% full.
- v) Re-vegetate of all disturbed areas with in two-week time of completion.

It shall be the responsibility of the developer, through their principal contractor, to ensure that temporary sediment and erosion controls are installed and maintained correctly as detailed below.

Sediment control should be able to be achieved by applying the following best sediment and erosion control management practices during the construction phase:

1. Establish a single stabilised entry/exit point for the site works, preferably not in the location of the proposed permanent driveway;
2. Construct a shake-down grid at the entrance to facilitate the removal of sediment from trucks leaving the site. The access road extending from the kerb to the grid should comprise a 150-200mm deep pad of 40mm crushed rock;
3. Install sediment fences along each boundary of the site;

4. Install bins and/or wind-proof litter areas on-site to minimise the dispersion of gross pollutants;
5. Maintain stockpiles on site of all materials necessary for the emergency repair of all erosion control devices. This includes silt fences, clean crushed rock for reapplication to the entrance road and for replacement of rock within temporary drainage channels;
6. Following each days construction works, ensure that any material on road surfaces is swept from the road, and not permitted to be washed down the gutters and piped drainage systems.

With regard to the construction and implementation of WSUD features this consultancy recommends the following options:

1. Do not construct or place filter media into trenches until all construction works that will add to sediment runoff have ceased onsite, or
2. Place filter media within device and place a suitable geofabric over the media along with 50 mm of shallow top soil and instantly turf, laying perpendicular to the flow path. This can then easily be removed prior to the final device planting.

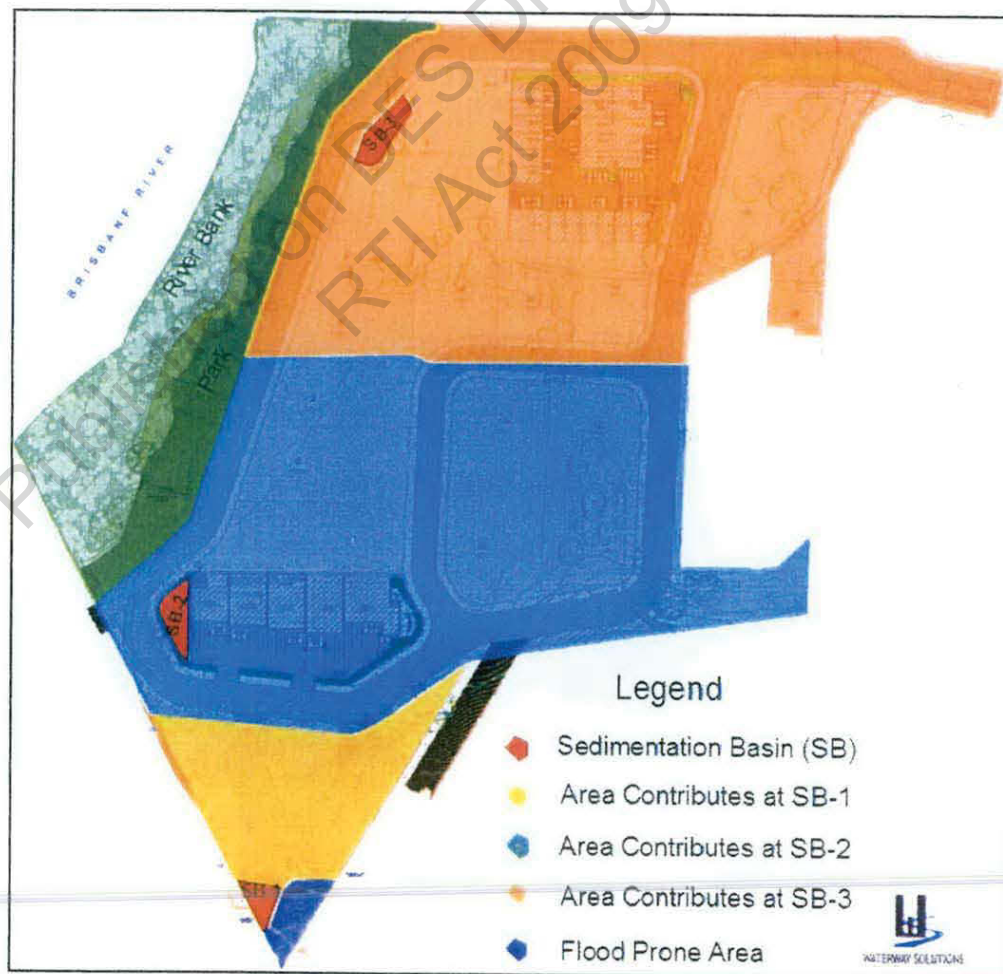


Figure 3.1: Indicative Sediment Basin Location

3.2.2 Permanent Water Quality Control (On Stream)

In order to comply with the Environmental Protection (Water) Policy, 1997 and to prevent the possible contamination of soil, stormwater and local watercourses the following best management practices are proposed which will be implemented permanently. Following outcomes will be achieved with the implementation of the proposed stormwater management plan:

- a. Potential contaminants associated with the industrial operation are not released into the environment;
- b. Safe, convenient and adequate stormwater treatment infrastructure will be available to the premise and
- c. Preventing stormwater from flowing untreated to the drainage system.

As per Council's Guideline on Identifying and Applying Water Quality Objectives in Ipswich City (January 2006), for a land-disturbing activity (Industrial and Commercial Developments), the key pollutants that need to be targeted primarily are:

- Suspended Solids (sediment);
- Gross Pollutants (Litter);
- Oxygen demanding substances (organic and chemical matter);
- Nutrients (Nitrogen and Phosphorous);
- Pathogens/Faecal coliforms (bacteria & viruses);
- Hydrocarbons (including oil & grease);
- Heavy Metals;
- Surfactants (detergents from car washing);
- Organochlorines & organophosphate (pesticides, herbicides);
- Thermal pollution (heat); and
- pH altering substances.

However due to the heterogeneity of industrial and commercial developments, based on the site specific assessment the following key pollutants have been identified as major targets:

- Suspended Solids (sediment);
- Gross Pollutants (Litter);
- Nutrients (Nitrogen and Phosphorous); and
- Hydrocarbons (including oil & grease).

The upper limits, with which the median values of the above mentioned indicators must comply, have been found within the *Table 2.3.1: Water Quality Objectives*. These are:

Table 3.2: Water Quality Objectives

Indicator	Environmental Values
Total Suspended Solids	15 mg/L
Total Phosphorus	70 µg/L
Total Nitrogen	650 µg/L
Litter / Gross Pollutants	No anthropogenic material > 5mm
Oils and Grease	No visible films or odour

Alternatively a much more recent document, "Water Sensitive Urban Design Manual (Working Draft 2006)" by Healthy Waterways, describes the Water Quality Objectives (WQO's) as recommended for the entire South East Queensland. The recommended WQO's are as follows:

- 80% reduction in Total Suspended Solids (Sediment) TSS;
- 60% reduction in Total Phosphorus TP;
- 45% reduction in Total Nitrogen TN; and
- 90% reduction in gross pollutants (i.e. anthropogenic material > 5mm in any dimension).

As pollutant export modelling typically focuses on nutrient and sediment transport during the post-construction phase, these pollutants will be the main focus of modelling assessments.

3.2.2.1 Strategy

The Model for Urban Stormwater Improvement Conceptualisation (MUSIC), version 3.1, developed by the Catchment Research Co-operative for Catchment Hydrology (CRCCH), has been used to quantify the water quality for the existing urban catchment and for the developed catchment. The model's algorithms are based on the known performance characteristics of common stormwater quality improvement measures.

For the post-developed condition water sensitive urban design techniques have been employed using the Stormwater Quality Improvement Devices. The stormwater management strategy is presented diagrammatically in Figure 3.2 "Indicative Treatment Locations" and by the MUSIC network indicated on Figure E.1 in Appendix E. In the Figure E.1, only indicative (lumped) treatment devices are presented for simplification of the MUSIC Model Layout. This can be summarised as follows:

- ~~Roof water from each lot will be collected by their individual 10kL rainwater tanks.~~
Overflow from these tanks will first be treated by the individual bio-retention basin followed by final treatment within the regional bio-retention basins, except lot 9. All other pervious and impervious areas of each lot (except lot 9) will also be

treated by their respective bio-retention basins followed by the regional bio-retention basin;

- All pervious and impervious areas within lot 9 will be treated only by the bio-retention basin 9. Overflow from bio-retention basin 9 will directly discharge to the south towards the railway reserve;
- Outflow from the individual bio-retention basins 6-12 and 16-17 will finally be treated within regional bio-retention basin 1. All other untreated runoff at and around these lots, especially the road systems will be treated within the regional bio-retention basin 1;
- Before entering into the regional bio-retention basin 1, all runoff will pass through a Gross Pollutant Trap, as indicated by GPT1 in Figure 3.2;
- Outflow from the individual bio-retention basins 3-5 will finally be treated within regional bio-retention basin 2. All other untreated runoff at and around these lots, especially the road systems will be treated within regional bio-retention basin 2. Before entering into the regional bio-retention basin 2, the flow will pass through a Gross Pollutant Trap (GPT2);
- Outflow from the individual bio-retention basins 1-2, 13-15 and 18-19 will finally be treated within regional bio-retention basin 2. All other untreated runoff at and around these lots, especially the road systems will be treated within regional bio-retention basin 2. Before entering into the regional bio-retention basin 2, the flow will pass through a Gross Pollutant Trap (GPT3);
- Overflow from the regional bio-retention basins will discharge to the park / Brisbane River;
- Rainwater tanks of 10kL at each lot have been proposed with the provision of 1kL/lot/day of reuse.



Figure 3.2: Indicative Treatment Locations

3.2.2.2 Music Model Parameters

For music modelling, 10 years of pluviograph rainfall data (1990 to 1999) from the Brisbane BOM station have been used. Industrial source nodes have been chosen to model the proposed development.

The parameters used for the storm event concentrations for the source nodes are generally based on the Brisbane City Council Guidelines, displayed in Tables 3.3 and 3.4 below.

Table 3.3: MUSIC Runoff Generation Parameters

Parameter	Industrial
Rainfall Threshold (mm)	1
Soil Capacity (mm)	120
Initial Storage (%)	25
Field Capacity	80
Infiltration Capacity Coefficient a	200
Infiltration Capacity Coefficient b	1
Initial Depth (mm)	50
Daily Recharge Rate (%)	25
Daily Baseflow Rate (%)	5
Daily Deep Seepage Rate (%)	0

Table 3.4: MUSIC Concentration Parameters for Ipswich Catchments

Land-use category		Log ₁₀ TSS (mg/L)		Log ₁₀ TP (mg/L)		Log ₁₀ TN(mg/L)	
		Storm Flow	Base Flow	Storm Flow	Base Flow	Storm Flow	Base Flow
Industrial	Mean	1.92	0.78	-0.59	-1.11	0.25	0.14
	Std Dev	0.44	0.45	0.36	0.48	0.32	0.20

The stormwater concentrations listed in the table 3.5 below have been adopted according to the Gold Coast City Council MUSIC modelling guideline when splitting the source nodes into different land use types. The values identified in Table 3.5 have been logged in order for input into the MUSIC model.

Table 3.5: MUSIC Stormflow Concentration Parameters as per Gold Coast Catchments

LAND USE CATEGORY	TSS CONCENTRATION MG/L	TP CONCENTRATION MG/L	TN CONCENTRATION MG/L
INDUSTRIAL			
ROADS	270	0.5	1.78
ROOFS	20	0.13	1.78
OTHER IMPERVIOUS AREAS	270	0.5	1.78
OTHER PERVIOUS AREAS	151	0.34	1.78

The fractions of imperviousness have been set based upon the assessment on the proposed site development plans. The park, flood affected area and river bank area have been excluded from the calculation. Roof areas, driveways and car parking areas are considered as 100% impervious. The remaining areas have been modelled with "other pervious/impervious area" on the assumption of 80% imperviousness and 20% perviousness after the development. Refer to catchment Table E.1 provided within Appendix E.

3.3 Developed Treated Case

3.3.1 Treatment Devices

In the model for the fully developed treated condition, nineteen individual and two regional bio-retention basins with associated rainwater tanks and three gross pollutant traps (GPT) have been considered as indicated in the locations in the Figure F.1 (included in Appendix F). The bioretention basin sizing can be located below within Table 3.6.

Bioretention systems promote the removal of particulate and soluble contaminants by transferring stormwater through a filter medium. A typical cross-section for each bioretention basin is included as Figure 3.3 below (from Melbourne Water, "WSUD Engineering Procedures: Stormwater" 2005). Dimensions specific to each basin are included as Table 3.6 below.

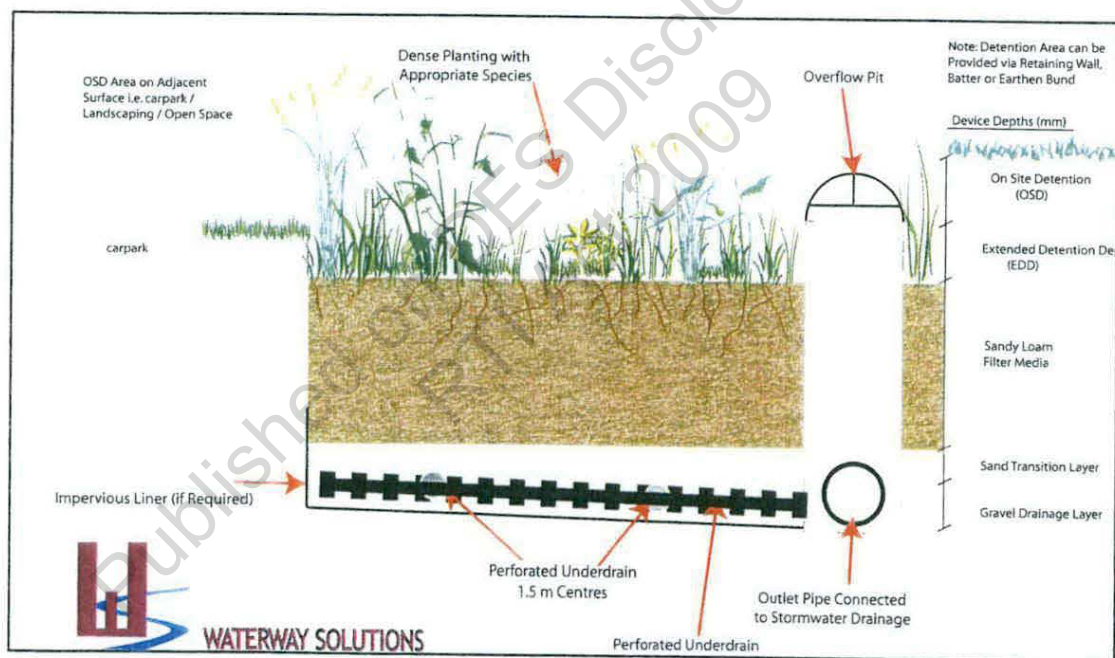


Figure 3.3: Typical section of a Bioretention System (refer Table 3.5 for dimensions)

Selection of appropriate filter media is a function of the infiltration rate required and the vegetation for the bioretention system. The modelling takes into account that the hydraulic conductivity assumed must be considered with regard to ponding of runoff above the filtration medium. Hence a lower infiltration rate – and thus higher detention time – could be utilised where ponding will increase the volume of runoff that can be treated.

Also to be considered in selection of filter media is the intention for landscaping within the bioretention area. In this case, each basin is assumed to involve deep planting to a depth of 600mm. This landscaping area requires sandy loam for planting, so the appropriate hydraulic conductivity has been selected as 180mm/h, with a particle diameter of 0.45mm, as recommended by Australian Runoff Quality. Typical cross sections of the devices can be located within Appendix B of this report.

It is proposed that the Landscape Designer shall ensure that the vegetation that is to be utilised within the device should be the similar vegetation species identified within Chapter 12 "Plant-Selection for WSUD Systems" of BCC's Draft WSUD Engineering Guidelines.

Table 3.6 Bioretention Basin Details

Bio-Basin	Lot No.	Surface Area (m ²)	Base Area (m ²)	Depth to overflow pipe/Weir (m)	Filter Depth (m)	Particle Size (mm)	Hydraulic Conductivity (mm/h)
Bio-1	1	40	40	0.2	0.6	0.45	180
Bio-2	2	40	40	0.2	0.6	0.45	180
Bio-3	3	10	10	0.2	0.6	0.45	180
Bio-4	4	20	20	0.2	0.6	0.45	180
Bio-5	5	25	25	0.2	0.6	0.45	180
Bio-6	6	25	25	0.2	0.6	0.45	180
Bio-7	7	25	25	0.2	0.6	0.45	180
Bio-8	8	30	30	0.2	0.6	0.45	180
Bio-9	9	40	40	0.2	0.6	0.45	180
Bio-10	10	25	25	0.2	0.6	0.45	180
Bio-11	11	25	25	0.2	0.6	0.45	180
Bio-12	12	25	25	0.2	0.6	0.45	180
Bio-13	13	25	25	0.2	0.6	0.45	180
Bio-14	14	20	20	0.2	0.6	0.45	180
Bio-15	15	20	20	0.2	0.6	0.45	180
Bio-16	16	25	25	0.2	0.6	0.45	180
Bio-17	17	20	20	0.2	0.6	0.45	180
Bio-18	18	30	30	0.2	0.6	0.45	180
Bio-19	19	10	10	0.2	0.6	0.45	180
Regional Bio-1		325	325	0.3	0.6	0.45	180
Regional Bio-2		350	350	0.3	0.6	0.45	180

3.3.2 Results

The following Table 3.7 provides music model pollutants results for pre and post developed conditions.

Table 3.7: MUSIC Results of Total Development Model: Post-Development Treatment

Pollutants	Sources	Residual	Reduction (%)
Total Flow (ML/yr)	78.0	73.7	5.4
Total Suspended Solids (kg/yr)	23.0E3	3.91E3	83.0
Total Phosphorus (kg/yr)	40.8	11.3	72.4
Total Nitrogen (kg/yr)	183	96.8	47.1
Gross Pollutants (kg/yr)	1.72E3	0.0	100.0

The above table 3.7 clearly demonstrates that the proposed stormwater quality improvement devices will improve the overall water quality indicators during the post-development phase, compared to the untreated developed site, with the reductions generally exceeding the required percentage reductions.

Furthermore, it is considered that this result is satisfactory, in light of the following **conservative assumption** within the modelling:

1. No reduction was made to the Percent Impervious area, recommended by the MUSIC manual; and also recommended in the literature by way of calibrating the Impervious Fraction by using Average Volumetric Runoff Coefficient available in the BCC Pollutant Export Modelling Guidelines.

3.4 Maintenance of Water Treatment Devices

Bioretention Basin

The vegetation within a bioretention device plays a vital role in maintaining the porosity of the filter media and a strong healthy growth of vegetation is critical to its performance. The Site Manager as asset custodian will need to undertake on-going maintenance of the water quality devices, and this comprises the tasks described below. For the bioretention basins, primarily for the first two years from completion of the works as this is the typical plant establishment period when weed removal and replanting may be required. The minimum maintenance requirement for the bioretention devices is as follows:

1. ~~Inflow systems and overflow pits require careful monitoring, as these can be~~ prone to scour and litter build up. Debris can block inlets or outlets and can be unsightly, particularly in high visibility areas. Inspection and removal of debris should be done regularly, and debris should be removed whenever it is

observed on a site. Where sediment forebays are adopted, regular inspection of the forebay is required (3 monthly) with removal of accumulated sediment undertaken as required.

2. Routine inspection of the bioretention basin profile to identify any areas of obvious increased sediment deposition, scouring from storm flows, rill erosion of the batters from lateral inflows, damage to the profile from vehicles and clogging of the bioretention basin (evident by a 'boggy' filter media surface).
3. Routine inspection of inflows systems, overflow pits and under-drains to identify and clean any areas of scour, litter build up and blockages.
4. Removal of sediment where it is smothering the bioretention basin vegetation.
5. Where a sediment forebay is adopted, removal of accumulated sediment.
6. Repairing any damage to the profile resulting from scour, rill erosion or vehicle damage by replacement of appropriate fill (to match onsite soils) and revegetating.
7. Tilling of the bioretention basin surface, or removal of the surface layer, if there is evidence of clogging.
8. Regular watering/ irrigation of vegetation until plants are established and actively growing.
9. Removal and management of invasive weeds (herbicides should not be used).
10. Removal of plants that have died and replacement with plants of equivalent size and species as detailed in the plant schedule.
11. Pruning to remove dead or diseased vegetation material and to stimulate growth.
12. Vegetation pest monitoring and control.

A complete reconstruction of the bioretention basin is required if the system fails to drain adequately after tilling of the surface has occurred. Maintenance should only occur after an extended rain free period when the soil in the bioretention system is dry. Inspections are also recommended following large storm events to check for scour and other damage. A Bioretention Maintenance Checklist is provided within Appendix G of this report.

Gross Pollutant Trap

Three (3) Gross Pollutant Traps (GPTs) have been considered for modelling (see Figure F.1 in Appendix F). However, the type has not been specified for the site. This will be selected at the design stage of the development. The GPT shall be selected to ensure that it is capable of treating hydrocarbons (oils) and litter from any hosing that is undertaken within the carparks. Installation and maintenance of the device will be in accordance with the manufacturer's specifications with a licensed waste removal firm being required to dispose of any waste removed from the device. An agreement for waste removal can be obtained prior to the commencement of use of the site.

4.0 HYDRAULIC IMPACT

This Section describes the regional flooding characteristics of the proposal, and how the proposal complies with the specific criteria of the Ipswich Planning Scheme.

4.1 Regional Flooding

The southern corner of the site, approximately 806m², is subjected to flooding where 1 in 100 year flood inundation level is 15.8m AHD, (see Figure 2.1). However, the proposed development will be at or above 25m AHD. Therefore, the development will not be inundated by regional flooding.

4.2 Local Drainage Impact

4.2.1 Peak Flowrates

There are a number of Sections within the Ipswich Planning Scheme which require that flows from the site have to be limited to that prior to development.

Note 2.1.1A of Planning Scheme Policy 3 – General Works, Part 2 – Stormwater Drainage states that *“(1) The design of the proposed drainage system is to ensure that the upstream drainage is not adversely affected and that the downstream drainage system is capable of adequately catering for the discharge of the additional flow produced as a result of the development; and (2) If the downstream system is not capable of carrying the increased discharge, measures are to be proposed to ensure the downstream system is capable of carrying the increased discharge or the stormwater is to be detained on the site.”*

Note 51 of Planning Scheme Policy 2 – Information Local Government May Request indicates that *“....(4) If the downstream system is not capable of carrying the increased discharge, measures are to be proposed to – (a) ensure that the downstream system is capable of carrying the intended discharge (which may include upgrading the existing downstream system); or (b) indicate the method of detention of stormwater on the site.”*

Pre-development and post-development stormwater peak flowrates have been calculated based on the standard procedures in Section 5 of the Queensland Urban Drainage Manual. Existing flood affected area, proposed park, and the river bank area have been excluded from the calculation. The OSD volume for all lots except lot 9 is presented in Section 4.2.2 while the same for lot is presented in Section 4.23. The calculations are included in the Appendix C.

4.2.2 Flow Attenuation Volume Within All Lots Except Lot 9

The results show that the peak flow for the proposed development will increase from 4.07m³/s of the pre-development phase to 5.77m³/s of the post-developed (unattenuated) case, with an increase of 42%.

The post development peak flow needs to be reduced by 1.70m³/s by using on-site detention. Initial sizing of the detention basin has been calculated using the following equation 6.05 of QUDM:

$$V_s / V_i = r (2 + r) / 3$$

$$V_i = \text{the inflow volume} = 4.t_c.Q_i / 3 \text{ and}$$

$$r = \text{the reduction ratio} = (Q_i - Q_o) / Q_i$$

The calculations are shown in Appendix C, with the results showing that an attenuation volume of about 467m³ is required. This volume of water can be accommodated by the following ways:

- allowing additional ponding of 30cm on top of the regional bio-retention basins that will accommodate OSD volume of around 193m³;
- The computed total impervious areas within 18 lots (lots 1-8 and 10-19) are around 35095m² (see Table E.1 in Appendix E). By allowing less than 100mm ponding only on 10% of the impervious areas (3510m²) in each lot, the remaining 274m³ of OSD volume could be accommodated.

4.2.3 Flow Attenuation Volume Within Lot 9

The results show that the peak flow for the proposed development will increase from 0.41m³/s of the pre-development phase to 0.59m³/s of the post-developed (unattenuated) case, with an increase of 44%. The post development peak flow needs to be reduced by 0.18m³/s by using on-site detention.

The calculations are shown in Appendix C, with the results showing that an attenuation volume of about 50m³ is required. This volume of water can be accommodated by the following ways:

- The computed total impervious area within lot 9 is around 4255m² (see Table E.1 in Appendix E). By allowing 125mm ponding only on 10% of the impervious areas (425m²) of the lot could be accommodated the OSD volume of 50m³.

5.0 Recommendations and Conclusion

5.1 Recommended Work List

Proposed Devices	Quantity	Volume (m ³)	Total Area (m ²)	Remarks
Individual Rainwater Tanks (RWT)	19	190		10kL at each lot, with a reuse provision of 1kL/lot/day
Sediment Basins	3	820	1229	See Table 3.1
Individual Bio-retention Basins	19	-	480	See Table 3.6
Regional Bio-retention Basins	2	-	675	See Table 3.6
Gross Pollutant Traps	3	-	-	See Section 3.3
On-site Detention (OSD), all lots except lot 9		467		See Section 4.2.2
OSD for lot 9		50		See Section 4.2.3

5.2 Summary

The report demonstrates that the relevant Council's requirements have been satisfactorily addressed and it is recommended that Council approve the RoL application subject to appropriate conditions.

5.3 Limitations and Qualifications

Waterway Solutions Pty Ltd has prepared this report for the sole purpose of Brown Consulting (QLD) Pty Ltd for the specific purposes of Development Application to Ipswich City Council for Reconfiguration of Lot. The overall approach, analysis, and recommendations of this report are strictly limited to the purpose and facts and matters stated in it and will not be used for any other development application, purpose or matter.

It is strongly recommended that the detailed design drawings for the building hydraulics / stormwater design be referred to this office for comment, in order to confirm whether the proposed drawings are consistent with the assumptions of this report.

In preparing this report we have assumed that all the information and documents provided to us by the Client and/or their Project Manager and representatives were accurate, complete and up-to-date. Where we have obtained information from a government body, we have assumed that the information is accurate; and we are not aware of any reason why any of the assumptions may be incorrect.

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APPENDICES

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APPENDIX A: SUBDIVISION CONCEPT PLAN



Figure A.1: CONCEPT LAYOUT

APPENDIX B: BIORETENTION PLAN & DEVICE DETAILS

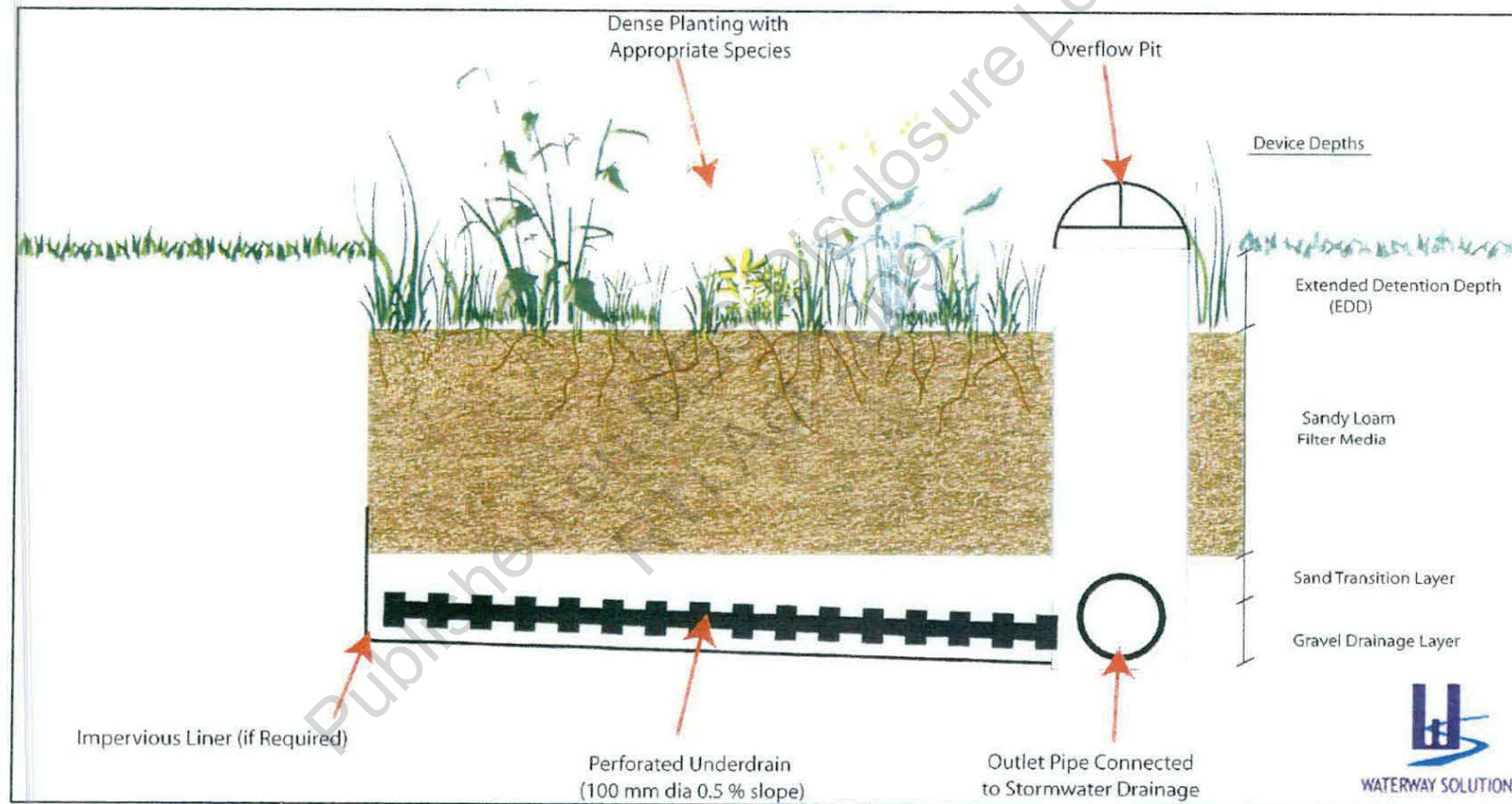


FIGURE B.1: CROSS-SECTION OF BIORETENTION SYSTEM

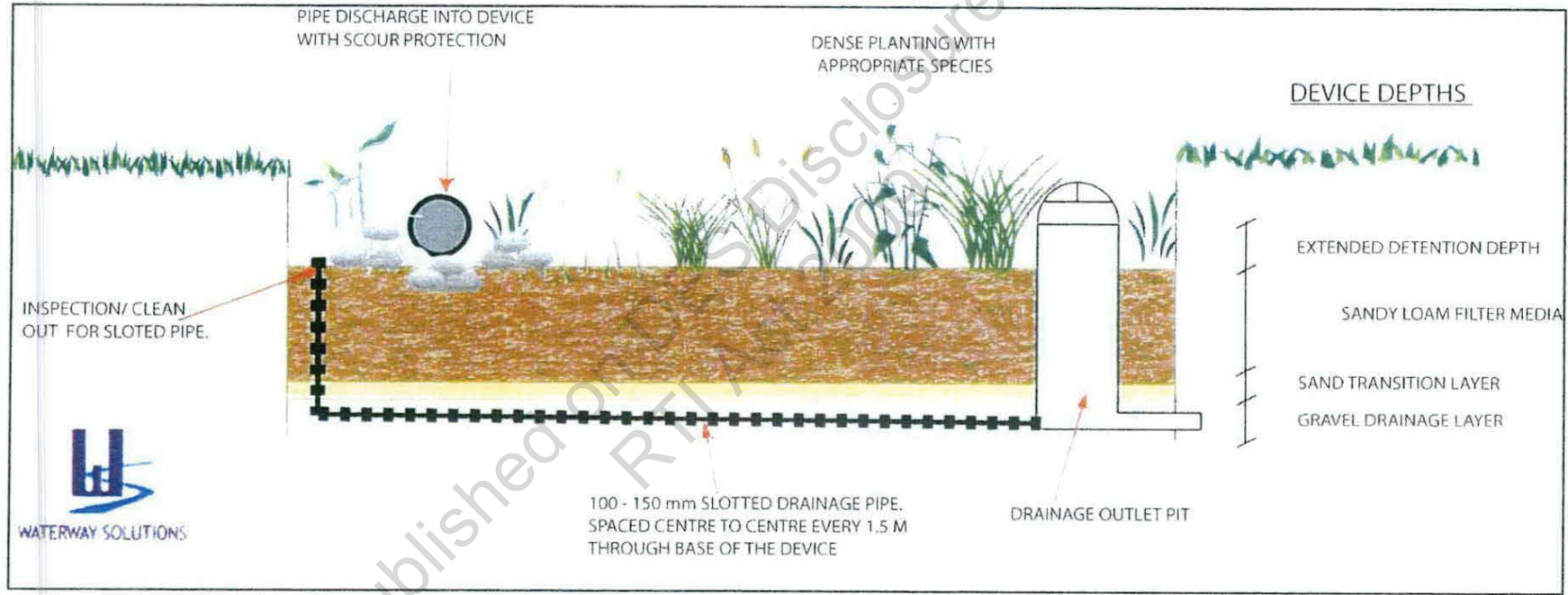


FIGURE B.2: LONG CROSS-SECTION OF BIORETENTION SYSTEM

APPENDIX C: FLOW ATTENUATION VOLUME CALCULATION

PART 1: OSD VOLUME WITHIN ALL LOTS EXCEPT LOT 9

PROJECT: Lot 7 on SP 133329, River Road, Redbank		
Calculation Sheet No. 1: Subject Site: Pervious areas		
TOTAL SITE AREA*	(m ²)	82759
	(ha)	8.2759
ESTIMATE OF FRACTION IMPERVIOUS AREA FOR EXISTING SITE		
ALLOTMENT	PERVIOUS (m²)	IMPERVIOUS AREA (m²)
VACANT	80259	
BUILDING		2500
CARPARK		
DRIVEWAY		
Total	80259	2500
F I =		0.030
ESTIMATE OF FRACTION IMPERVIOUS AREA FOR PROPOSED SITE		
ALLOTMENT	PERVIOUS (m²)	IMPERVIOUS AREA (m²)
BUILDING		7498
ROAD, DRIVEWAY		28375
OTHER IMPERVIOUS		36212
OTHER PERVIOUS	10674	
Total	10674	72085
F I =		0.87
* Lot 9, Flood affected area, Park and River Bank Area are excluded from the OSD calculation. Areas are approximate.		

PROJECT: Lot 7 on SP 133329, River Road, Redbank			
Time of concentration			
Friend's Formula:			
$t_c =$	$(107nL^{0.333})/S^{0.2}$		
Manning's Eqn:			
$t_c =$	$0.025L/S^{0.5}$		
Existing Scenario			
L =	100	overland sheet flow path length (m)	
n =	0.03	Horton's roughness value for the surface	
S =	2	slope of surface (%)	
$t_{c1} =$	13	overland sheet flow time (min)	(Friend's)
L =	150	channel flow length (m) for undeveloped site	
$t_{c1} =$	3.6	channel flow time (min)	(Manning's)
$t_{c(\text{total})} =$	16.6	sheet flow + channel flow (min)	
Post-development scenario			
L =	50	overland sheet flow path length (m)	
n =	0.02	Horton's roughness value for the surface	
S =	1	slope of surface (%)	
$t_{c1} =$	7.9	overland sheet flow time (min)	(Friend's)
L =	100	channel flow length (m) for developed site	
S =	1	slope of surface (%)	
$t_{c1} =$	2.5	channel flow time (min)	(Manning's)
$t_{c(\text{total})} =$	10.4	sheet flow + channel flow (min)	
Recommended Maximum Length of Overland Sheet			
Flow Path Used in Design			
Location	Typical Length	Maximum Length	
	(m)	(m)	
Urban	20 - 50	50	
Rural	50 - 200	200	
Values for Horton's 'n'			
0.015	Paved surface		
0.0275	Bare soil surface		
0.035	Poorly grassed surface		
0.045	Average grassed surface		
0.06	Densely grassed surface		

PROJECT: Lot 7 on SP 133329, River Road, Redbank

Calculation sheet No. 2: Subject Site: OSD.

Sizing of Onsite Storage for Peak Flow Attenuation

EXISTING SITE

DESCRIPTION: Vacant Land with Trees & Detached Dwelling

CATCHMENT AREA	A =	8.2759	ha
FRACTION IMPERVIOUS	f =	0.000	
TYPICAL GRADE OF LOTS		2.0	%
TIME OF CONCENTRATION, FROM FRIEND'S EQn	t_c =	16.6	min
100 YEAR RAINFALL INTENSITY	I 100	208	mm/h
10 YEAR COEFF. RUNOFF (3.5.7.2 GCCC LDG)	C10 =	0.71	
	F 100 =	1.2	
	C 100 =	0.85	
100 YEAR PEAK FLOWRATE	Q100 =	4.074	m ³ /sec

Proposed Development Site

DESCRIPTION: Industrial Development

CATCHMENT AREA	A =	8.2759	ha
FRACTION IMPERVIOUS	f =	0.000	
TYPICAL GRADE OF LOTS		1.0	%
TIME OF CONCENTRATION, FROM FRIEND'S EQn	t_c =	10.4	min
100 YEAR RAINFALL INTENSITY	I 100	251	mm/h
10 YEAR COEFF. RUNOFF (3.5.7.2 GCCC LDG)	C10 =	0.87	
	F 100 =	1.2	
	Prelim C100	1.04	
	C 100 =	1.00	
100 YEAR PEAK FLOWRATE	Q100 =	5.770	m ³ /sec

PRELIMINARY SIZING OF On- Site Detention

ARI 100							Detention volume (m ³)
Pre Q	Post Q	% increase	t_c	r	Vs/Vi	Vi	
(m ³ /s)	(m ³ /s)						
4.07	5.77	42	4.5	0.29	0.22	2077	467
Increase =		1.70	m ³ /s				

PROJECT: Lot 7 on SP 133329, River Road, Redbank					
Time of concentration					
Friend's Formula:					
	$t_c =$	$(107nL^{0.333})/S^{0.2}$			
Manning's Eqn:					
	$t_c =$	$0.025L/S^{0.5}$			
Existing Scenario					
L =	80	overland sheet flow path length (m)			
n =	0.03	Horton's roughness value for the surface			
S =	10	slope of surface (%)			
$t_{c1} =$	8.7	overland sheet flow time (min)		(Friend's)	
L =		channel flow length (m) for undeveloped site			
$t_{c1} =$		channel flow time (min)		(Manning's)	
$t_{c(total)} =$	8.7	sheet flow			
Post-development scenario					
L =	40	overland sheet flow path length (m)			
n =	0.02	Horton's roughness value for the surface			
S =	8	slope of surface (%)			
$t_{c1} =$	4.8	overland sheet flow time (min)		(Friend's)	
L =	20	channel flow length (m) for developed site			
S =	8	slope of surface (%)			
$t_{c1} =$	0.3	channel flow time (min)		(Manning's)	
$t_{c(total)} =$	5.1	sheet flow + channel flow (min)			

PROJECT: Lot 7 on SP 133329, River Road, Redbank**Calculation sheet No. 2: Subject Site: OSD.****Sizing of Onsite Storage for Peak Flow Attenuation****EXISTING SITE****DESCRIPTION: Vacant Land with Trees & Detached Dwelling**

CATCHMENT AREA	A =	0.6546	ha
FRACTION IMPERVIOUS	f =	0.000	
TYPICAL GRADE OF LOTS		8.0	%
TIME OF CONCENTRATION, FROM FRIEND'S EQn	t_c =	8.7	min
100 YEAR RAINFALL INTENSITY	I 100	269	mm/h
10 YEAR COEFF. RUNOFF (3.5.7.2 GCCC LDG)	C10 =	0.70	
	F 100 =	1.2	
	C 100 =	0.84	
100 YEAR PEAK FLOWRATE	Q100 =	0.411	m ³ /sec

Proposed Development Site**DESCRIPTION: Industrial Development**

CATCHMENT AREA	A =	0.6546	ha
FRACTION IMPERVIOUS	f =	0.806	
TYPICAL GRADE OF LOTS		7.0	%
TIME OF CONCENTRATION, FROM FRIEND'S EQn	t_c =	5.1	min
100 YEAR RAINFALL INTENSITY	I 100	325	mm/h
10 YEAR COEFF. RUNOFF (3.5.7.2 GCCC LDG)	C10 =	0.87	
	F 100 =	1.2	
	Prelim C100	1.04	
	C 100 =	1.00	
100 YEAR PEAK FLOWRATE	Q100 =	0.591	m ³ /sec

PRELIMINARY SIZING OF On- Site Detention

ARI 100							Detention volume (m ³)
Pre Q	Post Q	% increase	t_c	r	Vs/Vi	Vi	
(m ³ /s)	(m ³ /s)						
0.41	0.59	44	4.5	0.30	0.23	213	50
Increase =		0.18	m ³ /s				

APPENDIX D: SEDIMENT BASIN CALCULATIONS

PROJECT: Lot 7 on SP 133329, River Road, Redbank
Prediction of annual sediment load.

Sediment Basin No. 1

Cat.	Slope	Slope	Rain	R	K	LS	C	P	Load	Total Annual Sediment Yield
Area (ha)	Length (m)	grade	Intensity I_2 (mm)						(t/ha/yr)	(m ³)
0.73	60	10%	12.3	3354	0.007	0.8	0.85	1	13.3	10
Total										10

Sizing of the sediment basin

Q 10 flowrate (6 hour) (m ³ /s)	Design particle, D70 (mm)	Settling velocity (m/s)	Basin Surface Area (m ² /m ³ /s)	Actual Surface Area (m ²)	Effective Annual Sediment Yield (m ³)	Length (m)	Width (m)	Settling depth (calculated) (m)	Settling Depth (nom) (m)	Storage Depth (m)	Total Depth (m)	Volume (m ³)
0.0245	0.02	0.00029	4101	100	7	18	6	0.09	0.6	0.07	0.67	67

10 year 6 hr intensity = 18.3 mm/h

C 10 = 0.66

Area = 0.73 ha

Q 10 6 hr intensity = 0.0245 m³/s

Sediment Basin No. 2

Cat.	Slope	Slope	Rain	R	K	LS	C	P	Load	Total Annual Sediment Yield (m ³)
Area (ha)	Length (m)	grade	Intensity ⁶ I ₂ (mm)						(t/ha/yr)	
4.19	175	1%	12.3	3354	0.007	0.8	0.85	1	13.3	56
Total										56

Sizing of the sediment basin

Q 10 flowrate (6 hour) (m ³ /s)	Design particle, D70 (mm)	Settling velocity (m/s)	Basin Surface Area (m ² /m ³ /s)	Actual Surface Area (m ²)	Effective Annual Sediment Yield (m ³)	Length (m)	Width (m)	Settling depth (calculated) (m)	Settling Depth (nom) (m)	Storage Depth (m)	Total Depth (m)	Volume (m ³)
0.1406	0.02	0.00029	4101	577	39	42	14	0.21	0.6	0.07	0.67	385

10 year 6 hr intensity = 18.3 mm/h

C 10 = 0.66

Area = 4.19 ha

Q 10 6 hr intensity = 0.1406 m³/s

Sediment Basin No. 3

Cat.	Slope	Slope	Rain	R	K	LS	C	P	Load	Total Annual Sediment Yield
Area (ha)	Length (m)	grade	Intensity I_2 (mm)						(t/ha/yr)	(m ³)
4.01	150	1%	12.3	3354	0.007	0.8	0.85	1	13.3	53
Total										53

Sizing of the sediment basin

Q 10 flowrate (6 hour) (m ³ /s)	Design particle, D70 (mm)	Settling velocity (m/s)	Basin Surface Area (m ² /m ³ /s)	Actual Surface Area (m ²)	Effective Annual Sediment Yield (m ³)	Length (m)	Width (m)	Settling depth (calculated) (m)	Settling Depth (nom) (m)	Storage Depth (m)	Total Depth (m)	Volume (m ³)
0.1345	0.02	0.00029	4101	552	37	43	13	0.215	0.6	0.07	0.67	368

10 year 6 hr intensity = 18.3 mm/h

C 10 = 0.66

Area = 4.01 ha

Q 10 6 hr intensity = 0.1345 m³/s

APPENDIX E: MUSIC MODEL LAYOUT & CATCHMENT DATA



Figure E.1 MUSIC MODEL LAYOUT

Table E1: Catchment Data for Figure E.1

Item Name	Bio (6-8)	Bio (9)	Bio (10-11,17)	Bio (12,16)	Regional Bio-1	Bio (1-2)	Bio (3-5)	Bio (13-15)	Bio (18-19)	Regional Bio-2	Total Area
	(m ²)	(m ²)	(m ²)	(m ²)	(m ²)	(m ²)	(m ²)	(m ²)	(m ²)	(m ²)	(m ²)
Roof	1685	982	961	632		1867	759	866	729		8480
Road	12900					15475					28375
Pervious Area	2167	1269	1211	793	558	2409	956	1089	931	558	11943
Impervious Area	7302	4255	4163	2740	1302	8091	3287	3752	3157	1302	39352
Bio-retention Area*	80	40	70	50	325	80	55	65	40	350	1155
Sub-Total	11234	6546	6405	4216	15086	12447	5057	5772	4857	17686	89305
Total											89305

* Please see Table 3.6 for individual lot's bio-retention areas

APPENDIX F: CONCEPT DRAINAGE LAYOUT

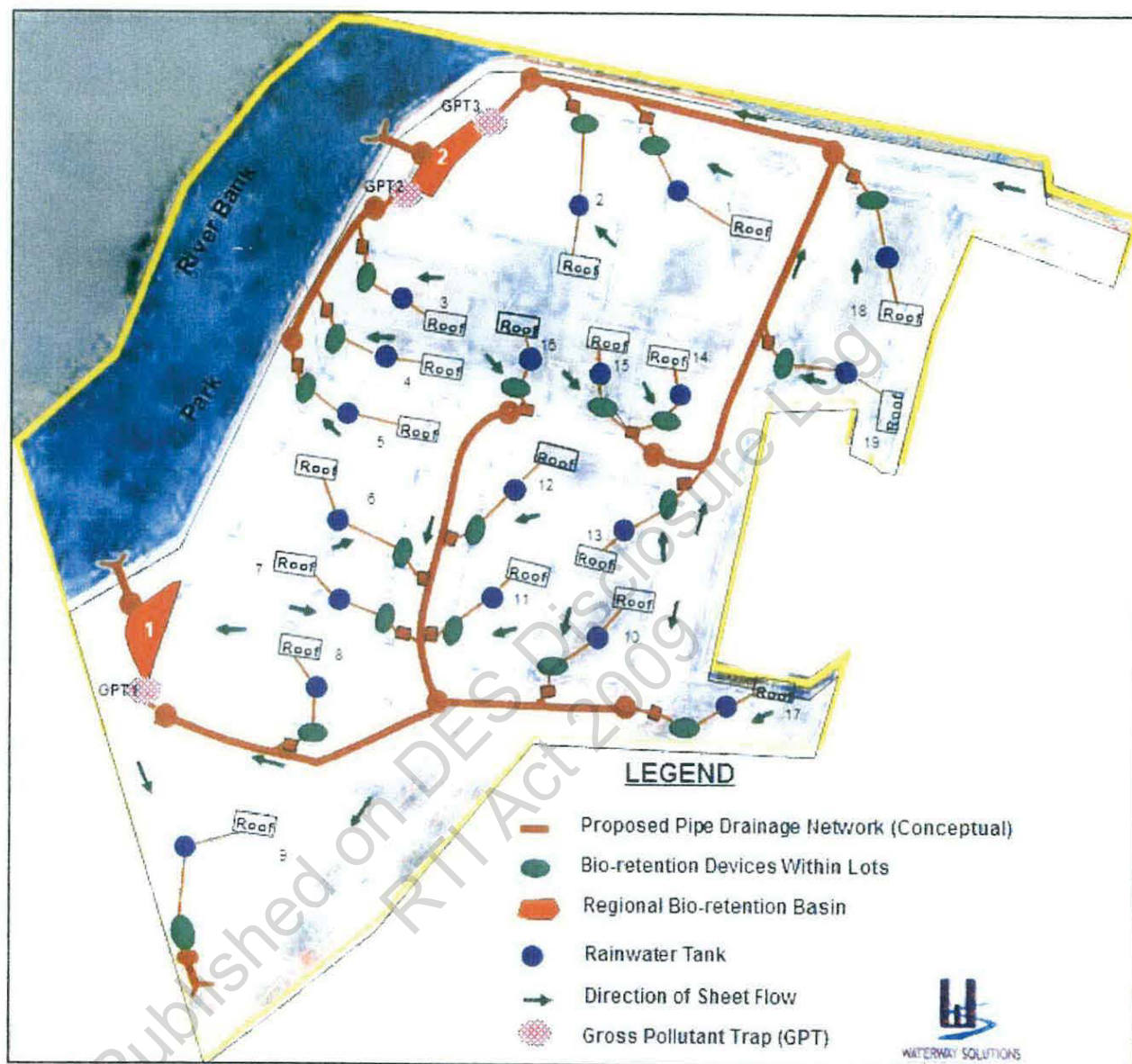


Figure F.1: PROPOSED DRAINAGE LAYOUT (CONCEPTUAL)

APPENDIX G: BIORETENTION MAINTENANCE CHECKLIST

Bioretention Basin Maintenance Checklist			
Inspection frequency:	1 – 6 Monthly	Date of visit:	
Location:			
Description:			
Site visit by:			
Inspection items	Y	N	Action required (details)
Sediment accumulation at inflow points?			
Litter within basin?			
Erosion at inlet or other key structures (eg crossovers)?			
Traffic damage present?			
Evidence of dumping (eg building waste)?			
Vegetation condition satisfactory (density, weeds etc)?			
Replanting required?			
Mowing required?			
Clogging of drainage points (sediment or debris)?			
Evidence of ponding?			
Damage/vandalism to structures present?			
Surface clogging visible?			
Drainage system inspected?			
Resetting of system required?			
Comments:			

(Source: Melbourne Water WSUD Engineering Procedures 2006)

ADAM PEKOL

CONSULTING



**REDBANK RIVER PRECINCT
TRAFFIC IMPACT ASSESSMENT**

PREPARED FOR
REDBANK RIVER PRECINCT PTY LTD

ref: 07-230 

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Written By JRJ	Reviewed By AAP	Approved By AAP	Signature sch4p4(6) Person	Date 4/02/08
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1.0 INTRODUCTION

1.1 Background

In October 2007, Adam Pekol Consulting was commissioned by Redbank River Precinct Pty Ltd to undertake a traffic impact assessment of a proposed industrial development at 61 River Road, Redbank. The proposed development site is shown in Figure 1.1.



FIGURE 1.1: LOCALITY PLAN

1.2 Aim

The aim of this assessment was to evaluate the proposed development in terms of its likely weekday morning and evening peak hour traffic generation, impact on the surrounding road network and site access operations.

1.3 Scope of Report

This report begins by summarising the characteristics of the surrounding road network and existing traffic operating conditions (Chapter 2). The scope and scale of the proposed development are then described, including a consideration of its likely traffic operating characteristics (Chapter 3). The external and internal road system is described in Chapter 4. The report concludes with a summary of key findings and recommendations (Chapter 5).

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2.0 EXISTING CONDITIONS

2.1 Existing Development

The subject site was formerly used for activities associated with wool production and is accessed via River Road. River Road is classified as an Industrial Collector and has a 7m wide (sealed) carriageway. The Ipswich Motorway is the major traffic facility serving the area, connecting the site to Brisbane to the east and Ipswich to the west. The Ipswich rail line runs near the site's southern boundary. Regular passenger rail services serve the nearby Redbank rail station, which is located about 1.5km from the site. An existing two lane bridge over the rail line links the wider Redbank peninsula to the Ipswich Motorway, via Brisbane Terrace, Brisbane Road and Mine Street.

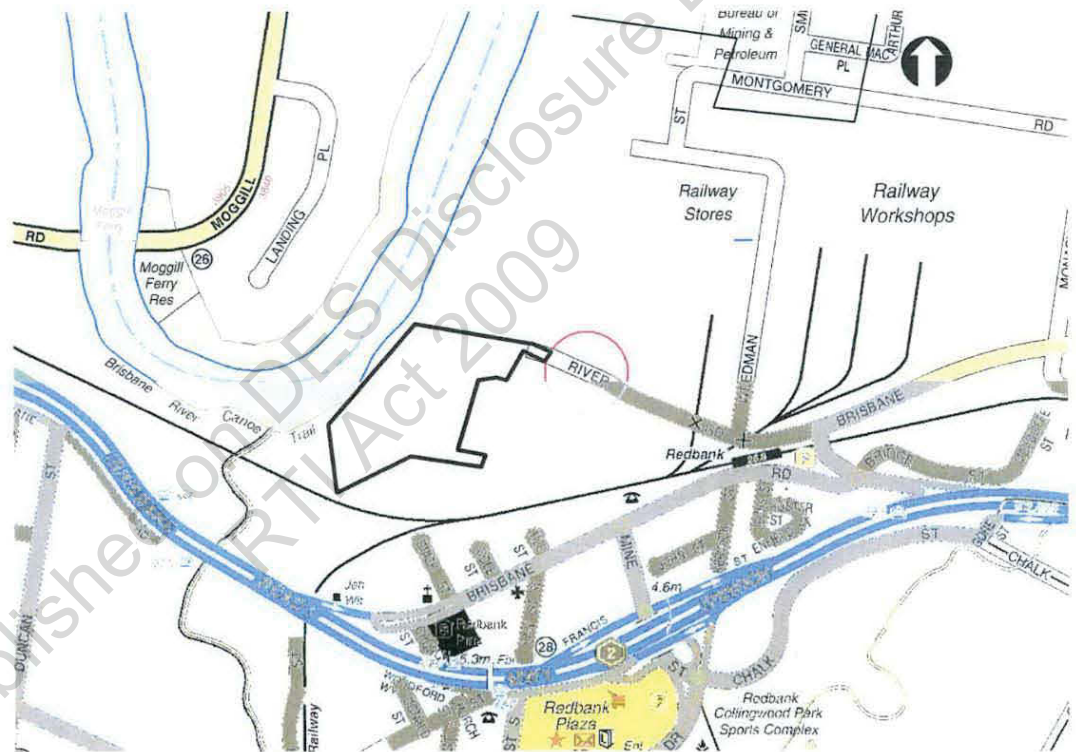


FIGURE 2.1: SURROUNDING ROAD NETWORK

Table 2.1 describes the road hierarchy of the surrounding road network.

TABLE 2.1: ROAD NETWORK ATTRIBUTES

Attribute	River Road	Weedman Street	Brisbane Terrace	Brisbane Road	Mine Street
Road Hierarchy	Collector	Access	Collector	Collector	Trunk Collector
Directionality	Two-Way	Two-Way	Two-Way	Two-Way	Two-Way
Number of Lanes	2	2	2	2	2
Speed Limit (km/h)	60	60	60	60	60
Jurisdiction	Council	Council	Council	Council	Council
Predominant Land-Use	Industrial	Industrial	Industrial	Residential / Retail / Commercial	Residential / Retail / Commercial
Kerb-and-Channel	No	No	Parts	Yes	Yes
Dedicated Parking	No	No	No	Parts	Yes
Footpaths	No	No	No	Parts	Yes
Bicycle Lanes	No	No	No	No	No
Bus Route	No	No	Yes	Yes	Yes

2.2 River Road Traffic Volumes

A traffic volume survey on River Road between Weedman Street and Railway line was undertaken for one week during October/November 2007. The results are summarised in Table 2.2 and attached in Appendix E.

TABLE 2.2: RIVER ROAD TRAFFIC VOLUME

Averages	
Weekday	7-day
1883 veh	1645 veh

2.3 Pedestrians, Cyclists and Public Transport

Formal pathways for pedestrians and cyclists are not available proximate to the subject site.

Scheduled passenger rail services stop at the nearby Redbank rail station on Brisbane Rd, which is located about 1.5 km from the site.

The following bus routes are available:

- 511, 521 – Brisbane Road between Redbank and Goodna;
- 500, 501 – Brisbane Terrace between Goodna and Ipswich station; and
- 520, 523 – Brisbane Road Redbank station and Springfield.

3.0 PROPOSED DEVELOPMENT

It is understood that the proposed development is to contain 19 lots with a Gross Floor Area (GFA) of approximately 24,000m² ground floor space and 8,000m² of mezzanine space. As part of the first stage it is proposed to develop Sites 1, 3, 8 and 9 (refer Appendix A and Table 3.1 below). A café and caretaker accommodation is proposed for site 3.

3.1 Site Layout and Access

The layout of the proposed development is shown on architects John Marsson & Associates Ltd, drawing reference no. 07-04-10 contained in Appendix C. The drawing shows the overall site plan and detail layouts of sites 1, 3, 8 and 9.

Access to the development is proposed via River Road. River Road circulates around the site as shown as 22m wide generally (less footpath along the River Bank section), and 20m wide for the minor circulation road. The road will also provide access to the south. The proposed connection stub road to the southern sites as shown in the drawing, will perform a superior function to the existing easement which is proposed to be extinguished.

The internal layout of the site appears logical and is expected to operate efficiently and cater for the likely industrial traffic generated by the development.

Vehicle Crossings

Vehicle crossings to Sites 1, 3, 8 and 9 are shown in the layout plan in Appendix A and will be built to "Australian Standard AS 2890.2-2002 Parking Facilities Part 2: Off-street commercial vehicle facilities".

3.2 Sight Distance

AUSTROADS "Guide to Traffic Engineering Practice Part 5 – Intersections at Grade" suggests that for River Road, an urban road with a posted speed limit of 60 km/hr, the safe intersection sight distance (SISD) requirement is 105m. On-site observations indicate that this sight distance is achieved in both directions of each of the site accesses for the four sites – Site 1, Site 3, Site 8 and Site 9.

The required sight distances are provided at bends and intersections.

3.3 Car Parking

Table 3.1 illustrates the parking supply rate under Council's Planning Scheme and the proposed on-site car parking provision for four of the sites.

TABLE 3.1: STAGE 1 DEVELOPMENT

Land Use	Scale m ²	Parking Provision Rate Ipswich Parking Code	Spaces	
			Required	Provided
Site 1	4040	1:100m ²	40	45
Site 8	3210	1:100m ²	32	33
Site 9	4100	1:100m ²	41	93
Site 3 Café	40	1:40m ²	5	5
Residential			2	2
TOTAL			120	178

A total of 177 car parking spaces are provided within the sites along with one disabled car park in each site. This number is more than the number required by the local Planning Scheme and therefore complies. Surplus spaces (58) will be used for employee parking for adjoining sites, which is permissible under the planning scheme.

3.4 Traffic Generation

The peak hour traffic generation for the proposed development has been estimated by applying a trip generation rate of 1.0 vehicle trip ends per 100m² of industrial gross floor area. This rate is sourced from Main Roads' *Road Planning and Design Manual* and accounts for ancillary office uses.

The proposed development is expected to generate about 240 vehicle trips during the morning and evening peak hour.

3.5 Commercial Vehicle Servicing

It is understood that the largest vehicle anticipated to access the site is a B-double/semi-trailer.

Adequate manoeuvring area has been provided to allow the trucks to service the site. Swept path drawings of the truck manoeuvring are presented in Appendix C and show that an AV can undertake manoeuvring throughout the site and enter and leave the site in a forward gear.

Adequate manoeuvring area has been provided to allow a refuse collection truck to service the site.

Vehicle Traffic Mix

From a review of traffic data of industrial sites in Lytton (Brisbane City) it is estimated that the heavy vehicle traffic will be approximately 20%. Therefore, 52 of the peak hour vehicle trips to/from the site will be heavy vehicles.

Data available from across South East Queensland for industrial sites shows that the heavy vehicle traffic by vehicle class would be:

- light rigid vehicles (ie small trucks) – 55%
- heavy rigid vehicles (ie large trucks not semi-trailers) – 17%; and
- articulated vehicles (ie semi-trailers or B-doubles) – 28%

However, because of smaller lot sizes (GFAs) and the current design of the proposed development, the heavy vehicle composition for the site is likely to be more biased towards the smaller vehicles. For this development, the following proportions by vehicle class are expected:

- light rigid vehicles – 55%;
- heavy rigid vehicles – 30%; and
- articulated vehicles – 15%

Applying this data to the site, the total traffic generated in a peak hour would be approximately:

- 192 passenger vehicles;
- 26 light rigid vehicles;
- 8 heavy rigid vehicles; and
- 14 articulated vehicles.

4.0 TRAFFIC IMPACT

The likely impact of the proposed development on traffic operations on River Road and internal subdivision roads has been assessed:

4.1 Internal Road Network

This section describes the operations of River Road and internal subdivision roads.

River Road is proposed to extend around the site and provide access to all 19 sites as well as property no's 99 and 64 B on River Road as required by Council.

River Road will be constructed to an Industrial Collector Road standard with a 14m carriageway and 22m road reserve, including footpath facilities. No footpath is provided along the river bank. Instead the 4m strip shall be used as parkland. Internal subdivision roads will have footpaths both sides.

Internal subdivision roads will be public roads designed to Industrial Access road standard with 12m wide carriageway and a reserve width of 20m and footpath on both sides. The site will also provide access to the site to the south.

Both types of roads will provide for AV circulation and manoeuvring on-road radii not less than 15.0m (desirable minimum Austroads standards). Swept path drawings of the vehicle circulating throughout are attached as Appendix C.

4.2 Pedestrians Cyclists and Public Transport

The proposed development is not expected to have a significant adverse impact on local pedestrian and cyclist operations or on public transport operations.

5.0 CONCLUSIONS

The impact of a proposed industrial development at River Road, Redbank, has been assessed.

The main points to note from this assessment include:

- the proposed development includes approximately 24,000m² GFA of industrial uses plus mezzanine space;
- River Road will be constructed as an Industrial Collector Road with a 14m carriageway and footpath facilities (22m road reserve);
- internal subdivision roads will be constructed as Industrial Access Roads with a 12m carriageway (20m road reserve);
- all roads and access driveways will be provided for AV/HRV operation and manoeuvring requirements as detailed in Ipswich City Council standards;
- the internal road network is expected to operate satisfactorily;
- satisfactory access is provided to the southern sites by way of a stub road which is superior to the existing easement, which is to be extinguished;
- all parking areas complies with Council requirements in terms of bay sizes, manoeuvring, aisle widths, and vehicles are able to leave the area in forward gear;
- parking spaces provided for Sites 1, 3, 8 and 9 meet the Council requirement; and
- the proposed development is not expected to have an adverse impact on cyclist and public transport operations.

**APPENDIX A
SITE LAYOUT**

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APPENDIX B
IPSWICH PARKING CODE

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12.9.3 Overall Outcomes for the Parking Code

The Overall Outcomes for the Parking Code are:

"Off-street parking areas and loading and unloading facilities are designed, constructed and maintained to—

- (a) provide a safe environment for both pedestrians and vehicles;
- (b) reduce traffic congestion by ensuring adequate off street facilities are provided by developments which are likely to generate traffic;
- (c) ensure that high standards of practicability, personal safety and aesthetic value are incorporated into the construction of off street parking areas and loading and unloading facilities
- (d) encourage integration with public transport facilities and non-motorised forms of transport and shared use of parking facilities in order to reduce the overall demand for parking facilities for private motor vehicles;
- (e) provide parking facilities for people with disabilities;
- (f) provide facilities for the parking of bicycles and motorcycles; and
- (g) protect the amenity of nearby users, particularly residents."

12.9.4 Parking Design and Construction Standards

Column 1 Specific Outcomes	Column 2 Probable Solutions	Column 3 Assessment
Site Considerations		
<p>(1)</p> <p>(a) Car parking is provided within the site of the development.</p> <p>(b) Long term or all day car parking areas are generally located to the rear or side of the property so as to be unobtrusive.</p> <p>(c) Entrances to car-parks are readily identifiable and convenient.</p> <p>(d) Car park site selection takes into account –</p> <ul style="list-style-type: none"> (i) the type of road frontage; (ii) the safety and convenience of ingress and egress points; (iii) provision of and scope for suitable drainage; (iv) the effects of the car-parking area on adjacent or nearby uses; (v) minimisation of pedestrian/vehicular conflicts; (vi) walking distances from the car-park to the destination; (vii) the potential for site landscaping; 	<p>No solution provided.</p>	<p>(1)</p> <ul style="list-style-type: none"> (a) Complies with Council requirements and Australian standards 2890 (b) N/A (c) as in (a) (d) as in (a) except for drainage which will be addressed by other

Column 1 Specific Outcomes	Column 2 Probable Solutions	Column 3 Assessment
<p>(viii) issues relating to public safety and security; and</p> <p>(ix) co-location and multi-use opportunities for shared parking arrangements.</p> <p>Note 12.9.4A</p> <p>(1) In relation to (a) above, the local government may be prepared to accept the provision of parking spaces on other land provided that the alternative location is within what the local government considers to be a reasonable and easy walking distance (e.g. 200 metres) from the lot upon which the development is to take place and will satisfy the parking requirements, without being detrimental to other developments in the locality.</p> <p>(2) In these instances, arrangements are to be made to ensure the continued use of the parking area in connection with the proposed use, while such use continues.</p> <p>(3) Any such proposal may require approval for a material change of use to a 'carpark'.</p>		
General Layout of Parking Areas		
<p>(5)</p> <p>(a) The design provides uncongested traffic flow within the parking area, thereby reducing the potential for vehicle queuing off-site and conflict between vehicles (drivers) trying for the same parking space.</p> <p>(b) The design minimises unnecessary areas for parking and manoeuvring, without compromising the safety and convenience of the car-park layout.</p> <p>Note 12.9.4A</p> <p>Reducing the size of parking areas</p> <p>—</p> <p>(a) decreases construction</p>	<p>No Solution Provided</p>	<p>(5)</p> <p>(a) Complies with Australian Standards AS2890 queuing requirements</p> <p>(b) Complies</p>

Column 1 Specific Outcomes	Column 2 Probable Solutions	Column 3 Assessment
<p>costs;</p> <p>(b) minimizes sealed areas and thereby reduce drainage runoff; and</p> <p>(c) enhances landscaping and visual aspects of the development (refer Figure 12.9.1)</p> <p><u>Consistent Outcome</u></p> <ul style="list-style-type: none"> no decrease in parking capacity; significant improvements in terms of visual amenity; and plentiful shade. 		
Design of Parking Modules, Circulation Roadways and Ramps		
<p>(6) Parking modules and associated circulation roadways and ramps are designed to—</p> <p>(a) move traffic to and from the road frontage with minimum disruption to through traffic and maximum pedestrian safety;</p> <p>(b) provide adequate capacity in circulation roadways and aisles to handle peak hour movements by minimising congestion;</p> <p>(c) arrange internal roadways to avoid as far as practicable conflicts between intersecting streams of circulating traffic;</p> <p>(d) provide minimum length travel paths between entry/exit points and parking spaces; and</p> <p>(e) safely treat points of conflict with pedestrians and other users.</p>	<p>(7) Parking modules, circulation roadways and ramps are designed in accordance with the provisions of Australia Standard AS2890.1 Part 1: Off Street car-parking.</p> <p>(8)</p>	<p>(6) Complies with Australian Standards AS2890.1</p>
Access Driveways and Queuing Areas		
<p>(5)</p> <p>(a) Access driveways are located to minimise conflict and designed to operate efficiently and safely taking into account—</p> <p>(i) the size of the parking area;</p>	<p>(9) Access driveways and queuing areas are located and designed in accordance with the provisions of Australian Standard AS 2890.1 Part 1: Off Street Car-parking.</p> <p>Note 12.9.4C</p>	<p>(a) Complies with AS 2890.1 Part 1 Off Street Car parking.</p>

Column 1 Specific Outcomes	Column 2 Probable Solutions	Column 3 Assessment
<ul style="list-style-type: none"> (ii) the amount and type of vehicle traffic using the parking area; (iii) the type of use (e.g. long-term, short-term, regular, casual); (iv) the capacity of the adjoining street system; (v) road frontage characteristics (i.e. type of road, vertical and horizontal geometry, traffic volume and speed control); (vi) the spacing and type of entrances and exits proposed relative to each other and other intersections; (vii) the location of existing or proposed medians and other traffic control devices; (viii) sight distances; (ix) pedestrian and vehicle safety aspects; (x) the potential for queuing vehicles; and (xi) any relevant provision for public transport. <p>(b) Access driveways catering for a high volume and turnover of vehicles are located—</p> <ul style="list-style-type: none"> (i) off side roads rather than directly from the frontage of a Designated Road; (ii) where possible, away from other uses and works generating a large amount of traffic; (iii) away from areas where there is a heavy and constant pedestrian movement along the footpath; (iv) away from areas where right turning traffic entering the site would obstruct through traffic; and (v) away from areas where traffic using the driveways will interfere 	<ul style="list-style-type: none"> (1) In most cases, access driveways should be located as far as practicable from any intersection. (2) Median breaks should not be provided on Designated Roads to provide access to property for right turning movements. (3) Consideration should be given to the queuing of vehicles in the entry road when a capacity restriction exists on site (e.g. a boom gate). (4) Where a site abuts a Designated Road or any other heavily trafficked road and has alternative access to a minor or lesser trafficked road, access should generally be derived from the minor road. (5) In some circumstances, it may be necessary to limit access to left turn only movements in and out of an access driveway. (6) Driveways should normally be combined entry/exit. (7) For car-parks served by multiple access points, each driveway should be designed on the basis of the number of parking spaces effectively served by that driveway. (8) Entry points should provide sufficient space for queuing of vehicles so as not to interfere with traffic flow in the frontage road. 	<p>(b) N/A</p>

Column 1 Specific Outcomes	Column 2 Probable Solutions	Column 3 Assessment
<p>or block the operations of bus stops, taxi ranks, loading zones or pedestrian crossings.</p> <p>(c) The widths of access driveways are designed and constructed taking into account the—</p> <p>(i) type of road frontage;</p> <p>(ii) traffic generating potential of the proposed development and the number of parking spaces required; and</p> <p>(iii) the potential for the queuing of vehicles on the entry road.</p>		
Public Safety		
<p>(10) The design, location and management of car parks promote public safety by—</p> <p>(a) being designed to optimise informal surveillance and to control inappropriate access;</p> <p>(b) being sufficiently well lit, with vandal proof lighting, to enable visibility of all external edges and routes providing access to the car-park;</p> <p>(c) avoiding the creation of concealment areas; and</p> <p>(d) being designed to avoid large (over 100 cars in a single block), continuous, car-parking areas, and where this cannot be avoided, effective surveillance is provided</p>	<p>(a) Informal surveillance is provided from adjoining uses by the placement or location of windows or retail premises, kiosks or other uses that generate activity on the edges of the parking area overlooking the car-park.</p> <p>(b) For large car-parks (i.e. in excess of 100 spaces) -</p> <p>(i) a single entry/exit point is provided within clear view of an attendant, or where provision of an attendant is not practical, more than one entry/exit point is provided so that the car-park does not become an entrapment area;</p> <p>(ii) an attendant trained for emergencies is provided;</p> <p>(iii) signage is provided, which—</p> <p>(A) identifies the location of parking modules, to enable users to easily relocate their vehicles;</p> <p>(B) identifies directions to exits, nearby destinations and</p>	<p>Parking areas will be well lit and safe as per Council guidelines. No areas are over 100 spaces.</p>

Column 1 Specific Outcomes	Column 2 Probable Solutions	Column 3 Assessment
	<p>emergency facilities (such as fire extinguishers, telephones or emergency buttons);</p> <p>(C) advises users to lock their vehicles and secure valuables; and</p> <p>(D) informs users of the security measures provided;</p> <p>(iv) organised surveillance is provided through regular patrols or mechanical means; and</p> <p>(v) emergency telephones or contact buttons are provided in highly accessible, convenient and identifiable locations</p>	
Separation of Pedestrian and Vehicular Circulation		
<p>(11)</p> <p>(a) Pedestrian routes are separated from vehicular circulation to allow protected access for pedestrians via the shortest practical route from the parking area to the use.</p> <p>(b) Pedestrian access does not pass through commercial or refuse vehicle reversing or loading areas.</p> <p>(c) Protection measures for pedestrians are located in areas of high pedestrian/vehicular conflict or high speed and may include—</p> <p>(i) physical barriers (e.g. bollards);</p> <p>(ii) pedestrian crossings;</p> <p>(iii) lighting;</p> <p>(iv) raised walkways between parking modules;</p> <p>(ii) speed humps; and</p> <p>(iii) mounding, landscaping or</p>		<p>Complies with Australian standards AS2890.</p>

Column 1 Specific Outcomes	Column 2 Probable Solutions	Column 3 Assessment
<p>fencing.</p> <p>Note 12.9.4D Figure 12.9.2 is an example of how the areas between car-parking spaces may be used for pedestrian paths, whilst the areas where vehicular circulation routes cross pedestrian paths may be restricted in width and paved to delineate pedestrian movement priority.</p>		
Parking Spaces for People with Disabilities		
<p>(12) Vehicle parking spaces for people with disabilities are well located and are provided in sufficient quantities and have adequate areas and dimensions to meet user needs.</p>	<p>(a) Parking spaces for people with disabilities are provided at the rates specified in Appendix C of Australian Standard AS2890.1 Part 1: Off Street Car-parking.</p> <p>(b) Car parking spaces for people with disabilities are located as near as possible to the entrance or entrances to the facility or use they serve.</p> <p>(c) Parking spaces for people with disabilities are designed in accordance with the provisions of Australian Standard AS2890.1 Part 1: Off Street Car-parking.</p> <p>(d) Pathways and ramps between parking areas and the entrances to buildings are designed in accordance with the provisions of Australian Standard AS1428.1: Design for Access and Mobility.</p> <p>(e) Parking spaces for people with disabilities are identified by a sign incorporating the International Symbol specified in Australian Standard AS1428.1: Design for Access and Mobility.</p> <p>(f) The sign is readily visible from a vehicle at</p>	<p>Complies with Australian Standards.</p>

Column 1 Specific Outcomes	Column 2 Probable Solutions	Column 3 Assessment
	the entrance to the car-park, or guide signs are provided to indicate the direction of the disabled parking spaces.	
Parking Spaces for Motorcycles		
(13) Motorcycle parking spaces have adequate areas and dimensions to meet user needs.	(13) Parking spaces for motorcycles are designed in accordance with the provisions of Section 2.4.7 of Australian Standard AS2890.1 Part 1: Off Street Car-parking	N/A
Bicycle Parking		
(14) (a) Specific areas for bicycle parking are set aside within uses likely to attract a high proportion of local use or youth patronage, including— (i) shopping centres; (ii) major factory or office complexes; (iii) educational establishments; (iv) sports, leisure and entertainment centres; (v) libraries and other public buildings; (vi) transit centres; (vii) parks and recreation areas; tourist facilities; and (viii) medical centres and hospitals (b) Shoppers, customers, messengers and visitors are encouraged to use bicycles by providing short term bicycle parking facilities which— (i) are conveniently located and readily accessible to intended destinations (ii) are located to facilitate casual surveillance in order to minimise incidents of theft or damage; and (iii) enable bicycles to be securely locked	(15) (a) Bicycle parking facilities are designed in accordance with the provisions of Australian Standard AS2890.3 Part 3: Bicycle Parking Facilities. (b) Bicycle parking is provided for the uses listed in sub-section (14)(a) above at the rate of one space per— (i) 750m ² of office floor space; and (ii) 500m ² of non-office floor space. (c) Long term bicycle parking space (e.g. for the use by employees) are provided with the following 'end of trip' facilities— (i) 1 locker per 2 bicycle parking spaces; and (ii) 1 shower cubicle with an ancillary change room per 10 bicycle parking spaces. (d) Short term bicycle parking areas are provided within 15 metres of the main entry to the building they are intended to serve. (e) At least 50% of long term bicycle parking areas are covered by a roof	N/A

Column 1 Specific Outcomes	Column 2 Probable Solutions	Column 3 Assessment
<p>without undue inconvenience.</p> <p>(c) Students, employees, residents and commuters, who are likely to stay at a site for several hours are encouraged to use bicycles by providing long term bicycle parking facilities which—</p> <ul style="list-style-type: none"> (i) are secure and weather protected; (ii) are conveniently located in relation to intended destinations; and (iii) include shower facilities where provided for use by employees. <p>(d) Bicycle parking facilities are designed—</p> <ul style="list-style-type: none"> (i) to ensure that motor vehicles cannot encroach into bicycle parking areas; (ii) so that they do not adversely affect pedestrian movements; (iii) to provide adequate directional signage; (iv) to provide lighting where the bicycle parking facilities are used at night; and (v) to facilitate access to both destinations and bicycle paths <p>Note 12.9.4E Subject to the provision of parking spaces as outlined in Table 12.9.1, an applicant may negotiate a proportional reduction in motor vehicle car-parking spaces, for any non residential development requiring car-parking facilities, by provided for the secure parking of bicycles at a rate of one (1) bicycle parking space for every twenty (2) car spaces or fifteen (15) employees (whichever is greater) or one (1) bicycle space for 500m² of gross floor area of shopping floor</p>		

Column 1 Specific Outcomes	Column 2 Probable Solutions	Column 3 Assessment
space, or 750m ² of office floor space or 500m ² of other floor space.		
Commercial Vehicle Facilities and Service Areas		
<p>Note 12.9.4F</p> <p>In cases where provision for off-street loading/unloading areas may prove difficult, the local government may consider requests from applicants to allow –</p> <p>(a) shared parking and loading areas, within limitations on the hours during which vehicular loading/unloading may take place; or</p> <p>(b) creation of kerbside loading zones.</p> <p>(16)</p> <p>(a) All areas for the manoeuvring and standing of commercial vehicles in association with loading and unloading are located wholly within the site and are separate from and do not encroach upon any part of the site set aside for other purposes.</p> <p>(b) All commercial vehicle manoeuvring areas and ingress and egress points are designed, wherever possible so that it is not necessary to drive between the property boundary and the carriageway of the frontage road in a reverse gear.</p>	<p>(17)</p> <p>(a) Service areas and service bays for commercial vehicles are designed in accordance with the provisions of Australian Standard AS2890.2 Part 2: Commercial Vehicle Facilities.</p> <p>(b) Access driveways to service areas and service bays are designed in accordance with the provisions of Australian Standard AS2890.2 Part 2: Commercial Vehicle Facilities.</p>	<p>Loading areas complies with Council requirements and vehicles that use the site.</p>

Parking Structures (including enclosed garages and multi-level car-parks)		
(18)	(19)	
<p>(a) Parking structures (including enclosed garages) are designed to provide adequate clearance from walls, columns, roofs and other obstructions, in order to facilitate ease of use.</p> <p>(b) Parking structures are designed—</p> <p>(i) as an integral part of a building; or</p> <p>(ii) where free standing—</p> <p>(A) are located as close as</p> <p>(B) possible to the use(s) they are intended to serve; and</p> <p>(C) are designed in a sympathetic and compatible manner with other nearby buildings.</p> <p>(c) Multi-level parking structures—</p> <p>(i) are designed to minimise visual impact on the streetscape and nearby uses;</p> <p>(ii) contribute to a lively pedestrian environment by including retail or other active uses on the ground floor, street frontage perimeter of the structure; and</p> <p>(iii) promote personal and public safety by—</p> <p>(A) having an attendant trained for emergencies on duty after hours;</p> <p>(B) having emergency telephones placed throughout, with accompanying illuminated international telephone signs;</p> <p>(C) having vandal proof and consistent lighting which enables visibility of</p>	<p>Parking structures are designed in accordance with the provisions of Australian Standard AS2890.1 Part 1: Off Street Car-parking</p>	<p>Complies with AS2890.1 off-street parking standards</p>

<p>all external edges and access routes throughout the carpark;</p> <p>(D) having white exit corridors, stairwells, walls and ceilings that reflect light;</p> <p>(E) having secured potential concealment spots;</p> <p>(F) providing organised surveillance through regular patrols;</p> <p>(G) providing mechanical surveillance and emergency telephones or buttons on each level, with illuminated international signs;</p> <p>(H) providing signage advising directions to stairs, lifts and exits, offices/buildings served, fire extinguishers and emergency buttons</p> <p>(I) providing parking module identification signs to enable users to easily relocate their vehicles; and</p> <p>(J) providing signs advising users to lock their vehicles, to secure valuables and informing users of the security measures installed</p>		
Tandem and Stacked Parking		
<p>Note 12.9.4G Tandem or stacked parking is not favored as a means of meeting the car-parking requirements of this Code, but may be approved in difficult situations.</p> <p>(20) A limited number of tandem parking spaces may be provided subject to evidence—</p> <p>(a) that there is a real need for tandem parking or stacked parking and that</p>	No Solution Provided	N/A

<p>the provision of tandem parking or stacked parking will not adversely affect the use of the site; and</p> <p>(b) tandem parking or stacked parking is primarily used to provide parking for people employed on the premises and likely to park all day or a major part of the day, or where a parking attendant is available during operational periods to assist with the parking and retrieval of vehicles; and</p> <p>(c) that provision is available on site for shifting cars without the movement of vehicles onto public streets.</p>		
Parcel Pick-up Areas		
<p>(21) Parcel pick-up areas are designed and located—</p> <p>(a) so as not to interrupt the flow of vehicles in circulation roadways; and</p> <p>(b) to enable pedestrians to move freely around vehicles in the parcel pick-up area without being endangered by traffic.</p>	No Solution Provided	N/A
Trolley Bays		
(22) Trolley bays are provided within shopping centre car-parks to enable the orderly storage of shopping trolleys.	(23) Trolley bays are designed in accordance with the provisions of Australian Standard AS2890.1 Part 1: Off Street Car-parking.	N/A
Speed Humps		
<p>(23) Speed humps, where necessary, are –</p> <p>(a) clearly visible to both drivers and pedestrians; and</p> <p>(b) designed and constructed to –</p> <p>(i) reduce vehicle speeds; and</p> <p>(ii) avoid damage to vehicles.</p>	(25) Speed humps are designed in accordance with the provisions of Australian Standard AS2890.1 Part 1: Off Street Car-parking.	N/A
Signage		
(26)	(27)	If required will comply with

<p>(a) Off street parking areas are designed to control traffic and parking movements rather than simply relying on signage directions.</p> <p>(b) The design of the parking area and its circulation pattern makes it difficult to breach traffic and parking rules.</p> <p>(c) Vehicular speed is limited by the design of the parking area.</p> <p>(d) Signage within parking areas is provided to—</p> <ul style="list-style-type: none"> (i) warn against hazards to safety or potential damage to vehicles; (ii) identify sections or rows of parking spaces so that users may easily relocate their vehicles; (iii) direct and inform drivers entering and circulating within carparks about vehicular entry points, exits and location of parking spaces for people with disabilities; (iv) direct pedestrians to lifts, stairs, amenities, exists and major destinations; and (v) inform users about security measures and where to go for assistance. <p>(e) Adequate, legible signage is provided to assist pedestrians, particularly older people and people with disabilities, to find their way safely around car-parks.</p> <p>(f) Clear and regular signage is provided to main pedestrian routes.</p> <p>(g) Signs are located so that they are not likely to be obscured by growing vegetation.</p> <p>(h) Signs are located at</p>	<p>(a) Signage is designed in accordance with the provisions of Australian Standards—</p> <ul style="list-style-type: none"> (i) AS2890.1 Part 1: Off Street Car-parking; and (ii) AS1742: Code of Uniform Traffic Control Devices. <p>All traffic signage and traffic control measure details are shown on the car-parking layout plan.</p>	<p>Australian and Council Standards.</p>
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entrances and near activity nodes.		
(i) Clear, recognisable signage is provided at bus stops, taxi ranks and public facilities.		
(ii) Signs intended for night use are illuminated.		

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Marking of Spaces		
(28)	(29)	Complies according to Australian Standard AS 2890.1
<p>(a) Parking areas are marked so as to clearly delineate individual parking spaces.</p> <p>(b) Visitor, disabled, motorcycle and bicycle parking spaces are clearly marked, and their location clearly sign posted.</p>	<p>Parking areas are permanently line-marked in accordance with the provisions of Australian Standard AS2890.1 Part 1: Off Street Car-parking, so as to clearly delineate individual parking spaces.</p>	
Car-park Lighting		
(30)	(31)	Lighting will be provided as required by Council.
<p>(a) Lighting is used to increase safety and security in and around car-parks.</p> <p>(b) Outdoor public spaces used or accessed after dark are appropriately and consistently lit to reduce the contrast between shadows and illuminated areas.</p> <p>(c) Lighting design is integrated with building, landscaping, signage, streetscape and public space design.</p> <p>(d) Light spillage onto adjoining land and roadways is avoided.</p> <p>(e) Energy use is minimised.</p> <p>(f) Lighting is appropriately placed to avoid shadows and glare which might put pedestrians or other vehicles at risk (i.e. shielded light at eye level).</p> <p>(g) Lighting is designed to avoid configurations of lights in areas within 6km of the RAAF Base Amberley runway that replicate the appearance of airport runways at night.</p>	<p>(i) Lighting within parking structures complies with the requirements of Australian Standard AS 1680: Interior Lighting.</p> <p>(ii) Illumination levels outside the boundaries of the site do not exceed 8 lux (lumens) when measured 1.5 metres outside the boundary of the site at any level upwards from the ground.</p> <p>(iii) Security lighting is consistent with Australian Standard AS 4282 (1997) The Control of Obtrusive Effects of Outdoor Lighting.</p> <p>(iv) Night lighting is controlled by photoelectric cells rather than time switches.</p> <p>(v) Areas not intended for night-time use are not lit or are closed off to avoid giving a false impression of safety.</p> <p>(vi) Principal pedestrian and bicycle movement routes, public spaces and outdoor signage in public spaces are lit in accordance with Australian Standard AS1158 (Public Lighting Code) so that these areas become the focus of legitimate pedestrian activity after dark.</p> <p>(vii) Areas which are heavily used by pedestrians, including main entries to</p>	

	<p>buildings and toilets and main pedestrian routes are lit with the power of 50-100 lux (lumens).</p> <p>(viii) Large car-parks (e.g. greater than 100 car spaces) do not include configurations of lights in straight parallel lines 500m – 1000m long in areas within 6km of the RAAF Base Amberley runway.</p> <p>Note 12.9.4H Outdoor public spaces used or access after dark should be consistently lit to reduce the contrast between shadows and illuminated areas.</p>	
Landscaping		
<p>(32)</p> <p>(a) Landscaping including natural features, planting, earthworks, and fencing in parking areas is used to –</p> <ul style="list-style-type: none"> (i) enhance the amenity of the site; (ii) reduce the harsh visual effect often created by open concrete and asphalt areas; (iii) provide shade for vehicles, site buildings and pedestrians; (iv) separate and define pedestrian and vehicular circulation routes; (v) provide wind protection where necessary; and (vi) reduce noise and light spillover (e.g. headlights and overhead lighting). <p>(b) Landscaping designs do not compromise public safety, the safety of traffic circulation and sight distances, in particular, the location and choice of vegetation species, or any other landscaping feature,</p>	<p>(33)</p> <ul style="list-style-type: none"> (i) A minimum of 1 space should be used for landscaping for every 8 standard car spaces. (ii) Areas used for landscaping within parking areas may be reduced to 2m in width but are distributed as evenly as possible (see Figure 12.9.4). (iii) Landscaping areas are protected from vehicular traffic by a barrier kerb (minimum height 100mm) or wheel stops. (iv) A minimum of 2 metres is set aside along the periphery of car-parking areas to allow for landscaping to be established, with a minimum 3 metre width being provided along any street frontage. <p>Note 12.9.4I All landscaping details as required by this Parking and Access Code are to be shown on a separate landscaping plan preferably submitted with any development application.</p>	<p>(a) Assessed by others.</p> <p>(b) Landscaping shown in plan comply with Austroads Standards</p>

<p>does not –</p> <ul style="list-style-type: none"> (i) create concealment areas; (ii) affect sight accessibility for vehicular or pedestrian traffic; (iii) affect visibility of carpark signage; or (iv) diminish casual surveillance of the parking area. <p>(c) Landscaping is used to break up the visual impact of large parking areas by distributing landscape areas throughout the parking area.</p> <p>(d) Landscaping also provides shade by the use of appropriately sized canopy trees which are robust and minimise nuisance from fruit and berries.</p> <p>(e) Landscaping is maintained by the property owner at the property owner's cost.</p> <p>(f) Landscaping is designed for minimum of maintenance.</p>		
---	--	--

Surface Treatment of Parking Areas		
<p>(34) The surface of areas upon which vehicles are parked or driven are treated in a manner which—</p> <ul style="list-style-type: none"> (a) reflects the frequency and duration of use, including provision for the sealing or paving of most parking areas; (b) provides for appropriate all weather use; (c) avoids the creation of a dust nuisance for on-site or nearby users; (d) provides for adequate drainage; and (e) reflects the intended character of the surrounding area. 	<p>(35)</p> <ul style="list-style-type: none"> (a) Sealed parking areas are constructed to the following standards— <ul style="list-style-type: none"> (i) low parking turnover – flush or chip seal (i.e. minimum depth of 150mm of compacted pavement material with a two (2) coat bitumen seal, except where soil tests indicate that a greater minimum depth of subbase required); and (ii) high parking turnover – asphaltic concrete. (b) Areas which should be protected from vehicular traffic (such as traffic islands, gardens, landscaping, aisle ends and pedestrian areas) are protected by being raised and bordered by a vertical-faced kerb or other suitable barrier (minimum height 100mm). <p>Note 12.9.4J</p> <ul style="list-style-type: none"> (1) The overhang of a vehicle must be taken into consideration when locating the kerb. (2) To obtain local government approval, engineering plans need to be submitted showing dimensions, levels, pavement type and thickness for all parking, access driveways and manoeuvring areas. (3) Despite sub-section (35) above, the use of alternative materials such as bricks or pavers may be considered, and in certain instances (e.g. character places) preferred, in order to enhance local character. (4) The local government may also consider the use of such alternative materials in areas 	<p>As per Council requirements.</p>

	of, for example, low traffic volume, intermittent use, in a rural environment, vehicular/pedestrian conflict areas or slow speed areas.	
Drainage		
<p>(36)</p> <p>(a) All stormwater drainage from paved and impervious areas is collected within the site and dipped to a nominated legal point of discharge.</p> <p>(b) Particular attention is given to the flow path of stormwater resulting from a storm with a 1 in 100 year return interval.</p>	<p>(37)</p> <p>(a) All stormwater drainage design is in accordance with the requirements of the Institute of Engineers, Australia, 1987: "Australian Rainfall and Runoff: A Guide to Flood Estimation", Volume 1, for a two year return period.</p> <p>(b) Where the internal driveway drains towards the street, a grated catch drain is installed immediately inside the property boundary.</p>	Assessed by others.
Miscellaneous		
<p>(38)</p> <p>(a) Where appropriate, parking areas are laid out so that vehicular and pedestrian traffic may conveniently connect with and travel between adjoining uses or lots.</p> <p>(b) Unless approved for another use, all parking areas are—</p> <p>(i) kept exclusively for parking;</p> <p>(ii) used exclusively for parking;</p> <p>(iii) maintained for continued use for parking; and</p> <p>(iv) available for use by both staff and visitors/clients.</p> <p>(c) Unless otherwise approved</p>	No Solution Provided	N/A

by the local government, all parking areas are to be available for users on-site and are not to be leased or sold to other persons		
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12.9.5 Parking Demand Standards

Column 1 Specific Outcomes	Column 2 Probable Solutions	
Material Change of Use and Extensions or Additions to Existing Uses and Works		
<p>(1)</p> <p>(a) Where an existing building occupied by an existing use is extended, or the area of land occupied by an existing use is increased, the requirements of this Code apply only to the extension of the existing building or to the use of the additional land.</p> <p>(b) The parking requirements for the extension or increased site area is to be calculated as follows –</p> <p style="padding-left: 40px;">A + B</p> <p style="padding-left: 40px;">where –</p> <p style="padding-left: 40px;">A is the parking demand of the extension or increased site area; and</p> <p style="padding-left: 40px;">B is the number of parking spaces (if any) lost as a result of the extension or increased site area.</p> <p>(c) Where an existing building or land is occupied by a new use (not being an existing use) and the parking demand of the new use is greater than the parking demand for the existing use, the parking requirements</p>	<p>No solution provided.</p>	<p>(a) N/A</p> <p>(b) N/A</p>

Column 1 Specific Outcomes	Column 2 Probable Solutions	
<p>for the new use is calculated as follows –</p> <p>C – D,</p> <p>where-</p> <p>C is the parking demand of the new use; and</p> <p>D is the parking demand of the existing use.</p> <p>Note 12.9.5B</p> <p>Where an existing building is to be occupied by a new use (not being an existing use), the local government may dispense with or modify the requirements of this Code in situations where –</p> <ul style="list-style-type: none"> (a) the existing building is proposed to remain substantially the same; (b) no increase in gross floor area of the existing building is proposed; and (c) the parking demand of the proposed use is similar to the existing use. 		
'Standard' Parking Demand for Specific Uses'		
<p>(2)</p> <ul style="list-style-type: none"> (a) Adequate provision is made for on-site parking commensurate with the needs of traffic generating uses and works. (b) All off-street carparking areas are constructed and available for use before the use commences. 	<p>(3)</p> <ul style="list-style-type: none"> (a) Parking spaces are provided in accordance with Table 12.9.1. (b) Where the number of parking spaces calculated using Table 12.9.1 is not a whole number, the number required is the next highest whole number. (c) Where the local government receives an application for the establishment of two (2) or more uses on the site, the 	<p>Complies with Council requirements.</p>

Column 1 Specific Outcomes	Column 2 Probable Solutions	
	<p>parking demand is calculated by totaling the requirements for each use.</p> <p>Note 12.9.5C</p> <p>(1) Table 12.9.1 specifies the parking demand for various uses as defined in the Planning Scheme together with other criteria for the provision of parking spaces.</p> <p>(2) The parking schedule sets out the minimum number of off-street parking spaces required for particular uses.</p> <p>(3) Where some shared or multiple use of the parking area is expected, the applicant should demonstrate the extent to which this will occur before any relaxation is determined by the local government.</p> <p>Where a use or proposed use involves the utilization of land not included in a building or structure, and then for the purpose of Schedule 2 the term gross floor area includes the land so used.</p>	
Hotel	<p>1 space per residential unit; plus</p> <p>1 space per resident manager; plus</p> <p>1 space per 15m² GFA (excluding residential component); plus</p> <p>Queuing space for 12 cars for any drive-in bottle shop; plus</p> <p>2 service vehicle parking and loading/unloading bays; plus</p> <p>bicycle parking facilities.</p>	N/A

APPENDIX C
AV SWEPT PATH DRAWINGS

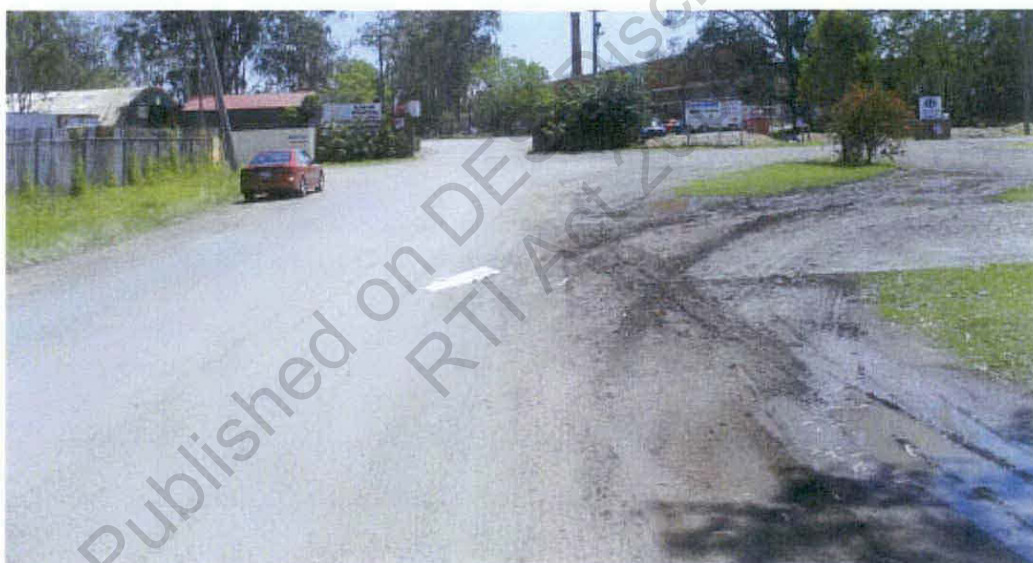
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APPENDIX D
PHOTOGRAPHS

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RIVER ROAD LOOKIN EAST FROM SITE



RIVER ROAD SITE ENTRANCE

APPENDIX E
RIVER ROAD TRAFFIC

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24144 - River Rd

River Rd between Weedman St / Railway Line
Eastbound

Time	Week 1					Averages	
	Tue 30	Wed 31	Thu 01	Fri 02	Sat 03		
						Weekday	7-day
0000-0100	0	1	0	2	0	1	1
0100-0200	0	1	1	0	0	1	0
0200-0300	0	0	0	0	0	0	0
0300-0400	0	2	2	1	2	1	1
0400-0500	3	3	4	3	0	3	3
0500-0600	29	35	28	27	11	30	26
0600-0700	58	59	55	66	29	60	53
0700-0800	47	47	47	45	6	47	38
0800-0900	37	38	35	38	11	37	32
0900-1000	78	60	59	66	33	66	59
1000-1100	70	64	59	57	28	63	56
1100-1200	60	41	64	74	33	60	54
1200-1300	67	72	59	83	46	70	65
1300-1400	53	70	57	54	33	59	53
1400-1500	134	114	137	113	44	125	108
1500-1600	91	76	98	61	18	82	69
1600-1700	92	86	104	72	10	89	73
1700-1800	71	78	76	40	13	66	56
1800-1900	12	20	15	21	18	17	17
1900-2000	23	15	17	26	10	20	18
2000-2100	19	22	19	17	2	19	16
2100-2200	9	11	9	15		11	11
2200-2300	27	24	26	15		23	23
2300-2400	0	1	2	2		1	1
Totals	980	940	973	898	347	948	835

24144 - River Rd

River Rd between Weedman St / Railway Line
Westbound

Time	Week 1					Averages	
	Tue 30	Wed 31	Thu 01	Fri 02	Sat 03		
						Weekday	7-day
0000-0100	0	0	0	0	0	0	0
0100-0200	0	0	0	0	1	0	0
0200-0300	1	0	2	0	0	1	1
0300-0400	0	3	2	1	1	2	1
0400-0500	12	14	11	9	5	12	10
0500-0600	110	107	107	119	57	111	100
0600-0700	107	112	114	99	36	108	94
0700-0800	65	59	52	55	11	58	48
0800-0900	84	72	74	61	19	73	62
0900-1000	64	65	65	69	26	66	58
1000-1100	62	49	62	60	37	58	54
1100-1200	64	50	53	56	28	56	50
1200-1300	54	50	54	65	21	56	49
1300-1400	68	74	67	49	22	65	56
1400-1500	82	80	93	70	19	81	69
1500-1600	56	43	57	29	14	46	40
1600-1700	53	65	64	61	8	61	50
1700-1800	20	28	22	12	14	21	19
1800-1900	9	15	14	21	18	15	15
1900-2000	27	22	23	22	4	24	20
2000-2100	11	11	15	11	1	12	10
2100-2200	12	10	7	6		9	9
2200-2300	2	3	6	7		5	5
2300-2400	1	1	0	0		1	1
Totals	964	933	964	882	342	936	820

24144 - River Rd

River Rd between Weedman St / Railway Line
Combined

Time	Week 1					Averages	
	Tue 30	Wed 31	Thu 01	Fri 02	Sat 03	Weekday	7-day
0000-0100	0	1	0	2	0	1	1
0100-0200	0	1	1	0	1	1	1
0200-0300	1	0	2	0	0	1	1
0300-0400	0	5	4	2	3	3	3
0400-0500	15	17	15	12	5	15	13
0500-0600	139	142	135	146	68	141	126
0600-0700	165	171	169	165	65	168	147
0700-0800	112	106	99	100	17	104	87
0800-0900	121	110	109	99	30	110	94
0900-1000	142	125	124	135	59	132	117
1000-1100	132	113	121	117	65	121	110
1100-1200	124	91	117	130	61	116	105
1200-1300	121	122	113	148	67	126	114
1300-1400	121	144	124	103	55	123	109
1400-1500	216	194	230	183	63	206	177
1500-1600	147	119	155	90	32	128	109
1600-1700	145	151	168	133	18	149	123
1700-1800	91	106	98	52	27	87	75
1800-1900	21	35	29	42	36	32	33
1900-2000	50	37	40	48	14	44	38
2000-2100	30	33	34	28	3	31	26
2100-2200	21	21	16	21	0	20	16
2200-2300	29	27	32	22	0	28	22
2300-2400	1	2	2	2	0	2	1
Totals	1944	1873	1937	1780	689	1884	1645

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REDBANK RIVER PRECINCT

Summary of Geotechnical Information

Prepared By Moreton Geotechnical under the
Direction of Ken Grubb

Table of Contents

- 1 Geotechnical Report
- 2 Broadscale Mining Study
- 3 Detailed Mining Study
- 4 Correspondence relating to Desktop Mining Study for the proposed Northern Road Corridor alternatives
- 5 Geophysical Investigations of Proposed Industrial Park
- 6 Stage 1 Detailed Study
- 7 Stage 2 Detailed Study

GEOTECHNICAL REPORT

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MORETON GEOTECHNICAL SERVICES PTY. LTD.

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Section 78B(2)(c) - Unreasonable

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Ref. 99/29
11 June 1999

Baird and Hayes Consulting Surveyors

Section 78B(2)(c) - Unreasonable

Att. sch4p4(6) Personal info

Re: **PRELIMINARY MINING STUDY OF THE WOOLLEN MILLS SITE
AT REDBANK**

1.0 **INTRODUCTION**

The work in this report was carried out at the request of Hilldon P/L and in accordance with our discussions of 4th June 1999.

It is understood that a reconfiguration of the site is proposed, also that Council require a report in this regard.

Work in this study, which has included researching available records, documents and reports, has also drawn on our company's previous involvement with minor extensions including the toilet and fire wall on this site.

Four plans are attached to this report.

2.0 **INVESTIGATION RESULTS**

The geology underlying the site consists of quaternary alluvium over rocks of the Ipswich Coal Measures, including conglomerate, sandstone, shale and coal. The beds of the coal measures generally dip slightly to the south east, however the dip angle is not known for certain. Denmead states that the dip on the beds along the riverbank nearby fluctuates considerably, whereas dips of 5 degrees to 20 degrees to the south east are indicated in other sources. The main seam of economic interest was the Redbank Seam which crops out along the river bank.

The history of mining under and in the immediate vicinity of the site has relied mainly on descriptions by Whitmore in two publications, i.e. "Coal in Queensland, The First Fifty Years" and "Coal in Queensland, The Late Nineteenth Century". Plans of the workings, if these existed, have not been traced by the DME, Whitmore or by our researching. The site area was essentially worked in three sub areas which combined to form the larger area, the extent of which is shown on Attachment 2. Mining was also carried out in five separate periods between 1843 and 1900 as follows:

1843 - 1848

Pioneer Mine (see Attachment 2) with the tunnel entry located due west of the site along the banks of the river. This was the first coal mine in Queensland, operated by Mr. Williams.

1857 - 1870

The mine operated by Messrs Towns and Campbell, which extended southwards from Portion 15 to Portions 14, 104, 105 and 106. This mine was also operated intermittently to at least 1888. The worked section of the seam was 1.2m thick, although the full section was 2.7m thick.

1884 - 1885

The Brisbane River Land, Coal & Pottery Company (see Attachment 3) operated by Mr. Hunter on the banks of the river in Portions 128 and 129 near the connection with Six Mile Creek.

1885

Bannockburn Colliery Company Ltd operated by Mr. Archibald. This phase extended on Mr. Hunter's operations.

1888 - 1900

Mr. Kelleter extended on Mr. Hunter's operations.

The 1884 - 1900 period of mining appears to be referred to by Denmead as the "Old" Redbank Colliery. Workings from the nearby 180 feet deep shaft shown on Attachments 2 and 3 (which Whitmore refers to as the "Main" Shaft), appear to be from this "Old" Redbank Colliery 1884 - 1900 phase.

Previous discussions with the DME revealed that coal mining leases do not cover the area.

BROADSCALE MINING STUDY

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A.B.N. 24 055 833 120

Ref. 2005/29

12 May 2005

Wilkinson Shaw & Associates

P.O. Box 8375

Woolloongabba 4102

Att. sch4p4(6) Personal information

Re: **BROADSCALE MINING STUDY AT LOT 7 SP 133329 RIVER ROAD, REDBANK**

1.0 INTRODUCTION

This study was carried out at your request (letter 26th April 2005) and in accordance with the details in our letter of 22nd March 2005, also the Saunders Havill Group instruction letter of 21st April 2005.

It is understood that a 12 lot industrial subdivision is proposed on this site.

Work in this study has included a site inspection, previous meetings at the Department of Natural Resources & Mines (DNRM), researching available reports and publications, utilising our previously gained knowledge in the area and reporting. All work was carried out by the undersigned Engineering Geologist.

The following are attached to this report:

1. an aerial photograph
2. a site plan
3. a plan (Cameron 1923) showing the "alleged boundary of old workings" as the dashed line, also an insert composite plan from the DNRM
4. a composite mine plan

2.0 INVESTIGATION RESULTS

2.1 SITE

Plans 1 and 2 attached shows some of the site details.

The site is essentially bounded by the Brisbane River in the west, the Brisbane-Ipswich rail corridor in the south, industrial buildings in the east and the projection of River Road in the north.

The site inspection revealed that the bulk of the land comprises a relatively level elevated grassed area with steep banks (with scattered medium to large native trees) down to the Brisbane River. Buildings and open storage areas comprise the northern area whereas old large army sheds exist just beyond the eastern boundary.

Probable mining features observed during the site inspection are described in Section 2.4 below.

2.2 PAST LAND USE

The area has experienced extensive past land use activities including coal mining between 1843 and 1900, early pastoral and abattoir activities, the first production of coke in Queensland (1888), "freezing works", woollen mills and extensive military activities during World War II.

2.3 GEOLOGY

The geology underlying the site consists of quaternary alluvium over rocks of the Ipswich Coal Measures, including conglomerate, sandstone, shale and coal.

The beds of the coal measures generally dip slightly to the south east, however the dip angle is not known for certain. Denmead states that the dip on the beds along the riverbank nearby fluctuates considerably, whereas dips of 5 degrees to 20 degrees to the south east are indicated in other sources including the attached mine plan.

The main seam of economic interest was the Redbank Seam which crops out along the river bank on and adjacent to this site.

The site inspection revealed the presence of surface alluvial sands, gravel and cobbles along tracks and in the upper part of the bank to the Brisbane River. Massive sandstone also crops out along the banks of the river. Fill in the form of large concrete pieces, old iron machinery, bricks, clay, coalstone etc was also noted around and below the top edge of the river bank.

Four deep boreholes were previously drilled by this company to the east of this site. One borehole drilled approximately 80m east of the River Road entry to this site, close to a documented shaft location, recorded alluvial clay to 23m with carbonaceous shale with some coal to 27m with an alternating shale and sandstone sequence (one bed of conglomerate) to termination depth at 80m.

2.4 MINING

The DNRM have no plans of the workings. Our knowledge of the history of mining under and in the immediate vicinity of the site has had to rely mainly on descriptions by Whitmore in two publications, i.e. "Coal in Queensland, The First Fifty Years" and "Coal in Queensland, The Late Nineteenth Century".

The site area was essentially worked in three sub areas which appear to have combined to form the larger area, the combined extent of which is apparently shown as the dashed line on the attached mine plan. Mining was also carried out in five separate periods between 1843 and 1900 as follows:

- 1843 - 1848 Operations from the Pioneer Mine, with the tunnel entry located along the banks of the river of this site as shown on the mine plan and composite mine plan attached to this report. This was the first coal mine in Queensland, which was operated by Mr. Williams.
- 1857 - 1870 The mine operated by Messrs Towns and Campbell, which extended southwards from Portion 15 to Portions 14, 104, 105 and 106, i.e. from the north towards the site area. The southern limit is shown as the dashed line with the notation "alleged boundary". This mine was also operated intermittently to at least 1888. The worked section of the seam was 1.2m thick, although the full section was 2.7m thick.
- 1882 - 1885 The Brisbane River Coal Mining Company operated by Mr. Hunter on the banks of the river in Portions 128 and 129 near the connection with Six Mile Creek - see attached mine plan and Whitmore's description below.
- 1885 Bannockburn Colliery Company Ltd operated by Mr. Archibald. This phase extended on Mr. Hunter's operations.
- 1888 - 1900 Mr. Kellet extended on Mr. Hunter's operations.

The following are extracts from Whitmore's "Coal in Queensland, The Late Nineteenth Century", in connection firstly with the 1882 - 1885 and then the 1888 - 1900 operations:

- "After a couple of seams had been located by trial shafts, two steep tunnels were driven from the bank of the Brisbane River into the lower of them which was claimed to be 5 feet (1.5m) in thickness. The tunnels were quickly extended in length to 300 feet (90m) and 400 feet (120m) respectively, and equipped with simple tramways which terminated at a large shoot on the river bank, capable of holding over 200

- tonnes of coal. When journalists visited the site in 1884 a number of rooms had been opened underground but the 5-foot (1.5m) coal seam had shrunk ominously in thickness to less than a metre, the remainder being banded shaly material; some coal was standing in the shoot but it was obviously of poor quality. A third tunnel which sought better coal was already 300 feet (90m) into the bank but a proposal to sink a vertical production shaft had been abandoned. The company persevered until June 1885 when it was wound up, John Hunter going north to try his hand at gold mining and Forsyth taking over the leases."
- "Kellett attempted to make coke from coal mined on his land but with indifferent results, the prime obstacle being the poor quality of the local coal. Kellett accepted Peacock's advice that he should wash the slack before coking it and made the courageous decision to build a small, integrated washery and coking plant, the first to be constructed in Queensland. The coal was taken from a shaft 75 feet (22.5m deep)."

The site inspection revealed the presence of the following features (see attached composite mine plan) which appear to relate to the past mining activities:

- an old wharf (probable coal loading facility) is located on the river bank below the northern boundary of this site
- coalstone, irregular ground and a sinkhole subsidence feature are located from about a third of the way down the bank towards the old wharf
- a probable shaft near the corner of the fenced enclosure near the top edge of the bank
- sandstone rock face along the river bank. The tunnels should have been located under the sandstone
- a shaft or subsidence feature (appears to have been previously fenced in) at the southern end of the levy bank just outside the site area

Coal mining leases no longer cover the area.

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AERIAL PHOTO



Release

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REF 2005/29

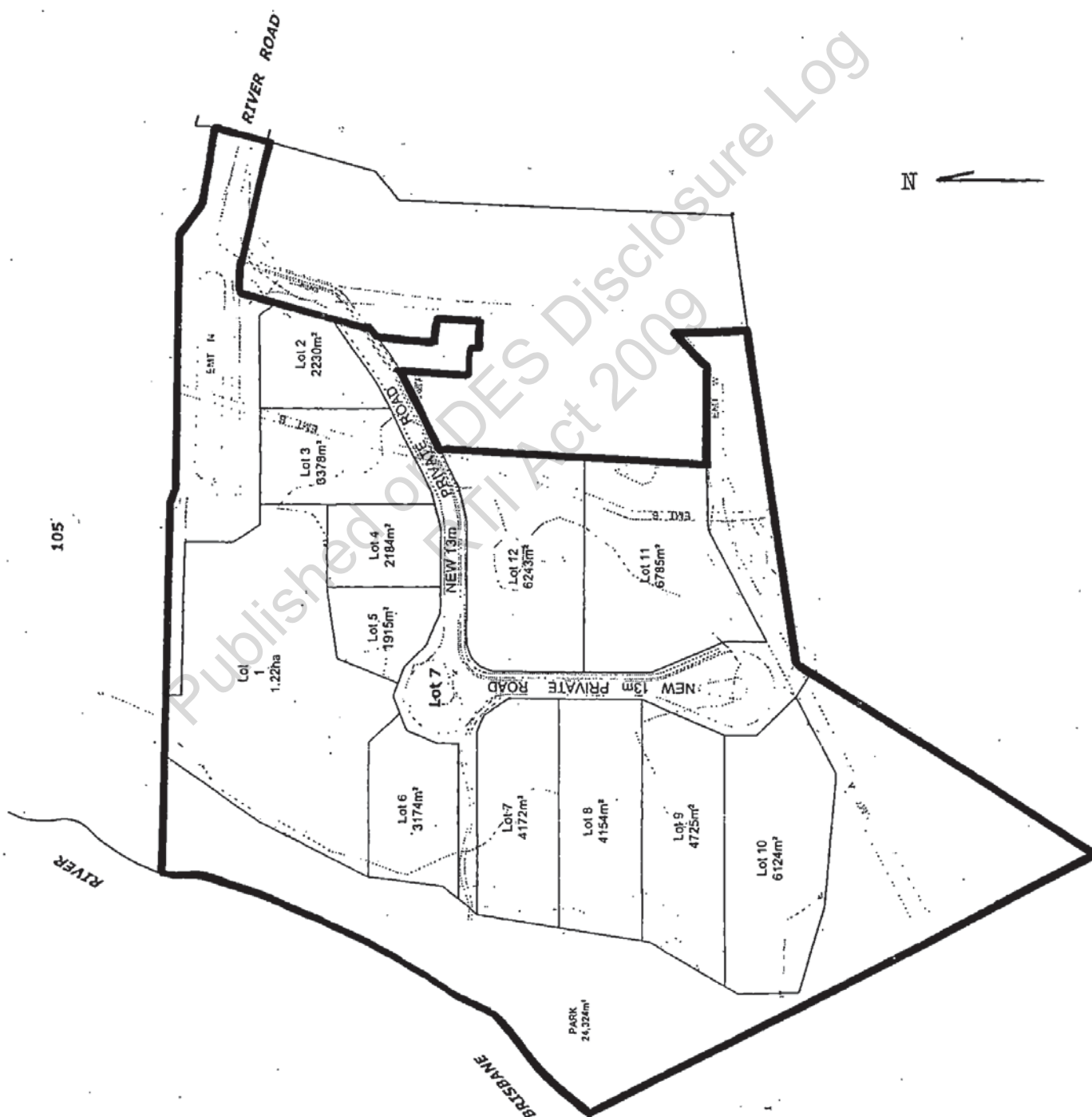
10.5.05

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SCALE 1:2800 APPROX

SITE PLAN



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Email mgs@gil.com.au

REF 2005/29

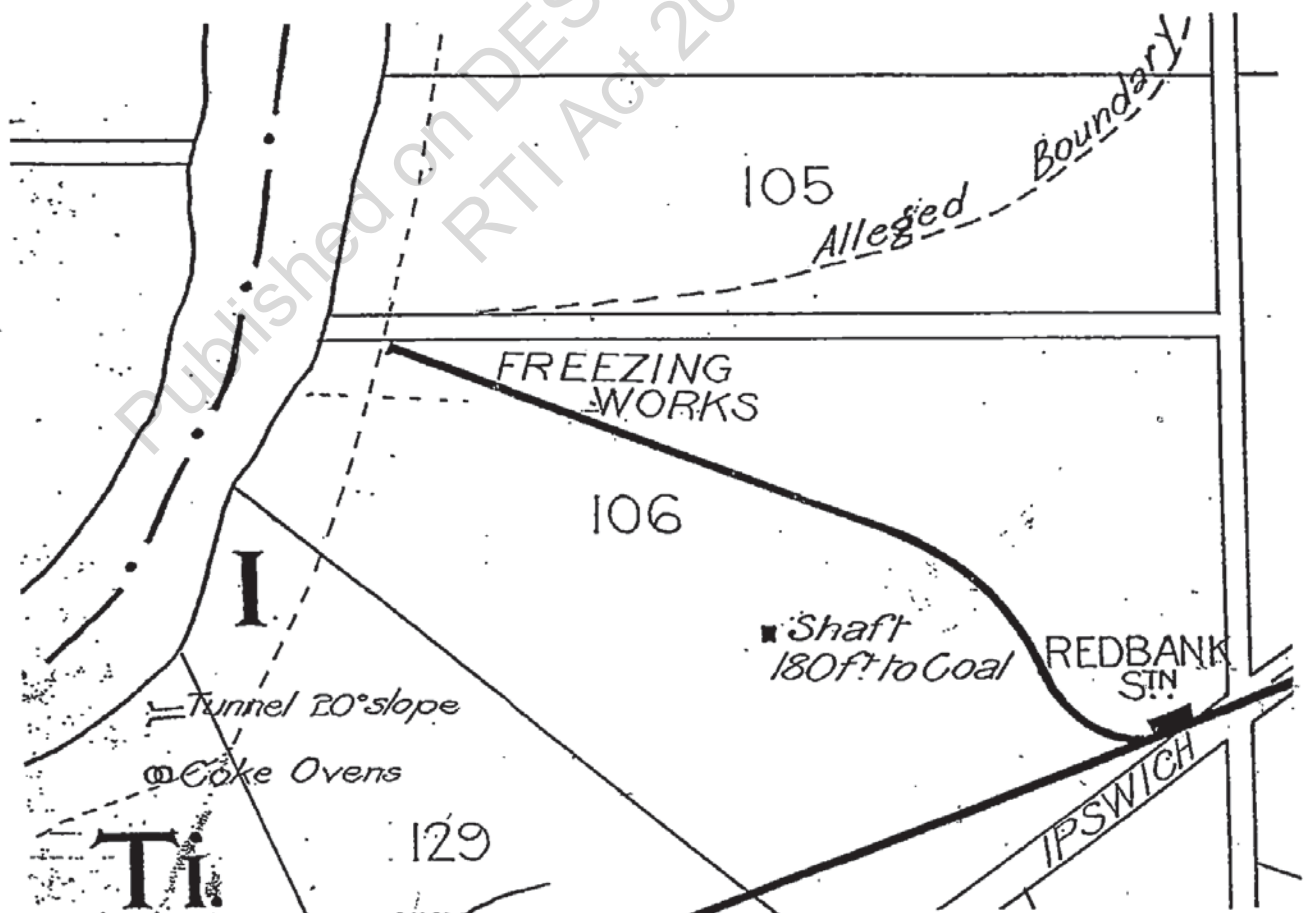
10.5.05

A.C.N. 055 833 120

A.B.N. 24 055 833 120

SCALES 1:6500 AND 1:25000 APPROX

MINE PLAN



MORETON GEOTECHNICAL SERVICES PTY. LTD.

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Telephone (07) 3294 6988

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REF 2005/29

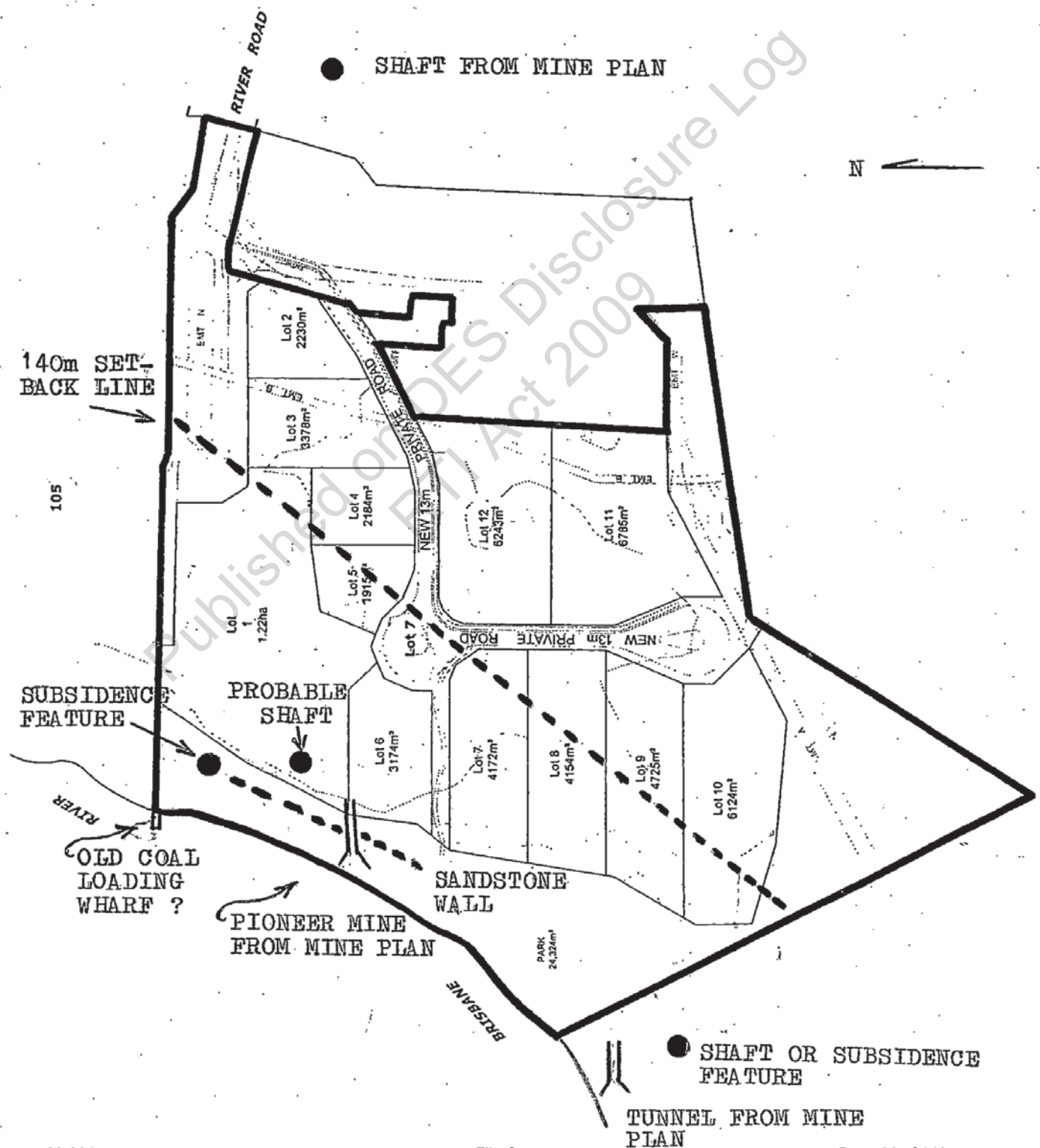
10.5.05

A.C.N. 055 833 120

A.B.N. 24 055 833 120

SCALE 1:2800 APPROX

COMPOSITE MINE PLAN



DETAILED MINING STUDY

MORETON GEOTECHNICAL SERVICES PTY. LTD.

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A.B.N. 24-055-833-120

Ref. 2005/29/02
30 June 2005

Saunders Havill Group
23 Edger Street
Bowen Hills
4006

Att.

sch4p4(6) Personal inform

Re: **DETAILED MINING STUDY AT LOT 7 SP133329 RIVER ROAD, REDBANK**

This proposal and estimate of costs letter follows our site meeting, together with your Clients, on 27th June 2005.

Our broadscale mining study report (ref. 2005/29 of 12th May 2005) revealed that undocumented mining has extended under this site between 1843 and 1900. The workings that could impact on this site appear to be from at least four Inclined tunnels and seven or more exploration, air or production shafts. The full extent, geometry and the state of the workings could only be surmised in the broadscale study due to the sketchy information that is available.

It is our proposal that a three stage investigation program be carried out in order to establish quantitative information on this site so that comments can be made on potential surface impacts if any, also on the types of industrial development most suited to the site. Details of the three investigation stages are as follows:

STAGE 1

A remote sensing (geophysical) electrical resistivity study (six lines between approximately 200m and 400m long, total length approximately 1600m) and accompanying commentary report by MGS is proposed for the initial study. This relatively cheap method of investigation, which has proven successful on a number of sites in the Ipswich area, will be aimed at establishing details on

Ref. 2005/29/02

-2-

the bulk geology (do the beds dip at 5 degrees or 20 degrees?), the extent of mining and aspects of the void spaces if possible. The findings of the study will also be used to target boreholes in the Stage 2 investigation work. Ecophyte Technologies P/L, who inspected the site on 28th June 2005, have provided the attached quotation of \$16,500.00 with an additional fee of \$880.00 to obtain the surface levels. The surface levelling program could alternatively be carried out by the Saunders Havill Group if this is preferred. Your Clients would need to commission Ecophyte under the terms and conditions on their attached quotation. MGS will supply a separate report (see attached costing) which will comment on the findings of the Ecophyte study in relation to the findings of our initial report.

Stage 2

Borehole drilling is proposed in this stage. The dip of the beds are not known, however our costing has assumed 5 boreholes to 40m average depth. The drilling, which will obtain information on the geology (type of rocks, depth to coal seam, thickness of coal seam etc), will also target features/anomalies obtained from the Ecophyte study. Your Clients will also need to commission the drilling company. MGS will again supply a separate report which will comment on the findings of the drilling program in relation to all known information.

STAGE 3

Excavating known and possible mine features (tunnels and shafts) using a backhoe is proposed in this stage. The findings of the work will positively establish the position of these features, as well as the extent to which the features are backfilled and also the methodology for capping these to render them permanently safe. MGS will again supply a report which will comment on the findings of the excavation works in relation to all known information. It is envisaged at this stage that the third stage report will be the final report that will provide recommendations on any implications of the mining under this site.

In summary, a three stage investigation is proposed. The estimated GST inclusive costings for each of the three stages, as per the rates shown on the attached sheet, are as follows:

Ref. 2005/29/02

-3-

Stage 1 - electrical resistivity survey and reporting

i. electrical resistivity study	\$16,500.00
ii. elevation survey	\$880.00
iii. MGS component	<u>\$3,718.0</u>
total	\$21,098.00

Stage 2 - drilling and reporting

drill rig hire and drilling	\$11,330.00
MGS component	<u>\$4,625.50</u>
total	\$15,955.50

Stage 3 - pit work

backhoe hire, supervision & reporting by MGS total \$3,822.50

At our present workload, the Stage 1 work could commence within 5 - 7 days of formal commissioning of MGS and Ecophyte. A realistic time frame for the completion of all three stages of the work is expected to be about 3 months.

Should you have any queries or wish to proceed with this work, then please do not hesitate to contact the undersigned.

MORETON GEOTECHNICAL SERVICES PTY LTD

sch4p4(6) Personal information

K. B. GRUBB**M.App.Sc., MIE Aust., CP Eng., RPEQ 2811**

Ref. 2005/29/02

ESTIMATE OF COSTS**STAGE 1 - ELECTRICAL RESISTIVITY SURVEY** - see attached sheet

i. electrical resistivity study	\$16,500.00
ii. elevation survey	\$880.00
iii. MGS component - site meeting 27/6, site meeting with Ecophyte 28/6, prepare submission, organisation, supervision & travel by Engineering Geologist...25 hrs at \$143 hr	\$3,575.00
vehicle charge...4 trips at \$16.50 each	\$66.00
drafting and reporting...item \$77	\$77.00
total	\$21,098.00

STAGE 2 - DRILLING (say 5 boreholes to 40m)

i. Drilling - establishment of rig on site item \$330	\$330.00
drilling 200m at \$55m	\$11,000.00
ii. Concreting top 6m of holes - concrete item \$220	\$220.00
iii. MGS component - organisation of drilling, supervision of drilling, concreting holes, travel, analysis & reporting by Engineering Geologist...30 hrs at \$143 hr	\$4,290.00
vehicle charge...3 trips at \$16.50 each	\$49.50
Drafting and typing...item \$66	\$66.00
total	\$15,955.50

STAGE 3 - PIT WORK

i. backhoe hire...10 hrs at \$88 hr	\$880.00
ii. MGS component - organisation, supervision, analysis & reporting by Engineering Geologist...20 hrs at \$143 hr	\$2,860.00
vehicle charge...1 trip at \$16.50	\$16.50
Drafting and typing...item \$66	\$66.00
total	\$3,822.50

note payment for MGS will be requested within 14 days of report date



Ecophyte Technologies Pty Ltd
ACN 202 604 474

Suite 3, Level 2, 131 Wickham Terrace
SPRING HILL QLD 4000
PH: +61 7 3831 3800
FAX: +61 7 3831 3805
EMAIL: contact@ecophyte.com

**Quotation for Geophysical Survey at a proposed Industrial Development
Site at Redbank, near Ipswich (ET139)**

1. Scope of Work

Conduct a Multi-electrode Resistivity survey to image underground mine workings in an area of known underground mining. The maximum depth of resistivity information to be retrieved from the survey is 50m bgs.

2. Survey Design

- 6 - 9 Multi-electrode Resistivity transects to a total of 1.6km length.

The orientation of the final survey transects will be made with consultation to Moreton Geotechnical Services.

3. Quotation

The fee for the additional DC Resistivity survey as outlined above is \$16500

The survey will also require relative elevation data to be acquired along the survey lines to allow for topographic corrections. Should the client wish for Ecophyte Technologies to supply this service an additional fee of **\$880**.

A combined DC Resistivity, Elevation data Survey fee is \$17380

These fees are inclusive of equipment hire, staff accommodation, freight, transportation to and from the site, report production and Goods and Services Tax.

4. Conditions

It is a requirement that 75% of the total Multi-electrode resistivity fee (\$12375) be deposited either by cheque or direct transfer to our account prior to commencement of survey.

The above fee is not inclusive of survey downtime due to delays in accessing the site, or persistent rain. Lightning poses a serious safety risk to our field crews and so we are unable to survey under these conditions. These delays will be charged at a rate \$950 per 24-hour period of delay on a pro-rata basis.

Our Bank account details are as follows:

Account Name: Ecophyte Technologies
Bank: Bank SA
BSB: 105148 Account Number: 023282040

**CORRESPONDENCE RELATING TO
DESKTOP MINING STUDY FOR
THE PROPOSED NORTHERN
ROAD CORRIDOR ALTERNATIVES**

MORETON GEOTECHNICAL SERVICES PTY. LTD.

PO Box 915 Ipswich 4305

Telephone (07) 3294 6988

Facsimile (07) 3294 6988

Email mgs@gil.com.au

A.C.N. 055 833 120

A.B.N. 24 055 833 120

27 July 2006

Maunsell Aecom

PO Box 1823

Milton

4064

Att. Mr. [sch4p4(6) Personal inform]

Re: **DESKTOP MINING STUDY FOR THE PROPOSED NORTHERN ROAD CORRIDOR ALTERNATIVES**

Thank you for the invitation to become involved with this project, as discussed at your meeting on 26th July.

Our company, in association with Taylor Mining Services P/L, have about 60 years combined knowledge and experience of coal mining matters in the Ipswich region. The attached list is a small sample of some of the projects that have been completed. Current work includes ongoing mining studies for a major recycled water corridor which commenced with Ipswich Water and has now continued with the Southern Regional Water Pipeline Alliance, a problematic large 330 kV transmission tower location for Powerlink, a new switchyard at Swanbank Power station etc. We recently also completed a desk-top study for Connell Wagners on three optional road corridor connections between the Warrego and Cunningham Highways in the Dinmore area. The desk-top study identified the mining issues and also provided recommendations on areas that required further detailed studies, which Connell Wagners are now handling in-house following the selection of the preferred route.

We will shortly be providing a costing to carry out a desk-top mining study to consider the potential mining impacts on the three optional routes shown on the attached plan. **We will however refrain from providing a costing or any input on mining issues associated with Option C across Mr [sch4p4(6) Personal inform] land at River Road Redbank, as this will be a conflict of interest for us in relation to [sch4p4(6) Pers] agreement with Maunsells.** Until such time as Golders complete their report, or [sch4p4(6) P] agrees to sell or supply the reports already prepared by MGS and until [sch4p4(6)] gives MGS the

~~go-ahead to further discuss this site, then this section of Option C will be~~
sterilised from any further communications.

Should you have any other queries in the meantime, then please do not
hesitate to contact the undersigned.

Regards

[Redacted] sch4p4(6) Personal information

Ken Grubb

cc

[Redacted] sch4p4(6) Personal information

Saunders Havill, fax 32519455

[Redacted] sch4p4(6) Personal information

Chai Law Practice, fax 33418647

Taylor Mining Services, fax 38162377

GEOPHYSICAL INVESTIGATIONS OF PROPOSED INDUSTRIAL PARK

Important information about your Ecophyte Technologies survey report.

These notes have been prepared by Ecophyte Technologies to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria and has been developed on the basis of your unique project specific requirements as understood by Ecophyte Technologies and applies only to the Site(s) investigated.

Project criteria typically include:

- the general nature of the project;
- its size and configuration;
- the location of any structures on the Site;
- other Site improvements;
- the presence of underground utilities;
- the additional risk imposed by scope-of-service limitations imposed by the client.

Your report should not be relied upon if there are any material changes to the project criteria, without first asking Ecophyte Technologies to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Ecophyte Technologies cannot accept responsibility for consequences that may occur due to changed factors if it is not consulted.

Natural processes and human activity create or vary subsurface conditions. For example, water levels can vary with time, fill may be placed on a Site and pollutants may migrate with the passing of time. Because a report is based on conditions extant at the time of the subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. You should consult Ecophyte Technologies to be advised how time may have impacted on the project.

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about the overall Site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual existing Site conditions, but steps may be taken to reduce the impact of unexpected conditions. For this reason the services of Ecophyte Technologies should be retained through the development stage, to:

- identify variances;
- conduct additional testing as required; and,
- recommend solutions to problems encountered.

Your report is based on the assumption that the Site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Ecophyte Technologies, who has prepared the report, is fully familiar with the background information needed to assess whether or not the reports recommendations are valid and whether or not changes should be considered as a project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted, and Ecophyte Technologies cannot be held responsible for such misinterpretation.

To avoid misuse of the information contained in your report, it is recommended that you confer with Ecophyte Technologies before passing your report on to another party who may not be familiar with the background and purpose of the report. Your report should not be applied to any other project other than that originally specified at the time the report as issued.

Moreton Geotechnical Services 21 December 2005
THIS REPORT IS NOT TO BE REPRODUCED EXCEPT IN ITS ENTIRETY.

ET139. Version 2
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0 Goals of Geophysical Survey

The goals of the survey and subsequent processing are summarised here:

- To investigate geophysical indications of former mine workings at a site of future industrial development;
- To interpret the geophysical indications, and estimate locations where boreholes may intersect anomalies related to former mine workings present within the geophysical dataset.

0.1 Summary

Information supplied by Moreton Geotechnical Services indicated that the survey site has been subject to underground coal mining activities during the period 1860 to 1920. These mine workings are known to be deep underground, but a significant risk of collapse and subsequent surface subsidence exists within the site.

Ecophyte Technologies was invited to provide a Geophysical Investigation into the location former mine workings present within the site. This report represents the findings of this investigation that was undertaken in several stages between 07 October and 23 November 2005.

Several geophysical indications were interpreted to be related to coal beds of Ipswich Coal Measures. Discrete anomalies are interpreted to be associated with Former Mine Workings.

1 Site Description

The site consists of open grassland at the western end of River Road, Redbank. The cadastral reference of the lot is SP-133329. A series of steep river terraces are present to the West, with industrial buildings located to the North and East. To the extreme South of the site lies an active train line. Numerous, well-established trees are present in alignments. It is expected that a number of subsurface utilities are present on the site. Of key concern is a main sewer trunk, which runs from the northeast to the southwest of the site. Other subsurface utilities include water and gas mains. Historic aerial photography displays that a series of dams were present

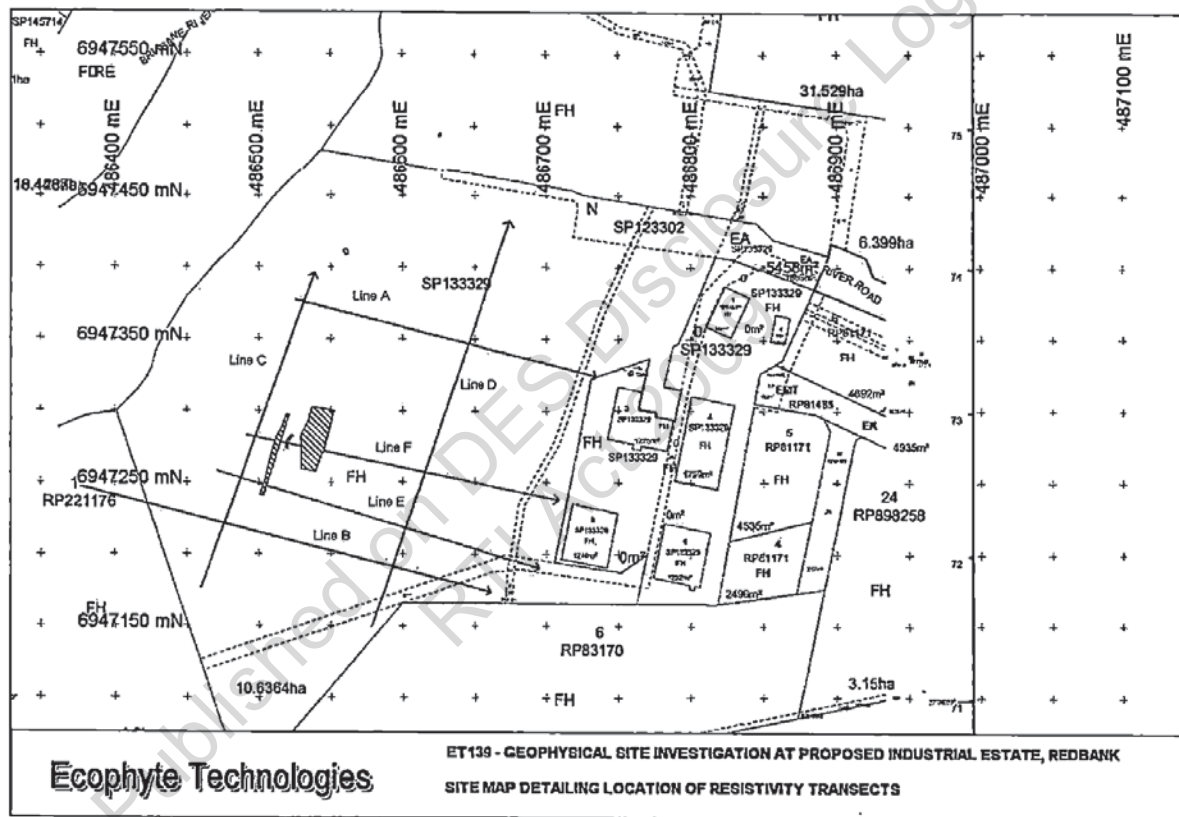


Figure One: Site Map detailing locations of Geophysical Transects as Line A, Line B, Line C and Line D. Line E and Line F were acquired across the former dam structures, and as such cannot be expected to provide reliable information about the geologic units.

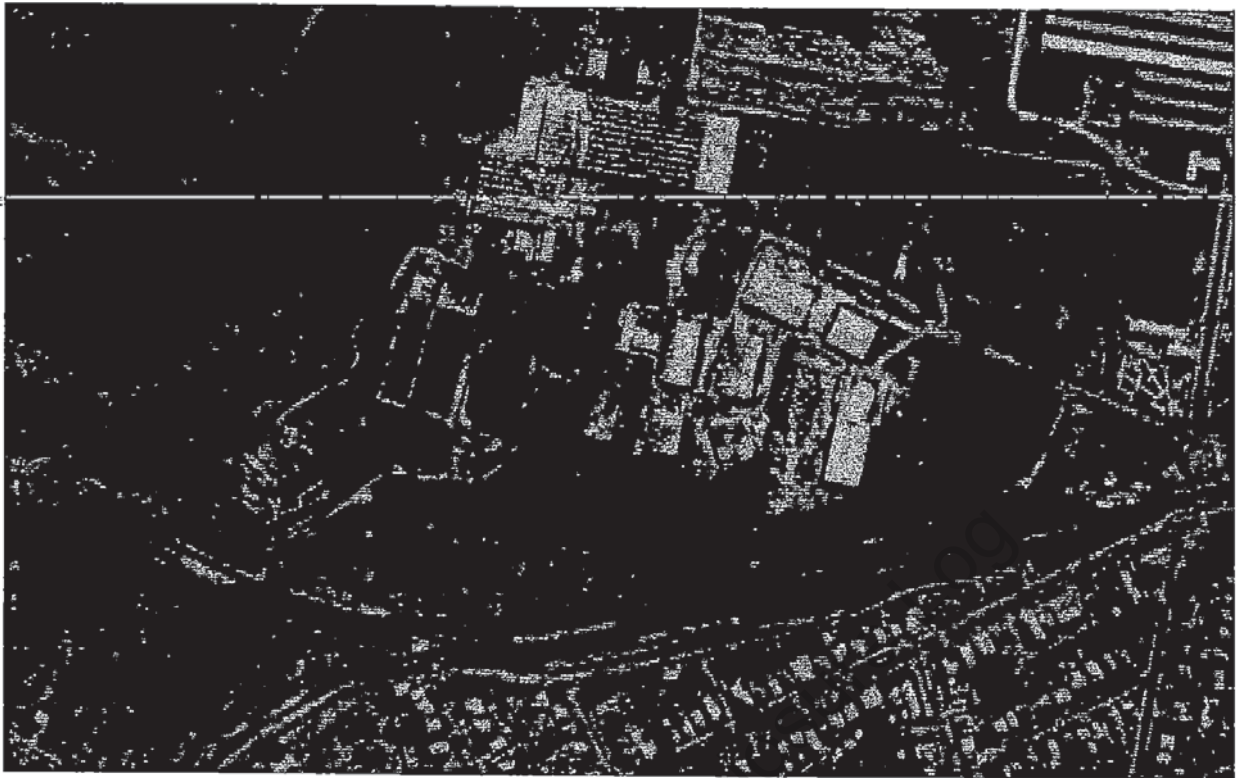


Figure Two: Aerial Photograph of the site from 26 June 1987. Two large rectangular dams can be seen in the central western section of the site.

2 Data Acquisition

2.1 Background of the Multi-electrode Resistivity Method (from M. H. Loke)

The purpose of electrical surveys is to determine the subsurface resistivity distribution by making measurements on the ground surface. From these measurements, the true resistivity of the subsurface can be estimated. The ground resistivity is related to various geological parameters such as the mineral and fluid content, porosity and degree of water saturation in the rock. The resistivity measurements are normally made by injecting current into the ground through two current electrodes, and measuring the resulting voltage difference at two potential electrodes. From the current (I) and voltage (V) values, an apparent resistivity (ρ_a) value is calculated.

$$\rho_a = k V / I \quad \dots(1)$$

where k is the geometric factor which depends on the arrangement of the four electrodes.

Resistivity meters normally give a resistance value, $R = V/I$, so in practice the apparent resistivity value is calculated by

$$\rho_a = k R$$

....(2)

The calculated resistivity value is not the true resistivity of the subsurface, but an "apparent" value which is the resistivity of a homogeneous ground which will give the same resistance value for the same electrode arrangement. The relationship between the "apparent" resistivity and the "true" resistivity is complex. To determine the true subsurface resistivity, an inversion of the measured apparent resistivity values using a computer program must be carried out.

2.1.1 The Relationship between Geology and Resistivity

Resistivity surveys give a picture of the subsurface resistivity distribution. To convert the resistivity picture into a geological picture, some knowledge of typical resistivity values for different types of subsurface materials and the geology of the area surveyed is important. Figure 01 gives the resistivity values of common rocks, soil materials and chemicals (Keller and Frischknecht 1966, Daniels and Alberty 1966). Igneous and metamorphic rocks typically have high resistivity values. The resistivity of these rocks is greatly dependent on the degree of fracturing, and the percentage of the fractures filled with ground water. Sedimentary rocks, which usually are more porous and have higher water content, normally have lower resistivity values. Wet soils and fresh ground water have even lower resistivity values. Clayey soil normally has a lower resistivity value than sandy soil. However, note the overlap in the resistivity values of the different classes of rocks and soils. This is because the resistivity of a particular rock or soil sample depends on a number of factors such as the porosity, the degree of water saturation and the concentration of dissolved salts. The resistivity of ground water varies from 10 to 100 ohm.m. depending on the concentration of dissolved salts. Note the low resistivity (about 0.2 ohm.m) of seawater due to the relatively high salt content.

Resistivity values have a much larger range compared to other physical quantities mapped by other geophysical methods. The resistivity of rocks and soils in a survey area can vary by several orders of magnitude. In comparison, density values used by gravity surveys usually change by less than a factor of 2, and seismic velocities usually do not change by more than a factor of 10. This makes the resistivity and other electrical or electromagnetic based methods very versatile geophysical techniques.

2.1.2 Resistivity Array Geometry

The data was acquired using the Dipole-Dipole array geometry. This array geometry utilised 5 or 6 metre electrode spacing. This spacing was chosen as a suitable compromise between depth of investigation, density of information and survey speed.

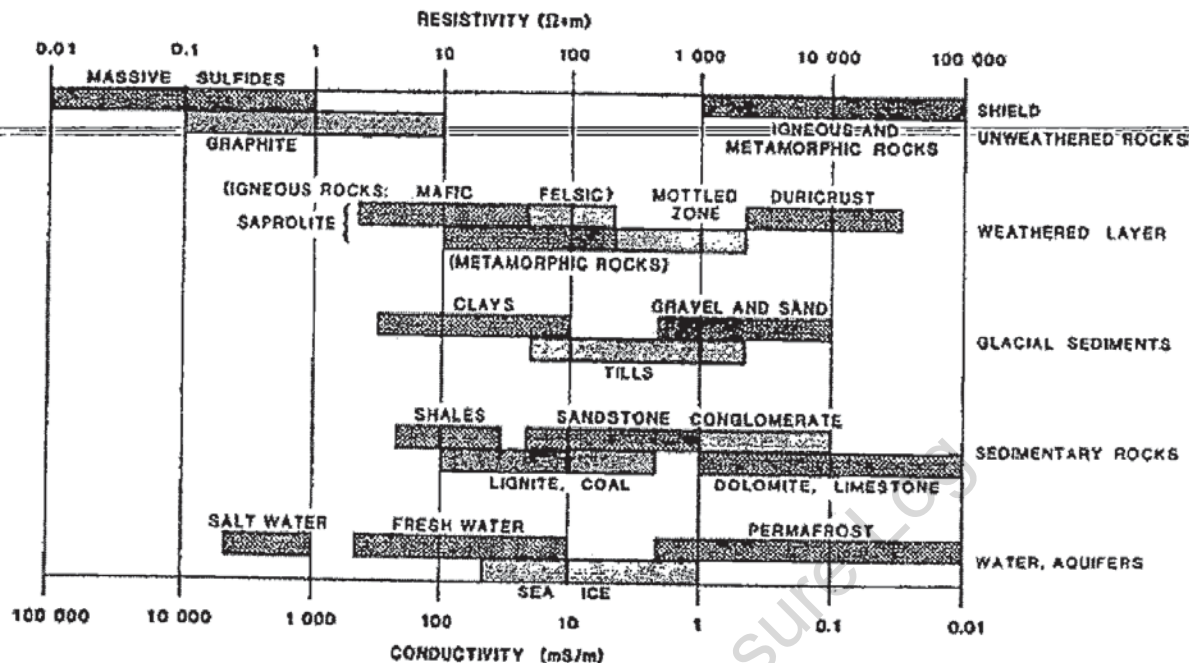


Figure Three: Typical Resistivity Value ranges for various material types.

2.2 Instrumentation

Data were collected using a SUPER STING Single Channel R1 IP Earth Resistivity Meter made by Advanced Geosciences Inc., Austin, Texas. The system consists of 56 hard-wired electrode switches; each separated by six metres of multi-core cable (Figure 02). The SuperSting earth resistivity meter controlled the application of current, measured the resulting potentials and recorded the results to an internal memory. For the cases of two-dimensional surveys, the cables are laid out along transect and the electrodes attached to stainless steel stakes driven about 200 mm into the ground.

The survey was conducted with reference to the American Society of Testing and Materials Standard (ASTM Standard D 6431-99). Contact resistance tests were performed prior to data collection to evaluate the ease with which current can be injected into the ground. The test involves passing current between electrode pairs in sequence to determine resistance of the very-near surface. The tests are ideally completed for each array after electrode deployment and prior to the start of the measurement phase. This contact resistance value (in Ohms) may range widely due to variations in soil mineralogy, structure or water content, with the manufacturer recommending values of less than 2000 Ω. Electrode installation error (ie. not properly seated to stake), or malfunctioning electrode switches (rare system fault) can be diagnosed allowing correction before the array data is collected.

Contact resistance values for this work program are generally in the range 200 to 1000 Ω however some were considerably higher. All electrodes were watered with saline fluid in a largely successful attempt to reduce contact resistance.

2.3 Survey Design and Location Control

The survey was designed prior to knowledge of the location of former dams on the site. Survey alignments were selected following guidance from Moreton Geotechnical Services. Alignments were chosen to provide the best indication of dip and strike of the Ipswich Coal Measures at the site. After discovery of previous dam structures the alignments had to be reoriented to avoid influence of these deeply filled pits.

The locations and elevation profiles of this survey transect was acquired by Taylor Mining Services, utilising a Laser Total Station and Real Time Kinematic Differential GPS as appropriate. This data was passed on to Ecophyte Technologies for location of transects and topographic correction of the data during the inversion process.

Table One. Locations of Geophysical Transects

Line ID	MGA Zone 56 mE, Start	MGA Zone 56 mN, Start	MGA Zone 56 mE, End	MGA Zone 56 mN, End	Length m
Line A	486,525.11	6,947,376.72	486,734.75	6,947,323.72	216
Line B	486,376.75	6,947,173.39	486,661.74	6,947,246.88	294
Line C	486,457.63	6,947,173.25	486,536.97	6,947,392.60	234
Line D	486,675.22	6,947,149.50	486,578.41	6,947,432.40	300
Line E	486,470.67	6,947,257.90	486,694.93	6,947,190.30	234
Line F	486,490.85	6,947,282.64	486,708.50	6,947,237.59	222
Total					1500

3 Data Interpretation Methodology

3.1 Multi-electrode Resistivity Data Processing

As a summary, the data points were resampled from 5 or 6 metre electrode spacing to 2.5 or 3 metres respectively to smooth the variation in data values and increase the resolution of the models created during the subsequent inversion process. Various damping and optimisation parameters are then applied to ensure that the models represent as good a fit as possible to the geological contrasts present at the survey site.

3.2 Multi-electrode Resistivity Data Interpretation Process

Numerous geophysical publications describe the types of resistivity anomalies that are associated with former mine workings. The interpretation methodology applied in this is derived from reviews of these publications, in addition to forward modelling and previous work undertaken by Ecophyte Technologies on this topic. Typically, inverse resistivity models are utilised in the interpretation and analysis of the resistivity data as the raw data cannot accurately approximate ground conditions. An exception was made in the case of this study due to the inverse models being affected by large resistivity gradients present at the site. This large gradient is present chiefly due to interpreted thick quaternary alluvium deposits of very low resistivity sitting directly above sandstone / sands and gravels / conglomerate of very high resistivity. This conformation of very high resistivity adjacent to very low resistivity values dominates the inverse models and no meaningful information regarding location of coal seams or former mine workings was interpretable from these inverse models. The raw measured apparent resistivity sections were, however, able to be usefully interpreted. This approach does have possible geometry errors related to spatial location of physical features, but for the purposes of this study, this approach should allow for additional confidence in the conceptual site Geologic model.

Interpretation of Former Mine Workings as detailed in this study is based on a combination of identification of contrasting geologic units and the direct identification of regions of reduced resistivity that may be associated with flooded mine workings. The expected key geologic units in this area are as follows:

- A. Triassic-Jurassic Ipswich Coal Measures possibly represented by:
 - 1. Raceview Formation – Lithology: Sublabile to quartzose sandstone, shale, mudstone, thin coal seams, siltstone
 - 2. Tivoli Formation – Lithology: sandstone, shale, siltstone and coal
- B. Triassic Aberdare Conglomerate – Lithology: Polymictic conglomerate, quartzose sandstone, siltstone, shale
- C. Quaternary Alluvium

The expected resistivity responses for the geologic units are based on lithology. Shale, siltstone and mudstone are expected to display resistivity ranges of 2 to 30 ohm.m. Sandstone is expected to have a range of 30 to 1000 ohm.m for the quartzose material. The Aberdare conglomerate is expected to show a range of resistivity values of 80 to 1500 ohm.m. Quaternary Alluvium such as overbank deposits are expected to be generally comprised of fine grained sediments (clay, mud silt) with a resistivity range of 1 to 30 ohm.m, but some gravels and sands are possible (resistivity

range 80 to 1000 ohm.m). Coal seams may have resistivity values in the range 50 to 1000 ohm.m depending on the amount of shale material incorporated into the matrix.

The resistivity data was interpreted with the aim of delineating discrete areas of abnormal resistivity in geologically reasonable locations for mine shafts. Voids resulting from coal mining activity are usually represented as zones of elevated resistivity when air filled (>300 ohm-m) or areas of low resistivity when water filled (<15 ohm-m) (Painter and Green, 2000). Furthermore, in areas underlain by voids the resistivity of the material overlaying these features will be artificially elevated due to fracturing in these areas. This resistivity will quickly decrease when collapse occurs (Carpenter, 1996).

The interpretation of features as being high, medium and low priority for further investigation was made on the basis of the above criteria namely:

- High or low resistivity when compared to the surrounding material and more generally in the ranges of >300 ohm-m or <15 ohm-m.
- Discrete geometry displayed either as a "bulls eye" or a vertical or horizontal clearly defined zone.
- Appropriate depth based on the current geological understanding of the region. This kind of feature should not however be ignored as it may indicate a void beneath it, as explained above.

Furthermore, resistivity surveying only provides an indication of the nature of the sub-surface based on a single physical property of the material, that is its resistivity.

4 Data Analysis and Interpretation

4.1 Line A

This survey transect is approximately parallel to an access road in the northwestern quadrant of the site (see Figure One). The total length of survey was 210m. Dipole-Dipole and Wenner resistivity array geometries were employed for this transect. Induced Polarization data was also acquired but was not used in this analysis. Five metre electrode spacing was employed for this line.

4.1.1 Line A – Dipole-Dipole Array

The Measured Apparent resistivity for this line displays regions of reduced resistivity. These regions align with a possible dip angle of coal beds. In this interpretation scheme these reduced resistivity regions are likely to be associated with former mine working of these coal seams. This section has been interpreted to display evidence of two discrete coal seams approximately 12.5m apart in vertical extent. The interpreted angle of dip is approximately 5 degrees to the East for both interpreted seams. The Top seam is interpreted to occur at 19 m bgs at the Western end of line; at the eastern, End of the line the seam descends to 32m bgs. The Bottom seam is interpreted to exist at 32 m bgs adjacent to start of line and descend to 44m bgs at the eastern end of section. A feature apparent in the Measured and Inverse Resistivity Model at 24m along the profile is interpreted to indicate the location of a former shaft associated with the mine workings. Anomalies were interpreted as being consistent with possible former mine workings.

4.2 Line B

This survey transect starts down on the lower river terrace to the extreme southwest of the site and continues approximately East. The total length of this traverse is 294m. Dipole-Dipole and Wenner resistivity array geometries were employed for this transect. Induced Polarization data was also acquired but was not used in this analysis.

4.2.1 Line B – Dipole-Dipole Array

This section has been interpreted to display evidence of two discrete coal seams approximately 13m apart in vertical extent. The interpreted angle of dip is approximately 6 degrees to the East for both interpreted seams. The Top seam is interpreted to occur at 18m bgs to the Western end, while at the eastern end the seam descends to 41m bgs. The Bottom seam is interpreted to exist at 31m bgs at the western end, and descends to 54m bgs at the eastern end of section. A feature interpreted to be a shaft associated with former mine workings was located at 63m along the profile. Anomalies were interpreted as being consistent with possible former mine workings.

4.3 Line C

This survey was conducted in a northerly direction adjacent to the edge of the cliffs in the western sector of the site. This survey transect starts down on the lower river terrace to the extreme southwest of the site and continues approximately East. The total length of this traverse is 294m. Dipole-Dipole and Wenner resistivity array geometries were employed for this transect. Induced Polarization data was also acquired but was not used in this analysis.

4.3.1 Line C – Dipole-Dipole Array

This section has been interpreted to display evidence of the strike of the same features interpreted in Line A and Line B. In the Measured Apparent Resistivity sections show two discrete flat lying features of reduced resistivity. These features are interpreted to be associated with coal seams. The interpreted features have an apparent dip of between 0.5 and 1.0 degree to the South. The Top Seam is interpreted to occur at about 18m bgs, while the Bottom Seam is interpreted to be 32m bgs. The separation between the seams is around 14m. Anomalies in this section were of a higher relative resistivity, and as such were interpreted as being possibly collapsed former mine workings.

4.4 Line D

This survey transect is almost parallel to Line C, but runs through the central East of the site. The position of this line was selected so as to ensure minimal effect from a local subsurface Sewer trunk.

4.4.1 Line D – Dipole-Dipole Array

The data present in this Measured Apparent Resistivity section provides further indication of the strike of the interpreted coal seams. A large number of low resistivity regions were present in this section. Many alignments are possible for the low resistivity regions, but good correlation is achieved with the previous sections. The interpreted Top Seam is predicted to occur at about 34 m bgs, the Bottom Seam at about 47m bgs. Both seams are interpreted to dip at about 0.5 degree to the South. Separation between seams is about 13m. Anomalies in this section were of a lower relative resistivity, and as such were interpreted as being possible former mine workings or alternately carbonaceous shale.

Table Two. Locations of Interpreted Anomalies

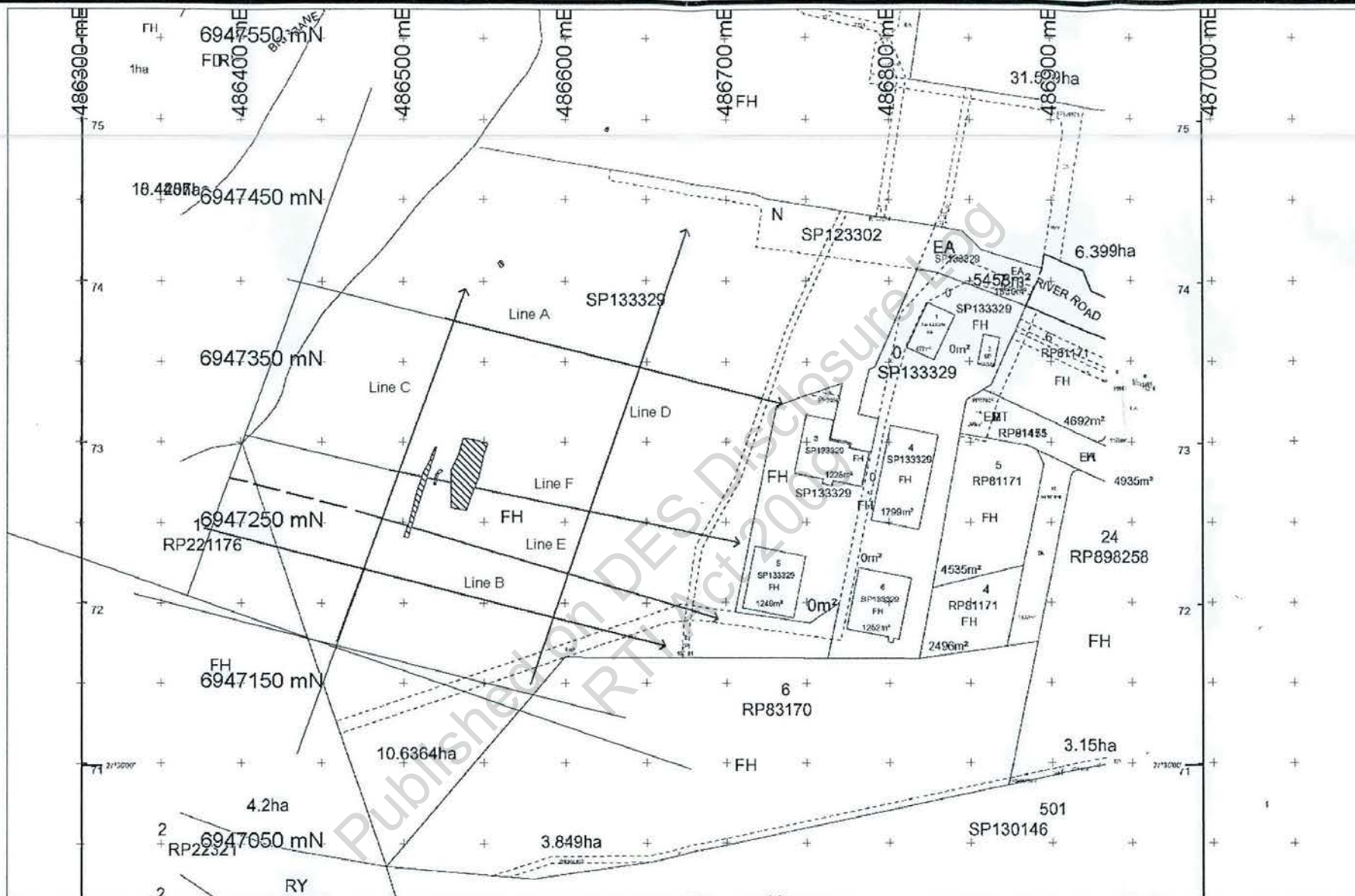
Pick Ref.	Priority	Description	MGA_mE	MGA_mN	m along Profile	Depth-m BGS
A1	HIGH	POSS. MINE WORKING	486617.96	6947265.81	100	40
A2	HIGH	POSS. MINE WORKING	486646.40	6947346.07	125	28
B1	HIGH	POSS. MINE WORKING	486447.69	6947228.63	73	23
B2	HIGH	POSS. MINE WORKING	486486.41	6947218.62	113	27
B3	HIGH	POSS. MINE WORKING	486536.70	6947205.67	165	32
B4	HIGH	POSS. MINE WORKING	486588.16	6947192.45	218	33
C1	MED	POSS. COLLAPSED MINE WORKING	486473.34	6947214.99	41	18
C2	MED	POSS. COLLAPSED MINE WORKING	486481.17	6947236.60	64	18
C3	MED	POSS. COLLAPSED MINE WORKING	486500.37	6947289.81	121	18
C4	MED	POSS. COLLAPSED MINE WORKING	486510.24	6947317.06	150	18
C5	LOW	POSS. COLLAPSED MINE WORKING	486490.94	6947263.64	93	32
D1	HIGH	POSS. MINE WORKING / CARB. SHALE	486622.32	6947352.17	123	36
D2	HIGH	POSS. MINE WORKING / CARB. SHALE	486626.38	6947288.96	147	35
D3	MED	POSS. MINE WORKING / CARB. SHALE	486607.10	6947233.68	89	36
D4	MED	POSS. MINE WORKING / CARB. SHALE	486643.98	6947341.07	203	36
Shaft A	HIGH	ENTRANCE/MINE WORKING	486546.95	6947371.20	24	10
Shaft B	HIGH	ENTRANCE/MINE WORKING	486437.58	6947231.54	63	12

Appendix A: Site Maps, Models and Interpretations

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RTI Act 2009

Moreton Geotechnical Services 21 December 2005
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ET139. Version 2
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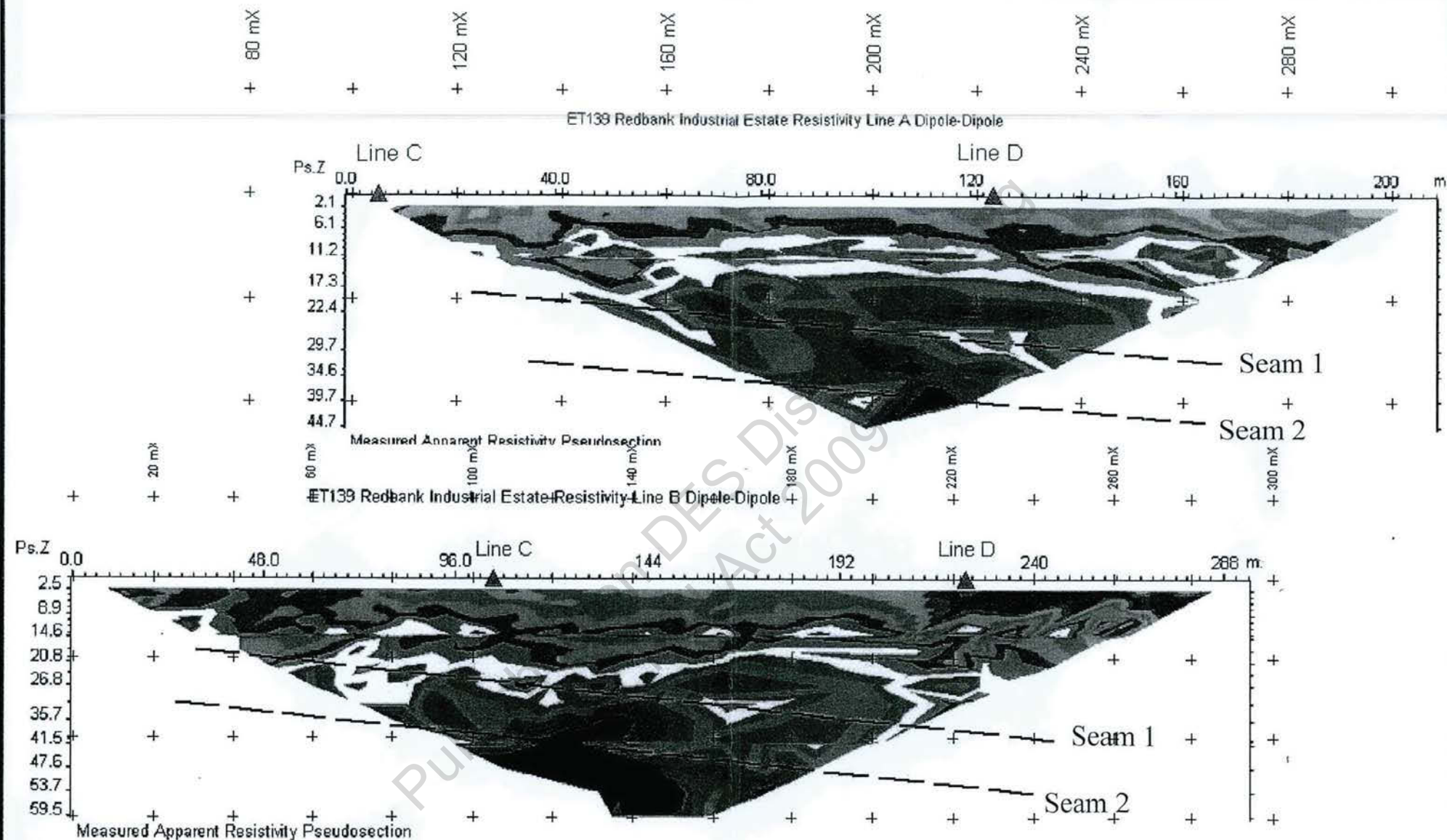
Ecophyte Technologies Pty Ltd
ACN : 098 864 478

Moreton Geotechnical Services

ET139 - Redbank Industrial Park - Sheet 1 of 6

Site map Detailing Location of Survey Lines

Date: 21 December 2005 Drafted by: BAK



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20-204

ET139 - Redbank Industrial Park - Sheet 2 of 6

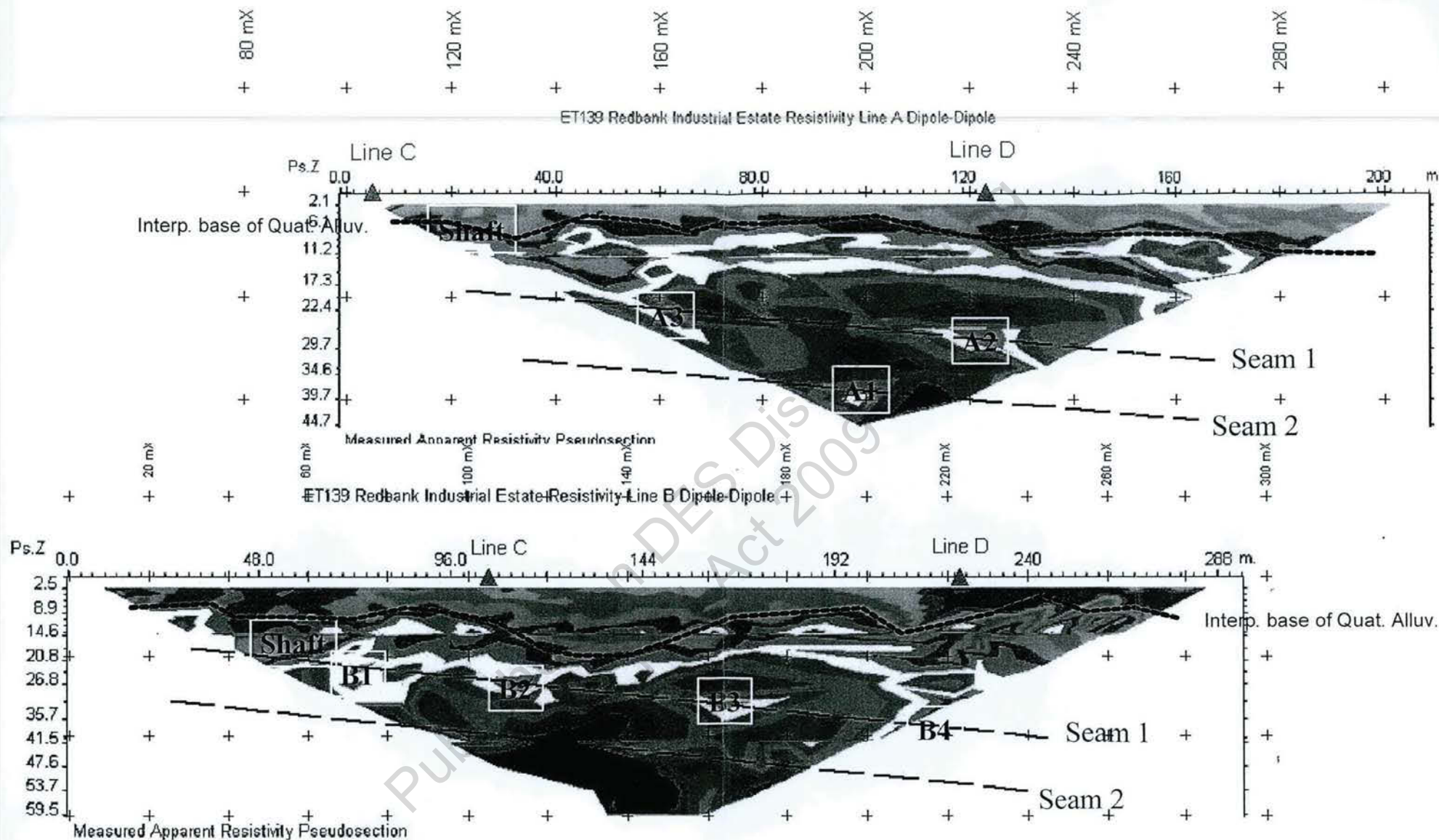
Measured Resistivity Models for Line A and Line B

File C

Date: 21 December 2005 Drafted by: BAK

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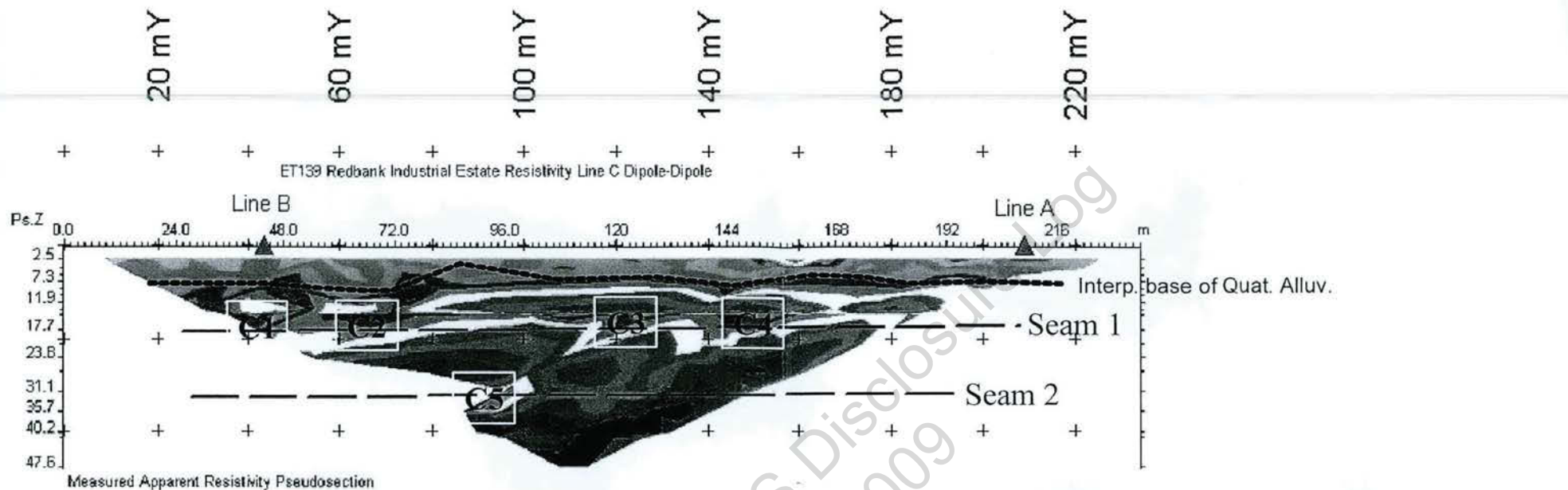
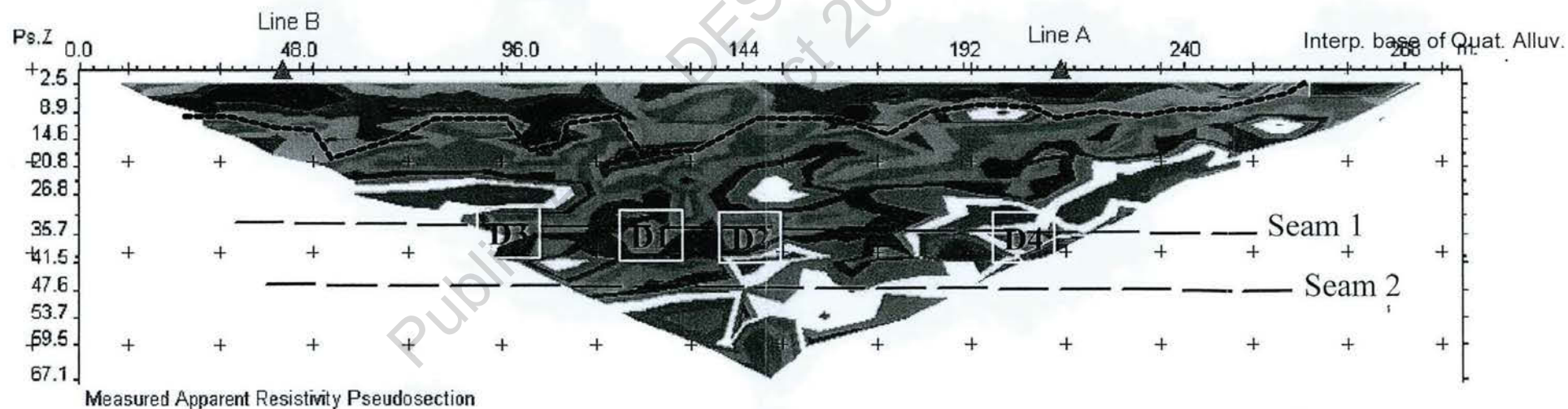
ET139 - Redbank Industrial Park - Sheet 4 of 6

Measured Resistivity Models for Line A and Line B

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ET139 - Redbank Industrial Park - Sheet 5 of 6

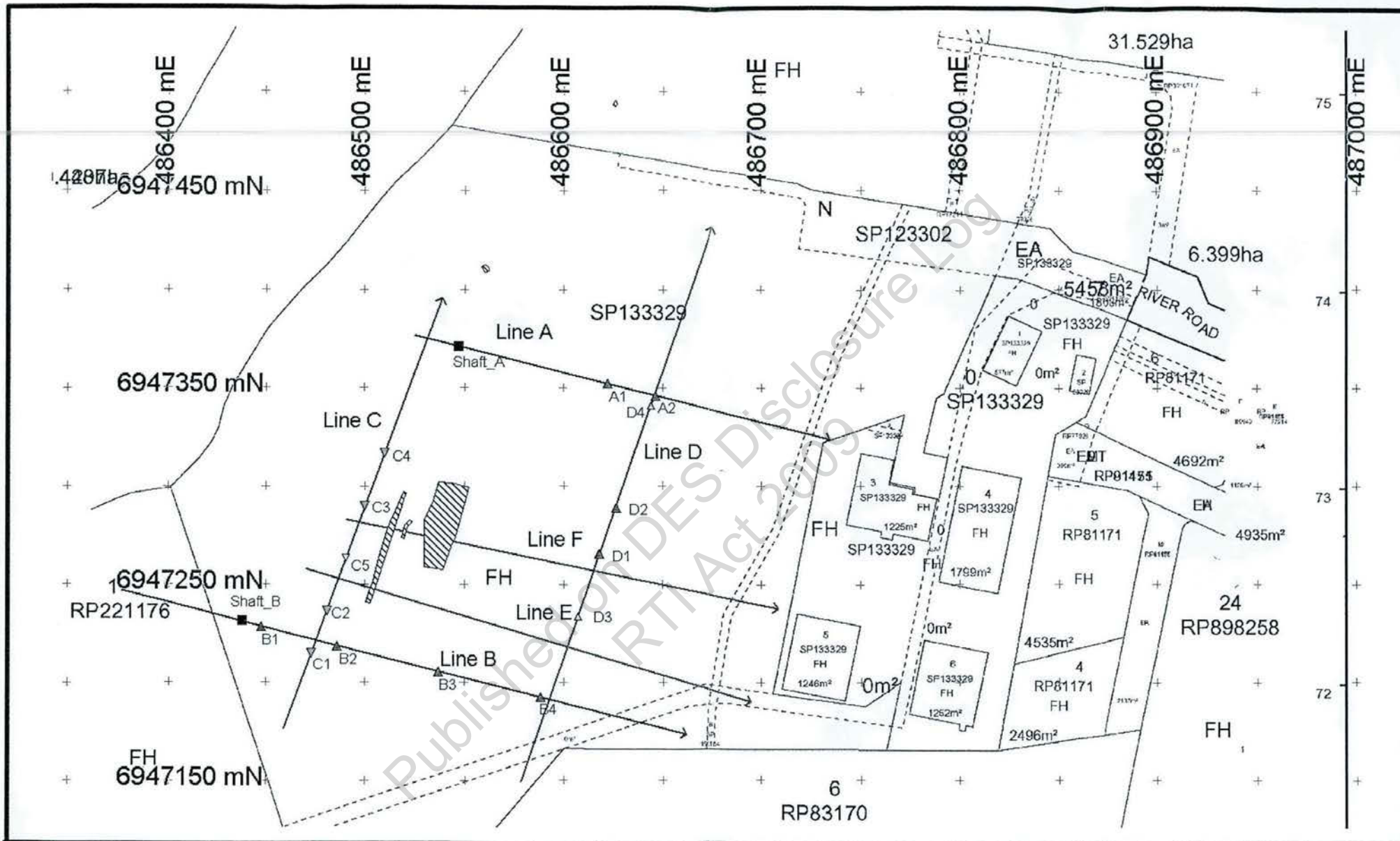
Measured Resistivity Models for Line C and Line D

File C

Date: 21 December 2005 Drafted by: BAK

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20-204

ET139 - Redbank Industrial Park - Sheet 6 of 6

Site map Detailing Location of Former Mine Workings

Date: 21 December 2005 Drafted by: BAK

File C

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STAGE 1 DETAILED STUDY

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Ref. 2005/29/08
23 December 2005

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Re: **RIVER ROAD, REDBANK - STAGE 1 DETAILED STUDY**

1.0 INTRODUCTION

The work in this report was carried out at your request on 26th September 2005 following our letter reference 2005/29/02 of 30th June 2005 to the Saunders Havill Group.

This report forms a supplement to our report reference 2005/29 of 12th May 2005, to which the reader is referred.

Work in this report covers the findings of a geophysical study by Ecophyte Technologies P/L (ET) who were commissioned by Chai Law Practice, also a review of the findings of the ET report in relation to comments in our earlier report.

A list of anomaly details and a site plan showing the locations of six electrical resistivity lines and fifteen anomalies is attached to this report.

A free-standing report covering the electrical resistivity testing by ET (report reference ET139 of 21st December 2005) also accompanies this report.

2.0 BACKGROUND

Our initial report of 12th May 2005 essentially found that undocumented mining, from at least four inclined tunnel entries along the river bank, took place under this site between 1843 and 1900. The coal was also accessed via

vertical exploration shafts, air shafts or production shafts at about seven locations, two of which were located on site. The full extent, geometry and the state of the workings can only be surmised due to the sketchy information available.

The understanding of the site is further complicated as details of the bedrock geology are limited. The dip angle on the beds in particular were indicated to have a possible range of 5 degrees to 20 degrees to the south east. The most gentle dip would indicate possible undocumented workings at 20 - 40m cover depth range, whereas a cover depth range of 20 - 95m would exist for the steeper dipping beds.

A geophysical study (electrical resistivity method) was subsequently instituted in order to establish as much information as possible (at relatively low cost) on the geology, faults and particularly the mine workings under the area of interest. The study and findings of the study are discussed in more detail in Sections 3.0 and 4.0 below.

3.0 GEOPHYSICAL STUDY

3.1 ELECTRICAL RESISTIVITY TESTING

The electrical resistivity survey was carried out along six lines, the positions of which are shown in the free-standing ET report. Two of the lines had to be abandoned (see Lines E and F on the attached plan) when the draft results (graphic sections) showed large unexpected anomalies (backfilled settling ponds) close to surface. This complicating factor is discussed in more detail in Section 4.3 below.

The technique used essentially involves pumping direct current electricity into the ground via a cable and electrode system. A 5 - 6m electrode spacings was used. The current in the ground is then recorded by computer. Similar soils and rocks have similar electrical responses. The recorded data is then manipulated using different techniques to produce colour charts showing the areas where similar materials and anomalies exist. The study in question was aimed at locating anomalies with specific electrical properties which show the geology, faults and mine workings.

Establishing the topography along each line by survey was carried out in order that topographically corrected electrical resistivity graphic sections could be produced.

Full details of the methodology and results of the survey, which covered a maximum depth range of 40 - 60m, have been provided in a free-standing ET report attached to this report. ET have assessed the output and drawn conclusions based on their knowledge of the site. Eight graphic sections and two plans have been provided which separately show interpreted geological and mining information using the Dipole-Dipole method of processing.

4.0 INVESTIGATION RESULTS

4.1 ELECTRICAL RESISTIVITY TESTING

Reference to the free-standing ET report essentially indicates that the following was interpreted:

- that the technical aspect of producing the "coloured graphic sections" was complicated by the occurrence of a near surface conductive probable alluvium layer resting directly on top of highly resistive probable sandstone bedrock
- that two coal seams dip away from the river bank at an apparent angle of approximately 5 - 6 degrees. The top coal seam is indicated to occur at between 15m and 45m depth, whereas the lower seam is indicated to be about 10m - 15m deeper.
- that flooded mine workings are generally indicated on both seams
- Table 2 lists seventeen anomalies (see also the attached table) which were inferred to be related to possible former mine workings. Ten of the anomalies, including two shafts, were rated as high priority. Six anomalies were rated as medium priority, whereas one anomaly was rated as low priority. The depths of the anomalies ranged between 10m and 40m. The locations of the seventeen anomalies are shown on the plan attached to this report.

4.2 SUPPLEMENTARY RESEARCH

A search of aerial photographs and other sources was carried out as a result of encountering the large unexpected anomalies on two of the electrical resistivity lines (E and F) which had to be abandoned. The supplementary work revealed that a number of large square to rectangular ponds were previously located in the area between Lines A, B, C and D. The 1987

aerial photograph included in the ET report shows these ponds. Further checking of records accessed by Chai Law Practice revealed that these were settling ponds for the old woollen mills; that these had been backfilled, and that the EPA had discussed the matter in their file reference 900109 (Lot 23, plan SP123302) of 1.2.2000.

Reports by Hollingsworth Dames & Moore, referenced in the E.P.A. document, were viewed on site on 15.12.05 with sch4p4(6) Personal The reports provided extensive details on environmental rehabilitation aspects but no information on the bedrock geology or past mining activities.

4.3 SURVEY

Taylor Mining Services P/L were commissioned by ET to pick up the positions of the electrical resistivity lines as well as other features of interest on the site.

The attached plan shows the locations of Shafts A and B as well as cross-hatched areas where surface depressions exist over part of the backfilled settling ponds.

A detailed plan (including underground services) by Baird & Hayes Consulting Surveyors was prepared for Hildon P/L in 1999. A copy of the plan was supplied to MGS by the Saunders Havill Group. It is understood from sch4p4(6) P sch4p4(that additional underground services have been located since the production of the plan.

5.0 COMMENT

In summary, the work in this study indicates:

- the presence of backfilled settling ponds
- that alluvium overlies beds of sandstone, which in turn appears to overlie beds of shale and coal
- that two coal seams, that dip at an angle of less than 10 degrees to the east or south east, exist within the depth range tested
- that workings could exist on the upper seam in the 15m to 40m depth range across the site

- that workings could also exist on the lower seam which occurs at 10m - 15m below the upper seam

In conclusion, the work in this study has increased our knowledge of the site. Notwithstanding this, drilling will need to be carried out at some of the high priority anomaly locations to establish the accuracy of this non-invasive method of study, also to obtain the geological profile and height and state of any abandoned workings.

In the event that the drilling confirms the findings of the geophysical study, then this will constrain the potential use of the site, i.e. on the size of the lots and the type of construction etc. The initially proposed lot layout could also prove to be a high risk approach, i.e. permit buildings of large dimensions, which would be considered unacceptable. Buildings in the area of the backfilled ponds will, in addition to normal soil reactivity and any mining considerations, need to be designed to cater for the prevailing bearing pressure or settlement characteristics of the backfill.

4.0 LIMITATIONS

This report, which may contain attachments in the form of plans, borehole record sheets, laboratory test results etc, must be read in its entirety.

The work in this report was produced for Chai Law Practice and their Associates on the basis of information available at the time of writing. This report will not contain sufficient information for other parties and purposes.

While care has been taken in producing this report, it needs to be said that there will always be some risk associated with developing in these settings. Recommendations put forward in this report are aimed at minimising the risk.

This company accepts no responsibility for works which do not fully comply with the recommendations in this report.

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date 22.12.05

ANOMALY LISTING

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Pick Reference	Priority	Description	MGA_mE	MGA_mN	m along Profile	Depth m BGS
A1	HIGH	POSS. MINE WORKING	486617.96	6947265.81	100	40
A2	HIGH	POSS. MINE WORKING	486646.40	6947346.07	125	28
B1	HIGH	POSS. MINE WORKING	486447.69	6947228.63	73	23
B2	HIGH	POSS. MINE WORKING	486486.41	6947218.62	113	27
B3	HIGH	POSS. MINE WORKING	486536.70	6947205.67	165	32
B4	HIGH	POSS. MINE WORKING	486588.16	6947192.45	218	33
C1	MED	POSS. COLLAPSED MINE WORKING	486473.34	6947214.99	41	18
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C3	MED	POSS. COLLAPSED MINE WORKING	486500.37	6947289.81	121	18
C4	MED	POSS. COLLAPSED MINE WORKING	486510.24	6947317.06	150	18
C5	LOW	POSS. COLLAPSED MINE WORKING	486490.94	6947263.64	93	32
D1	HIGH	POSS. MINE WORKING / CARB. SHALE	486622.32	6947352.17	123	36
D2	HIGH	POSS. MINE WORKING / CARB. SHALE	486626.38	6947288.96	147	35
D3	MED	POSS. MINE WORKING / CARB. SHALE	486607.10	6947233.68	89	36
D4	MED	POSS. MINE WORKING / CARB. SHALE	486643.98	6947341.07	203	36
Shaft_A	HIGH	ENTRANCE/MINE WORKING	486546.95	6947371.20	24	10
Shaft_B	HIGH	ENTRANCE/MINE WORKING	486437.58	6947231.54	63	12

STAGE 2 DETAILED STUDY

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19 April 2006

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Att. sch4p4(6) Personal informati

Re: **RIVER ROAD, REDBANK - STAGE 2 DETAILED STUDY**

1.0 INTRODUCTION

The work in this report was carried out at your request following our letter reference 2005/29/10 of 14th February 2006 to the Saunders Havill Group.

This report forms a supplement to our report reference 2005/29/08 of 23rd December 2005, to which the reader is referred.

The work in this report covers the findings of a deep drilling program carried out on 12th and 13th April 2006.

It is understood that 1000 - 2000 m² lots are now being considered for an estate that will ideally include tilt-up concrete panel double storey construction with mezzanine floors.

Digital photographs and a plan showing the borehole locations are attached to this report.

2.0 BACKGROUND

The geophysical investigation carried out as access permitted in the Stage 1 detailed study (away from concrete slabs and the backfilled settling ponds) indicated that a number of conditions exist under the site. Inferred geological conditions including alluvium over sandstone and shale bedrock, the likely presence of two coal seams dipping at 10 degrees to the east or south east and probable workings in the 15 - 40m depth range were

investigated during the drilling of five boreholes that ranged in depth between 18m and 53m.

The boreholes, which were drilled by a large rotary percussion rig, were drilled to approximately 175mm diameter in the top 6.0m and 140mm diameter between 6.0m and termination depth. The boreholes were drilled at high and medium priority anomaly locations as follows:

Borehole No.	Anomaly No.	Depth drilled (m)
1	Shaft "A"	31.8
2	C4	18.0
3	C1	42.0
4	A1	53.0
5	D1	44.0

The upper 3m to 6m, in four of the five boreholes, were filled with readymix concrete. One borehole (Borehole 2) which was terminated due to collapsing alluvial soils at 18m depth, was by comparison backfilled with soil cuttings.

3.0 INVESTIGATION RESULTS

The following is a summary of the information recorded from the boreholes.

Borehole 1 recorded alluvial soils (mainly silts and sands) to 16.0m depth, with sandstone to 25.5m, with carbonaceous shale, some coal and ground water to 26.5m, with shale to 30.0m, with carbonaceous shale and coal to 30.5m, with an open water-filled void smelling of mine gas (1.3m high) to termination depth at 31.8m.

Borehole 2 recorded alluvial soils (mainly silts and sands) to 18.0m. This borehole was abandoned due to constant collapsing at depth and loss of drilling air.

Borehole 3 recorded alluvial soils (mainly silts and sands) to 25.0m, with sandstone to 28.0m, with shale to 42m including very easy drilling between 32.0m and 34.0m.

Borehole 4 recorded alluvial soils (mainly silts and sands) to 19.0m with sandstone to 23.0m and shale and coal to 25.0m, with shale and sandstone to 35.0m, with shale to 36.0m, with sandstone to 40.0m, with shale to 42.0m, with sandstone and strong water inflow to termination depth at 53.0m.

Borehole 5 recorded alluvial soils (mainly silts and sands) to 27.0m, with sandstone to 32.0m, with shale (water seepage, very easy drilling and mild mine gas smell) to 37m, with sandstone to termination depth at 44.0m.

4.0 COMMENT

The drilling has revealed that the thickness of alluvial soils increases from Borehole 1 (16.0m) to Boreholes 2 (18.0m) and 3 (25.0m). The thickness also increases from the top of the river bank towards the existing igloo building. The alluvial soils also attain a maximum thickness of 27.0m at the location of Borehole 5. The relatively thick cover of mainly silt and sand alluvial soils made for difficult drilling conditions. The uppermost bedrock was also found to comprise sandstone which thinned out and became deeper away from Borehole 1. Shale (including two coal seams in a 5m interval) to a total thickness of between 5.0m and 14.0m was found to underlie the upper sandstone. A 1.3m high water-filled mine void was only encountered in Borehole 1. Very easy drilling with minor air loss was however encountered within the shale zone at between 32.0m and 34.0m and 32m to 37m in Boreholes 3 and 5 respectively.

In summary, the work in this study has added to our knowledge of the site. The essentially granular 'more pliable' alluvial soil cover, that ranges between 16.0m and 27.0m thick in the area tested, should be beneficial and dampen any potential subsidence effects. The soil cover is however expected to decrease to less than 16.0m in the northern area beyond the projection of the end of River Road, whereas the upper sandstone is also indicated to increase in thickness in the same direction. The loss of potential benefits due to the reduced soil cover in the northern area is therefore expected to be offset to some extent by the benefit of the expected increasing thickness of strong sandstone roof cover in that area. The plan attached to our initial report (ref. 2005/29 of 12th May 2005) indicated that the tunnel entry of the Pioneer Mine dipped at 20 degrees in an easterly direction. On the basis of a 20 degree dip angle and an allowance for the rising topography from the tunnel entry, then

the seam should have been intersected at approximately 35m depth at the location of Borehole 3. The nearby B2 high priority anomaly in addition anticipated possible mine workings at 27m. Coal or voids were however not recorded to 42.0m depth, whereas very easy drilling with minor air loss was recorded within the shale in the 32.0m to 34.0m depth range, i.e. at a similar depth below the upper sandstone as the void recorded in Borehole 1. The drilling therefore indicates that the coal was either pillar-extracted and the more pliable shale roof rock has subsided to some greater extent or that the coal seam has deteriorated into a shale bed. The coal seam, on the basis of an assumed 20 degree dip from the recorded level in Borehole 1, should also occur at approximately 57m at the location of Borehole 4, i.e. below the sandstone in which the drilling was terminated at 53m. A less steep dip angle would by comparison have resulted in the coal seam or workings being recorded in the depth range drilled. Available information on balance therefore indicates that the beds dip to the east, south east at about 20 degrees rather than the less steep 10 degrees that was anticipated. The coal seam of interest is therefore expected to occur at approximately 25 - 30m depth adjacent to the top of the river bank with the deeper part of the seam to the north and the shallow part of the seam to the south. The seam, or the projection of the seam, is also expected to occur at approximately 90m below ground level along the eastern side of the site.

The journalist's 1884 inspection (previously reported on) indicated that since the opening of the mine (three tunnels in 1884) the tunnels had been quickly extended to between 90m and 120m from the bank, also that the lower of two seams was worked, and that the 1.5m thick worked seam had shrunk ominously to less than 1.0m in thickness. Based on the findings of this report, a tunnel length of 120m would result in a cover depth of approximately 45m. Mining under this site is therefore known to have extended to at least 120m from the tunnel entries with a resultant maximum cover depth of about 45m. The "ominous" reduction in seam thickness however indicates that the mining either did not extend much further or that it was of a progressively reducing height.

The assessment of potential subsidence impacts on this site is complicated by the lack of any mine plans, the large area investigated and the relative paucity of information obtained in the work carried out to date. Assumptions have therefore had to be made in relation to the average void height, extraction ratios, whether or not subsidence has already occurred etc. Average maximum potential subsidence effects of 3mm/m (strain), 4.5mm/m

(compression) and ground tilts in the order of 1 in 40 are however indicated to be possible adjacent to the top of the river bank. The alluvial cover is expected to provide some dampening effect on these potential values. Nonetheless, these potential surface impacts will require that the lot sizes be kept small and that buildings with maximum flexibility (portal frame steel sheet cladding type buildings) be constructed to minimise the risk of any subsidence damage in this area. This option assumes that the portal frames be levelled if or when required, that flat or waffle raft type slabs are used and that replacing or resurfacing of the slabs can be accepted in the main. If necessary, and that flexible connections are installed where all buildings meet with the structures. Buried services in this area should in general be made as flexible as possible. Buried electricity lines could be 'snaked' in PVC pipes. Flexible poly type pipe 'snaking' up trenches could be used in place of PVC pipes etc. Buried gas lines are not recommended in this area as well as generally across the site.

Compaction

The potential surface subsidence impacts are expected to reduce progressively to the east due to the expected increasing thickness of alluvial soils, the increasing depth of the coal seam and the rapid thinning of the coal seam in that direction.

In conclusion, the work in this report has confirmed that mining, including probable localised pillar extraction, has extended eastwards of the top of the river bank for a distance of at least approximately 70m where a maximum cover depth in the order of 45m exists. The 45m cover line is shown on the attached borehole plan in an attempt to rationalise the conditions on this site. Lots in the order of 1000 m² and flexible portal frame type buildings, as discussed above, are only recommended to the west (river side) of the 45m cover line. A river bank setback line will in any case also be required north of about Borehole 2 to cater for natural river bank instability, old rubbish previously thrown over the bank and subsidence ground cracks and voids. By comparison, larger lots in the order of 2000 m² and tilt-up panel construction with mezzanine floors is considered acceptable to the east of the 45m cover line. Flat or waffle slab construction and other details recommended above are however also considered necessary to the east of the 45m cover line to minimise potential subsidence impacts. The previously recommended Stage 3 investigation (investigation of the known shafts using an excavator) will still need to be carried out to establish the precise locations and extent to which formal concrete cappings are required. Finally, all other recommendations previously provided, as applicable, still stand.

5.0 LIMITATIONS

This report, which may contain attachments in the form of plans, borehole record sheets, laboratory test results etc, must be read in its entirety.

The work in this report was produced for Chai Law Practice and their Associates on the basis of information available at the time of writing. This report will not contain sufficient information for other parties and purposes.

While care has been taken in producing this report, it needs to be said that there will always be some risk associated with developing in these settings. This is more so on this site where undocumented underground mining has occurred and where the surface has experienced multiple past land uses over an extended period of time. Recommendations put forward in this report are aimed at minimising the risk.

This company accepts no responsibility for works which do not fully comply with the recommendations in this report.

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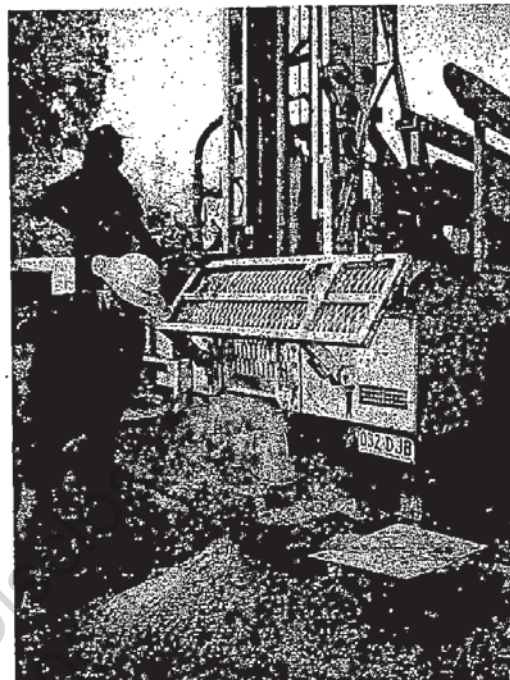
Email mgs@gil.com.au

A.C.N. 055 833 120

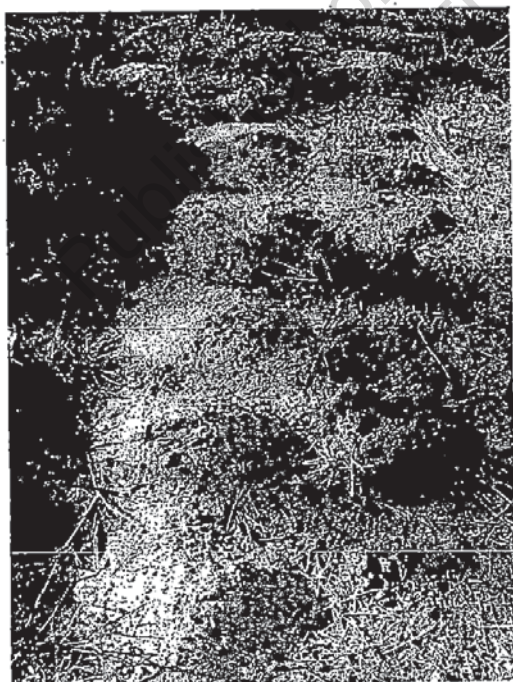
A.B.N. 24 055 833 120



BOREHOLE 4



BOREHOLE 4



SAMPLES FROM BOREHOLE 1



BOREHOLE 3