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PEMBROKE

Olive Downs Coking Coal Project

Draft Environmental Impact Statement

Appendix D

Groundwater Assessment

Olive Downs Coking Coal Project

Groundwater Assessment

FOR

Pembroke Olive Downs Pty Ltd

BY

NPM Technical Pty Ltd
trading as
HydroSimulations

Project number: PEM002

Report: HS2018/26

Date: July 2018

DOCUMENT REGISTER

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A	Stage 1 Report	9 February 2018	Draft to Pembroke, Resource Strategies
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TABLE OF CONTENTS

LIST OF TABLES

FIGURES

APPENDICES

1 INTRODUCTION

HydroSimulations has been engaged by Pembroke Olive Downs Pty Ltd (Pembroke) to undertake a Groundwater Assessment for the proposed Olive Downs Coking Coal Project (the Project), for incorporation into a broader Environmental Impact Statement (EIS).

The proposed Project is an open cut coal mine in the northern Bowen Basin, Central Queensland. The Project is located approximately 170 kilometres (km) southwest of Mackay, 40 km southeast of the township of Moranbah and 40 km north of Dysart (**Figure 1-1**). The Project is located within the Isaac Regional Council Local Government Area.

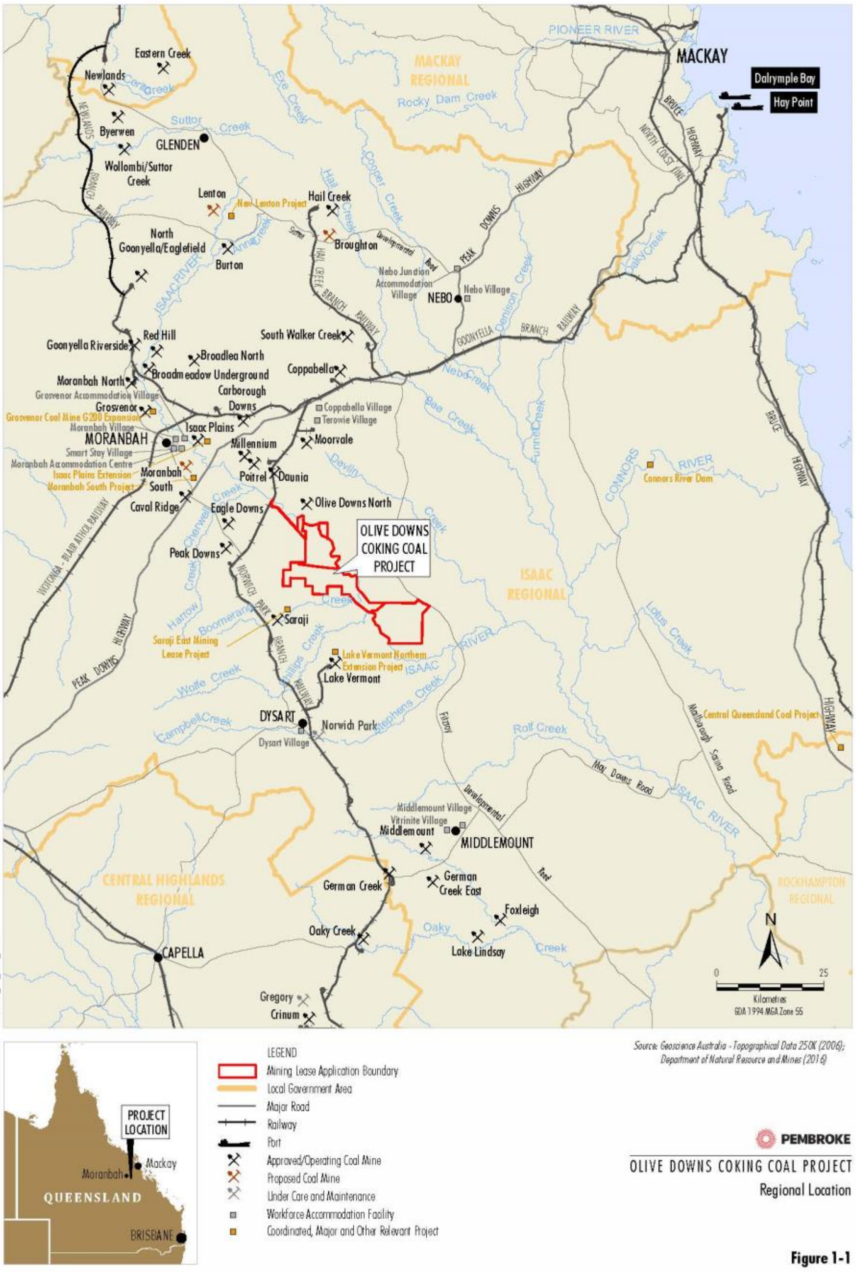

Figure 1-1 Project Location and Study Area

1.1 OLIVE DOWNS COKING COAL PROJECT PROPOSED MINING OPERATIONS

The Project will consist of a series of open cut pits exploiting the Rangal Coal Measures (targeting the Leichhardt and Vermont seams) to extract up to 20 million tonnes (Mt) of metallurgical coal over a mine life of approximately 79 years (commencing approximately in 2020 or upon grant of all required approvals). Based on the planned maximum production rate, approximately 400 million tonnes (Mt) of product coal would be produced during the life of the Project.

The Project is comprised of Mineral Development Licences (MDLs) covering approximately 25,300 hectares (**Figure 1-2**). The Project is divided into three Mining Lease Application areas (MLAs):

- MLA 700032 - Olive Downs South (ODS) domain – northern.
- MLA 700033 - Olive Downs South (ODS) domain – southern.
- MLA 700034 – Willunga domain.

Located west to south-west of the Project are existing mine operations, Peak Downs, Saraji and Lake Vermont. Located immediately to the north of the Project is the approved Olive Downs North project (ML 70354), Daunia Mine, Poitrel Mine and Moorvale Mine. Construction of infrastructure at Olive Downs North commenced in 2017, with operations commencing in 2018 (subject to the approval of the CMJV minority parties).

No underground mining operations are proposed as part of the Project. Therefore, surface subsidence caused by underground goafing would not occur. Any residual subsidence associated with dewatering and depressurisation of groundwater from the surrounding formations at the Project site (i.e. deep Permian coal measures) and to a far lesser extent in the overlying Quaternary, Tertiary and Triassic formations would be negligible and immeasurable for off-site open cut effects.

Throughout this report, the terms “the Project” and “Study Area” are used as defined by:

- The Project (Site) is equivalent to the area incorporated by the MLA 700032, MLA 700033 and MLA 700034 boundaries.
- The Study Area is the regional area surrounding the Project considered in detail within this assessment, as shown in **Figure 1-1**, and is synonymous with the groundwater model boundary. The selection of this boundary is discussed in **Section 6**.

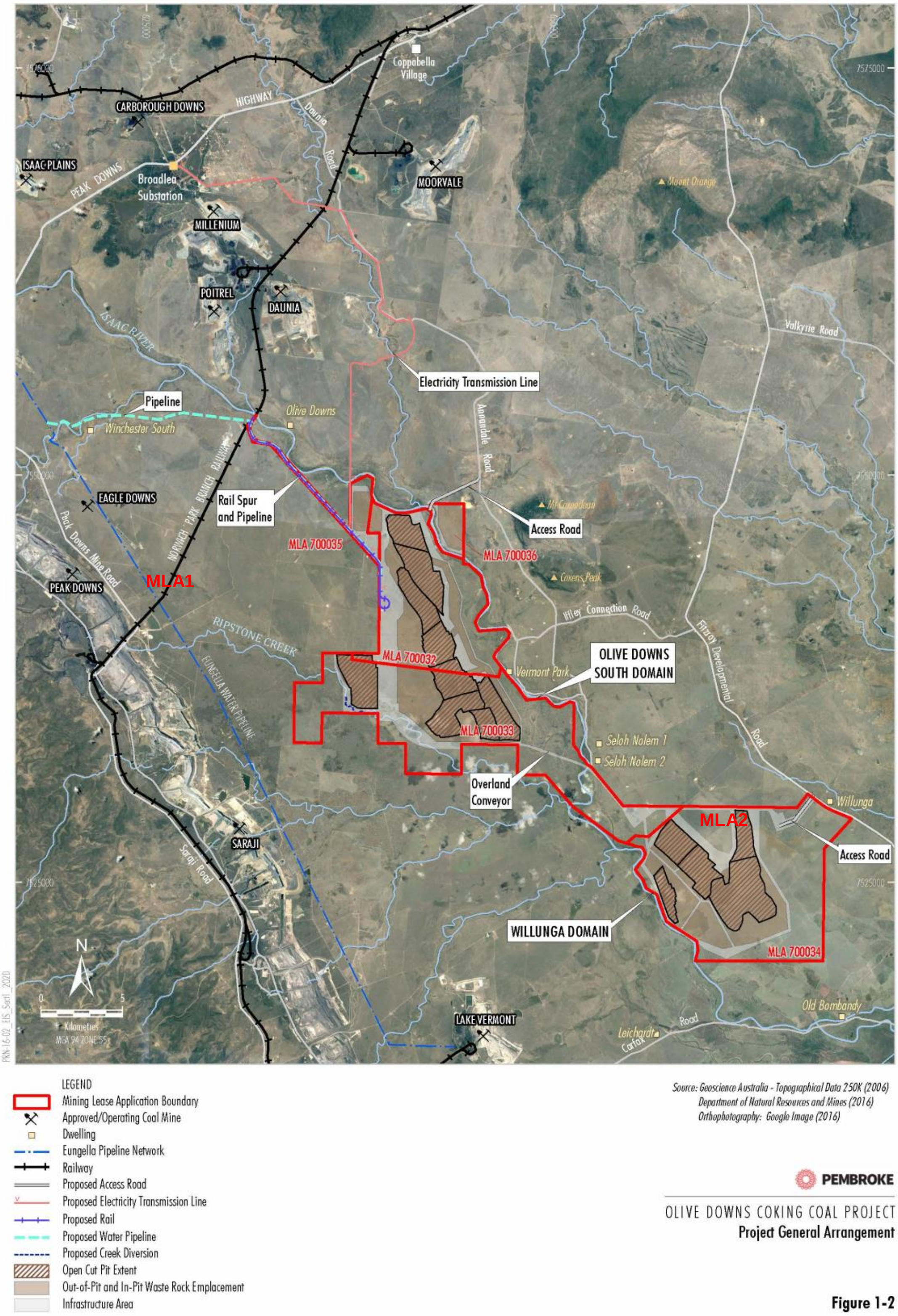

Figure 1-2 Project General Arrangement

1.2 PROJECT DESIGN

The Project is a proposed greenfield open cut coal mine within the Bowen Basin. The coal resource would be mined by conventional open cut mining (e.g. excavators, dozers, front end loaders and trucks) and strip mining methods. Associated Project linear infrastructure corridors include an 18 km rail spur connecting to the Norwich Park Branch Railway, a water pipeline connecting to the Eungella pipeline network, an electricity transmission line (ETL) and access roads. Product coal would be transported by rail to the Dalrymple Bay Coal Terminal. A map showing the location of the Project ODS Domain, open cut pits, waste rock emplacement areas and associated infrastructure is presented in **Figure 1-3**.

The Project involves activities and infrastructure relevant to this groundwater assessment, including:

- Two box-cuts and two open cut pits to be mined down to the Vermont Upper Seam of the Rangal Coal Measures.
- Out of pit and in pit waste rock emplacement areas.
- On-site run-of-mine (ROM) coal handling and crushing facilities at both mine domains.
- Coal Handling and Processing Plant (CHPP) at the ODS domain.
- Out-of-pit rejects emplacement area.
- In-pit rejects containment facilities (i.e. mine voids).
- Progressive development of sediment dams and water storage dams, pumps, pipelines etc.
- Diversion of Ripstone Creek and surface water releases (in accordance with relevant principles and conditions of the Final Model Water Conditions for Coal Mines in the Fitzroy Basin (Department of Environment and Heritage Protection [DEHP], 2013).
- Flood levee along the Isaac River.
- Wastewater and sewage treatment by package sewage treatment plants.
- Other associated infrastructure, including site offices, crib facilities, bathhouse, stores/warehouse, workshops and re-fuelling facilities (including diesel storage), power lines and back-up power generator, and communication facilities; and
- Post–closure rehabilitated final landform with three final voids.

The Project is proposed to progress over seven stages that run for approximately 10 years each (**Table 1-1**). Further details on the proposed timing of the mine plan is included in **Appendix B**. The Project is a greenfield venture, with limited previous work completed beyond exploration activities prior to the hand-over to Pembroke in May 2016. A Pre-Feasibility Study was carried out by Peabody Energy. To the best of HydroSimulations' understanding, no groundwater monitoring or modelling was conducted during this study. Investigation for potential water supply for the operation indicates connection to the Eungella Pipeline would provide water to the site. Water harvesting from the Isaac River would be used to supplement water supply. Groundwater was deemed as unlikely to be an economical water supply source due the low yielding nature of the geology at site, with no connection to the Great Artesian Basin.

Table 1-1 Olive Downs Coking Coal Project Stages

Project Stage	Year	Waste Rock (Mbcm)
Stage 1	2020-2030	12.2 – 116.3
Stage 2	2031-2040	189.0 – 297.2
Stage 3	2041-2050	199.3 – 298.3
Stage 4	2051-2060	123.0 – 148.6
Stage 5	2061-2072	48.9 – 115.2
Stage 6	2073-2085	47.5 – 49.3
Stage 7	2086-2098	6.3 – 19.4

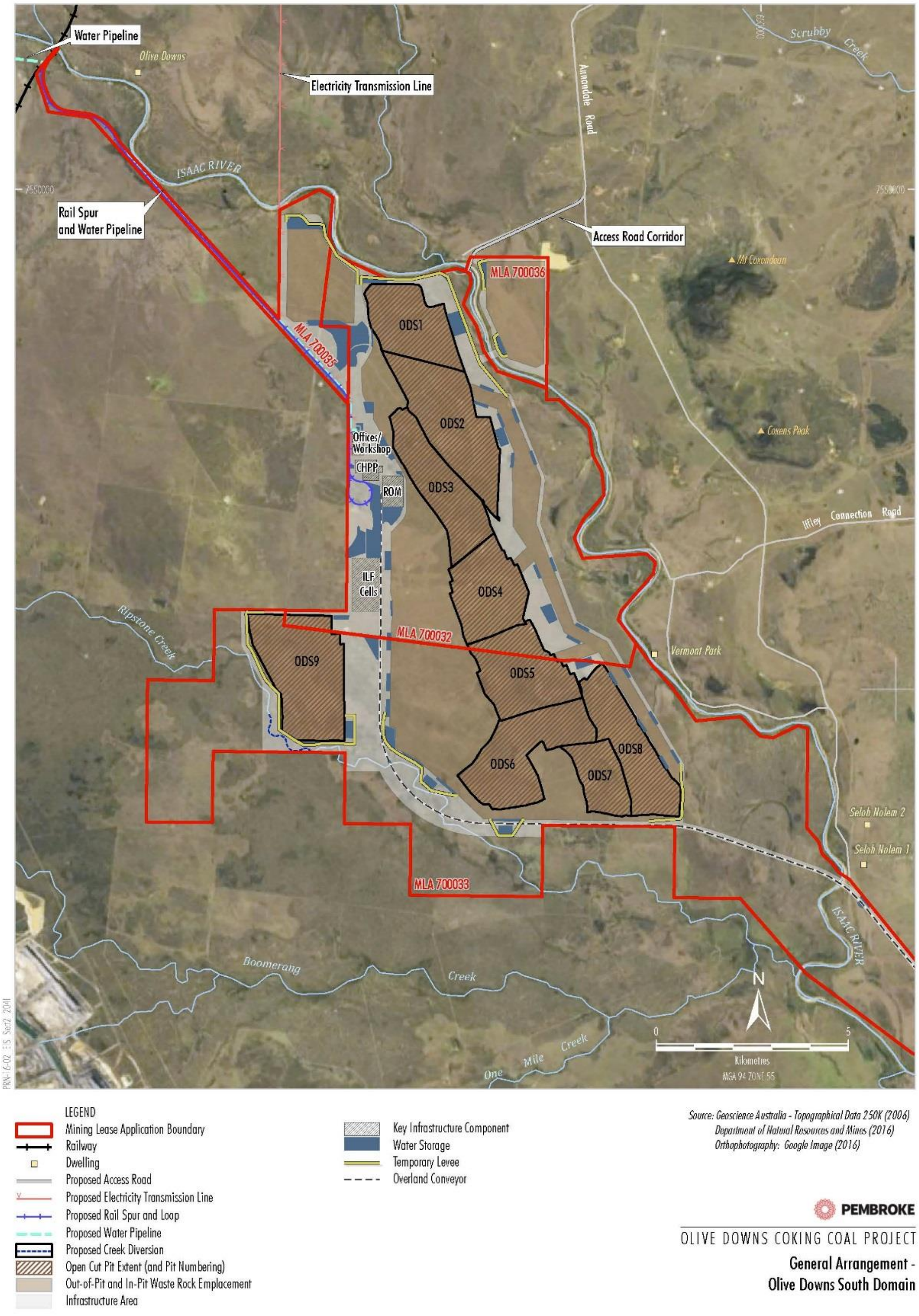

Figure 1-3 Proposed Project Layout – ODS Domain

1.3 OBJECTIVES

The groundwater assessment was undertaken in accordance with the Queensland government requirements and the *Commonwealth Environment Protection and Biodiversity Conservation (EPBC Act) 1999*, (Water Trigger). The groundwater assessment comprised two parts: (i) a description of the existing hydrogeological environment; and (ii) an assessment of the impacts of mining on that environment. To this end, the stated scope of work was to:

- Review of relevant groundwater, geotechnical and environmental reports to characterise the geological and hydrogeological setting of the Project.
- Review of publicly available hydrogeological data such as The Queensland Government's spatial data system (Queensland Globe) and The Bureau of Meteorology's (BoM) National Groundwater Information System (NGIS) (BoM, 2018c).
- Review of the existing census of groundwater supply bores in the area to confirm locations, usage and groundwater quality.
- Characterisation of the existing groundwater resources, including properties and quality.
- Conceptualisation of the groundwater regime of the Project Site and Study Area.
- Assessment on the potential interaction between the Isaac River alluvium and the Project;
- Construction and calibration of a numerical groundwater flow model suitable for assessment of potential impacts of the Project, in accordance with the Australian Groundwater Modelling Guidelines (Barnett *et al.*, 2012) and Murray Darling Basin Commission guidelines (Middlemis *et al.*, 2000).
- Predictive modelling of the scale and extent of mining impacts upon groundwater levels, groundwater quality and groundwater users at various stages during mine operations and post closure.
- Modelling of cumulative impacts of Project, surrounding mines and the Bowen Gas Project.
- Assessment of the extent of groundwater impacts as a result of the operation of the proposed mine, including long term impacts on regional groundwater levels and water quality impacts on environmental flows and baseflows.
- Assessment of potential groundwater dependant ecosystem (GDE) impacts resulting from short and/or long-term changes in the quantity and quality of groundwater.
- Assessment of the potential third party impacts (i.e. private bores) as a result of changes to the regional groundwater system.
- Development of feasible mitigation and management strategies where potential adverse impacts are identified.
- Development of a groundwater monitoring program and mitigation measures.

2 REGULATORY FRAMEWORK

The following sections summarise Commonwealth and Queensland Governments' groundwater legislation and policies relevant to the Project.

2.1 QUEENSLAND REGULATORY FRAMEWORK

2.1.1 WATER REGULATION

The *Queensland Water Act 2000* (Water Act), supported by the subordinate *Water Regulation 2016*, is the primary legislation regulating groundwater resources in Queensland. The purpose of the Water Act is to advance sustainable management and efficient use of water resources by establishing a system for planning, allocation and use of water. The Water Act is enacted under a framework of catchment specific Water Plans (WPs). Water resources within the Project area are captured under the Water Plan (Fitzroy Basin) 2011, which was current as at 2 September 2017. The plan covers surface water (zone WQ1301) associated with Isaac River, and groundwaters (zone WQ1310 – Fitzroy Basin groundwaters).

As part of the Project, Pembroke is proposing to exercise underground water rights during the period in which resource activities will be carried out at MLA 700032, MLA 700033 and MLA 700034. This will affect groundwater within the Isaac Connors Groundwater Management Area (GMA – Zone 34) of the Fitzroy Basin under the Water Plan (Fitzroy Basin) 2011. This relates to both Groundwater Unit 1 (containing aquifers of the Quaternary alluvium) and Groundwater Unit 2 (sub-artesian aquifers) as shown in **Figure 2-1**. The extent of Groundwater Unit 1 (Isaac Connors Alluvium Groundwater Sub-area) is based on the mapped extent of Quaternary alluvium, which is mapped within the Project footprint. As discussed further in **Section 4.2**, the extent of alluvium has been refined based on site specific information.

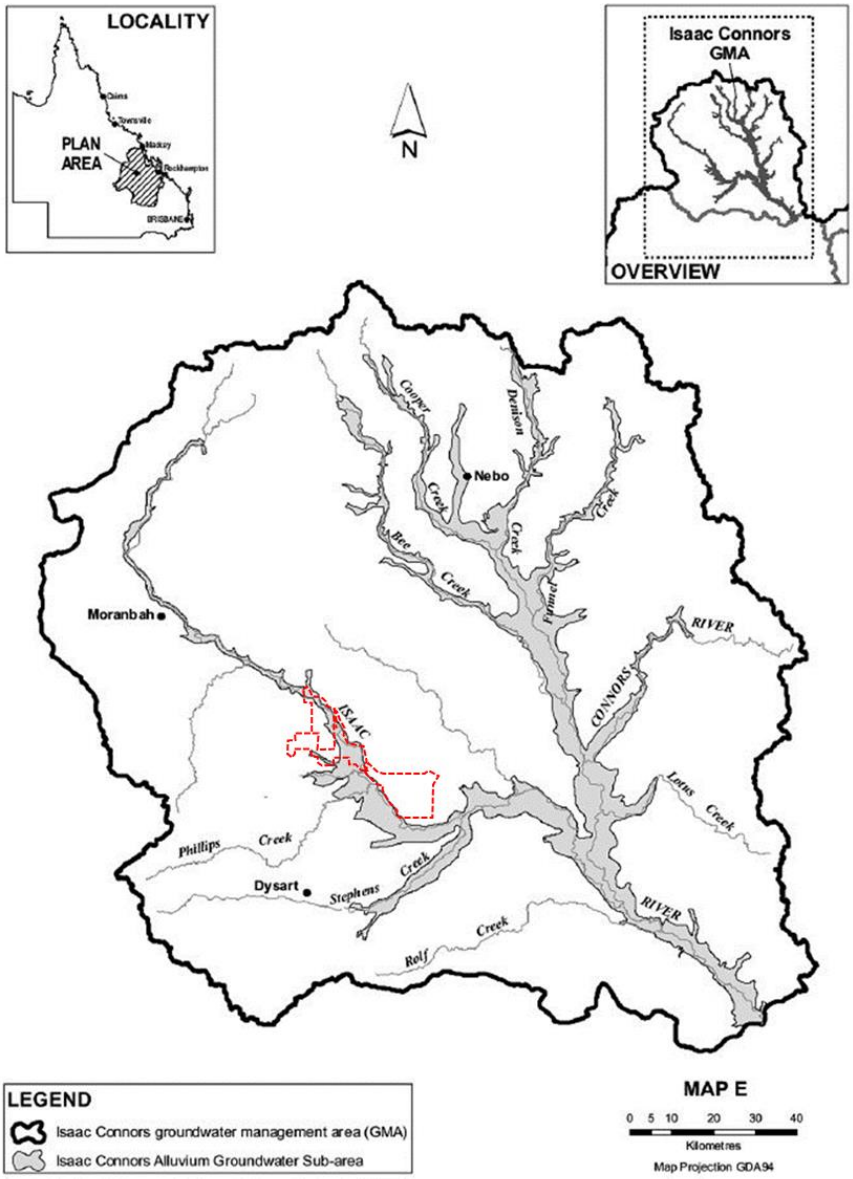

Figure 2-1 Location of the Project within the Isaac Connors GMA (Water Plan (Fitzroy Basin), Map E)

2.1.2 ENVIRONMENTAL AUTHORITY

Under the *Environmental Protection Act 1994* (EP Act), an EIS assessment is required as part of the application for Environmental Authority (EA) to undertake an environmentally relevant activity. The EIS process assesses the potential environmental impact of the Project, and how impacts should be avoided, minimised and managed. The EIS also informs subsequent approval decisions under the EP Act and other relevant legislation. The Department of Environment and Science (DES) is responsible for the administration and delivery of EIS assessments.

In accordance with the EP Act, Project specific Terms of Reference (TOR) were issued by the Department of State Development in June 2017. Groundwater specific items are presented in **Table 2-1**, along with details on where the item has been addressed within the report.

In addition, minimum reporting requirements for groundwater impact assessments are outlined within the EP Act Guideline *Requirements for site-specific and amendment applications – underground water rights*. A summary of the guideline requirements and where they have been addressed within this report is provided in **Table 2-2**.

Table 2-1 Olive Downs Terms of Reference

SECTION IN TOR	DETAIL	SECTION IN REPORT
11.23	The National Partnership Agreement on Coal Seam Gas and Large Coal Mining, to which Queensland is a signatory, specifies that all coal seam gas and large coal mining proposals that are likely to have a significant impact on water resources are to be referred to the Independent Expert Scientific Committee (IESC) for advice.	Project referred to IESC
11.24	In relation to the proposed mine and access road (EPBC 2017/7867), the EIS must provide details on the current state of groundwater and surface water in the region as well as any use of these resources.	Groundwater captured under Section 5
11.25	The EIS must describe and assess the impacts to water resources giving consideration to the Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments – impacts on water resources.	Section 7
11.26	The EIS must address the information requirements contained in the Information Guidelines for the Independent Expert Scientific Committee advice on coal seam gas and large coal mining development proposals and provide a cross-reference table to identify where each component of the guidelines has been addressed.	Appendix A
11.61	The assessment of impacts on water will be in accordance with DEHP application requirements for activities with impacts to water.	Section 6 and Section 7
11.62	Detail the chemical and physical characteristics of surface waters and groundwater within the area that may be affected by the project.	Groundwater captured under Section 5
11.63	In accordance with section 126A of the Environmental Protection Act 1994 state how any proposed exercise of underground water rights for the life of the project would be carried out on site and describe the aquifers affected or likely to be affected.	Section 6 and Section 7
11.64	Identify the quantity, quality and location of all potential discharges of water and waste water by the project, whether as point sources (such as controlled discharges from regulated dams) or diffuse sources (such as seepage from waste rock dumps or irrigation to land of treated sewage effluent). Assess the potential impacts of any discharges on the quality and quantity of receiving waters taking into consideration the assimilative capacity of the receiving environment and the practices and procedures that would be used to avoid or minimise impacts.	Section 6 and Section 7
11.65	Demonstrate how the implementation of mitigation strategies would mitigate significant impacts of water discharges on the receiving environment. Information should be supported with references to relevant legislation, policies, guidelines and modelling.	Section 8
11.66	Describe how the achievement of the objectives would be monitored and audited, and how corrective actions would be managed.	Section 8
11.67	Describe the quality, quantity and significance of groundwater in the project area and any surrounding area potentially affected by the projects activities, in accordance with the Department of Environment and Heritage Protection's TOR guideline – Water,	Groundwater captured under Section 5
11.68	Provide details of any proposed impoundment, extraction, discharge, injection, use or loss of surface water or groundwater. Identify any approval or allocation that would be needed under the *Water Act 2000*.	Section 6 and Section 7
11.69	Detail any significant diversion or interception of overland flow including an assessment of impacts in accordance with the DNRM Guideline on Watercourse Diversions and include consideration of the alternatives. Include maps of suitable scale showing the location of diversions and other water-related infrastructure in relation to mining infrastructure.	See surface water assessment.

SECTION IN TOR	DETAIL	SECTION IN REPORT
11.70	Describe the options for supplying water to the project, and assess any potential consequential impacts in relation to the objectives of the Water Resource (Fitzroy Basin) Plan 2011 and any resource operations plan that may apply.	Section 7
11.71	Identify any quantitative standards and indicators which will be used to describe the ecological values and health of surface water environments.	See surface water assessment
11.72	Develop hydrological models as necessary to describe the inputs, movements, exchanges and outputs of all significant quantities and resources of surface water and groundwater that may be affected by the project. The models should address the range of climatic conditions that may be experienced at the site, and adequately assess the potential impacts of the project on water resources including to the post-decommissioning phase. The models should include a site water balance. This should enable a description of the project's impacts at the local scale and in a regional context including proposed: a) changes in flow regimes from diversions, water take and discharges b) alterations to riparian vegetation and bank and channel morphology c) direct and indirect impacts arising from the development.	Groundwater model described in Appendix B
11.73	Describe the groundwater impact of water evaporation from mined out areas and its impact on local regional groundwater, including long term equilibrium rates of groundwater losses through pit evaporation and equilibrium contaminant and salt transport rates from the pit into groundwater. List the primary contaminants mobilised. The groundwater model should be peer reviewed.	Section 6 and Section 7 Peer review included in Appendix C
11.74	Provide details of the management strategies for mine-affected water for the life of the project to demonstrate minimisation of any impacts to land and waters, in particular off-site.	Section 8

Table 2-2 Requirements for Site-Specific and Amendment Applications – Underground Water Rights

	DETAIL	SECTION IN REPORT
Part A	A statement that the applicant proposes to exercise underground water rights.	Section 2
Part B	A description of the area/s in which underground water rights are proposed to be exercised.	Section 1
Part C	A description of the aquifer/s affected or likely to be affected.	
	• Aquifer type (confined, unconfined, fractured etc)	Section 5.3
	• Geology/ stratigraphy for each aquifer	Section 4
	• Depth to and thickness of the aquifers	Section 4
	• Physical integrity of the aquifer, fluvial processes and morphology	Section 5
	• Depth to water level and seasonal changes in levels	Section 5 and Appendix A
	• Hydrogeological cross sections	Section 5.7
	• Maps (spatial extent)	Section 4 and Section 5.3
Part D	An analysis of the movement of underground water to and from the aquifer.	

	DETAIL	SECTION IN REPORT
	• Inputs (i.e. recharge) and outputs (i.e. baseflow and abstraction)	Section 5.3
	• Underground water elevations (i.e. mapped groundwater flow directions)	Section 5.3
	• Connectivity between aquifers and hydraulic properties	Section 5.2
	• Preferential flow pathways (i.e. faults)	Section 5.3
	• Springs	Section 5.6
Part E	A description of the area of the aquifer where the water level is predicted to decline because of the exercise of underground water rights. Predictions should • Be made for the life of the resource project and for post resource tenure closure • Be made about the timing, spatial extent and magnitude of maximum water level declines in affected aquifers • Be made about the timing and magnitude of groundwater level equilibrium in affected aquifers Produce potentiometric contour maps showing maximum predicted water level decline for each affected aquifer. Modelling methodology, including: • Model type (e.g. numerical or analytical) • Modelling platform • Model inputs • Model boundary conditions • Model assumptions and limitations • Sensitivity analysis and calibration results	Appendix B
Part F	The predicted quantities of water to be taken or interfered with because of the exercise of underground water rights	Section 6 and Section 7
	Details on the methodology used for measuring extraction volumes and developing the extraction schedule.	Appendix B
Part G	Information on predicted impacts to the quality of groundwater that will, or may, happen because of the exercise of underground water rights.	Section 7
	Identify the quality of the groundwater prior to the resource activity commencing.	Section 5.4
	Explain the variation of chemical concentrations as a result of chemical reactions over the life of the project due to the exercise of underground water rights (i.e. changes in salinity and concentration of dissolved gas)	Section 5.4.4 and Section 7
	Estimate extent and likelihood of groundwater quality impacts, with justification based on potential sources of contamination.	Section 7
Part H	Identifying and describing environmental values • Information on the environmental values that will, or may, be affected by the exercise of underground water rights • Describe and define environmental value of aquifers, presenting available raw data used Document groundwater use, including details on operating bores within the areas predicted to be affected by the exercise of underground water rights.	Section 5 and Appendix A

	DETAIL	SECTION IN REPORT
	Nature and extent of the impacts on the environmental values (risk assessment): • The magnitude, relative size or actual extent of any impact in relation to the environmental value being affected • The vulnerability or resilience of the environmental value (severity and duration) Uncertainty of impacts and any assumptions	Uncertainty analysis within Appendix B
	Surface subsidence impacts.	Section 1.1
Part I	Information on strategies for avoiding, mitigating or managing the predicted impacts on the environmental values or predicted impacts on the quality of groundwater. Strategies for avoiding, mitigating and managing the predicted impacts on both environmental values and predicted changes in groundwater quality should include: • Objectives which define the outcomes that are intended to be achieved (i.e. avoiding, mitigating and managing the predicted impacts) and a description of unavoidable impacts to environmental values • Measures (specific methods/procedures/tools) to be implemented to demonstrate how the objectives will be achieved • Indicators relevant to protection of the environmental values (i.e. indicators are the values that are to be measured to gauge whether the objectives are being achieved and are used to are to be used in auditing the performance of measures) • A program for monitoring the indicators (see EP Act Guideline for requirements) • A reporting program which includes triggers for the review of the strategies, and identifies additional data, assessment, analysis and reporting requirements	Section 8

2.2 COMMONWEALTH

The EPBC Act is administered by the Department of the Environment and Energy (DoEE). The EPBC Act is designed to protect national environmental assets, known as Matters of National Environmental Significance (MNES). Under the 2013 amendment to the EPBC Act, impacts on groundwater resources were included, and are known as the ‘water trigger’.

The Project has been declared a Controlled Action by the DoEE, with water resources being one of the controlling provisions. Due to the Bilateral Agreement between the Commonwealth of Australia and the State of Queensland (2004), only one impact assessment is required. However, the impact assessment is reviewed separately by the State and Commonwealth. The Independent Expert Scientific Committee (IESC) is a statutory body under the EPBC Act that provides scientific advice to the Commonwealth Environment Minister and relevant state ministers. Guidelines have been developed in order to assist the IESC in reviewing coal seam gas (CSG) or large coal mining development proposals that are likely to have significant impacts on water resources. This includes completion of an independent peer review of numerical groundwater modelling in accordance with the Australian Groundwater Modelling Guidelines (Barnett *et al.* 2012). The IESC information requirements checklist is presented in **Table 2-3**, with details on where aspects have been addressed and documented within the report.

Table 2-3 IESC Information Requirements Checklist

	Specific Information Needs	Section Addressed
	Description of the Proposal	
	Provide a regional overview of the proposed project area including a description of the: • *geological basin;* • *coal resource;* • *surface water catchments;* • *groundwater systems;* • *water-dependent assets; and* • *past, present and reasonably foreseeable coal mining and CSG developments.*	Sections 1.2, 3.2, 3.3, 4.1 and 5.7
	Describe the statutory context, including information on the proposal's status within the regulatory assessment process and any applicable water management policies or regulations.	Sections 1 and 2
	Describe the proposal's location, purpose, scale, duration, disturbance area, and the means by which it is likely to have a significant impact on water resources and water-dependent assets.	Sections 1 and 2
	Describe how impacted water resources are currently being regulated under state or Commonwealth law, including whether there are any applicable standard conditions.	Sections 1 and 2
	Risk Assessment	
	Identify and assess all potential environmental risks to water resources and water-related assets, and their possible impacts. In selecting a risk assessment approach consideration should be given to the complexity of the project, and the probability and potential consequences of risks.	Section 7 and Appendix B
	Assess risks following the implementation of any proposed mitigation and management options to determine if these will reduce risks to an acceptable level based on the identified environmental objectives.	Section 7 and Appendix B
	Incorporate causal mechanisms and pathways identified in the risk assessment in conceptual and numerical modelling. Use the results of these models to update the risk assessment.	Section 7 and Appendix B
	The risk assessment should include an assessment of: • *all potential cumulative impacts which could affect water resources and water-related assets; and* • *mitigation and management options which the proponent could implement to reduce these impacts.*	Section 7 and Appendix B
	Groundwater – Context and Conceptualisation	
	Describe and map geology at an appropriate level of horizontal and vertical resolution including: • *definition of the geological sequence(s) in the area, with names and descriptions of the formations and accompanying surface geology, cross-sections and any relevant field data.* • *geological maps appropriately annotated with symbols that denote fault type, throw and the parts of sequences the faults intersect or displace.*	Sections 4.1 and 4.2
	Define and describe or characterise significant geological structures (e.g. faults, folds, intrusives) and associated fracturing in the area and their influence on groundwater – particularly groundwater flow, discharge or recharge. • *Site-specific studies (e.g. geophysical, coring / wireline logging etc.) should give consideration to characterising and detailing the local stress regime and fault structure (e.g. damage zone size, open/closed along fault plane, presence of clay/shale smear, fault jogs or splays).* • *Discussion on how this fits into the fault's potential influence on regional-scale groundwater conditions should also be included.*	Sections 4, 5.2 and 5.3
	Provide site-specific values for hydraulic parameters (e.g. vertical and horizontal hydraulic conductivity and specific yield or specific storage characteristics including the data from which these parameters were derived) for each relevant hydrogeological unit. In situ observations of these parameters should be sufficient to characterise the heterogeneity of these properties for modelling.	Sections 5.2 and 5.3
	Provide time series level and water quality data representative of seasonal and climatic cycles.	Section 5.4
	Provide data to demonstrate the varying depths to the hydrogeological units and associated standing water levels or potentiometric heads, including direction of groundwater flow, contour maps, and hydrographs. All boreholes used to provide this data should have been surveyed.	Sections 4.2 and 5.2 and Appendix A
	Provide hydrochemical (e.g. acidity/alkalinity, electrical conductivity, metals, and major ions) and environmental tracer (e.g. stable isotopes of water, tritium, helium, strontium isotopes, etc.) characterisation to identify sources of water, recharge rates, transit times in aquifers, connectivity between geological units and groundwater discharge locations.	Section 5.4
	Describe the likely recharge, discharge and flow pathways for all hydrogeological units likely to be impacted by the proposed development.	Sections 5.2 and 5.3

	Specific Information Needs	Section Addressed
	Assess the frequency (and time lags if any), location, volume and direction of interactions between water resources, including surface water/groundwater connectivity, inter-aquifer connectivity and connectivity with sea water.	Sections 5.2 and 5.3
	Groundwater – Analytical and Numerical Modelling	
	Provide a detailed description of all analytical and/or numerical models used, and any methods and evidence (e.g. expert opinion, analogue sites) employed in addition to modelling.	Section 6.1 and Section 2 of Appendix B
	Undertake groundwater modelling in accordance with the Australian Groundwater Modelling Guidelines (Barnett et al. 2012), including independent peer review.	Section 6.1, Appendix B and Attachment 4 of EIS
	Calibrate models with adequate monitoring data, ideally with calibration targets related to model prediction (e.g. use baseflow calibration targets where predicting changes to baseflow).	Section 6.1 and Appendix B
	Describe each hydrogeological unit as incorporated in the groundwater model, including the thickness, storage and hydraulic characteristics, and linkages between units, if any.	Sections 5 and 6 and Section 2 of Appendix B
	Describe the existing recharge/discharge pathways of the units and the changes that are predicted to occur upon commencement, throughout, and after completion of the proposed project.	Sections 5.3, 6.4, 7.2, 7.3 and 7.4
	Describe the various stages of the proposed project (construction, operation and rehabilitation) and their incorporation into the groundwater model. Provide predictions of water level and/or pressure declines and recovery in each hydrogeological unit for the life of the project and beyond, including surface contour maps for all hydrogeological units.	Sections 6.2, 6.3, 6.4 and 6.5
	Identify the volumes of water predicted to be taken annually with an indication of the proportion supplied from each hydrogeological unit.	Section 6.2
	Undertake model verification with past and/or existing site monitoring data.	Appendix B
	Provide an explanation of the model conceptualisation of the hydrogeological system or systems, including multiple conceptual models if appropriate. Key assumptions and model limitations and any consequences should also be described.	Sections 5.7 and 6.1 and Section 6 of Appendix B
	Consider a variety of boundary conditions across the model domain, including constant head or general head boundaries, river cells and drains, to enable a comparison of groundwater model outputs to seasonal field observations.	Section 2.4 of Appendix B
	Undertake sensitivity analysis and uncertainty analysis of boundary conditions and hydraulic and storage parameters, and justify the conditions applied in the final groundwater model (see Middlemis and Peeters [in press]).	Sections 5 and 6 of Appendix B
	Provide an assessment of the quality of, and risks and uncertainty inherent in, the data used to establish baseline conditions and in modelling, particularly with respect to predicted potential impact scenarios.	Section 6 of Appendix B
	Undertake an uncertainty analysis of model construction, data, conceptualisation and predictions (see Middlemis and Peeters [in press]).	Appendix B
	Provide a program for review and update of models as more data and information become available, including reporting requirements.	Section 8.2
	Provide information on the magnitude and time for maximum drawdown and post-development drawdown equilibrium to be reached.	Sections 6.3, 6.4, 6.5 and 6.6

Specific Information Needs	Section Addressed
Groundwater – Impacts to Water Resources and Water-dependent Assets	
Provide an assessment of the potential impacts of the proposal, including how impacts are predicted to change over time and any residual long-term impacts. Consider and describe: • *any hydrogeological units that will be directly or indirectly dewatered or depressurised, including the extent of impact on hydrological interactions between water resources, surface water/groundwater connectivity, interaquifer connectivity and connectivity with sea water.* • *the effects of dewatering and depressurisation (including lateral effects) on water resources, water-dependent assets, groundwater, flow direction and surface topography, including resultant impacts on the groundwater balance.* • *the potential impacts on hydraulic and storage properties of hydrogeological units, including changes in storage, potential for physical transmission of water within and between units, and estimates of likelihood of leakage of contaminants through hydrogeological units.* • *the possible fracturing of and other damage to confining layers.* • *for each relevant hydrogeological unit, the proportional increase in groundwater use and impacts as a consequence of the proposed project, including an assessment of any consequential increase in demand for groundwater from towns or other industries resulting from associated population or economic growth due to the proposal.*	Sections 6 and 7
Describe the water resources and water-dependent assets that will be directly impacted by mining or CSG operations, including hydrogeological units that will be exposed/partially removed by open cut mining and/or underground mining.	Sections 3.3, 5.7, 6 and 7
For each potentially impacted water resource, provide a clear description of the impact to the resource, the resultant impact to any water-dependent assets dependent on the resource, and the consequence or significance of the impact.	Sections 6 and 7 and Surface Water Assessment
Describe existing water quality guidelines, environmental flow objectives and other requirements (e.g. water planning rules) for the groundwater basin(s) within which the development proposal is based.	Sections 1.3, 5.4 and 8.2
Provide an assessment of the cumulative impact of the proposal on groundwater when all developments (past, present and/or reasonably foreseeable) are considered in combination.	Section 3.3, 6.5
Describe proposed mitigation and management actions for each significant impact identified, including any proposed mitigation or offset measures for long-term impacts post mining.	Section 8
Provide a description and assessment of the adequacy of proposed measures to prevent/minimise impacts on water resources and water-dependent assets.	Section 8
Groundwater – Data and Monitoring	
Provide sufficient data on physical aquifer parameters and hydrogeochemistry to establish pre-development conditions, including fluctuations in groundwater levels at time intervals relevant to aquifer processes.	Section 5.1 and 8.2 and Appendix A
Develop and describe a robust groundwater monitoring program using dedicated groundwater monitoring wells – including nested arrays where there may be connectivity between hydrogeological units – and targeting specific aquifers, providing an understanding of the groundwater regime, recharge and discharge processes and identifying changes over time.	Section 8.2 and Appendix A
Develop and describe proposed targeted field programs to address key areas of uncertainty, such as the hydraulic connectivity between geological formations, the sources of groundwater sustaining GDEs, the hydraulic properties of significant faults, fracture networks and aquitards in the impacted system, etc., where appropriate.	Section 8.2 and Appendix B
Provide long-term groundwater monitoring data, including a comprehensive assessment of all relevant chemical parameters to inform changes in groundwater quality and detect potential contamination events.	Sections 5.4 and 8 and Section 3 of Appendix A

Specific Information Needs	Section Addressed
Ensure water quality monitoring complies with relevant National Water Quality Management Strategy (NWQMS) guidelines (ANZECC/ARMCANZ 2000) and relevant legislated state protocols (e.g. QLD Government 2013).	Section 8 and Appendix A
Cumulative Impacts – Context and Conceptualisation	
Provide cumulative impact analysis with sufficient geographic and temporal boundaries to include all potentially significant water-related impacts.	Sections 3.3 and 6.5
Consider all past, present and reasonably foreseeable actions, including development proposals, programs and policies that are likely to impact on the water resources of concern in the cumulative impact analysis. Where a proposed project is located within the area of a bioregional assessment consider the results of the bioregional assessment.	Section 3.3 and 6.5
Cumulative Impacts – Impact	
Provide an assessment of the condition of affected water resources which includes: • *identification of all water resources likely to be cumulatively impacted by the proposed development;* • *a description of the current condition and quality of water resources and information on condition trends;* • *identification of ecological characteristics, processes, conditions, trends and values of water resources;* • *adequate water and salt balances; and,* • *identification of potential thresholds for each water resource and its likely response to change and capacity to withstand adverse impacts (e.g. altered water quality, drawdown).*	Section 6.5 and Section 5 of Appendix B
Assess the cumulative impacts to water resources considering: • *the full extent of potential impacts from the proposed project, (including whether there are alternative options for infrastructure and mine configurations which could reduce impacts), and encompassing all linkages, including both direct and indirect links, operating upstream, downstream, vertically and laterally;* • *all stages of the development, including exploration, operations and post closure/decommissioning;* • *appropriately robust, repeatable and transparent methods;* • *the likely spatial magnitude and timeframe over which impacts will occur, and significance of cumulative impacts; and,* • *opportunities to work with other water users to avoid, minimise or mitigate potential cumulative impacts.*	Section 6.5 and Section 5 of Appendix B
Cumulative Impacts – Mitigation, Monitoring and Management	
Identify modifications or alternatives to avoid, minimise or mitigate potential cumulative impacts. Evidence of the likely success of these measures (e.g. case studies) should be provided.	Section 6.5
Identify cumulative impact environmental objectives.	Sections 3.3 and 6.5
Identify measures to detect and monitor cumulative impacts, pre and post development, and assess the success of mitigation strategies.	Sections 8.1 and 8.2
Describe appropriate reporting mechanisms.	Section 8.2
Propose adaptive management measures and management responses.	Sections 8.1 and 8.2

3 EXISTING CONDITIONS

3.1 CLIMATE

The climate at the Study Area is sub-tropical with higher temperatures, higher rainfall and higher evaporation occurring over the summer months (December to February). The closest Bureau of Meteorology (BoM) weather station is located at Iffley (station 034100), at the eastern edge of MLA 700032. This weather station has been in operation since 1998; however, there are several instances of missing data. Approximately 5 km south-east of the Project at Carfax (station 034016) a weather station has been operating since 1962. This station has a fairly continuous record with only a few occasional months of missing data. A more recent station at Moranbah Airport (station 034035) has been open since 2012. **Table 3-1** provides the details of the nearby operational weather stations.

Table 3-1 Operational BoM weather stations near the Project

Name	Site Number	Date Commenced	Latitude	Longitude	Elevation (mAHD)	Operational Status	Distance from Project (km)
Iffley	034100	1998	22.24º S	148.43º E	173	Open	0
Carfax	034016	1962	22.46º S	148.68º E	128	Open	5
Moranbah Airport	034035	2012	22.06º S	148.08º E	232	Open	35

The weather station at Carfax has the most complete long term data set and is therefore the most useful for assessing long-term rainfall trends in the vicinity of the Project. The average annual rainfall recorded at Carfax (station 034016) from 1962 to 2017 is 619 millimetres (mm). The highest annual rainfall for this period was recorded for the year 2010 with an annual rainfall of 1251 mm, while the lowest was 262 mm recorded in 1992. Monthly averages for all three stations are listed in **Table 3-2**.

Table 3-2 Average Monthly Rainfall (mm)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Carfax	111.2	94.1	61.5	32.3	35.7	29.0	23.1	23.5	19.5	34.4	55.9	98.6	619
Iffley	110.3	88.1	54.4	41.7	16.4	41.7	18.0	41.4	14.8	35.8	59.6	90.9	613
Moranbah Airport	104.6	103.1	103.8	32.3	19.6	22.7	43.6	10.9	11.7	5.6	53.0	80.0	591

Source: http://www.bom.gov.au/climate/data/index.shtml

Rainfall trends for Carafax over the past century are indicated by analysis of the residual mass curve (RMC, or cumulative deviation from the mean) (**Figure 3-1**). Positive gradients on this curve (rising limbs) confirm wetter conditions than normal, while negative gradients (falling limbs) indicate dry conditions. Normal rainfall conditions are inferred during periods of fairly stable residual mass. **Figure 3-1** shows that, over the past 50 years, the wettest periods occurred during 1973-1979, 2007-2008 and in 2010. The driest periods were 1963-1970, 1991-1998 and 2001-2006. From 2011 to present rainfall has been more or less consistent with the long-term average.

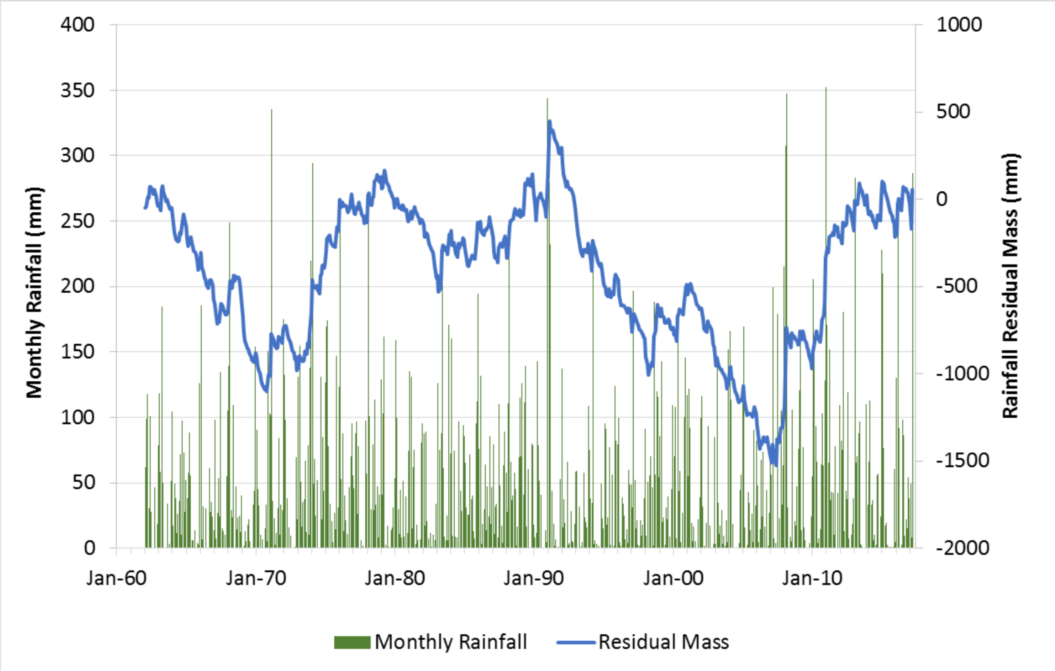

Figure 3-1 Long-term Monthly Rainfall and Rainfall Residual Mass Curve at Carfax (Station 034016)

The RMC performs an additional service: if rainfall recharge is a significant source of groundwater, the temporal variability in recorded groundwater levels can be expected to mimic the pattern of this curve. That is, natural fluctuations in the groundwater table result from temporal changes in rainfall recharge to groundwater systems. Typically, changes in groundwater elevation reflect the deviation between the long-term monthly (or yearly) average rainfall, and the actual rainfall, illustrated by the rainfall RMC. Groundwater hydrographs are assessed in **Section** 5.

Actual and potential evapotranspiration have been taken from BoM's Australia wide interpolation dataset at the locations of the weather stations (BoM, 2018). The potential ET in the district is about 1600 mm/yr according to BoM (2012) (**Table 3-3**). The definition of potential ET is: *"… the ET that would take place, under the condition of unlimited water supply, from an area so large that the effects of any upwind boundary transitions are negligible and local variations are integrated to an areal average. For example, this represents the evapotranspiration which would occur over a very large wetland or large irrigated area, with a never-ending water inflow*". Further to this, where the water table approaches the ground surface, ET can also approach the potential ET value.

Table 3-3 Average Monthly Potential Evapotranspiration (mm)

PE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Carfax	187	155	170	124	96	80	81	100	126	172	189	188	1668
Iffley	181	151	167	122	96	80	81	99	125	172	188	184	1646
Moranbah Airport	175	147	163	120	95	80	81	98	124	171	186	179	1619

The actual ET in the district is about 600 mm/year according to BoM (2012) (**Table 3-4**). The definition for actual ET is: "... the *ET that actually takes place, under the condition of existing water supply, from an area so large that the effects of any upwind boundary transitions are negligible and local variations are integrated to an areal average*". For example, this represents the predicted ET that is occurring over a large area of land under the existing (mean) rainfall conditions.

Table 3-4 Average Monthly Actual Evapotranspiration (mm)

AE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Carfax	72	64	70	45	33	29	29	29	34	55	67	67	594
Iffley	70	65	71	46	35	31	30	29	33	54	67	66	597
Moranbah Airport	63	62	65	43	33	29	27	25	28	47	62	60	544

Figure 3-2 shows potential monthly ET exceeds rainfall over the entire year, often by more than double. Actual ET is equal to or slightly less that rainfall for all months except during the "wet" season between December and March, when rainfall exceeds actual ET.

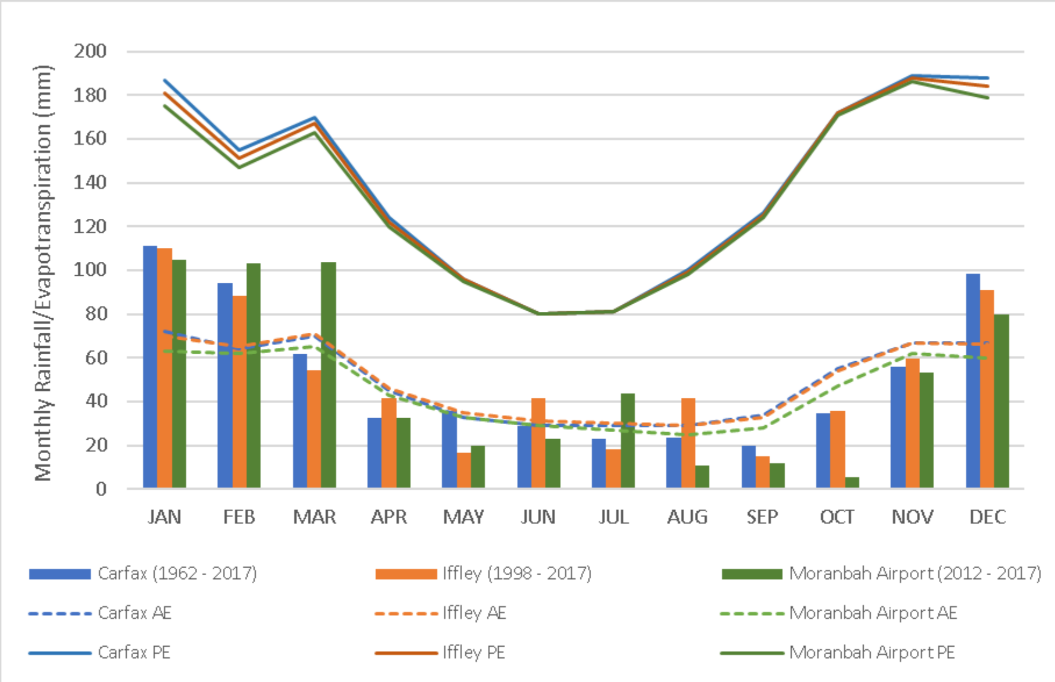

Figure 3-2 Average Monthly Rainfall and Evapotranspiration at Nearby Weather Stations

3.2 TOPOGRAPHY AND DRAINAGE

The Project is located on the Isaac River floodplain of the Isaac Connors catchment, a sub-catchment of the upper Fitzroy Basin. The topography of the Project area is relatively flat with gentle undulation and average elevations of approximately 200 mAHD (**Figure 3-3**). Elevations range between 150 mAHD southeast of the Project to 250 mAHD in the north. Low mountain ranges of up to 400 mAHD border the Project to the northeast and southwest.

The Isaac River is the major drainage feature of the region, and flows from northwest to southeast, dividing the Project into its three MLA areas; ODS (northern and southern) on the western side of the river and Willunga downstream on the eastern side (**Figure 3-3**). At the Project Site, the Isaac River is characterised by a wide and deep stream channel with steeply sloping banks. The ODS domain is drained by an un-named creek within the western tributaries of Isaac River, as well as Ripstone Creek and its minor tributaries (**Figure 3-3).** Ripstone Creek is an ephemeral creek that flows into Boomerang Creek and is used as a controlled release point by Peak Downs Mine (EPML00318213) and the currently inactive (care and maintenance) Eagle Downs Mine (EPML00586713). Boomerang Creek, One Mile Creek and Phillips Creek occur between the Willunga and ODS Domains, flowing in an easterly direction towards the Isaac River. These creeks do not pass through the ODS domain, so they would not be directly impacted by open cut mining activity. The Willunga Domain is drained by an un-named ephemeral tributary that flows towards the Isaac River to the west.

There is a Department of Natural Resources, Mines and Energy (DNRME) gauging station located at Isaac River at Deveril (station 130410A), which is adjacent to the Project MDL at Iffley. A gauging station (Olive Downs) referred to as 'ISDS' has also been installed downstream of the Project in the Isaac River at the bridge on Fitzroy Developmental Road, just downstream of the confluence with Stephens Creek. Data records are taken at 10 minute intervals, with logging commencing on 22 December 2016. As at 13 March 2018, five flow events (peak flow greater than 1 m^3/s) have been recorded at this gauge. The greatest discharge was recorded in March 2018 at 804 m^3/s. **Figure 3-3** shows the relative locations of the stream gauging stations.

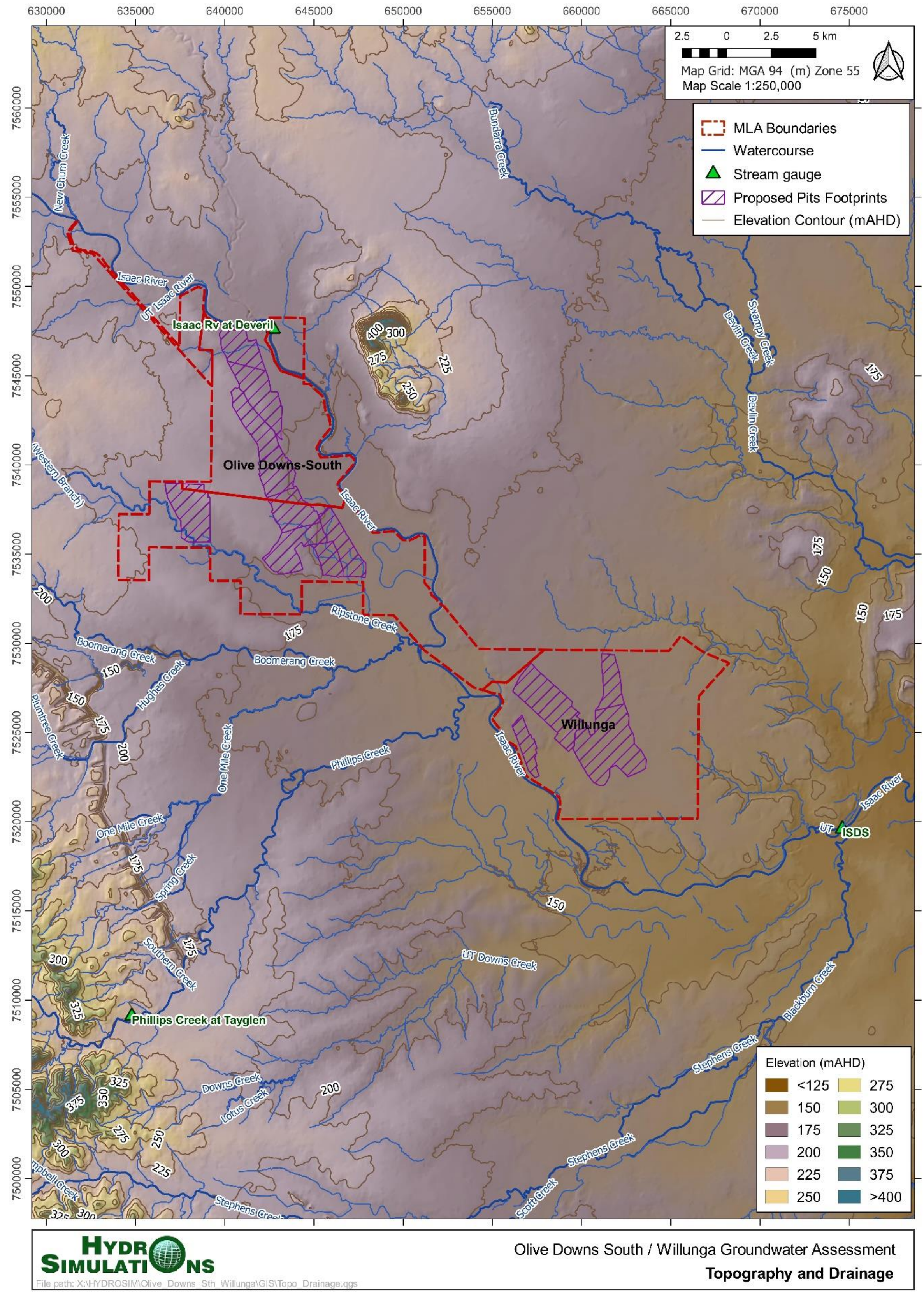

Figure 3-3 Topography and Drainage

Table 3-5 presents a summary of stream gauge stations along the Isaac River near the Project, derived from the DNRM Water Monitoring Information Portal (WMIP) (DNRME, 2018b). The table includes details from two regional stations (not shown on Figure 3-3), one located over 66 km upstream along the Isaac River at Goonyella (station 130414A), and one 90 km downstream at Yatton (130401A).

Table 3-5 DNRM Stream Gauging Stations

Station Location	Number	Distance from Project	Zero-gauge Elevation (mAHD)	Mean Flow (ML/day)	Max Flow (GL/day)	Max Flow Date
Isaac Rv at Deveril	130410A	Adjacent east of Project	169.30	460	228	Mar 1988
ISDS (Isaac Rv)	-	20 km downstream from the MLA700033 boundary	136.93	-	-	-
Isaac Rv at Goonyella	130414A	66 km upstream (along channel)	230.06	157	138	Mar 1988
Isaac Rv at Yatton	130401A	90 km downstream (along river channel)	89.15	5380	2060	Mar 2017

The table shows that at the site adjacent to the Project MDL (Station 130410A) the Isaac River flows at an average rate of 460 ML/day. This is higher than the upstream gauge at Goonyella, indicating contributions from upstream catchments and tributaries, such as New Chum Creek and Cherwell Creek (not shown on Figure 3-3). Flows at Yatton (Station 130401A) markedly increase with the confluence of the Isaac River with the Connors River.

Figure 3-4 presents daily mean stream discharge at the Isaac River at Deveril station (130410A) from 2006 to January 2018, compared against daily rainfall. The graphs show that flows within the Isaac River are typically ephemeral, with short-duration flows generally occurring over the summer months.

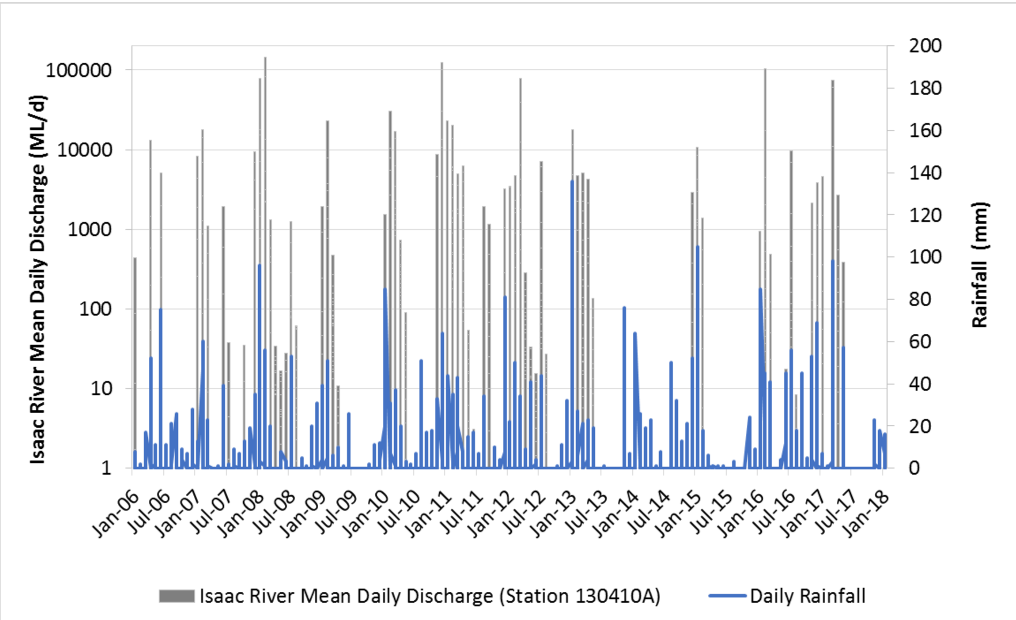

Figure 3-4 Isaac River (Station 130410A) Stream Flow and Rainfall at Carfax (Station 034016)

Based on daily flow data since 1968, **Figure 3-5** shows that the Isaac River flows only 38 percent of the time, with less than 15 percent probability of flows exceeding 100 ML/day. Less than 2% of readings exceed 50,000 ML/day, which include high flow/flood events in 2008 (January and February), 2010 (December), 2012 (March), 2016 (February) and 2017 (March).

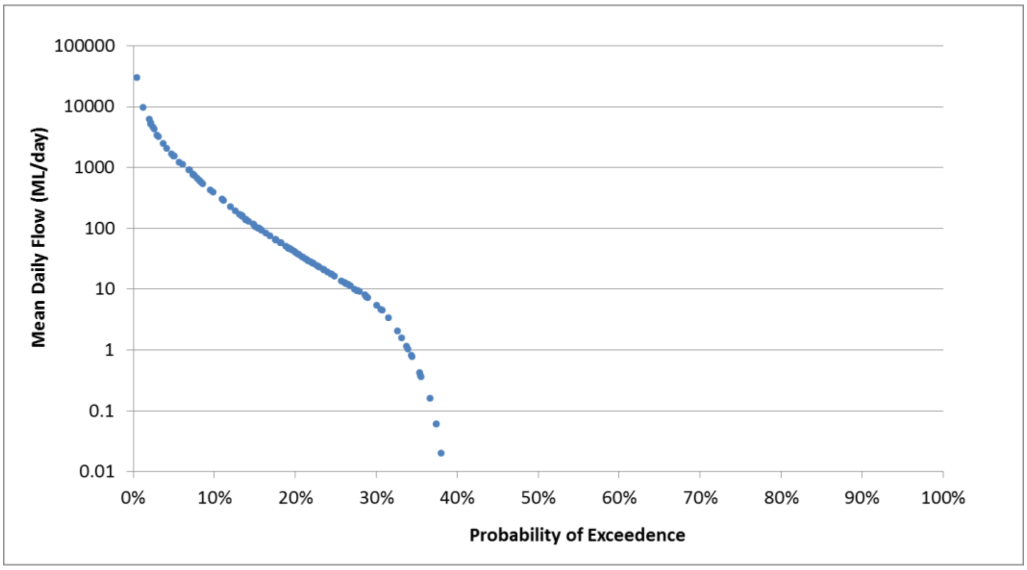

Figure 3-5 Isaac River (Station 130410A) Mean Daily Flow Duration Curve (1968 – 2017 data)

3.3 LAND USE AND MINING

The Project MLAs cover approximately 25,300 ha of land along the Isaac River floodplain. The land is largely covered with native pasture used for cattle grazing. Cattle grazing and associated agricultural practices have impacted and influenced the vegetation across the Project area to varying extents, ranging from negligible to heavy. Small areas are potentially used for opportunistic cropping; however, there is no Strategic Cropping Land (SCL) mapped within the Project Site. A number of unsealed farm access tracks and minor farm infrastructure (i.e. fences and dams) occur within the Project Site.

The predominant surrounding land uses within the Study Area are mining and agriculture (grazing). There are several proposed and active coal mining operations near to the Project, particularly to the north and west. There are also several proposed wellfields for extraction of CSG associated with the Bowen Gas Project. **Table 3-6** summarises the nearby mines.

Table 3-6 Proposed and current operations near to the Project

Mine	Status	Type	Planned Start	Planned End	Distance from Project	Target Coal
Bowen Gas Project[1]	Proposed	Coal Seam Gas	~2017 (On Hold)	2055	Proposed wells in and around Project	Rangal Coal Measures, Moranbah Coal Measures
Olive Downs North[1]	Approved	Open Cut	2019	2029	Adjacent, north	Rangal Coal Measures
Lake Vermont[1]	Operating	Open Cut	2014	2045	12 km south-west	Rangal Coal Measures
Lake Vermont North Extension Project[1]	Approved	Open Cut	2017	2044	5 km south-west	Rangal Coal Measures

Mine	Status	Type	Planned Start	Planned End	Distance from Project	Target Coal
Saraji[1]	Operating	Open Cut	1974	2040	5 km south-west	Moranbah Coal Measures
Saraji East[1]	Proposed	Underground - Longwall	TBD	TBD	5 km south-west	Moranbah Coal Measures
Peak Downs[1]	Operating	Open Cut	1972	2075	12 km west	Moranbah Coal Measures
Eagle Downs[1]	Operating	Underground - Longwall	~2017 (On Hold)	2064	10 km north-west	Moranbah Coal Measures
Poitrel[1]	Operating	Open Cut	2006	2026	10 km north-west	Rangal Coal Measures
Daunia[1]	Operating	Open Cut	2011	2034	10 km north-west	Rangal Coal Measures
Millennium	Operating	Open Cut	2005	2018	15 km north-west	Rangal Coal Measures
Millennium Expansion	Approved	Open Cut	2011	2027	15 km north-west	Rangal Coal Measures
Moorvale	Operating	Open Cut	2003	2017+	18 km north	Rangal Coal Measures
Coppabella	Operating	Open Cut	1998	2035	25 km north	Rangal Coal Measures, Fort Cooper Coal Measures
Caval Ridge	Operating	Open Cut	2013	2043	25 km north-west	
Isaac Plains	Operating	Open Cut	2006	2070	20 km north-west	Rangal Coal Measures
Norwich Park	Care and Maintenance	Open Cut	1979	2012	25 km south-west	German Creek Formation
Moranbah South	Proposed	Underground – Longwall and Bord and Pillar	2017 (On Hold)	2060	20km north-west	Moranbah Coal Measures

Note:

1. Cumulative impacts assessed as part of this project

On Hold – Projects approved and proposed to commence, but have not yet commenced

A brief summary of each of the surrounding mines to be included in the cumulative assessment is provided below. These mines are included largely based on their proximity to the Project Site. In areas with multiple mines in close proximity (e.g. to the northwest of the Project), only the closest mines to the Project are included in the cumulative assessment under the assumption that cumulative drawdown will be governed by these closest mines. Consideration was given to including Moorvale Mine (15 km north of the Project). However, it was not included in the assessment due to lack of available information regarding mine timing, its distance from the Project and the fact that any cumulative drawdown resulting from mining at Moorvale Mine would be insignificant compared with that resulting from the adjacent Olive Downs North mine.

The potential for cumulative impacts due to the neighbouring mining and gas developments is discussed in **Section 6.**

3.3.1 BOWEN GAS PROJECT

The Bowen Gas Project (BGP) is a CSG development by Arrow Energy Pty Ltd (Arrow), targeting gas within coal seams of the Rangal Coal Measures and Moranbah Coal Measures. The BGP proposes to extract approximately 270 GL of water and gas over a period of 55 years from 6000+ extraction wells covering and area of 9,500 km^2. Arrow has identified an extraction wellfield targeting the Rangal Coal Measures and Moranbah Coal Measures in the vicinity of the Project. While the final well locations and relative timing of these activities are yet to be finalised, gas extraction has been conservatively modelled for the purposes of cumulative assessment concurrently with the Project for a model run and is presented in **Section 6.**

3.3.2 OLIVE DOWNS NORTH

The Olive Downs North mine is situated directly north of the Project, with the Isaac River running between the two leases. The Rangal Coal Measures will be mined through open cut methods and ROM coal transported by private haul road to the nearby Moorvale Mine for processing and rail load out.

3.3.3 LAKE VERMONT

The Lake Vermont Coal Mine is a medium size open cut coal mine producing coking and pulverised coal injection (PCI) coal for the export market to be used in steel production, with a majority ownership held by Jellinbah Group. Mining operations at the site commenced in September 2008, with first coal production in January 2009. The target production rate is 12.0 Mtpa, targeting the Rangal Coal Measures. The project has gained recent approval to extend the existing mining operation into new mining areas to the north of the current operation.

3.3.4 SARAJI

The Saraji Mine is an open cut metallurgical coal mine operated by BHP Billiton Mitsubishi Alliance (BMA). The mine targets the Moranbah Coal Measures where they shallow at the western limb of the Bowen Basin. Coal extraction commenced in 1974 and is expected to continue until approximately 2040. No details regarding mine progression have been obtained from BMA, therefore for the purposes of this study it is assumed the mine will continue to develop primarily in an easterly direction following the coal seam down-dip.

3.3.5 SARAJI EAST

The proposed Saraji East project includes an underground single-seam mine operation and associated project infrastructure. The Saraji East project has planned extraction of up to 7 Mtpa of metallurgical product coal for the export market over a life of 25 to 30 years, and is located adjacent to the existing Saraji Open Cut Coal Mine. The project is currently undergoing the EIS process and is anticipated to commence in coal extraction in 2024, subject to approval (BMA, 2017).

3.3.6 PEAK DOWNS

The Peak Downs Mine is an open cut metallurgical coal mine operated by BMA and follows the strike of the Moranbah Coal Measures, north of Saraji. Coal extraction commenced in 1972 and is expected to continue until approximately 2075. As per the Saraji Mine, no details regarding mine progression have been obtained from BMA, therefore for the purposes of this study it is assumed the mine will continue to develop from its current extents in an easterly direction.

3.3.7 EAGLE DOWNS

Eagle Downs is a multi-seam underground mine operated by Aquila Resources and Eagle Downs Coal Management Pty Ltd (a subsidiary of Vale Australia Holdings Pty Ltd). The project targets the Moranbah Coal Measures using longwall extraction. The project was approved in 2011 and development of a small boxcut and drift commenced in 2013. However, no activities have been conducted at the site since 2015. First coal production may occur from 2019, and the project proposes a production rate of up to 11 Mtpa with a mine life of 50 years.

3.3.8 POITREL

The Poitrel Coal Mine Project owned by BHP Mitsui Coal Pty Ltd (BMC) is located 25 km east south-east of Moranbah. The project is an open cut mine targeting the Leichhardt and Vermont seams within the Rangal Coal Measures, which consists of 79 Mt of resources. The mine is projected to produce up to 5 Mtpa of ROM coal for at least 20 years (EPA, 2005).

3.3.9 DAUNIA

Daunia Mine is a component of the BMA Bowen Basin Coal Growth Project and is located approximated 30 km south-east of Moranbah. As with Poitrel, Daunia is an open cut mine targeting the Leichhardt and Vermont seams within the Rangal Coal Measures. The mine is located on the eastern limb of an anticline that separates it from adjacent Poitrel Mine. The mine has a production rate of 4Mt per year with a mine life of 21 years (Queensland Government Coordinator-General, 2009).

4 GEOLOGY

4.1 REGIONAL GEOLOGY

The Olive Downs coal deposit is in the northern part of the Bowen Basin, a foreland sedimentary basin of approximately 200,000 km^2 (**Figure 4-1**). The Bowen Basin is a NNW-SSE oriented basin and contains the largest coal reserves in Australia. The southern half of the Bowen Basin is covered by the Surat Basin, and the Galilee Basin exists to the west (Geoscience Australia, 2017).

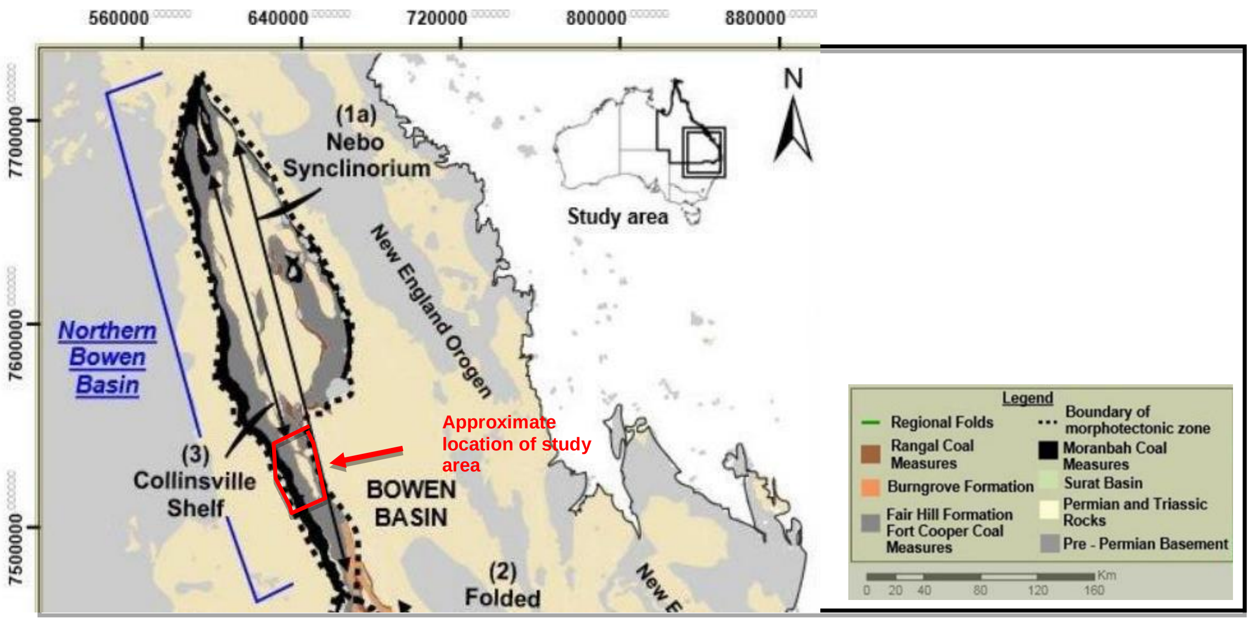

Figure 4-1 Structural Setting of the Bowen Basin (after Dickins and Malone, (1973))

Basin geology within the Collinsville Shelf includes the basal Permian aged Back Creek Group, which is comprised of generally fine grained clastic sediments deposited in a fluvial to shallow marine environment. The Back Creek Group is conformably overlain by the Blackwater Group, which includes the Moranbah Coal Measures, Fort Cooper Coal Measures and upper Rangal Coal Measures. The economic seams of the Project are contained in the Late Permian Rangal Coal Measures. The Permian sediments occur at outcrop on the eastern and western edges of the Basin, and are unconformably overlain by the Triassic aged terrestrial sediments of the Rewan Group. While not present at the Project Site, isolated pockets of remnant quartzose sandstones of the Middle Triassic Clematis Group are also mapped near the ODS domain, on the eastern side of the Isaac River.

The Permian and Triassic sediments are covered by a thin veneer of unconsolidated to semi-consolidated Cainozoic sediments (Tertiary to Quaternary alluvium and colluvium). The alluvial sediments are localised along rivers and creeks (i.e. Isaac River). Volcanic intrusions and extrusions (i.e. basalt) are also present within the region, but not mapped at the Project Site.

The generalised regional stratigraphy is summarised in **Table 4-1**. The hard-rock solid geology is presented in **Figure 4-2**, based on the 1:500k solid geology outcrop mapping of the Bowen Basin. The surficial geology is shown in **Figure 4-3**, and is based on the Clermont (SF5511) and St Lawrence (SF5512) 1:250k geological maps, as compiled within the Queensland Geology Detailed Surface Mapping (DNRM 2017[1]).

[1] https://www.business.qld.gov.au/industries/mining-energy-water/resources/geoscience-information/digital-data/geological-mapping

Table 4-1 Regional Stratigraphy

Period		Stratigraphic Unit		Description	Distribution	Max Thickness (m)
Cainozoic		Isaac River Quaternary alluvium (Qa)		Flood plain alluvium comprising clay, silt, sand and gravel.	Surficial cover localised along Isaac River	~ 50 m
Cainozoic		Regolith - alluvium, colluvium and other sediments in floodplains, alluvial fans, and high terraces (Qr, Qr\b and TQa)		Colluvial and residual deposits comprising poorly sorted clay, silt, sand, gravel and black soils, silts and muds derived from weathered basalts.	Surficial cover across site	~ 20 m
Cainozoic		Duaringa Formation (Tu)		Mudstone, sandstone, conglomerate, siltstone, oil shale, lignite and basalt	Isolated areas mapped at Willunga, and present to south and east of Study area	~100 m
Triassic		Mimosa Group	Clematis Group (Re)	Cross-bedded quartz sandstone, some quartz conglomerate and minor red-brown mudstone.	Isolated outcrop to the east of the Project	~100 m
Triassic		Mimosa Group	Rewan Group (Rr) (Rewan Formation and Sagittarius Sandstone)	Rewan Formation: green lithic sandstone, pebbly lithic sandstone, green to reddish brown mudstone and minor volcanolithic pebble conglomerate (at base). Sagittarius Sandstone: lithic sandstone interbedded with mudstones and siltstones with scattered carbonaceous plant material.	Within Project Site; Outcrops or subcrops in the majority of the Project area.	~840
Permian	Late	Blackwater Group	Rangal Coal Measures (Pwj)	Coal seams, carbonaceous shale and mudstone, tuff, siltstone and mudstone	Within Project Site; Outcrops or subcrops in the majority of the Project area	~200
Permian	Late	Blackwater Group	Fort Cooper Coal Measures (Pwt) (Fair Hill Formation)	Coal, brown and green sandstone, conglomerate, carbonaceous shale, tuff	Within Project Site; Outcrops or subcrops in the majority of the Project Site	~350
Permian	Late	Blackwater Group	Moranbah Coal Measures (Pwb)	Quartzose to sublabile locally argillaceous sandstone, siltstone, mudstone, carbonaceous mudstone and coal	Within/underlies Project Site; Outcrops or subcrops in the west of the Project area	~ 400
Permian	Early to Middle	Back Creek Group	(Pb)	Quartzose to lithic sandstone, siltstone, carbonaceous shale, minor coal and sandy coquinite.	Within/underlies Project Site; Outcrops west of mines and extends under mined areas to the east	~400

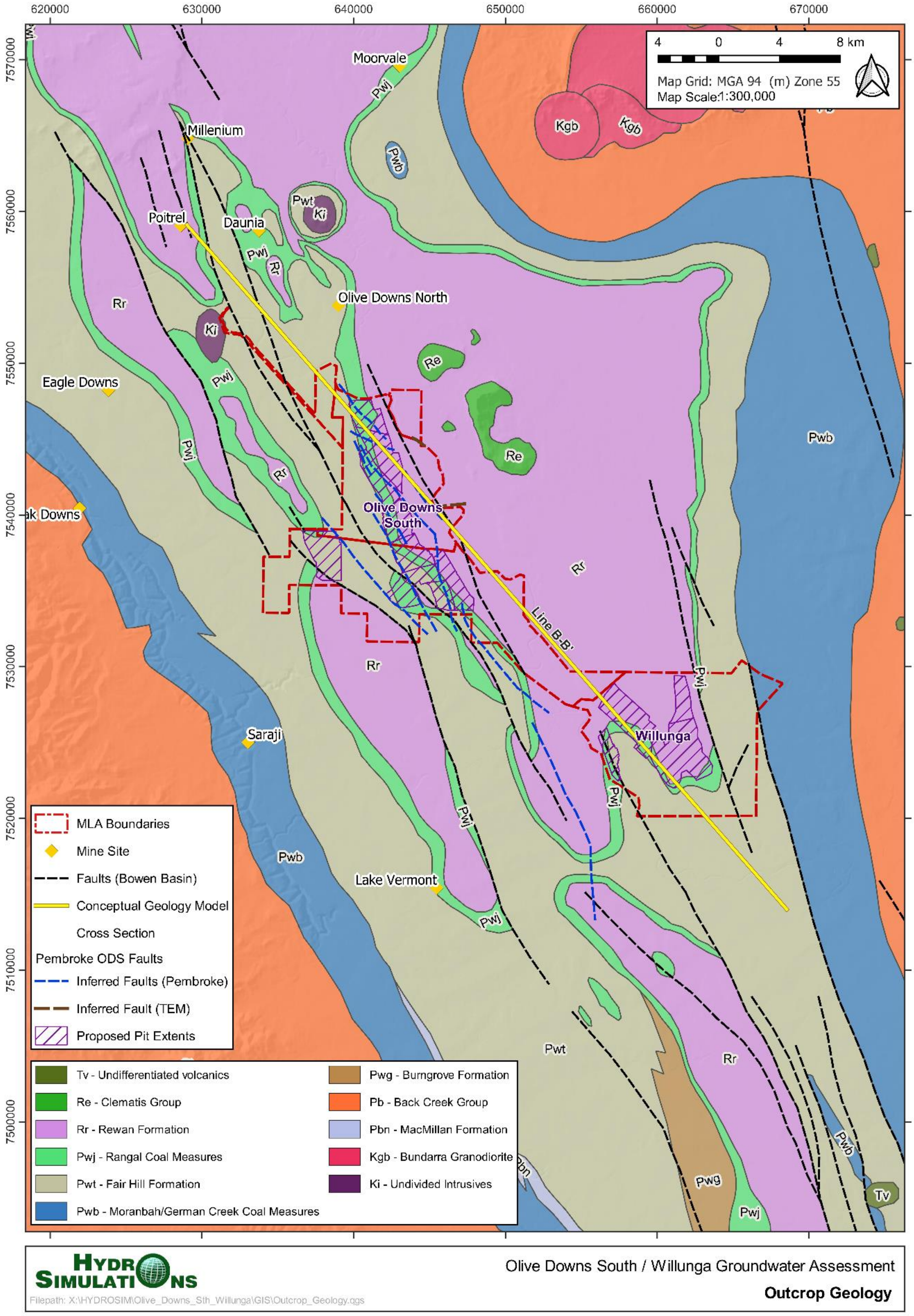

Figure 4-2 Outcrop Geology

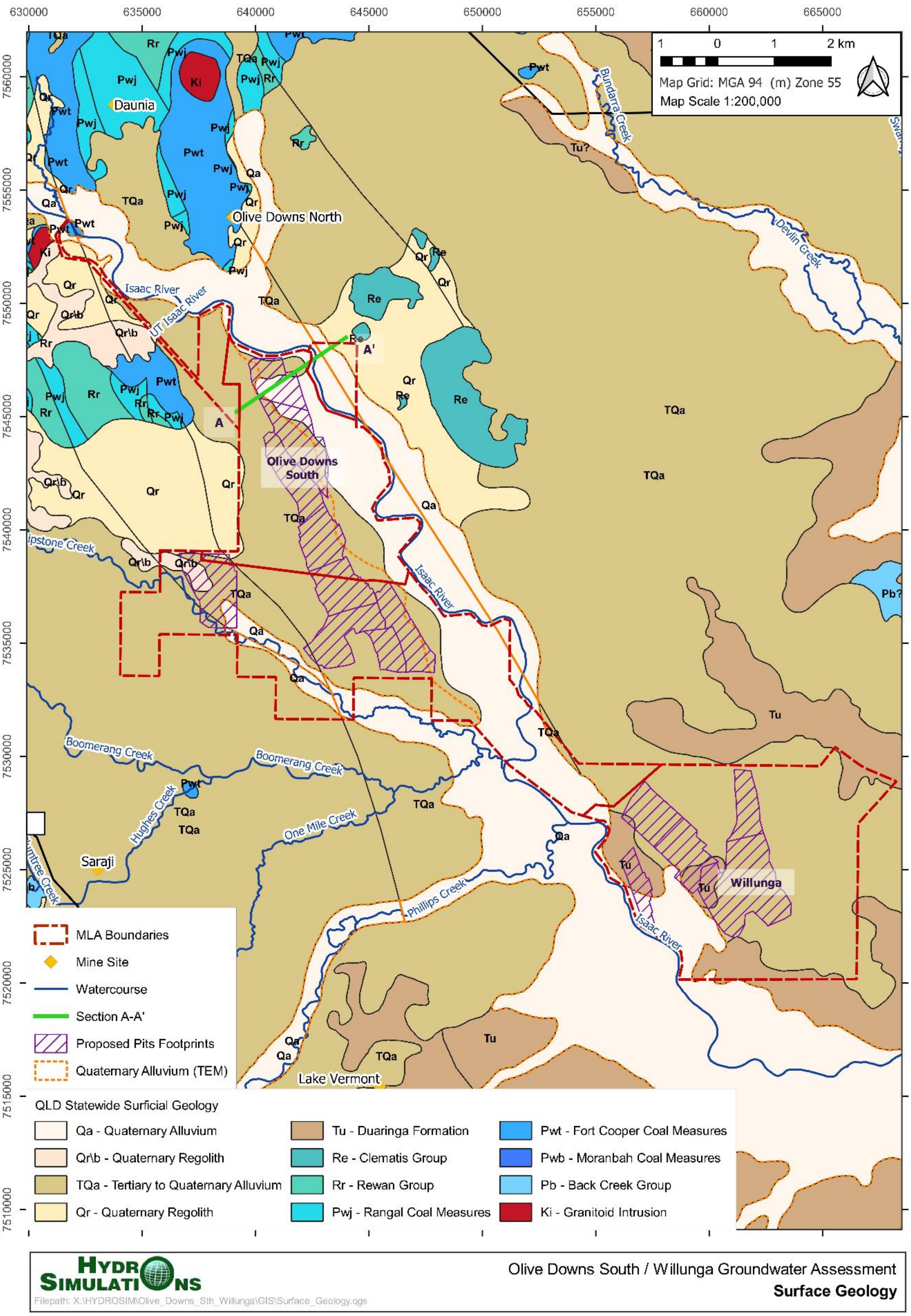

Figure 4-3 Surface Geology

4.2 LOCAL GEOLOGY

The stratigraphic profile within the Study Area comprises three distinct units:

- Cainozoic sediments (alluvium and regolith);
- Early Triassic Rewan Group; and
- Permian aged coal measures.

Each of the main stratigraphic units is discussed in further detail below. The structural geology of the Study Area is also discussed in **Section 0**.

4.2.1 CAINOZOIC SEDIMENTS

Alluvium

State (Queensland Government) Detailed Surface Geology mapping (**Figure 4-3**) shows that alluvium is localised along the Isaac River. At the Project Site, the alluvium is present on the northern and eastern edge of the ODS domain and on the western edge of the Willunga domain. The extent and thickness of the unconsolidated sediments was assessed at the Project Site using a transient electromagnetic (TEM) survey conducted by Groundwater Imaging Pty Ltd in July 2017. The survey tested the resistivity of ground cover to a depth of about 60 m and was verified using site geological drill data. The TEM survey identified that alluvial sediments occur further west than is mapped at the ODS domain. These sediments are generally less than 12 m thick, but the alluvium can be up to 30 m thick within a narrow corridor along the Isaac River, thinning out with distance from the river. The TEM mapped extent of alluvium is presented in **Figure 4-4**, compared to State Detailed Surface Geology, and full results are included in **Appendix A**. The revised extent and interpolated thickness of the alluvium at the Project Site is presented in **Figure 4-5** based on findings from the TEM survey, along with the CSIRO Soil and Landscape Grid of Australia (CSIRO 2015) data and site geological logs.

Lithological logs for site bores indicate the alluvium comprises a heterogeneous distribution of fine to coarse grained sands interspersed with lenses of clays and gravels. These sediments, while spatially variable, generally comprise four main stratigraphic sequences:

- Upper soil and clay layer (0 m – 10 m thick)
- Sand and sandy clay unit (3 m – 15 m thick)
- Sand and gravel unit (0 m – 8 m thick)
- Basal clay unit (> 1 m thick)

The heterogeneous distribution of alluvial sediments is shown in the geological cross section in **Figure 4-6** (see **Figure 4-3** for section line location). This heterogeneity is also visible in the TEM results, with discrete areas of more saline water detected within the alluvium, likely correlating to less permeable (i.e. finer grained) horizons (**Appendix A**).

Regolith

The surficial regolith material covering much of the Project Site comprises Cainozoic (Quaternary to Tertiary) aged sediments, including alluvium and colluvium. Older alluvial (TQa) sediments are distributed extensively across the region and colluvium and residual deposits (Qr and Qr\b) within isolated patches to the north. The Cainozoic (Tertiary) aged Duaringa Formation (Tu) is also mapped at surface at the southern end of the Study area, within the Willunga Domain. Site drilling logs indicate the sequences exhibit similar geological characteristics, and have therefore been grouped as ‘regolith’ within this report.

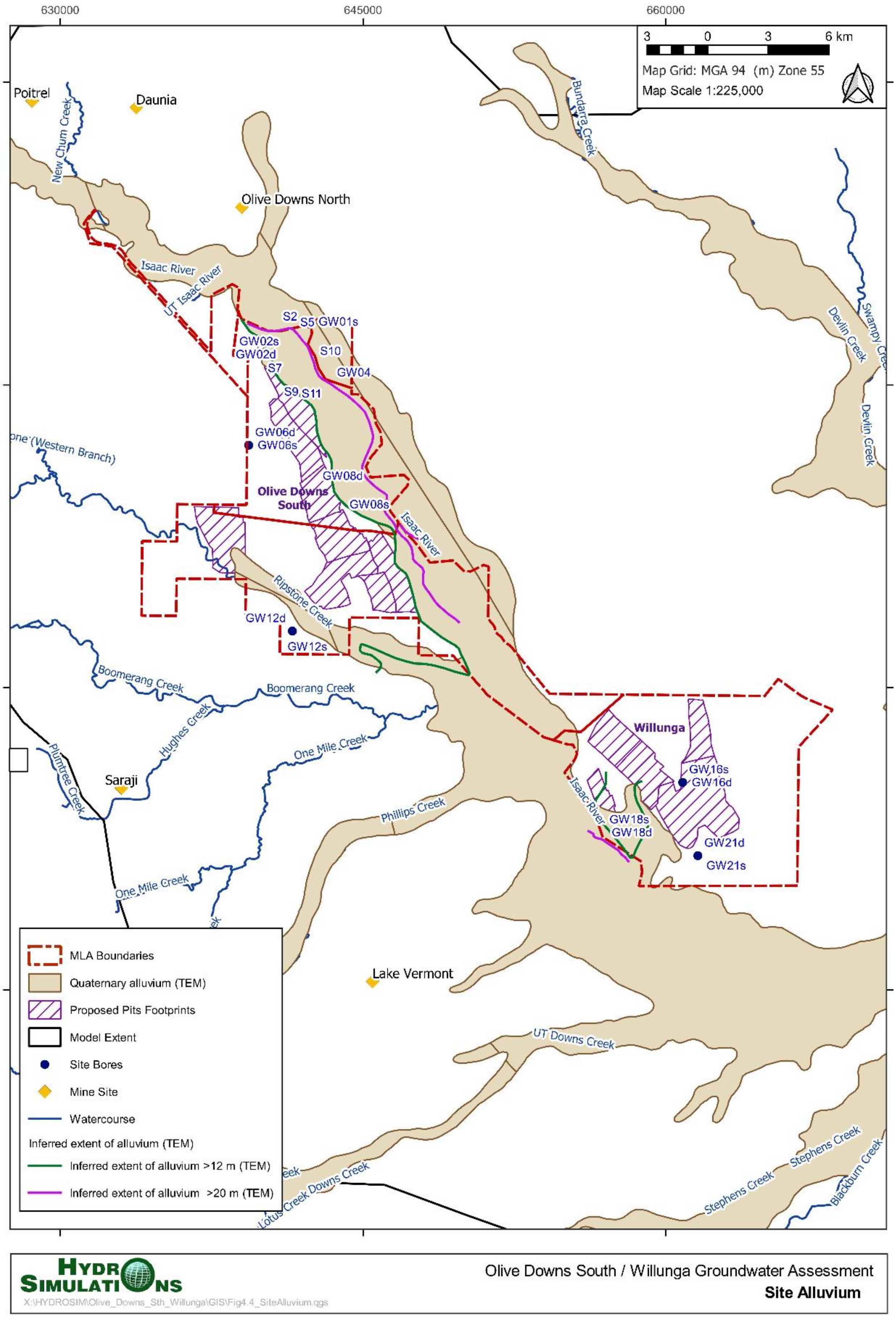

Figure 4-4 Site Alluvium

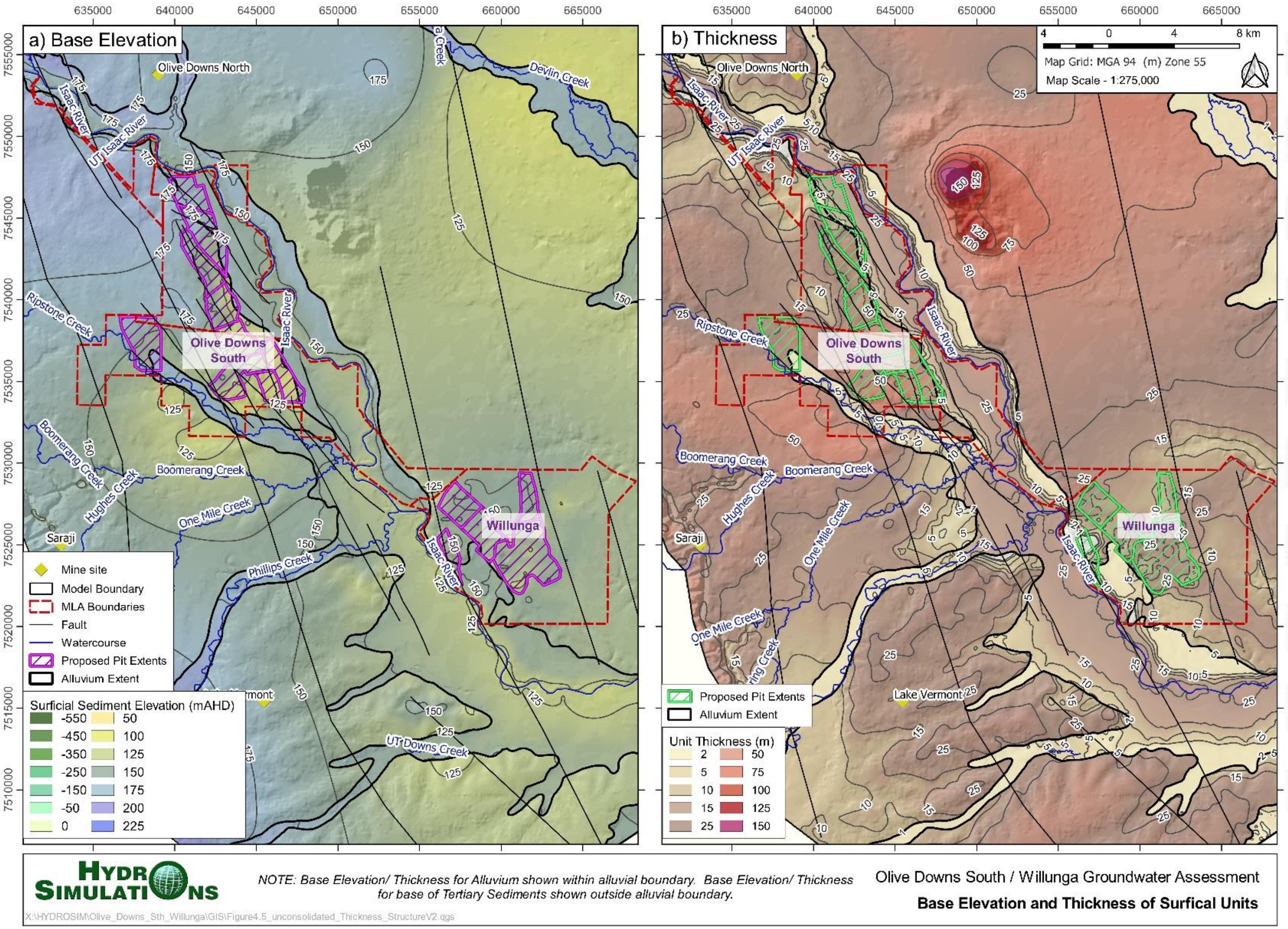

Figure 4-5 Base Elevation and Thickness of Surficial Units

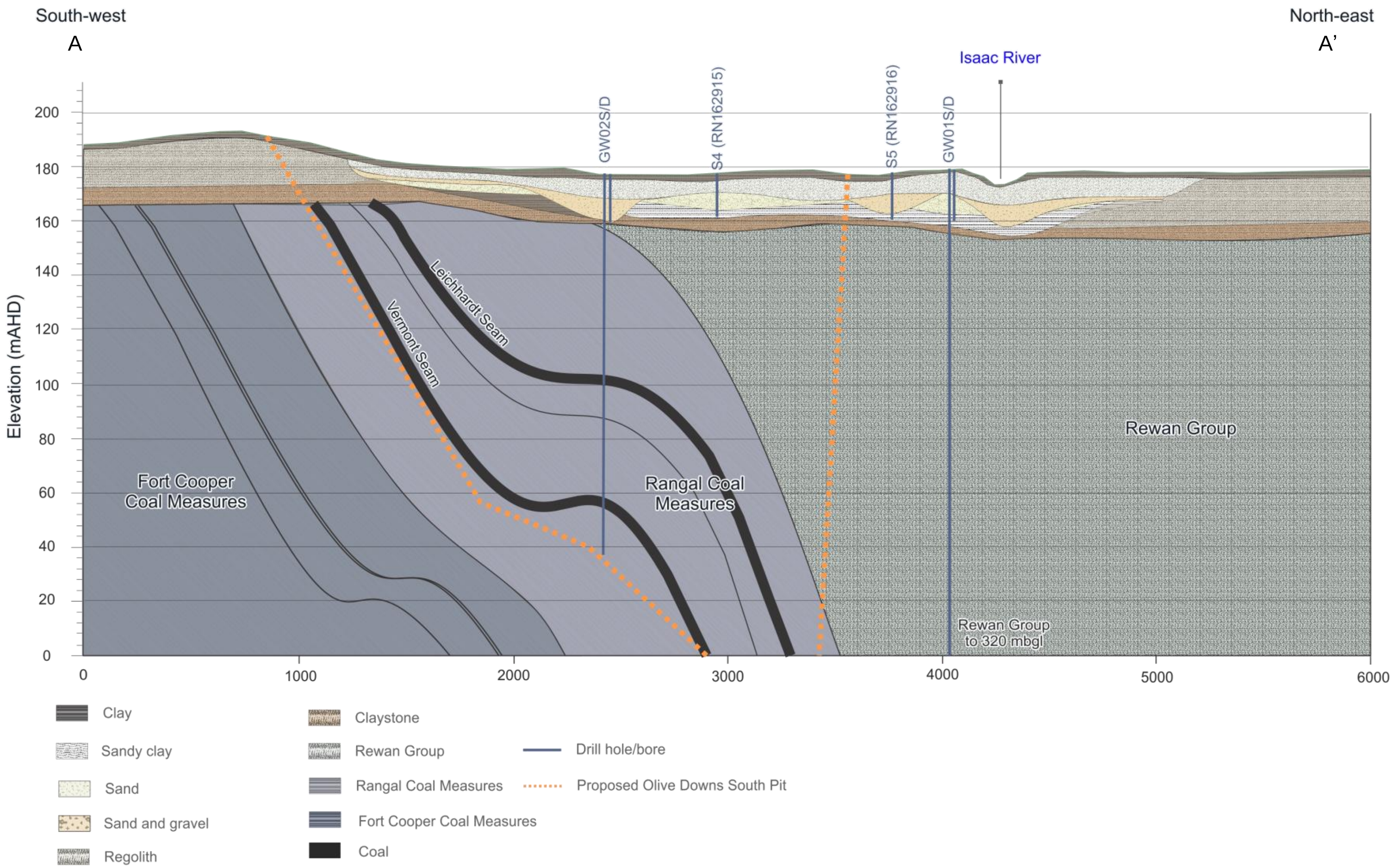

Figure 4-6 Geological Cross Section – ODS Domain

Based on site geological logs, the regolith comprises a heterogeneous distribution of fine to coarse grained sand, clay, sandstone and claystone. The regolith material is generally 15 m to 45 m thick. The units are all recorded as being highly weathered, with the depth of weathering extending to around 50 m below ground level (mbgl), into the underlying coal measures (IMC 2014). The extent and thickness of the regolith material is presented in **Figure 4-4**, interpolated based on site geological data and the CSIRO Soil and Landscape Grid of Australia (CSIRO 2015) data.

4.2.2 TRIASSIC

The Triassic sediments include an isolated pocket of Clematis Group sediments to the east of the Isaac River near the ODS domain, and the more regionally extensive Rewan Group. The outcrop of Clematis Group is approximately 100 m thick and forms a localised topographic high at an elevation of around 330 mAHD. The Clematis Group comprises cross-bedded quartzose sandstone with minor conglomerate and mudstone.

Regionally the Rewan Group unconformably overlies the Permian coal measures as in-fill material. The unit is largely absent where the Permian coal measures occur at outcrop, and thickens towards the Isaac River. At the Project Site, the Rewan Group is present throughout the Vermont Park and southern Iffley areas but is limited to a small area in the north-western corner of Willunga only.

The Triassic aged Rewan Group sediments include two formations, the Rewan Formation that comprises green lithic sandstone, pebbly lithic sandstone, green to reddish brown mudstone and minor volcanolithic pebble conglomerate, and the underlying Sagittarius Sandstone unit that comprises lithic sandstone interbedded with mudstones and siltstones with scattered carbonaceous plant material.

The Rewan Group occurs beneath the alluvium and regolith, from approximately 20 m depth, and is up to around 300 m thick where it occurs within the Project Site (**Figure 4-7**). The transition from the Rewan Group to the underlying Permian coal measures is generally difficult to define. Transition is often based on the change in colour (i.e. green-grey to blue-grey) and depth (15 m to 60 m) above the first major coal seam (Leichhardt Seam) of the Rangal Coal Measures (JB Mining Services 2016). Interpolated structure and thickness contours of the Rewan Group at the Project Site are presented in **Figure 4-7**, based on the site geological model, drill data and other publicly available data.

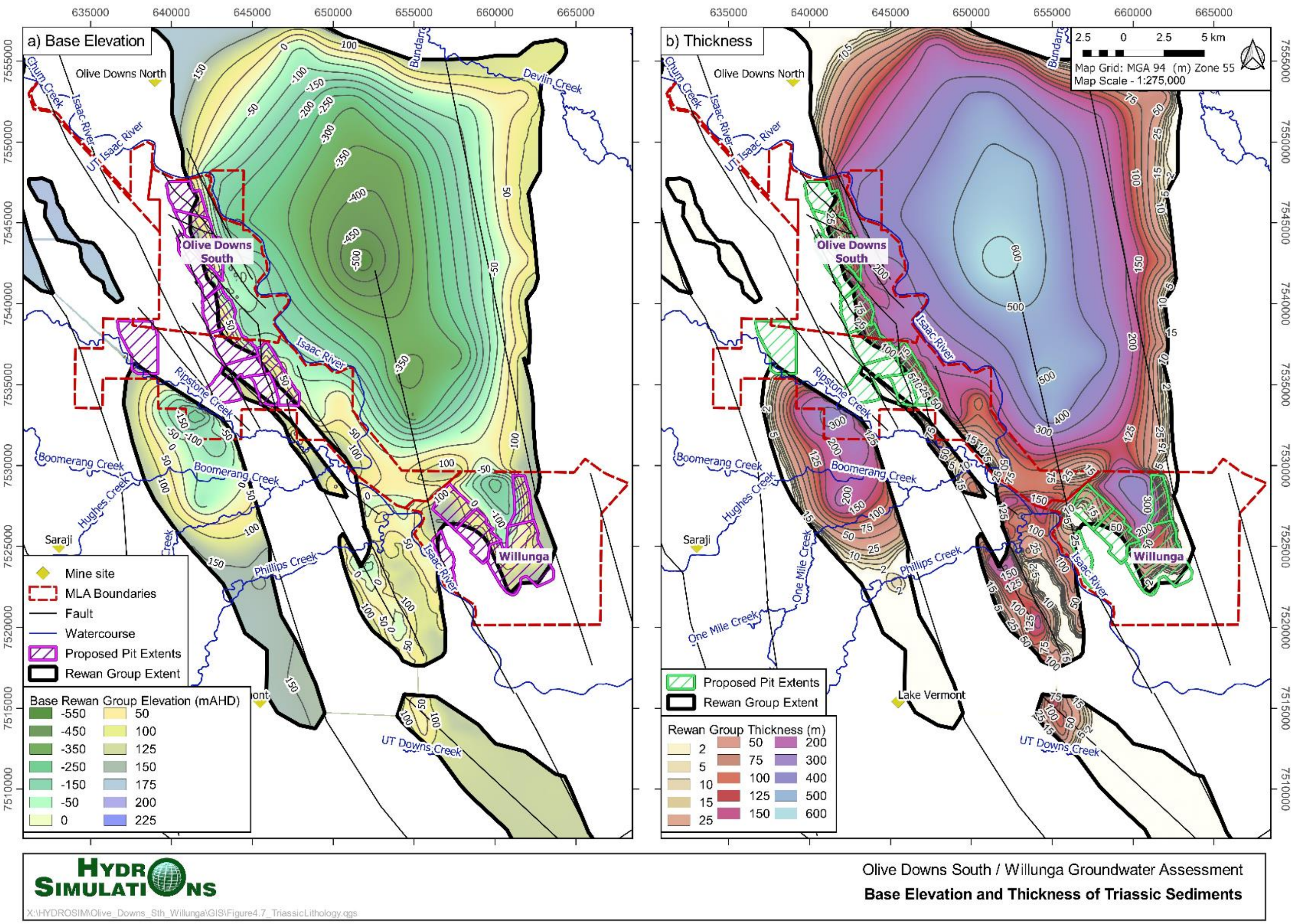

Figure 4-7 Structure and Thickness of Triassic Sediments

4.2.3 PERMIAN COAL MEASURES (BLACKWATER GROUP)

Permian coal-bearing sediments of the Blackwater Group form the main economic resource of the numerous mines in the Study Area. In increasing depth (age) order, the major coal measures in the area include the:

- Rangal Coal Measures;
- Fort Cooper Coal Measures; and
- Moranbah Coal Measures.

Each of these units is discussed further below.

Rangal Coal Measures

The shallowest coal measures, the Rangal Coal Measures are around 90 m – 195 m thick at the Project Site and contain the target seams for the Project (JB Mining Services 2016). The Rangal Coal Measures comprise light grey, cross-bedded, fine to medium grained labile and well cemented sandstones, grey siltstones, mudstones, shale and coal seams. The non-coal portions of the sequence being predominantly sandstones, siltstones, mudstone and shales are referred to as interburden in the mining context. The stratified sequences can be fractured and displaced through faulting. However, drilling logs indicate this is localised along fault lines and is logged as small, discontinuous horizons vertically (< 20 m). Further details on the structural geology are outlined within **Section 0**.

The principal coal seams of the Project are the Lower Leichhardt and Vermont Upper seams of the Rangal Coal Measures. Within the Project Site, the Lower Leichhardt Seam has three main splits:

- LL1 (Lower Leichhardt 1) – < 1 m thick
- LL2 (Lower Leichhardt 2) – approximately 2.5 m thick
- LL3 (Lower Leichhardt 3) – approximately 1.7 m thick;
- The Leichhardt Seam occurs at depths of between 25 m and 317 mbgl, at elevations of around 150 mAHD to -142 mAHD at ODS domain (IMC 2014). At Willunga, the Leichhardt Seam occurs 30 m to 270 mbgl, at elevations of around 130 mAHD to -110 mAHD (IMC 2012). The Vermont Upper Seam (VU2) is approximately 3.8 m to 5.1 m thick and is separated from the overlying Leichhardt Seam by 29 m to 54 m of interburden material. Representative stratigraphic columns (**Figure 4-8**) show the average seam thickness at the Project Site. Based on the site geological model and drilling data, interpolated structure and thickness contours of the Lower Leichhardt Seam and Vermont Upper Seam at the Project Site are presented in **Figure 4-9** and **Figure 4-10**, respectively.

Fort Cooper Coal Measures

The Fort Cooper Coal Measures conformably underlie the Rangal Coal Measures and also occur at outcrop to the east and west of the Isaac River. At the Project Site, drilling logs indicate the Fort Cooper Coal Measures are present around 20 m below the Vermont Upper Seam, around 140 m to 380 mbgl (IMC 2012; IMC 2014).

The unit is approximately 350 m thick and comprises tuffaceous sandstones, siltstones, mudstones and coal seams. The transition between the Rangal Coal Measures and the Fort Cooper Coal Measures is marked by the 0.5 m to 1.5 m thick Yarrabee Tuff; a basin-wide marker bed comprised of weak, brown tuffaceous claystone. Economic coal seams of the Fort Cooper Coal Measures include the Vermont Lower Seam, although the unit is not intended to be targeted by mining at the Project.

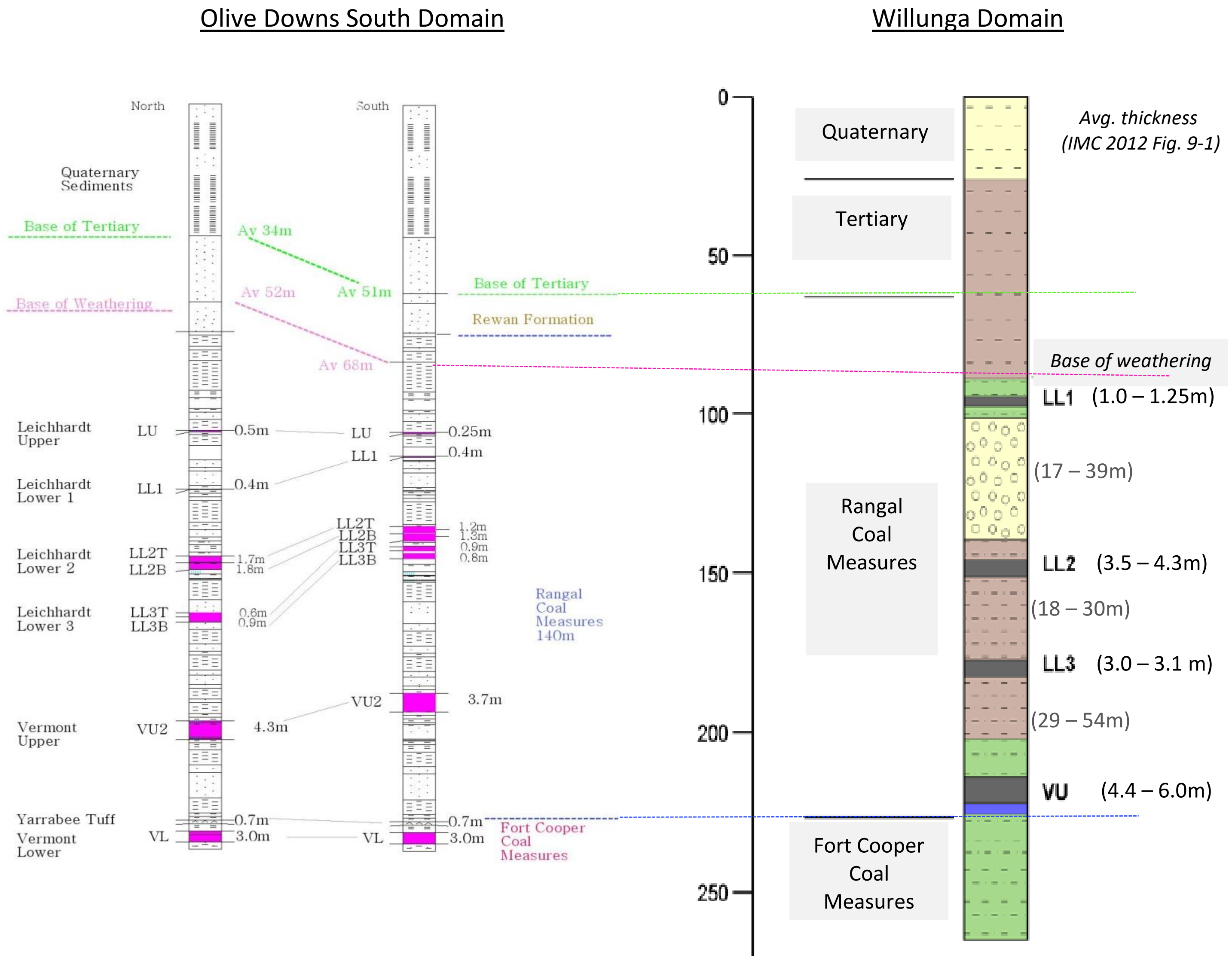

Figure 4-8 Representative Stratigraphic Sections for the ODS Domain (IMC 2014) and Willunga Domain (IMC 2012)

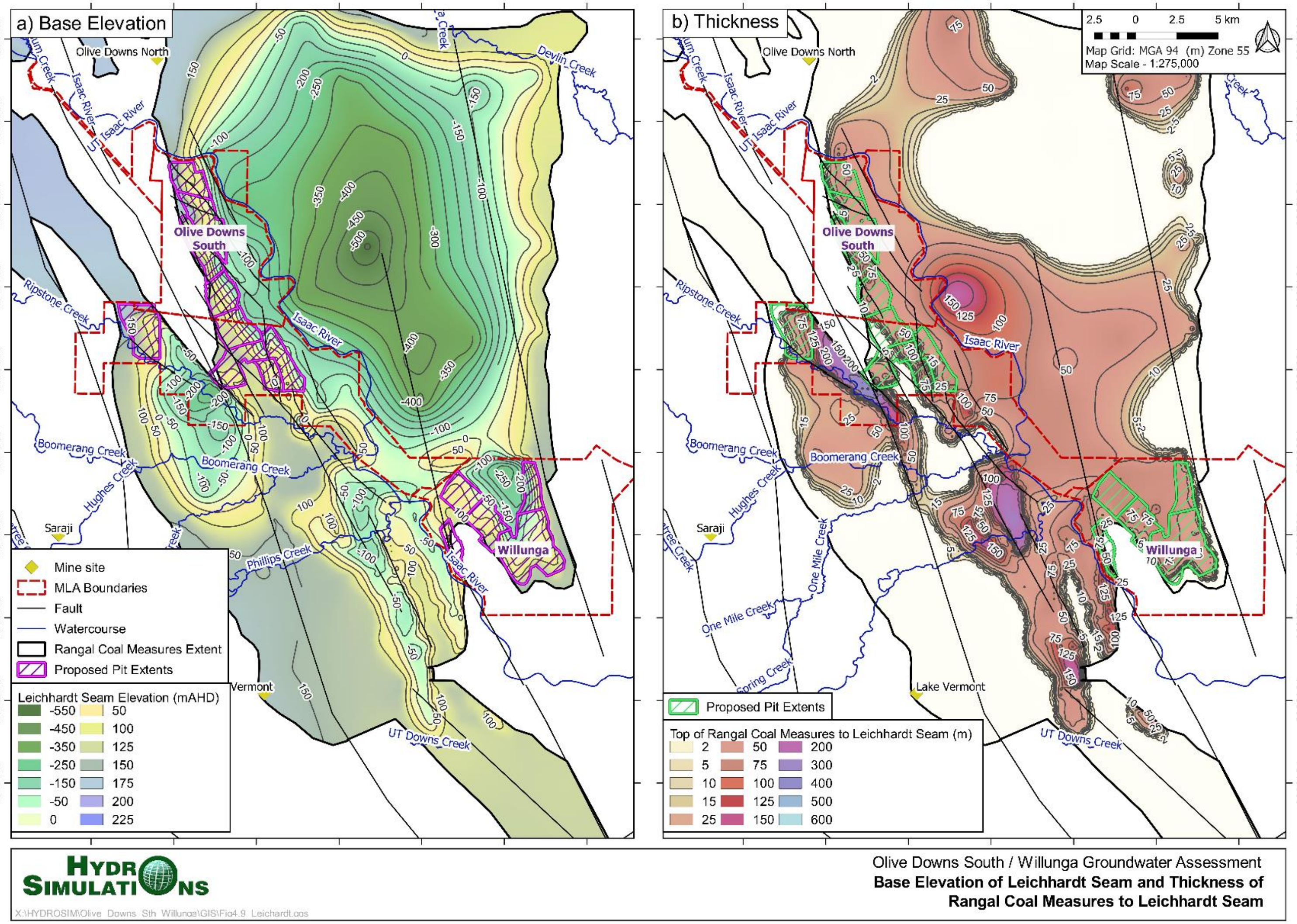

Figure 4-9 Base Elevation of Leichhardt Seam and Thickness of Rangal Coal Measures to Leichhardt Seam

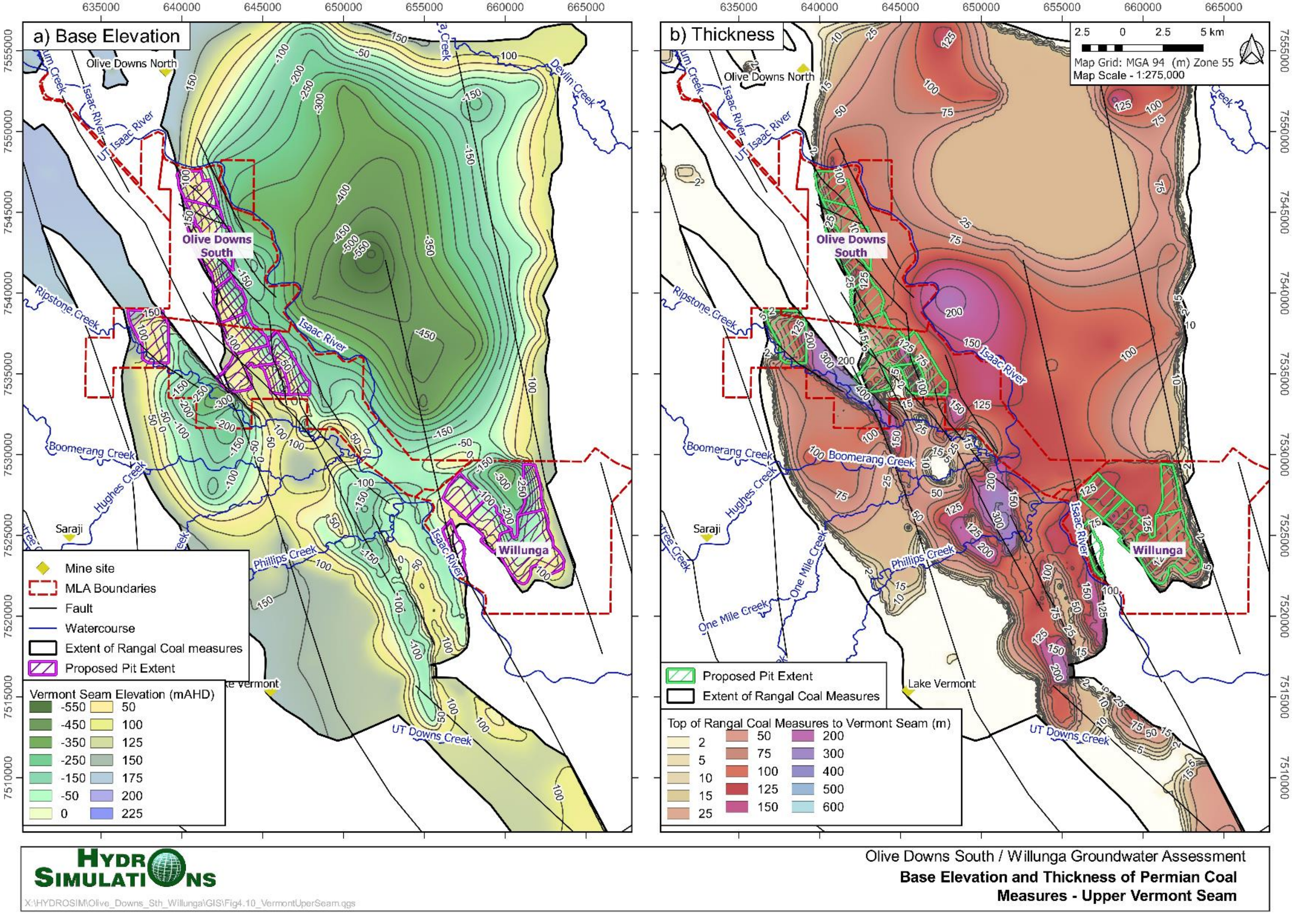

Figure 4-10 Base Elevation and Thickness of Permian Coal Measures to Upper Vermont Seam

Moranbah Coal Measures

The Moranbah Coal Measures conformably underlie the Fort Cooper Coal Measures. The coal measures occur at subcrop to the west of the Project Site, where they are targeted as part of the Peak Downs and Saraji mines. The Moranbah Coal Measures comprise volcanic lithic sandstones, with lesser siltstone, mudstone, conglomerate and coal.

4.2.4 STRUCTURAL GEOLOGY

The Permian coal measures occur as stratified sequences of interbedded and consolidated sandstone, siltstone, mudstone and coal. The Permian coal measures occur as a southerly plunging syncline structure, with the coal measures present at outcrop to the east and west of the Isaac River. Igneous intrusions are present within the region, with the Bundara Intrusive Complex and Feeder Dyke located to the north-east, near Daunia Mine (IMC 2012). However; igneous intrusions are largely limited to the deeper Fort Cooper Coal Measures and no major features have been mapped at site.

Compressive deformation of the Bowen Basin units occurred from the Middle to Late Triassic period, resulting in regional uplift and erosion, folding of sediments and strike-slip movement along faults to accommodate contraction. This lead to a series of north-south trending faults with (generally) westward directed thrusts, which bound the eastern margin of the basin (Green, 1997). All faulting is truncated by the Tertiary unconformity, with little to no fault activity during the Cainozoic (Esterle *et al.,* 2002, Clark *et al.,* 2011). Regional faults are shown on **Figure 4-2**, including faults mapped by Pembroke and potential faults identified as part of the TEM survey.

Within the ODS domain, the coal measures dip around 7° to the east, which steepens in the south to 15° to the east. The ODS domain is moderately to highly faulted with several regional fault structures with a dominant north-north-west trend, including the Iffley Fault Zone. The faults have throws of up to 100 m (JB Mining Services 2016), resulting in vertical displacement in some places. On the western side of the ODS domain is the Isaac Thrust Fault, which has up to 500 m vertical displacement. This displacement effectively separates the two proposed open cut pits within the ODS domain.

At Willunga, the coal measures dip around 5° to 7° towards the west. However, dips within the Willunga domain can vary due to minor folding, with an eastern and western syncline separated by a small anticline (IMC 2014). The Willunga domain does not appear to have any significant faulting.

5 HYDROGEOLOGY

Based on the understanding of the geological setting presented above, the hydrogeological regime relevant to the Project comprises the following hydrogeological units:

- Cainozoic sediments:
  - Quaternary alluvium – unconfined aquifer localised along Isaac River
  - Regolith – unconfined and largely unsaturated unit bordering alluvium;
- Triassic Rewan Group – aquitard;
- Permian coal measures with:
  - Hydrogeologically ‘tight’ interburden units; and
  - Coal sequences that exhibit secondary porosity through cracks and fissures.

The sandstones of the Clematis Group are generally considered to form an aquifer and are included within the Great Artesian Basin (GAB) aquifers. However, at Project Site the unit only occurs as a small isolated outcrop, and is not regionally extensive or hydraulically connected to the GAB. Consequently, the Clematis Group is not discussed in detail in this report.

This section discusses each of the hydrogeological units relevant to the Project, covering hydraulic properties, groundwater occurrence, hydraulic gradients, recharge, discharge, groundwater quality and water use.

5.1 GROUNDWATER MONITORING

Pembroke has a Project groundwater monitoring network that comprises a total of 21 bores and five vibrating wire piezometers (VWP) containing a total of 20 sensors. The network was first established in November 2016, and in November 2017 additional alluvial monitoring bores (S-series bores) were constructed. The network’s monitoring bores target a range of hydrostratigraphic units, including:

- Quaternary alluvium
- Regolith (Cainozoic sediments)
- Rewan Group
- Coal seams of the Rangal Coal Measures
- Interburden and overburden material of the Rangal Coal Measures.

The locations of the 26 monitoring bores are shown in **Figure 5-1** and details provided in **Table 5-1**. Further details about the groundwater monitoring network are included within **Appendix A**.

Table 5-1 Project Groundwater Monitoring Network

Hole	Site		Project	Type	Easting	Northing	Screen Depth (mbgl)	Monitored Unit	T.D. (m)
IF3839P	GW01s		Iffley	MB	642481	7547491	13 - 19	Alluvium	20
IF3837P	GW02s		Iffley	MB	641152	7546517	7 - 19	Alluvium	19
IF3838P	GW02d		Iffley	MB	641141	7546507	118.65 - 127.65	VU	137
IF3841P	GW04		Iffley	MB	643388	7544973	6 - 15	Alluvium	41
IF3835P	GW06s		Iffley	MB	639329	7542005	4 - 10	Regolith	10
VP3833P	GW08s		Iffley	MB	645312	7539839	6 - 12	Alluvium	13
VP3831P	GW12s		Vermont Park	MB	641504	7532788	30 - 42	Regolith	42
VE3827P	GW16s		Willunga	MB	660836	7525291	12 - 27	Regolith	27
VE3829P	GW18s		Willunga	MB	656889	7522809	9 - 15	Alluvium	15
VE3830P	GW18d		Willunga	MB	656868	7522804	174 - 183	VU	183
VE3825P	GW21s		Willunga	MB	661590	7521656	3 - 9	Regolith	9
VE3826P	GW21d		Willunga	MB	661585	7521655	148 - 157	Rangal Interburden	157
IF3856P	S7		Iffley	MB	641443	7545828	14.5 – 20.5	Alluvium	21
IF3857P	S9		Iffley	MB	641767	7545426	14.5 – 20.5	Alluvium	22
IF3858P	S11		Iffley	MB	642455	7545332	8 - 14	Alluvium	14
IF3859P	S10		Iffley	MB	642552	7546035	18 - 24	Alluvium	24
IF3860P	S8		Iffley	MB	642340	7546343	9 - 15	Alluvium	15
IF3861P	S6		Iffley	MB	642054	7546721	11.5 – 17.5	Alluvium	21
IF3862P	S4		Iffley	MB	641567	7546845	11.5 – 17.5	Alluvium	18
IF3863P	S5		Iffley	MB	642239	7547332	11.5 – 17.5	Alluvium	24
IF3864P	S2		Iffley	MB	641386	7547617	11.5 – 17.5	Alluvium	18
IF3840P	GW01d	VWP1	Iffley	VWP	642479	7547491	402	VU	413
		VWP2					352	Leichhardt Seam	
		VWP3					221.5	Rewan	
		VWP4					63	Rewan	
IF3836P	GW06d	VWP1	Iffley	VWP	639334	7542008	190.7	Fort Cooper - siltstone	203
		VWP2					136.5	Fort Cooper - coal	
		VWP3					117.5	Fort Cooper - sandstone	
		VWP4					38	Fort Cooper - sandstone	

Hole	Site		Project	Type	Easting	Northing	Screen Depth (mbgl)	Monitored Unit	T.D. (m)
VP3834P	GW08d	VWP1	Iffley	VWP	645312	7539846	177	Leichhardt Seam	585
		VWP2					137	Rangal Overburden	
		VWP3					94	Rewan	
		VWP4					70*	Rewan	
VP3832P	GW12d	VWP1	Vermont Park	VWP	641495	7532795	505	Leichhardt Seam	519
		VWP2					484.5	Leichhardt Seam	
		VWP3					391*	Rangal Overburden	
		VWP4					108*	Rewan	
VE3828P	GW16d	VWP1	Willunga	VWP	660835	7525287	327*	VU	339
		VWP2					269	Leichhardt Seam	
		VWP3					147	Rewan	
		VWP4					91	Rewan	

Note: Coordinates in GDA 94 MGA Zone 55
mbgl – meters below ground level

T.D. – total drilled depth of bore, in meters below ground level

VU – Vermont Upper Seam (coal)

MB – open standpipe monitoring bore

VWP – vibrating wire piezometer

* Sensor giving potentially erroneous readings from installation

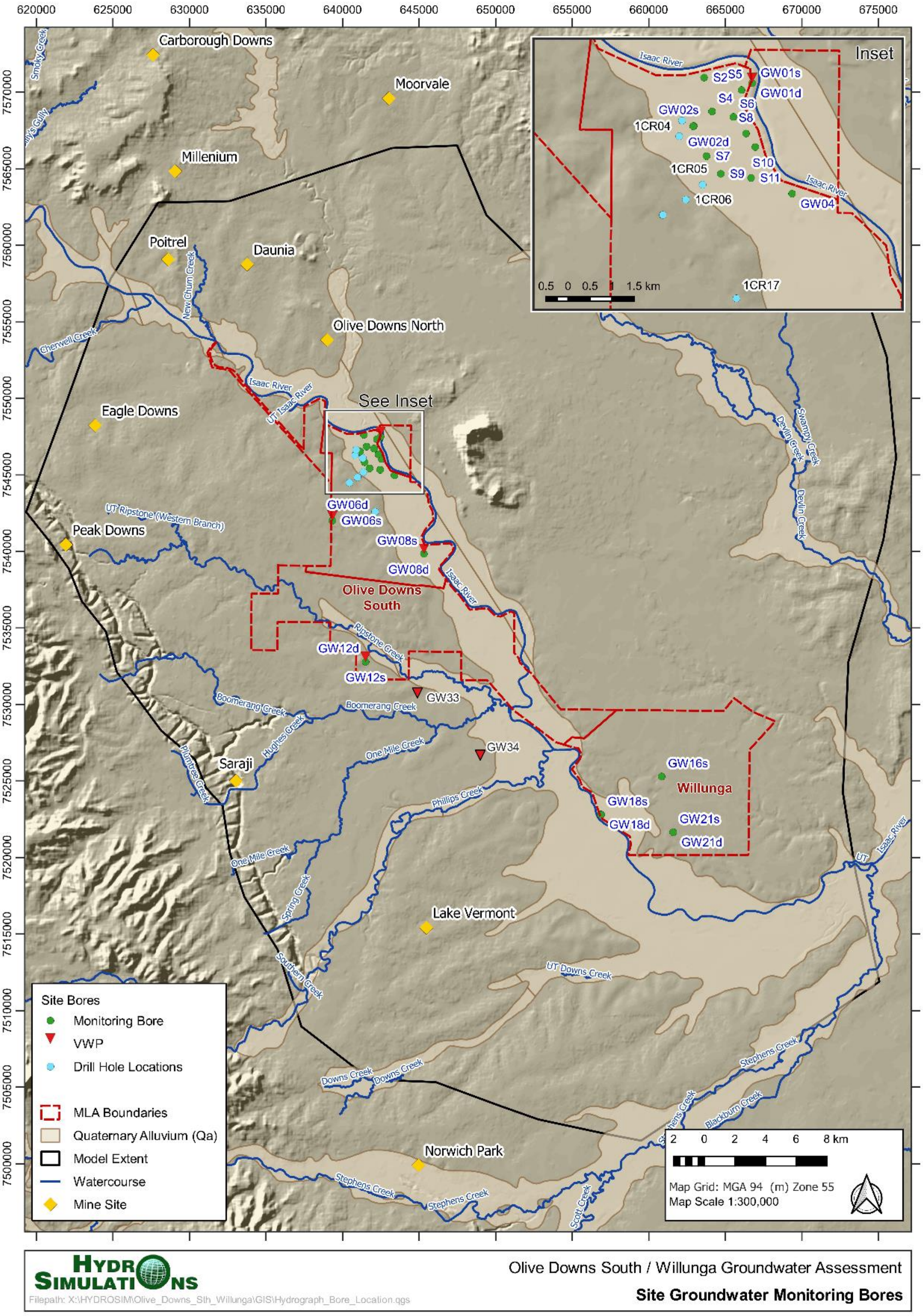

Figure 5-1 Site Groundwater Monitoring Bores

5.2 HYDRAULIC PROPERTIES

As part of this groundwater assessment, extensive hydraulic testing was conducted on all major geological units at site. This included testing of core samples for vertical and horizontal hydraulic conductivity (anisotropy), slug testing and packer testing for horizontal hydraulic conductivity, as well as documented airlift yields. This section presents a summary of the field hydraulic data and comparison to reported hydraulic properties within external sources. Full details on the hydraulic testing conducted is included within **Appendix A.**

5.2.1 SITE HYDRAULIC DATA

Field results for horizontal (Kh) and vertical (Kv) hydraulic conductivity are presented in **Figure 5-2**, separated by test method. The method is presented as results can vary based on the analysis undertaken.

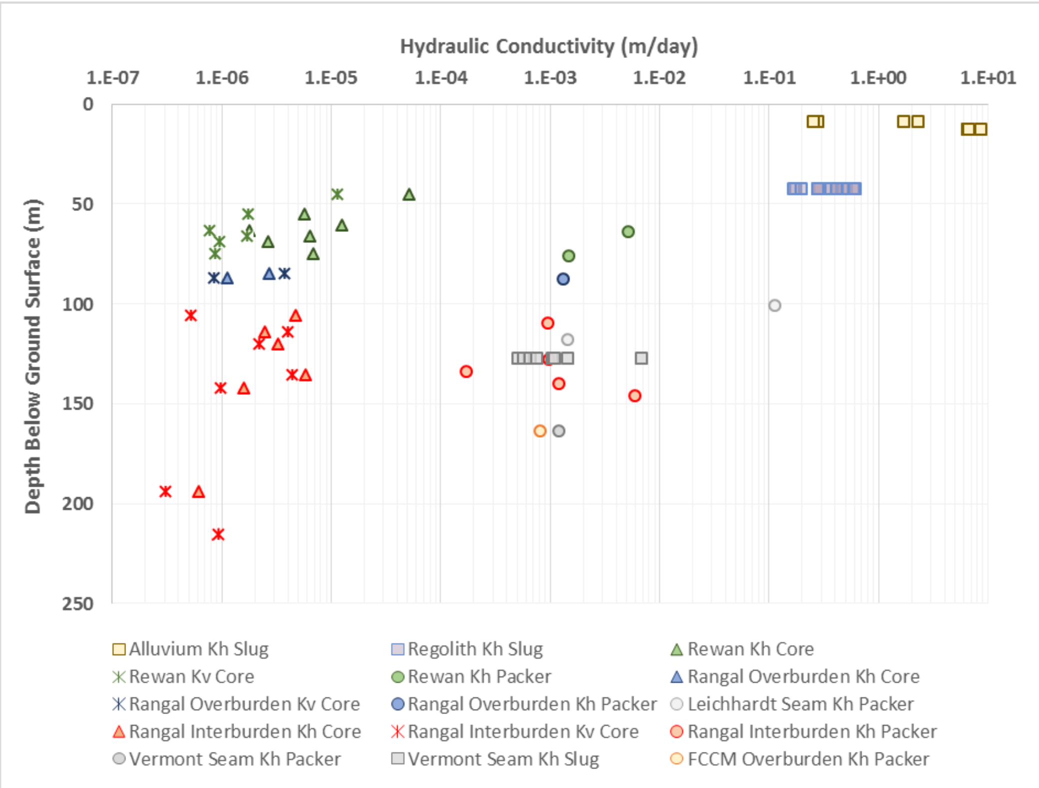

Figure 5-2 Summary of Results for All Site Hydraulic Testing

The testing results are summarised in **Table 5-2**. The results show that the hydraulic conductivity of the alluvium is variable, which reflects the heterogeneous nature of the alluvial sediments. The Rewan Group sediments exhibit a low permeability, similar to the interburden/overburden material of the Rangal Coal Measures. The coal seams of the coal measures recorded higher hydraulic conductivity. This is due to the dual porosity of the coal seams, with a primary matrix porosity and a second (dominant) porosity provided by fractures (joints and cleats). **Figure 5-2** shows that the hydraulic conductivity of the Rewan Group sediments as well as the Permian coal measures, declines with depth. This is due to increasing overburden pressure reducing the aperture of fractures and cleats.

Comparison of Kh and Kv indicates that within the Rewan Group materials the Kv is around 10% to 40% of Kh. Anisotropy for the Rangal Coal Measures interburden material was more variable, with Kv ranging between 11% and 76% of Kh. Some core samples were collected within the coal seam roof/ floor material and proximal to fault zones, where practicable (i.e. for competent samples).

Results for these samples indicated a Kv of between 50% to 160% of Kh. It should be noted that with numerical groundwater modelling, model layers represent a simplification of multiple stratified sequences. Therefore the modelled Kv will have a greater ratio (i.e. 1:100) compared to field readings for a single discrete unit.

Table 5-2 Project Hydraulic Testing Results Summary

	Kh range (m/day)	Kv range (m/day)
Alluvium	2.6×10^{-1} to 8.7	-
Regolith	1.7×10^{-1} to 6.2×10^{-1}	-
Rewan Group	1.8×10^{-6} to 5.2×10^{-3}	7.8×10^{-7} to 1.1×10^{-5}
Rangal Coal Measures – Interburden/ Overburden	6.2×10^{-7} to 6.0×10^{-3}	3.1×10^{-7} to 4.5×10^{-6}
Rangal Coal Measures – Coal	5.2×10^{-4} to 1.2×10^{-1}	-
Fort Cooper Coal Measures - Overburden	8.2×10^{-4}	-

5.2.2 HYDRAULIC CONDUCTIVITY RANGES

A histogram of the spread of hydraulic conductivity (Kh) from the field testing is presented in **Figure 5-3**. The results are compared to the range of documented values for the various units, as presented in **Appendix A**.

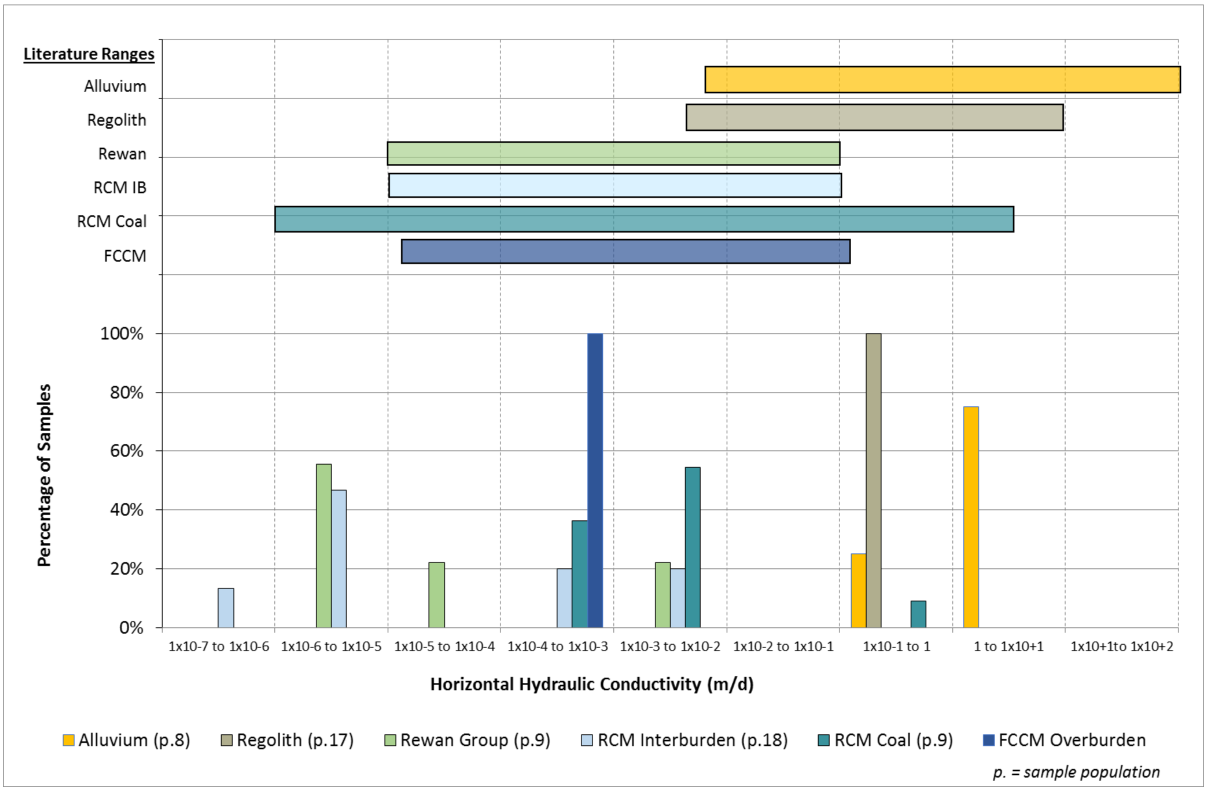

Figure 5-3 Histogram of Horizontal Hydraulic Conductivity (Kh) Distribution

The comparison shows that the field results for alluvium, regolith, Rangal Coal Measures coal and Fort Cooper Coal Measures fall within the range of field data collected through other studies across the Bowen Basin. However, the site data records some lower readings for the Rewan Group, and a broader range in results for the Rangal Coal Measures interburden.

5.2.3 FAULTS

As discussed in **Section 0**, faulting has been mapped within the Permian Coal Measures at the Project Site, which includes the Isaac Thrust Fault Zone. As identified by Jourde *et al.* (2002), faulting can result in higher permeabilities within strata parallel with the fault plane, and lower permeabilities within strata perpendicular to the fault plane. However; this can also be dependent on whether faults are currently active (Paul *et al.* 2009). Faulting has been inactive within the Bowen Basin for over 140 million years (Clark *et al.* 2011), indicating that the fault zones are less likely to act as conduits to flow. This relates to filling of the fractured pore spaces over time through hydrothermal alteration and mineralisation (Uysal *et al.* 2000). Drill core logs from the Project Site show that where fractures and faults have been geologically logged, many fractures are “healed” with calcite and siderite. This indicates that although the system is a fractured network, many of the existing fractures are cemented. This cementation is likely to have an effect of reducing effective permeability when compared to any open fracture network.

As discussed in **Section 5.2.1**, to help understand the hydraulic properties of the site stratigraphy, analysis of coal seam roof/ floor core samples collected proximal to a fault zone was undertaken. The samples recorded vertical hydraulic conductivity of around 50% to 160% of horizontal conductivity. This indicates the faulting may provide either conduits or barriers to vertical flow at the Project Site. It is also noted that areas of increased Kv are limited vertically, with samples collected from the same drill hole at different horizons (interburden and Rewan Group) returning a lower Kv of between 11% and 76% of Kh.

The behaviour of faults within the Study Area was also assessed as part of the Bowen Gas Project. Kinnon (2010) assessed the movement of water and gas across a series of faults in the Bowen Basin using stable isotope and water quality analysis to assess zones of potential recharge, water mixing and flow pathways. Higher gas production rates were also observed on either side of a major fault, with differences in isotopic compositions of produced water for wells north and south of the major fault line at similar depths, implying little communication across the fault boundary, and suggesting that the fault acts as a permeability barrier to water and gas flow. The results of the study showed that compartmentalisation was evident and that this was due to the structural geology (faulting) in the basin.

Based on a detailed literature review of the effect of faulting on groundwater flow, Coffey (2014) has developed a conceptual model for fault zone hydraulic characterisation in the Bowen Basin (**Figure 5-4**), largely based on Jourde *et al.* (2002) and Flodin *et al.* (2001). This conceptualisation provides a means of inferring hydraulic conductivities of the fault core and the fault damage zone from regional hydraulic conductivity, with the fault core typically one to three orders of magnitude lower conductivity than the regional host rock, and the damage zone approximately 1 order of magnitude higher. Section 6.1.1 in **Appendix B** describes a novel method of simulating the fault core and the fault damage zones which allows the full range of barrier or conduit or mixed characteristics of the fault zone to be explored through rigorous uncertainty analysis.

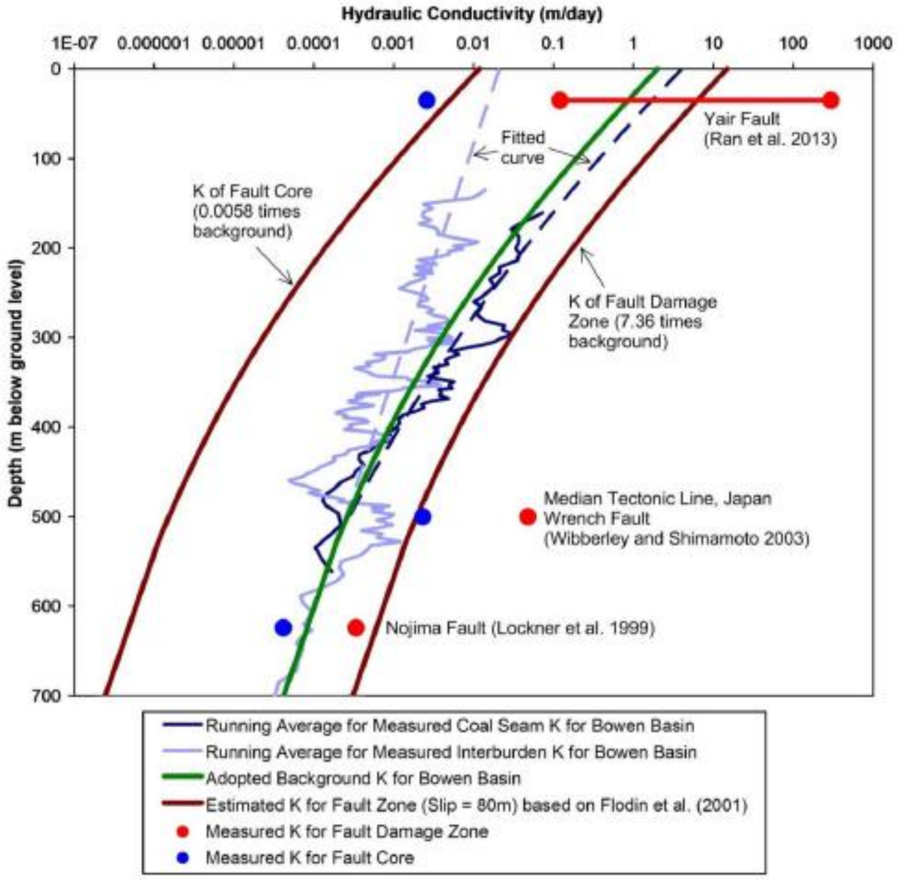

Figure 5-4 Fault Conceptual Model Developed by Coffey (2014) Based on Other Studies

5.3 GROUNDWATER DISTRIBUTION, FLOW, RECHARGE AND DISCHARGE

This section presents a discussion on the distribution and flow of groundwater plus the recharge and discharge processes for alluvium, regolith, Rewan Group sediments and Permian coal measures.

5.3.1 ALLUVIUM

Distribution and Flow

Groundwater monitoring conducted at the Project includes 14 monitoring bores intersecting the alluvium (GW01s, GW02s, GW04, GW08s, GW18s, S2 and S4 to S11). Of the bores, four (GW04, GW08s, S2 and S11) have remained dry between June 2017 and February 2018. The remaining bores record a saturated thickness of between 2 m to 12 m within the alluvium. **Figure 5-5** presents the mapped extent of alluvium and the saturated thickness interpolated from available data and groundwater modelling. The figure shows that the surficial alluvium along the upper reaches of creeks is largely dry. Alluvium of the Isaac River itself does appear saturated however, with the greatest saturated thickness along the river alignment.

A spatial contour distribution of groundwater levels in the Isaac River alluvium (**Figure 5-6**) has been developed using a combination of water levels obtained in alluvial monitoring bores installed as part of the Project, and from water level observations collected during the landholder bore census survey in October 2017. The water levels in the alluvium clearly follow the down-stream flow gradient of the Isaac River, with southeasterly flow gradients. Alluvial groundwater elevations range from around 167 mAHD at the northern end of the ODS domain, down to 140 mAHD at the Willunga domain to the southeast.

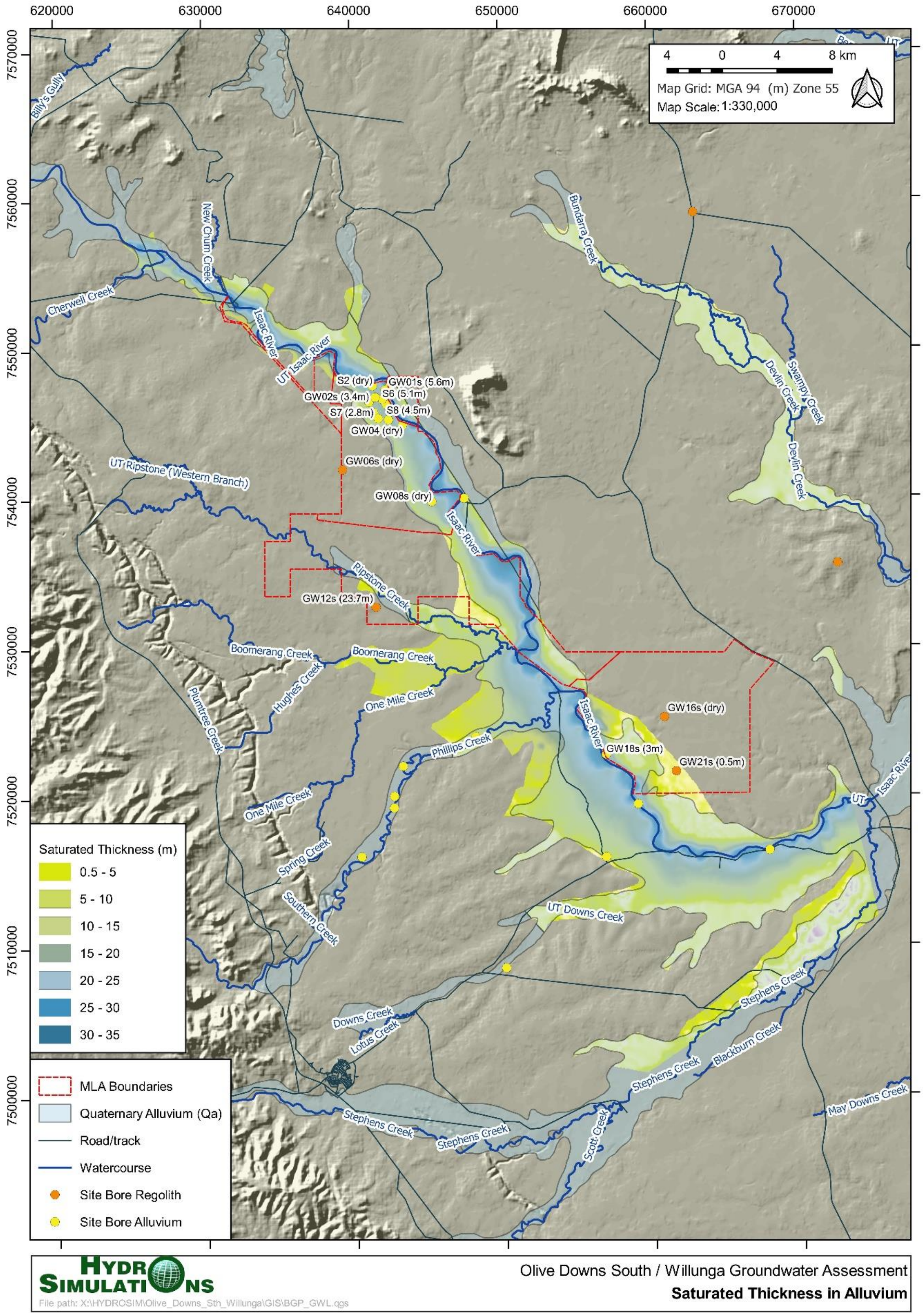

Figure 5-5 Saturated Thickness in Alluvium

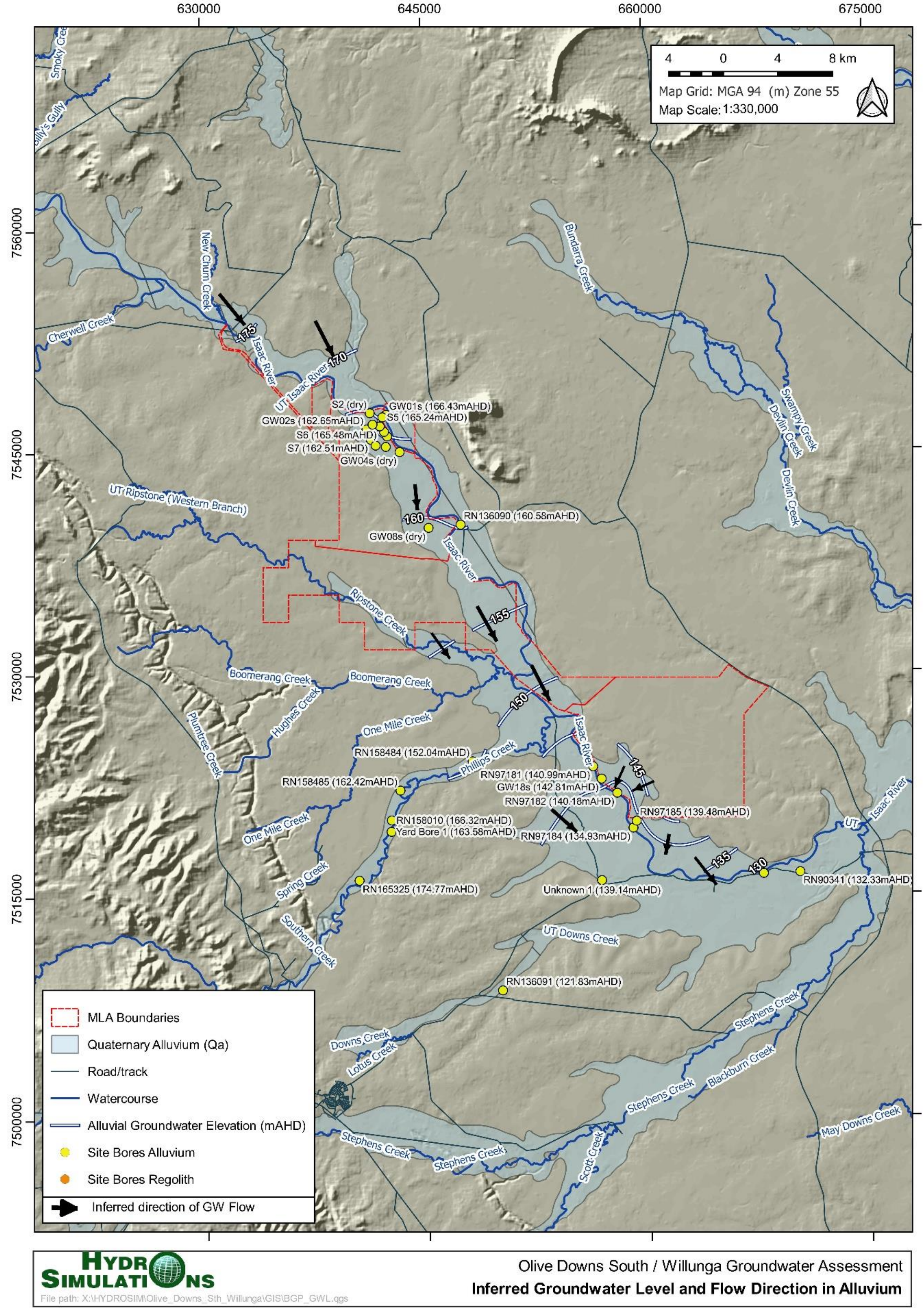

Figure 5-6 Inferred Groundwater Level and Flow Direction in Alluvium

Recharge and Discharge

Groundwater within the alluvium is unconfined, with water levels between 10 and 20 mbgl (the top of the unit). Alluvial groundwater levels at the ODS domain are presented in **Figure 5-7** and in **Figure 5-8** (bore GW18s) for Willunga. Groundwater elevations at the ODS domain range between 162 mAHD and 167 mAHD, around 10 to 17 mbgl. The higher elevations (S8 and GW01s) recorded for bores positioned closest to the Isaac River. Groundwater elevations for bore GW18s (**Figure 5-8**) are at around 143 mAHD, approximately 13 mbgl.

As shown in **Figure 5-7** and **Figure 5-8**, groundwater levels within the alluvium have remained relatively stable to slightly declining from June 2017 to December 2017. Bore GW01s records the greatest change in groundwater levels over the monitoring period, with a 1.4 m decline from June 2017 to February 2018, despite above average rainfall experienced from October 2017 to December 2017 and over February 2018. The lack of response to rainfall trends may relate to the presence of surficial clays restricting groundwater recharge, as discussed in **Section 4.2**.

Figure 5-7 presents the elevation of water (ponded or flowing) within the Isaac River as recorded at the Deveril stream gauge located 200 m from bore GW01s. As shown in the figure, levels at GW01s remained over 3 m below the river elevation between June 2017 and February 2018, indicating losing conditions at the ODS domain. **Figure 5-8** shows the approximate level of the Isaac River near GW18 based on the digital elevation model (DEM) from site. The graph shows that groundwater levels are around 3 m below the river elevation between June 2017 and February 2018, indicating losing conditions at the Willunga domain. Surface water and groundwater interactions are discussed further in **Section 5.3.5**.

Overall, recharge to the alluvium is considered to be mostly from stream flow or flooding (losing streams), with direct infiltration of rainfall also occurring where there are no substantial clay barriers in the shallow sub-surface. Groundwater within the alluvium is likely discharged as evapotranspiration from riparian vegetation growing along the Isaac River, as well as potential baseflow contributions after significant rainfall and flood events. Geological logs indicate the alluvium is underlain by low permeability stratigraphy (i.e. claystone, siltstone and sandstone) at the Project, which likely restricts the rate of downward leakage to underlying formations. Localised perched water tables within the alluvium are evident where waterbodies continue to hold water throughout the dry period (e.g. pools in the Isaac River and floodplain wetlands) occurring where clay layers slow the percolation of surface water.

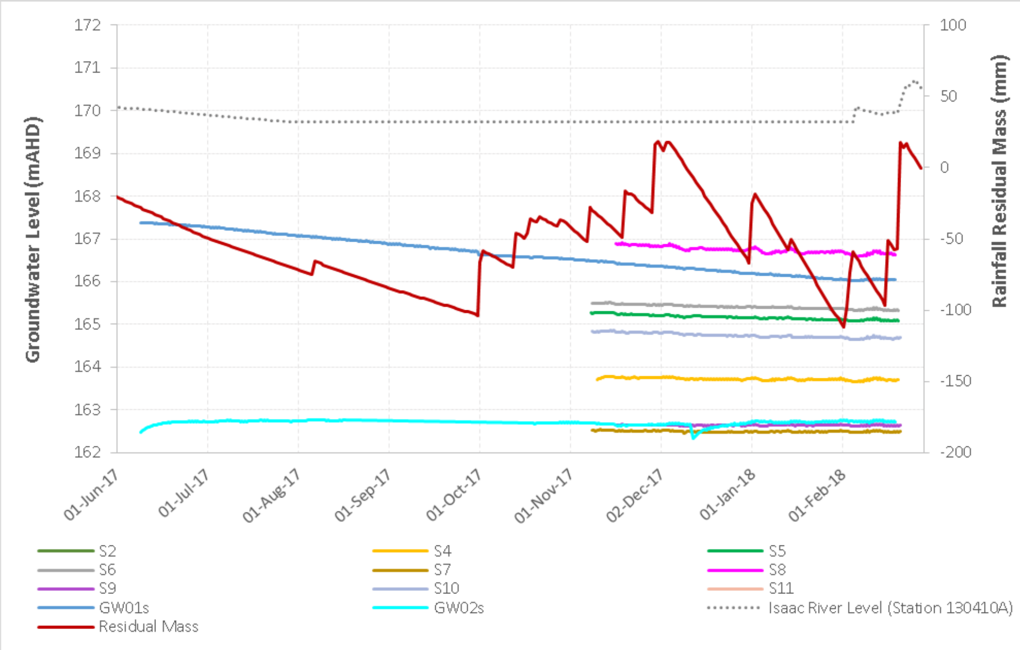

Figure 5-7 Hydrograph of Alluvial Groundwater Trends at ODS Domain

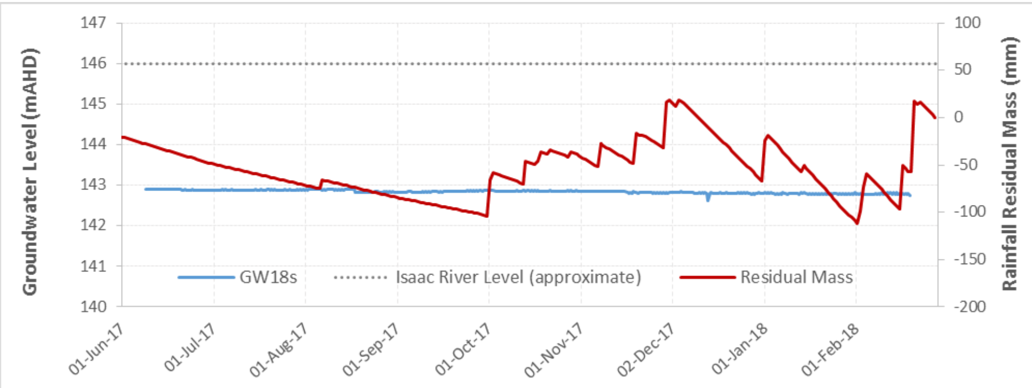

Figure 5-8 Hydrograph of Alluvial Groundwater Trends at Willunga Domain

5.3.2 REGOLITH

Distribution and Flow

Groundwater monitoring conducted at the Project includes two monitoring bores intersecting the regolith at the ODS domain (GW06s and GW12s) and two within the Willunga domain (GW16s and GW21s). Of these bores, two (GW06s and GW16s) have remained dry (unsaturated) between June 2017 and February 2018. Similar unsaturated conditions have been recorded for exploration holes intersecting the regolith across the Project site.

As outlined above, the presence of water within the regolith has been recorded at two of the Project site monitoring bores. Bore GW12s, which is located along Ripstone Creek, records a saturated thickness of around 23 m in the regolith, while bore GW21s at Willunga has a saturated thickness of less than 1 m. The spatial distribution of the regolith bores and recorded saturated thickness of the unit is presented in **Figure 5-5**. Overall, the regolith is considered to be largely unsaturated, with the presence of water restricted to lower elevation areas along the Isaac River and the lower reaches of its tributaries (i.e. Ripstone Creek). Flow within the regolith where it is saturated is likely a reflection of topography, flowing towards nearby drainage lines.

Recharge and Discharge

Water within the regolith, where it is saturated, occurs at depths of around 8 m to 19 m below surface. Groundwater elevations at the two site regolith bores containing water (GW12s and GW21s) are presented in **Figure 5-9**. Groundwater levels have remained relatively stable to slightly declining between June 2017 and February 2018 at these bores, despite above average rainfall from October to December 2017 and over February 2018. As discussed in **Section 4.2**, the regolith material comprises low permeability strata (i.e. clay and claystone), which likely restricts rainfall recharge. Groundwater discharge is likely to occur primarily via evapotranspiration, with some baseflow to streams from the regolith under wet climatic conditions. Vertical seepage through the regolith is likely to be limited by the underlying low-permeability Rewan Group and other aquitards.

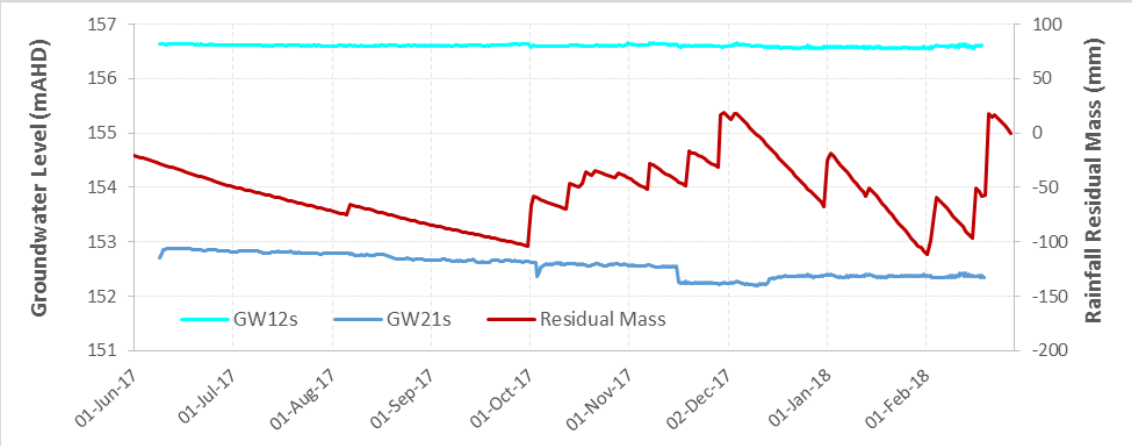

Figure 5-9 Hydrograph of Regolith Groundwater Trends

5.3.3 REWAN GROUP

Distribution and Flow

At the Project Site, the Rewan Group is present throughout the Vermont Park and southern Iffley areas of Olive Downs South but is limited to a small area in the north-western corner of the Willunga Domain. Where it occurs at and surrounding the Project Site, the Rewan Group is present beneath the alluvium and regolith. The unit thickens towards the Isaac River, and can be up to 300 m thick at the Project Site. In general, the occurrence of the unit can vary regionally based on the structural setting. The Rewan Group comprises low permeability lithologies and is typically considered an aquitard.

Groundwater monitoring conducted at the Project includes three VWP's with operational sensors targeting the Rewan Group (GW01d, GW08d and GW16d). Confined groundwater conditions occur within the Rewan Group sediments. Groundwater elevations range from 163 mAHD at the northern end of ODS domain (GW01d), down to 136 mAHD at the Willunga domain (GW16d), indicating a general south-easterly hydraulic gradient. It should be noted; however, that the very low permeability strata that comprise the Rewan Group mean that groundwater transmission and flow within this unit is likely very limited.

Recharge and Discharge

Groundwater elevations for VWP's GW01d, GW08d and GW16d are shown in **Figure 5-10**, **Figure 5-11** and **Figure 5-12**, respectively. Excluding recovery/ stabilisation trends following construction and likely erroneous data, the graphs show that groundwater elevations within the Rewan Group have remained stable to slightly declining over 2017. At all sites, groundwater elevations within the Rewan Group are above those recorded within the deeper Permian coal measures, indicating a downward hydraulic gradient. **Figure 5-10** presents trends for nested alluvial bore GW01s, which show alluvial groundwater levels above the Rewan Group groundwater elevation. This indicates a downward gradient from the overlying alluvium. However, as outlined above, due to the low permeability of the Rewan Group stratigraphy (**Section 5.2**), the unit is considered an aquitard, restricting groundwater flow.

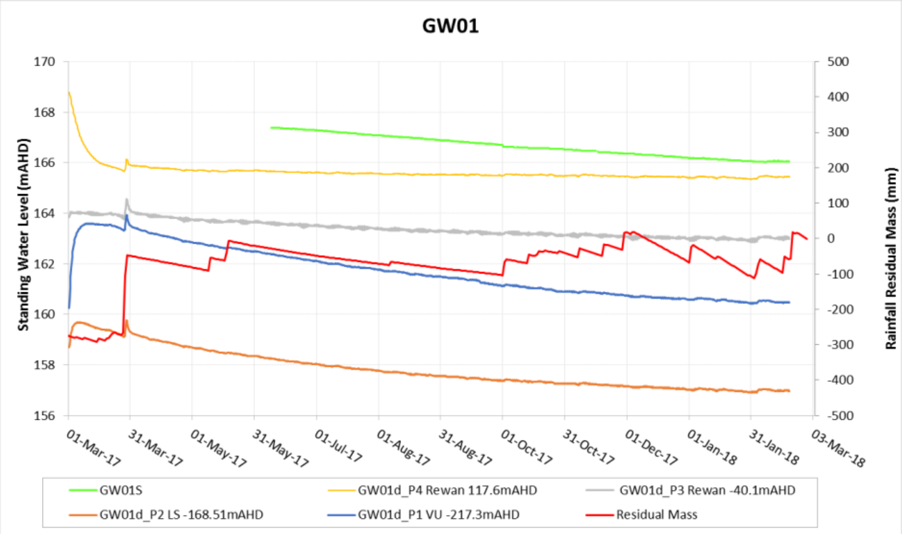

Figure 5-10 Hydrograph for VWP GW01d and Bore GW01s (ODS)

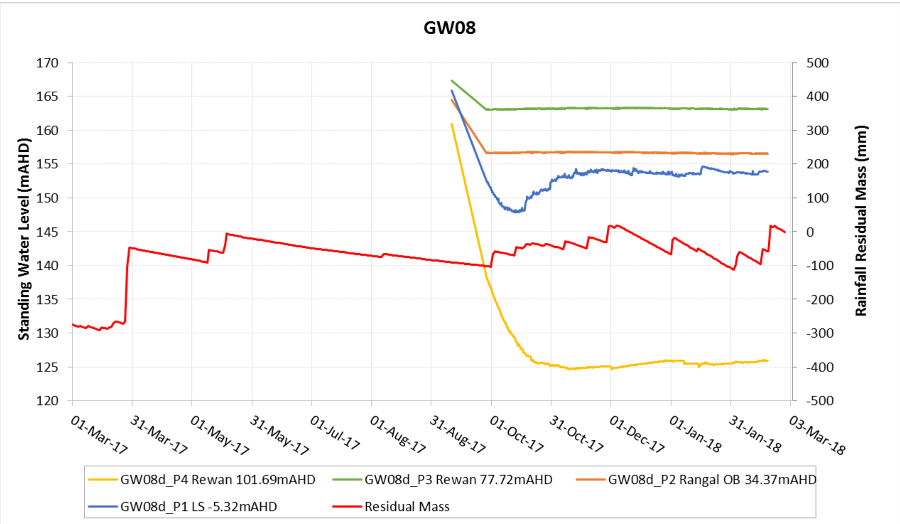

Figure 5-11 Hydrograph for VWP GW08d (ODS)

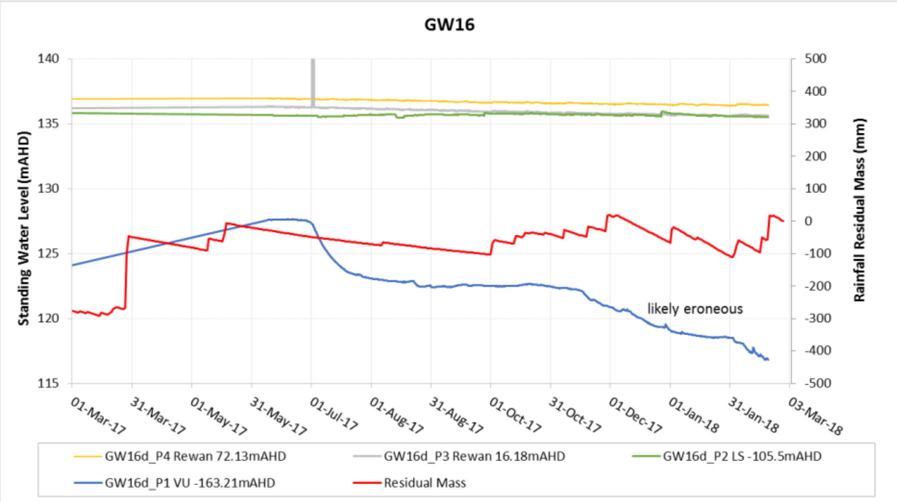

Figure 5-12 Hydrograph for VWP GW16d (Willunga)

5.3.4 PERMIAN COAL MEASURES

Distribution and Flow

The Permian coal measures underlie the Rewan Group and surficial cover, and outcrop along the ridgelines to the east and west of the Study Area. Groundwater occurrence within the Permian coal measures is largely restricted to the more permeable coal seams that exhibit secondary porosity through fractures and cleats (**Section 5.2**).

Groundwater monitoring conducted at the Project includes two monitoring bores (GW02d, GW18d) targeting the coal seams, one bore (GW21d) targeting the interburden and five VWP locations (GW01d, GW06d, GW08d, GW12d and GW16d) targeting multiple units within the Permian coal measures sequence. A spatial contour distribution of groundwater levels in the Permian coal measures (**Figure 5-13**) has been developed using a combination of site monitoring data, data from the landholder bore census and other publicly available data. The water levels in the Permian coal measures generally follow the down-stream flow gradient of the Isaac River, with southeast hydraulic gradients. Permian groundwater elevations range from around 170 mAHD north of the ODS domain, down to 130 mAHD at the Willunga domain to the southeast.

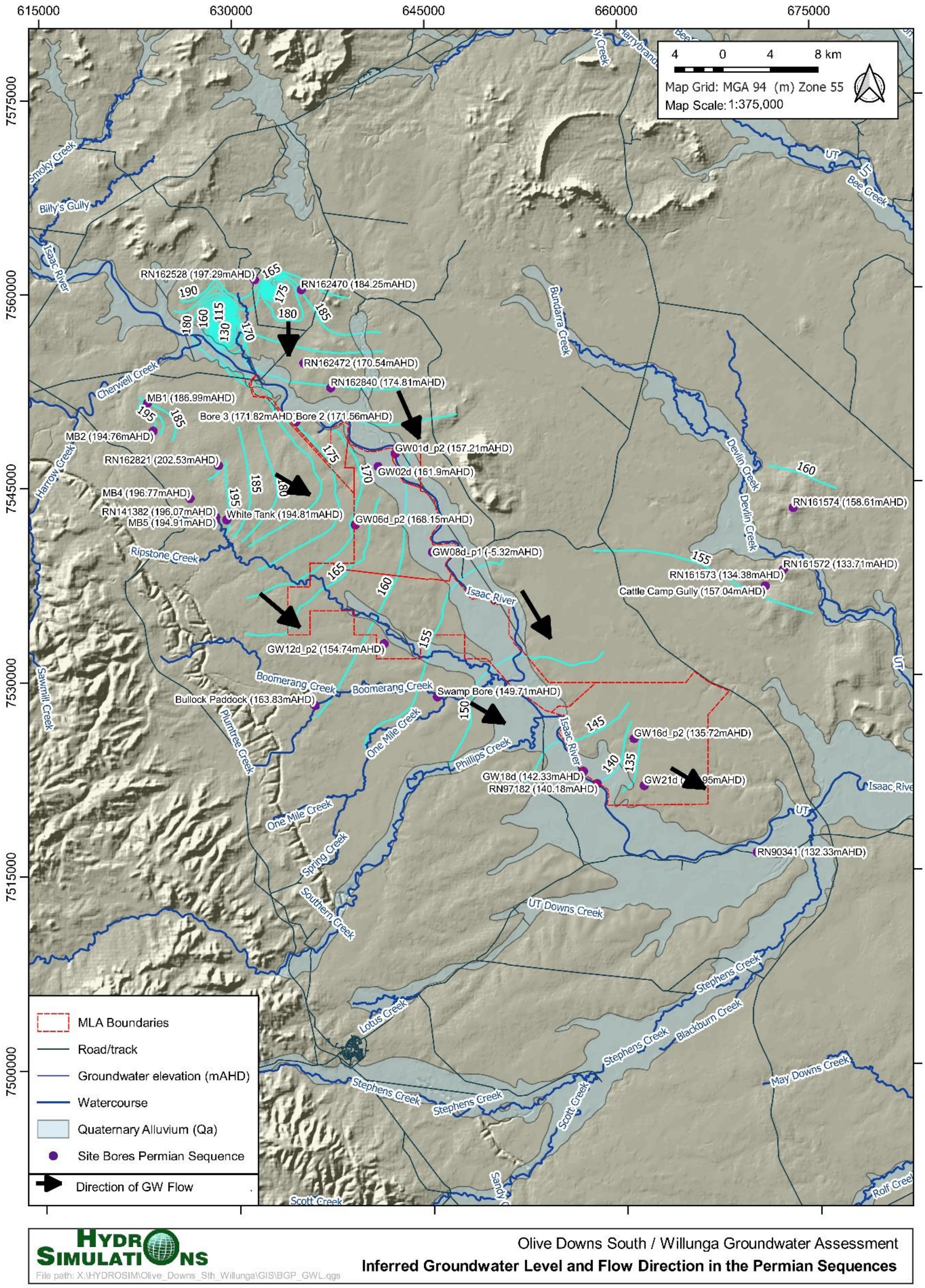

Figure 5-13 Inferred Groundwater Level and Flow Direction in Permian Sequences

Recharge and Discharge

Groundwater level trends for monitoring points targeting the alluvium and underlying Permian coal measures (Rangal Coal Measures unit) are presented in **Figure 5-14**, **Figure 5-15**, **Figure 5-16** and **Figure 5-17**. Trends for the underlying Fort Cooper Coal Measures unit are presented in **Figure 5-18**. Groundwater within the Permian coal measures is confined and sub-artesian. For the shallower coal measures, groundwater elevations are generally at or below groundwater elevations within the overlying unconfined sediments (i.e. GW18), indicating a downward hydraulic gradient. However, with increased depth of cover and pressure the hydraulic gradient within the Permian coal measures reverses. This coincides with a decrease in hydraulic conductivity with depth as discussed in **Section 5.2**.

Recharge to the Permian coal measures occurs where the unit occurs at subcrop. Due to the low permeability of the interburden material, groundwater largely flows horizontally within the coal measures, along the bedding plane of the coal seams. Groundwater discharge occurs via evaporation and abstraction from active mine areas.

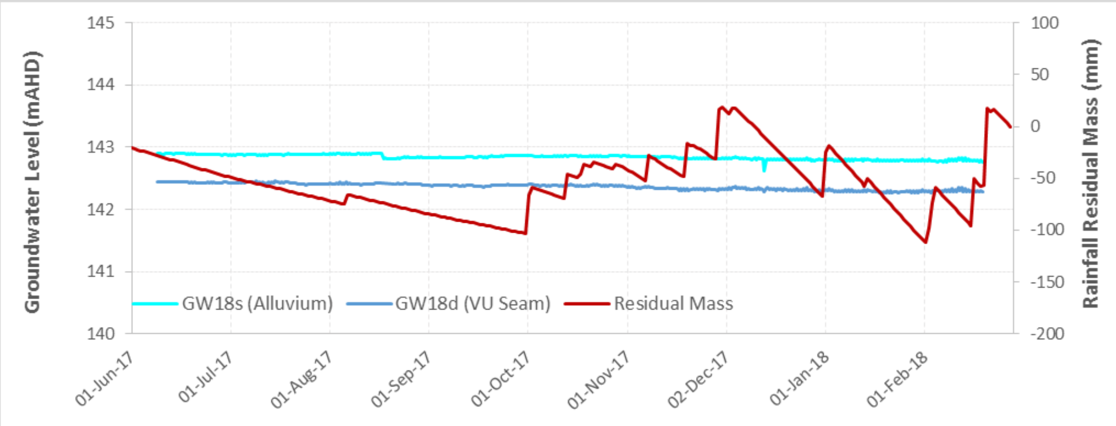

Figure 5-14 Hydrograph for Nested Bores GW18s and GW18d (Willunga)

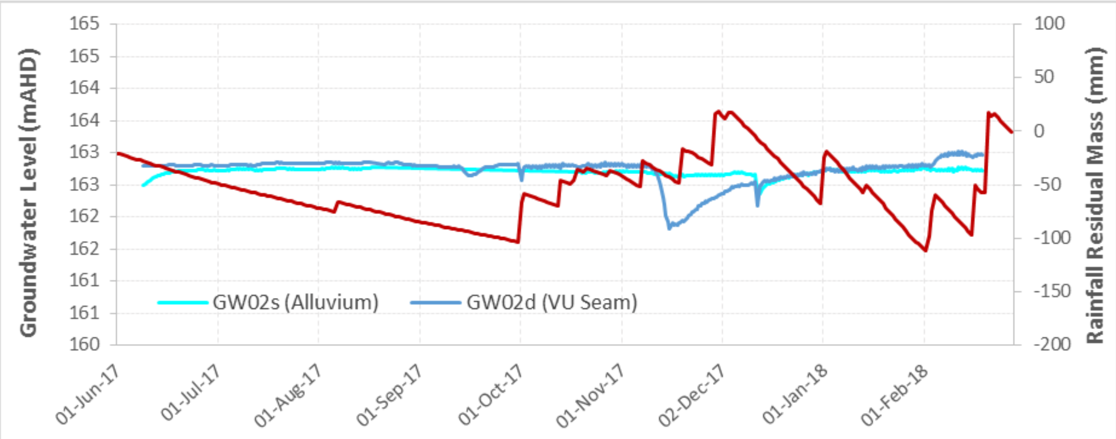

Figure 5-15 Hydrograph for Nested Bores GW02s and GW02d (ODS)

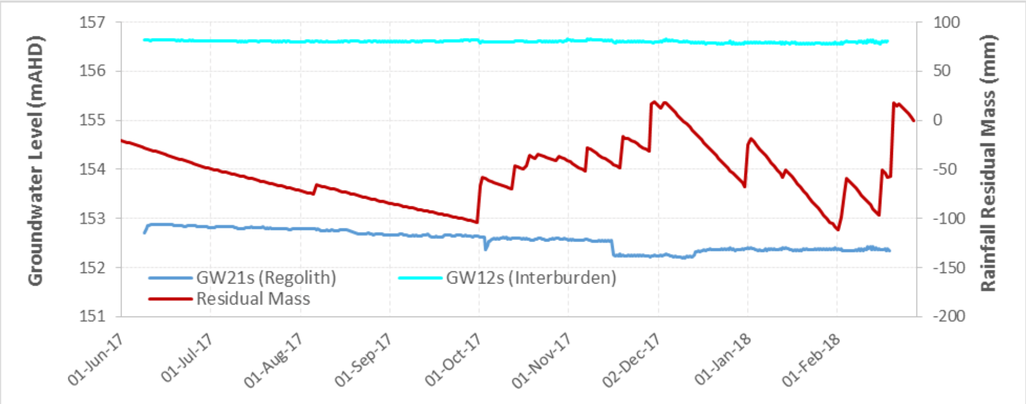

Figure 5-16 Hydrograph for Nested Bores GW21s and GW21d (Willunga)

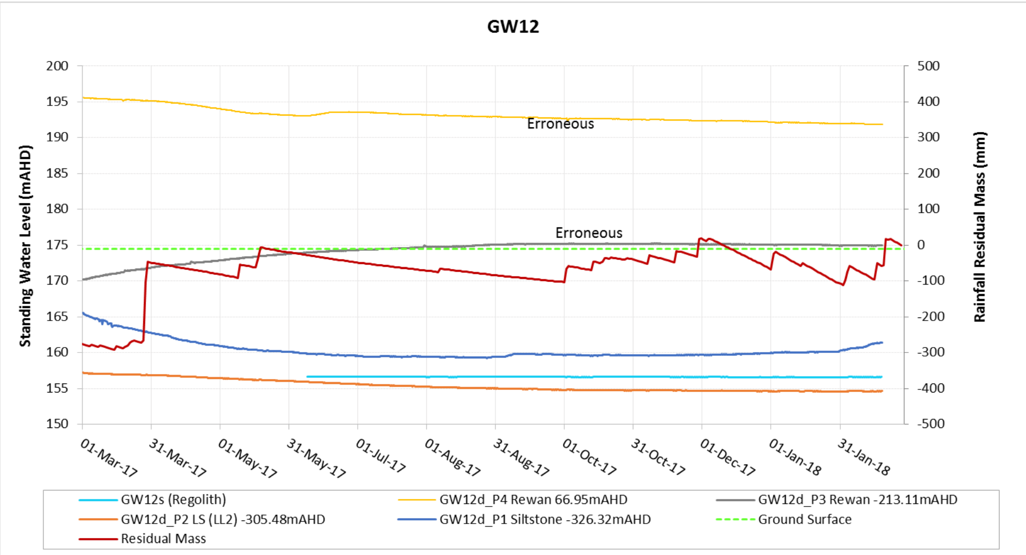

Figure 5-17 Hydrograph for GW12s and VWP GW12d (ODS)

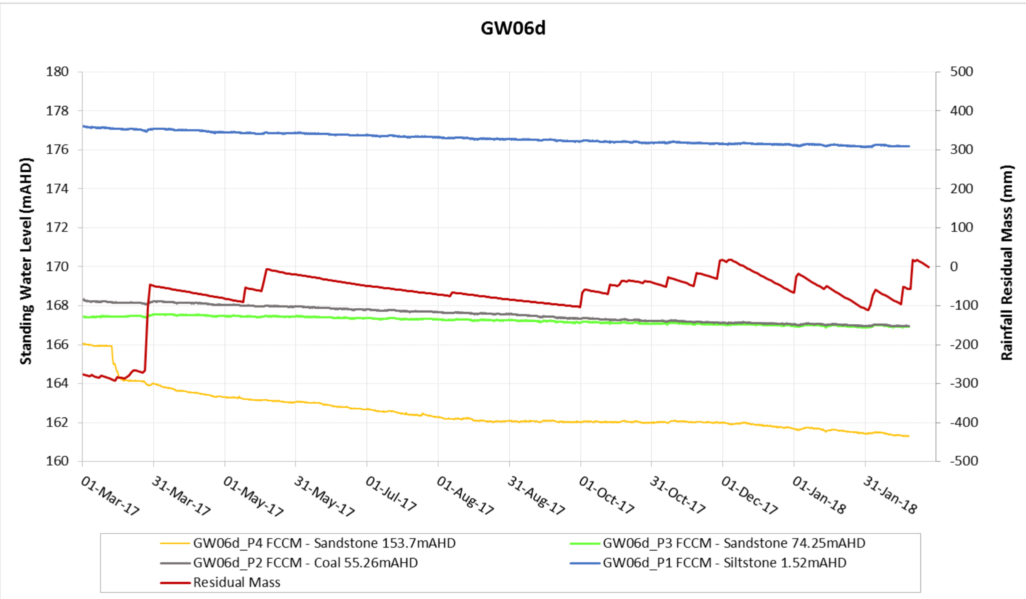

Figure 5-18 Hydrograph for VWP GW06d (ODS)

5.3.5 GROUNDWATER INTERACTION WITH WATERCOURSES

In central Queensland, highly seasonal rainfall results in intermittent stream flow, limited groundwater recharge and deep water tables. In this environment, the most appropriate way to assess surface water and groundwater interaction is by comparing stream stage elevation data to the underlying groundwater elevation in a nearby monitoring bore. The Isaac River at Deveril (130410A) stream gauge provides a long-term record of stream stage for the Isaac River adjacent to the Project Site. The WMIP data indicate that at Station 130410A surface water (flowing and ponded) elevations generally remain around 170 mAHD. The gauge has recorded a maximum stream elevation of 179 mAHD, which has been recorded four times since 1970, in March 1979, March 1988, January 1991 and February 2008.

The closest bore with long-term groundwater level monitoring in the Isaac River alluvium is registered bore RN13040180, which is approximately 40 km downstream of the stream gauge (see **Section 5.5** for mapped location). The bore is located approximately 80 m from the Isaac River, along Carfax Road. Water levels in this bore clearly follow the rainfall residual mass curve, indicating that rainfall derived recharge (including from stream flow) is a key source of water to this aquifer (**Figure 5-19**). From 1970 to present, water levels within the alluvium at RN13040180 were recorded between 12 m to 18 m below ground surface.

Sharp peaks have been recorded occasionally in the dataset and appear to correlate with times of high flow in the Isaac River; however, there does not appear to be a definitive relationship between river level/ magnitude of discharge and magnitude of fluctuation in groundwater level. This is likely to be in part a reflection of the intermittent water level data (where data at times corresponding to high river levels is often not recorded presumably due to flooding).

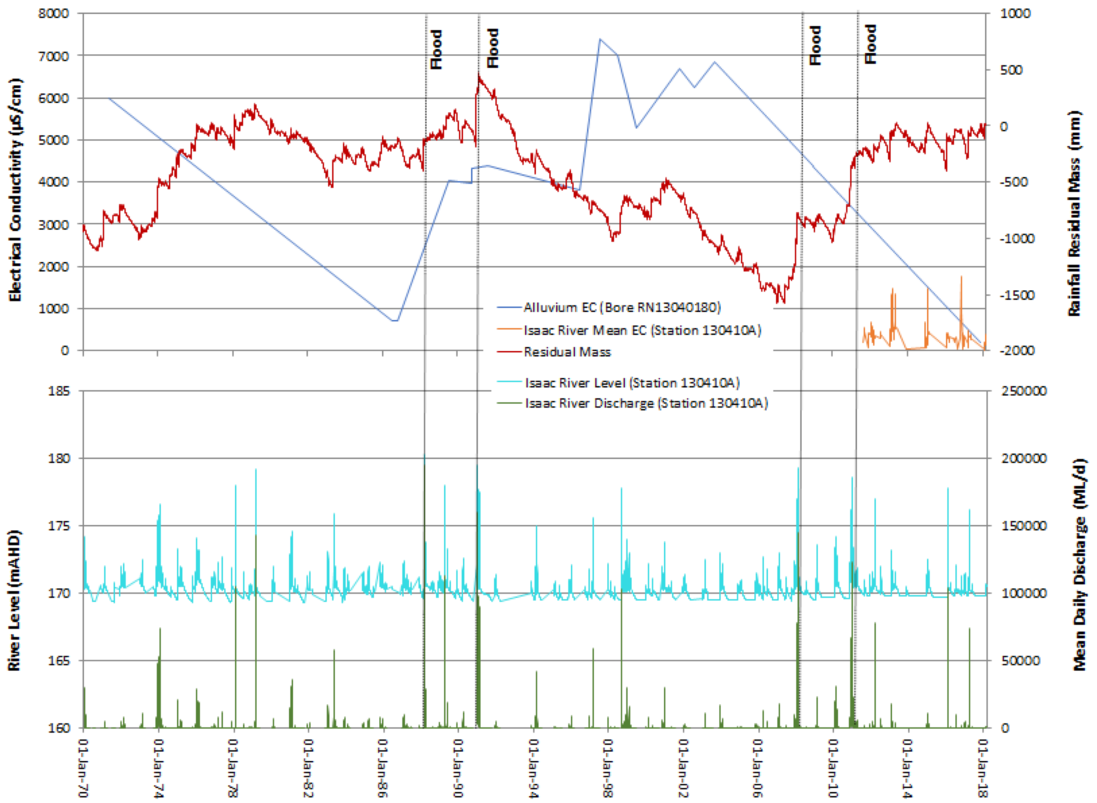

Figure 5-19 Groundwater Level in RN13040180 with Rainfall Residual Mass and Isaac River Levels and Discharge for Stream Gauge 130410A

Groundwater monitoring bores were installed within the alluvium at the Project Site, including one adjacent to the Isaac River stream gauge (GW01s) and one approximately 1.6 km south-west of the river (GW02s). Comparison between stream gauge levels and monitored groundwater levels are presented in **Figure 5-20**. The graph shows that groundwater levels within the alluvium remained more than 2 m below river levels, with the depth to water in the alluvium increasing with distance away from the river.

It is expected that the Isaac River is largely a losing system with stream-stage above that of the local groundwater levels, resulting in the water draining through the alluvial sediments to the local groundwater system. Occasional periods of baseflow to the river from the underlying alluvium may occur after prolonged rainfall events or following flood events. Under these conditions, recharged alluvial sediments will drain to the river as the hydraulic gradient reverses and sustains stream-flow for a short period after the rainfall event.

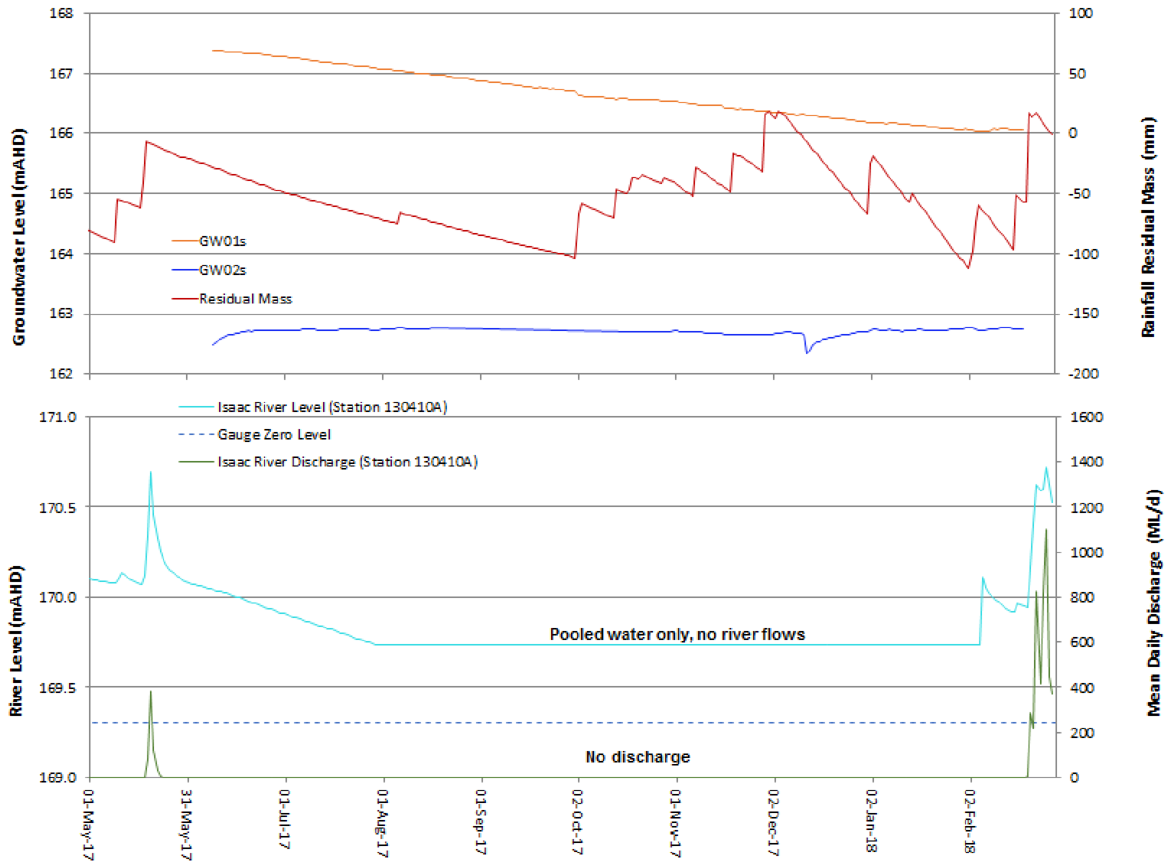

Figure 5-20 Groundwater Level in GW01s and GW02s with Rainfall Residual Mass and Isaac River Levels and Discharge for Stream Gauge 130410A

5.4 BASELINE WATER QUALITY

This section reports on the characteristics and beneficial use of groundwater within the various geological units across the Project Site and wider Study Area. The main units include alluvium, regolith, interburden (sandstone/ siltstone) and coal of the Permian aged coal measures. Water quality results for surface water (Isaac River) and leachate analysis of potential spoil and rejects materials are also discussed below. **Appendix A** presents the groundwater quality data collected at site, as well as other publicly available data.

5.4.1 WATER TYPE

The proportions of the major anions and cations were used to determine the hydrochemical facies of groundwaters sampled. The anion-cation balance for Project Site monitoring bores is shown on the Piper diagram in **Figure 5-21**. The results for these monitoring bores generally indicate that although the cation compositions are similar between groundwater units, there are clear differences in the anion makeup of groundwater from each unit. Alluvium groundwaters can be classified as Na-Ca or Na-Mg type water, and are higher in bicarbonate than the other groundwater units. The proportion of chloride is higher within the regolith material, which can be classified as Na-Cl-SO_4 or Na-Cl-HCO_3 type water. The Permian coal measures generally contain Na-Cl type water, with some also recording a high proportion of Mg but with very little sulphate compared to the other groundwater units.

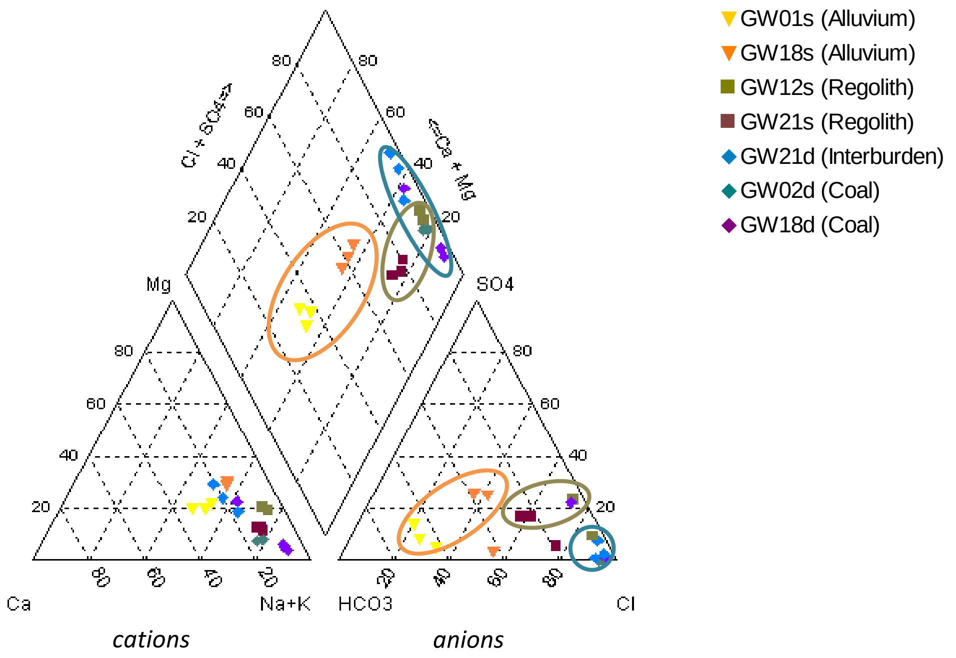

Figure 5-21 Piper Diagram of Project Site bores

Major ion data collected from site bores, collected as part of the landholder bore census and publicly available sources is presented in **Figure 5-22**, along with data for the Isaac River at Deveril (station 130410A). **Figure 5-22** shows that the broader dataset roughly aligns with results for site monitoring bores; however a greater spread is visible.

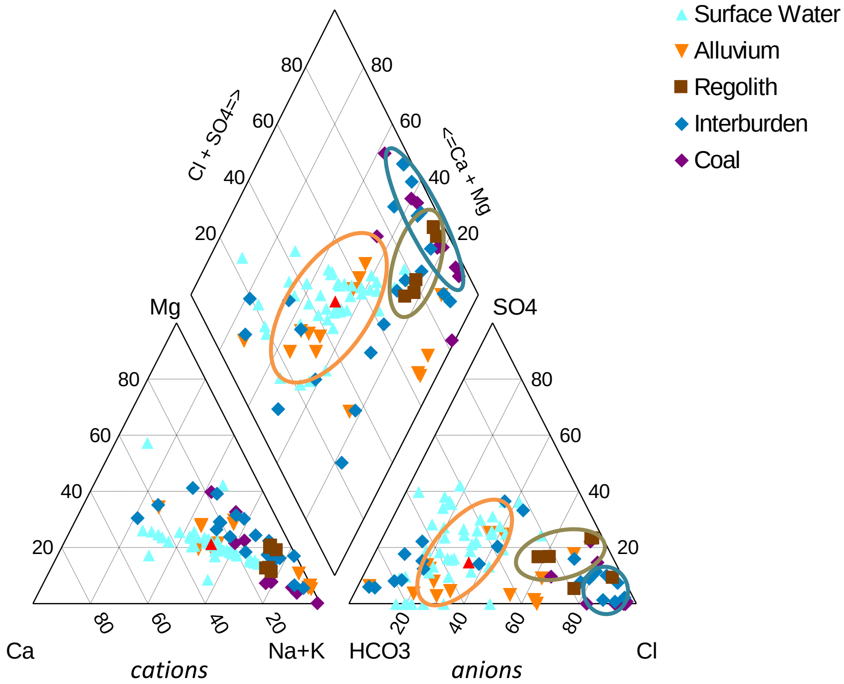

Figure 5-22 Piper Diagram of All Data

5.4.2 SALINITY

Water quality data from site bores, collected as part of the landholder bore census and publicly available sources provides useful information on the beneficial use of groundwater associated with the major stratigraphic units. Salinity is a key constraint to water management and groundwater use, and can be described by total dissolved solid (TDS) concentrations.

Figure 5-24 presents the TDS data associated with waters screened in the various geological horizons for Project monitoring bores, registered bores and publicly available data (see **Appendix A**).

The graph shows that water within the Isaac River is largely fresh, while water within the alluvium is fresh to moderately saline with an average TDS of 1,458 mg/L, ranging between 201 mg/L and 3,430 mg/L. Water within the regolith material is generally highly saline, but can be brackish to moderately saline with an average TDS of 9,757 mg/L, ranging between 1,460 mg/L and 18,600 mg/L. Water within the Permian coal measures can range between fresh and highly saline, but is generally saline within the coal seams, and brackish to moderately saline within the interburden units. As presented in **Appendix A**, coal seam units of the Permian coal measures record an average TDS of 7,402 mg/L, ranging between 2,544 mg/L and 14,700 mg/L. The interburden units of the Permian coal measures record an average TDS of 4,746 mg/L, ranging between 421 mg/L and 18,400 mg/L.

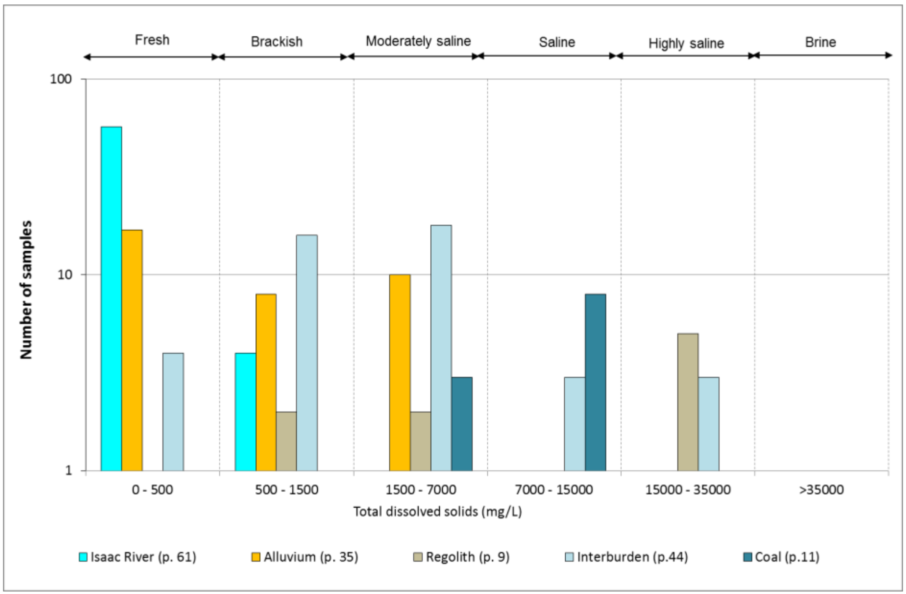

Figure 5-23 FAO (2013) Salinity Ranking by Unit

Available long-term trends in salinity within the alluvium and Isaac River within the Study Area are presented in **Figure 5-24**. As discussed above, salinity within the alluvium can be highly variable spatially. As demonstrated by **Figure 5-24**, salinity can also vary at one location temporally. Results for government alluvial bore RN13040180 indicates EC can range between 199 µS/cm and 7,400 µS/cm (fresh to moderately saline). **Figure 5-24** also presents EC as recorded at Isaac River station 130410A since 2011, which ranges between 49 µS/cm and 1,173 µS/cm (fresh to brackish).

The water quality data for the alluvium occasionally shows an inverse correlation in EC to rainfall residual mass curve, with rising EC recorded during periods of declining/ below average rainfall and vice versa. However, due to the lack of temporal readings, there is no clear correlation between groundwater salinity in the alluvium at RN13040180 and stream flow and salinity of the Isaac River.

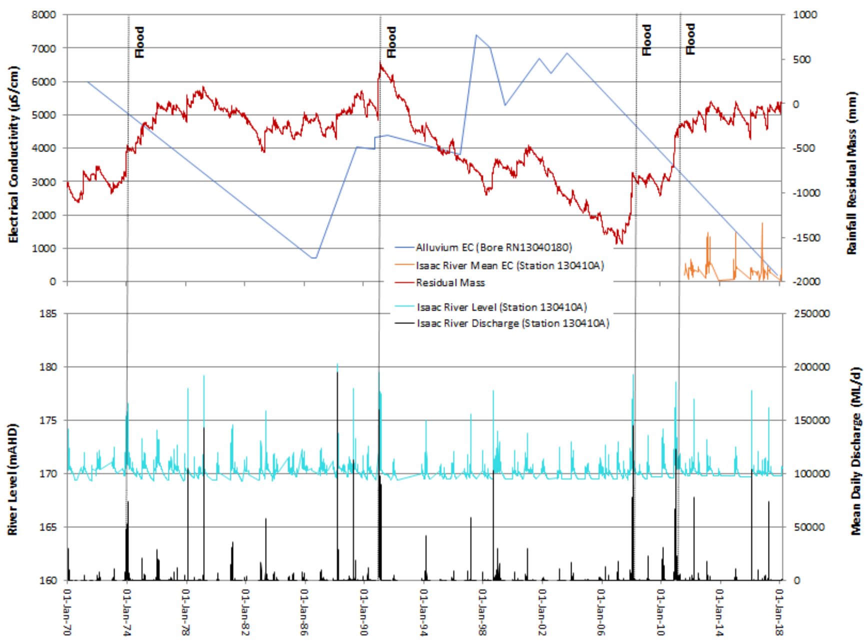

Figure 5-24 Isaac River Salinity

Spatial distribution of TDS is shown in **Figure 5-25**, which is based on measured TDS and calculated[2] from available EC data (see **Appendix A** for data summary). The figure depicts all fresh water quality localised along the Isaac River, with brackish to moderately saline water along the river and tributaries. As expected, the salinity within the coal measures appears to increase with depth. Bores within the coal measures near the subcrop areas west of site generally record moderately saline water quality, which increases to saline quality where the coal measures are deepest near Isaac River. This corresponds with the coal measures being largely recharged by rainfall where they occur at subcrop.

5.4.3 BENEFICIAL GROUNDWATER USE

The Project falls within Isaac Connors Groundwater Management Area (GMA – Zone 34) of the Fitzroy Basin under the Water Plan (Fitzroy Basin) 2011. Groundwater at the Project Site includes alluvial groundwater under GMA Groundwater Unit 1 and water within the hard rock aquifers in GMA Groundwater Unit 2 (sub-artesian aquifers). The management objective of the Water Plan (Fitzroy Basin) 2011 is to maintain the 20th, 50th and 80th percentiles water quality results in order to preserve or enhance groundwater quality for its recognised uses. In the case of Isaac groundwaters, these values include aquatic ecosystems, irrigation, farm supply/ use, stock watering, primary recreation, drinking water as well as being of cultural and spiritual value.

In order to understand the groundwater resources within the Study Area, available water quality data has been compared to the:

- Fitzroy Basin Zone 34 groundwater quality objectives for deep and shallow water;
- Australian Drinking Water Guidelines (ADWG) (NHMRC 2011);
- ANZECC (2000) guidelines for aquatic ecosystems, irrigation (long term and short term) and stock water supply.

Details on the data sources and the summary data (average, median, minimum, maximum and population) are included within **Appendix A.**

Comparing the data to relevant guideline levels, the summary results indicate that water within the Quaternary alluvium is generally suitable for stock water supply and irrigation. However, the alluvial groundwater generally exceeds guidelines levels for drinking water (i.e. TDS, chloride and sodium) and freshwater aquatic systems. The alluvial groundwater also records concentrations of total and dissolved copper above the Fitzroy Plan Water Quality Objectives (WQO) for Zone 34 (shallow).

Water within the regolith material exhibits poorer quality compared to the alluvium and is not considered a suitable groundwater resource for livestock, irrigation, drinking water or aquatic ecosystems. The water within regolith material also exceeds the Fitzroy Plan WQO (Zone 34 – shallow) for EC, chloride, calcium, sodium, hardness, magnesium, sulfate, copper and manganese.

Water within the siltstones and sandstones of the Permian coal measures is generally suitable for stock water supply, with the exception of some TDS concentrations exceeding guideline levels for pigs and poultry. In contrast, groundwater within the coal seams generally exhibit a higher TDS, which is on average higher than the guideline level for beef cattle but below the guideline level for sheep. Comparison of results to the guideline levels indicates the coal measures are not considered a suitable groundwater resource for irrigation, drinking water or aquatic ecosystems. Groundwater within the coal measures (coal and interburden) record concentrations of manganese and iron above the Fitzroy Plan WQO (Zone 34 –shallow).

[2] Calculated based on ANZECC (2000) approach of EC (µS/cm) x 0.67 = TDS (mg/L)

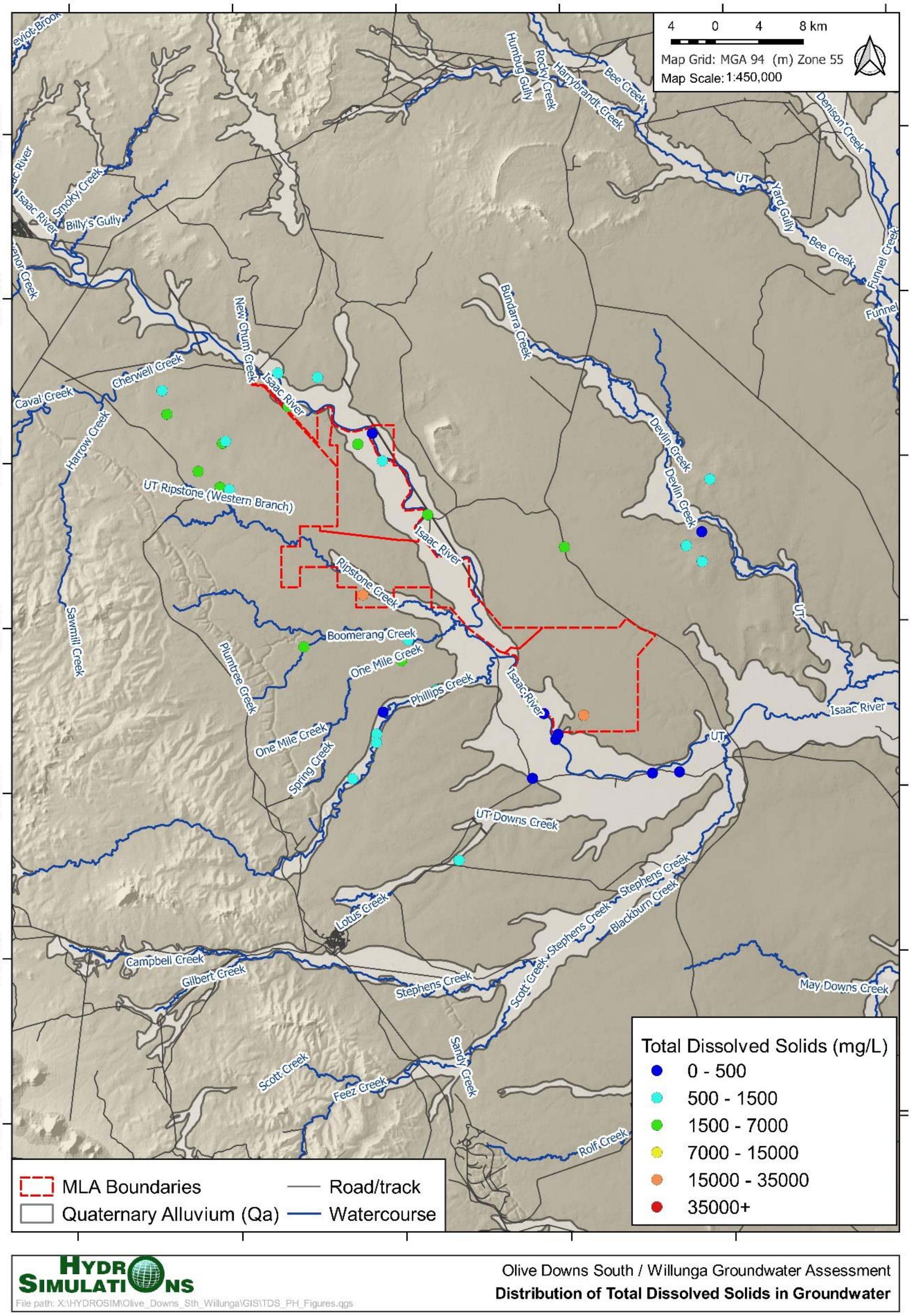

Figure 5-25 Distribution of Total Dissolved Solids in Groundwater

5.4.4 LEACHATE ANALYSIS

Leachate analysis was conducted by Terrenus Earth Sciences in November 2017. The analysis was conducted on interburden (claystone, sandstone and siltstone) material representative of future spoil material, and carbonaceous claystones and siltstone (coal seam roof and floor) representative of potential rejects material. It is important to note that the results from the geochemistry assessment (Terrenus Earth Sciences, 2018) represent an 'assumed worst case' scenario as the samples are pulverised prior to testing, and therefore have a very high surface area compared to materials in the field and do not account for mixing during emplacement.

The analysis of the samples tested as being representative of spoil material (as a bulk material) found:

- All samples were identified as non-acid forming (NAF) with most showing very low Sulfur content (<0.1%).
- One sample returned 'uncertain' results, due to conflicting results.
- pH is generally 9.0 and ranges between 5.4 and 9.7, with only one reading below pH 7.
- EC is generally 400 µS/cm and ranges between 158 µS/cm and 1,050 µS/cm.
- Sulfur content is generally 27 mg/L and ranges between 4 mg/L and 92 mg/L
- Aluminum concentrations are around 0.3 mg/L and range between <0.2 mg/L and 0.5 mg/L.
- Arsenic concentrations are around 0.12 mg/L and range between <0.02 mg/L and 0.5 mg/L.
- Metals concentrations were all below the laboratory limit of reporting for Ba, Be, B, Cd, Co, Cr, Cu, Fe, Hg, Mn, Ni, Pb and Zn.

Overall, the geochemical assessment found that the potential spoil material is expected to be overwhelmingly NAF, with excess acid neutralising capacity (ANC) and has a negligible risk of developing acid conditions. Furthermore, spoil is predicted to generate low to moderate salinity surface run-off and seepage with low soluble metal/metalloid concentrations. However; some spoil materials may be sodic (to varying degrees) with potential for dispersion and erosion (to varying degrees).

Analysis of the samples tested as being representative of potential reject material found:

- Six of the eight samples were identified as NAF, with five classified as having very low Sulfur content (<0.1%).
- One sample returned 'uncertain' results, due to conflicting results.
- One sample was classified as potentially acid forming (PAF) – derived from carbonaceous claystone of the Lower Leichhardt Seam roof at a depth of 104 m below surface.
- pH is generally 8.9 and ranges between 6.9 and 9.6.
- EC is generally 293 µS/cm and ranges between 120 µS/cm and 554 µS/cm.
- Sulfur content is generally 49 mg/L and ranges between 6 mg/L and 206 mg/L
- Aluminum concentrations are around 0.4 mg/L and range between <0.2 mg/L and 1.0 mg/L.
- Arsenic concentrations are around 0.07 mg/L and range between <0.02 mg/L and 0.22 mg/L.

- Metals concentrations were all below the laboratory limit of reporting for Ba, Be, B, Cd, Co, Cr, Cu, Fe, Hg, Mn, Ni, Pb and Zn.

Overall, the geochemical assessment found that 30% of potential reject material has a relatively low degree of risk associated with potential acid generation. The material has a low sulfur (and sulphide) concentration and low metals/metalloids concentrations. The magnitude of any localised acid, saline or metalliferous drainage would be buffered by the presence of the alkaline NAF spoil. As a bulk material (of relatively small total quantity), coal reject is regarded as posing a generally low risk of environmental harm and health-risk.

5.5 GROUNDWATER USAGE - ANTHROPOGENIC

It is noted in the literature review and from site visits that landholder pumping from the alluvial sediments at the Project is currently used for stock water supply purposes.

A search of the Queensland Government's Groundwater Bore Database (GWBD) and the Bureau of Meteorology's National Groundwater Information System (NGIS) was carried out in May 2017 for registered bores within the Study Area. This search indicated that there are 200 registered bores, of which 80 bores (40%) are used for groundwater monitoring and investigations, and 69 bores (34.5%) are used for water supply. The remainder of bores have an unknown use or resulted from exploration activities (**Table 5-3**).

Table 5-3 Registered use of groundwater bores within the Study Area

Use	Count	Percent of Total
Groundwater monitoring (mine monitoring, water resource investigation etc)	80	40
Water Supply	69	34.5
Unknown	43	21.5
Exploration (petroleum, gas, coal, stratigraphic etc)	8	4
Total	200	100

A field bore census of groundwater bores and wells within 20 km of the Project was conducted by external field contractors (ENRS) from September to November 2017. The bore census involved visiting bores on 12 properties, with a total of 120 bore locations assessed. Of the 120 bores:

- 40 bores were found to be existing and in use;
- 35 bores are existing but not in use;
- 7 bores were of unknown status (could not access); and
- 38 bores were abandoned and destroyed.

Figure 5-26 shows the locations and uses of registered bores and those visited during the bore census, with full results of the census provided in **Appendix A**.

Of the existing and unknown bores with water use information available, 49 are used for stock water supply, 17 are used of groundwater monitoring and 6 are used for domestic water supply. For the existing and unknown bores with geological information available, 22 intersect alluvium, 10 are within regolith material and 30 intersect Permian aged coal measures (Rangal Coal Measures, Blackwater Group and Back Creek Group).

Twenty two of the inspected bores were equipped with a submersible pump with variable power sources (i.e. mains power, diesel motor and windmill). Twenty five bores were positioned near water storage tanks, ranging in size from 20 kilolitres (kL) to 100 kL, with two bores equipped with a float actuated pressure switch to maintain tank water levels. There were limited details on abstraction volumes and yields, but some reported maximum yields of around 1 L/s to 2 L/s.

Four of the existing bores inspected as part of the bore census are within 5 km of the proposed pit footprints within the ODS domain. Three of the bores (Bore 8, RN141677 and RN136090) intersect the Isaac River alluvium, while one bore (Swamp Bore) on the Meadowbrook property intersects Permian coal measures to a depth of around 85 m. Two of the four bores (Bore 8 and RN136090) are equipped with submersible pumps and are used for stock and domestic purposes, respectively. Bore RN141677 is not currently used and the measured total depth does not match with the drill details, indicating the bore may have collapsed. Swamp Bore is also not currently in use or equipped, but the landholder indicates it has previously been used for stock water supply with a yield of around 1,600 gallons per hour (GPH).

Seven of the bores inspected as part of the bore census are within 5 km of the proposed pit footprints within the Willunga Domain. The seven bores (RN97180, RN97181, RN97182, RN97183, RN97184, RN97185 and River Bore) are relatively shallow (< 40 m deep), intersect the Isaac River alluvium and are used for stock water supply. Three of the bores (RN97181, RN97182 and River Bore) are equipped with electric submersible pumps, with a maximum yield of around 1.3 L/s. One of the bores (RN97180) is assumed to be present, but could not be accessed during the bore census but the landholder indicated the bore has had a yield of 800 GPH.

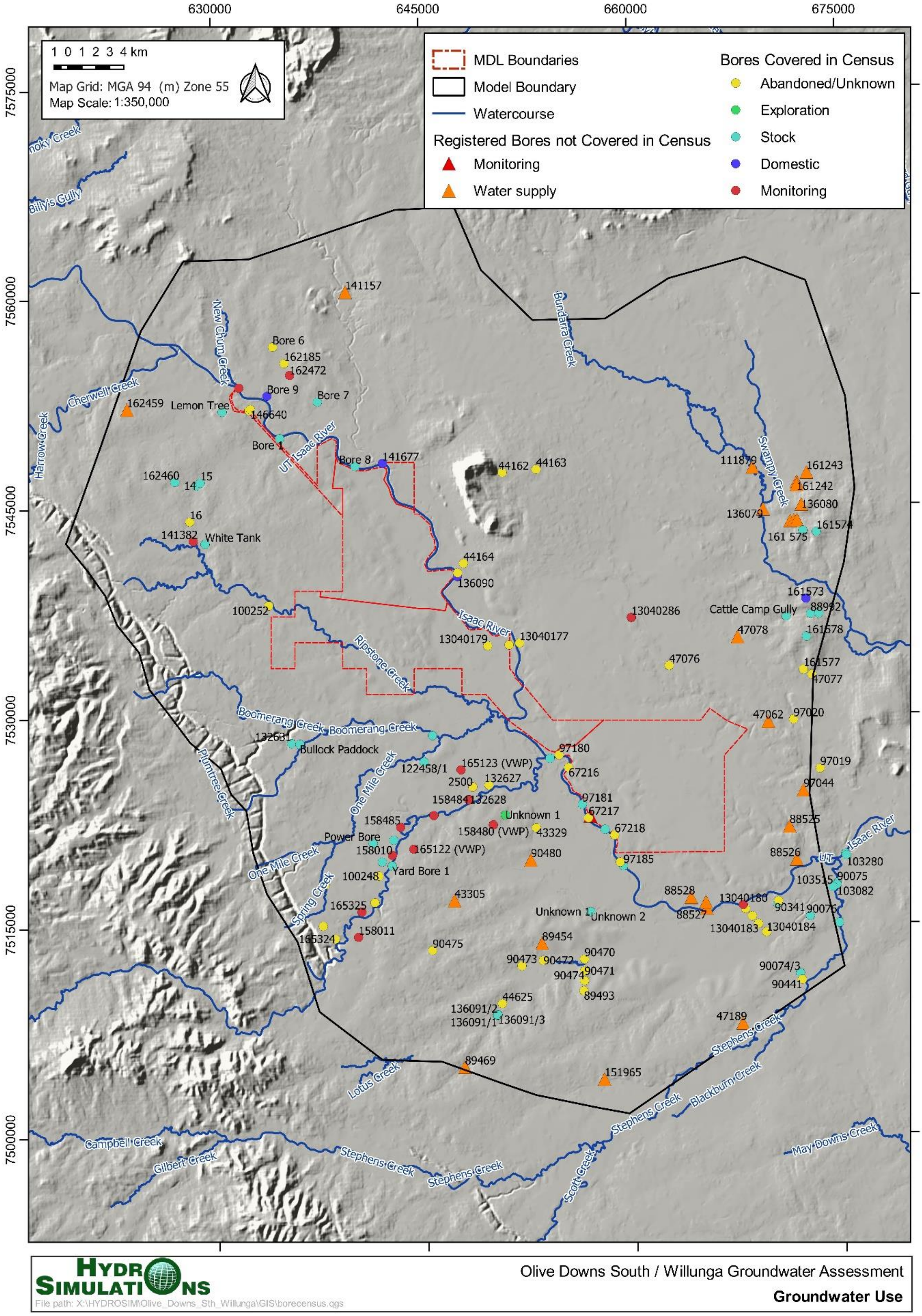

Figure 5-26 Groundwater Use

5.6 GROUNDWATER USAGE – ENVIRONMENTAL

5.6.1 GROUNDWATER DEPENDENT ECOSYSTEMS (GDES)

A groundwater dependant ecosystem (GDE) is one in which the plant and/or animal community is dependent on the availability of groundwater to maintain its structure and function.

National Atlas of Groundwater Dependent Ecosystems

Desktop mapping of potential GDEs through-out QLD (BoM 2018b) indicates that areas with possible high, moderate and low potential for groundwater interaction occur within the Project locality. In the Study Area the GDE Atlas classifies ecosystems based on the potential for dependence on groundwater based on multiple lines of scientific evidence. Ecosystems have been mapped as either:

- High potential for groundwater interaction (indicating a strong possibility the ecosystem is interacting with groundwater);
- Moderate potential for groundwater interaction; or
- Low potential for groundwater interaction (indicating it is relatively unlikely the ecosystem will be interacting with groundwater, and will include ecosystems that are not interacting with groundwater).

Surface ecosystems that may be reliant on surface expression of groundwater are shown in **Figure 5-27**. Surface ecosystems that may be reliant on subsurface groundwater are shown in **Figure 5-28**. The desktop GDE mapping (BoM, 2018b) indicates:

- Terrestrial vegetation associated with the Isaac River, Phillips Creek, North Creek, Cherwell Creek and the downstream extent of Ripstone Creek is mapped as having a high potential to be dependent on the subsurface expression of groundwater.
- Aquatic habitat associated with the Isaac River, Phillips Creek, North Creek and Cherwell Creek is mapped as having a high potential to be dependent intermittently on the surface expression of groundwater.
- Terrestrial vegetation and aquatic habitat associated with a number of palustrine wetlands surrounding the Olive Downs South and Willunga domains is mapped as having a moderate potential to be associated with the surface expression of groundwater.
- All other terrestrial vegetation (regional ecosystems mapped by DSITI, 2018) and aquatic habitat within the Project locality, is broadly mapped as having a low to moderate potential of being associated with the presence of groundwater (BoM, 2018).

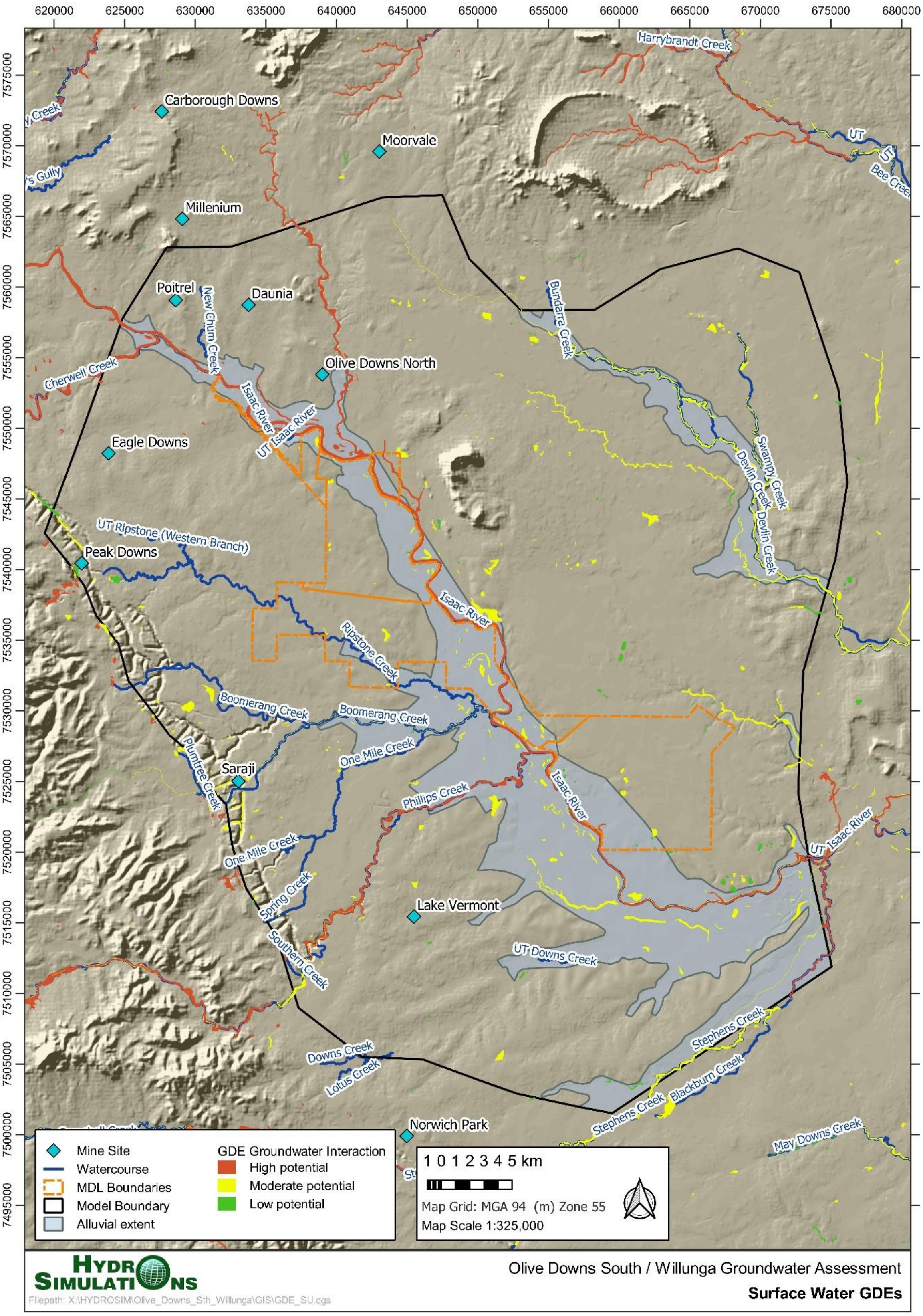

Figure 5-27 Surface Water GDEs

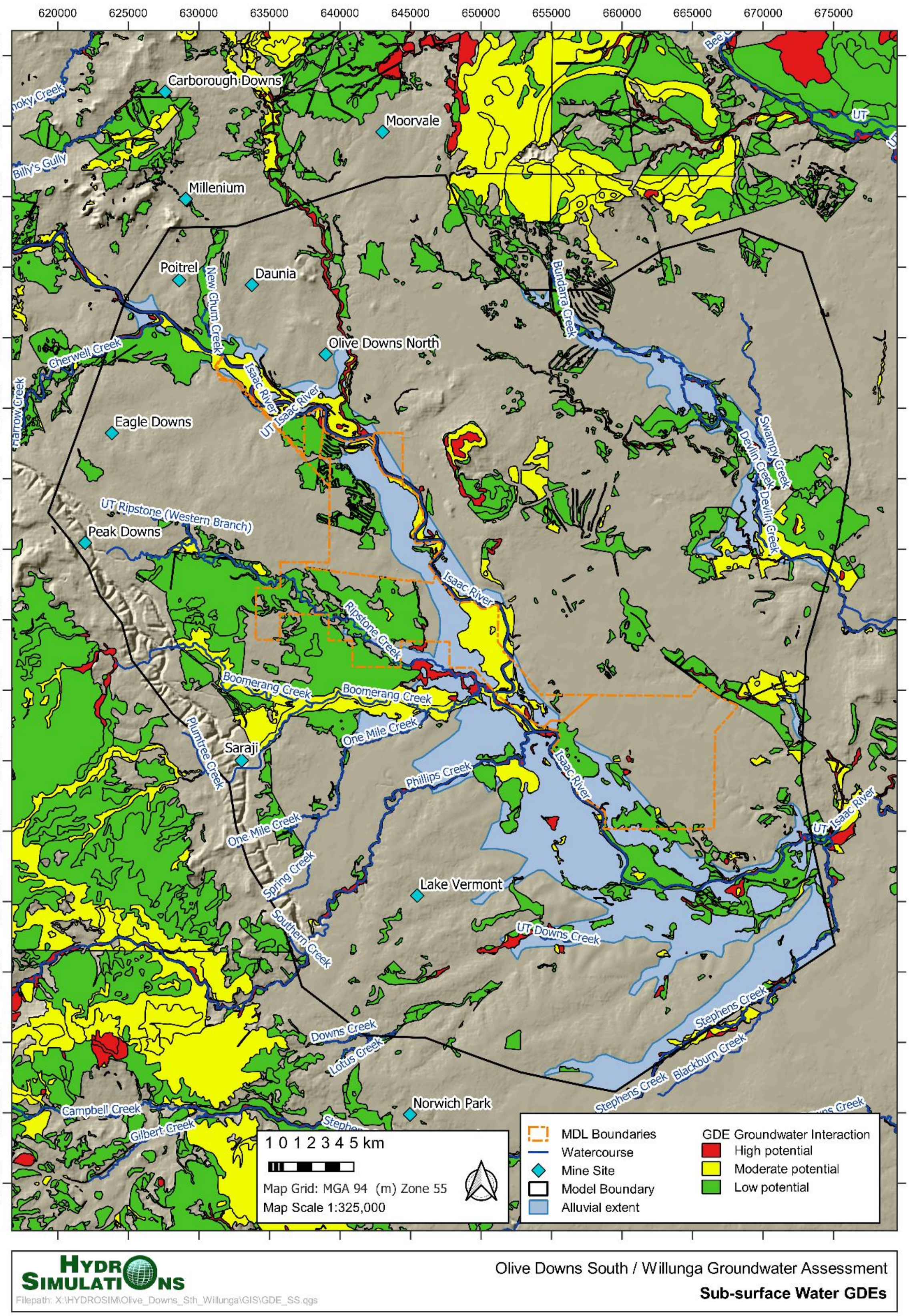

Figure 5-28 Sub-surface Water GDEs

Field Verification

The accuracy of the desktop GDE mapping (BoM 2018) of the Project locality has been reviewed by DPM Envirosciences (2018a), with the following conclusions made in relation to the presence/absence of GDEs based on detailed site surveys and assessments:

- The majority of the terrestrial vegetation associated with the Isaac River, Phillips Creek, North Creek and Cherwell Creek is unlikely to be dependent on groundwater given the vegetation communities along these features are known to occur more widely across the landscape and are not restricted to areas where they could potentially access groundwater. There are areas of RE 11.3.25, RE 11.3.27 and RE 11.3.4 along the Isaac River which contain Queensland Blue Gum (*Eucalyptus tereticornis*) and River Oak (*Casuarina cunninghamiana*) which have the potential to be reliant on access to groundwater (IESC, 2018). The existing groundwater monitoring network within the Project area indicates that the groundwater levels within the Olive Downs South and Willunga domains range from approximately 10 m to 17 m below surface (**Section 5.3**). Based on the depth to groundwater surrounding the Olive Downs South and Willunga domains being greater than 10 mbgl, DPM Envirosciences (2018a) concluded that these communities have a low likelihood of being reliant on access to groundwater.
- Consistent with the IESC (2018) *Assessing Groundwater-Dependent Ecosystems: IESC Information Guidelines Explanatory Note*, the ephemeral nature of the aquatic habitat associated with Isaac River, Phillips Creek, North Creek and Cherwell Creek indicates that these habitats have a low likelihood of being dependent on groundwater (**Figure 5-29** to **Figure 5-32**).
- Terrestrial vegetation and aquatic habitat associated with the palustrine wetlands surrounding the Olive Downs South and Willunga domains could potentially be reliant on groundwater given the RE mapped by DSITI (2018). DSITI (2018) has mapped these areas as RE 11.3.27 and RE 11.5.17 which contain River Red Gum (*Eucalyptus camaldulensis*) and Queensland Blue Gum, both species that could be reliant on the presence of groundwater to some degree. However, given groundwater levels in this area have been identified as being in excess of 10 mbgl (**Section 5.3**), DPM Envirosciences concluded that these communities would have a low likelihood of being reliant on groundwater. In addition, the aquatic ecology surveys identified aquatic macroinvertebrate species within these wetlands that are indicative of an area subject to complete drying and wetting cycles (DPM Envirosciences, 2018b). The clay-rich substrates of these wetlands are likely to hold surface run-on for extended periods, creating a 'perched' system not influenced by groundwater levels (DPM Envirosciences, 2018b).

Figure 5-29 North Creek (DPM Envirosciences October 2017)

Figure 5-30 Cherwell Creek (DPM Envirosciences October 2017)

Figure 5-31 Isaac River (DPM Envirosciences October 2017)

Figure 5-32 Phillips Creek (DPM Envirosciences October 2017)

5.6.2 STYGOFAUNA

DPM Envirosciences also undertook stygofauna sampling at two alluvial bores, GW01s and GW18s that were identified as having favourable water quality for the presence of stygofauna. Other monitoring locations were not sampled due to being too saline or being dry at the time of sampling. The survey was conducted in October 2017, with results finding no stygofauna present within either bore.

5.6.3 SPRINGS

A spring vent is a point where there is a surface expression of groundwater, with groundwater flow occurring intermittently or continuously. The Queensland Government maintains an inventory of identified springs in the Queensland Springs Database (DES, 2018b). No springs have been identified around the Project area.

5.6.4 INTERNATIONALLY AND NATIONALLY IMPORTANT WETLANDS

A search of the EPBC Act 'Protected Matters Report' (DEE, 2017) found that there are no Internationally or Nationally Important Wetlands within the Project area. The closest wetlands of international importance are located approximately 150 km east of the Project and include those of the Shoalwater and Corio Bays Area. Lake Elphinstone is the closest nationally important wetland, located 70 km north (upstream) of the Project (DPM Envirosciences, 2017). Due to their distance from site, no internationally and nationally important wetlands will be impacted by the Project.

5.7 CONCEPTUAL MODEL

A conceptual model of the groundwater regime has been developed based on the review of the hydrogeological data for the Project Site and surrounds.

The Project Site is within the northern part of the Bowen Basin, which comprises Permian aged coal measures that have been folded into a syncline structure that strikes in a north-west to south-east direction. The geology of the Project Site comprises the stratified sequences of the Moranbah Coal Measures, Fort Cooper Coal Measures and Rangal Coal Measures that dip towards the Isaac River. The Project targets the Leichhardt Seam and Vermont Seam of the Rangal Coal Measures, that occur at subcrop at the western side of the ODS domain and the eastern side of the Willunga domain. The coal seams are deepest near the Isaac River, generally over 200 mbgl. The Triassic Rewan Group sediments unconformably overlie the coal measures and can be around 300 m thick within the Project Site. Surficial cover includes the alluvium along the Isaac River, as well as regolith material comprising Quaternary to Tertiary sediments. The main hydrogeological features at the Project site include:

- Alluvium associated with the Isaac River.
- Regolith.
- Rewan Group aquitard.
- Permian strata that host the coal measures.

The alluvium comprises a heterogeneous distribution of clays, sandy clay, sands and gravels. The hydraulic properties of the alluvium vary due to the variable lithologic composition, with field tests indicating horizontal hydraulic conductivity can range between 2.6 x10^{-1} m/day and 8.7 m/day. Groundwater occurs within the alluvium at depths of around 10 to 20 mbgl, and more than 4.5 m below the base of the Isaac River. This indicates that under current conditions the Isaac River is disconnected from the groundwater system. Regionally, groundwater flow within the alluvium is a subdued reflection of topography, with groundwater flowing in a south-easterly direction consistent with the alignment of the Isaac River. However, local groundwater levels within the alluvium are highest within 300 m of the river, indicating a potential local flow direction away from the river to the east and west. This also indicates potential losing conditions from the river to the underlying alluvium during flow periods. Spatially, the alluvium is variably saturated, with two alluvial bores (GW04) and GW08s) recorded as dry since July 2017. Localised perched water tables are also evident where waterbodies continue to hold water throughout the dry period (e.g. pools in the Isaac River and floodplain wetlands) occurring where clay layers slow the percolation of surface water.

Recharge to the alluvium is considered to be mostly from stream flow or flooding (losing streams), with direct infiltration of rainfall also occurring rapidly where there are no substantial clay barriers in the shallow sub-surface. On a regional scale, discharge is via evapotranspiration from vegetation growing along creek beds and minor short duration baseflow events after significant rainfall/flooding. Infiltration to underlying formations is likely to be limited to areas in connection with relatively high permeability units (e.g. coal seams and possibly faults). General downwards recharge to deeper units is limited by the low permeability (confining) Rewan Group and coal measure interburden sequences. Water quality data for the alluvium indicates it can be fresh to moderately saline and highly spatially and temporally variable, is mostly suitable for stock water supply and irrigation, but is not suitable for drinking water and freshwater aquatic ecosystems. Review of the Queensland GWDB and a landholder census indicates alluvial groundwater along the Isaac River is used by local landholders, predominantly for stock water supply. Ecological studies identified that riparian vegetation along the Isaac River has a low likelihood of dependence on alluvial groundwater. Sampling conducted in October 2017 did not identify any stygofauna present within the alluvium at site bores GW01s and GW18s.

There is also a broad expanse of shallow Tertiary-Quaternary aged sediments across the Project Site, which forms the base of the unconfined shallow groundwater system. The groundwater flow processes are similar to those of the alluvium, however the fluxes are expected to be significantly lower due to the dominance of clay within the Tertiary sediments. In areas near the Isaac River and creeks (i.e. Ripstone Creek), water has been detected within the regolith material at depths of around 10 to 17 mbgl. Outside of these areas the regolith material is largely unsaturated. Water quality data for the regolith indicates it is generally highly saline, but can be brackish to moderately saline. Water within the regolith is generally of poor quality and not considered suitable for stock, irrigation, aquatic ecosystems or drinking water. However, review of the Queensland GWDB and landholder census identified that six of the 120 bores surveyed potentially intersect the regolith material. These bores are located over 4 km from the Project site.

In the Permian strata, groundwater is encountered in the coal seams and in the sandstone/siltstone units of lower permeability. As with the rest of the Bowen Basin, the coal seams are the main groundwater bearing units within the Permian sequences, with low permeability interburden generally confining the individual seams. The coal seams are dual porosity in nature with a primary matrix porosity and a secondary (dominant) porosity provided by fractures (joints and cleats). Hydraulic conductivity of the coal decreases with depth due to increasing overburden pressure reducing the aperture of fractures. Vertical movement of groundwater (including recharge) is limited by the confining interburden layers, meaning that groundwater flow is primarily horizontal through the seams with recharge only occurring at subcrop. Review of fault behaviour at site and from external studies has identified that faults can increase vertical hydraulic conductivity parallel to the fault trace, and reduce it perpendicular to the fault trace. However, any increases in vertical hydraulic conductivity is limited to small vertical horizons (< 20 m) and is variable between faults dependent on localised hydrothermal activity and mineralisation in-filling pore spaces. Regionally, groundwater within the Permian coal measures flows in a south-easterly direction. Review of water quality data indicates water within the Permian coal measures is generally saline, but can range between fresh to highly saline. Groundwater within the coal measures is only considered suitable for some stock, with the type of stock dependent on the TDS range (i.e. beef cattle or sheep). Review of the Queensland GWDB indicates around 17 private bores target the coal measures for water supply; within only one within 5 km of the Project (Swamp Bore).

Three conceptual cross-sections, made from the northwest-southeast section (see **Figure 4-2**) through the proposed ODS and Willunga domain areas, of the hydrogeological system are presented:

- **Figure 5-33** illustrating the conceptual model of the area prior to any mining.
- **Figure 5-35** showing how the conceptual model of the area is modified to account for the effects of mining.
- **Figure 5-35** showing how the conceptual model of the area is modified to account for the effects of mining and coal seam gas extraction.

The figures present the conceptualised groundwater conditions for the Project, demonstrating depressurisation of the Permian coal measures in response to the proposed open cut pits and the Bowen Gas Project wells.

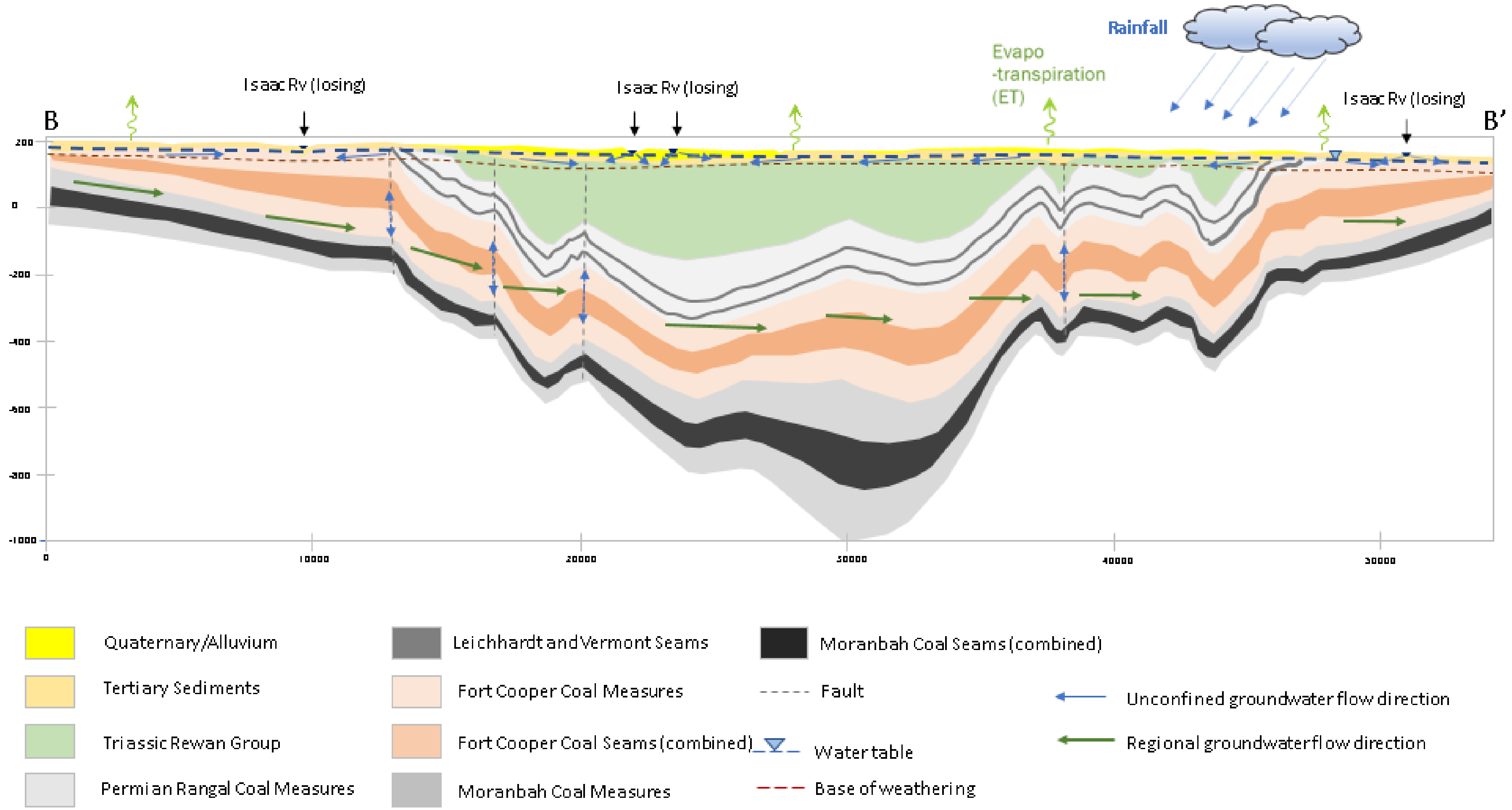

Figure 5-33 Conceptual Model of the Groundwater System Pre-mining

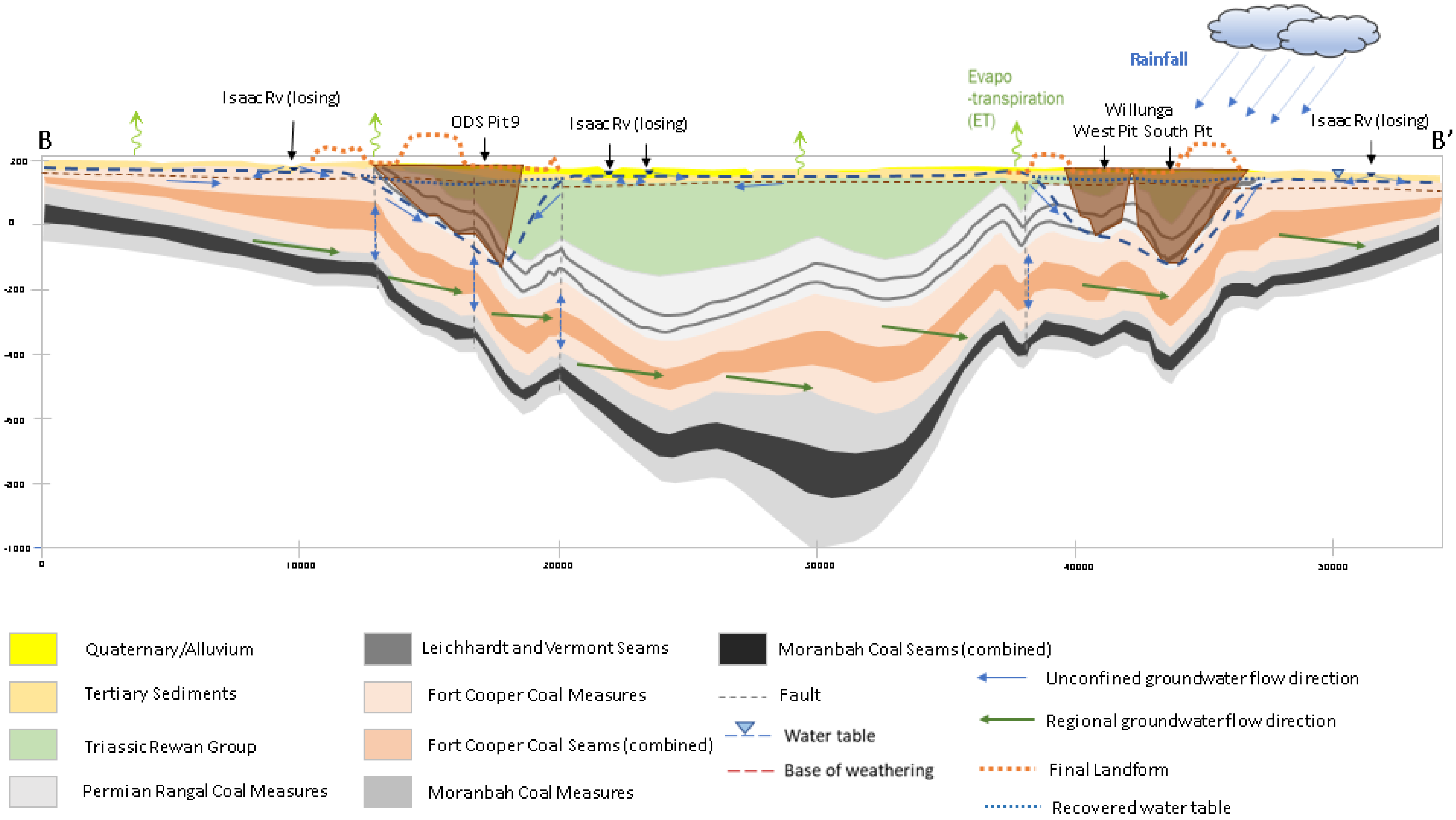

Figure 5-34 Conceptual Model of the Groundwater System During and Post Mining

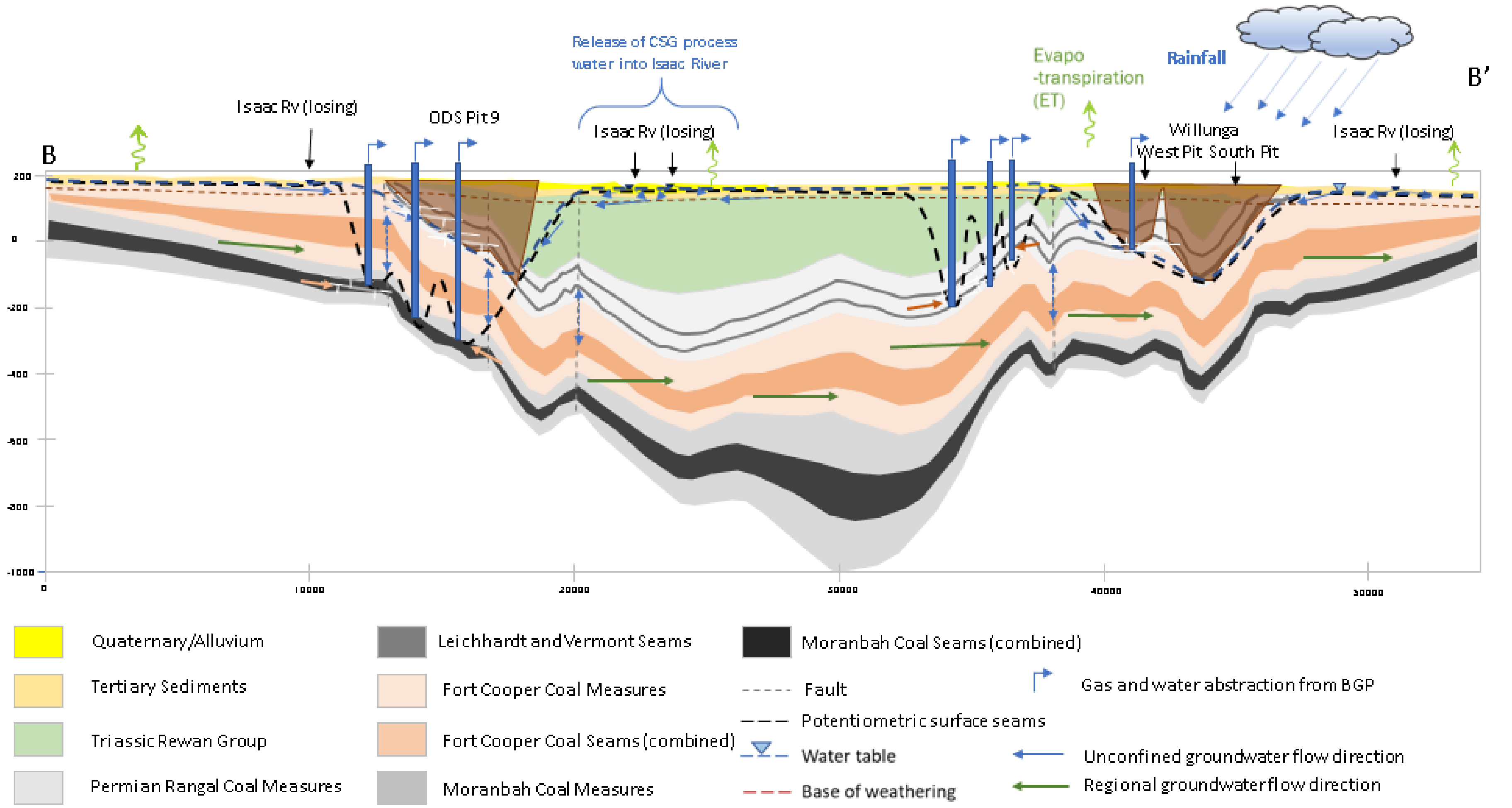

Figure 5-35 Conceptual Model of the Groundwater System During Mining with Coal Seam Gas Extraction

6 GROUNDWATER SIMULATION MODEL

6.1 MODEL DETAILS

This section provides a summary of the design and development of the numerical groundwater model. Full details on the design of the numerical groundwater model are included within **Appendix B**.

6.1.1 MODEL OBJECTIVES

Numerical modelling was undertaken to assess the impact of the Project on the groundwater regime. The objectives of the predictive modelling were to:

- assess the groundwater inflow to the mine workings as a function of mine position and timing;
- simulate and predict the extent and area of influence of dewatering and the level and rate of drawdown at specific locations; and
- identify areas of potential risk, where groundwater impact mitigation/ control measures may be necessary.

6.1.2 MODEL DESIGN

The numerical groundwater model was developed based on the conceptual groundwater model, presented within **Section 5.7**. The model was developed using Geographic Information Systems (GIS) in conjunction with MODFLOW-USG, which is distributed by the United States Geological Survey (USGS). MODFLOW-USG is a relatively new version of the popular MODFLOW code (McDonald and Harbaugh, 1988) developed by the United States Geological Survey (USGS). MODFLOW is the most widely used code for groundwater modelling and has long been considered an industry standard.

The model is roughly 55 km x 70 km at its widest extents and comprises 91,806 cells per layer. The model domain is discretised into 14 layers representing key geological units within the alluvium, regolith (Tertiary sediments), Rewan Group, Rangal Coal Measures, Fort Cooper Coal Measures and Moranbah Coal Measures . Over the 14 model layers, with pinch-out areas (where a layer is not present) in layers 2 to 14, the total cell count for the model is 966,821. The model grid has been developed as a Voronoi mesh, with cells aligned and variably sized to focus on key features such as rivers, mine areas and faults.

6.1.3 MODEL CALIBRATION

The numerical model includes a steady-state calibration (pre 2006) and transient calibration (2006 to 2017). Both the steady-state and transient calibrations capture historical mining at Peak Downs, Saraji, Lake Vermont, Poitrel and Daunia Mines. Mining was represented in the model using the drain package, with the drain cells set to the base of the target coal seam for each pit and within the target coal seam for underground mines. The objective of the calibration was to replicate the groundwater levels measured in the site monitoring network and available private bores, in accordance with Australian groundwater modelling guidelines (Barnett *et al.* 2012).

The steady-state calibration achieved a 8.7 % scaled root mean square (SRMS) error, which is within acceptable limits (i.e. 10%), recommended by the Australian groundwater modelling guidelines (Barnett et al. 2012). The transient calibration achieved a 7.9 % SRMS error, which is within acceptable limits (i.e. 10%), recommended by the Australian groundwater modelling guidelines (Barnett *et al.* 2012). A detailed description of the calibration procedure is provided in **Appendix B**.

6.1.4 MODEL PERFORMANCE AND LIMITATIONS

Under the earlier MDBC 2001 modelling guideline (Middlemis *et al.*2001), the model is best categorised as an Impact Assessment Model of medium complexity. That earlier guide (Middlemis *et al.,* 2001) describes this model type as follows:

> *"Impact Assessment model - a moderate complexity model, requiring more data and a better understanding of the groundwater system dynamics, and suitable for predicting the impacts of proposed developments or management policies."*

Barnett *et al.* (2012) developed a system within the modelling guidelines to classify the confidence level for groundwater models. Models are classified as Class 1, Class 2 or Class 3 in order of increasing confidence based on key indicators such as available data, calibration procedures, consistency between calibration and predictive analysis and level of stresses. Under these guidelines, this model would be classified as a Confidence Level 2 (Class 2) groundwater model, with the following key indicators (based on **Table 2-1** of Barnett *et al.*, 2012):

- Groundwater head observations and bore logs are available and with a reasonable spatial coverage around the site and regionally.
- Seasonal fluctuations are not accurately replicated in all parts of the model domain (Level 2).
- Scaled RMS error and other calibration statistics are acceptable (Level 3).
- Suggested model use is for prediction of impacts of proposed developments in medium value aquifers (Level 2).

6.1.5 MODEL PREDICTION

Transient predictive modelling was undertaken to simulate both the proposed mining at the Project and surrounding mines from January 2018 to December 2095. The model timing used variable stress period durations, being monthly, annually or five yearly (as mining progressed into the future). Three numerical model scenarios were run:

- Null Run – No future mining within the Study Area.
- Approved – Approved and foreseeable mining within the Study Area.
- Cumulative – Approved and foreseeable mining plus the Project.

Additional model scenarios were run to test the sensitivity of the model to changes in a range of key parameters and model assumptions. This included changes to specific yield, spoil parameters and the properties of faults. Assessment of cumulative impacts associated with the approved Bowen Gas Project that overlaps with the Project was also undertaken. Results from the sensitivity analysis are presented in **Appendix B**. In addition, a comprehensive Monte Carlo uncertainty analysis was undertaken - details in **Appendix B** Section 6.

6.2 PREDICTED GROUNDWATER INTERCEPTION

The predicted total annual volumes of groundwater predicted to be intercepted as part of the Project is shown in **Figure 6-1**. This total volume includes water removed in rock material with mining, as well as water evaporated from the pit surface. It is therefore an over-estimate of water that could report to the site water balance.

As shown in **Figure 6-1,** the combined inflows to the open cut operations would peak in Year 2037. The total peak inflow due to the Project is expected to be about 4.5 ML/day (1,636 ML/year), while the average is expected to be about 1.7 ML/day (638 ML/year) over the duration of mining.

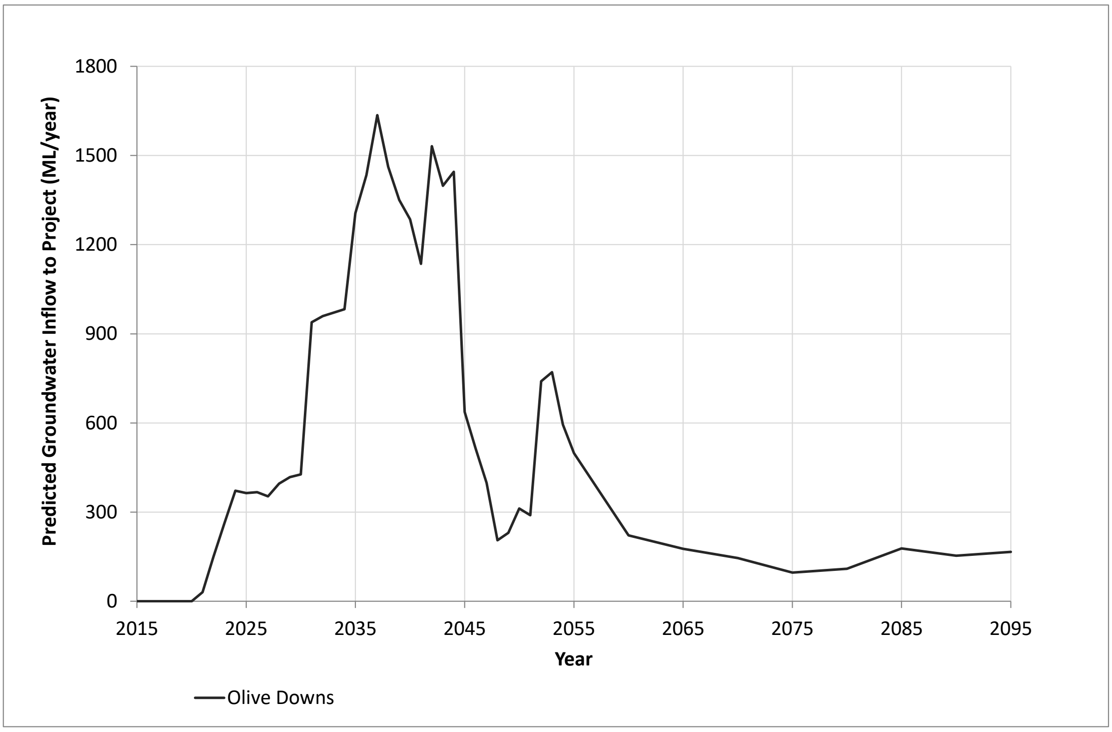

Figure 6-1 Predicted Olive Downs Coking Coal Project Mine Inflows

Figure 6-2 shows the predicted interception of groundwater separated out for the Water Plan (Fitzroy Basin) 2011 groundwater zones, being:

- Groundwater Unit 1 (containing aquifers of the Quaternary alluvium); and
- Groundwater Unit 2 (sub-artesian aquifers).

The results indicate that up to 623 ML/year is abstracted from Groundwater Unit 1 and up to 1,199 ML/year is abstracted from Groundwater Unit 2 over the life of the Project.

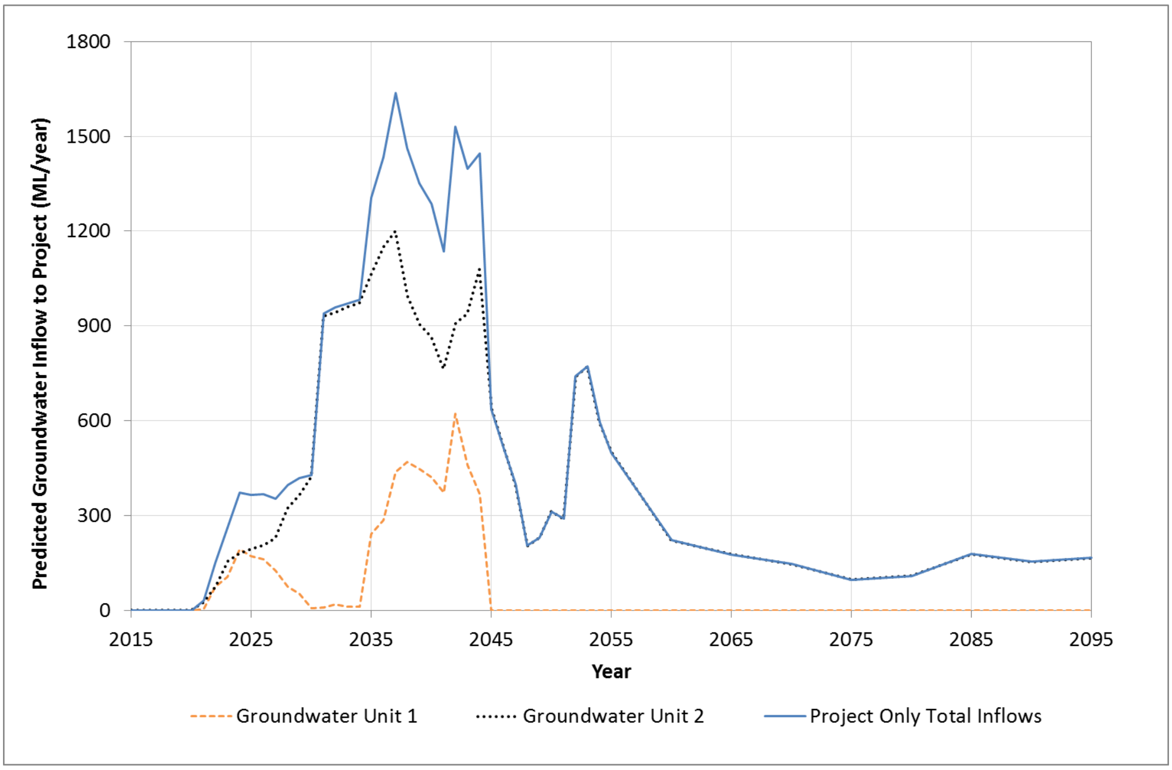

Figure 6-2 Predicted Olive Downs Coking Coal Project Mine Inflows by Groundwater Unit

The predictions are also further divided by the two mine domains and mine progress stages in **Table 6-1**. As shown in **Table 6-1**, the majority of take from Groundwater Unit 1 and Groundwater Unit 2 occurs at the Willunga Domain.

Table 6-1 Predicted Groundwater Inflows

	OLIVE DOWNS SOUTH DOMAIN AVERAGE GROUNDWATER INFLOWS (ML/YEAR)		WILLUNGA DOMAIN AVERAGE GROUNDWATER INFLOWS (ML/YEAR)		TOTAL AVERAGE INFLOWS (ML/YEAR)	
	Groundwater Unit 1 (Alluvium)	Groundwater Unit 2 (Hardrock)	Groundwater Unit 1 (Alluvium)	Groundwater Unit 2 (Hardrock)	Groundwater Unit 1 (Alluvium)	Groundwater Unit 2 (Hardrock)
STAGE 1	88	238	0	44	88	283
STAGE 2	4	704	267	278	271	981
STAGE 3	0	414	145	137	145	551
STAGE 4	0	470	0	31	0	500
STAGE 5	0	94	0	27	0	121
STAGE 6	0	72	0	72	0	143
STAGE 7	0	143	0	16	0	160
ANNUAL MAXIMUM	**192**	**844**	**623**	**415**	**623**	**1199**

6.3 PREDICTED MAXIMUM DRAWDOWNS

The process of mining reduces water levels in surrounding groundwater units. The extent of the zone affected is dependent on the properties of the aquifers/aquitards and is referred to as the zone of depressurisation in a confined aquifer and zone of drawdown within the water table. Depressurisation and drawdown is greatest at the working coal-face, and gradually reduces with distance from the mine.

Maximum drawdown due to the Project is obtained by comparing the difference in groundwater levels for the Approved model run and the Cumulative model run. The maximum drawdown is a combination of the maximum drawdown values recorded at each cell at any time over the duration of the predictive model. The figure also shows the locations of private bores intersecting the unconsolidated sediments. Discussion on the maximum predicted groundwater level drawdown at the private bores is included in **Section 7.2**. **Figure 6-3** shows the maximum drawdown due to the Project within the regolith and alluvium (Layer 1 and Layer 2 combined) where the unit is predicted to be saturated. As shown in **Figure 6-3**, drawdown in the alluvium can extend up to 4 km north and 5 km south-east of the ODS domain. Alluvial drawdown at the Willunga domain is restricted to within 3 km of the proposed pit. **Figure 6-3** also shows that drawdown within the regolith material could extend up to 11 km west to south-west of the ODS domain and approximately 6 km north to south-east of the Willunga domain.

Figure 6-4 and **Figure 6-5** show the maximum drawdown due to the Project within the Leichhardt and Vermont seams (Layer 5 and Layer 7), respectively. The figures include private bores within the region that intersect the Rangal coal measures. It should be noted that no private bores intersect the Leichhardt Seam and Vermont Seam, but apparently intersect the interburden units. Discussion on the maximum predicted groundwater level drawdown at the private bores is included in **Section 7.2**. As shown in **Figure 6-4** maximum groundwater level drawdown within the Leichhardt Seam can extend up to 8 km to the south-west of the ODS Domain and 5 km north of the Willunga Domain. **Figure 6-5** shows that maximum groundwater level drawdown within the deeper Vermont Seam can extend up to 11 km to the south-west of the ODS Domain and 5 km north of the Willunga Domain. Groundwater level drawdown within the mined coal seams is influenced by the structure of the unit. As shown in **Figure 6-4** and **Figure 6-5**, drawdown is limited to where the coal is present and extends furthest where the coal seams occur at subcrop west of the ODS Domain.

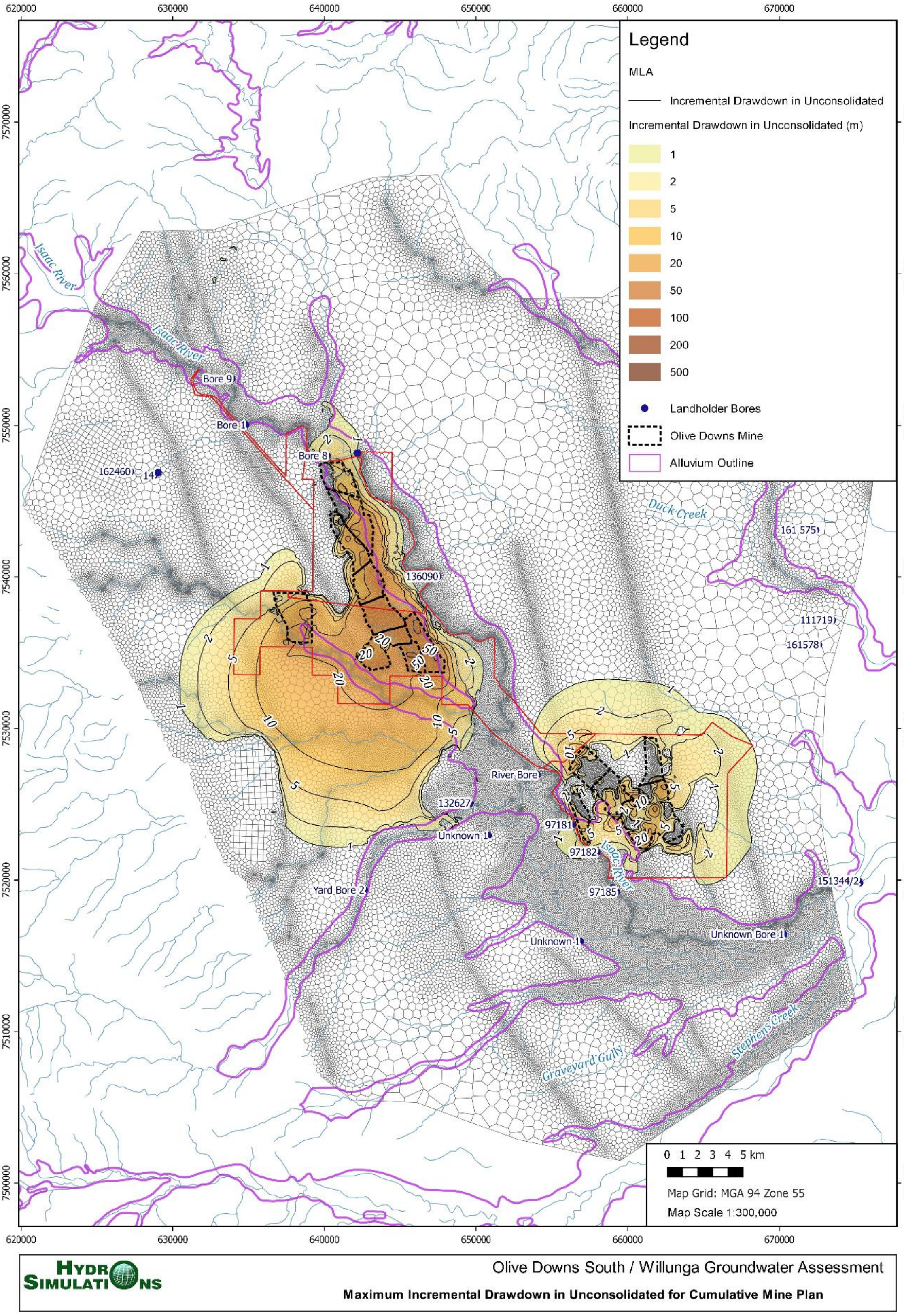

Figure 6-3 Maximum Incremental Drawdown in Unconsolidated Sediments

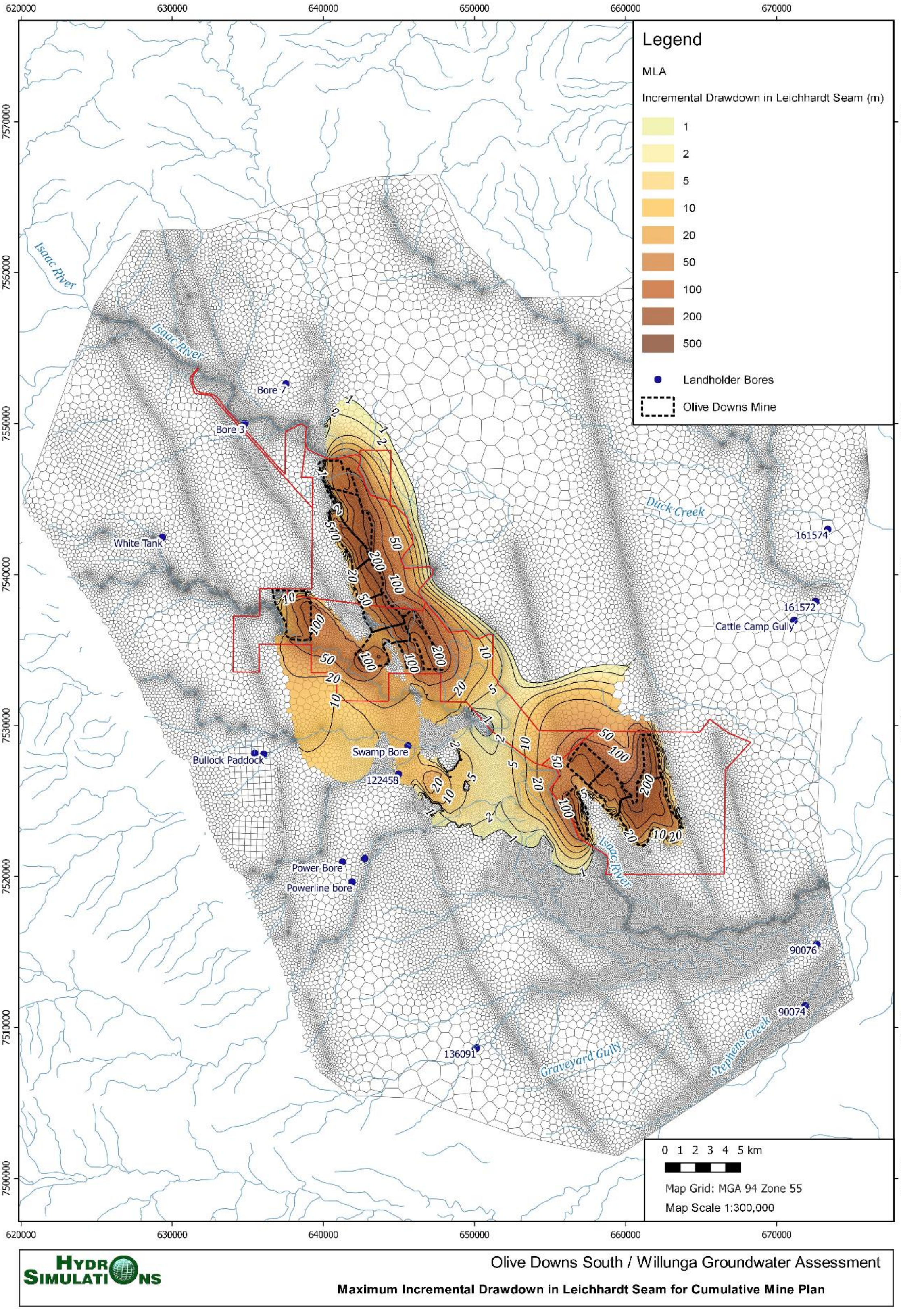

Figure 6-4 Maximum Incremental Drawdown in Leichhardt Seam (Layer 5)

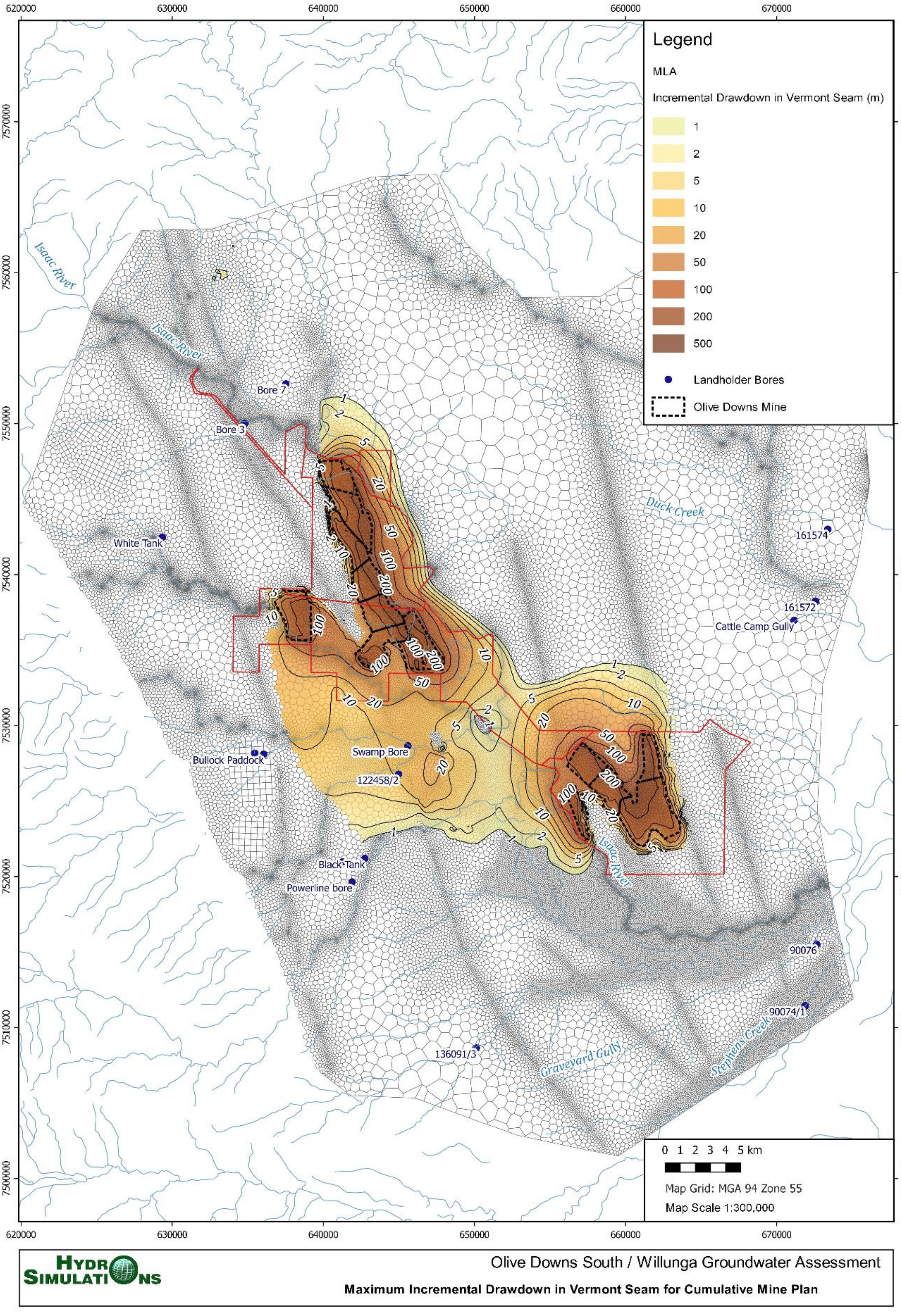

Figure 6-5 Maximum Incremental Drawdown in Vermont Seam (Layer 7)

6.4 INCIDENTAL WATER IMPACTS

6.4.1 INFLUENCE ON ALLUVIUM

Over the extent of Quaternary alluvium, there is a predicted average loss of 0.2 ML/day and a maximum loss of 1.1 ML/day of water from the alluvium as a result of exercising the underground water rights for the Project. Interference of the alluvial groundwater largely relates to increased leakage to the underlying Permian coal measures that are depressurised as a result of the Project, which is distinct from direct interception of alluvial groundwater within the proposed pit (**Section 6.2**).

6.4.2 INFLUENCE ON BASEFLOW

The change in water levels induced by mining increases the hydraulic gradient between the alluvium and the Isaac River. As outlined within the conceptual model (**Section 5.7**), the Isaac River is largely a losing system, with seepage of surface water into the underlying alluvium. The model predicts the rate of seepage from the river to the alluvium will increase by an average of 2.6 ML/day over the life of the mine. This is considered a conservative overestimate as the model does not represent an unsaturated zone that can form between the bed of the river and the underlying groundwater unit, which serves to limit the hydraulic gradient and interconnectivity.

Isaac River is ephemeral in nature, with flows following rainfall events that generate runoff. The baseflow predicted by the groundwater model therefore represents water moving through the shallow sediments in the base of the river under the surface. On average, when the Isaac River flows, 460 ML/day of surface water is discharged downstream. The conservative estimate of 2.6 ML/day increased seepage from the Isaac River to the alluvium therefore represents a potential 0.5% reduction in flow.

The Ripstone Creek is also planned to be diverted as part of the Project. Comparison between water fluxes for the Approved and Cumulative mine plans indicates no perceptible change in flow along Ripstone Creek. This is likely due to the ephemeral nature and upslope position of Ripstone Creek.

At the completion of the Project, the final landform would retain three final voids. The zones of influence would retract around the final voids as groundwater levels recover. This would result in a reduction in the long-term loss of baseflow to 1.9 ML/day at post closure equilibrium.

6.5 CUMULATIVE IMPACTS

Cumulative impacts associated with approved and foreseeable open cut and underground coal mines surrounding the Project was modelled. The surrounding mines within the model include Poitrel, Daunia, Peak Downs, Lake Vermont, Eagle Downs and Saraji (see **Appendix B** Figure 2-4).

Figure 6-6 to **Figure 6-8** show the maximum cumulative drawdown of approved and foreseeable mining, plus the Project. The maximum drawdowns are obtained by calculating the maximum difference in heads between the Cumulative and Null Run scenarios at each cell at any time over the duration of the predictive model.

Figure 6-6 shows maximum cumulative drawdown within alluvium and regolith (maximum drawdown within saturated extent of layer 1 and layer 2 combined) for the Project. The figure shows the zone of depressurisation from surrounding open cut and underground mines has reached the zone of impact from mining at Olive Downs South. The magnitude of drawdowns is greatest in or closely around the mining area, and gradually reduces with distance from the mine. The zone of depressurisation from Willunga is not affected by mining at surrounding mines.

Figure 6-7 and **Figure 6-8** show the cumulative maximum depressurisation within the Leichhardt Seam and Vermont Seam for the Project. As above, the zone of depressurisation from surrounding open cut and underground mines interacts with the zone of impact from mining at Olive Downs South. As shown in the figures, groundwater drawdown extends further to the west of the ODS domain, which appears to relate to modelled mining activities at Saraji Mine. Maximum cumulative groundwater drawdown within the coal seams extends up to 13 km from mine operations, and is influenced by the extent of the geological unit.

Assessment of cumulative impacts associated with the approved Bowen Gas Project was undertaken as a sensitivity analysis as it directly overlaps with the Study Area. Results from this assessment are presented in the sensitivity analysis (**Appendix B**). Based on the modelling results, cumulative groundwater drawdown extents from the Bowen Gas Project are predicted to be greater than impacts produced by the Project alone.

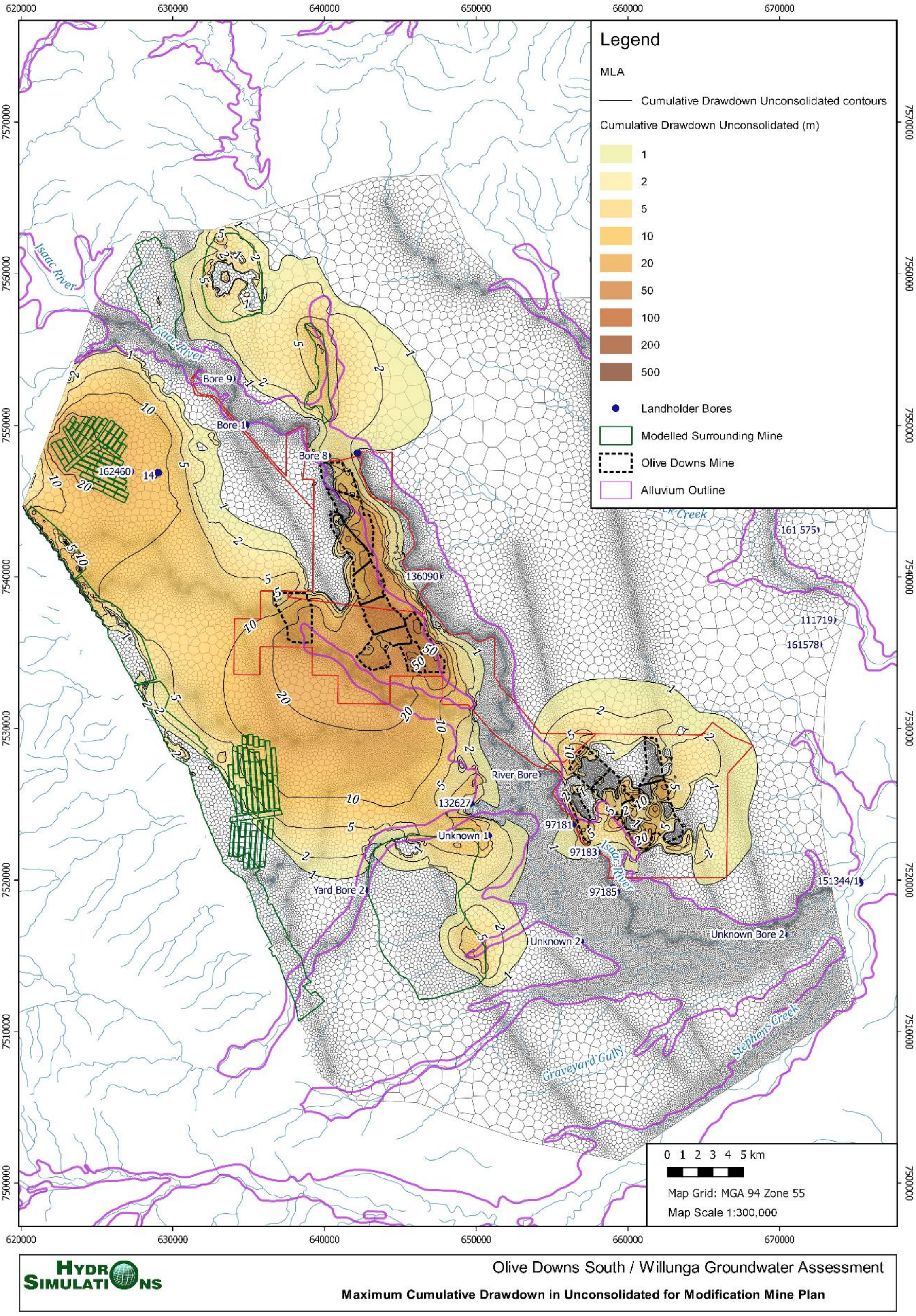

Figure 6-6 Maximum Cumulative Drawdown in Unconsolidated Sediments (Layer 1 and 2)

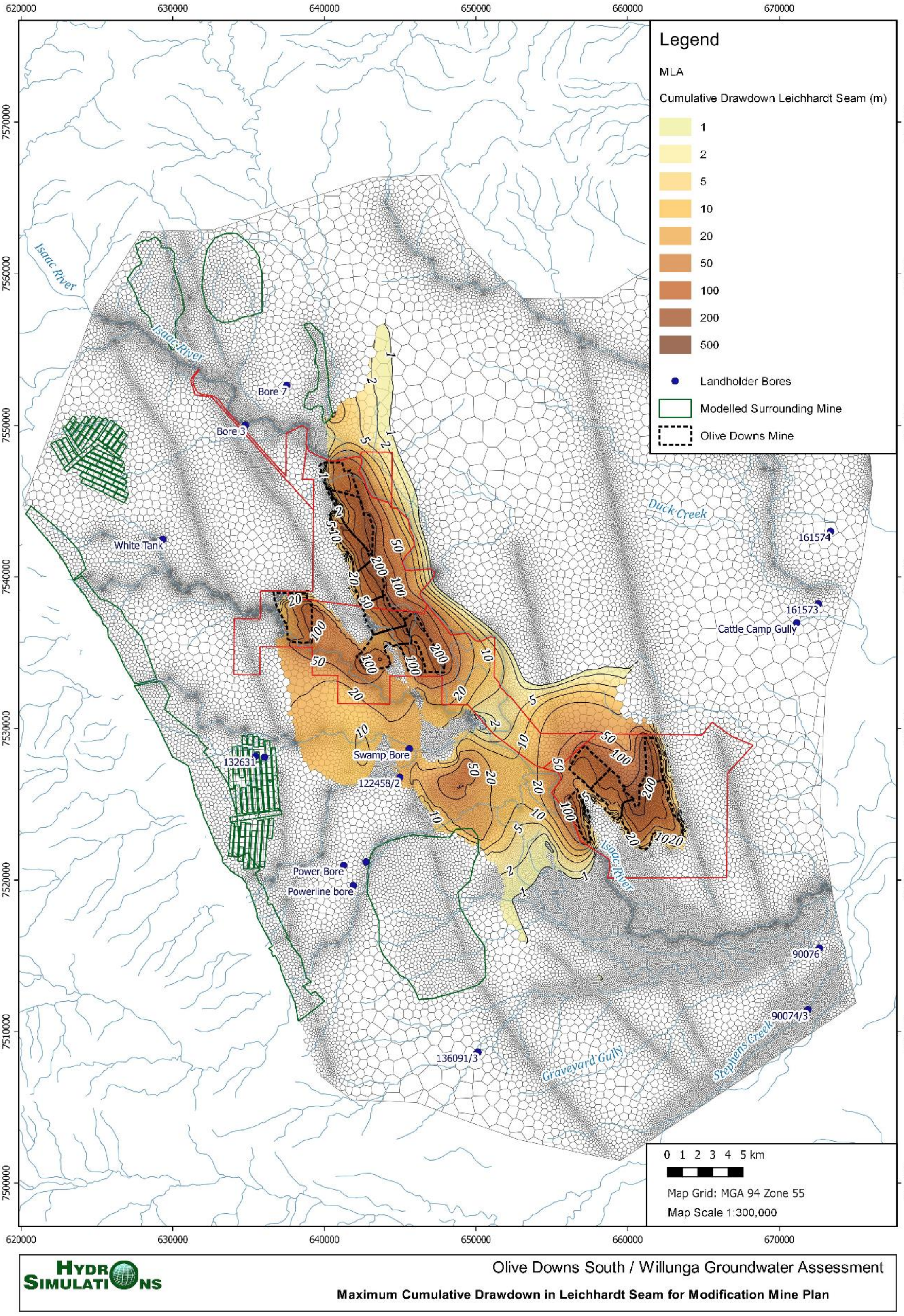

Figure 6-7 Maximum Cumulative Drawdown in the Leichhardt Seam (Layer 5)

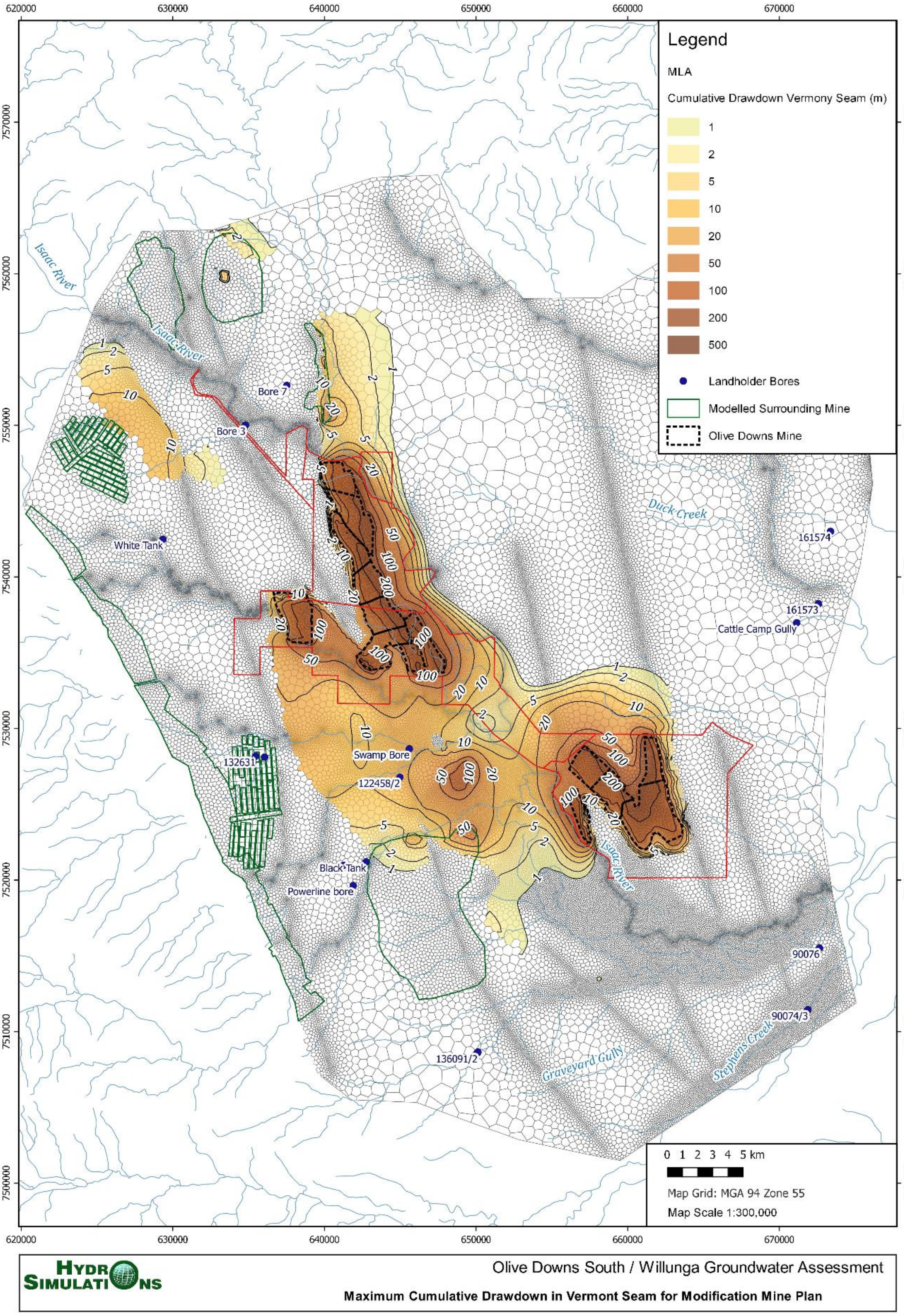

Figure 6-8 Maximum Cumulative Drawdown in the Vermont Seam (Layer 7)

6.6 POST-MINING EQUILIBRIUM

Post mining impacts were investigated with a recovery model, commencing from the end of mining and run for 200 years. The model used the end of mining groundwater levels as the starting heads, and removed all drain cells simulating the proposed mining areas to allow groundwater levels to equilibrate. At the end of mining, the properties of the final voids cells were converted to values representative of void values. The locations of the final voids are shown in Figure 6-10.

The final voids left in the Olive Downs open pits will accept water due to rainfall and inflow from recovered groundwater levels. The final void water level was determined by the balance between the direct rainfall, rainfall runoff from the surrounding catchment and groundwater inflow against the evaporation loss from the lake surface. This was achieved through surface water balance modelling (see Hatch, 2018), which utilised groundwater inflow predictions to estimate the pit lake elevations over time.

Figure 6-9 illustrates the predicted recovery of groundwater levels that will form in the final voids. The graph shows that the groundwater recovery is a slow process with the recovery rate declining as it reaches equilibrium conditions.

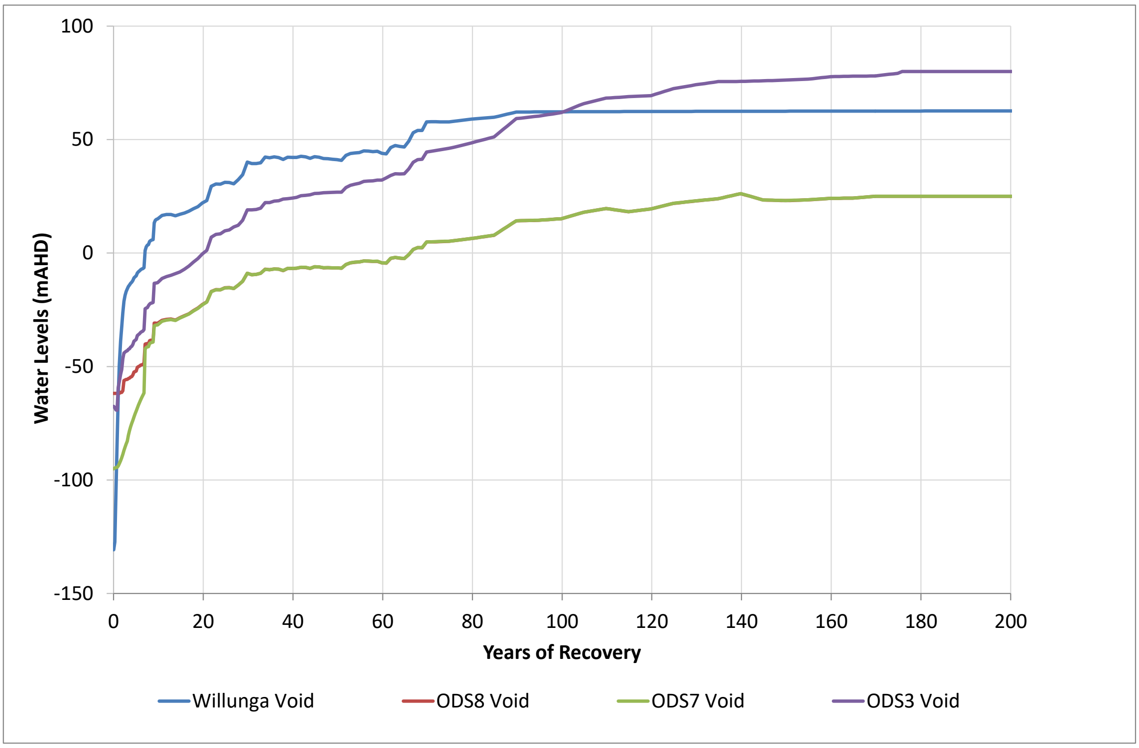

Figure 6-9 Final voids Recovery over time

Figure 6-9 shows the changes in groundwater levels at equilibrium conditions 200 years post mining, with long-term pit lake levels in the voids of:

- 80 mAHD within ODS3 void;
- 25 mAHD within ODS7/ODS8 void; and
- 63 mAHD within WIL5 void.

The predicted equilibrium void water levels (at 200 years) for unconsolidated lithologies and the Leichhardt Seam (Layer 7) are shown in **Figure 6-10** and **Figure 6-11**, respectively. As shown in **Figure 6-10** alluvial groundwater levels show a localised flow towards the two voids in the ODS domain. Adjacent to the pits, groundwater levels at the northern end of ODS1 recover back towards pre-mining levels at approximately 167 mAHD, while groundwater levels south of ODS8 recover to approximately 130 mAHD. Groundwater levels within the alluvium surrounding Willunga recover back towards pre-mining levels at approximately 140 mAHD to 146 mAHD.

Figure 6-11 shows the recovered groundwater levels within the Permian coal measures (Leichhardt Seam), final voids and spoil material within the backfilled pits. The figure also shows a general flow direction towards the mine area from the surrounding Permian coal measures. The figure also shows that groundwater within the ODS rehabilitated pits would flow in a general south-easterly direction towards the ODS7/ODS8 final void. This includes flow through the ODS3 final void towards the down-gradient ODS7/ODS8 final void. Within the rehabilitated pits, groundwater levels at the northern end of ODS1 would recover to approximately 140 mAHD to 161 mAHD, while groundwater levels south of ODS8 would recover to approximately 25 mAHD to 100 mAHD. In localised areas at the northern end of ODS1, recovered groundwater levels are expected to be close to alluvial groundwater levels and the base of alluvium, indicating potential interaction in localised areas. Groundwater levels within the Permian coal measures at Willunga would recover back to between 63 mAHD to 110 mAHD in the main pit area (WIL2 to WIL5), while groundwater levels within the fully backfilled pit (WIL1) would recover back towards 143 mAHD. Predicted levels within WIL1 are in line with the predicted alluvial groundwater levels and the base of alluvium at this location, indicating potential interaction in this area. Discussion on the potential water quality impacts associated with interaction between groundwater within alluvium and backfilled pits is included in **Section 7.4**.

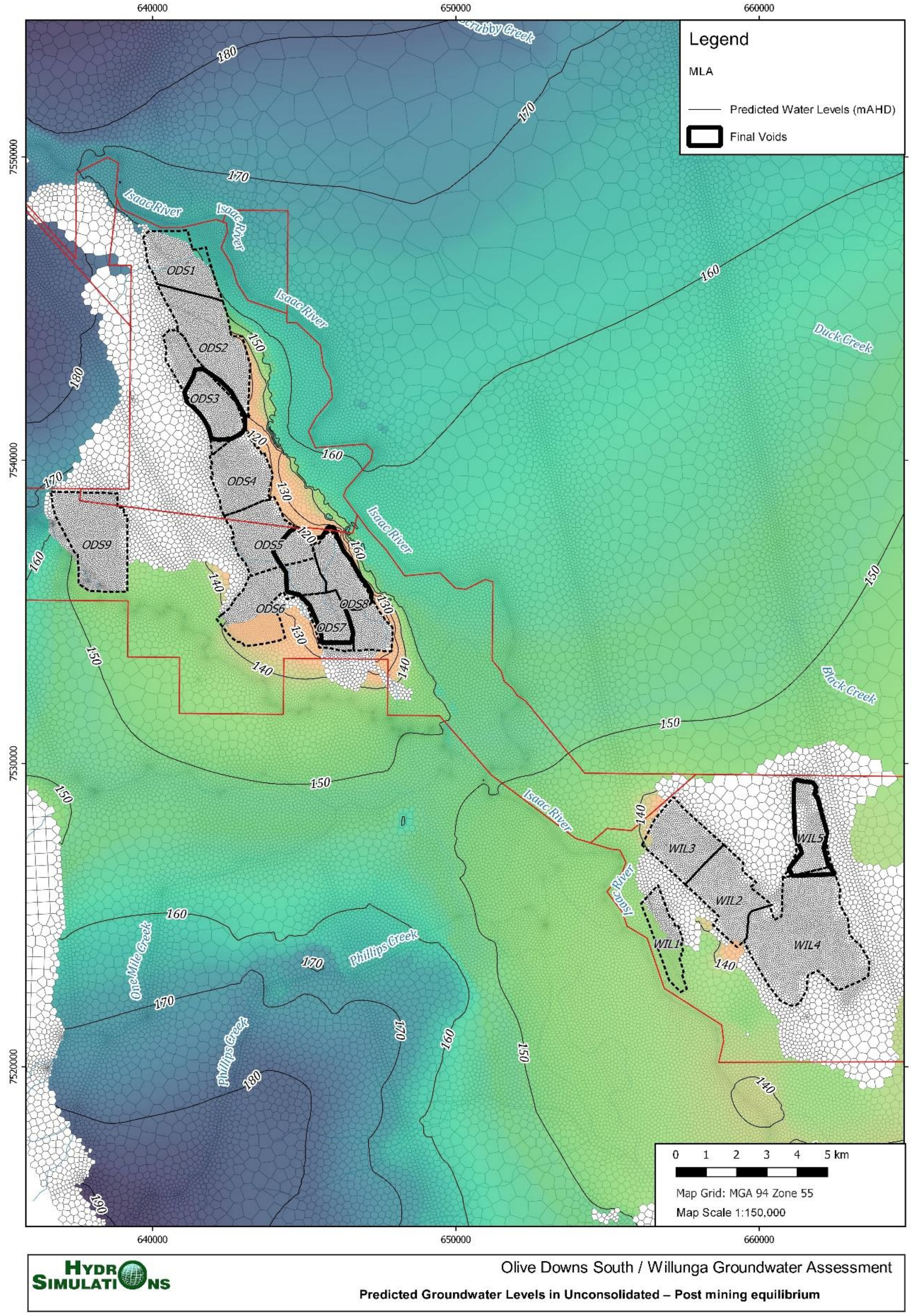

Figure 6-10 Predicted Groundwater Levels in Unconsolidated Sediments (Layer 1 and 2)– Post mining equilibrium

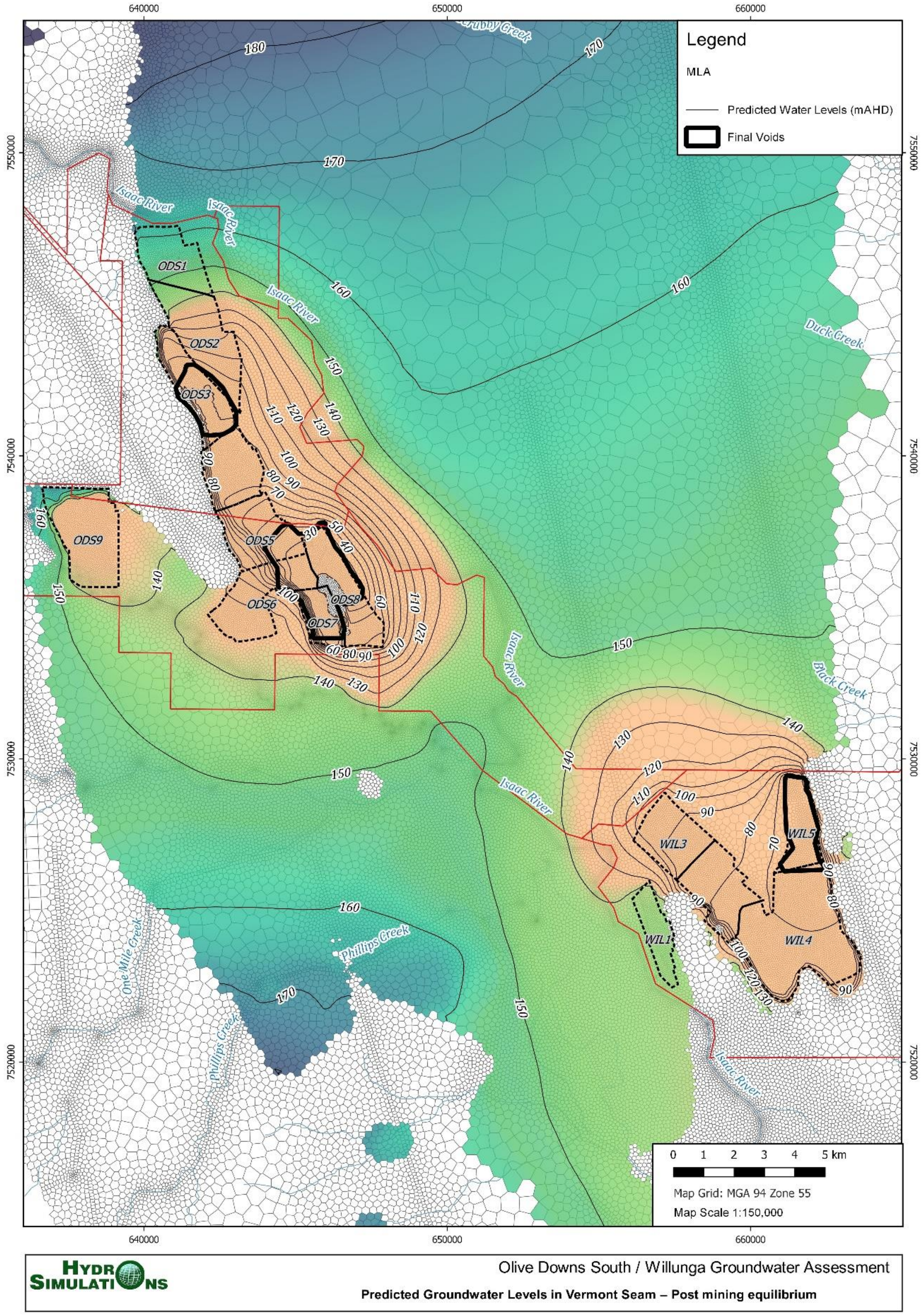

Figure 6-11 Predicted Groundwater Levels in the Vermont Seam (Layer 7) – Post Mining Equilibrium

7 IMPACTS ON THE GROUNDWATER RESOURCE

7.1 WATER LICENSING

The Project directly intercepts groundwater from Groundwater Unit 1 (Quaternary alluvium) and Groundwater Unit 2 (sub-artesian aquifers) under the Water Plan (Fitzroy Basin) 2011. The predicted take of groundwater has been extracted from the model drain cells and geological budget zones. The predicted direct take over time is presented in **Section 6.2**, which indicates that over the life of the project groundwater licensing will involve allocation of up to:

- 623 ML/year for Groundwater Unit 1; and
- 1,199 ML/year for Groundwater Unit 2.

Post mining, there will be evaporation from the lakes that will form within the final voids. The predicted loss of groundwater due to evaporative processes following mine closure is presented in **Section 6.6**. The results indicate that at equilibrium post closure, groundwater licensing will involve allocation of:

- 146 ML/year for Groundwater Unit 1; and
- 183 ML/year for Groundwater Unit 2.

7.2 POTENTIAL IMPACT ON GROUNDWATER USERS

7.2.1 REGISTERED PRODUCTION BORES

Figure 6-3 shows the locations of registered alluvial private bores and mine bores in the vicinity the Project, in relation to the predicted incremental drawdown in the alluvium and regolith (Layer 1 and Layer 2 combined). It is predicted that two bores within the alluvium will experience more than 1 m drawdown in the alluvium due to the Project.

Figure 6-4 and **Figure 6-5** show the registered bores interpreted as drawing groundwater from the Permian strata in relation to predicted incremental drawdown within the Leichhardt and Vermont seams (Layer 5 and Layer 7), respectively. It is predicted that three bores within the Permian coal measures will experience more than 1 m drawdown due to the Project.

Table 7-1 presents a summary of existing bores for which the maximum predicted Project drawdown is greater than 1 m. Bore attributes were derived from the landholder bore census, as presented in **Appendix A**.

Table 7-1 Predicted Maximum Drawdown at Private Bores Due to Project

Bore ID	Property Owner	Depth (mbgl)	Screen (mbgl)	Geology	SWL mbgl (2017)	Model Layer	Predicted SWL mbgl (2017)	Predicted Maximum Project Drawdown (m)
Bore 8	Olive Downs	-	-	Alluvium	-	1	13.4	3.6
RN97181 (Pisscutter)	Willunga	18.97	17.4 - 18.3	Alluvium	11.9	1	9.7	1.6
Swamp Bore	Meadowbrook	84.75	84.8	Permian	17.3	6	6.4	14.4
RN122458 (Rolfies #2)	Meadowbrook	51.48	38.5 - 50.5	Permian	21.6	4	13.0	11.5
RN122458 (Rolfies #1)	Meadowbrook	102.85	-	Permian	21.6	6	13.0	11.5

Note: *SWL – Standing Water Level* *mbgl – metres below ground level*

As presented in **Table 7-1**, Bore 8 intersects the Isaac River alluvium on the Olive Downs property. Bore 8 is equipped with a submersible pump that is apparently used by the landholder for stock water supply. The construction of Bore 8 is unknown, but is anticipated to be less than 20 m deep due to the target geology. The predicted decline in groundwater level of 3.6 m has potential to impact on groundwater supply from the bore. However, drawdown within the bore is associated with mining in Pit 1 of the ODS domain, which concludes mining in model year 2044. Based on the mine schedule, alluvial groundwater at Bore 8 is expected to recover to about 50% of pre-mining levels during the life of the Project.

Bore RN97181 intersects the Isaac River alluvium, is less than 20 m deep and located on the Willunga property. Bore RN97181 is equipped with a submersible pump and used for stock water supply. The bore is apparently constructed with screen to 18.3 m depth and groundwater levels are predicted to decline by up to 1.6 m. Maintenance works (e.g. lowering of the pump) may be necessary to ensure the groundwater supply is maintained during the life of the Project; however, the Project will not impact on the landholder's ability to use the bore. Drawdown within RN97181 is associated with mining at the WIL1 satellite pit that intersects alluvium, which concludes mining in model year 2044. Based on the mine schedule, alluvial groundwater at RN97181 is expected to recover to near pre-mining levels during the life of the Project.

The three potentially impacted bores intersecting the Permian coal measures (Swamp Bore, RN122458 and RN122458) are all located on the Meadowbrook property. From the bore census, it is understood the bores are not currently in use but have historically been used for stock water supply. The bores are apparently constructed with screen over 38.5 m below surface, and groundwater levels are predicted to decline to about 25 m below surface. If the bores were to be used, this may influence the installation of pump equipment, but will not impact on the landholder's ability to use the bore. Drawdown within the three bores is largely associated with mining at Pit 6, Pit 7 and Pit 8 of the ODS domain, which commence from model year 2030. Groundwater levels are predicted to recover slightly at the end of mining, to around 11 mbgl (Swamp Bore) and 18 mbgl (RN122458 bores).

7.2.2 ECOLOGICAL SITES

Paleochannel lake, ox-bow lakes and floodchannel wetlands were field verified by DPM Envirosciences, as discussed in **Section 5.6**. The field assessment identified aquatic macroinvertebrates indicative of an area subject to complete drying and wetting cycles. The clay-rich substrates of the temporary waterbodies are likely to hold surface run-on for extended periods, creating a ‘perched’ system not influenced by groundwater drawdown.

As discussed in **Section 5.6**, tracts of remnant and regrowth also exist in isolated patches across the site and areas of riparian vegetation occur along the banks of the Isaac River. Based on the current depth to groundwater within the alluvium generally being below 10 m, DPM Envirosciences indicated this vegetation has a low likelihood of being dependent on access to groundwater.

Discussion on the changes in alluvial groundwater levels during and at the end of mining are included below. Discussion is based on the maximum groundwater level drawdown prediction (**Figure 6-3**) and predicted heads within the alluvium at the end of mining (**Appendix B)**.

As shown in **Figure 6-3**, within the ODS domain the 1 m alluvial groundwater drawdown extent is predicted to extend up to 4 km north and 5 km south-east of the pit area. Groundwater drawdown east and south of the pit is predicted to range between 5 m and 50 m. The alluvium is removed where it occurs within the pit domain, and is largely unsaturated where it occurs within approximately 1 km east and south of the pit. Within approximately 1.5 km east and south of the pit, alluvial groundwater occurs over 15 m below surface. Only one alluvial bore exists in this area (GW08s), which indicates groundwater within the alluvium currently occurs over 12 m below surface. At the northern end of the ODS domain, maximum drawdown ranges between 1 m and 10 m. At the end of mining, alluvial groundwater levels at the northern end are predicted to range between 159 mAHD and 167 mAHD, approximately 10 to 16 mbgl. This is in line with the current observed depth to groundwater for alluvial bores in the area (i.e. S2, S4 – S8, S9, GW01s and GW02s).

At Willunga the groundwater drawdown within the alluvium extends up to 1 km south and 3 km north to west of the pit area (**Figure 6-3**). The alluvium is removed where it occurs within the pit domain. Groundwater drawdown of between 1 m and 15 m is predicted within the alluvium surrounding the pit area (**Figure 6-3**). The predicted heads (**Appendix B**) indicate that at the end of mining alluvial groundwater levels could range between 140 mAHD and 146 mAHD, approximately 10 to 20 mbgl. Only one alluvial bore exists in this area (GW18s), which indicates groundwater within the alluvium currently occurs about 13 mbgl.

7.3 POTENTIAL IMPACTS ON SURFACE DRAINAGE

The Isaac River is the major drainage feature of the region, which is located adjacent to the ODS domain and Willunga domain and flows in a south-easterly direction.

The change in water levels induced by mining increases the hydraulic gradient between the alluvium and the Isaac River. The model predicts that the rate of seepage from the river to the alluvium will increase by an average of 2.6 ML/day over the life of the mine. This is considered a conservative overestimate as the model does not represent an unsaturated zone that can form between the bed of the river and the underlying groundwater unit, which serves to limit the hydraulic gradient and interconnectivity.

The Isaac River is ephemeral in nature, with flows following rainfall events that generate runoff. The baseflow predicted by the groundwater model therefore represents water moving through the shallow sediments in the base of the river under the surface. On average, when the Isaac River flows, 460 ML/day of surface water is discharged downstream. The conservative estimate of 2.6 ML/day increased seepage from the Isaac River to the alluvium therefore represents a potential 0.5% reduction in flow.

The Ripstone Creek is also planned to be diverted as part of the Project. Comparison between water fluxes for the Approved and Cumulative mine plans indicates no perceptible change in flow along Ripstone Creek. This is likely due to the ephemeral nature and upslope position of Ripstone Creek.

Post mining the final landform will retain three final voids. The zones of influence will retract around the final voids and groundwater levels will recover. This would result in a reduction in the long-term loss of baseflow to about 1.9 ML/day at post closure equilibrium.

7.4 POTENTIAL IMPACTS ON GROUNDWATER QUALITY

This section describes the potential sources and pathways of groundwater contamination associated with the Project.

7.4.1 OUT OF PIT WASTE ROCK EMPLACEMENT AREAS

As the mine progresses, waste rock material will be placed within selected out of pit emplacement areas. The out of pit waste rock emplacement areas may produce seepage as a result of rainfall inundation. Runoff from disturbed areas outside the mining pit and infrastructure areas, such as waste rock emplacement areas (both active and under rehabilitation) will be captured in the sediment dams and managed under the mine water management system. The system will be designed to capture and reuse water captured on site, with the only offsite discharge being via approved discharge points.

As outlined in **Section 5.4.4**, leachate analysis of the waste rock material was conducted by Terrenus Earth Sciences. The analysis found that waste rock material was non-acid forming, fresh (EC of 158 µS/cm to 1,050 µS/cm) and low in sulfur content (4 mg/L to 92 mg/L). As presented in **Appendix A**, the waste rock material exhibits similar to improved water quality compared to water within regolith material. However, the waste rock material generally exhibits poorer water quality compared to the alluvium. As outlined in **Section 4.2**, the Cainozoic sediments generally comprise surficial soil and clays, up to 10 m in thickness. Where the low permeability surficial clays are present, they would inhibit potential seepage from the waste rock emplacement to the underlying regolith and alluvium.

7.4.2 IN PIT WASTE ROCK EMPLACEMENT AREAS

The in-pit waste rock emplacement areas will be rehabilitated progressively as the mine develops using proven rehabilitation techniques. The mine plan includes fully backfilling satellite pit ODS9, as well as partially backfilling areas of ODS (i.e. ODS1, ODS2, ODS4, ODS5 and ODS6). Similarly, the mine plan for Willunga includes fully backfilling satellite pit WIL1 and partially backfilling pits WIL2, WIL3 and WIL4.

As discussed in **Section 6.6**, groundwater within the backfilled pit at the northern end of ODS domain (ODS1) and the fully backfilled pit at Willunga (WIL1) are predicted to recover back towards pre-mining levels. These groundwater levels are above the base of alluvium, potentially enabling interaction between water between the in pit waste rock material and surrounding alluvium. However, examination of paired simulated hydrographs in the waste rock and in the adjacent alluvium shows that there would be no hydraulic gradient from the waste to the alluvium. As presented in **Appendix A**, the waste rock material exhibits similar to improved water quality compared to groundwater within the Permian coal measures and regolith material. While the waste rock material generally exhibits poorer water quality compared to the alluvium, the groundwater levels would either remain below or, in some cases slightly above, the base of alluvium. However, an hydraulic gradient would not exist to enable interaction between water in the in pit waste rock material and surrounding alluvium.

7.4.3 FINAL VOIDS

Within the ODS domain two final voids are proposed, one at ODS3 and one within ODS7/ODS8. The two voids are separated by waste rock material, which enables flow-through from ODS3 towards ODS7/ODS8. Modelling has determined that the void water levels could recover back to approximately 80 mAHD in ODS3, and to 25 mAHD in ODS7/ODS8.The recovered levels in ODS3 and ODS7/ODS8 are around 65 m and 140 m below the pre-mining groundwater levels, which means these final voids would act as sinks to groundwater flow.

Within the Willunga domain one final void is proposed within the WIL5 pit area, with modelling predicting a final void pit lake level of around 63 mAHD. Based on this, groundwater levels will remain over 77 m below the pre-mining groundwater level, which means this final void would act as a sink to groundwater flow.

Water within these final voids will evaporate from the lake surface, and draw in groundwater from the surrounding geological units. Evaporation from the lake surface will concentrate salts in the lake slowly over time. This gradually increasing salinity will not pose a risk to the surrounding groundwater regime as the final voids would remain as permanent sinks.

7.4.4 WORKSHOPS AND STORAGE

All workshop and fuel/chemical storage areas will be developed in accordance with current Australian Standards. This includes refuelling areas and chemical storage areas to be designed with adequate bunding and equipped for immediate spill clean-up. These controls represent standard practice and a legislated requirement at mine sites for preventing the contamination of the groundwater regime. Therefore, there is considered to be limited potential for groundwater contamination to occur with relation to workshops and fuel/chemical storage.

8 MANAGEMENT AND MITIGATION MEASURES

8.1 MITIGATION MEASURES

8.1.1 MINE-AFFECTED WATER

The proposed mine plan includes strategies to manage mine-affected water for the life of the project. Potential sources of mine-affected water include the proposed out of pit rejects emplacement area, in-pit rejects containment facilities within the mine voids and groundwater inflows.

The proposed out of pit initial rejects storage facility has been located on the western side of the ODS domain, outside of the extent of alluvium and drainage features. The out of pit waste rock emplacement will be constructed and decommissioned to Australian Standards to ensure containment of fine reject material.

Rejects material will also be stored within the final void locations within the pits. As outlined in **Section 7.4.3**, groundwater within the final voids is predicted to remain below pre-mining levels. Therefore, it is anticipated the final voids would act as groundwater 'sinks', capturing water associated with in-pit rejects.

Groundwater seepage to the pit cannot be prevented and will be pumped from the pit to ensure safe operating conditions. The groundwater seepage will be collected and contained within mine water dams and utilised for processing and dust suppression on site. Water release points will also be established along Ripstone Creek and Isaac River, with releases conducted in accordance with regulatory requirements. A catchment management system will be developed to divert surface water flows away from the mine area. This includes development of flood levees to minimise surface water inundation to the mine area.

During mining operations, direct groundwater inflows from alluvium exposed in the highwall of the open cut would be intercepted prior to it reaching the floor of the open cut for use in the mine water management system or pumping back to the Isaac River. This would be achieved by the installation of sumps and a pump/pipe system on a bench of the open cut (as is the current practice for similar circumstances at other mines in Australia).

8.1.2 GROUNDWATER USE

The potential impacts on groundwater users (privately owned landholder bores) are described in **Section 7.2**. Make good measures would be put in place with affected landholders to ensure the bore owner has access to a similar quantity and quality of water for the water bore's authorised purpose. This may include deepening a bore to increase its pumping capacity, constructing a new water supply bore, providing water from an alternative source or financial compensation.

8.2 MANAGEMENT

8.2.1 GROUNDWATER MONITORING PROGRAM

The groundwater monitoring program established as part of EIS groundwater investigations will be continued throughout the life of the Project. Recording of groundwater levels from existing monitoring bores and VWPs will continue and will enable natural groundwater level fluctuations (such as responses to rainfall) to be distinguished from potential groundwater level impacts due to depressurisation resulting from proposed mining activities.

Groundwater quality sampling of existing monitoring bores will continue in order to provide longer term baseline groundwater quality information around the project site, and to detect any changes in groundwater quality during and post mining.

Table 8-1 summarises the groundwater monitoring program, and **Figure 8-1** shows the bore locations. The network has been consolidated to remove bores in close proximity to each other (i.e. S6 and S10) and includes additional 12 proposed monitoring locations (GW22-GW33) where gaps exist. The proposed bores are positioned around the pit footprint and proposed waste rock emplacement areas, with another (GW33) to the south of the ODS domain to assess predicted drawdown extent. It is noted that the DoEE approval conditions for the Lake Vermont Coal Mine Northern Extension Project (issued 29 June 2018) require complementary monitoring in the Quaternary and Tertiary sediments, primarily to the west of the Willunga Domain and south of ODS.

For the purpose of obtaining baseline data, the network presented in **Table 8-1** includes five locations within the footprint of the proposed pits and waste rock emplacements (S2, S4, GW02s/d, GW16s and GW21s). These bores will continue to be monitored until they are destroyed with mine progression. The network also includes one registered bore (RN158484) that has been constructed as a monitoring bore within the alluvium along Phillips Creek. As the bore is located on private property, access to this bore would be dependent on approval from the property owner (i.e. Lake Vermont).

Table 8-1 Proposed Site Monitoring Program

Site	Status	Type	Easting	Northing	Screen Depth (mbgl)	Monitored Unit	SWL	WQ	Location
GW22	Prop.	MB	640193*	7547639*	~ 13 - 15	Alluvium	Q	Q	North of ODS pit
GW23	Prop.	MB	646895*	7537007*	~ 13 – 15	Alluvium	D/Q	Q	East of ODS pit, between pit and Isaac River
GW24	Prop.	MB	648450*	7533805*	~ 13 – 15	Alluvium	D/Q	Q	South-east of ODS pit, between pit and potential GDEs
GW25	Prop.	MB	640345*	7540008*	~ 13 – 15	Regolith	D/Q	Q	East of proposed rejects emplacement
GW26	Prop.	MB	639307*	7538727*	~ 13 – 15	Regolith	D/Q	Q	South of proposed tailings emplacement
GW27	Prop.	MB	639465*	7535303*	~ 13 – 15	Alluvium	D/Q	Q	Ripstone Creek, downstream of Pit 9
GW28	Prop.	MB	642729*	7533536*	~ 13 – 15	Alluvium	D/Q	Q	Ripstone Creek, downstream of Pit 9 and Pit 6
GW29	Prop.	MB	661474*	7529571*	~ 13 – 15	Regolith	D/Q	Q	North of Willunga, between pit/void and Black Creek
GW30	Prop.	MB	655607*	7526597*	~ 13 – 15	Alluvium	D/Q	Q	North-west of Willunga, between pit and Isaac River
GW31	Prop.	MB	656306*	7524283*	~ 13 - 15	Alluvium	D/Q	Q	West of Willunga, between pit and Isaac River

Site	Status	Type	Easting	Northing	Screen Depth (mbgl)	Monitored Unit	SWL	WQ	Location
GW32	Prop.	MB	656588*	7528729*	~ 13 – 15	Regolith	D/Q	Q	North of Willunga (WIL3)
GW33^	Prop.	MB	643663*	7531867*	~ 85 – 100	Permian	D/Q	Q	South of Pit 6 (between pit and neighbouring landholder bores)
RN158484‡	EX	MB	648152	7524058	13 – 19	Alluvium	D/Q	Q	Along Philips Creek. Monitoring bore installed in 2013 on Lake Vermont.
GW01s	EX	MB	642481	7547491	13 - 19	Alluvium	D/Q	Q	North-east end of ODS (Pit 1), between pit and Isaac River
GW02s	EX	MB	641152	7546517	7 - 19	Alluvium	D/Q†	Q†	Within mine footprint
GW02d	EX	MB	641141	7546507	118.65 - 127.65	Vermont Upper	D/Q†	Q†	Within mine footprint
GW04	EX	MB	643388	7544973	6 - 15	Alluvium	D/Q	Q	North-east end of ODS (Pit 2), between pit and Isaac River
GW06s	EX	MB	639329	7542005	4 - 10	Regolith	D/Q	Q	North of proposed rejects emplacement
GW08s	EX	MB	645312	7539839	6 - 12	Alluvium	D/Q	Q	East of ODS (Pit 4), between pit and Isaac River
GW12s	EX	MB	641504	7532788	30 - 42	Regolith	D/Q	Q	South of Ripstone Creek and ODS
GW16s	EX	MB	660836	7525291	12 - 27	Regolith	D/Q†	Q†	Within mine footprint
GW18s	EX	MB	656889	7522809	9 - 15	Alluvium	D/Q	Q	South-west of Willunga, between pit and Isaac River
GW18d	EX	MB	656868	7522804	174 - 183	Vermont Upper	D/Q	Q	
GW21s	EX	MB	661590	7521656	3 - 9	Regolith	D/Q†	Q†	Within WRE footprint south of Willunga
GW21d	EX	MB	661585	7521655	148 - 157	Rangal Interburden	D/Q†	Q†	
S11	EX	MB	642455	7545332	8 – 14	Alluvium	D/Q	Q	East of ODS (Pit1) Between pit and Isaac River
S8	EX	MB	642340	7546343	9 - 15	Alluvium	D/Q	Q	East of ODS (Pit2) Between pit and Isaac River
S4	EX	MB	641567	7546845	11.5 – 17.5	Alluvium	D/Q†	Q†	Within mine footprint
S5	EX	MB	642239	7547332	11.5 – 17.5	Alluvium	D/Q	Q	East of ODS (Pit1) Between pit and Isaac River

Site		Status	Type	Easting	Northing	Screen Depth (mbgl)	Monitored Unit	SWL	WQ	Location
S2		EX	MB	641386	7547617	11.5 – 17.5	Alluvium	D/Q†	Q	Within WRE area east of ODS (Pit 1)
GW01d	VWP1	EX	VWP	642479	7547491	402	Vermont Upper	D	-	North-east end of ODS (Pit 1), between pit and Isaac River
	VWP2					352	Leichhardt Seam	D		
	VWP3					221.5	Rewan	D		
	VWP4					63	Rewan	D		
GW06d	VWP1	EX	VWP	639334	7542008	190.7	Fort Cooper - siltstone	D	-	North of proposed tailings emplacement and west of ODS (Pit 3)
	VWP2					136.5	Fort Cooper - coal	D		
	VWP3					117.5	Fort Cooper - sandstone	D		
	VWP4					38	Fort Cooper - sandstone	D		
GW08d	VWP1	EX	VWP	645312	7539846	177	Leichhardt Seam	D	-	East of ODS (Pit 4), between pit and Isaac River
	VWP2					137	Rangal Overburden	D		
	VWP3					94	Rewan	D		
	VWP4					70**	Rewan	-		
GW12d	VWP1	EX	VWP	641495	7532795	505	Leichhardt Seam	D	-	South of Ripstone Creek and ODS
	VWP2					484.5	Leichhardt Seam	D		
	VWP3					391**	Rangal Overburden	-		
	VWP4					108**	Rewan	-		
GW16d	VWP1	EX	VWP	660835	7525287	327**	Vermont Upper	-	-	Within mine footprint (Willunga)
	VWP2					269	Leichhardt Seam	D†		
	VWP3					147	Rewan	D†		
	VWP4					91	Rewan	D†		

Note: *EX – Existing* *Prop. – Proposed*
MB – Monitoring bore *VWP – Vibrating Wire Piezometer*
SWL – Standing water level *WQ – Water quality monitoring for analytes listed below*
Q – Quarterly monitoring frequency *D – Daily monitoring frequency using automatic logger*
D/Q – Daily monitoring frequency using automatic logger and manually dipped on a quarterly basis
** Approximate location only – to be confirmed through ground truthing*
*** Damaged/erroneous VWP sensor*
† Bore located within proposed mine footprint and to be monitored up until removed with mine progression
‡ Inclusion in monitoring network dependent on approval to access the bore from owner (Lake Vermont)
^ The final location proposed south of the ODS domain and west of the Willunga domain would be subject to landholder access and agreement, and placement of Lake Vermont additional bores.

Groundwater quality monitoring will continue to be undertaken on a quarterly basis as outlined within **Table 8-1**. As part of the full water quality monitoring, in addition to collecting field parameters (EC and pH), water samples will be submitted to a NATA accredited laboratory (ALS) for analysis of:

- Physio-chemical indicators (total dissolved solids (TDS) and total suspended solids (TSS).
- Major Ions (calcium, fluoride, magnesium, potassium, sodium, chloride, sulphate), hardness and ionic balance (total anions/cations).
- Total alkalinity as $CaCO_3$, HCO_3, CO_3.
- Total and dissolved metals: (Ag, Al, As, B, Ba, Be, Cd, Co, Cr, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, U, V and Zn).

It is also proposed that quarterly groundwater level and quality monitoring be conducted on accessible landholder bores predicted be impacted by the Project (see **Section 7.2**). Dependent on landholder permission, the bores should also be equipped with flow meters, to enable separation of Project impacts and impacts related to private bore usage.

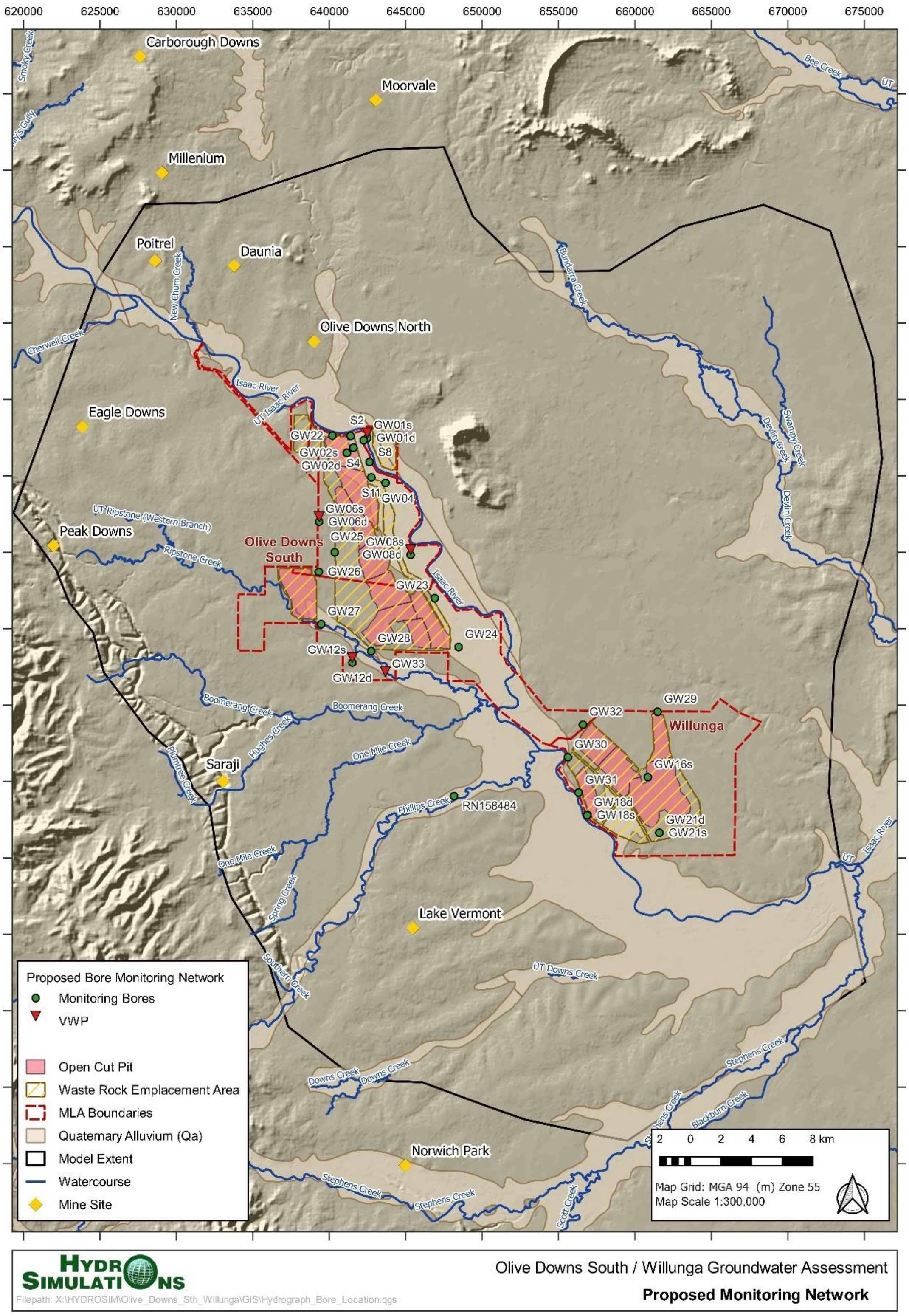

Figure 8-1 Proposed Groundwater Monitoring Network

8.2.2 IMPACT ASSESSMENT CRITERIA

Groundwater monitoring criteria will be established to monitor predicted impacts on both environmental values and predicted changes in groundwater quality. Impact assessment criteria for the site will be documented within a Water Management Plan (WMP).

Groundwater quality trigger levels will be developed in line with the Department of Science, Information Technology and Innovation (DSITIA) guideline on "*Using monitoring data to assess groundwater quality and potential environmental impacts*" (DSITI, 2017). The trigger levels will be established once 12 to 24 months of data have been collected from the site monitoring network. As per the DSITI (2017) guidelines, the triggers will be established in consideration of the Water Plan (Fitzroy Basin) 2011 WQOs, ANZECC (2000) criteria and site specific conditions. Trigger criteria will be established for each groundwater unit potentially impacted by the Project, being alluvium, regolith and the Permian coal measures.

All site monitoring bores are located within the zone of predicted groundwater level change due to the Project. Therefore, changes in groundwater levels at the site bores will be compared to predicted groundwater trends to evaluate any deviations from the predicted trends.

8.2.3 DATA MANAGEMENT AND REPORTING

Routine groundwater monitoring will be conducted on a quarterly basis, as outlined in **Section 8.2.1**. Data will be stored within a consolidated groundwater database. Quality assurance and quality control procedures will be put in place to help ensure the accuracy of data entered within the database. Prior to commencement of coal extraction, groundwater quality triggers will be established as outlined in **Section 8.2.2**.

When coal extraction commences at site, findings from the quarterly monitoring events will be presented in a factual quarterly monitoring report. The quarterly review will include identification of any groundwater quality trigger exceedances. Where a trigger exceedance is identified, the regulator will be notified within 28 days. Investigation into the cause of the exceedance will also be conducted by suitably qualified personnel. The groundwater database and factual quarterly reports will be available for provision to the regulator upon request.

Each year an annual review of groundwater level and quality trends will be conducted by a suitably qualified person and provided to the regulator. The review will assess the change in groundwater level and quality over the year, compared to historical trends and impact assessment predictions. The annual review will discuss any groundwater trigger exceedances or where trends show potential for environmental harm.

8.2.4 FUTURE MODELLING

Every five years the validity of the model predictions would be assessed and if the data indicate significant divergence from the model predictions, the groundwater model would be updated for simulation of mining.

9 LIMITATIONS

Model calibration data is based on approximately 9 months of monitoring data collected during the groundwater investigation program for the Project at the time of model construction, and publicly available data from surrounding projects. Rainfall recharge events during the monitoring period (to date) have been sporadic and the consequence of this is that there is limited data available to calibrate to seasonal variations in water level (i.e. averages only). The datasets should therefore continue to be augmented as baseline monitoring is conducted during upcoming seasons.

The model geometry away from the Project area (beyond the limits of the Site geological model) is interpolated and estimated from publicly available data and regional scale mapping (e.g. Qld Government mapping and EIS documentation [including the Bowen Gas Project]). Consequently, the depths, thickness and extents of the model layers away from the Project may not closely replicate reality. This is of particular note when simulating the cumulative impacts of surrounding mines. The coal seams of the Fort Cooper Coal Measures and Moranbah Coal Measures are simplified to single seams with aggregated seam thickness; as mining is applied conservatively to the base of this simplified seam, the depths of the surrounding mines may not be accurate and the stresses exaggerated.

Similarly, the timing and extent of surrounding mine activities have been largely inferred from publicly available data, and therefore an over- or under-estimation of impacts, or timing of impacts, may result due to this.

As the specific yields of Permian formations are not well known, a conservative approach has been adopted that maximises the off-site drawdown extent. A sensitivity analysis (with higher specific yields) has shown that the drawdown extent could be less extensive but the drawdowns proximal to the pits could be greater, and mine inflows could also be higher. A thorough examination of uncertainty has been undertaken with a Monte Carlo analysis of 312 calibrated model realisations.

10 CONCLUSION

The Project is a proposed greenfield open cut coal mine within the northern Bowen Basin of Queensland. The Project targets two coal seams (Vermont Seam and Leichhardt Seam) of the Rangal Coal Measures across two mine domains, Olive Downs South and Willunga.

This Groundwater Assessment for the Project included collection and analysis of field data, conceptualisation of the groundwater regime and development of a numerical groundwater model to assess potential groundwater impacts. The key findings of this assessment are:

- The Project has a predicted maximum mine inflow of about 623 ML/year for Groundwater Unit 1 (Alluvium) and 1,199 ML/year for Groundwater Unit 2 (Hardrock).
- Groundwater level drawdown within the alluvium could extend approximately 4 km north and 5 km south-east of the ODS domain, and approximately 3 km of the proposed pit at the Willunga domain.
- Groundwater level drawdown within the Permian coal measures could extend up to 11 km to west to south-west of the ODS Domain and 6 km north to south-west of the Willunga Domain.
- Two registered bores (Bore 8 and RN97181) intersecting alluvium are predicted to have a decline in groundwater levels at a point in time over the life of the Project.
- Three registered bores (Swamp Bore and two bores at RN122458) intersecting the Permian coal measures are predicted to have a decline in groundwater levels at a point in time over the life of the Project.
- The net indirect loss of groundwater from the entire expanse of alluvium (within the model domain) to underlying rock strata due to the Project is expected to be about 0.2 ML/day on average, with a peak loss of 1.1 ML/day.
- Predicted groundwater drawdown due to the Project indicates increased leakage from the Isaac River to the underlying alluvium by up to 2.6 ML/day, which represents a potential 0.5% reduction in flow. This is predicted to reduce to 1.9 ML/day at post closure equilibrium.
- Post mining, the two final voids in the ODS domain and one void in Willunga domain will act as groundwater 'sinks', drawing groundwater towards the void locations.

A Water Management Plan will be developed for the Project, and will include details on the groundwater monitoring plan. The existing site monitoring network will be expanded to include an additional 11 bores within the shallow stratigraphy (alluvium and regolith). Once sufficient data have been collected from the site monitoring network, site specific trigger levels will be established and specified within the groundwater monitoring plan. As part of the program, trigger exceedances will be investigated, and management measures may be implemented as a result of the investigation.

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Appendices

Appendix A Fieldwork Appendix

Olive Downs Coking Coal Project

Appendix A

Fieldwork Appendix

FOR

Pembroke Olive Downs Pty Ltd

BY

NPM Technical Pty Ltd

trading as

HydroSimulations

May 2018

1 INTRODUCTION

This Appendix describes the available groundwater data for the Project Site. The field data were used to conceptualise and develop a numerical groundwater model of the Study Area. The field data include:

- Groundwater monitoring network and program.
- Groundwater levels.
- Water quality analysis.
- Hydraulic testing.
- Geophysical survey.
- Surrounding private bores (bore census).

The sections below describe the raw data.

2 GROUNDWATER MONITORING

2.1 NETWORK

Pembroke has a groundwater monitoring network that comprises a total of 21 bores and five vibrating wire piezometers (VWP) with a total of 20 sensors. The network was first established in November 2016, and additional alluvial bores (S-series bores) were constructed in November 2017. The monitoring bores were all constructed with 50 mm PVC casing. The existing bores target a range of lithological units, including:

- Quaternary alluvium.
- Regolith (Tertiary sediments).
- Rewan Group.
- Coal seams of the Rangal Coal Measures.
- Interburden and overburden material of the Rangal Coal Measures.

A list of all bores and VWPs installed across the Project area is included in **Table A2-1** and the locations of the bores are shown within the main report. Bore construction logs are also included within **Attachment A1**.

Table A2-1 Site Groundwater Monitoring Network

Hole	Site	Project	Type	Easting	Northing	Screen Depth (mbgl)	Target	T.D. (m)
IF3839P	GW01s	Iffley	MB	642481	7547491	13 - 19	Alluvium	20
IF3837P	GW02s	Iffley	MB	641152	7546517	7 - 19	Alluvium	19
IF3838P	GW02d	Iffley	MB	641141	7546507	118.65 - 127.65	VU	137
IF3841P	GW04	Iffley	MB	643388	7544973	6 - 15	Alluvium	41
IF3835P	GW06s	Iffley	MB	639329	7542005	4 - 10	Regolith	10
VP3833P	GW08s	Iffley	MB	645312	7539839	6 - 12	Alluvium	13
VP3831P	GW12s	Vermont fPark	MB	641504	7532788	30 - 42	Regolith	42
VE3827P	GW16s	Willunga	MB	660836	7525291	12 - 27	Regolith	27
VE3829P	GW18s	Willunga	MB	656889	7522809	9 - 15	Alluvium	15
VE3830P	GW18d	Willunga	MB	656868	7522804	174 - 183	VU	183

Hole	Site		Project	Type	Easting	Northing	Screen Depth (mbgl)	Target	T.D. (m)
VE3825P	GW21s		Willunga	MB	661590	7521656	3 - 9	Regolith	9
VE3826P	GW21d		Willunga	MB	661585	7521655	148 - 157	Rangal Interburden	157
IF3856P	S7		Iffley	MB	641443	7545828	14.5 – 20.5	Alluvium	21
IF3857P	S9		Iffley	MB	641767	7545426	14.5 – 20.5	Alluvium	22
IF3858P	S11		Iffley	MB	642455	7545332	8 - 14	Alluvium	14
IF3859P	S10		Iffley	MB	642552	7546035	18 - 24	Alluvium	24
IF3860P	S8		Iffley	MB	642340	7546343	9 - 15	Alluvium	15
IF3861P	S6		Iffley	MB	642054	7546721	11.5 – 17.5	Alluvium	21
IF3862P	S4		Iffley	MB	641567	7546845	11.5 – 17.5	Alluvium	18
IF3863P	S5		Iffley	MB	642239	7547332	11.5 – 17.5	Alluvium	24
IF3864P	S2		Iffley	MB	641386	7547617	11.5 – 17.5	Alluvium	18
IF3840P	GW01d	VWP1	Iffley	VWP	642479	7547491	402	VU	413
		VWP2					352	Leichhardt Seam	
		VWP3					221.5	Rewan	
		VWP4					63	Rewan	
IF3836P	GW06d	VWP1	Iffley	VWP	639334	7542008	190.7	Fort Cooper	203
		VWP2					136.5	Fort Cooper	
		VWP3					117.5	Fort Cooper	
		VWP4					38	Tertiary	
VP3834P	GW08d	VWP1	Iffley	VWP	645312	7539846	177	Leichhardt Seam	585
		VWP2					137	Rangal Overburden	
		VWP3					94	Rewan	
		VWP4					70*	Rewan	
VP3832P	GW12d	VWP1	Vermont Park	VWP	641495	7532795	505	Leichhardt Seam	519
		VWP2					484.5	Leichhardt Seam	
		VWP3					391*	Rangal Overburden	
		VWP4					108*	Rewan	
VE3828P	GW16d	VWP1	Willunga	VWP	660835	7525287	327*	VU	339
		VWP2					269	Leichhardt Seam	
		VWP3					147*	Rewan	
		VWP4					91	Rewan	

Note: Coordinates in GDA 94 MGA Zone 55
mbgl – metres below ground level
T.D. – total drilled depth of bore, in metres below ground level
VU – Vermont Upper Seam (coal)
MB – open standpipe monitoring bore
VWP – vibrating wire piezometer
* Sensor giving potentially erroneous readings from installation

2.2 PROGRAM

The monitoring bores are used for hydraulic conductivity testing and ongoing monitoring of water levels and water quality sampling. Routine water level and quality monitoring are conducted by external contractors, Environment & Natural Resource Solutions (ENRS), in accordance with industry guidelines[1][2][3].

2.2.1 WATER LEVEL MONITORING

Water levels are measured manually on a quarterly basis and automatic data loggers have been installed in each piezometer to provide a continuous data record, with water levels recorded at 12-hourly intervals. Loggers were installed in May 2017 for the GW-series bores and November 2017 for the S-series bores.

All VWPs are equipped with dataloggers and save pressure and temperature readings on a six hourly basis. As part of the routine quarterly monitoring, VWP data are downloaded. It is noted that the results appear erroneous for one sensor at VWP location GW08d (VWP4), two sensors at VWP location GW12d (VWP3 and VWP4) and GW16d (VWP1 and VWP3), and are not considered representative of the groundwater regime.

Hydrographs for the site monitoring network are presented and discussed within the main report. Additional water level data were also obtained from Queensland Globe and publicly available reports for the numerical model calibration, as discussed in **Appendix B**. This includes hydrographs for registered bores (i.e. RN13040180 and RN162528), which have publicly available time series water level data. Further details on registered bores are provided in **Section** 6. The model calibration also utilised time series trends for VWPs on the Lake Vermont mine lease (LV1235 to LV2375W), which are presented within the publicly available groundwater impact assessment (JBT, 2016).

2.2.2 WATER QUALITY MONITORING

Field water quality parameters were collected from the GW-series bores by Gauge in June 2017. Field parameters include pH, electrical conductivity (EC), dissolved oxygen, oxidation reduction potential (ORP) and temperature.

Full water quality monitoring was conducted at site in October 2017 and December 2017 by ENRS. Groundwater quality monitoring will continue to be undertaken on a quarterly basis. As part of the full water quality monitoring, in addition to collecting field parameters, water samples are submitted to a NATA accredited laboratory (ALS) for analysis of:

- Physio-chemical indicators (total dissolved solids (TDS) and total suspended solids (TSS).
- Major Ions (calcium, fluoride, magnesium, potassium, sodium, chloride, sulphate), hardness and ionic balance (total anions/cations).
- Nutrients (ammonia, nitrite, nitrate, TKN, total nitrogen, total phosphorus and reactive phosphorus).

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[1] Geoscience Australia (2009) "Groundwater Sampling and Analysis – A Field Guide" (record 2009/27)

[2] The Australian/New Zealand Standard Water quality – "Sampling, Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples" (AS/NZS 5667.1:1998)

[3] The Australian/New Zealand Standard Water quality – "Sampling, Part 11: Guidance on sampling of groundwaters" (AS/NZS 5667.11:1998)

- Total alkalinity as $CaCO_3$, HCO_3, CO_3.
- Total and dissolved metals: (Ag, Al, As, B, Ba, Be, Cd, Co, Cr, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, U, V and Zn).
- Total recoverable hydrocarbons (C_6 – C_{40}) and BTEXN.

3 GROUNDWATER QUALITY

3.1 WATER QUALITY DATA

This section presents a summary of the sources of data used to develop the summary of water quality presented in **Section 3.2**.

3.1.1 SITE GROUNDWATER DATA

Full groundwater quality sampling of the site (GW) bores has occurred three times, in October 2017, December 2017 and February 2018. Laboratory water quality results from the three sampling events are presented in **Attachment A2**. In addition to this, field parameters were tested for the GW-series bores by Gauge in July 2017, and for registered landholder bores as part of the bore census (**Section 6**) by ENRS.

3.1.2 SITE SURFACE WATER DATA

Surface water sampling was conducted in July 2017 and August 2017 at eight sampling locations along the Isaac River and Ripstone Creek. Full details on the sampling are provided within the Surface Water Assessment. In addition to this, long term (since 1964) surface water quality data are available from the DNRM Water Monitoring Information Portal (WMIP) for the gauging station located at Isaac River at Deveril (station 130410A).

3.1.3 QUEENSLAND GROUNDWATER DATABASE

In addition to the site monitoring network, groundwater quality data are also publicly available from Queensland Globe Groundwater Database for registered bores within the region. Water quality data have been obtained for 18 registered bores that had stratigraphic logs available to confirm the target aquifer. A summary of the bores and their identified geology is included in **Table A3-1**.

Table A3-1 Summary of Registered Bores with Water Quality Data

RN	DEPTH (m)	GEOLOGY	RN	DEPTH (m)	GEOLOGY
43639	31	Sandstone and shale (RCM)	67250	38	Shale underlying alluvium
44053	32	Sandstone(RCM)	84141	46.9	Sandstone and shale (RCM)
44161	25.9	Alluvium	88526	40.4	Coal (RCM)
44625	57.9	Coal and shale (RCM)	89454	60.9	Coal (RCM)
47054	27.4	Sandstone and shale (RCM)	165124	82	Sandstone (RCM)
47055	45.7	Sandstone (RCM)	13040180	28.5	Alluvium
47056	57.3	Sandstone (RCM)	13040181	18.6	Alluvium
47189	30.5	Alluvium	13040184	18.6	Alluvium
67248	42.2	Sandstone and shale (RCM)	13040286	100.3	Siltstone and shale (RCM)

Note: RCM – Rangal Coal Measures

3.1.4 PUBLICLY AVAILABLE DATA

Water quality data were also obtained from publicly available groundwater assessment reports for surrounding mine operations. Data were used where sufficient detail was available on the bore location and target aquifer. The data obtained include:

- Lake Vermont – Laboratory analysis of Rangal Coal Measures bore LV2375W from May 2017.

- Eagle Downs – Laboratory analysis of Fort Cooper Coal Measures within four site bores (MB1, MB2, MB4 and MB5), drill hole (E795017) and landholder bore (Windmill#1) from 2007 and 2008.

3.2 WATER QUALITY SUMMARY

Table A3-2 presents a summary of the water quality results across the main groundwater bearing units, the alluvium, regolith, coal measures (interburden and coal), as well as from leachate testing of potential spoil and rejects material. The results are also compared against the:

- NHMRC drinking water guidelines;
- ANZECC (2000) fresh water aquatic ecosystem (slightly-moderately disturbed systems);
- ANZECC (2000) livestock drinking guidelines;
- ANZECC (2000) irrigation guidelines (long-term and short-term); and
- Fitzroy Plan Water Quality Objectives for Zone 34 (deep and shallow groundwater – 80th percentile).

The data include results consistently recorded below the laboratory limit of reporting for nitrite for alluvium, regolith and coal, as well as for a range of dissolved metals:

- Beryllium, cadmium, mercury and selenium - for all materials;
- Barium, boron, iron, manganese, nickel and zinc - for the potential spoil and rejects materials;
- Molybdenum - for regolith;
- Aluminium - for alluvium, regolith and interburden;
- Chromium - for alluvium, coal, spoil and rejects;
- Cobalt - for interburden and potential spoil and rejects; and
- Lead - for alluvium, regolith, coal and potential spoil and rejects.

Based on available information, the water quality data were assessed for representativeness. Where samples were identified as potentially being non-representative of the groundwater unit (i.e. grab samples or samples during drilling) these data were not used within the summary table (**Table A3-2)**. Discussion on the water quality values and findings is included within the main report (**Section 5.4**).

Table A3-2 Summary Water Quality Data

Analyte		Unit	NHMRC Drinking water	ANZECC (2000) Fresh Water Aquatic	ANZECC (2000) Short term irrigation	ANZECC (2000) Long term irrigation	ANZECC (2000) Stock Water	Fitzroy Plan WQO 80^{th} Percentile Deep /Shallow	Isaac River	Quaternary alluvium	Regolith	RCM - Interburden	RCM - Coal	Spoil	Rejects
pH (Field)	Av.	pH unit	6.5 - 8.5[b]	6.5 – 8.5	6.0 - 8.5	6.0 - 8.5	-	8.03 / 8.10	7.7	7.4	6.7	7.6	7.5	9.1	9.0
	Med.								7.7	7.5	6.8	7.7	7.5	9.3	9.2
	Min.								6.6	6.2	6.2	6.4	6.9	5.4	6.9
	Max.								8.5	9.2	7.0	8.4	8.0	9.9	9.7
	Pop.								64	19	8	21	10	161	39
EC (Field)	Av.	µS/cm	-	120 - 300	-	-	-	16,000 / 8,910	365	1676	14816	5245	11296	423	307
	Med.								320	936	19640	3003	11764	351	282
	Min.								79	140	1839	631	4460	141	102
	Max.								2020	6000	26800	24640	16000	1670	985
	Pop.								61	35	9	43	10	161	39
Hardness	Av.	mg/L	200[b]	-	-	-	-	3,208 / 2,228	80	312	2163	1928	2019	-	-
	Med.								73	194	2020	549	1360	-	-
	Min.								15	88	264	193	616	-	-
	Max.								300	847	4240	7010	5269	-	-
	Pop.								55	14	6	17	9	-	-
TDS	Av.	mg/L	600[b]	-	-	-	3,000 - 13,000*	-	186	1458	9757	4746	7402	283	206
	Med.								155	1910	9545	2514	7445	235	189
	Min.								47	201	1460	421	2544	94	68
	Max.								842	3430	18600	18400	14700	1119	660
	Pop.								43	13	6	23	10	161	39
TSS	Av.	mg/L	-	<40 - <75	-	-	-	-	536	86	786	11	16	-	-
	Med.								67	39	164	11	8	-	-
	Min.								5	5	12	6	5	-	-
	Max.								3605	354	2680	14	37	-	-
	Pop.								51	6	6	4	6	-	-
Chloride	Av.	mg/L	250[b]	-	-	-	-	5,905 / 3,185	47	522	4764	2511	4105	63	30
	Med.								32	338	4530	945	4295	32	18

Analyte		Unit	NHMRC Drinking water	ANZECC (2000) Fresh Water Aquatic	ANZECC (2000) Short term irrigation	ANZECC (2000) Long term irrigation	ANZECC (2000) Stock Water	Fitzroy Plan WQO 80th Percentile Deep /Shallow	Isaac River	Quaternary alluvium	Regolith	RCM - Interburden	RCM - Coal	Spoil	Rejects
	Min.								3	13	571	15	1212	8	10
	Max.								294	1710	9290	9810	6680	294	96
	Pop.								45	14	6	23	10	27	8
Calcium	Av.	mg/L	-	-	-	-	1,000	442 / 215	15	43	230	256	325	3	2
	Med.								16	24	220	65	327	2	2
	Min.								3	4	53	3	11	2	2
	Max.								42	121	422	1160	659	10	4
	Pop.								45	14	6	23	10	27	8
Sodium	Av.	mg/L	180[b]	-	-	-	-	2,565 / 1,500	42	427	2758	1159	1959	80	63
	Med.								30	299	2489	720	2205	70	60
	Min.								4	35	415	44	578	32	22
	Max.								300	1210	5620	3880	2990	204	118
	Pop.								55	14	6	23	10	27	8
Magnesium	Av.	mg/L	-	-	-	-	-	491 / 389	7	50	382	237	245	2	2
	Med.								8	27	348	94	120	2	2
	Min.								2	8	32	28	2	2	2
	Max.								25	136	774	1000	880	8	2
	Pop.								45	14	6	23	10	27	8
Sulphate	Av.	mg/L	500[a] / 250[b]	-	-	-	1,000 – 2,400 (pigs)	398 / 318	24	56	**673**	139	157	27	49
	Med.								10	10	**630**	80	12	18	24
	Min.								1	1	74	9	1	4	6
	Max.								410	198	1330	373	922	92	206
	Pop.								48	14	6	23	9	27	8
Potassium	Av.	mg/L	-	-	-	-	-	-	4.4	3.6	19.3	7.3	9.7	3.2	2.8
	Med.								4.6	3	18	5	9	2	2
	Min.								1.9	1	1	1	4	2	2
	Max.								8.3	9	41	22	14	10	4
	Pop.								42	12	6	22	9	27	8

Analyte		Unit	NHMRC Drinking water	ANZECC (2000) Fresh Water Aquatic	ANZECC (2000) Short term irrigation	ANZECC (2000) Long term irrigation	ANZECC (2000) Stock Water	Fitzroy Plan WQO 80^{th} Percentile Deep /Shallow	Isaac River	Quaternary alluvium	Regolith	RCM - Interburden	RCM - Coal	Spoil	Rejects
Fluoride	Av.	mg/L	1.5[a]	-	2	1	2	0.400 / 0.500	0.2	0.3	**0.5**	0.3	0.2	-	-
	Med.								0.2	0.18	0.55	0.20	0.15	-	-
	Min.								0.1	0.02	0.30	0.01	0.01	-	-
	Max.								0.3	1.00	0.70	1.10	0.40	-	-
	Pop.								52	14	6	17	8	-	-
Bicarbonate	Av.	mg/L	-	-	-	-	-	650 / 878	90	511	488	595	436	1017	1042
	Med.								95	444	489	512	396	550	427
	Min.								27	130	304	220	222	38	47
	Max.								231	904	644	1100	690	5680	3460
	Pop.								45	14	6	22	10	27	8
Ammonia	Av.	mg/L	0.5[b]	0.9 (pH 8)	-	-	-	-	0.03	0.11	0.05	1.73	4.25	-	-
	Med.								0.03	0.05	0.03	1.23	4.40	-	-
	Min.								0.01	0.01	0.01	0.34	3.35	-	-
	Max.								0.1	0.40	0.16	4.13	4.74	-	-
	Pop.								18	6	6	4	6	-	-
Nitrate	Av.	mg/L	50[a]	Refer to guidelines	-	-	400	14.92 / 5.30	1.7	2.2	0.7	0.6	0.04	-	-
	Med.								0.85	0.06	0.40	0.01	0.02	-	-
	Min.								0.01	0.01	0.04	0.01	0.01	-	-
	Max.								18.0	12.90	2.26	8.60	0.16	-	-
	Pop.								40	11	6	21	8	-	-
Nitrite	Av.	mg/L	3[a]	Refer to guidelines	-	-	30	-	<0.01	0.01	<0.01	0.01	<0.01	-	-
	Med.								<0.01	<0.01	<0.01	0.01	<0.01	-	-
	Min.								<0.01	<0.01	<0.01	0.01	<0.01	-	-
	Max.								<0.01	<0.01	<0.01	0.02	<0.01	-	-
	Pop.								10	6	6	9	7	-	-
Aluminium (t)	Av.	mg/L	*0.2*[b c]	*0.055*	*20*	*5*	*5*	-	0.6	0.6	**16.4**	2.5	0.2	-	-
	Med.								0.5	0.21	7.06	0.02	0.14	-	-
	Min.								0.11	0.01	0.05	0.01	0.01	-	-

Analyte		Unit	NHMRC Drinking water	ANZECC (2000) Fresh Water Aquatic	ANZECC (2000) Short term irrigation	ANZECC (2000) Long term irrigation	ANZECC (2000) Stock Water	Fitzroy Plan WQO 80th Percentile Deep /Shallow	Isaac River	Quaternary alluvium	Regolith	RCM - Interburden	RCM - Coal	Spoil	Rejects
	Max.								1.3	2.12	54.30	17.40	0.52	-	-
	Pop.								10	7	6	7	7	-	-
Arsenic (t)	Av.								<0.001	0.002	0.006	0.005	0.006	-	-
	Med.								<0.001	0.001	0.004	0.004	0.007	-	-
	Min.	mg/L	*0.01[a]*	*As (III) 0.024 As (V) 0.013*	*2*	*0.1*	*0.5*	-	<0.001	0.001	0.001	0.001	0.001	-	-
	Max.								<0.001	0.004	0.017	0.010	0.011	-	-
	Pop.								10	6	6	6	7	-	-
Barium (t)	Av.								-	0.2	0.2	**4.5**	**12.9**	-	-
	Med.								-	0.23	0.19	1.37	13.47	-	-
	Min.	mg/L	*2[a]*	-	-	-	-	-	-	0.2	0.04	0.6	1.4	-	-
	Max.								-	0.3	0.6	14.8	21.4	-	-
	Pop.								-	6.0	6.0	4.0	6.0	-	-
Beryllium (t)	Av.								-	<0.001	0.002	0.003	0.002	-	-
	Med.								-	<0.001	0.001	0.001	0.001	-	-
	Min.	mg/L	*0.06[a]*	-	*0.5*	*0.1*	-	-	-	<0.001	0.001	0.001	0.001	-	-
	Max.								-	<0.001	0.003	0.010	0.010	-	-
	Pop.								-	6	6	5	7	-	-
Boron (t)	Av.								0.1	0.2	**1.3**	**0.4**	0.3	-	-
	Med.								0.1	0.20	1.23	0.4	0.25	-	-
	Min.	mg/L	*4[a]*	*0.37*	*refer to guideline*	*0.5*	*7 (cattle)*	-	0.03	0.05	0.92	0.2	0.19	-	-
	Max.								0.1	0.32	1.79	0.48	0.7	-	-
	Pop.								27.0	7.0	6.0	7.0	7.0	-	-
Cadmium (t)	Av.								<0.0001	<0.0001	**0.0003**	**0.0009**	**0.0008**	-	-
	Med.								<0.0001	<0.0001	0.0002	0.0001	0.0001	-	-
	Min.								<0.0001	<0.0001	0.0001	0.0001	0.0001	-	-
	Max.	mg/L	*0.002[a]*	*0.0002*	*0.05*	*0.01*	*0.01*	-	<0.0001	<0.0001	0.0007	0.0050	0.0050	-	-
	Pop.								10	6	6	6	7	-	-

Analyte		Unit	NHMRC Drinking water	ANZECC (2000) Fresh Water Aquatic	ANZECC (2000) Short term irrigation	ANZECC (2000) Long term irrigation	ANZECC (2000) Stock Water	Fitzroy Plan WQO 80th Percentile Deep /Shallow	Isaac River	Quaternary alluvium	Regolith	RCM - Interburden	RCM - Coal	Spoil	Rejects
	Av.								<0.001	0.004	**0.06**	0.01	0.002	-	-
	Med.								<0.001	0.0030	0.031	0.0045	0.001	-	-
Chromium (t)	Min.	mg/L	*0.05[a]*	*CrIII – ID Cr(VI) 0.001*	*1*	*0.1*	*1*	-	<0.001	0.0010	0.008	0.001	0.001	-	-
	Max.								<0.001	0.0090	0.19	0.028	0.01	-	-
	Pop.								10	6	6	6	7	-	-
	Av.								0.001	0.004	0.04	0.003	0.003	-	-
	Med.								0.001	0.003	0.019	0.001	0.003	-	-
Cobalt (t)	Min.	mg/L	-	-	*0.1*	*0.05*	*1*	-	0.001	0.001	0.003	0.001	0.001	-	-
	Max.								0.002	0.011	0.13	0.01	0.01	-	-
	Pop.								10	6	6	5	7	-	-
	Av.								0.002	**0.04**	**0.8**	**0.02**	**0.01**	-	-
	Med.								0.001	0.020	0.38	0.01	0.008	-	-
Copper (t)	Min.	mg/L	*2[a] / 1[b]*	*0.0014*	*5*	*0.2*	*1 (cattle)*	*0.030 / 0.030*	0.001	0.001	0.11	0.002	0.002	-	-
	Max.								0.004	0.15	3.02	0.075	0.02	-	-
	Pop.								10	7	6	7	7	-	-
	Av.								0.3	**0.9**	**23.2**	**4.4**	**3.2**	-	-
	Med.								0.3	0.05	12.89	0.16	3.58	-	-
Iron (t)	Min.	mg/L	0.3[b]	-	10	0.2	-		0.28	0.05	0.05	0.02	0.02	-	-
	Max.								0.3	4.43	80.6	40.8	8.15	-	-
	Pop.								1	12	6	10	9	-	-
	Av.								<0.001	0.002	**0.013**	**0.005**	0.002	-	-
	Med.								<0.001	0.0010	0.006	0.0015	0.001	-	-
Lead (t)	Min.	mg/L	*0.01[a]*	*0.0034*	*5*	*2*	*0.1*	-	<0.001	0.0010	0.001	0.001	0.001	-	-
	Max.								<0.001	0.0030	0.04	0.013	0.01	-	-
	Pop.								10	6	6	6	7	-	-
	Av.								0.25	0.08	**0.76**	**1.39**	**1.23**	-	-
Manganese (t)	Med.	mg/L	*0.5[a] / 0.1[b]*	*1.9*	*10*	*0.2*	-	*0.291 / 0.160*	0.18	0.0500	0.419	0.74	0.23	-	-
	Min.								0.02	0.0010	0.003	0.01	0.001	-	-

Analyte		Unit	NHMRC Drinking water	ANZECC (2000) Fresh Water Aquatic	ANZECC (2000) Short term irrigation	ANZECC (2000) Long term irrigation	ANZECC (2000) Stock Water	Fitzroy Plan WQO 80th Percentile Deep /Shallow	Isaac River	Quaternary alluvium	Regolith	RCM - Interburden	RCM - Coal	Spoil	Rejects
	Max.								0.98	0.2190	2.2	5.54	3.38	-	-
	Pop.								10	11	6	10	8	-	-
Mercury (t)	Av.	mg/L	-	*0.0006*	*0.002*	*0.002*	*0.002*	-	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	-	-
	Med.								<0.0001	<0.0001	0.0001	<0.0001	<0.0001	-	-
	Min.								<0.0001	<0.0001	0.0001	<0.0001	<0.0001	-	-
	Max.								<0.0001	<0.0001	0.0002	<0.0001	<0.0001	-	-
	Pop.								10	6	6	6	7	-	-
Molybdenum (t)	Av.	mg/L	*0.05[a]*	-	*0.05*	*0.01*	*0.15*	-	0.001	0.001	0.001	0.005	0.006	-	-
	Med.								0.001	0.0010	0.0010	0.0015	0.0040	-	-
	Min.								0.001	0.0010	0.0010	0.0010	0.0020	-	-
	Max.								0.002	0.0020	0.0020	0.0130	0.0140	-	-
	Pop.								10	6	6	6	7	-	-
Nickel (t)	Av.	mg/L	*0.02[a]*	*0.011*	*2*	*0.2*	*1*	-	0.00	**0.01**	**0.14**	**0.02**	0.01	-	-
	Med.								0.002	0.0140	0.0815	0.0160	0.0070	-	-
	Min.								0.001	0.0010	0.0180	0.0050	0.0020	-	-
	Max.								0.00	0.0300	0.4460	0.0570	0.0120	-	-
	Pop.								10	6	6	6	7	-	-
Selenium (t)	Av.	mg/L	*0.01[a]*	*Total – 0.011 SeIIV - ID*	*0.05*	*0.02*	*0.02*	-	<0.01	<0.01	**0.01**	<0.01	<0.01	-	-
	Med.								<0.01	<0.01	0.01	<0.01	<0.01	-	-
	Min.								<0.01	<0.01	0.01	<0.01	<0.01	-	-
	Max.								<0.01	0.0100	0.02	<0.01	<0.01	-	-
	Pop.								10	6	6	6	7	-	-
Zinc (t)	Av.	mg/L	*3[b]*	*0.008*	*2*	*2*	*20*	*0.317 / 0.060*	0.01	0.02	**0.19**	**0.13**	**0.15**	-	-
	Med.								0.005	0.0140	0.044	0.129	0.071	-	-
	Min.								0.005	0.0050	0.022	0.010	0.022	-	-
	Max.								0.01	0.0330	0.924	0.383	0.41	-	-
	Pop.								10	7	6	7	7	-	-

Analyte		Unit	NHMRC Drinking water	ANZECC (2000) Fresh Water Aquatic	ANZECC (2000) Short term irrigation	ANZECC (2000) Long term irrigation	ANZECC (2000) Stock Water	Fitzroy Plan WQO 80th Percentile Deep /Shallow	Isaac River	Quaternary alluvium	Regolith	RCM - Interburden	RCM - Coal	Spoil	Rejects
Aluminium (d)	Av.	mg/L	*0.2[b c]*	*0.055*	*20*	*5*	*5*	-	0.16	<0.01	<0.01	<0.01	0.0	0.3	0.4
	Med.								0.07	<0.01	<0.01	<0.01	0.01	0.2	0.3
	Min.								0.01	<0.01	<0.01	<0.01	0.01	0.2	0.2
	Max.								1.10	<0.01	<0.01	<0.01	0.02	1.0	1.0
	Pop.								20	7	6	6	6	27	8
Arsenic (d)	Av.	mg/L	*0.01[a]*	*As (III) 0.024 As (V) 0.013*	*2*	*0.1*	*0.5*	-	<0.001	0.001	0.002	0.004	0.005	0.121	0.070
	Med.								<0.001	0.001	0.002	0.002	0.004	0.040	0.030
	Min.								<0.001	0.001	0.001	0.001	0.001	0.020	0.020
	Max.								<0.001	0.002	0.004	0.018	0.013	0.50	0.22
	Pop.								10	6	6	9	6	27	8
Barium (d)	Av.	mg/L	*2[a]*	-	-	-	-	-	-	0.2	0.1	**4.0**	**13.1**	<0.2	<0.2
	Med.								-	**0.21**	**0.12**	**1.10**	**13.47**	<0.2	<0.2
	Min.								-	0.16	0.04	0.41	0.64	<0.2	<0.2
	Max.								-	0.31	0.22	13.20	23.10	<0.2	<0.2
	Pop.								-	6	6	4	6	27	8
Beryllium (d)	Av.	mg/L	*0.06[a]*	-	*0.5*	*0.1*	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.02	<0.02
	Med.								-	<0.001	<0.001	<0.001	<0.001	<0.02	<0.02
	Min.								-	<0.001	<0.001	<0.001	<0.001	<0.02	<0.02
	Max.								-	<0.001	<0.001	<0.001	<0.001	<0.02	<0.02
	Pop.								-	6	6	4	6	27	8
Boron (d)	Av.	mg/L	*4[a]*	*0.37*	*refer to guideline*	*0.5*	*7 (cattle)*	-	0.1	0.2	**1.3**	**0.4**	0.3	<0.2	<0.2
	Med.								0.1	0.2	**1.28**	**0.38**	0.24	<0.2	<0.2
	Min.								0.05	0.05	1.03	0.34	0.19	<0.2	<0.2
	Max.								0.1	0.30	1.61	0.43	0.37	<0.2	<0.2
	Pop.								10	7	6	6	6	27	8
Cadmium (d)	Av.	mg/L	*0.002[a]*	*0.0002*	*0.05*	*0.01*	*0.01*	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.02	<0.02
	Med.								<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.02	<0.02
	Min.								<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.02	<0.02

Analyte		Unit	NHMRC Drinking water	ANZECC (2000) Fresh Water Aquatic	ANZECC (2000) Short term irrigation	ANZECC (2000) Long term irrigation	ANZECC (2000) Stock Water	Fitzroy Plan WQO 80th Percentile Deep /Shallow	Isaac River	Quaternary alluvium	Regolith	RCM - Interburden	RCM - Coal	Spoil	Rejects
	Max.								<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.02	<0.02
	Pop.								10	6	6	5	6	27	8
Chromium (d)	Av.								<0.001	<0.001	**0.004**	**0.001**	<0.001	<0.02	<0.02
	Med.								<0.001	<0.001	**0.003**	**0.001**	<0.001	<0.02	<0.02
	Min.	mg/L	0.05[a]	CrIII – ID Cr(VI) 0.001	1	0.1	1	-	<0.001	<0.001	0.001	0.001	<0.001	<0.02	<0.02
	Max.								<0.001	<0.001	0.01	0.002	<0.001	<0.02	<0.02
	Pop.								10	6	6	5	6	27	8
Cobalt (d)	Av.								<0.001	0.00	0.004	<0.001	0.002	<0.02	<0.02
	Med.								<0.001	0.001	0.003	<0.001	0.001	<0.02	<0.02
	Min.	mg/L	-	-	0.1	0.05	1	-	<0.001	0.001	0.001	<0.001	0.001	<0.02	<0.02
	Max.								<0.001	0.003	0.013	<0.001	0.004	<0.02	<0.02
	Pop.								10	6	6	4	6	27	8
Copper (d)	Av.								0.02	**0.0**	**0.2**	**0.003**	**0.003**	<0.02	<0.02
	Med.								0.01	**0.003**	**0.107**	**0.002**	**0.003**	<0.02	<0.02
	Min.	mg/L	2[a] / 1[b]	0.0014	5	0.2	1 (cattle)	0.030 / 0.030	0.00	0.001	0.001	0.001	0.001	<0.02	<0.02
	Max.								0.1	0.141	0.593	0.010	0.005	<0.02	<0.02
	Pop.								22	7	6	10	6	27	8
Iron (d)	Av.								0.2	0.1	0.1	**0.3**	**2.6**	0.2	0.2
	Med.								0.1	**0.05**	<0.05	0.06	**1.45**	0.2	0.2
	Min.	mg/L	0.3[b]	-	10	0.2	-	0.246 / 0.140	0.01	0.05	<0.05	0.02	0.02	0.2	0.2
	Max.								1.7	0.15	<0.05	1.74	7.41	0.2	0.2
	Pop.								23	12	6	9	8	27	8
Lead (d)	Av.								<0.001	<0.001	<0.001	**0.004**	<0.001	<0.02	<0.02
	Med.								<0.001	<0.001	<0.001	0.001	<0.001	<0.02	<0.02
	Min.	mg/L	0.01[a]	0.0034	5	2	0.1	-	<0.001	<0.001	<0.001	0.001	<0.001	<0.02	<0.02
	Max.								<0.001	<0.001	<0.001	0.012	<0.001	<0.02	<0.02
	Pop.								10	6	6	9	6	27	8

Analyte		Unit	NHMRC Drinking water	ANZECC (2000) Fresh Water Aquatic	ANZECC (2000) Short term irrigation	ANZECC (2000) Long term irrigation	ANZECC (2000) Stock Water	Fitzroy Plan WQO 80th Percentile Deep /Shallow	Isaac River	Quaternary alluvium	Regolith	RCM - Interburden	RCM - Coal	Spoil	Rejects
Manganese (d)	Av.	mg/L	*0.5[a] / 0.1[b]*	*1.9*	*10*	*0.2*	*-*	*0.291 / 0.160*	0.05	0.05	**0.21**	**1.17**	**1.41**	<0.02	<0.02
	Med.								0.01	**0.043**	**0.019**	**0.417**	**0.236**	<0.02	<0.02
	Min.								0.001	0.001	0.005	0.010	0.001	<0.02	<0.02
	Max.								0.28	0.176	1.180	4.940	3.190	<0.02	<0.02
	Pop.								19	11	6	9	7	27	8
Mercury (d)	Av.	mg/L	-	*0.0006*	*0.002*	*0.002*	*0.002*	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Med.								<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Min.								<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Max.								<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Pop.								10	6	6	5	6	27	8
Molybdenum (d)	Av.	mg/L	*0.05[a]*	-	*0.05*	*0.01*	*0.15*	-	0.001	0.001	0.001	0.004	0.004	-	-
	Med.								0.001	0.001	0.001	0.001	0.003	-	-
	Min.								0.001	0.001	0.001	0.001	0.002	-	-
	Max.								0.002	0.002	0.001	0.013	0.01	-	-
	Pop.								10	6	6	5	6	-	-
Nickel (d)	Av.	mg/L	*0.02[a]*	*0.011*	*2*	*0.2*	*1*	-	0.001	0.01	**0.03**	**0.015**	0.005	<0.02	<0.02
	Med.								0.001	0.009	**0.027**	**0.012**	0.004	<0.02	<0.02
	Min.								0.001	0.001	0.017	0.003	0.002	<0.02	<0.02
	Max.								0.01	0.032	0.049	0.026	0.010	<0.02	<0.02
	Pop.								10	6	6	5	6	27	8
Selenium (d)	Av.	mg/L	*0.01[a]*	*Total – 0.011 SeIIV - ID*	*0.05*	*0.02*	*0.02*	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.02
	Med.								<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.02
	Min.								<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.02
	Max.								<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.02
	Pop.								10	6	6	9	6	27	8

Analyte		Unit	NHMRC Drinking water	ANZECC (2000) Fresh Water Aquatic	ANZECC (2000) Short term irrigation	ANZECC (2000) Long term irrigation	ANZECC (2000) Stock Water	Fitzroy Plan WQO 80th Percentile Deep /Shallow	Isaac River	Quaternary alluvium	Regolith	RCM - Interburden	RCM - Coal	Spoil	Rejects
Zinc (d)	Av.	mg/L	*3[b]*	*0.008*	*2*	*2*	*20*	*0.317 / 0.060*	0.01	0.01	0.02	0.01	**0.12**	<0.02	<0.02
	Med.								0.005	0.02	0.02	0.01	**0.04**	<0.02	<0.02
	Min.								0.005	0.01	0.01	0.01	0.01	<0.02	<0.02
	Max.								0.02	0.02	0.04	0.01	0.33	<0.02	<0.02
	Pop.								20	7	6	6	6	27	8

Notes: *Values below the limit of reporting were set at the limit for the calculations*

** Maximum concentration at which good condition might be expected, with 13,000 mg/L for sheep, 5,000 mg/L for beef cattle, 4,000 mg/L for dairy cattle, 6,000 mg/L for horses and 3,000 mg/L for pigs and poultry.*

Metals water quality triggers apply to dissolved metals for all analytes but iron (total iron). Presented for both total and dissolved in table for comparison

[a] NHMRC Health Guidelines for Drinking Water (2015)

[b] NHMRC Aesthetic Guidelines for Drinking Water (2015)

[c] NHMRC acid-soluble aluminium concentrations (2015)

4 HYDRAULIC TESTING

In order to obtain site specific data on the hydraulic properties of key hydrostratigraphic units, a range of field tests has been conducted. This includes testing of core samples for laboratory measurement of vertical and horizontal hydraulic conductivity (anisotropy), slug testing and packer testing for horizontal hydraulic conductivity, as well as documented exploration drillhole airlift yields.

4.1 CORE TESTING

Site specific laboratory hydraulic property testing has been undertaken on core samples opportunistically selected from holes drilled as part of a resource definition program for both the Rewan Group and coal seam interburden. Core samples were obtained from exploration holes 1CR04, 1CR05 and 1CR17 from the base of weathering to the base of the Rangal Coal Measures. Each of the holes is located within 300 m of fault traces mapped by Pembroke within the ODS domain.

The 1CR04 English log indicates faulting and fracturing of the strata at around 80 m. The English log for 1CR05 indicates fracturing at around 48 m depth; no other faulting or fracturing was documented. Faulting was detected within drillhole 1CR17 at around 85, 95, 150 and 160 m depth. More significant faulting was also identified around the Leichhardt Lower Seam, from around 180 to 200 m depth. Core samples were tested within each hole proximal to the fault zones, dependent on the competency of the core. Core from the coal seams themselves were not able to be tested due to the cleated nature of the coal resulting in the inability to obtain a solid core sample.

Table A4-1 summarises the horizontal and vertical hydraulic conductivity results. It is generally accepted that laboratory scale testing such as the reported core testing represents a minimum (lower bound) hydraulic conductivity. This is because testing at this scale can only capture the hydraulic conductivity of a very small portion of the overall flow system and doesn't include the effects of preferential flow paths such as fracture networks which are likely to increase the overall hydraulic conductivity of a given lithology.

Table A4-1 Hydraulic Conductivity

Bore	Screened Formation	Depth From (m)	Depth To (m)	Kh (m/day)	Kv (m/day)
1CR04	Rewan	45.11	45.35	5.18×10^{-5}	1.14×10^{-5}
1CR04	Rewan	55.22	55.45	5.79×10^{-6}	1.75×10^{-6}
1CR04	Rewan	66.35	66.50	6.43×10^{-6}	1.70×10^{-6}
1CR04	Rangal Overburden (above LL1)*	85.10	85.26	2.75×10^{-6}	3.80×10^{-6}
1CR04	Rangal interburden (between LL2 and LL3)	106.03	106.22	4.80×10^{-6}	5.21×10^{-7}
1CR04	Rangal Leich interburden (between LL3 and VU)	120.21	120.37	3.29×10^{-6}	2.22×10^{-6}
1CR05	Rewan	60.67	60.87	1.27×10^{-5}	-
1CR05	Rewan	68.63	68.90	2.65×10^{-6}	9.55×10^{-7}
1CR05	Rangal Overburden	87.14	87.37	1.14×10^{-6}	8.55×10^{-7}
1CR05	LL2 - LL3 interburden	114.23	114.50	2.48×10^{-6}	4.04×10^{-6}
1CR05	LL3 - VU interburden	142.06	142.28	1.60×10^{-6}	9.88×10^{-7}
1CR17	Rewan	63.34	63.57	1.81×10^{-6}	7.76×10^{-7}
1CR17	Rewan	74.91	75.15	6.95×10^{-6}	8.80×10^{-7}
1CR17	Leichhardt/Vermont Interburden	135.27	135.52	5.85×10^{-6}	4.46×10^{-6}

Bore	Screened Formation	Depth From (m)	Depth To (m)	Kh (m/day)	Kv (m/day)
1CR17	Leichhardt interburden repeat LL2-LL3*	194.26	194.47	6.24×10^{-7}	3.11×10^{-7}
1CR17	Leichhardt/Vermont Interburden repeat*	215.50	215.74	9.47×10^{-7}	9.38×10^{-7}

*Note: * proximal to fault zone*

4.2 SLUG TESTING

Slug testing was carried out by ENRS in boreholes constructed as part of the groundwater monitoring program in September 2017. Rising and falling head tests were undertaken and analysed using the KGS (Hyder, 1994), Bouwer-Rice (1989) and Hvorslev (1951) methods. Results of individual analyses are presented in **Table A4-2** and **Attachment A3**.

Table A4-2 Horizontal conductivity for borehole slug tests

Bore	Screened Formation	Test Method	Analysis Method	K (m/day)
GW01s	Alluvium	Falling Head	KGS	6.63
		Falling Head	KGS	6.63
		Rising Head	KGS	8.68
		Rising Head	KGS	6.73
GW02d	Coal	Falling Head	KGS	5.17×10^{-4}
		Falling Head	KGS	5.75×10^{-4}
		Rising Head	KGS	6.63×10^{-4}
		Rising Head	KGS	6.89×10^{-3}
		Rising Head	Bouwer-Rice	7.60×10^{-4}
		Rising Head	Hvorslev	1.06×10^{-3}
		Rising Head	Bouwer-Rice	1.10×10^{-3}
		Rising Head	Hvorslev	1.45×10^{-3}
GW12s	Regolith	Falling Head	KGS	5.00×10^{-1}
		Falling Head	KGS	5.88×10^{-1}
		Falling Head	KGS	3.65×10^{-1}
		Rising Head	KGS	1.76×10^{-1}
		Rising Head	KGS	2.92×10^{-1}
		Falling Head	Bouwer-Rice	2.90×10^{-1}
		Falling Head	Hvorslev	5.14×10^{-1}
		Rising Head	Bouwer-Rice	1.70×10^{-1}
		Rising Head	Hvorslev	4.30×10^{-1}
		Falling Head	Bouwer-Rice	2.80×10^{-1}
		Falling Head	Hvorslev	6.17×10^{-1}
		Rising Head	Bouwer-Rice	2.00×10^{-1}
		Rising Head	Hvorslev	4.79×10^{-1}

Bore	Screened Formation	Test Method	Analysis Method	K (m/day)
		Falling Head	Bouwer-Rice	3.70 x 10^{-1}
		Falling Head	Hvorslev	4.21 x 10^{-1}
		Rising Head	Bouwer-Rice	2.80 x 10^{-1}
		Rising Head	Hvorslev	6.04 x 10^{-1}
GW18s	Alluvium	Falling Head	Bouwer-Rice	2.30
		Falling Head	Hvorslev	2.83 x 10^{-1}
		Rising Head	Bouwer-Rice	1.70
		Rising Head	Hvorslev	2.57 x 10^{-1}
GW18d	Coal	Falling Head	Bouwer-Rice	3.40 x 10^{-3}
		Falling Head	Hvorslev	7.95 x 10^{-3}
		Falling Head	Bouwer-Rice	7.00 x 10^{-3}
		Falling Head	Hvorslev	8.65 x 10^{-3}
		Rising Head	Bouwer-Rice	3.50 x 10^{-3}
		Rising Head	Hvorslev	2.94 x 10^{-3}
GW21d	Coal	Falling Head	KGS	1.05 x 10^{-1}
		Falling Head	KGS	2.30 x 10^{-1}
		Rising Head	KGS	3.63 x 10^{-2}
		Rising Head	KGS	6.77 x 10^{-2}
		Rising Head	Bouwer-Rice	3.90 x 10^{-2}
		Rising Head	Hvorslev	3.47 x 10^{-2}
		Rising Head	Bouwer-Rice	4.80 x 10^{-2}
		Rising Head	Hvorslev	4.95 x 10^{-2}

4.3 PACKER TESTING

Packer testing was carried out at borehole 1CR04 using straddle packers to test the interval below base of weathering to the base of the RCM. Data was analysed by ENRS, as summarised in **Table A4-3**. Results show that significant flow occurs across the LL2 seam relative to the remainder of the profile, with an hydraulic conductivity of about 0.12 m/day. The lowest permeability was about 1.7 x10^{-4} m/day, recorded in the Rangal interburden (between the Leichhardt and Vermont Seams). Packer testing was only undertaken in one location, therefore may not be representative of the expected variability across the site as a whole.

Table A4-3 Packer Test Results Summary

From	To	Lugeon	Kh M/day	Lithology
52	164	0.4	7.51×10^{-3}	Overall profile
58	64	0.5	5.19×10^{-3}	Rewan
70	76	0.1	1.50×10^{-3}	Rewan
82	88	0.1	1.34×10^{-3}	Rangal OB
97	101	12.3	1.15×10^{-1}	LL2
106	110	0.1	9.71×10^{-4}	LL int
112	118	0.1	1.46×10^{-3}	LL3
124	128	0.1	9.93×10^{-4}	Rangal IB
130	134	0	1.73×10^{-4}	Rangal IB
136	140	0.1	1.21×10^{-3}	Rangal IB
142	146	0.1	5.95×10^{-3}	Rangal IB
148	164	0.1	1.21×10^{-3}	Vermont/Rangal UB
160	164	0.1	8.15×10^{-4}	FCCM OB

4.4 AIRLIFT YIELD

Airlift flow rates were not measured during the drilling of exploration or monitoring boreholes as the bores were drilled with water (not air) meaning that information regarding water strike and yield during drilling was not able to be determined. Airlift testing at borehole 1CR04 was undertaken prior to packer testing, and indicated a yield of 0.26 L/sec.

4.5 LITERATURE REVIEW

CDM Smith (2013) presented a summary of hydraulic properties used in previous studies in the Bowen Basin. A version of that summary is presented as **Table A4-4**, presenting only those strata which are relevant to this study. A literature review of a number of other studies from the Bowen Basin and Galilee Bowen was conducted by HydroSimulations, and data added to **Table A4-4**. The individual sources for data are shown in **Table A4-4** in items notated from 1 to 16.

Table A4-4 Summary of Adopted Hydraulic Properties from Other Bowen Basin Studies

Formation	Age	Conceptual role	Kh [m/d]	Kv [m/d]	Sy (%)	Ss (m^{-1})	Source
Alluvium	Quaternary	Aquifer	1.0 to $4.0 \times 10^{+1}$	1.0×10^{-1} to $2.5 \times 10^{+1}$	5.0×10^{-1} to 1.8×10^{-1}	5.0×10^{-4}	2
			$1.0 \times 10^{+2}$	$1.0 \times 10^{+1}$	2.5×10^{-1}	1.0×10^{-3}	1
			7.0×10^{-1} to 1.5×10^{-1}	-	-	-	3
			$1.0 \times 10^{+1}$	1.0	2.0×10^{-1}	1.0×10^{-4}	7
			8.8×10^{-2} to 3.8×10^{-1}				5
			$1.0 \times 10^{+1}$	1.0	1.0×10^{-1}	1.0×10^{-5}	10
				3.8×10^{-1} to 8.41			12
			1.5	3.75×10^{-1}	1.2×10^{-1}	8.6×10^{-6}	14

Formation	Age	Conceptual role	Kh [m/d]	Kv [m/d]	Sy (%)	Ss (m^{-1})	Source
			1.0		1.0		15
			7.0×10^{-3} to 4.2		3.0×10^{-2}		16
Colluvium	Quaternary/ Tertiary		1.0×10^{-1}				15
Duaringa Fm	Tertiary	Aquifer	6.0×10^{-1}	1.8×10^{-2}			9
			5.0×10^{-3} to 5.0×10^{-1}	5.0×10^{-4} to 5.0×10^{-2}	5.0×10^{-2} to 1.5×10^{-1}	5.0×10^{-6} to 5.0×10^{-4}	2
Undifferentiated Tertiary Sediments	Tertiary		4.3×10^{-1}				13
			5.0×10^{-1}	1.25×10^{-1}	5.0×10^{-2}	8.6×10^{-6}	14
			1.0×10^{-2}	2.0×10^{-3}			15
			1.0	5.0×10^{-2}	5.0×10^{-3}	1.0×10^{-5}	16
Clematis Sandstone	Triassic	Aquifer		1.10×10^{-7}			11
			5.0×10^{-2} to 5.0	5.0×10^{-3} to 5.0×10^{-1}	1.2×10^{-1} to 2.5×10^{-1}	5.0×10^{-6} to 5.0×10^{-4}	2
			6.0×10^{-1}	1.8×10^{-2}			9
Rewan Fm	Triassic	Aquitard	1.0×10^{-5} to 1.0×10^{-4}	1.0×10^{-6} to 1.0×10^{-4}	5.0×10^{-3}	1.0×10^{-6}	1
			1.0×10^{-1}		5.0×10^{-2}	5.0×10^{-6}	6
			1.0×10^{-4}	1.0×10^{-5}	1.0×10^{-2}	1.0×10^{-5}	10
			3.6×10^{-4}	7.4×10^{-6}			11
				2.22×10^{-8}			13
			5.0×10^{-4} to 5.0×10^{-2}	1.0×10^{-7} to 1.0×10^{-4}	1.0×10^{-1} to 2.5×10^{-1}	5.0×10^{-6} to 5.0×10^{-4}	2
			2.0×10^{-3}	5.0×10^{-4}			14
			1.0×10^{-3}	2.0×10^{-4}	3.0×10^{-2}	8.6×10^{-6}	15
			9.0×10^{-4}	5.4×10^{-5}			9
Rangal Coal Measures	Permian	Coal seams - aquifers	2.8×10^{-3} to 4.7×10^{-2}				4
			1.0×10^{-5} to 5.0×10^{-2}	5.0×10^{-4} to 5.0×10^{-3}	1.0×10^{-2} to 1.2×10^{-2}	5.0×10^{-6} to 5.0×10^{-4}	2
			1.0×10^{-2}	2.5×10^{-3}	5.0×10^{-2}	8.6×10^{-6}	14
			2.0×10^{-5} to 2.3	2.0×10^{-6} to 1.0×10^{-1}			15
							3
			1.0×10^{-6} to 1.0	1.0×10^{-6} to 1.0	1.0×10^{-2}	1.0×10^{-6}	1
			1.11×10^{-1} to 9.0×10^{-1}		8.0×10^{-2}	4.0×10^{-4}	7
			5.0		5.0×10^{-2}	5.0×10^{-6}	6
			5.0×10^{-2}	5.0×10^{-3}	1.0×10^{-2}	1.0×10^{-5}	10
			9.0×10^{-4}	1.8×10^{-5}			9
		Interburden - aquitards	1.0×10^{-4}	7.0×10^{-8}	5.0×10^{-2}	1.0×10^{-5}	2

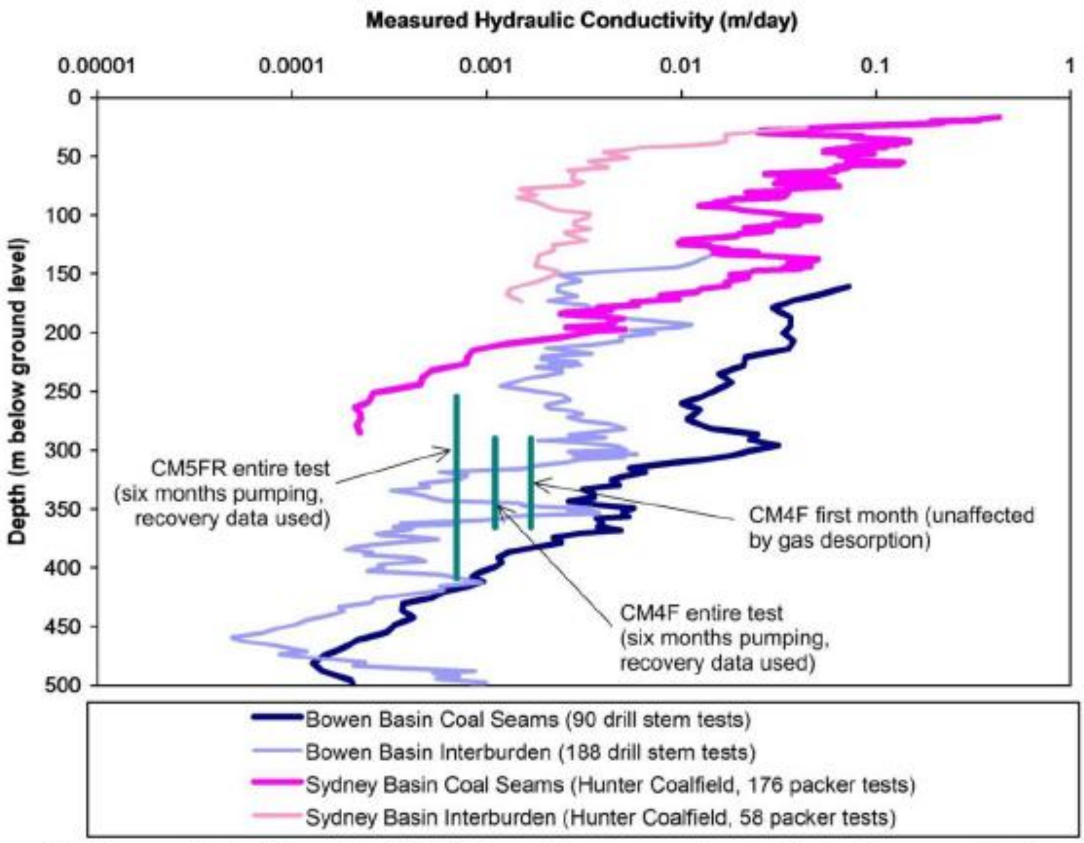
Formation	Age	Conceptual role	Kh [m/d]	Kv [m/d]	Sy (%)	Ss (m^{-1})	Source
			1.2×10^{-1}	3.0×10^{-2}	3.0×10^{-2}	8.6×10^{-6}	14
			2.0×10^{-5} to 2.0×10^{-2}	2.0×10^{-6} to 2.0×10^{-3}			15
			1.0×10^{-1}		5.0×10^{-2}	5.0×10^{-6}	6
			1.0×10^{-3}	1.0×10^{-5}	1.0×10^{-2}	1.0×10^{-5}	10
Fort Cooper Coal Measures	Permian	Coal seams - aquifers	1.00×10^{-5} to 5.00×10^{-2}	1.0×10^{-8} to 8.0×10^{-5}	1.0×10^{-2} to 1.2×10^{-2}	5.0×10^{-6} to 5.0×10^{-4}	2
			5.3×10^{-1}				13
			2.0×10^{-3}	2.0×10^{-5}			15
			4.0×10^{-1}		1.0×10^{-3} to 5.0×10^{-4}		16
		Interburden / underburden - aquitard	2.0×10^{-1}	4.0×10^{-1}	7.0×10^{-3}		16
Moranbah Coal Measures	Permian	Coal seams - aquifers	1.0×10^{-5} to 5.0×10^{-2}	1.0×10^{-5} to 1.0×10^{-3}	1.0×10^{-2} to 1.2×10^{-2}	5.0×10^{-6} to 5.0×10^{-4}	2
			1.7×10^{-1}				5
			6.0×10^{-2}				16
		Interburden / underburden - aquitard	1.0×10^{-5} to 5.0×10^{-2}	1.0×10^{-5} to 1.0×10^{-3}	1.0×10^{-2} to 1.2×10^{-2}	5.0×10^{-6} to 5.0×10^{-4}	2
			3.0×10^{-2}				5
			2.0×10^{-4}	2.00×10^{-5}			15
			6.0×10^{-3}				16
Back Creek Group	Permian	Aquitard	1.0×10^{-2} to 1.0×10^{-3}	1.0×10^{-5} to 1.0×10^{-3}	1.8×10^{-1} to 3.0×10^{-2}	5.0×10^{-6} to 5.0×10^{-4}	8
			1.0×10^{-3}	1.0 x 10-5	1.0×10^{-2}	1.0×10^{-5}	10

Source: Source of hydraulic data, summarised below and full references provided in main report.

1: AGE (2006) 2: Ausenco-Norwest (2012) 3: JBT (2012)
4: Parsons Brinckerhoff (2010) 5: URS (2009) 6: BHP BMA (2009)
7: Matrix Plus (2010) 8: URS (2012) 9: AGE (2013)
10: CDM Smith (2013) 11: GHD (2013a) 12: OGIA (2016)
13: Coffey (2014) 14: JBT(2016) 15: KCB (2016) 16: AGE (2016)

Regional hydraulic testing results

Coffey (2014) compiled packer testing data from many mines in the northern Bowen Basin, and found that, although there is a degree of variability in the dataset due to irregular fracturing, there is a general trend of reducing hydraulic conductivity with depth (**Figure A4-1**). This is likely due to increasing overburden pressure resulting in a reduction in fracture aperture. Hydraulic conductivity of the coal seams is typically about three times higher than the interburden.

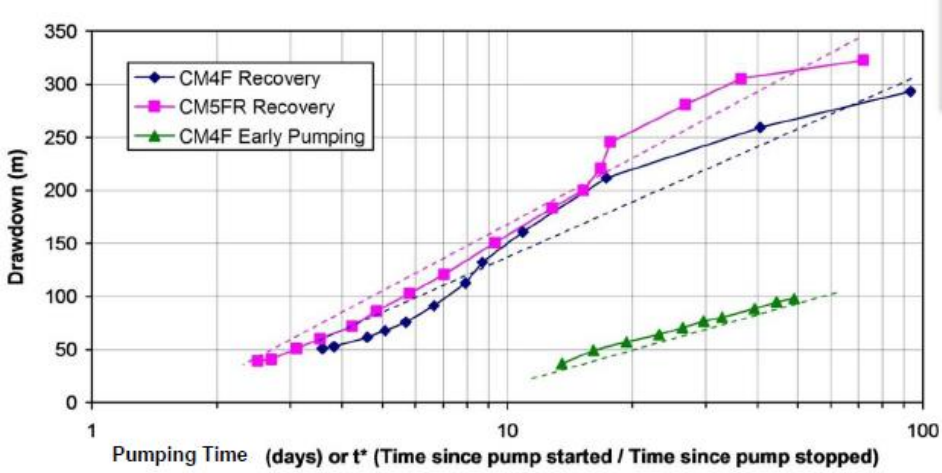


(a) Measured hydraulic conductivity (K) from drill stem or packer tests in the Bowen and Sydney Basins. The lines represent running 10-point geometric means of the respective K versus depth distributions. Each distribution has a standard devation of about 1 decade around the geometric mean, at a given depth. This is normal for typical fractured media.

Figure A4-1 Summary of Packer Test Results for Bowen Basin and Sydney Basin (after Coffey, 2014)

Pumping tests

Arrow (2013b) carried out long-term pumping tests on two hydraulically fractured wells (CM4F and CM5FR) followed by numerical simulation of the host media, to assess the economic potential of coal seams for gas production in the Baralaba Area. Coffey (2014) analysed the drawdown measurements from these tests to interpret the transmissivity of the host media (**Figure A4-2**).



Well and Pumping Phase	CM004F Recovery	CM005FR Recovery	CM004F Early Pumping
Drawdown Rate (m/decade)	150	210	100
Pumping Rate (L/day)	11000	11000	11200
Transmissivity (m2/day)	0.0134	0.0096	0.0205
Hydraulic Conductivity (m/day)	1.11E-03	6.98E-04	1.69E-03

Figure A4-2 Results from Test Pumping at Baralaba (after Coffey, 2014)

5 TEM

A transient electromagnetic (TEM) survey was conducted by Groundwater Imaging Pty Ltd in July 2017. The survey tested the resistivity of ground cover to a depth of about 60 m and was verified using site geological drill data. The full TEM survey report is included in **Attachment A4**.

6 LANDHOLDER BORE CENSUS

A field census of groundwater bores and wells in the vicinity of the Project was conducted by ENRS. The bore census was conducted from September to November 2017 and involved visiting bores on 12 properties. Details on the bores are provided in **Table A6-1** and bore census cards are presented in **Attachment A5**.

The geology for bores as presented in **Table A6-1** has been assumed based on available geological logs from the Queensland Groundwater Database and mapped geology.

Table A6-1 Bore Census Details

Bore ID	Local Bore Name	Property	Easting	Northing	Elevation (mAHD)	Year Drilled	Date Visited	Measured Total Depth (mbgl)	Screen (mbgl)	SWL (mbgl)	EC (µS/cm)	pH	Bore Status	Purpose	Geology	Comment
CATTLE CAMP GULLY	Cattle Camp Gully	Cattle camp	671137	7536973	154	~1930	30-09-2017	89.4		6.9	900	7.7	No	Stock	Back Creek Group	piston (not deployed) pump, motor power.
161578	Powerline	Cattle camp	672586	7535520	191	-	30-09-2017	113.42	96 - 142	46.9	2208	7.1	No	Stock	Duaringa Formation	No pump, no power.
111719	Bore Behind Dam	Cattle camp	673489	7537157	149	2002	01-10-2017	-	52 - 60	-	-	-	Yes	Stock	Tertiary - Undifferentiated	Submersible pump, mains power, equipped withflow gauge and power meter. Pump deployed - Sample tap ceased
88992	Mandle Brot Bore	Cattle camp	672888	7537124	156	1993	02-10-2017	-	35 - 59	-	-	-	Yes	Stock	Basalt	Submersible pump, mains power, equipped withflow gauge. Pump deployed
161572	House Bore	Cattle camp	672572	7538233	178	2016	30-09-2017	184.37	77 - 161	37.4	631	8.2	No	Domestic	Back Creek Group	No pump, no power.
161573	House Supply	Cattle camp	672562	7538229	175	2016	30-09-2017	57.47	46 - 53	36.7	710	6.8	No	Domestic	Back Creek Group	No pump, no power.
161 575	Rosewood	Cattle camp	672394	7543106	198	2017	30-09-2017	83.14	60 - 84	27.7	499	6.7	No	Stock	Duaringa Formation	No pump, no power.
161574	KP	Cattle camp	673374	7543006	203	2017	30-09-2017	121.4	90 - 120	25.3	889	7.4	No	Stock	Back Creek Group	No pump, no power.
13040286	-	Cattle camp	659986	7536977	165	2004	11-09-2017	*107	94.3 - 100.3	*44.1	-	-	Yes	Monitoring	Blackwater Group	Measurement obtained from DNR online output. Data provided in MBGL - Data Available online
UNKNOWN BORE 1	Yard Bore Large	Leichardt	670295	7516420	149	-	14-11-2017	73.73	-	11.4	1324	7.0	No	Stock	Isaac River Alluvium	No pump, no power. Bore drilled by McCarther Coal during exploration. Hole left open as water quality was Not to be 'good'. Never Used
UNKNOWN BORE 2	Yard Bore Small	Leichardt	670294	7516425	149	-	14-11-2017	177.87	-	11.1	140	6.9	No	Stock	Isaac River Alluvium	No pump, no power. Casing to 60m - Info from Cap, 'Bore ID BB1333'. Strong rotten egg odour. Low EC, possibly heavily stratified
136091/1	-	Leichardt	650061	7508592	174	-	14-11-2017	76.82	58 - 62	44.9	1662	6.8	No	Stock	Blackwater Group	No pump, mains power. - *Multiple bores present. No filed measurements directly correlate to bore report

Bore ID	Local Bore Name	Property	Easting	Northing	Elevation (mAHD)	Year Drilled	Date Visited	Measured Total Depth (mbgl)	Screen (mbgl)	SWL (mbgl)	EC (µS/cm)	pH	Bore Status	Purpose	Geology	Comment
136091/2	-	Leichardt	650091	7508608	171	-	14-11-2017	-	58 - 62	-	-	-	Yes	Stock	Blackwater Group	Submersible pump, mains power, equipped with flow gauge. Pump deployed - *Multiple bores present. No filed measurements directly correlate to bore report
136091/3	-	Leichardt	650116	7508649	186	-	14-11-2017	84.53	58 - 62	46.2	4750	6.9	No	Stock	Blackwater Group	No pump, mains power. - *Multiple bores present. No filed measurements directly correlate to bore report
136091/4	-	Leichardt	650106	7508653	168	-	14-11-2017	55.66	58 - 62	45.1	4419	7.1	No	Stock	Blackwater Group	No pump, no power. - *Multiple bores present. No filed measurements directly correlate to bore report
44625	-	Leichardt	650437	7509443	-	1973	14-11-2017	-	53.3 - 57.9	-	-	-	AD	-	Blackwater Group	Registered coordinates visited - no bore present - Land representative not aware of bores presence or status
90470	-	Leichardt	656369	7512572	-	1993	14-11-2017	-	-	-	-	-	AD	-	Duaringa Formation	No bore present - DNR report lists status as 'abandoned and destroyed' Land representative not aware of bores presence or status
90471	-	Leichardt	656361	7511724	-	1993	14-11-2017	-	-	-	-	-	AD	-	Blackwater Group	No bore present - DNR report lists status as 'abandoned and destroyed' Land representative not aware of bores presence or status
90474	-	Leichardt	656354	7511038	-	1993	14-11-2017	-	30 - 48	-	-	-	AD	-	Duaringa Formation	No bore present - Land representative not aware of bores presence or status
89493	-	Leichardt	656309	7510312	-	1993	14-11-2017	-	51 - 63	-	-	-	AD	-	Blackwater Group	Site could not be accessed – assume bore is present - Land representative not aware of bores presence or status
90472	-	Leichardt	653417	7512498	-	1993	14-11-2017	-	-	-	-	-	AD	-	Blackwater Group	No bore present - DNR report lists status as 'abandoned and destroyed' Land representative not aware of bores presence or status

Bore ID	Local Bore Name	Property	Easting	Northing	Elevation (mAHD)	Year Drilled	Date Visited	Measured Total Depth (mbgl)	Screen (mbgl)	SWL (mbgl)	EC (µS/cm)	pH	Bore Status	Purpose	Geology	Comment
90473	-	Leichardt	651871	7512131	-	1993	14-11-2017	-	-	-	-	-	AD	-	Blackwater Group	No bore present - DNR report lists status as 'abandoned and destroyed' Land representative not aware of bores presence or status
BORE 8	5 Mile Bore	Olive Downs	640186	7547990	188	-	13-11-2017	-	-	-	-	-	Yes	Stock	Isaac River Alluvium	Submersible pump, Genset power, equipped with flow meter. Pump deployed. **Within 5 km of ODS domain pit.**
BORE 7	Saltwater Bore	Olive Downs	637518	7552628	192	-	13-11-2017	16.36	-	15.3	994	6.8	No	Stock	Fort Cooper Coal Measures	No pump, Powerline power, equipped with flow meter. Bore not in use. No pump present. Casing heavily corroded
BORE 6	Turkeys Nest	Olive Downs	634323	7556584	-	-	13-11-2017	-	-	-	-	-	Unknown	-	-	Site could not be accessed – assume bore is present - Unable to access due to proximity to mine blasting exclusion zone
162185	-	Olive Downs	635149	7555403	-	2013	13-11-2017	-	120 - 138	-	-	-	Unknown	-	Rangal Coal Measures	Site could not be accessed – assume bore is present - Unable to access due to proximity to mine blasting exclusion zone
162472	-	Olive Downs	635533	7554547	193	2009	13-11-2017	90.3	81 - 90	22.4	-	-	Yes	Monitoring	-	Standpipe damaged, bailer couldn't pass - Monument damaged, supported by starposts
BORE 9	House Bore	Olive Downs	633886	7553064	189	-	13-11-2017	-	-	-	935.8	7.0	Yes	Domestic	Alluvium	Screw pump, mains power. Pump deployed -
162439	MB8	Olive Downs	631866	7553657	196	2015	13-11-2017	11.878	8.9 - 11.9	11.8	-	-	Yes	Monitoring	Isaac River Alluvium	insufficient volume for grab sample -
POWERLINE BORE	Powerline bore	Lake Vermont	641899	7519646	190	-	12-11-2017	-	-	-	1443	7.3	Yes	Stock	Back Creek Group	Submersible pump, Powerline power. Pump deployed
YARD BORE 1	Yard Bore 1	Lake Vermont	642611	7519351	185	~1930	12-11-2017	95.66	-	21.0	1512	7.5	No	Stock	Alluvium	- Pump, mains power. Bore no longer in use due to heavy corrosion in casing. Land owner noted that water is known to have a high sulphur content
YARD BORE 2	Yard Bore 2	Lake Vermont	642617	7519347	190	-	12-11-2017	-	-	-	-	-	Yes	Stock	Alluvium	Submersible pump, mains power. Pump deployed - Tank overflow returns to Yard Bore #1

Bore ID	Local Bore Name	Property	Easting	Northing	Elevation (mAHD)	Year Drilled	Date Visited	Measured Total Depth (mbgl)	Screen (mbgl)	SWL (mbgl)	EC (µS/cm)	pH	Bore Status	Purpose	Geology	Comment
132627	Green Tank	Lake Vermont	649621	7525089	170	2007	12-11-2017	-	35 - 40	-	-	-	No	-	Duaringa Formation	Unable to locate, likely buried - Anecdotally bore was capped near to ground surface and has likely been trampled or buried
132628	-	Lake Vermont	648220	7524052	-	2007	12-11-2017	-	85 - 95	-	-	-	AD	-	Duaringa Formation	Registered coordinates visited - no bore present
158481 (VWP)	-	Lake Vermont	643243	7522128	185	2013	12-11-2017	-	0 - 102	-	-	-	Yes	Monitoring	Permian Coal Measures	VWP - Readings taken but calibration information required to process - VWP Red - HZ 6025 / Temp 27.1 VWP Black - HZ 7093 / Temp 25.6 VWP Yellow - HZ 7062 - Temp 26.2 VWP Blue - HZ 6323 / Temp 27.9
158485	-	Lake Vermont	643243	7522125	181	2013	12-11-2017	22.17	16 - 22	13.5	560	7.2	Yes	Monitoring	Quaternary - Undefined	
100248	-	Lake Vermont	641645	7518640	-	1993	12-11-2017	-	-	-	-	-	AD	-	-	Registered coordinates visited - no bore present
165122 (VWP)	-	Lake Vermont	644182	7520541	181	2013	12-11-2017	-	0 - 91	-	-	-	Yes	Monitoring	Permian Coal Measures	VWP - Readings taken but calibration information required to process - VWP Red - HZ 7650 / Temp 21.2 VWP Black - HZ 8804 / Temp 25.0 VWP Yellow - HZ 7320 - Temp 27.3 VWP Blue - HZ 7229 / Temp 26.5
90475	-	Lake Vermont	645463	7513291	-	-	12-11-2017	-	-	-	-	-	Unknown	-	Blackwater Group	Site could not be accessed – assume bore is present - unable to access due to railroad corridor and blasting activity
158011	-	Lake Vermont	640150	7514275	194	2012	12-11-2017	32.39	24.5 - 30.5	17.5	6340	7.0	Yes	Monitoring	Fair Hill Formation	Rotten egg odour
165323	-	Lake Vermont	637620	7515091	-	2016	12-11-2017	-	7 - 13	-	-	-	Unknown	-	Quaternary - Undefined	Site could not be accessed – assume bore is present - unable to access as within mine site
165324	-	Lake Vermont	638481	7514161	-	2016	12-11-2017	-	6 - 12	-	-	-	Unknown	-	Quaternary - Undefined	Site could not be accessed – assume bore is present - unable to access as within mine site

Bore ID	Local Bore Name	Property	Easting	Northing	Elevation (mAHD)	Year Drilled	Date Visited	Measured Total Depth (mbgl)	Screen (mbgl)	SWL (mbgl)	EC (µS/cm)	pH	Bore Status	Purpose	Geology	Comment
158013	-	Lake Vermont	637781	7518065	-	2012	12-11-2017	-	99.5 - 105.5	-	-	-	Unknown	-	Moranbah Coal Measures	Site could not be accessed – assume bore is present - unable to access due to blasting activity
165325	-	Lake Vermont	640412	7516077	188	2016	12-11-2017	17.71	12 - 18	16.3	1439	7.0	Yes	Monitoring	Quaternary - Undefined	Concrete plinth damaged
84538	-	Lake Vermont	641354	7516737	-	1954	12-11-2017	-	27.4 - 109.7	-	-	-	AD	-	-	Registered coordinates visited - no bore present
158010	-	Lake Vermont	642638	7520120	186	2012	12-11-2017	34.3	27 - 33	17.0	1236	7.0	Yes	Monitoring	Fair Hill Formation	MW35 written on inside of cap
RIVER BORE	River Bore	Lake Vermont	654027	7526947	166	-	11-11-2017	38.45	-	14.1	616	6.5	No	Stock	Alluvium	No pump, no power. Bore unused since installation. Structure erected ready to house bore equipment. **Within 5 km of Willunga domain pit**
43329	-	Lake Vermont	653010	7521999	-	1974	11-11-2017	-	-	-	-	-	AD	-	Isaac River Alluvium	Registered coordinates visited - no bore present - Site is within 20m of drainage channel
158480 (VWP)	-	Lake Vermont	649913	7522233	166	2013	11-11-2017	-	0 - 94	-	-	-	Yes	Monitoring	-	VWP - Readings taken but calibration information required to process - VWP Red - HZ 7007 / Temp 26.3 VWP Black - HZ 7509 / Temp 26.0 VWP Yellow - HZ 7208 - Temp 27.9 VWP Blue - HZ 7207 / Temp 27.3
UNKNOWN 1	-	Lake Vermont	656849	7515959	160	-	11-11-2017	130.84	-	30.8	16610	6.6	No	Exploration	Alluvium	No pump, no power. Likely exploration hole. Looks to have been recently drilled
2500	-	Lake Vermont	648454	7524968	-	-	11-11-2017	-	-	-	-	-	AD	-	-	Registered coordinates visited - no bore present - Land representative not aware of bores presence or status
158484	-	Lake Vermont	648152	7524058	163	2013	11-11-2017	18.6	13 - 19	17.3	1401	7.2	Yes	Monitoring	Quaternary - Undefined	Plinth damaged

Bore ID	Local Bore Name	Property	Easting	Northing	Elevation (mAHD)	Year Drilled	Date Visited	Measured Total Depth (mbgl)	Screen (mbgl)	SWL (mbgl)	EC (µS/cm)	pH	Bore Status	Purpose	Geology	Comment
165124 (VWP)	-	Lake Vermont	648156	7524044	163	2013	11-11-2017	-	-	-	-	-	Yes	Monitoring	Permian Coal Measures	VWP - Readings taken but calibration information required to process - VWP Red - HZ 7049 / Temp 27.3 VWP Yellow - HZ 7725 - Temp 26.4 VWP Blue - HZ 6606 / Temp 26.8
165123 (VWP)	-	Lake Vermont	647629	7526188	164	2013	11-11-2017	-	-	-	-	-	Yes	Monitoring	Permian Coal Measures	VWP - Readings taken but calibration information required to process - VWP Red - HZ 6004 / Temp 25.6 VWP Black - HZ 6270 / Temp 26.2 VWP Yellow - HZ 7334 - Temp 27.0 VWP Blue - HZ 7163 / Temp 28.1
158483	-	Lake Vermont	645638	7522932	171	2013	11-11-2017	19.97	14 - 20	-	-	-	Yes	Monitoring	Quaternary - Undefined	
158482(VWP)	-	Lake Vermont	645638	7522933	174	2013	11-11-2017	-	-	-	-	-	Yes	Monitoring	Permian Coal Measures	VWP - Readings taken but calibration information required to process - VWP Red - HZ 6552 / Temp 26.6 VWP Black - HZ 7247 / Temp 27.8 VWP Yellow - HZ 5563 - Temp no response VWP Blue - HZ 6959 / Temp 28.5
WHITE TANK	White Tank	Winchester Downs	629347	7542483	212	-	10-11-2017	52.52	-	16.7	1721	6.7	No	Stock	Back Creek Group	No pump, no power. No pump deployed. Near to watering trough
141382	-	Winchester Downs	628494	7542693	205	2008	10-11-2017	50.8	48.5 - 51.5	14.4	2281	6.0	Yes	Monitoring	Back Creek Group	No logger deployed. Monument cap broken at hinge
16	-	Winchester Downs	628258	7544098	-	-	10-11-2017	-	-	-	-	-	AD	-	-	Registered coordinates visited - no bore present - Land representative not aware of bores presence or status. Coordinates near to large abandoned iron tank Drilling subs and fittings in area
14	-	Winchester Downs	628742	7546690	202	-	10-11-2017	14.13	-	3.3	3003	7.2	No	Stock	Regolith	No pump, windmill power. Windmill blades on ground

Bore ID	Local Bore Name	Property	Easting	Northing	Elevation (mAHD)	Year Drilled	Date Visited	Measured Total Depth (mbgl)	Screen (mbgl)	SWL (mbgl)	EC (µS/cm)	pH	Bore Status	Purpose	Geology	Comment
162460	Number One	Winchester Downs	627204	7546953	215	-	10-11-2017	10.87	-	-	-	-	Yes	Stock	Regolith	Submersible pump, Genset power, equipped with flow meter. Insufficient water to take sample. Appears to be a duplicate bore as adjacent bore appears to have a similar construction. Submersible pump deployed down adjacent bore. Windmill positioned over bore
15	-	Winchester Downs	629039	7546882	204	-	10-11-2017	23.2	-	9.5	2063	7.5	No	Stock	Regolith	No pump, no power. Methane present at 2.4% - Appears to previously have had piston pump installed
2485	-	Winchester Downs	632576	7552064	-	-	10-11-2017	-	-	-	-	-	AD	-	-	Registered coordinates visited - no bore present - Land representative not aware of bores presence or status
146640	-	Winchester Downs	632691	7552118	-	-	10-11-2017	-	16 - 23.5	-	-	-	AD	-	-	Registered coordinates visited - no bore present - Land representative not aware of bores presence or status
LEMON TREE	Lemon Tree	Winchester Downs	630655	7551954	195	-	10-11-2017	-	-	-	-	-	Yes	Stock	Basalt	Submersible pump, Genset power, equipped with flow meter. Pump deployed
13040180	-	Carfax	667825	7516351	147	1970	15-11-2017	28	0 - 28.5	16.2	199	7.5	Yes	monitoring	Isaac River Alluvium	No pump, no power. Bottom of well felt silty
13040181	-	Carfax	667995	7516067	-	1971	15-11-2017	-	0 - 18.6	-	-	-	AD	-	Isaac River Alluvium	Registered coordinates visited - no bore present - Bore report status abandoned and destroyed
13040182	-	Carfax	668470	7515544	-	1971	15-11-2017	-	-	-	-	-	AD	-	-	Registered coordinates visited - no bore present - Bore report status abandoned but still usable. No mention of water in bore report
13040183	-	Carfax	668911	7514985	-	1971	15-11-2017	-	0 - 16.8	-	-	-	AD	-	Isaac River Alluvium	Registered coordinates visited - no bore present - Bore report status abandoned and destroyed
13040184	-	Carfax	669488	7514387	-	1971	15-11-2017	-	0 - 18.6	-	-	-	AD	-	Isaac River Alluvium	Registered coordinates visited - no bore present - Bore report status abandoned and destroyed

Bore ID	Local Bore Name	Property	Easting	Northing	Elevation (mAHD)	Year Drilled	Date Visited	Measured Total Depth (mbgl)	Screen (mbgl)	SWL (mbgl)	EC (µS/cm)	pH	Bore Status	Purpose	Geology	Comment
UNKNOWN BORE 1	Unknown Bore 1	Carfax	670295	7516420	145	-	15-11-2017	17.5	-	13.5	343	6.0	No	Stock	Alluvium	No pump, no power. Near to powerline
UNKNOWN BORE 2	Unknown Bore 2	Carfax	670294	7516425	135	-	15-11-2017	-	-	-	-	-	No	Stock	Alluvium	Likely piston (downhole) pump, no power. Pump rods deployed down bore - Threaded steel casing; potentially drill rod. Not sample due to pump rods deployed/broken down bore
90341	-	Carfax	670362	7516607	-	1984	15-11-2017	-	16 - 18.1	-	-	-	AD	-	Isaac River Alluvium	Registered coordinates visited - no bore present
90075	Bridge Bore	Carfax	674591	7517833	144	1992	15-11-2017	-	17 - 29	-	-	-	Yes	Stock	Blackwater Group	Submersible pump, Powerline power. Pump deployed
103082	2nd Bridge Bore	Carfax	674586	7517730	148	1997	15-11-2017	-	20 - 27	-	-	-	Yes	Stock	Blackwater Group	Submersible pump, mains power. Pump deployed
103515	-	Carfax	674298	7517580	143	1999	15-11-2017	-	19.2 - 43.9	-	-	-	Yes	Stock	Blenheim Formation	Submersible pump, Genset power. Pump deployed
151344/1	-	Carfax	675224	7519939	136	2006	15-11-2017	17.97	15 - 22.5	13.6	-	-	No	Stock	Isaac River Alluvium	No pump, no power. Water not field tested, dead snake in bore - Bores present at site of a similar depth to bore report but of a PVC, not steel well construction
151344/2	-	Carfax	675226	7519939	145	-	15-11-2017	15.97	15 - 22.5	13.7	698	7.4	No	Stock	Isaac River Alluvium	No pump, no power.
103280	-	Carfax	675289	7519820	147	1999	15-11-2017	-	-	-	1173	6.8	Yes	Stock	Sedimentary - Undifferentiated	Submersible pump, mains power. Pump deployed; sample tap present - Slow drip coming from bore manifold. Possible decommissioned bore approximately 30cm from pumping bore
90074/1	3 Mile - 1	Carfax	671886	7511445	157	-	15-11-2017	-	26.5 - 44.8	-	-	-	No	Stock	Blackwater Group	No pump, no power.
90074/2	3 Mile - 2	Carfax	671877	7511442	157	-	15-11-2017	-	26.5 - 44.8	-	-	-	Yes	Stock	Blackwater Group	Submersible pump, solar power.
90074/3	3 Mile - 3	Carfax	671883	7511437	153	1963	15-11-2017	-	26.5 - 44.8	-	-	-	No	Stock	Blackwater Group	Likely piston (downhole) pump, windmill power.3 bores present at site. From drillers construction log this is likely the original bore. Windmill not connected/functional

Bore ID	Local Bore Name	Property	Easting	Northing	Elevation (mAHD)	Year Drilled	Date Visited	Measured Total Depth (mbgl)	Screen (mbgl)	SWL (mbgl)	EC (µS/cm)	pH	Bore Status	Purpose	Geology	Comment
90440	Spelt Paddock Bore	Carfax	674723	7515024	156	1995	15-11-2017	-	21 - 36	-	-	-	Yes	Stock	Blackwater Group	Submersible pump, Powerline power.
90441	Petes Bore	Carfax	672015	7510960	-	1995	15-11-2017	-	24 - 36	-	-	-	AD	-	Blackwater Group	Registered coordinates visited - no bore present
90076	House Bore	Carfax	672641	7515517	144	1968	15-11-2017	-	21 - 39.6	-	-	-	Yes	Stock and domestic	Blackwater Group	Submersible pump, Powerline power. Manual control switch
141677	-	Deverill	642164	7548178	191	2009	12-09-2017	9.6	12 - 24	-	-	-	No	Domestic	New Chum Formation	No pump, near to mains power. Field Measurements don't correlate with drillers logs. Within 4 km of ODS domain pit, on Pembroke owned land.
136090	Homestead Bore	Iffley	647486	7540034	183	2002	12-09-2017	22.4	84 - 90	12.4	2187	6.6	Yes	Domestic	Isaac River Alluvium	Submersible pump, mains power. SWL measurements taken from adjacent disused bore. Pumping bore was operational at time of measurement. Driller's construction log doesn't match site observations. **Within 5 km of ODS domain pit, on Pembroke owned land.**
44164	-	Iffley	647938	7540971	-	1974	12-09-2017	-	27.4 - 28.1	-	-	-	AD	-	Isaac River Alluvium	Registered coordinates visited - no bore present - Land representative not aware of bores presence or status
44161	-	Iffley	647509	7540289	170	1973	12-09-2017	-	23.4 - 25.9	-	-	-	AD	no	Isaac River Alluvium	No pump, no power. No bore present - Bore located - decommissioned
44162	-	Iffley	650787	7547451	-	-	29-09-2017	-	-	-	-	-	AD	-	-	Registered coordinates visited - no bore present - Land representative not aware of bores presence or status
44163	-	Iffley	653229	7547658	-	-	29-09-2017	-	-	-	-	-	AD	-	-	Registered coordinates visited - no bore present - Land representative not aware of bores presence or status
BORE 1	Bore 1	Wynette	634791	7550019	189	-	29-09-2017	-	-	-	-	-	No	Stock	Regolith	Submersible pump, Genset power. Pump deployed - No sample or gas measurements taken due to headworks

Bore ID	Local Bore Name	Property	Easting	Northing	Elevation (mAHD)	Year Drilled	Date Visited	Measured Total Depth (mbgl)	Screen (mbgl)	SWL (mbgl)	EC (µS/cm)	pH	Bore Status	Purpose	Geology	Comment
BORE 2	Bore 2	Wynette	634788	7550024	191	-	29-09-2017	19.24	-	15.4	2903	6.7	No	Stock/monitoring	Regolith	No pump, no power. Water level logger present in bore - Bore was drilled when Bore 1 became dry 15 years ago. Bore doesn't yield sufficient volumes to warrant the permanent deployment of a pump
BORE 3	Bore 3	Wynette	634785	7550009	187	-	29-09-2017	93.4	-	15.3	6677	7.4	No	Stock	Permian Coal Measures	No pump, no power. Methane present at 0.6%. Likely penetrating coal measures - Drilled at same time as bore 2 but to an increased depth looking for an alternate aquifer
97181	Pisscutter	Willunga	656325	7523641	167	1996	13-09-2017	18.97	17.37 - 18.3	11.9	298	6.9	Yes	Stock	Isaac River Alluvium	Submersible pump, powerline power, equipped withflow meter. Two wells, one open and one with pump deployed. Sample taken from open bore. Land owner claims max yield of 1500 GPH. **Within 5 km of Willunga domain pit.**
97180	Top Bore	Willunga	654694	7527196	-	1996	17-09-2017	-	15.24 - 16.4	-	-	-	Unknown	-	Isaac River Alluvium	Site could not be accessed – assume bore is present - Unable to access due to standing water. Land owner claims max yield of 800 GPH. **Within 5 km of Willunga domain pit.**
97185	Bottom Bore	Willunga	659239	7519220	164	1996	17-09-2017	18.8	16.76 - 17.68	13.5	442.8	7.1	No	Stock	Isaac River Alluvium	No pump, powerline power, equipped withflow meter. Land owner claims max yield of 1200 GPH. **Within 5 km of Willunga domain pit**
97184	Leichardt Bore	Willunga	659014	7519480	163	1996	17-09-2017	19.85	16.46 - 17.37	13.8	598.5	6.8	Yes	Stock	Isaac River Alluvium	Submersible pump, powerline power, equipped with power meter. Two wells, one open and one with pump deployed. Sample taken from open bore. **Within 5 km of Willunga domain pit,**

Bore ID	Local Bore Name	Property	Easting	Northing	Elevation (mAHD)	Year Drilled	Date Visited	Measured Total Depth (mbgl)	Screen (mbgl)	SWL (mbgl)	EC (µS/cm)	pH	Bore Status	Purpose	Geology	Comment
97182	Blue Pump 5"	Willunga	657944	7521843	165	1996	17-09-2017	20.27	17.37 - 18.29	12.5	472.5	7.2	Yes	Stock	Isaac River Alluvium	No pump, powerline power. Adjacent pump operating at time of measurements. **Within 5 km of Willunga domain pit,**
97183	Blue Pump 8"	Willunga	657950	7521838	165	1996	17-09-2017	-	17.68 - 18.29	-	-	-	Yes	Stock	Isaac River Alluvium	Submersible pump, powerline power, equipped with flow meter. Pumping at time of inspection. **Within 5 km of Willunga domain pit,**
67216	-	Willunga	655364	7526286	-	1996	17-09-2017	-	3.6 - 4.6	-	-	-	AD	-	Isaac River Alluvium	No bore present - Land owner aware of bores presence but confirms bore has since been abandoned / destroyed
67217	-	Willunga	656764	7522670	-	1984	17-09-2017	-	0 - 3.3	-	-	-	AD	-	Isaac River Alluvium	No bore present - Land owner aware of bores presence but confirms bore has since been abandoned / destroyed
67219	-	Willunga	659013	7519487	-	1984	17-09-2017	-	0 - 3.3	-	-	-	AD	-	Isaac River Alluvium	No bore present - Land owner aware of bores presence but confirms bore has since been abandoned / destroyed
67218	-	Willunga	658629	7521429	-	1984	17-09-2017	-	0 - 3.3	-	-	-	AD	-	Isaac River Alluvium	No bore present - Land owner aware of bores presence but confirms bore has since been abandoned / destroyed
47077	-	Willunga	672940	7532788	-	1975	17-09-2017	-	-	-	-	-	AD	-	-	No bore present - Land owner confirms no bore is present at location
161577	-	Willunga	672339	7533163	-	2017	17-09-2017	-	84	-	-	-	AD	-	Back Creek Group	No bore present - Test hole. Backfilled due to poor water quality
47076	-	Willunga	662675	7533512	-	1975	17-09-2017	-	-	-	-	-	AD	-	-	No bore present - Land owner confirms no bore is present at location
97019	-	Willunga	673471	7526074	-	1968	17-09-2017	-	-	-	-	-	AD	-	-	No bore present - Land owner confirms no bore is present at location
97020	-	Willunga	671585	7529583	-	1968	17-09-2017	-	-	-	-	-	AD	-	-	No bore present - Land owner confirms no bore is present at location

Bore ID	Local Bore Name	Property	Easting	Northing	Elevation (mAHD)	Year Drilled	Date Visited	Measured Total Depth (mbgl)	Screen (mbgl)	SWL (mbgl)	EC (µS/cm)	pH	Bore Status	Purpose	Geology	Comment
132631	Iffley	Meadowbrook	635452	7528174	200	2007	18-11-2017	*327.41	316 - 325	-	-	-	No	Stock	Back Creek Group	Belt driven rotary pump, Diesel Motor power, equipped withflow gauge. Pump deployed. TD from landowner - Max bore output 15,000 GPH. SWL ~40mbGL according to land owner
BULLOCK PADDOCK	Bullock Paddock	Meadowbrook	636052	7528117	185	-	18-11-2017	49.9	-	21.3	6212	7.4	No	Stock	Back Creek Group	No pump, no power. Land owner recalls bore was ~90m depth but dip line unable to pass 50.2mbTOC - Strong rotten egg odour
SWAMP BORE	Swamp Bore	Meadowbrook	645595	7528661	171	-	18-11-2017	84.75	-	17.3	1078	7.0	No	Stock	Permian Coal Measures	No pump, no power. Land owner claims output to be 1500 GPH
122458/1	Rolfies #1	Meadowbrook	644973	7526776	172	2006	18-11-2017	51.48	38.5 - 50.5	21.6	5098	7.3	No	Stock	Back Creek Group	No pump, no power. Land owner claims output to be 2000 GPH. Rotten egg odour
122458/2	Rolfies #2	Meadowbrook	644971	7526779	174	-	18-11-2017	102.85		21.6	8666	7.3	No	Stock	Back Creek Group	No pump, no power. Exploration hole
BLACK TANK	Black Tank	Meadowbrook	642742	7521198	173	-	18-11-2017	*45	-	-	-	-	Yes	Stock	Fort Cooper Coal Measures	Submersible pump, Genset power. Pump deployed. TD from landowner - Land owner claims output to be 1000 GPH Shelter and headworks damaged in storm ~7 years ago
POWER BORE	Power Bore	Meadowbrook	641260	7520977	186	-	18-11-2017	*40	-	16.0	-	-	Yes	Stock	Fort Cooper Coal Measures	Submersible pump, mains power. Pump deployed, dip measured through poly. TD from landowner - Land owner claims output to be 1000 GPH
100252	-	Seloh Nolem - Vermont Park	633893	7538053	-	-	07-06-2017	-	-	-	-	-	AD	-	-	No bore present - Bore located - decommissioned. Surveyed by Gage Environmental. **Within 5 km of ODS domain pit.**
13040177	-	Seloh Nolem - Vermont Park	651926	7535228	-	-	10-09-2017	-	-	-	-	-	AD	-	-	Registered coordinates visited - no bore present - Land representative not aware of bores presence or status

Bore ID	Local Bore Name	Property	Easting	Northing	Elevation (mAHD)	Year Drilled	Date Visited	Measured Total Depth (mbgl)	Screen (mbgl)	SWL (mbgl)	EC (µS/cm)	pH	Bore Status	Purpose	Geology	Comment
13040178	-	Seloh Nolem - Vermont Park	651167	7535107	-	1971	10-09-2017	-	-	-	-	-	AD	-	-	Registered coordinates visited - no bore present - Land representative not aware of bores presence or status
13040179	-	Seloh Nolem - Vermont Park	649627	7535053	-	1971	10-09-2017	-	-	-	-	-	AD	-	-	Registered coordinates visited - no bore present - Land representative not aware of bores presence or status

***Note**: Coordinates in GDA94 Z55 based on handheld GPS field coordinates*
** Coordinates derived from GWDB, not field verified.*
Elevation based on handheld GPS
Bore Status AD – Abandoned and Destroyed

Attachments

A1 – Drill Logs

A2 – Water Quality Data

A3 – Hydraulic Testing Analysis

A4 – TEM Survey

A5 – Landholder Bore Census

Attachment A1 – Drill Logs

BOREHOLE LOG

IF3839P

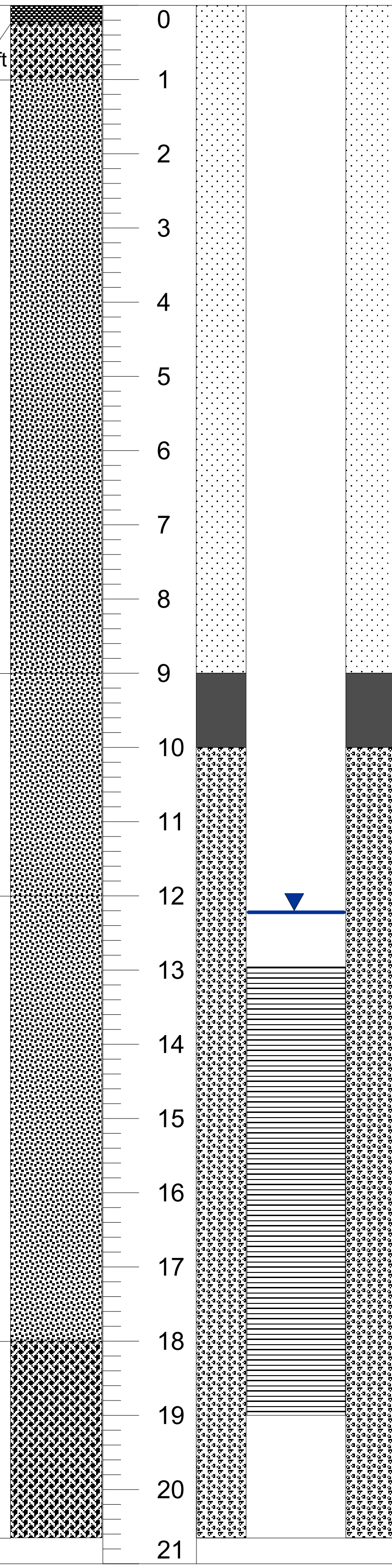
HOLE ID: IF3839P
SITE: GW01S
TD: 20.65 mBGL
TOC: 180.65 mAHD
EASTING: 642471.18
NORTHING: 7547491.63
DATUM: GDA94 ZONE 55
LONGITUDE: 148.2254
LATITUDE: - 22.1019
ELEVATION: 179.75 mAHD

PROJECT NO.: PEM002
PROJECT NAME: Iffley
DATE DRILLED: 28/2/2017
LOGGED BY: R. THOMAS

DRILLING COMPANY: DEPCO DRILLING
LICENCED DRILLER:
DRILLING METHOD: AIR 0 - 20.65 mBGL
HOLE DIAMETER: 150mm 0 - 20.65 mBGL

Comments: N/A

Stratigraphic Interpretation	Soil or Rock Field Material Description	Depth (mBGL)	Bore Description
Quaternary	Soil: medium to dark brown, residual, loose	0	TOC: Cement plinth with lockable steel monument cover 1.05 mAGL
Tertiary	Clay: medium to dark brown, extremely weathered, soft	0 - 1	
Tertiary	Sand: fine grained, brownish orange, extremely weathered	1 - 9	Grout: 0 - 9 mBGL; Blank 50mm PVC Class 18: 0 - 13 mBGL
Tertiary	Sand: fine to medium grained, quartzose lithic, extremely weathered	9 - 12	Bentonite: 9 - 10 mBGL
Tertiary	Sand: fine to coarse grained, quartzose lithic, extremely weathered	12 - 18	SWL: 13.268 mBTOC - 8/6/2017; Screen depth: 13 - 19 mBGL (1.5mm slotted 50mm PVC Class 18); Gravel (2-4mm): 10 - 20.65 mBGL
Tertiary	Clay: greyish blue, highly weathered	18 - 20.65	Backfilled: 19 - 20.65 mBGL



BOREHOLE LOG

IF3840P

HOLE ID: IF3840P
SITE: GW01D
TD: 412.65 mBGL
TOC: 181.577 mAHD
EASTING: 642475.43
NORTHING: 7547488.53
DATUM: GDA94 ZONE 55
LONGITUDE: 148.2254
LATITUDE: - 22.1019
ELEVATION: 179.78 mAHD

PROJECT NO.: PEM002
PROJECT NAME: Iffley
DATE DRILLED: 22/2/2017 - 24/2/2017
LOGGED BY: R. THOMAS

DRILLING COMPANY: DEPCO DRILLING
LICENCED DRILLER:
DRILLING METHOD: AIR 0 - 5 mBGL, MUD 5 - 412.65 mBGL
HOLE DIAMETER: 200mm 0 - 61.65 mBGL, 125mm 61.65 - 412.65 mBGL

Comments: N/A

Stratigraphic Interpretation	Soil or Rock Field Material Description
Quaternary	Clay: sandy ferruginous, extremely weathered
	Sand: fine to coarse grained, extremely weathered, quartzose
	Clay: sandy throughout, extremely weathered
Rewan Group	Mudstone: ferruginous, highly weathered
	Claystone: slightly to moderately weathered, low strength
	Sandstone: fine to medium grained, minor siltstone units
	Claystone: greyish blue, low strength
	Sandstone: fine to medium grained
	Siltstone: blueish grey, low strength, sandstone unit towards bottom
	Claystone: greenish blue, rare calcite fragments
	Sandstone: fine to medium grained, siltstone, claystone units
	Siltstone: grey, fresh, low strength
	Sandstone: fine to medium grained, claystone, siltstone units
	Siltstone: fresh, low strength, minor sandstone, claystone units
	Sandstone: fine to medium grained, minor siltstone, claystone units
Rangal Coal Measures	Siltstone: dark grey, fresh, very low strength
	Sandstone: medium grained, lithic sidertic, fresh
	Coal: LU, LL, sandstone interburden
	Sandstone: fine to medium grained, minor siltstone unit
	Coal: LL2T, LL2B, fresh
	50% Sandstone: fine grained, 50% siltstone: grey, fresh
	Coal: LL3, fresh
	Sandstone: fine to medium grained, minor siltstone units
	Coal: VU, fresh
	Sandstone: fine to medium grained, carbonaceous shale, siltstone units

Depth (mBGL): 0, 20, 40, 60, 80, 100, 120, 140, 160, 180, 200, 220, 240, 260, 280, 300, 320, 340, 360, 380, 400, 420

Bore Construction	Bore Description
	GW01 - P4: 63 mBGL
	GW01 - P3: 221.5 mBGL
	GW01 - P2: 352 mBGL
	GW01 - P1: 402 mBGL

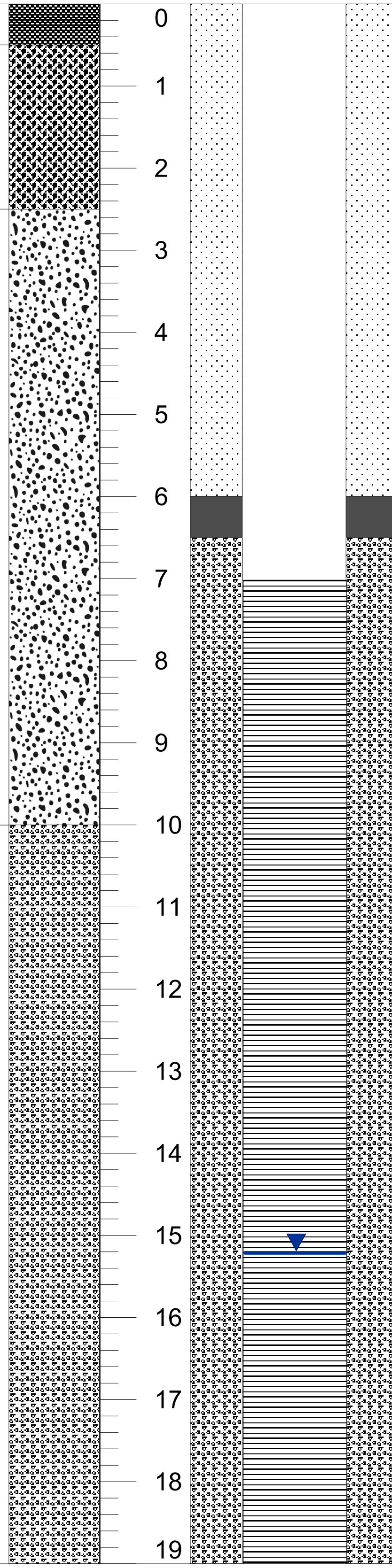
BOREHOLE LOG
IF3837P

HYDRO SIMULATIONS

PROJECT NO.: PEM002 PROJECT NAME: IFFLEY DATE DRILLED: 21/2/2017 LOGGED BY: D. HOGAN	DRILLING COMPANY: DEPCO DRILLING LICENCED DRILLER: DRILLING METHOD: AIR 0 - 5 mBGL, WATER 5 - 19 mBGL HOLE DIAMETER: 150mm 0 - 19 mBGL	HOLE ID: IF3837P SITE: GW02S TD: 19 mBGL TOC: 179.11mAHD EASTING: 641151.51 NORTHING: 7546517.02 DATUM: GDA94 ZONE 55 LONGITUDE: 148.228 LATITUDE: - 22.1051 ELEVATION: 178.21mAHD

Comments: Small amount of water at base of hole. Highy saline. Hole blocked at 4m.

Stratigraphic Interpretation	Soil or Rock Field Material Description	Graphic Log	Depth (mBGL)	Bore Construction	Bore Description
Quaternary	Soil: brown, highly weathered		0		TOC: Cement plinth with lockable steel monument cover 1.12 mABGL
Tertiary	Clay: orangey brown, highly weathered		1 - 2		Grout: 0 - 6 mBGL
	Sandstone: fine to medium grained, highly weathered		3 - 10		Blank 50mm PVC Class 18: 0 - 7 mBGL Bentonite: 6 - 6.5 mBGL Gravel (2-4mm): 6.5 - 19 mBGL
	Gravel: orange, iron stained, highly weathered		10 - 19		Screen Depth: 7 - 19 mBGL (1.5mm slotted 50mm PVC Class 18) SWL: 15.21m - 8/6/2017 PVC end cap: 19 mBGL



BOREHOLE LOG

IF3838P

HOLE ID: IF3838P
SITE: GW02D
TD: 136.65 mBGL
TOC: 179.11 mAHD
EASTING: 641148.24
NORTHING: 7546512.38
DATUM: GDA94 ZONE 55
LONGITUDE: 148.228
LATITUDE: - 22.1051
ELEVATION: 178.4 mAHD

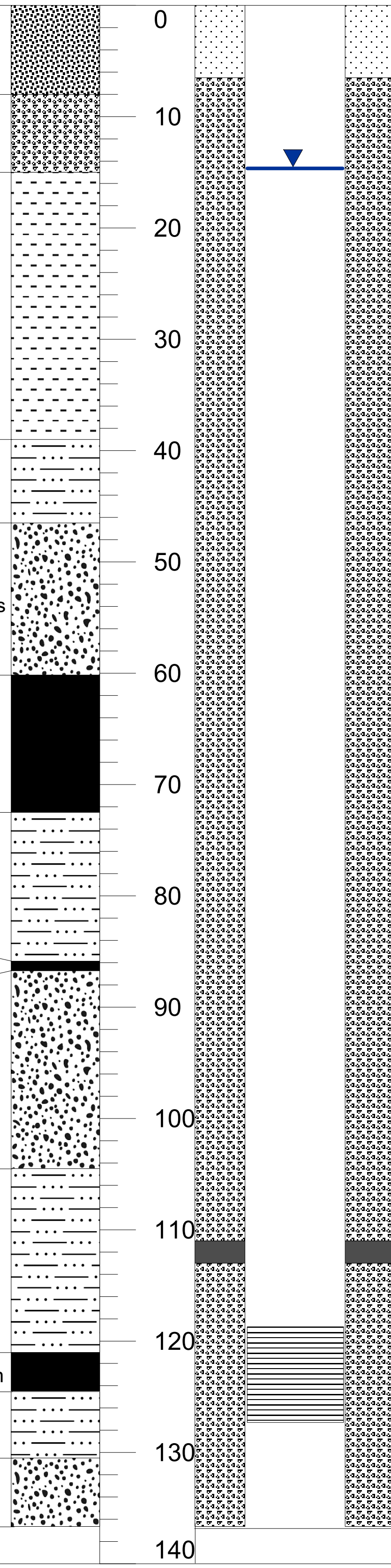
PROJECT NO.: PEM002
PROJECT NAME: IFFLEY
DATE DRILLED: 19/2/2017 - 20/2/2017
LOGGED BY: D. HOGAN

DRILLING COMPANY: DEPCO DRILLING
LICENCED DRILLER:
DRILLING METHOD: AIR 0 - 42 mBGL, MUD 42 - 136.65 mBGL
HOLE DIAMETER: 230mm 0 - 42 mBGL, 125mm 42 - 136.65 mBGL

Comments: N/A

Stratigraphic Interpretation	Soil or Rock Field Material Description
Tertiary	Sand: fine to medium grained, minor clay units, highly weathered
Tertiary	Gravel: pinkish orange, iron stained, highly weathered
Rewan Group	Claystone: yellowish, slightly to highly weathered
Rangal Coal Measures	Siltstone: grey, sandy clayey fragments, fresh
Rangal Coal Measures	Sandstone: fine to coarse grained, minor siltstone units
Rangal Coal Measures	Coal: 4.42m coal, LU, LL1, LL2T, LL2B, claystone, siltstone,and sandstone interburdens
Rangal Coal Measures	Siltstone: grey, fresh, minor sandstone and claystone units
Rangal Coal Measures	Coal: LL3
Rangal Coal Measures	Sandstone: fine to medium grained, minor siltstone and claystone units
Rangal Coal Measures	Siltstone: grey, fresh, sandy fragments
Rangal Coal Measures	Coal: 3.45m coal, carbonaceous claystone interburden
Rangal Coal Measures	Siltstone: grey, fresh, sandy fragments
Rangal Coal Measures	Sandstone: medium grained, fresh

Graphic Log | Depth (mBGL) | Bore Construction



Bore Description

TOC: Cement plinth with lockable steel monument cover 1.2 mAGL

Grout: 0 - 6.5 mBGL

SWL: 16.19 mBTOC - 8/6/2017

Surface Casing (150mm): 0 - 42mBGL

Blank 50mm PVC Class 18: 0 - 118.65 mBGL

Backfill: 6.5 - 111 mBGL

Bentonite: 111 - 113 mBGL

Gravel (2-4mm): 113 - 136.65 mBGL

Screen Depth: 118.65 - 127.65 mBGL (1.5mm slotted 50mm PVC Class 18)

Blank 50mm PVC Class 18: 127.65 - 136.65 mBGL

PVC end cap: 136.65 mBGL

BOREHOLE LOG

IF3841P

HOLE ID: IF3841P
SITE: GW04
TD: 41 mBGL
TOC: 178.23 mAHD
EASTING: 643384.879
NORTHING: 7544973.847
DATUM: GDA94 ZONE 55
LONGITUDE: 148.2427
LATITUDE: - 22.1140
ELEVATION: 177.44 mAHD

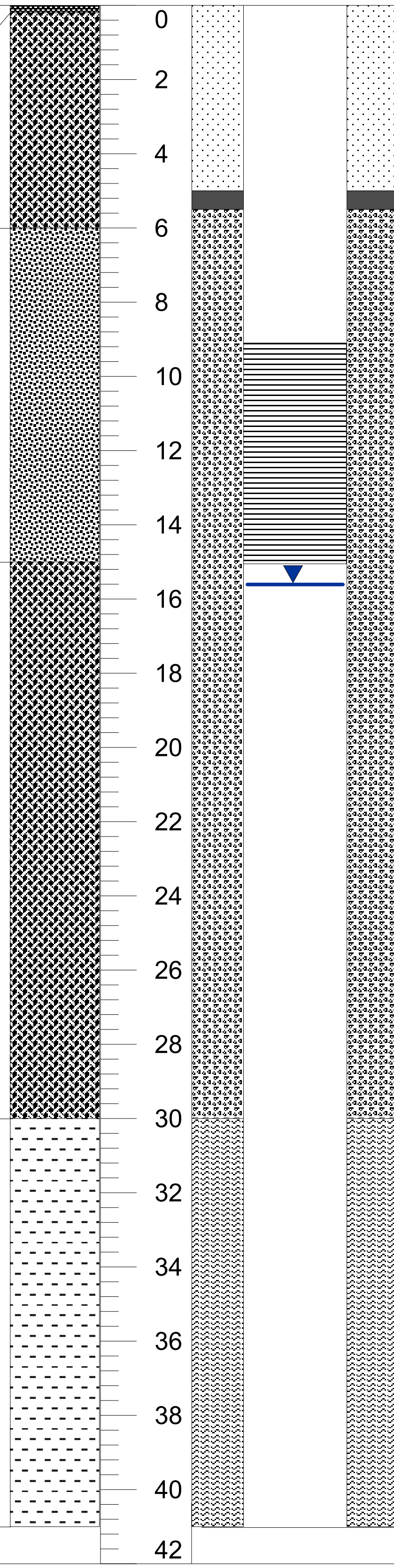
PROJECT NO.: PEM002
PROJECT NAME: Iffley
DATE DRILLED: 28/2/2017 - 1/3/2017
LOGGED BY: R. THOMAS

DRILLING COMPANY: DEPCO DRILLING
LICENCED DRILLER:
DRILLING METHOD: MUD 0 - 41 mBGL
HOLE DIAMETER: 150mm 0 - 41 mBGL

Comments:

Stratigraphic Interpretation	Soil or Rock Field Material Description
Quaternary Alluvium	Soil: medium to dark brown, residual, loose
Quaternary Alluvium	Clay: extremely weathered, soft to firm
Quaternary Alluvium	Sand: fine to coarse grained, extremely weathered, loose
Tertiary	Clay: extremely weathered, firm
Rewan Group	Claystone: reddish brown, sandy, extremely weathered, low strength

Graphic Log | Depth (mBGL) | Bore Construction



Bore Description

TOC: Cement plinth with lockable steel monument cover 0.92 mAGL

Grout: 0 - 5 mBGL

Bentonite: 5 - 5.5 mBGL

Blank 50mm PVC Class 18: 0 - 6 mBGL

Screen depth: 6 - 15 mBGL
(1.5mm slotted 50mm PVC Class 18)

SWL: 16.72 mBTOC - 8/6/2017

Gravel (2-4mm): 5.5 - 30 mBGL

Blank 50mm PVC Class 18: 15 - 30 mBGL

Backfill: 30 - 41 mBGL

BOREHOLE LOG

IF3835P

HOLE ID: IF3835P
SITE: GW06S
TD: 10 mBGL
TOC: 191.77 mAHD
EASTING: 639328.643
NORTHING: 7542006.955
DATUM: GDA94 ZONE 55
LONGITUDE: 148.216
LATITUDE: - 22.1318
ELEVATION: 190.94 mAHD

PROJECT NO.: PEM002
PROJECT NAME: Iffley
DATE DRILLED: 19/2/2017
LOGGED BY: D. HOGAN

DRILLING COMPANY: DEPCO DRILLING
LICENCED DRILLER:
DRILLING METHOD: AIR 0 - 10 mBGL
HOLE DIAMETER: 230mm 0 - 10 mBGL

Comments: No SWL, borehole dry.

Stratigraphic Interpretation	Soil or Rock Field Material Description	Depth (mBGL)
Quaternary	Soil: brown, extremely weathered	0 - 0.5
Tertiary	Sand: fine to medium grained, highly weathered	0.5 - 3
Tertiary	Sand: medium to coarse grained, highly weathered	3 - 6.5
Tertiary	Clay: highly weathered	6.5 - 10

Bore Description:

TOC: Cement plinth with lockable steel monument cover 1.18 mAGL

Grout: 0 - 3 mBGL

Blank 50mm PVC Class 18: 0 - 4 mBGL

Bentonite: 3 - 3.5 mBGL

Gravel (2-4mm): 3.5 - 10 mBGL

Dry - 8/6/2017

Screen Depth: 4 - 10 mBGL
(1.5mm slotted 50mm PVC Class 18)

PVC end cap: 10 mBGL

HYDRO SIMULATIONS

BOREHOLE LOG

IF3836P

HOLE ID: IF3836P
SITE: GW06D
TD: 203 mBGL
TOC: 192.86 mAHD
EASTING: 639333.84
NORTHING: 7542008.663
DATUM: GDA94 ZONE 55
LONGITUDE: 148.216
LATITUDE: - 22.1318
ELEVATION: 190.94 mAHD

PROJECT NO.: PEM002
PROJECT NAME: Iffley
DATE DRILLED: 14/2/2017 - 16/2/2017
LOGGED BY: D. HOGAN

DRILLING COMPANY: DEPCO DRILLING
LICENCED DRILLER:
DRILLING METHOD: AIR 0 - 4 mBGL, MUD 4 - 203 mBGL
HOLE DIAMETER: 230mm 0 - 4 mBGL, 175mm 4 - 34.6 mBGL, 125mm 34.6 - 203 mBGL

Comments: No SWL, borehole dry.

Stratigraphic Interpretation	Soil or Rock Field Material Description
Tertiary	Gravel: top layer of soil and sand present
	Claystone: highly weathered, puggy
FCCM	Sandstone: fine to coarse grained
	Coal: 1m VL2, claystone interburden
	Sandstone: fine to coarse grained, minor siltstone units
	Coal: 1.67m, claystone, siltstone interburdens
	Sandstone: medium to coarse grained, minor claystone, siltstone and siderite units
	Coal: 5.71m, claystone, siltstone, and siderite interburdens
	Sandstone: medium grained, minor claystone and siltstone units
	Coal: 1.69m, claystone, siltstone and siderite interburdens
	Siltstone: grey, fresh, sandy fragments

Depth (mBGL): 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210

Bore Description
GW06 - P4: 38 mBGL
GW06 - P3: 117.5 mBGL
GW06 - P2: 136.5 mBGL
GW06 - P1: 190.7

BOREHOLE LOG

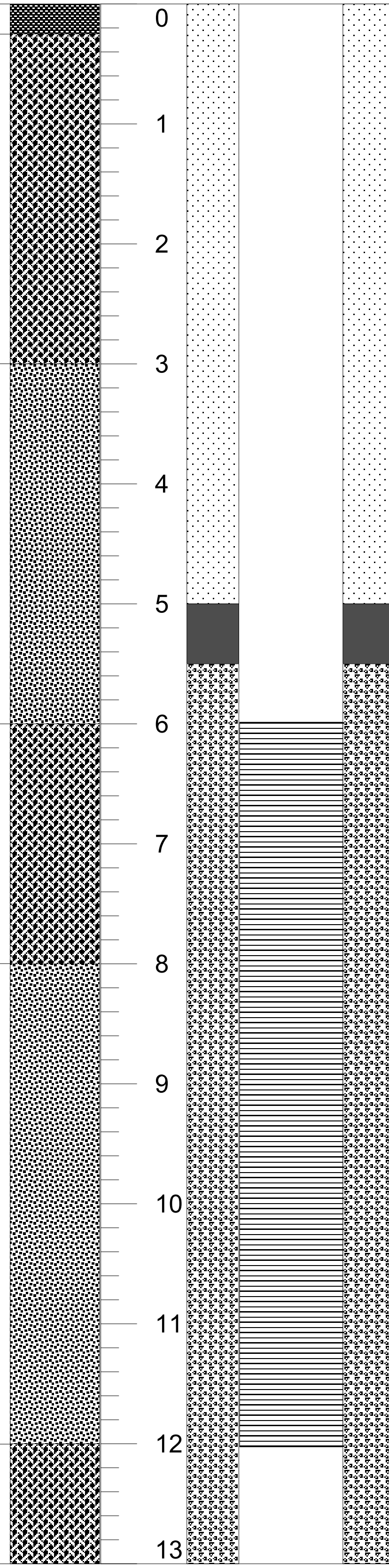
VP3833P

PROJECT NO.: PEM002 PROJECT NAME: IFFLEY DATE DRILLED: 28/2/2017 LOGGED BY: R. THOMAS	DRILLING COMPANY: DEPCO DRILLING LICENCED DRILLER: DRILLING METHOD: AIR 0 - 13 mBGL HOLE DIAMETER: 150mm 0 - 13 mBGL

HOLE ID: VP3833P
SITE: GW08S
TD: 13 mBGL
TOC: 172.27 mAHD
EASTING: 645323.48
NORTHING: 7539847.27
DATUM: GDA94 ZONE 55
LONGITUDE: 148.2436
LATITUDE: - 22.1426
ELEVATION: 171.51 mAHD

Comments: No SWL, dry.

Stratigraphic Interpretation	Soil or Rock Field Material Description	Graphic Log	Depth (mBGL)	Bore Construction	Bore Description
Quaternary Alluvium	Soil: medium to dark brown, residual soil, loose		0		TOC: Cement plinth with lockable steel monument cover 0.91 mAGL
Quaternary Alluvium	Clay: Yellowish, light to medium brown, extremely weathered and soft		1 – 3		Grout: 0 - 5 mBGL Surface Casing (50mm): 0 - 12 mBGL
Quaternary Alluvium	Sand: fine grained, light to medium brown, extremely weathered and loose		3 – 6		Bentonite: 5 - 5.5 mBGL
Quaternary Alluvium	Clay: reddish mottled brown, sandy, extremely weathered and soft		6 – 8		Screen Depth: 6 - 12 mBGL (1.5mm slotted 50mm PVC Class 18)
Quaternary Alluvium	Sand: fine to medium grained, extremely weathered, and loose		8 – 12		Dry - 8/6/2017 Gravel (2-4mm): 5.5 - 13 mBGL PVC end cap: 12 mBGL
Tertiary	Clay: clayey lateritic, extremely weathered and stiff		12 – 13		



HYDRO SIMULATIONS

BOREHOLE LOG

VP3834P

HOLE ID: VP3834P
SITE: GW08D
TD: 585 mBGL
TOC: N/A
EASTING: 645312
NORTHING: 7539846
DATUM: GDA94 ZONE 55
LONGITUDE: 148.2436
LATITUDE: - 22.1426
ELEVATION: 171.42 mAHD

PROJECT NO.: PEM002
PROJECT NAME: Iffley
DATE DRILLED: 4/2/2017 - 7/2/2017
LOGGED BY: R. THOMAS

DRILLING COMPANY: DEPCO DRILLING
LICENCED DRILLER:
DRILLING METHOD: AIR 0 - 7 mBGL, MUD 7 - 585 mBGL
HOLE DIAMETER: 230mm 0 - 68 mBGL, 120mm 68 - 585 mBGL

Comments: Hole intersected major thrust fault, multiple transitions between Rewan, RCM throughout. Intrustions @ 172-184m.

Stratigraphic Interpretation	Soil or Rock Field Material Description
Quaternary	Sand: coarse to fine grained, minor clay units
Tertiary	Clay: highly to extremely weathered, soft to stiff
Rangal Coal Measures	Claystone: slightly weathered and very low strength
	Siltstone: slightly weathered and very low strength
	Claystone: minor siltstone and sandstone units
	Sandstone: fine to medium grained with minor siltstone units
	Claystone: with minor sandstone (up to 6m) and siltstone units
	Sandstone: fine to medium grained with minor siltstone units
	Coal: fresh, low strength
	Siltstone: blackish to dark grey, with minor sandstone units
	Sandstone: fine to medium grained, with minor siltstone units
	Coal: coked and clayey (4.09m), igneous rock, sandstone interburdens
Rewan Group	Siltstone: blackish to dark grey, with minor sandstone and shale units
	Sandstone: fine to medium grained, with minor siltstone (up to 4m thick) and shale units
	Siltstone: dark grey, minor mudstone, sandstone, and claystone units
	Mudstone: medium to dark brown, minor sandstone and claystone units
	Sandstone: fine to medium grained, minor claystone and siltstone units
	Siltstone: medium to dark grey, minor sandstone units
	Claystone: irregularly bedded with siltstone and sandstone
Rangal Coal Measures	Sandstone: fine to medium grained, minor claystone and siltstone units
	Siltstone: medium to dark grey, minor sandstone units
	Coal
	Siltstone: dark grey, fresh and sandy laminae
	Sandstone: fine to medium grained, minor siltstone units
	Coal: LL2T, LL2B, LL3 (5.87m total), with carbonaceous shale
	Siltstone: dark grey, fresh, with minor sandstone units
	Coal: Vermont Upper Seam (3.87m), claystone interburden
	Sandstone: fine to medium grained, with minor siltstone and claystone units

Graphic Log

Depth (mBGL): 0, 40, 80, 120, 160, 200, 240, 280, 320, 360, 400, 440, 480, 520, 560, 600

Bore Construction

Bore Description

GW08D - VWP4: 70 mBGL

GW08D - VWP3: 94 mBGL

GW08D - VWP2: 137 mBGL

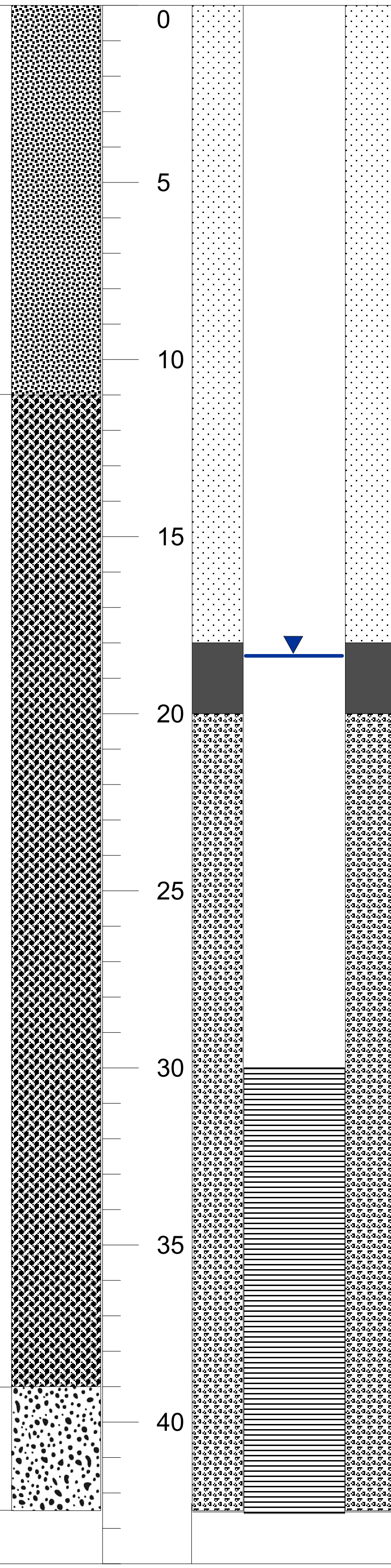
GW08D - VWP1: 177 mBGL

Fault occuring at 183 mBGL

HYDRO SIMULATIONS	# BOREHOLE LOG VP3831P	HOLE ID: VP3831P SITE: GW12s TD: 42.5 mBGL TOC: 175.84 mAHD EASTING: 641497.83 NORTHING: 7532790.52 DATUM: GDA94 ZONE 55 LONGITUDE: 148.2225 LATITUDE: - 22.1817 ELEVATION: 174.88 mAHD
PROJECT NO.: PEM002 PROJECT NAME: Vermont Park DATE DRILLED: 2/12/2016 LOGGED BY: D. HOGAN	DRILLING COMPANY: DEPCO DRILLING LICENCED DRILLER: DRILLING METHOD: N/A HOLE DIAMETER: 230mm 0 - 5.4 mBGL, 125mm 5.4 - 42.5 mBGL	

Comments: N/A

Stratigraphic Interpretation	Soil or Rock Field Material Description	Graphic Log	Depth (mBGL)	Bore Construction	Bore Description
Quaternary	Sand: fine to medium grained, extremely weathered		0 - 11		TOC: Cement plinth with lockable steel monument cover 0.89 mAGL Surface Casing (150mm): 0 - 5.4 mBGL Grout: 0 - 18 mBGL Blank 50mm PVC Class 18: 0 - 30 mBGL
Tertiary	Clay: pink, orange, highly weathered		11 - 39		SWL: 19.19 mBTOC - 27/2/2017 Bentonite: 18 - 20 mBGL Gravel: 20 - 42.5 mBGL Screen Depth 30 - 42.5 mBGL (1.5mm slotted 50mm PVC Class 18)
	Sandstone: fine to medium grained		39 - 42.5		PVC end cap: 42.5 mBGL



HYDRO SIMULATIONS

BOREHOLE LOG

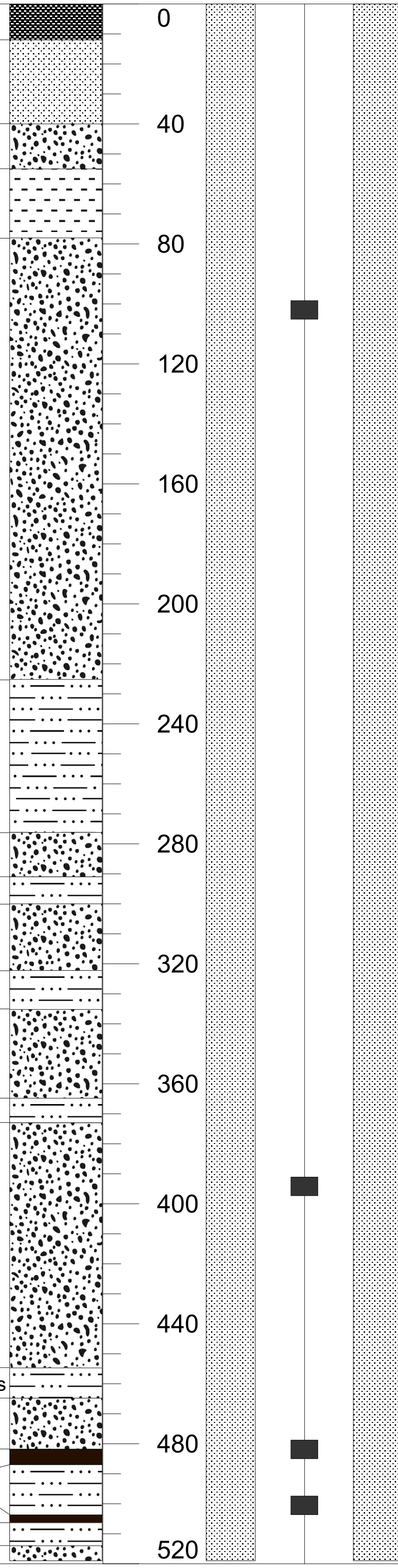
VP3832P

PROJECT NO.: PEM002 PROJECT NAME: VERMONT PARK DATE DRILLED: 3/12/2016 - 8/12/2016 LOGGED BY: D. HOGAN	DRILLING COMPANY: DEPCO DRILLING LICENCED DRILLER: DRILLING METHOD: AIR 0 - 3 mBGL, MUD 3 - 519 mBGL HOLE DIAMETER: 230mm 0 - 81 mBGL, 125mm 81 - 519 mBGL	HOLE ID: VP3832P SITE: GW12d TD: 519 mBGL TOC: 176.89 mAHD EASTING: 641492.44 NORTHING: 7532790.10 DATUM: GDA94 ZONE 55 LONGITUDE: 148.2225 LATITUDE: - 22.1817 ELEVATION: 175.14 mAHD

Comments: N/A

Stratigraphic Interpretation	Soil or Rock Field Material Description
Quaternary	Top soil layer, alternating layers of sand and clay
Tertiary	Alternating layers of sand and clay
Rewan Group	Sandstone: medium to coarse grained
	Claystone: moderately to highly weathered
	Sandstone: fine to medium grained, with minor claystones and siltstones
	Siltstone: with minor clays and claystones
	Sandstone: very fine to medium grained
	Siltstone: grey and fresh
	Sandstone: fine to medium grained, with minor siltstones
	Siltstone: grey and fresh
	Sandstone: very fine to medium grained
	Siltstone: grey and fresh
	Sandstone: fine to medium grained, minor siltstones and 0.38m coal at base
Rangal Coal Measures	Siltstone: 0.38m coal overlaying, minor sandstone units
	Sandstone: fine to medium grained, minor claystones and siltstones
	Coal: LL2
	Siltstone: minor sandstones
	Coal: LL3
	Siltstone: grey and fresh
	Sandstone: fine to medium grained

Graphic Log	Depth (mBGL)	Bore Construction	Bore Description



Bore Description
GW12 - P4: 108 mBGL
GW12 - P3: 391 mBGL
GW12 - P2: 484.5 mBGL
GW12 - P1: 505 mBGL

BOREHOLE LOG

VE3827P

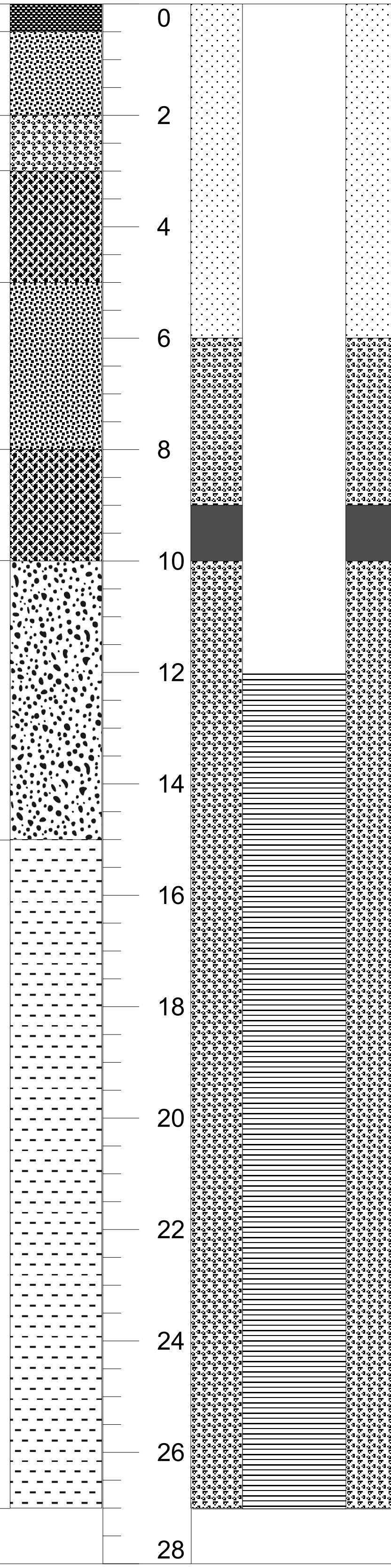
HOLE ID: VE3827P
SITE: GW16S
TD: 27 mBGL
TOC: 164.21 mAHD
EASTING: 660839.69
NORTHING: 7525290.73
DATUM: GDA94 ZONE 55
LONGITUDE: 148.3343
LATITUDE: - 22.2215
ELEVATION: 162.87 mAHD

PROJECT NO.: PEM002
PROJECT NAME: Willunga
DATE DRILLED: 2/11/2016 - 3/11/2016
LOGGED BY: D. HOGAN

DRILLING COMPANY: DEPCO DRILLING
LICENCED DRILLER:
DRILLING METHOD: AIR 0 - 27 mBGL
HOLE DIAMETER: 175mm 0 - 9.7 mBGL, 125mm 9.7 - 27 mBGL

Comments: No SWL, borehole dry.

Stratigraphic Interpretation	Soil or Rock Field Material Description	Depth (mBGL)
Quaternary	Soil: brown, residual	0
Quaternary	Sand: orange, extremely weathered	
Quaternary	Gravel: creamy white, highly weathered	2
Quaternary	Clay: orangey brown, highly weathered	4
Quaternary	Sand: coarse grained, highly weathered	6
Tertiary	Clay: brownish yellow, highly weathered	8
Tertiary	Sandstone: coarse grained, yellowish orange, highly weathered	10 - 12 - 14
Tertiary	Claystone: creamy yellow, highly weathered	16 - 18 - 20 - 22 - 24 - 26
		28



Bore Description

Grout: 0 - 6 mBGL

Surface Casing (150mm): 0 - 9.7 mBGL

Gravel (2-4mm): 6 - 9 mBGL

Bentonite: 9 - 10 mBGL

Blank PVC Class 18 50mm: 0 - 12 mBGL

Gravel(2-4mm): 10 - 27 mBGL

Dry: 8/6/2017

Screen Depth: 12 - 27 mBGL
(1.5mm slotted 50mm PVC Class 18)

PVC end cap: 27 mBGL

HYDROSIMULATIONS

BOREHOLE LOG

VE3828P

HOLE ID: VE3828P
SITE: GW16d
TD: 339 mBGL
TOC: 164.90 mAHD
EASTING: 660833.99
NORTHING: 7525287.55
DATUM: GDA94 ZONE 55
LONGITUDE: 148.3343
LATITUDE: - 22.2215
ELEVATION: 163 mAHD

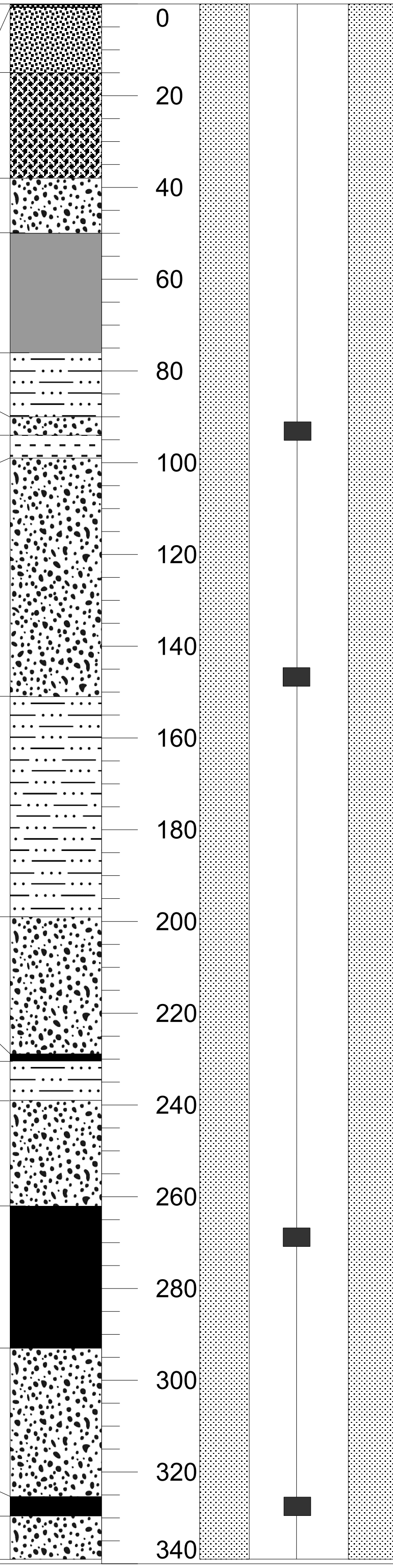
PROJECT NO.: PEM002
PROJECT NAME: WILLUNGA
DATE DRILLED: 13/11/2016 - 17/11/2016
LOGGED BY: D. HOGAN & R. THOMAS

DRILLING COMPANY: DEPCO DRILLING
LICENCED DRILLER:
DRILLING METHOD: MUD 0 - 339 mBGL
HOLE DIAMETER: 175mm 0 - 86.2 mBGL, 125mm 86.2 - 339 mBGL

Comments: N/A

Stratigraphic Interpretation	Soil or Rock Field Material Description
Quaternary	Soil: brown, highly weathered
Tertiary	Sand: coarse grained, 2.5m clay unit
	Clay: greyish cream, highly weathered
Rewan Group	Sandstone: medium to coarse grained, highly weathered
	Not Logged
	Siltstone: bluish light to medium grey, fresh
	Sandstone: fine to medium grained
	Claystone: minor sandstone and siltstone units
	Sandstone: fine to coarse grained with minor claystones and siltstones
	Siltstone: minor sandstone, claystone units
Rangal Coal Measures	Sandstone: fine to medium grained, minor claystone, sandstone units
	Coal: LL1
	Siltstone: grey, minor claystones
	Sandstone: fine to medium grained
	Coal: LL2TF, LL2T, LL2B, shale, siltstone and sandstone interburdens (22.46m total)
	Sandstone: fine to medium grained
	Coal: VU, VL, claystone interburden
	Sandstone: fine to medium grained

Graphic Log | Depth (mBGL) | Bore Construction



Bore Description

GW16 - P4: 91 mBGL

GW16 - P3: 147 mBGL

GW16 - P2: 269 mBGL

GW16 - P1: 327 mBGL

HYDRO SIMULATIONS

BOREHOLE LOG

VE3829P

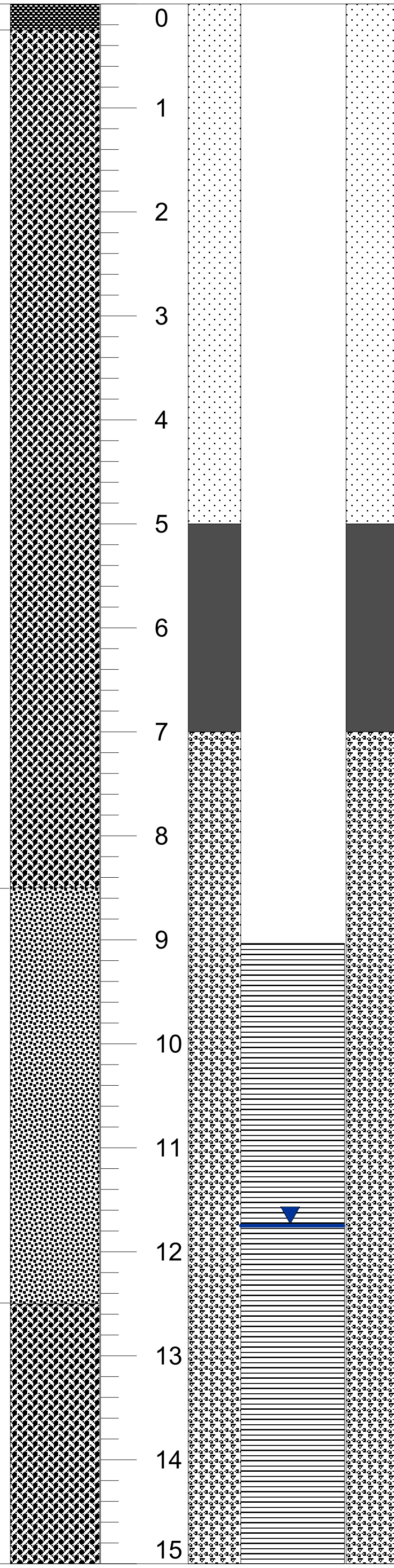
HOLE ID: VE3829P
SITE: GW18S
TD: 15 mBGL
TOC: 156.24 mAHD
EASTING: 656884.58
NORTHING: 7522810.43
DATUM: GDA94 ZONE 55
LONGITUDE: 148.3126
LATITUDE: - 22.2337
ELEVATION: 154.82 mAHD

PROJECT NO.: PEM002
PROJECT NAME: Willunga
DATE DRILLED: 21/11/2016
LOGGED BY: R. THOMAS

DRILLING COMPANY: DEPCO DRILLING
LICENCED DRILLER:
DRILLING METHOD: AIR 0 -15 mBGL
HOLE DIAMETER: 175mm 0 - 5.5 mBGL, 125mm 5.5 - 15 mBGL

Comments:

Stratigraphic Interpretation	Soil or Rock Field Material Description	Graphic Log	Depth (mBGL)	Bore Construction	Bore Description
Quaternary	Soil: dark brown, loose		0		TOC: Cement plinth with lockable steel monument cover 1.5 mAGL
	Clay: reddish medium brown, extremely weathered and soft				Grout: 0 - 5 mBGL
					Surface Casing (150mm): 0 - 5.5 mBGL
					Blank 50mm PVC Class 18: 0 - 9 mBGL
					Bentonite: 5 - 7 mBGL
					Gravel(2-4mm): 7 - 15 mBGL
	Sand: fine grained, reddish to orange and extremely weathered				Screen Depth: 9 - 15m (1.5mm slotted 50mm PVC Class 18)
					SWL: 13.322 mBTOC - 28/2/2017
	Clay: reddish mottled grey, extremely weathered, firm		15		PVC end cap: 15 mBGL



BOREHOLE LOG

VE3830P

HOLE ID: VE3830P	SITE: GW18D
TD: 183 mBGL	TOC: 156.04 mAHD
EASTING: 656890.69	NORTHING: 7522809.27
DATUM: GDA94 ZONE 55	LONGITUDE: 148.3125
LATITUDE: - 22.2337	ELEVATION: 154.76 mAHD

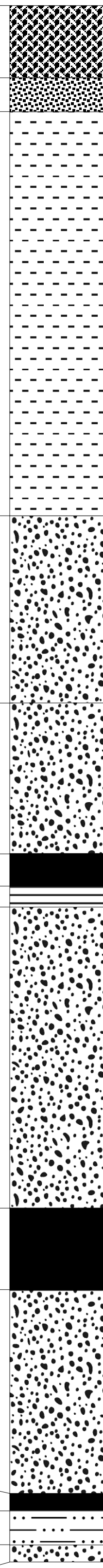
PROJECT NO.: PEM002
PROJECT NAME: Willunga
DATE DRILLED: 19/11/2016 - 20/11/2016
LOGGED BY: R. THOMAS

DRILLING COMPANY: DEPCO DRILLING
LICENCED DRILLER:
DRILLING METHOD: MUD 0 -183 mBGL
HOLE DIAMETER: 175mm 0 - 51 mBGL, 125mm 51 - 183 mBGL

Comments:

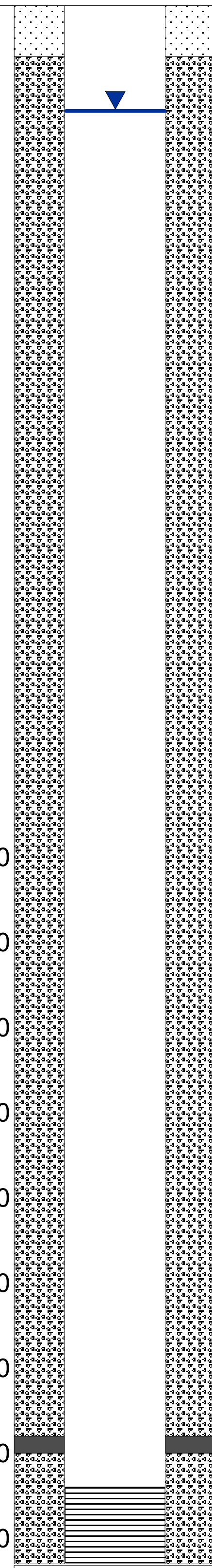
Stratigraphic Interpretation	Soil or Rock Field Material Description
Quaternary	Clay: soft to firm, extremely weathered, top soil 0.25m
	Sand: fine grained, extremely weathered, and loose
Rewan Group	Claystone: minor clay present
	Sandstone: fine to medium grained
Rangal Coal Measures	Sandstone: fine to medium grained
	Coal: LL1, stony, and fresh
	Carbonaceous Shale
	Sandstone: fine to medium grained, minor siltstone
	Coal: 5.87m coal - LL2T, LL2, LL3, stony and fresh, siltstone and sandstone interburden
	Sandstone: fine to medium grained
	Coal: VU, fresh
	Siltstone: dark grey, and fresh
	Sandstone: fine to medium grained

Graphic Log



Depth (mBGL): 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190

Bore Construction



Bore Description

TOC: Cement plinth with lockable steel monument cover 1.39 mAGL
Grout: 0 - 6 mBGL
SWL: 13.527 mBTOC - 28/2/2017
Surface Casing (150mm): 0 - 71 mBGL
Blank 50mm PVC Class 18: 0 - 174 mBGL
Gravel(2-4mm): 6 - 168 mBGL
Bentonite: 168 - 170 mBGL
Gravel: 170 - 183 mBGL
Screen Depth: 174 - 183m
(1.5mm slotted 50mm PVC Class 18)
PVC end cap: 183 mBGL

BOREHOLE LOG

VE3825P

HOLE ID: VE3825P
SITE: GW21S
TD: 9 mBGL
TOC: 162.07 mAHD
EASTING: 661580.15
NORTHING: 7521652.58
DATUM: GDA94 ZONE 55
LONGITUDE: 148.3411
LATITUDE: -22.3412
ELEVATION: 160.77 mAHD

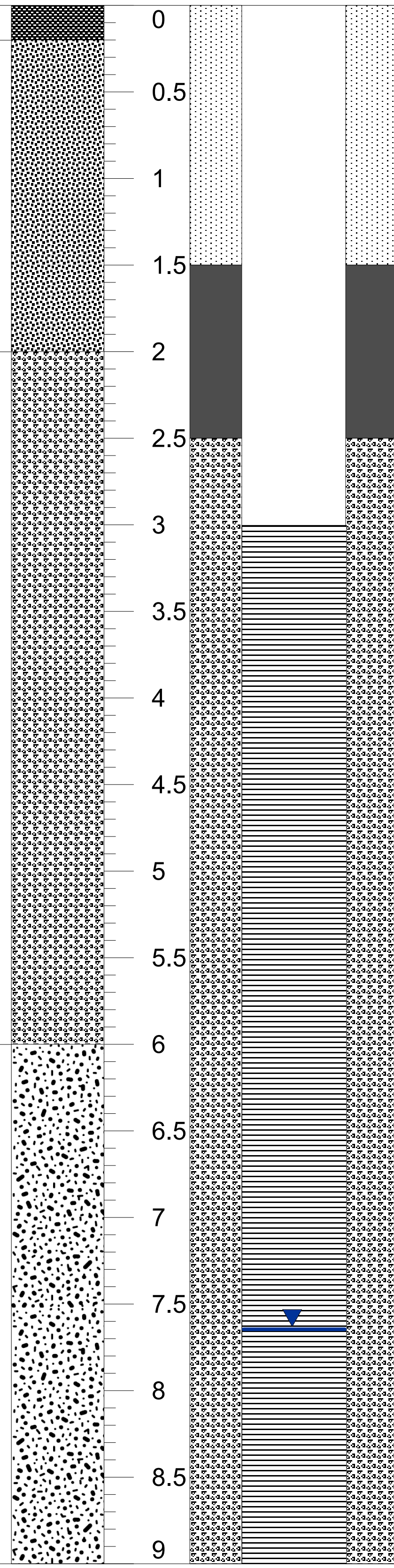
PROJECT NO.: PEM002
PROJECT NAME: Willunga
DATE DRILLED: 3/11/2016
LOGGED BY: D. HOGAN

DRILLING COMPANY: DEPCO DRILLING
LICENCED DRILLER:
DRILLING METHOD: AIR 0 - 9 mBGL
HOLE DIAMETER: 175mm 0 - 5.8 mBGL, 125mm 5.8 - 9 mBGL

Comments: N/A

Stratigraphic Interpretation	Soil or Rock Field Material Description
Quaternary	Soil: brown, residual
	Sand: medium to coarse grained.
	Gravel: highly weathered
	Sandstone: medium to coarse grained.

Graphic Log | Depth (mBGL) | Bore Construction



Bore Description

TOC: Cement plinth with lockable steel monument cover 1.5 mAGL

Grout: 0 - 1.5 mBGL

Blank 50mm PVC Class 18: 0 - 3 mBGL

Bentonite: 1.5 - 2.5 mBGL

Gravel(2-4mm): 2.5 - 9 mBGL

Screen Depth: 3 - 9 mBGL
(1.5mm slotted 50mm PVC Class 18)

SWL: 9.165 mBTOC - 28/2/2017

PVC End Cap: 9 mBGL

BOREHOLE LOG

VE3826P

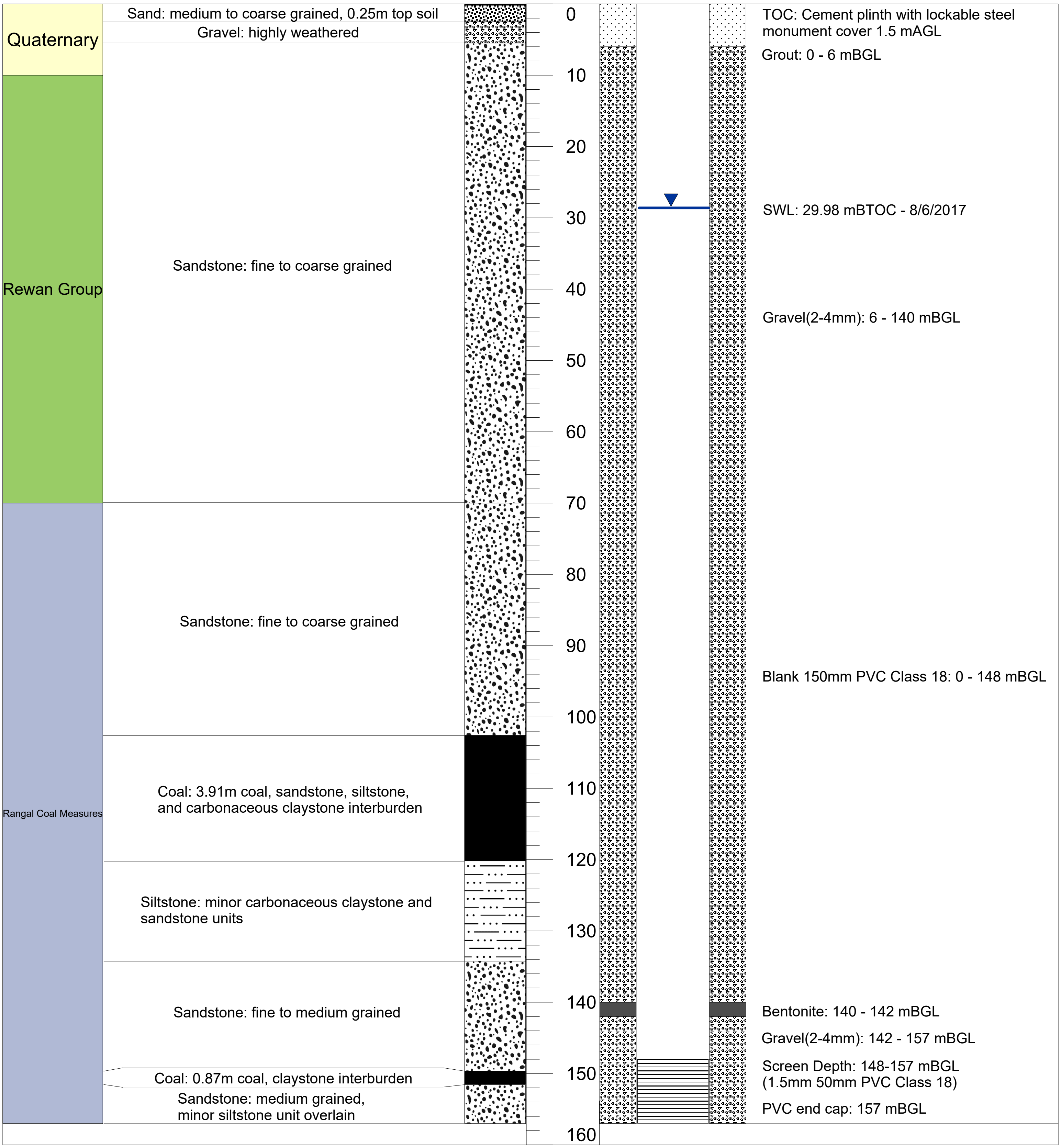
HOLE ID: VE3826P
SITE: GW21D
TD: 157 mBGL
TOC: 162.09 mAHD
EASTING: 661579.53
NORTHING: 7521647.74
DATUM: GDA94 ZONE 55
LONGITUDE: 148.3411
LATITUDE: - 22.2412
ELEVATION: 160.77 mAHD

PROJECT NO.: PEM002
PROJECT NAME: Willunga
DATE DRILLED: 3/11/2016 - 11/11/2016
LOGGED BY: D. HOGAN

DRILLING COMPANY: DEPCO DRILLING
LICENCED DRILLER:
DRILLING METHOD: MUD 0 - 157 mBGL
HOLE DIAMETER: 175mm 0 - 56 mBGL, 125mm 56 - 157 mBGL

Comments: N/A

Stratigraphic Interpretation	Soil or Rock Field Material Description	Graphic Log	Depth (mBGL)	Bore Construction	Bore Description



BORE REPORT

REG NUMBER 162910

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-11-26	**MAP-SCALE**	
OFFICE	Mackay	**SUB-AREA**		**LONGITUDE**	148-22-31	**MAP-SERIES**	
DATE LOG RECD	24-OCT-17	**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	641766	**MAP-NO**	
D/O FILE NO.		**LOT**	11	**NORTHING**	7545427	**MAP NAME**	
R/O FILE NO.		**PLAN**	KL135	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**		**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.19065787	**PARISH NAME**	6000-NO LONGER USED			**ORIGINAL BORE NO**	
GIS LNG	148.37517503	**COUNTY**				**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	29/09/2017			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**	LAGOS, DAMIEN				
ROLES	MM	**DRILL COMPANY**	DEPCO				
		METHOD OF CONST.	ROTARY AIR				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	29/09/2017	1	Polyvinyl Chloride			50	0.00	5.50
A	29/09/2017	2	Perforated or Slotted Casing			50	5.50	20.50
X	29/09/2017	3	Grout			146	0.00	5.00
X	29/09/2017	4	Bentonite Seal			146	5.00	5.50
X	29/09/2017	5	Gravel Pack			146	5.50	20.50

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	1.00	SOIL
2	1.00	5.00	CLAY
3	5.00	19.00	SAND (SOAK)
4	19.00	20.50	CLAY

BORE REPORT

REG NUMBER 162910

STRATIGRAPHY DETAILS
**** NO RECORDS FOUND ****

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	5.50	20.50	SAND			N			N	UC	ISAAC RIVER ALLUVIUM

PUMP TEST DETAILS PART 1
**** NO RECORDS FOUND ****

PUMP TEST DETAILS PART 2
**** NO RECORDS FOUND ****

BORE CONDITION
**** NO RECORDS FOUND ****

ELEVATION DETAILS
**** NO RECORDS FOUND ****

WATER ANALYSIS PART1
**** NO RECORDS FOUND ****

WATER ANALYSIS PART 2
**** NO RECORDS FOUND ****

WATER LEVEL DETAILS
**** NO RECORDS FOUND ****

WIRE LINE LOG DETAILS
**** NO RECORDS FOUND ****

FIELD MEASUREMENTS
**** NO RECORDS FOUND ****

BORE REPORT

REG NUMBER 162910

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

BORE REPORT

**** End of Report. Produced:** 30/01/2018 09:14:20 AM ******

BORE REPORT

REG NUMBER 162917

REGISTRATION DETAILS

		BASIN	1304	LATITUDE	22-10-15	MAP-SCALE	
OFFICE	Mackay	SUB-AREA		LONGITUDE	148-22-17	MAP-SERIES	
DATE LOG RECD	24-OCT-17	SHIRE	3980-ISAAC REGIONAL	EASTING	641386	MAP-NO	
D/O FILE NO.		LOT	11	NORTHING	7547619	MAP NAME	
R/O FILE NO.		PLAN	KL135	ZONE	55	PROG SECTION	
H/O FILE NO.		ORIGINAL DESCRIPTION		ACCURACY		PRES EQUIPMENT	
				GPS ACC			
GIS LAT	-22.17089131	PARISH NAME	6000-NO LONGER USED			ORIGINAL BORE NO	
GIS LNG	148.37129759	COUNTY				BORE LINE	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	DATE DRILLED	01/10/2017			DATA OWNER	
STATUS	Existing	DRILLERS NAME	LAGOS, DAMIEN				
ROLES	MM	DRILL COMPANY	DEPCO				
		METHOD OF CONST.	ROTARY AIR				

CASING DETAILS

**** NO RECORDS FOUND ****

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	1.00	SOIL
2	1.00	6.00	SANDY CLAY
3	6.00	12.00	SAND
4	12.00	15.00	GRAVEL
5	15.00	17.50	CLAY

STRATIGRAPHY DETAILS

**** NO RECORDS FOUND ****

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME

BORE REPORT

REG NUMBER 162917

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	5.50	17.50	SAGR			N			N	UC	ISAAC RIVER ALLUVIUM

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

****** NO RECORDS FOUND ******

WATER ANALYSIS PART1

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

****** NO RECORDS FOUND ******

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

FIELD MEASUREMENTS

****** NO RECORDS FOUND ******

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

BORE REPORT

**** End of Report. Produced:** 30/01/2018 09:09:30 AM ******

BORE REPORT

REG NUMBER 162915

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-10-40	**MAP-SCALE**	
OFFICE	Mackay	**SUB-AREA**		**LONGITUDE**	148-22-23	**MAP-SERIES**	
DATE LOG RECD	24-OCT-17	**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	641566	**MAP-NO**	
D/O FILE NO.		**LOT**	11	**NORTHING**	7546845	**MAP NAME**	
R/O FILE NO.		**PLAN**	KL135	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**		**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.17786721	**PARISH NAME**	6000-NO LONGER USED			**ORIGINAL BORE NO**	
GIS LNG	148.37311093	**COUNTY**				**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	01/10/2017			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**	LAGOS, DAMIEN				
ROLES	MM	**DRILL COMPANY**	DEPCO				
		METHOD OF CONST.	ROTARY AIR				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	01/10/2017	1	Polyvinyl Chloride			50	0.00	5.50
A	01/10/2017	2	Perforated or Slotted Casing			50	5.50	17.50
X	01/10/2017	3	Grout			146	0.00	5.00
X	01/10/2017	4	Bentonite Seal			146	5.00	5.50
X	01/10/2017	5	Gravel Pack			146	5.50	17.50

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	1.00	SOIL
2	1.00	5.00	CLAY
3	5.00	9.00	SANDY CLAY
4	9.00	15.00	SAND

BORE REPORT

REG NUMBER 162915

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
5	15.00	17.50	CLAY

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	5.50	17.50	SAND			N			N	UC	ISAAC RIVER ALLUVIUM

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

****** NO RECORDS FOUND ******

WATER ANALYSIS PART1

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

****** NO RECORDS FOUND ******

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

GROUNDWATER DATABASE

BORE REPORT

REG NUMBER 162915

FIELD MEASUREMENTS

****** NO RECORDS FOUND ******

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

**** End of Report. Produced:** 30/01/2018 09:11:39 AM ******

GROUNDWATER DATABASE

BORE REPORT

REG NUMBER 162916

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-10-24	**MAP-SCALE**	
OFFICE	Mackay	**SUB-AREA**		**LONGITUDE**	148-22-47	**MAP-SERIES**	
DATE LOG RECD	24-OCT-17	**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	642241	**MAP-NO**	
D/O FILE NO.		**LOT**	11	**NORTHING**	7547331	**MAP NAME**	
R/O FILE NO.		**PLAN**	KL135	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**		**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.17342249	**PARISH NAME**	6000-NO LONGER USED			**ORIGINAL BORE NO**	
GIS LNG	148.37961376	**COUNTY**				**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	01/10/2017			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**	LAGOS, DAMIEN				
ROLES	MM	**DRILL COMPANY**	DEPCO				
		METHOD OF CONST.	ROTARY AIR				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	01/10/2017	1	Polyvinyl Chloride			50	0.00	5.50
A	01/10/2017	2	Perforated or Slotted Casing			50	5.50	17.50
X	01/10/2017	3	Grout			146	0.00	5.00
X	01/10/2017	4	Bentonite Seal			146	5.00	5.50
X	01/10/2017	5	Gravel Pack			146	5.50	17.50

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	1.00	SOIL
2	1.00	4.00	CLAY
3	4.00	9.00	SANDY CLAY
4	9.00	17.00	SANDY GRAVEL: SOAK

BORE REPORT

REG NUMBER 162916

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
5	17.00	17.50	CLAY

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	5.50	17.50	SAGR			N			N	UC	ISAAC RIVER ALLUVIUM

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

****** NO RECORDS FOUND ******

WATER ANALYSIS PART1

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

****** NO RECORDS FOUND ******

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

BORE REPORT

REG NUMBER 162916

FIELD MEASUREMENTS

****** NO RECORDS FOUND ******

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

BORE REPORT

**** End of Report. Produced:** 30/01/2018 09:10:35 AM ******

GROUNDWATER DATABASE

BORE REPORT

REG NUMBER 162914

REGISTRATION DETAILS

OFFICE	Mackay	**BASIN**	1304	**LATITUDE**	22-10-44	**MAP-SCALE**	
DATE LOG RECD	24-OCT-17	**SUB-AREA**		**LONGITUDE**	148-22-40	**MAP-SERIES**	
D/O FILE NO.		**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	642055	**MAP-NO**	
R/O FILE NO.		**LOT**	11	**NORTHING**	7546720	**MAP NAME**	
H/O FILE NO.		**PLAN**	KL135	**ZONE**	55	**PROG SECTION**	
		ORIGINAL DESCRIPTION		**ACCURACY**		**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.17895614	**PARISH NAME**	6000-NO LONGER USED			**ORIGINAL BORE NO**	
GIS LNG	148.37786391	**COUNTY**				**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	01/10/2017			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**	LAGOS, DAMIEN				
ROLES	MM	**DRILL COMPANY**	DEPCO				
		METHOD OF CONST.	ROTARY AIR				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	01/10/2017	1	Polyvinyl Chloride			50	0.00	5.50
A	01/10/2017	2	Perforated or Slotted Casing			50	5.50	17.50
X	01/10/2017	3	Grout			146	0.00	5.00
X	01/10/2017	4	Bentonite Seal			146	5.00	5.50
X	01/10/2017	5	Gravel Pack			146	5.50	17.50

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	1.00	SOIL
2	1.00	5.00	CLAY
3	5.00	7.00	SANDY CLAY
4	7.00	15.00	SAND

BORE REPORT

REG NUMBER 162914

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
5	15.00	17.50	CLAY

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	5.50	17.50	SAND			N			N	UC	ISAAC RIVER ALLUVIUM

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

****** NO RECORDS FOUND ******

WATER ANALYSIS PART1

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

****** NO RECORDS FOUND ******

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

BORE REPORT

REG NUMBER **162914**

FIELD MEASUREMENTS

****** NO RECORDS FOUND ******

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

BORE REPORT

**** End of Report. Produced:** 30/01/2018 09:11:08 AM ******

BORE REPORT

REG NUMBER 162909

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-11-13	**MAP-SCALE**	
OFFICE	Mackay	**SUB-AREA**		**LONGITUDE**	148-22-19	**MAP-SERIES**	
DATE LOG RECD	24-OCT-17	**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	641444	**MAP-NO**	
D/O FILE NO.		**LOT**	11	**NORTHING**	7545828	**MAP NAME**	
R/O FILE NO.		**PLAN**	KL135	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**		**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.18706248	**PARISH NAME**	6000-NO LONGER USED			**ORIGINAL BORE NO**	
GIS LNG	148.37201703	**COUNTY**				**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	28/09/2017			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**	LAGOS, DAMIEN				
ROLES	MM	**DRILL COMPANY**	DEPCO				
		METHOD OF CONST.	ROTARY AIR				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	28/09/2017	1	Polyvinyl Chloride			50	0.00	5.50
A	28/09/2017	2	Perforated or Slotted Casing			50	5.50	20.50
X	28/09/2017	3	Grout			146	0.00	5.00
X	28/09/2017	4	Bentonite Seal			146	5.00	5.50
X	28/09/2017	5	Gravel Pack			146	5.50	20.50

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	5.00	CLAY
2	5.00	16.00	SAND
3	16.00	17.00	GRAVEL
4	17.00	19.00	CLAY/GRAVEL

GROUNDWATER DATABASE

BORE REPORT

REG NUMBER 162909

STRATIGRAPHY DETAILS

**** NO RECORDS FOUND ****

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	5.50	20.50	SAGR			N			N	UC	ISAAC RIVER ALLUVIUM

PUMP TEST DETAILS PART 1

**** NO RECORDS FOUND ****

PUMP TEST DETAILS PART 2

**** NO RECORDS FOUND ****

BORE CONDITION

**** NO RECORDS FOUND ****

ELEVATION DETAILS

**** NO RECORDS FOUND ****

WATER ANALYSIS PART1

**** NO RECORDS FOUND ****

WATER ANALYSIS PART 2

**** NO RECORDS FOUND ****

WATER LEVEL DETAILS

**** NO RECORDS FOUND ****

WIRE LINE LOG DETAILS

**** NO RECORDS FOUND ****

FIELD MEASUREMENTS

**** NO RECORDS FOUND ****

REG NUMBER **162909**

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

**** End of Report. Produced:** 30/01/2018 09:15:00 AM ******

BORE REPORT

REG NUMBER 162913

REGISTRATION DETAILS

OFFICE	Mackay	**BASIN**	1304	**LATITUDE**	22-10-56	**MAP-SCALE**	
DATE LOG RECD	24-OCT-17	**SUB-AREA**		**LONGITUDE**	148-22-50	**MAP-SERIES**	
D/O FILE NO.		**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	642341	**MAP-NO**	
R/O FILE NO.		**LOT**	11	**NORTHING**	7546343	**MAP NAME**	
H/O FILE NO.		**PLAN**	KL135	**ZONE**	55	**PROG SECTION**	
		ORIGINAL DESCRIPTION		**ACCURACY**		**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.18233763	**PARISH NAME**	6000-NO LONGER USED			**ORIGINAL BORE NO**	
GIS LNG	148.38067062	**COUNTY**				**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	01/10/2017			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**	LAGOS, DAMIEN				
ROLES	MM	**DRILL COMPANY**	DEPCO				
		METHOD OF CONST.	ROTARY AIR				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	01/10/2017	1	Polyvinyl Chloride			50	0.00	6.00
A	01/10/2017	2	Perforated or Slotted Casing			50	6.00	15.00
X	01/10/2017	3	Grout			146	0.00	5.00
X	01/10/2017	4	Bentonite Seal			146	5.00	6.00
X	01/10/2017	5	Gravel Pack			146	6.00	15.00

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	1.00	SOIL
2	1.00	5.00	CLAY
3	5.00	12.50	SAND
4	12.50	15.00	CLAY

GROUNDWATER DATABASE

BORE REPORT

REG NUMBER 162913

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	6.00	15.00	SAND			N			N	UC	ISAAC RIVER ALLUVIUM

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

****** NO RECORDS FOUND ******

WATER ANALYSIS PART1

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

****** NO RECORDS FOUND ******

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

FIELD MEASUREMENTS

****** NO RECORDS FOUND ******

BORE REPORT

REG NUMBER 162913

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

BORE REPORT

**** End of Report. Produced:** 30/01/2018 09:12:29 AM ******

BORE REPORT

REG NUMBER 162912

REGISTRATION DETAILS

		BASIN	1304	LATITUDE	22-11-06	MAP-SCALE	
OFFICE	Mackay	SUB-AREA		LONGITUDE	148-22-58	MAP-SERIES	
DATE LOG RECD	24-OCT-17	SHIRE	3980-ISAAC REGIONAL	EASTING	642551	MAP-NO	
D/O FILE NO.		LOT	11	NORTHING	7546036	MAP NAME	
R/O FILE NO.		PLAN	KL135	ZONE	55	PROG SECTION	
H/O FILE NO.		ORIGINAL DESCRIPTION		ACCURACY		PRES EQUIPMENT	
				GPS ACC			
GIS LAT	-22.18509309	PARISH NAME	6000-NO LONGER USED			ORIGINAL BORE NO	
GIS LNG	148.38273425	COUNTY				BORE LINE	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	DATE DRILLED	29/09/2017			DATA OWNER	
STATUS	Existing	DRILLERS NAME	LAGOS, DAMIEN				
ROLES	MM	DRILL COMPANY	DEPCO				
		METHOD OF CONST.	ROTARY AIR				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	29/09/2017	1	Polyvinyl Chloride			50	0.00	5.50
A	29/09/2017	2	Perforated or Slotted Casing			50	5.50	24.00
X	29/09/2017	3	Grout			146	0.00	5.00
X	29/09/2017	4	Bentonite Seal			146	5.00	5.50
X	29/09/2017	5	Gravel Pack			146	5.50	24.00

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	1.00	SOIL
2	1.00	6.00	CLAY
3	6.00	21.00	SAND
4	21.00	24.00	CLAY

BORE REPORT

REG NUMBER 162912

STRATIGRAPHY DETAILS

**** NO RECORDS FOUND ****

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	5.50	24.00	SAND CLAY			N			N	UC	ISAAC RIVER ALLUVIUM

PUMP TEST DETAILS PART 1

**** NO RECORDS FOUND ****

PUMP TEST DETAILS PART 2

**** NO RECORDS FOUND ****

BORE CONDITION

**** NO RECORDS FOUND ****

ELEVATION DETAILS

**** NO RECORDS FOUND ****

WATER ANALYSIS PART1

**** NO RECORDS FOUND ****

WATER ANALYSIS PART 2

**** NO RECORDS FOUND ****

WATER LEVEL DETAILS

**** NO RECORDS FOUND ****

WIRE LINE LOG DETAILS

**** NO RECORDS FOUND ****

FIELD MEASUREMENTS

**** NO RECORDS FOUND ****

REG NUMBER **162912**

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

BORE REPORT

**** End of Report. Produced:** 30/01/2018 09:12:59 AM ******

BORE REPORT

REG NUMBER 162911

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-11-29	**MAP-SCALE**	
OFFICE	Mackay	**SUB-AREA**		**LONGITUDE**	148-22-55	**MAP-SERIES**	
DATE LOG RECD	24-OCT-17	**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	642454	**MAP-NO**	
D/O FILE NO.		**LOT**	11	**NORTHING**	7545333	**MAP NAME**	
R/O FILE NO.		**PLAN**	KL135	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**		**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.19145038	**PARISH NAME**	6000-NO LONGER USED			**ORIGINAL BORE NO**	
GIS LNG	148.38185567	**COUNTY**				**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	29/09/2017			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**	LAGOS, DAMIEN				
ROLES	MM	**DRILL COMPANY**	DEPCO				
		METHOD OF CONST.	ROTARY AIR				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	29/09/2017	1	Polyvinyl Chloride			50	0.00	5.50
A	29/09/2017	2	Perforated or Slotted Casing			50	5.50	14.50
X	29/09/2017	3	Grout			146	0.00	5.00
X	29/09/2017	4	Bentonite Seal			146	5.00	5.50
X	29/09/2017	5	Gravel Pack			146	5.50	14.50

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	1.00	SOIL
2	1.00	5.00	CLAY
3	5.00	7.00	SANDY CLAY
4	7.00	12.00	SAND

BORE REPORT

REG NUMBER 162911

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
5	12.00	14.50	CLAY

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	5.50	14.50	SAND			N			N	UC	ISAAC RIVER ALLUVIUM
			CLAY								

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

****** NO RECORDS FOUND ******

WATER ANALYSIS PART1

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

****** NO RECORDS FOUND ******

WIRE LINE LOG DETAILS

BORE REPORT

REG NUMBER 162911

****** NO RECORDS FOUND ******

FIELD MEASUREMENTS

****** NO RECORDS FOUND ******

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

**** End of Report. Produced:** 30/01/2018 09:13:36 AM ******

Attachment A2 – Water Quality Data

CERTIFICATE OF ANALYSIS

Work Order	: **EB1720395**	Page	: 1 of 11
Client	: **PEMBROKE RESOURCES SOUTH PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR ROHAN LAST	Contact	: Customer Services EB
Address	: LEVEL 21 50 BRIDGE STREET SYDNEY NSW, AUSTRALIA 2000	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 02 9037 4708	Telephone	: +61-7-3243 7222
Project	: ENRS0600	Date Samples Received	: 05-Oct-2017 09:20
Order number	: ENRS0600	Date Analysis Commenced	: 09-Oct-2017
C-O-C number	: ----	Issue Date	: 13-Oct-2017 13:31
Sampler	: ML & TF		
Site	: PEMBROKE - OLIVE DOWNS		
Quote number	: BNBQ/333/16		
No. of samples received	: 9		
No. of samples analysed	: 9		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Andrew Epps	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Diana Mesa	2IC Organic Chemist	Brisbane Organics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Tom Maloney	Nutrients Section Supervisor	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EG035T (Total Mercury): Positive results for Mercury have been confirmed by re-extraction and re-analysis.
- It is recognised that EG020-T (Total Metals by ICP-MS) is less than EG020-F (Dissolved Metals by ICP-MS) for some samples. However, the difference is within experimental variation of the methods.
- EK061G (Total Kjeldahl Nitrogen as N): Sample EB1720395_004 (GW12) was diluted due to matrix interference. LOR adjusted accordingly.
- The presence of high SO4 may bias the EC low.
- TDS by method EA-015 may bias high due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	GW1s	GW2	GW2s	GW12	GW18
			Client sampling date / time	01-Oct-2017 00:00	01-Oct-2017 00:00	01-Oct-2017 00:00	01-Oct-2017 00:00	03-Oct-2017 00:00
Compound	CAS Number	LOR	Unit	EB1720395-001	EB1720395-002	EB1720395-003	EB1720395-004	EB1720395-005
				Result	Result	Result	Result	Result
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**201**	**7300**	**26100**	**17600**	**7020**
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	**22**	<5	**1580**	**12**	**11**
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	**89**	**1360**	**7670**	**4240**	**616**
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**130**	**306**	**458**	**608**	**222**
Total Alkalinity as CaCO3	----	1	mg/L	**130**	**306**	**458**	**608**	**222**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**5**	<1	**1530**	**1330**	**12**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**35**	**4520**	**11100**	**9290**	**4290**
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**19**	**342**	**977**	**422**	**151**
Magnesium	7439-95-4	1	mg/L	**10**	**122**	**1270**	**774**	**58**
Sodium	7440-23-5	1	mg/L	**45**	**2270**	**4910**	**5110**	**2460**
Potassium	7440-09-7	1	mg/L	**3**	**14**	**14**	**36**	**9**
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	**0.02**
Arsenic	7440-38-2	0.001	mg/L	<0.001	**0.008**	<0.001	<0.001	**0.002**
Boron	7440-42-8	0.05	mg/L	<0.05	**0.19**	**0.55**	**1.58**	**0.22**
Barium	7440-39-3	0.001	mg/L	**0.233**	**21.2**	**0.180**	**0.045**	**7.14**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	**0.0004**	**0.0001**	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	**0.003**	**0.016**	**0.003**	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	**0.005**	<0.001
Copper	7440-50-8	0.001	mg/L	**0.057**	**0.005**	**0.175**	**0.159**	<0.001
Manganese	7439-96-5	0.001	mg/L	**0.116**	**3.12**	**1.67**	**0.007**	**0.161**
Nickel	7440-02-0	0.001	mg/L	**0.003**	**0.005**	**0.076**	**0.017**	**0.003**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	GW1s	GW2	GW2s	GW12	GW18
			Client sampling date / time	01-Oct-2017 00:00	01-Oct-2017 00:00	01-Oct-2017 00:00	01-Oct-2017 00:00	03-Oct-2017 00:00
Compound	CAS Number	LOR	Unit	EB1720395-001	EB1720395-002	EB1720395-003	EB1720395-004	EB1720395-005
				Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued								
Zinc	7440-66-6	0.005	mg/L	**0.011**	**0.310**	**0.029**	**0.039**	**0.028**
Molybdenum	7439-98-7	0.001	mg/L	<0.001	**0.002**	**0.002**	**0.001**	**0.010**
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	**0.021**	**0.009**	<0.001
Iron	7439-89-6	0.05	mg/L	**0.15**	**5.97**	<0.05	<0.05	**0.13**
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.21**	<0.01	**25.9**	**0.11**	**0.21**
Arsenic	7440-38-2	0.001	mg/L	<0.001	**0.009**	**0.007**	<0.001	**0.003**
Boron	7440-42-8	0.05	mg/L	**0.05**	**0.23**	**0.65**	**1.75**	**0.28**
Barium	7440-39-3	0.001	mg/L	**0.241**	**21.1**	**0.618**	**0.046**	**7.24**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	**0.005**	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	**0.0006**	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	**0.003**	**0.106**	**0.004**	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	**0.044**	**0.008**	<0.001
Copper	7440-50-8	0.001	mg/L	**0.092**	**0.002**	**0.531**	**0.182**	**0.005**
Manganese	7439-96-5	0.001	mg/L	**0.142**	**3.38**	**3.40**	**0.012**	**0.178**
Nickel	7440-02-0	0.001	mg/L	**0.004**	**0.007**	**0.249**	**0.018**	**0.004**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	**0.020**	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	**0.08**	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	**0.006**	**0.344**	**0.442**	**0.034**	**0.055**
Molybdenum	7439-98-7	0.001	mg/L	<0.001	**0.003**	**0.002**	**0.001**	**0.014**
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	**0.024**	**0.010**	<0.001
Iron	7439-89-6	0.05	mg/L	**0.36**	**6.27**	**52.6**	**0.26**	**0.45**
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	**0.0002**	<0.0001
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.1**	**0.1**	**0.6**	**0.4**	**0.4**
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	<0.01	**4.52**	**0.09**	**0.01**	**4.27**
EK057G: Nitrite as N by Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	GW1s	GW2	GW2s	GW12	GW18
			Client sampling date / time	01-Oct-2017 00:00	01-Oct-2017 00:00	01-Oct-2017 00:00	01-Oct-2017 00:00	03-Oct-2017 00:00
Compound	CAS Number	LOR	Unit	EB1720395-001	EB1720395-002	EB1720395-003	EB1720395-004	EB1720395-005
				Result	Result	Result	Result	Result
EK057G: Nitrite as N by Discrete Analyser - Continued								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.03**	<0.01	**0.28**	**0.04**	**0.16**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.03**	<0.01	**0.28**	**0.04**	**0.16**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.3**	**5.9**	**2.3**	<0.5	**4.8**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	**0.3**	**5.9**	**2.6**	<0.5	**5.0**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.02**	**0.17**	**1.29**	**0.05**	**0.08**
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	**0.02**	**0.13**	**0.04**	**0.01**	**0.05**
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L	<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
C29 - C36 Fraction	----	50	µg/L	<50	<50	<50	<50	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L	<50	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	<20	<20	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L	<20	<20	<20	<20	<20
>C10 - C16 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
>C34 - C40 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
^ >C10 - C40 Fraction (sum)	----	100	µg/L	<100	<100	<100	<100	<100
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L	<100	<100	<100	<100	<100
EP080: BTEXN								
Benzene	71-43-2	1	µg/L	<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L	<2	<2	<2	<2	**7**
Ethylbenzene	100-41-4	2	µg/L	<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	<2	<2	<2

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	GW1s	GW2	GW2s	GW12	GW18
			Client sampling date / time	01-Oct-2017 00:00	01-Oct-2017 00:00	01-Oct-2017 00:00	01-Oct-2017 00:00	03-Oct-2017 00:00
Compound	CAS Number	LOR	Unit	EB1720395-001	EB1720395-002	EB1720395-003	EB1720395-004	EB1720395-005
				Result	Result	Result	Result	Result
EP080: BTEXN - Continued								
ortho-Xylene	95-47-6	2	µg/L	<2	<2	<2	<2	<2
^ Total Xylenes	1330-20-7	2	µg/L	<2	<2	<2	<2	<2
^ Sum of BTEX	----	1	µg/L	<1	<1	<1	<1	7
Naphthalene	91-20-3	5	µg/L	<5	<5	<5	<5	<5
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	2	%	115	119	122	117	118
Toluene-D8	2037-26-5	2	%	96.6	98.1	97.0	97.2	95.2
4-Bromofluorobenzene	460-00-4	2	%	91.8	93.4	89.8	92.6	90.2

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	GW18s	GW21	GW21s	GW25	----
			Client sampling date / time	03-Oct-2017 00:00	03-Oct-2017 00:00	03-Oct-2017 00:00	03-Oct-2017 00:00	----
Compound	CAS Number	LOR	Unit	EB1720395-006	EB1720395-007	EB1720395-008	EB1720395-009	--------
				Result	Result	Result	Result	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**1910**	**11200**	**1460**	**16500**	----
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	**56**	**6**	**295**	**11**	----
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	**847**	**6970**	**264**	**7010**	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**769**	**446**	**304**	**442**	----
Total Alkalinity as CaCO3	----	1	mg/L	**769**	**446**	**304**	**442**	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**180**	**364**	**74**	**373**	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**664**	**9500**	**606**	**9810**	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**115**	**1150**	**53**	**1160**	----
Magnesium	7439-95-4	1	mg/L	**136**	**996**	**32**	**1000**	----
Sodium	7440-23-5	1	mg/L	**475**	**3220**	**415**	**3290**	----
Potassium	7440-09-7	1	mg/L	<1	**19**	**2**	**19**	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Arsenic	7440-38-2	0.001	mg/L	**0.002**	<0.001	**0.003**	<0.001	----
Boron	7440-42-8	0.05	mg/L	**0.24**	**0.34**	**1.07**	**0.35**	----
Barium	7440-39-3	0.001	mg/L	**0.180**	**0.408**	**0.181**	**0.407**	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
Cobalt	7440-48-4	0.001	mg/L	**0.003**	<0.001	**0.013**	<0.001	----
Chromium	7440-47-3	0.001	mg/L	**0.001**	**0.001**	<0.001	**0.002**	----
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Manganese	7439-96-5	0.001	mg/L	**0.176**	**0.406**	**1.18**	**0.417**	----
Nickel	7440-02-0	0.001	mg/L	**0.014**	**0.026**	**0.049**	**0.025**	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	GW18s	GW21	GW21s	GW25	----
			Client sampling date / time	03-Oct-2017 00:00	03-Oct-2017 00:00	03-Oct-2017 00:00	03-Oct-2017 00:00	----
Compound	CAS Number	LOR	Unit	EB1720395-006	EB1720395-007	EB1720395-008	EB1720395-009	--------
				Result	Result	Result	Result	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Zinc	7440-66-6	0.005	mg/L	**0.022**	**0.011**	<0.005	**0.012**	----
Molybdenum	7439-98-7	0.001	mg/L	**0.002**	<0.001	**0.001**	<0.001	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Uranium	7440-61-1	0.001	mg/L	**0.012**	**0.002**	**0.001**	**0.002**	----
Iron	7439-89-6	0.05	mg/L	**0.09**	**0.15**	<0.05	**0.15**	----
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.63**	**0.02**	**29.8**	**0.03**	----
Arsenic	7440-38-2	0.001	mg/L	**0.004**	**0.001**	**0.009**	**0.002**	----
Boron	7440-42-8	0.05	mg/L	**0.27**	**0.40**	**1.20**	**0.43**	----
Barium	7440-39-3	0.001	mg/L	**0.189**	**0.570**	**0.353**	**0.811**	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	**0.002**	<0.001	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	**0.0004**	<0.0001	----
Cobalt	7440-48-4	0.001	mg/L	**0.005**	<0.001	**0.056**	<0.001	----
Chromium	7440-47-3	0.001	mg/L	**0.005**	**0.002**	**0.073**	**0.006**	----
Copper	7440-50-8	0.001	mg/L	**0.012**	**0.002**	**0.450**	**0.002**	----
Manganese	7439-96-5	0.001	mg/L	**0.219**	**0.966**	**1.50**	**1.50**	----
Nickel	7440-02-0	0.001	mg/L	**0.016**	**0.023**	**0.192**	**0.022**	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	**0.022**	<0.001	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	**0.08**	<0.01	----
Zinc	7440-66-6	0.005	mg/L	**0.023**	**0.139**	**0.104**	**0.129**	----
Molybdenum	7439-98-7	0.001	mg/L	**0.002**	<0.001	<0.001	<0.001	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	**0.001**	<0.001	----
Uranium	7440-61-1	0.001	mg/L	**0.014**	**0.002**	**0.002**	**0.002**	----
Iron	7439-89-6	0.05	mg/L	**1.93**	**0.26**	**32.8**	**0.30**	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.8**	**0.2**	**0.7**	**0.2**	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.40**	**0.34**	**0.16**	**0.57**	----
EK057G: Nitrite as N by Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	GW18s	GW21	GW21s	GW25	----
			Client sampling date / time	03-Oct-2017 00:00	03-Oct-2017 00:00	03-Oct-2017 00:00	03-Oct-2017 00:00	----
Compound	CAS Number	LOR	Unit	EB1720395-006	EB1720395-007	EB1720395-008	EB1720395-009	--------
				Result	Result	Result	Result	----
EK057G: Nitrite as N by Discrete Analyser - Continued								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.62**	**0.18**	**0.89**	**0.09**	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.62**	**0.18**	**0.89**	**0.09**	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.3**	**0.6**	**0.3**	**0.8**	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	**0.9**	**0.8**	**1.2**	**0.9**	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.17**	**0.13**	**0.12**	**0.10**	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	**0.10**	**0.13**	**0.03**	**0.07**	----
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	**140**	<20	**100**	----
C10 - C14 Fraction	----	50	µg/L	<50	<50	<50	<50	----
C15 - C28 Fraction	----	100	µg/L	<100	<100	<100	<100	----
C29 - C36 Fraction	----	50	µg/L	<50	<50	<50	<50	----
^ C10 - C36 Fraction (sum)	----	50	µg/L	<50	<50	<50	<50	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	20	µg/L	<20	**140**	<20	**100**	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L	<20	**140**	<20	**100**	----
>C10 - C16 Fraction	----	100	µg/L	<100	<100	<100	<100	----
>C16 - C34 Fraction	----	100	µg/L	<100	<100	<100	<100	----
>C34 - C40 Fraction	----	100	µg/L	<100	<100	<100	<100	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L	<100	<100	<100	<100	----
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L	<100	<100	<100	<100	----
EP080: BTEXN								
Benzene	71-43-2	1	µg/L	<1	<1	<1	<1	----
Toluene	108-88-3	2	µg/L	**3**	**3**	<2	**3**	----
Ethylbenzene	100-41-4	2	µg/L	<2	<2	<2	<2	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	<2	<2	----

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

			Client sample ID	GW18s	GW21	GW21s	GW25	----
			Client sampling date / time	03-Oct-2017 00:00	03-Oct-2017 00:00	03-Oct-2017 00:00	03-Oct-2017 00:00	----
Compound	CAS Number	LOR	Unit	EB1720395-006	EB1720395-007	EB1720395-008	EB1720395-009	--------
				Result	Result	Result	Result	----
EP080: BTEXN - Continued								
ortho-Xylene	95-47-6	2	µg/L	<2	<2	<2	<2	----
^ **Total Xylenes**	1330-20-7	2	µg/L	<2	<2	<2	<2	----
^ **Sum of BTEX**	----	1	µg/L	**3**	**3**	<1	**3**	----
Naphthalene	91-20-3	5	µg/L	<5	<5	<5	<5	----
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	2	%	**118**	**118**	**116**	**119**	----
Toluene-D8	2037-26-5	2	%	**95.4**	**93.7**	**95.3**	**96.7**	----
4-Bromofluorobenzene	460-00-4	2	%	**88.0**	**97.8**	**91.1**	**100**	----

Surrogate Control Limits

Sub-Matrix: **WATER**

Compound	*CAS Number*	*Recovery Limits (%)* Low	High
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	66	138
Toluene-D8	2037-26-5	79	120
4-Bromofluorobenzene	460-00-4	74	118

ENRS
Environment & Natural Resource Solutions

Chain of Custody

ALS

☐SYDNEY 277-289
Ph: 02 8784 8555 E:
☐NOWRA 4/13 Ge
Ph: 02 4423 2063 E
☐WOLLONGONG
Ph: 02 4225 3125

Environmental Division
Brisbane
Work Order Reference
EB1720395

Telephone : + 61-7-3243 7222

CLIENT:	Pembroke Resources Pty Ltd	TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)	☒ Standard TAT (List due date): ☐ Non Standard or urgent TAT (List due date):
OFFICE:	21/50 Bridge St, Sydney NSW 2000		
PROJECT NO./PO:	ENRS0600	ALS QUOTE NO.:	PEMRES
SITE/DESCRIPTION:	Pembroke - Olive Downs	COUNTRY OF ORIGIN:	
PROJECT MANAGER:	Rohan Last	CONTACT PH:	02 9037 4708
SAMPLER:	ML & TF	SAMPLER MOBILE:	0401518443
COC Emailed to ALS? (YES / NO)		EDD FORMAT (or default):	
Email Reports to (will default to PM if no other addresses are listed):	tmackillop@resourcestrategies.com.au lab@enrs.com.au		
Email Invoice to (will default to PM if no other addresses are listed):			

COC SEQUENCE NUMBER (Circle)

COC:	1	2	3	4	5	6	7
OF:	1	2	3	4	5	6	7

FOR LABORATORY USE ONL
Custody Seal Intact?
Free ice / frozen ice bricks present
Random Sample Temperature on R
Other comment:

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:
[signature]		
DATE/TIME: 4/10/2017	DATE/TIME:	DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION	ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).										Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TRH (C6-C40)	W-3T (Total 15 metals)	W-3 (Dissolved 15 metals)	Total Metals: Al, Fe, Co, Mo, Se, Ag, U	Dissolved Metals: Al, Fe, Co, Mo, Se, Ag, U	NT-8A (NO2, NO3, NH3, TN, TP, PO3)	NT-1D (Major Ions (Ca, Mg, Na, K) + Hardness)	NT-2A (F, S04, Cl, Alkalinity)	TSS	Total Dissolved Solids (TDS) by gravimetic analysis	Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
	GW1s	1/10/2017	GW	Bottles	1	1	1	1	1	1	1	1	1	1	
	GW2	1/10/2017	GW	Bottles	1	1	1	1	1	1	1	1	1	1	
	GW2s	1/10/2017	GW	Bottles	1	1	1	1	1	1	1	1	1	1	
	GW12	1/10/2017	GW	Bottles	1	1	1	1	1	1	1	1	1	1	
	GW18	3/10/2017	GW	Bottles	1	1	1	1	1	1	1	1	1	1	
	GW18s	3/10/2017	GW	Bottles	1	1	1	1	1	1	1	1	1	1	
	GW21	3/10/2017	GW	Bottles	1	1	1	1	1	1	1	1	1	1	
	GW21s	3/10/2017	GW	Bottles	1	1	1	1	1	1	1	1	1	1	
	GW25	3/10/2017	GW	Bottles	1	1	1	1	1	1	1	1	1	1	
				TOTAL		9	9	9	9	9	9	9	9	9	

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; LI = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EB1720395**	Page	: 1 of 14
Client	: **PEMBROKE RESOURCES SOUTH PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR ROHAN LAST	Telephone	: +61-7-3243 7222
Project	: ENRS0600	Date Samples Received	: 05-Oct-2017
Site	: PEMBROKE - OLIVE DOWNS	Issue Date	: 13-Oct-2017
Sampler	: ML & TF	No. of samples received	: 9
Order number	: ENRS0600	No. of samples analysed	: 9

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **Matrix Spike outliers exist - please see following pages for full details.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
ED045G: Chloride by Discrete Analyser	EB1720395--002	GW2	**Chloride**	16887-00-6	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EG020F: Dissolved Metals by ICP-MS	EB1720395--002	GW2	**Barium**	7440-39-3	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EG020F: Dissolved Metals by ICP-MS	EB1720395--002	GW2	**Manganese**	7439-96-5	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EK055G: Ammonia as N by Discrete Analyser	EB1720395--002	GW2	**Ammonia as N**	7664-41-7	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser	EB1719266--002	Anonymous	**Total Kjeldahl Nitrogen as N**	----	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method		Extraction / Preparation			Analysis		
Container / Client Sample ID(s)		*Date extracted*	*Due for extraction*	***Days overdue***	*Date analysed*	*Due for analysis*	***Days overdue***
EA015: Total Dissolved Solids dried at 180 ± 5 °C							
Clear Plastic Bottle - Natural							
GW1s, GW2s,	GW2, GW12	----	----	----	09-Oct-2017	08-Oct-2017	**1**
EA025: Total Suspended Solids dried at 104 ± 2°C							
Clear Plastic Bottle - Natural							
GW1s, GW2s,	GW2, GW12	----	----	----	09-Oct-2017	08-Oct-2017	**1**
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural							
GW1s, GW2s,	GW2, GW12	----	----	----	09-Oct-2017	03-Oct-2017	**6**
Clear Plastic Bottle - Natural							
GW18, GW21, GW25	GW18s, GW21s,	----	----	----	09-Oct-2017	05-Oct-2017	**4**
EK071G: Reactive Phosphorus as P by discrete analyser							

Matrix: **WATER**

Method / Container / Client Sample ID(s)		Extraction / Preparation: Date extracted	Due for extraction	Days overdue	Analysis: Date analysed	Due for analysis	Days overdue
EK071G: Reactive Phosphorus as P by discrete analyser - Analysis Holding Time Compliance							
Clear Plastic Bottle - Natural							
GW1s,	GW2,	----	----	----	09-Oct-2017	03-Oct-2017	**6**
GW2s,	GW12						
Clear Plastic Bottle - Natural							
GW18,	GW18s,	----	----	----	09-Oct-2017	05-Oct-2017	**4**
GW21,	GW21s,						
GW25							
EP080/071: Total Petroleum Hydrocarbons							
Amber Glass Bottle - Unpreserved							
GW1s,	GW2,	09-Oct-2017	08-Oct-2017	**1**	----	----	----
GW2s,	GW12						
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions							
Amber Glass Bottle - Unpreserved							
GW1s,	GW2,	09-Oct-2017	08-Oct-2017	**1**	----	----	----
GW2s,	GW12						

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type / Method	Count: QC	Count: Regular	Rate (%): Actual	Rate (%): Expected	Quality Control Specification
Laboratory Duplicates (DUP)					
TRH - Semivolatile Fraction	0	16	0.00	10.00	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)					
TRH - Semivolatile Fraction	0	16	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation: Date extracted	Due for extraction	Evaluation	Analysis: Date analysed	Due for analysis	Evaluation

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation: Date extracted	Due for extraction	Evaluation	Analysis: Date analysed	Due for analysis	Evaluation
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Clear Plastic Bottle - Natural (EA015H)								
GW1s, GW2s,	GW2, GW12	**01-Oct-2017**	**----**	----	----	**09-Oct-2017**	08-Oct-2017	×
Clear Plastic Bottle - Natural (EA015H)								
GW18, GW21, GW25	GW18s, GW21s,	**03-Oct-2017**	**----**	----	----	**09-Oct-2017**	10-Oct-2017	✓
EA025: Total Suspended Solids dried at 104 ± 2°C								
Clear Plastic Bottle - Natural (EA025H)								
GW1s, GW2s,	GW2, GW12	**01-Oct-2017**	**----**	----	----	**09-Oct-2017**	08-Oct-2017	×
Clear Plastic Bottle - Natural (EA025H)								
GW18, GW21, GW25	GW18s, GW21s,	**03-Oct-2017**	**----**	----	----	**09-Oct-2017**	10-Oct-2017	✓
EA065: Total Hardness as CaCO3								
Clear Plastic Bottle - Filtered; Lab-acidified (ED093F)								
GW1s, GW2s,	GW2, GW12	**01-Oct-2017**	**----**	----	----	**12-Oct-2017**	29-Oct-2017	✓
Clear Plastic Bottle - Filtered; Lab-acidified (ED093F)								
GW18, GW21, GW25	GW18s, GW21s,	**03-Oct-2017**	**----**	----	----	**12-Oct-2017**	31-Oct-2017	✓
ED037P: Alkalinity by PC Titrator								
Clear Plastic Bottle - Natural (ED037-P)								
GW1s, GW2s,	GW2, GW12	**01-Oct-2017**	**----**	----	----	**10-Oct-2017**	15-Oct-2017	✓
Clear Plastic Bottle - Natural (ED037-P)								
GW18, GW21, GW25	GW18s, GW21s,	**03-Oct-2017**	**----**	----	----	**10-Oct-2017**	17-Oct-2017	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Clear Plastic Bottle - Natural (ED041G)								
GW1s, GW2s,	GW2, GW12	**01-Oct-2017**	**----**	----	----	**09-Oct-2017**	29-Oct-2017	✓
Clear Plastic Bottle - Natural (ED041G)								
GW18, GW21, GW25	GW18s, GW21s,	**03-Oct-2017**	**----**	----	----	**09-Oct-2017**	31-Oct-2017	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation: Date extracted	Due for extraction	Evaluation	Analysis: Date analysed	Due for analysis	Evaluation
ED045G: Chloride by Discrete Analyser								
Clear Plastic Bottle - Natural (ED045G) GW1s, GW2s,	GW2, GW12	**01-Oct-2017**	**----**	----	----	**09-Oct-2017**	29-Oct-2017	✓
Clear Plastic Bottle - Natural (ED045G) GW18, GW21, GW25	GW18s, GW21s,	**03-Oct-2017**	**----**	----	----	**09-Oct-2017**	31-Oct-2017	✓
ED093F: Dissolved Major Cations								
Clear Plastic Bottle - Filtered; Lab-acidified (ED093F) GW1s, GW2s,	GW2, GW12	**01-Oct-2017**	**----**	----	----	**12-Oct-2017**	29-Oct-2017	✓
Clear Plastic Bottle - Filtered; Lab-acidified (ED093F) GW18, GW21, GW25	GW18s, GW21s,	**03-Oct-2017**	**----**	----	----	**12-Oct-2017**	31-Oct-2017	✓
EG020F: Dissolved Metals by ICP-MS								
Clear Plastic Bottle - Filtered; Lab-acidified (EG020B-F) GW1s, GW2s,	GW2, GW12	**01-Oct-2017**	**----**	----	----	**12-Oct-2017**	30-Mar-2018	✓
Clear Plastic Bottle - Filtered; Lab-acidified (EG020B-F) GW18, GW21, GW25	GW18s, GW21s,	**03-Oct-2017**	**----**	----	----	**12-Oct-2017**	01-Apr-2018	✓
EG020T: Total Metals by ICP-MS								
Clear Plastic Bottle - Unfiltered; Lab-acidified (EG020B-T) GW1s, GW2s,	GW2, GW12	**01-Oct-2017**	**10-Oct-2017**	30-Mar-2018	✓	**10-Oct-2017**	30-Mar-2018	✓
Clear Plastic Bottle - Unfiltered; Lab-acidified (EG020B-T) GW18, GW21, GW25	GW18s, GW21s,	**03-Oct-2017**	**10-Oct-2017**	01-Apr-2018	✓	**10-Oct-2017**	01-Apr-2018	✓
EG035F: Dissolved Mercury by FIMS								
Clear Plastic Bottle - Filtered; Lab-acidified (EG035F) GW1s, GW2s,	GW2, GW12	**01-Oct-2017**	**----**	----	----	**12-Oct-2017**	29-Oct-2017	✓
Clear Plastic Bottle - Filtered; Lab-acidified (EG035F) GW18, GW21, GW25	GW18s, GW21s,	**03-Oct-2017**	**----**	----	----	**12-Oct-2017**	31-Oct-2017	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation: Date extracted	Due for extraction	Evaluation	Analysis: Date analysed	Due for analysis	Evaluation
EG035T: Total Recoverable Mercury by FIMS							
Clear Plastic Bottle - Unfiltered; Lab-acidified (EG035T) GW1s, GW2, GW2s, GW12	**01-Oct-2017**	----	----	----	**10-Oct-2017**	29-Oct-2017	✓
Clear Plastic Bottle - Unfiltered; Lab-acidified (EG035T) GW18, GW18s, GW21, GW21s, GW25	**03-Oct-2017**	----	----	----	**10-Oct-2017**	31-Oct-2017	✓
EK040P: Fluoride by PC Titrator							
Clear Plastic Bottle - Natural (EK040P) GW1s, GW2, GW2s, GW12	**01-Oct-2017**	----	----	----	**10-Oct-2017**	29-Oct-2017	✓
Clear Plastic Bottle - Natural (EK040P) GW18, GW18s, GW21, GW21s, GW25	**03-Oct-2017**	----	----	----	**10-Oct-2017**	31-Oct-2017	✓
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G) GW1s, GW2, GW2s, GW12	**01-Oct-2017**	----	----	----	**09-Oct-2017**	29-Oct-2017	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G) GW18, GW18s, GW21, GW21s, GW25	**03-Oct-2017**	----	----	----	**10-Oct-2017**	31-Oct-2017	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G) GW1s, GW2, GW2s, GW12	**01-Oct-2017**	----	----	----	**09-Oct-2017**	03-Oct-2017	×
Clear Plastic Bottle - Natural (EK057G) GW18, GW18s, GW21, GW21s, GW25	**03-Oct-2017**	----	----	----	**09-Oct-2017**	05-Oct-2017	×
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G) GW1s, GW2, GW2s, GW12	**01-Oct-2017**	----	----	----	**09-Oct-2017**	29-Oct-2017	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G) GW18, GW18s, GW21, GW21s, GW25	**03-Oct-2017**	----	----	----	**10-Oct-2017**	31-Oct-2017	✓

Matrix: **WATER**

Evaluation: ✘ = Holding time breach ; ✓ = Within holding time.

Method	Sample Date	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G) GW1s, GW2, GW2s, GW12	**01-Oct-2017**	**11-Oct-2017**	29-Oct-2017	✓	**11-Oct-2017**	29-Oct-2017	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G) GW18, GW18s, GW21, GW21s, GW25	**03-Oct-2017**	**11-Oct-2017**	31-Oct-2017	✓	**11-Oct-2017**	31-Oct-2017	✓
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK067G) GW1s, GW2, GW2s, GW12	**01-Oct-2017**	**11-Oct-2017**	29-Oct-2017	✓	**11-Oct-2017**	29-Oct-2017	✓
Clear Plastic Bottle - Sulfuric Acid (EK067G) GW18, GW18s, GW21, GW21s, GW25	**03-Oct-2017**	**11-Oct-2017**	31-Oct-2017	✓	**11-Oct-2017**	31-Oct-2017	✓
EK071G: Reactive Phosphorus as P by discrete analyser							
Clear Plastic Bottle - Natural (EK071G) GW1s, GW2, GW2s, GW12	**01-Oct-2017**	**----**	----	----	**09-Oct-2017**	03-Oct-2017	✘
Clear Plastic Bottle - Natural (EK071G) GW18, GW18s, GW21, GW21s, GW25	**03-Oct-2017**	**----**	----	----	**09-Oct-2017**	05-Oct-2017	✘
EP080/071: Total Petroleum Hydrocarbons							
Amber Glass Bottle - Unpreserved (EP071) GW1s, GW2, GW2s, GW12	**01-Oct-2017**	**09-Oct-2017**	08-Oct-2017	✘	**10-Oct-2017**	18-Nov-2017	✓
Amber Glass Bottle - Unpreserved (EP071) GW18, GW18s, GW21, GW21s, GW25	**03-Oct-2017**	**09-Oct-2017**	10-Oct-2017	✓	**10-Oct-2017**	18-Nov-2017	✓
Amber VOC Vial - Sulfuric Acid (EP080) GW1s, GW2, GW2s, GW12	**01-Oct-2017**	**09-Oct-2017**	15-Oct-2017	✓	**09-Oct-2017**	15-Oct-2017	✓
Amber VOC Vial - Sulfuric Acid (EP080) GW18, GW18s, GW21, GW21s, GW25	**03-Oct-2017**	**09-Oct-2017**	17-Oct-2017	✓	**09-Oct-2017**	17-Oct-2017	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation: Date extracted	Due for extraction	Evaluation	Analysis: Date analysed	Due for analysis	Evaluation
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
Amber Glass Bottle - Unpreserved (EP071)								
GW1s, GW2s,	GW2, GW12	**01-Oct-2017**	**09-Oct-2017**	08-Oct-2017	×	**10-Oct-2017**	18-Nov-2017	✓
Amber Glass Bottle - Unpreserved (EP071)								
GW18, GW21, GW25	GW18s, GW21s,	**03-Oct-2017**	**09-Oct-2017**	10-Oct-2017	✓	**10-Oct-2017**	18-Nov-2017	✓
Amber VOC Vial - Sulfuric Acid (EP080)								
GW1s, GW2s,	GW2, GW12	**01-Oct-2017**	**09-Oct-2017**	15-Oct-2017	✓	**09-Oct-2017**	15-Oct-2017	✓
Amber VOC Vial - Sulfuric Acid (EP080)								
GW18, GW21, GW25	GW18s, GW21s,	**03-Oct-2017**	**09-Oct-2017**	17-Oct-2017	✓	**09-Oct-2017**	17-Oct-2017	✓
EP080: BTEXN								
Amber VOC Vial - Sulfuric Acid (EP080)								
GW1s, GW2s,	GW2, GW12	**01-Oct-2017**	**09-Oct-2017**	15-Oct-2017	✓	**09-Oct-2017**	15-Oct-2017	✓
Amber VOC Vial - Sulfuric Acid (EP080)								
GW18, GW21, GW25	GW18s, GW21s,	**03-Oct-2017**	**09-Oct-2017**	17-Oct-2017	✓	**09-Oct-2017**	17-Oct-2017	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: ✗ = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	4	29	**13.79**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	4	34	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	9	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	9	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	1	9	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	1	9	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	15	**13.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	0	16	**0.00**	**10.00**	✗	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	2	29	**6.90**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	34	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	2	9	**22.22**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	9	**22.22**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Control Samples (LCS) - Continued							
Total Mercury by FIMS	EG035T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	2	29	**6.90**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	34	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	2	29	**6.90**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	34	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Matrix Spikes (MS) - Continued							
Total Phosphorus as P By Discrete Analyser	EK067G	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	0	16	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Total Dissolved Solids (High Level)	EA015H	WATER	In house: Referenced to APHA 2540C. A gravimetric procedure that determines the amount of \`filterable\` residue in an aqueous sample. A well-mixed sample is filtered through a glass fibre filter (1.2um). The filtrate is evaporated to dryness and dried to constant weight at 180+/-5C. This method is compliant with NEPM (2013) Schedule B(3)
Suspended Solids (High Level)	EA025H	WATER	In house: Referenced to APHA 2540D. A gravimetric procedure employed to determine the amount of \`non-filterable\` residue in a aqueous sample. The prescribed GFC (1.2um) filter is rinsed with deionised water, oven dried and weighed prior to analysis. A well-mixed sample is filtered through a glass fibre filter (1.2um). The residue on the filter paper is dried at 104+/-2C . This method is compliant with NEPM (2013) Schedule B(3)
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocyanate forms highly-coloured ferric thiocyanate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Metals by ICP-MS - Suite A	EG020A-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.

Analytical Methods	Method	Matrix	Method Descriptions
Dissolved Metals by ICP-MS - Suite B	EG020B-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Metals by ICP-MS - Suite B	EG020B-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45µm filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Total Mercury by FIMS	EG035T	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the unfiltered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Fluoride by PC Titrator	EK040P	WATER	In house: Referenced to APHA 4500-F C: CDTA is added to the sample to provide a uniform ionic strength background, adjust pH, and break up complexes. Fluoride concentration is determined by either manual or automatic ISE measurement. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al (1976), Zhang et al (2006). This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
TRH - Semivolatile Fraction	EP071	WATER	In house: Referenced to USEPA SW 846 - 8015A The sample extract is analysed by Capillary GC/FID and quantification is by comparison against an established 5 point calibration curve of n-Alkane standards. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)
TRH Volatiles/BTEX	EP080	WATER	In house: Referenced to USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. Alternatively, a sample is equilibrated in a headspace vial and a portion of the headspace determined by GCMS analysis. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)
Digestion for Total Recoverable Metals	EN25	WATER	In house: Referenced to USEPA SW846-3005. Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM (2013) Schedule B(3)
Separatory Funnel Extraction of Liquids	ORG14	WATER	In house: Referenced to USEPA SW 846 - 3510B 100 mL to 1L of sample is transferred to a separatory funnel and serially extracted three times using 60mL DCM for each extract. The resultant extracts are combined, dehydrated and concentrated for analysis. This method is compliant with NEPM (2013) Schedule B(3) . ALS default excludes sediment which may be resident in the container.
Volatiles Water Preparation	ORG16-W	WATER	A 5 mL aliquot or 5 mL of a diluted sample is added to a 40 mL VOC vial for sparging.

QUALITY CONTROL REPORT

Work Order	: **EB1720395**	Page	: 1 of 11
Client	: **PEMBROKE RESOURCES SOUTH PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR ROHAN LAST	Contact	: Customer Services EB
Address	: LEVEL 21 50 BRIDGE STREET SYDNEY NSW, AUSTRALIA 2000	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 02 9037 4708	Telephone	: +61-7-3243 7222
Project	: ENRS0600	Date Samples Received	: 05-Oct-2017
Order number	: ENRS0600	Date Analysis Commenced	: 09-Oct-2017
C-O-C number	: ----	Issue Date	: 13-Oct-2017
Sampler	: ML & TF		
Site	: PEMBROKE - OLIVE DOWNS		
Quote number	: BNBQ/333/16		
No. of samples received	: 9		
No. of samples analysed	: 9		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Andrew Epps	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Diana Mesa	2IC Organic Chemist	Brisbane Organics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Tom Maloney	Nutrients Section Supervisor	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QC Lot: 1161871)									
EB1720395-001	GW1s	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	201	202	0.497	0% - 20%
EA025: Total Suspended Solids dried at 104 ± 2°C (QC Lot: 1161870)									
EB1720395-001	GW1s	EA025H: Suspended Solids (SS)	----	5	mg/L	22	20	9.52	No Limit
ED037P: Alkalinity by PC Titrator (QC Lot: 1164052)									
EB1720395-001	GW1s	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	130	131	0.00	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	130	131	0.00	0% - 20%
EB1720634-001	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	67	66	2.14	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	67	66	2.14	0% - 20%
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 1161281)									
EB1720537-001	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	552	555	0.557	0% - 20%
EB1720395-001	GW1s	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	5	5	0.00	No Limit
ED045G: Chloride by Discrete Analyser (QC Lot: 1161282)									
EB1720537-001	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	220	223	1.55	0% - 20%
EB1720395-001	GW1s	ED045G: Chloride	16887-00-6	1	mg/L	35	34	0.00	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 1163078)									
EB1720484-001	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	22	22	0.00	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	12	12	0.00	0% - 50%
		ED093F: Sodium	7440-23-5	1	mg/L	41	40	3.26	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	6	7	0.00	No Limit
EB1720395-001	GW1s	ED093F: Calcium	7440-70-2	1	mg/L	19	19	0.00	0% - 50%

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
				Laboratory Duplicate (DUP) Report					
ED093F: Dissolved Major Cations (QC Lot: 1163078) - continued									
EB1720395-001	GW1s	ED093F: Magnesium	7439-95-4	1	mg/L	10	10	0.00	0% - 50%
		ED093F: Sodium	7440-23-5	1	mg/L	45	45	0.00	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	3	3	0.00	No Limit
EG020F: Dissolved Metals by ICP-MS (QC Lot: 1163077)									
EB1720484-001	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Barium	7440-39-3	0.001	mg/L	0.037	0.038	0.00	0% - 20%
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.004	0.004	0.00	No Limit
		EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.003	0.002	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.00	No Limit
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit
EB1720395-001	GW1s	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Barium	7440-39-3	0.001	mg/L	0.233	0.238	1.92	0% - 20%
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.057	0.058	0.00	0% - 20%
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.116	0.116	0.00	0% - 20%
		EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.003	0.003	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.011	0.010	0.00	No Limit
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	0.15	0.15	0.00	No Limit
EG020F: Dissolved Metals by ICP-MS (QC Lot: 1163080)									
EB1720484-001	Anonymous	EG020B-F: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
				Laboratory Duplicate (DUP) Report					
EG020F: Dissolved Metals by ICP-MS (QC Lot: 1163080) - continued									
EB1720484-001	Anonymous	EG020B-F: Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
EB1720395-001	GW1s	EG020B-F: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020B-F: Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
EG020T: Total Metals by ICP-MS (QC Lot: 1163103)									
EB1720395-001	GW1s	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.241	0.239	1.15	0% - 20%
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.006	140	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.092	0.089	2.91	0% - 20%
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.142	0.173	19.3	0% - 20%
		EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	<0.001	0.004	114	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.004	0.006	54.2	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.006	0.008	28.6	No Limit
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	0.21	0.21	0.00	0% - 20%
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Boron	7440-42-8	0.05	mg/L	0.05	<0.05	0.00	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	0.36	0.37	3.10	No Limit
EB1720589-001	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.068	0.067	1.58	0% - 20%
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	0.001	<0.001	0.00	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.001	0.001	0.00	No Limit
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.015	0.012	18.7	0% - 50%
		EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	0.039	0.040	0.00	0% - 20%
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.012	0.011	9.73	0% - 50%
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.00	No Limit
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	0.81	0.85	5.54	0% - 20%
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Boron	7440-42-8	0.05	mg/L	0.09	0.08	0.00	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	0.62	0.59	4.86	0% - 50%
EG020T: Total Metals by ICP-MS (QC Lot: 1163104)									
EB1720395-001	GW1s	EG020B-T: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG020T: Total Metals by ICP-MS (QC Lot: 1163104) - continued									
EB1720395-001	GW1s	EG020B-T: Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
EB1720589-001	Anonymous	EG020B-T: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020B-T: Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
EG035F: Dissolved Mercury by FIMS (QC Lot: 1163079)									
EB1720484-002	Anonymous	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EB1720395-001	GW1s	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 1163112)									
EB1718467-001	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	0.0002	0.0002	0.00	No Limit
EB1720395-005	GW18	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EK040P: Fluoride by PC Titrator (QC Lot: 1164051)									
EB1720395-001	GW1s	EK040P: Fluoride	16984-48-8	0.1	mg/L	0.1	0.1	0.00	No Limit
EB1720634-001	Anonymous	EK040P: Fluoride	16984-48-8	0.1	mg/L	0.2	0.2	0.00	No Limit
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 1160831)									
EB1720395-001	GW1s	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	0.07	152	No Limit
EB1720663-001	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.02	<0.01	0.00	No Limit
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 1162305)									
EB1719237-003	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	1.13	1.12	0.00	0% - 20%
EB1720579-001	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.88	0.86	2.91	0% - 20%
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 1161284)									
EB1720395-001	GW1s	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 1160832)									
EB1720395-001	GW1s	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.03	0.03	0.00	No Limit
EB1720663-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.06	0.05	0.00	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 1162304)									
EB1719237-003	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.43	0.39	9.03	0% - 20%
EB1720579-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.06	0.08	32.2	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 1165052)									
EB1719266-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	3.7	4.2	13.2	No Limit
EB1720395-006	GW18s	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.3	0.2	0.00	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 1165051)									
EB1719266-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	1.31	1.26	4.39	0% - 20%
EB1720395-006	GW18s	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.17	0.18	0.00	0% - 50%
EK071G: Reactive Phosphorus as P by discrete analyser (QC Lot: 1161283)									
EB1720395-001	GW1s	EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	0.02	0.02	0.00	No Limit
EP080/071: Total Petroleum Hydrocarbons (QC Lot: 1160817)									
EB1718467-001	Anonymous	EP080: C6 - C9 Fraction	----	20	µg/L	<20	<20	0.00	No Limit
EB1720395-005	GW18	EP080: C6 - C9 Fraction	----	20	µg/L	<20	20	0.00	No Limit
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QC Lot: 1160817)									

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
				Laboratory Duplicate (DUP) Report					
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QC Lot: 1160817) - continued									
EB1718467-001	Anonymous	EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	0.00	No Limit
EB1720395-005	GW18	EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	20	0.00	No Limit
EP080: BTEXN (QC Lot: 1160817)									
EB1718467-001	Anonymous	EP080: Benzene	71-43-2	1	µg/L	<1	<1	0.00	No Limit
		EP080: Toluene	108-88-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.00	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: ortho-Xylene	95-47-6	2	µg/L	<2	<2	0.00	No Limit
		EP080: Naphthalene	91-20-3	5	µg/L	<5	<5	0.00	No Limit
EB1720395-005	GW18	EP080: Benzene	71-43-2	1	µg/L	<1	<1	0.00	No Limit
		EP080: Toluene	108-88-3	2	µg/L	7	8	0.00	No Limit
		EP080: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.00	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: ortho-Xylene	95-47-6	2	µg/L	<2	<2	0.00	No Limit
		EP080: Naphthalene	91-20-3	5	µg/L	<5	<5	0.00	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QCLot: 1161871)								
EA015H: Total Dissolved Solids @180°C	----	10	mg/L	<10	293 mg/L	102	88	112
				<10	2000 mg/L	99.8	88	112
EA025: Total Suspended Solids dried at 104 ± 2°C (QCLot: 1161870)								
EA025H: Suspended Solids (SS)	----	5	mg/L	<5	150 mg/L	103	88	112
				<5	1000 mg/L	99.0	88	112
ED037P: Alkalinity by PC Titrator (QCLot: 1164052)								
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	50 mg/L	115	80	120
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 1161281)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	102	85	118
				<1	100 mg/L	101	85	118
ED045G: Chloride by Discrete Analyser (QCLot: 1161282)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	113	90	115
				<1	1000 mg/L	115	90	115
ED093F: Dissolved Major Cations (QCLot: 1163078)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	----	----	----	----
ED093F: Magnesium	7439-95-4	1	mg/L	<1	----	----	----	----
ED093F: Sodium	7440-23-5	1	mg/L	<1	----	----	----	----
ED093F: Potassium	7440-09-7	1	mg/L	<1	----	----	----	----
EG020F: Dissolved Metals by ICP-MS (QCLot: 1163077)								
EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	91.6	79	118
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	101	88	116
EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	94.4	81	117
EG020A-F: Barium	7440-39-3	0.001	mg/L	<0.001	0.5 mg/L	104	70	130
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	97.0	88	108
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	96.9	87	113
EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	105	86	112
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.2 mg/L	92.6	88	114
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	103	89	110
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	96.7	89	120
EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	<0.001	0.1 mg/L	106	89	112
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	106	89	113
EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	101	83	112
EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	101	88	114
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.2 mg/L	99.7	87	113

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report Spike Concentration	Spike Recovery (%) LCS	Recovery Limits (%) Low	Recovery Limits (%) High
EG020F: Dissolved Metals by ICP-MS (QCLot: 1163077) - continued								
EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	0.5 mg/L	91.6	81	125
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	98.4	82	114
EG020F: Dissolved Metals by ICP-MS (QCLot: 1163080)								
EG020B-F: Silver	7440-22-4	0.001	mg/L	<0.001	0.1 mg/L	105	85	114
EG020B-F: Uranium	7440-61-1	0.001	mg/L	<0.001	----	----	----	----
EG020T: Total Metals by ICP-MS (QCLot: 1163103)								
EG020A-T: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	101	80	114
EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	102	88	112
EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	98.0	81	119
EG020A-T: Barium	7440-39-3	0.001	mg/L	<0.001	0.5 mg/L	92.1	70	130
EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	97.0	88	111
EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	101	89	115
EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	102	89	115
EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	0.2 mg/L	98.4	88	116
EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	97.6	89	112
EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	99.1	88	114
EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	<0.001	0.1 mg/L	105	90	114
EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	101	88	116
EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	103	79	111
EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	102	87	114
EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.2 mg/L	101	84	114
EG020A-T: Boron	7440-42-8	0.05	mg/L	<0.05	0.5 mg/L	105	82	128
EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	98.9	82	118
EG020T: Total Metals by ICP-MS (QCLot: 1163104)								
EG020B-T: Silver	7440-22-4	0.001	mg/L	<0.001	0.1 mg/L	101	84	117
EG020B-T: Uranium	7440-61-1	0.001	mg/L	<0.001	----	----	----	----
EG035F: Dissolved Mercury by FIMS (QCLot: 1163079)								
EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	101	84	118
EG035T: Total Recoverable Mercury by FIMS (QCLot: 1163112)								
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	100	84	118
EK040P: Fluoride by PC Titrator (QCLot: 1164051)								
EK040P: Fluoride	16984-48-8	0.1	mg/L	<0.1	0.5 mg/L	104	80	117
EK055G: Ammonia as N by Discrete Analyser (QCLot: 1160831)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	1 mg/L	95.0	86	112
EK055G: Ammonia as N by Discrete Analyser (QCLot: 1162305)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	1 mg/L	89.1	86	112
EK057G: Nitrite as N by Discrete Analyser (QCLot: 1161284)								

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EK057G: Nitrite as N by Discrete Analyser (QCLot: 1161284) - continued								
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	98.0	90	110
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 1160832)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	97.2	89	115
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 1162304)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	97.6	89	115
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 1165052)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	92.7	70	111
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 1165051)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	99.0	77	109
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 1161283)								
EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	0.5 mg/L	101	88	115
EP080/071: Total Petroleum Hydrocarbons (QCLot: 1160817)								
EP080: C6 - C9 Fraction	----	20	µg/L	<20	160 µg/L	89.5	76	122
EP080/071: Total Petroleum Hydrocarbons (QCLot: 1161323)								
EP071: C10 - C14 Fraction	----	50	µg/L	<50	1211 µg/L	84.8	38	114
EP071: C15 - C28 Fraction	----	100	µg/L	<100	2103 µg/L	85.9	50	132
EP071: C29 - C36 Fraction	----	50	µg/L	<50	----	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 1160817)								
EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	185 µg/L	87.4	75	123
EP080: C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L	<20	----	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 1161323)								
EP071: >C10 - C16 Fraction	----	100	µg/L	<100	1696 µg/L	84.0	43	119
EP071: >C16 - C34 Fraction	----	100	µg/L	<100	1496 µg/L	85.6	49	134
EP071: >C34 - C40 Fraction	----	100	µg/L	<100	----	----	----	----
EP080: BTEXN (QCLot: 1160817)								
EP080: Benzene	71-43-2	1	µg/L	<1	10 µg/L	91.8	77	119
EP080: Toluene	108-88-3	2	µg/L	<2	10 µg/L	88.0	78	122
EP080: Ethylbenzene	100-41-4	2	µg/L	<2	10 µg/L	85.8	78	119
EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	20 µg/L	86.4	77	121
EP080: ortho-Xylene	95-47-6	2	µg/L	<2	10 µg/L	91.7	76	121
EP080: Total Xylenes	1330-20-7	2	µg/L	<2	----	----	----	----
EP080: Sum of BTEX	----	1	µg/L	<1	----	----	----	----
EP080: Naphthalene	91-20-3	5	µg/L	<5	10 µg/L	93.8	75	120

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report Spike Concentration	SpikeRecovery(%) MS	Recovery Limits (%) Low	High
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 1161281)							
EB1720395-002	GW2	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	20 mg/L	103	70	130
ED045G: Chloride by Discrete Analyser (QCLot: 1161282)							
EB1720395-002	GW2	ED045G: Chloride	16887-00-6	400 mg/L	# Not Determined	70	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 1163077)							
EB1720395-002	GW2	EG020A-F: Aluminium	7429-90-5	0.5 mg/L	84.9	70	130
		EG020A-F: Arsenic	7440-38-2	0.1 mg/L	94.8	70	130
		EG020A-F: Beryllium	7440-41-7	0.1 mg/L	93.4	70	130
		EG020A-F: Barium	7440-39-3	0.5 mg/L	# Not Determined	70	130
		EG020A-F: Cadmium	7440-43-9	0.1 mg/L	92.3	70	130
		EG020A-F: Chromium	7440-47-3	0.1 mg/L	89.2	70	130
		EG020A-F: Cobalt	7440-48-4	0.1 mg/L	91.7	70	130
		EG020A-F: Copper	7440-50-8	0.2 mg/L	77.5	70	130
		EG020A-F: Lead	7439-92-1	0.1 mg/L	96.4	70	130
		EG020A-F: Manganese	7439-96-5	0.1 mg/L	# Not Determined	70	130
		EG020A-F: Molybdenum	7439-98-7	0.1 mg/L	93.5	70	130
		EG020A-F: Nickel	7440-02-0	0.1 mg/L	89.9	70	130
		EG020A-F: Selenium	7782-49-2	0.1 mg/L	83.9	70	130
		EG020A-F: Vanadium	7440-62-2	0.1 mg/L	95.4	70	130
		EG020A-F: Zinc	7440-66-6	0.2 mg/L	86.0	70	130
		EG020A-F: Boron	7440-42-8	0.5 mg/L	88.8	70	130
EG020T: Total Metals by ICP-MS (QCLot: 1163103)							
EB1718467-002	Anonymous	EG020A-T: Arsenic	7440-38-2	1 mg/L	103	70	130
		EG020A-T: Beryllium	7440-41-7	0.1 mg/L	104	70	130
		EG020A-T: Barium	7440-39-3	1 mg/L	101	70	130
		EG020A-T: Cadmium	7440-43-9	0.5 mg/L	99.8	70	130
		EG020A-T: Chromium	7440-47-3	1 mg/L	99.4	70	130
		EG020A-T: Cobalt	7440-48-4	1 mg/L	99.4	70	130
		EG020A-T: Copper	7440-50-8	1 mg/L	97.6	70	130
		EG020A-T: Lead	7439-92-1	1 mg/L	109	70	130
		EG020A-T: Manganese	7439-96-5	1 mg/L	116	70	130
		EG020A-T: Nickel	7440-02-0	1 mg/L	96.8	70	130
		EG020A-T: Vanadium	7440-62-2	1 mg/L	100	70	130

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Spike Concentration	SpikeRecovery(%) MS	Recovery Limits (%) Low	Recovery Limits (%) High
EG020T: Total Metals by ICP-MS (QCLot: 1163103) - continued							
EB1718467-002	Anonymous	EG020A-T: Zinc	7440-66-6	1 mg/L	100.0	70	130
EG035F: Dissolved Mercury by FIMS (QCLot: 1163079)							
EB1720395-002	GW2	EG035F: Mercury	7439-97-6	0.01 mg/L	86.2	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 1163112)							
EB1718467-002	Anonymous	EG035T: Mercury	7439-97-6	0.01 mg/L	74.7	70	130
EK040P: Fluoride by PC Titrator (QCLot: 1164051)							
EB1720395-002	GW2	EK040P: Fluoride	16984-48-8	5 mg/L	122	70	130
EK055G: Ammonia as N by Discrete Analyser (QCLot: 1160831)							
EB1720395-002	GW2	EK055G: Ammonia as N	7664-41-7	0.4 mg/L	# Not Determined	70	130
EK055G: Ammonia as N by Discrete Analyser (QCLot: 1162305)							
EB1719266-001	Anonymous	EK055G: Ammonia as N	7664-41-7	0.4 mg/L	78.2	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 1161284)							
EB1720395-002	GW2	EK057G: Nitrite as N	14797-65-0	0.4 mg/L	91.4	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 1160832)							
EB1720395-002	GW2	EK059G: Nitrite + Nitrate as N	----	0.4 mg/L	97.8	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 1162304)							
EB1719266-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	20 mg/L	87.9	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 1165052)							
EB1719266-002	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	# Not Determined	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 1165051)							
EB1719266-002	Anonymous	EK067G: Total Phosphorus as P	----	1 mg/L	105	70	130
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 1161283)							
EB1720395-002	GW2	EK071G: Reactive Phosphorus as P	14265-44-2	0.4 mg/L	94.5	70	130
EP080/071: Total Petroleum Hydrocarbons (QCLot: 1160817)							
EB1718467-002	Anonymous	EP080: C6 - C9 Fraction	----	40 µg/L	81.6	70	130
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 1160817)							
EB1718467-002	Anonymous	EP080: C6 - C10 Fraction	C6_C10	40 µg/L	82.2	70	130
EP080: BTEXN (QCLot: 1160817)							
EB1718467-002	Anonymous	EP080: Benzene	71-43-2	10 µg/L	90.1	70	130
		EP080: Toluene	108-88-3	10 µg/L	82.8	70	130

CERTIFICATE OF ANALYSIS

Work Order	: **ET1701860**		
Client	: **PEMBROKE RESOURCES SOUTH PTY LTD**	Laboratory	: Environmental Division Townsville
Contact	: MR ROHAN LAST	Contact	: Customer Services ET
Address	: LEVEL 21 50 BRIDGE STREET SYDNEY NSW, AUSTRALIA 2000	Address	: 14-15 Desma Ct, Bohle Townsville QLD AUSTRALIA 4814
Telephone	: 02 9037 4708	Telephone	: +61 7 4796 0600
Project	: ENRS0600	Date Samples Received	: 15-Dec-2017 09:00
Order number	: ----	Date Analysis Commenced	: 15-Dec-2017
C-O-C number	: ----	Issue Date	: 02-Jan-2018 16:01
Sampler	: ML & TB		
Site	: Pembroke - Olive Downs		
Quote number	: BNBQ/333/16		
No. of samples received	: 9		
No. of samples analysed	: 9		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Andrew Epps		Townsville Inorganics, Townsville, QLD
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Organics, Smithfield, NSW
Greg Vogel		Townsville Inorganics, Townsville, QLD
Raymond Commodore	Instrument Chemist	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EG020: It is recognised that total concentration is less than dissolved for some metal analytes. However, the difference is within experimental variation of the methods.
- LOR raised for TKN for various samples due due to sample matrix.
- ED041G:LOR raised for Total Kjeldahl N on various samples due to sample matrix.
- EK055G, EK061G: It has been noted that Ammonia is greater than TKN for sample no:6, however this difference is within the limits of experimental variation.
- EA015H, EA025H, ED037P, ED041G, ED045G, EK040P, EK055G, EK057G, EK058G, EK059G, EK071G conducted by ALS Townsville, NATA accreditation no. 825, (Site no. 23313)

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)			Client sample ID	GW1s	GW2	GW2s	GW8s	GW12
			Client sampling date / time	12-Dec-2017 00:00	12-Dec-2017 00:00	12-Dec-2017 00:00	12-Dec-2017 00:00	12-Dec-2017 00:00
Compound	CAS Number	LOR	Unit	ET1701860-001	ET1701860-002	ET1701860-003	ET1701860-004	ET1701860-005
				Result	Result	Result	Result	Result
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	206	7970	22100	6250	16900
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	<5	<5	454	17700	32
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	134	342	492	569	641
Total Alkalinity as CaCO3	----	1	mg/L	134	342	492	569	641
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	9	<1	1470	332	1180
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	29	3840	9940	2170	8200
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	22	401	1080	106	371
Magnesium	7439-95-4	1	mg/L	8	117	1250	145	754
Sodium	7440-23-5	1	mg/L	35	2290	4830	1670	5620
Potassium	7440-09-7	1	mg/L	3	14	14	10	41
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	----	----	7840	----	----
Total Hardness as CaCO3	----	1	mg/L	88	1480	----	862	4120
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	----	<0.01
Arsenic	7440-38-2	0.001	mg/L	<0.001	0.013	<0.001	----	<0.001
Boron	7440-42-8	0.05	mg/L	0.07	0.23	0.62	----	1.44
Barium	7440-39-3	0.001	mg/L	0.230	19.8	0.155	----	0.057
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	----	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.0006	----	0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	0.004	0.014	----	0.003
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	----	0.010
Copper	7440-50-8	0.001	mg/L	0.015	0.002	0.816	----	0.054
Manganese	7439-96-5	0.001	mg/L	0.051	2.98	1.42	----	0.005
Nickel	7440-02-0	0.001	mg/L	0.032	0.010	0.055	----	0.019
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	----	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	----	<0.01

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)			Client sample ID	GW1s	GW2	GW2s	GW8s	GW12
			Client sampling date / time	12-Dec-2017 00:00	12-Dec-2017 00:00	12-Dec-2017 00:00	12-Dec-2017 00:00	12-Dec-2017 00:00
Compound	CAS Number	LOR	Unit	ET1701860-001	ET1701860-002	ET1701860-003	ET1701860-004	ET1701860-005
				Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued								
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	----	<0.01
Zinc	7440-66-6	0.005	mg/L	**0.015**	**0.332**	**0.023**	----	**0.026**
Molybdenum	7439-98-7	0.001	mg/L	<0.001	**0.004**	**0.002**	----	<0.001
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	----	<0.001
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	**0.024**	----	**0.010**
Iron	7439-89-6	0.05	mg/L	<0.05	**7.41**	<0.05	----	<0.05
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	**0.02**	**0.44**	----	**0.32**
Arsenic	7440-38-2	0.001	mg/L	<0.001	**0.011**	<0.001	----	<0.001
Boron	7440-42-8	0.05	mg/L	<0.05	**0.19**	**0.54**	----	**1.25**
Barium	7440-39-3	0.001	mg/L	**0.245**	**21.4**	**0.169**	----	**0.051**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	----	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	**0.0006**	----	**0.0001**
Cobalt	7440-48-4	0.001	mg/L	<0.001	**0.004**	**0.019**	----	**0.003**
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	**0.002**	----	**0.012**
Copper	7440-50-8	0.001	mg/L	**0.021**	**0.008**	**0.957**	----	**0.112**
Manganese	7439-96-5	0.001	mg/L	**0.049**	**2.97**	**1.49**	----	**0.003**
Nickel	7440-02-0	0.001	mg/L	**0.030**	**0.012**	**0.060**	----	**0.018**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	----	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	----	<0.01
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	----	<0.01
Zinc	7440-66-6	0.005	mg/L	**0.014**	**0.414**	**0.028**	----	**0.029**
Molybdenum	7439-98-7	0.001	mg/L	<0.001	**0.004**	**0.002**	----	<0.001
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	----	**0.002**
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	**0.024**	----	**0.008**
Iron	7439-89-6	0.05	mg/L	<0.05	**8.15**	**0.80**	----	**0.37**
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	<0.0001
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	<0.0001
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.1**	**0.1**	**0.5**	**0.2**	**0.3**
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.07**	**4.00**	**0.26**	----	**0.08**

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)			Client sample ID	GW1s	GW2	GW2s	GW8s	GW12
			Client sampling date / time	12-Dec-2017 00:00	12-Dec-2017 00:00	12-Dec-2017 00:00	12-Dec-2017 00:00	12-Dec-2017 00:00
Compound	CAS Number	LOR	Unit	ET1701860-001	ET1701860-002	ET1701860-003	ET1701860-004	ET1701860-005
				Result	Result	Result	Result	Result
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	----	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.04**	**0.02**	**0.28**	----	**0.05**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.04**	**0.02**	**0.28**	----	**0.05**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	**5.1**	<0.5	----	<0.5
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	<0.1	**5.1**	<0.5	----	<0.5
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.01**	**0.28**	**0.06**	----	**0.08**
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	**0.01**	**0.22**	**0.03**	----	<0.01
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	**3.68**	**115**	**321**	**79.5**	**269**
Total Cations	----	0.01	meq/L	**3.36**	**130**	**367**	**90.1**	**326**
Ionic Balance	----	0.01	%	**4.65**	**5.90**	**6.74**	**6.26**	**9.65**
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	<20	<20	----	<20
C10 - C14 Fraction	----	50	µg/L	<50	<50	<50	----	<50
C15 - C28 Fraction	----	100	µg/L	<100	<100	<100	----	<100
C29 - C36 Fraction	----	50	µg/L	<50	<50	<50	----	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L	<50	<50	<50	----	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	<20	----	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L	<20	<20	<20	----	<20
>C10 - C16 Fraction	----	100	µg/L	<100	<100	<100	----	<100
>C16 - C34 Fraction	----	100	µg/L	<100	<100	<100	----	<100
>C34 - C40 Fraction	----	100	µg/L	<100	<100	<100	----	<100
^ >C10 - C40 Fraction (sum)	----	100	µg/L	<100	<100	<100	----	<100
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L	<100	<100	<100	----	<100
EP080: BTEXN								

Analytical Results

Sub-Matrix: GROUNDWATER
(Matrix: WATER)

			Client sample ID	GW1s	GW2	GW2s	GW8s	GW12
			Client sampling date / time	12-Dec-2017 00:00	12-Dec-2017 00:00	12-Dec-2017 00:00	12-Dec-2017 00:00	12-Dec-2017 00:00
Compound	*CAS Number*	*LOR*	*Unit*	ET1701860-001	ET1701860-002	ET1701860-003	ET1701860-004	ET1701860-005
				Result	Result	Result	Result	Result
EP080: BTEXN - Continued								
Benzene	71-43-2	1	µg/L	<1	<1	<1	----	<1
Toluene	108-88-3	2	µg/L	<2	<2	<2	----	<2
Ethylbenzene	100-41-4	2	µg/L	<2	<2	<2	----	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	<2	----	<2
ortho-Xylene	95-47-6	2	µg/L	<2	<2	<2	----	<2
^ Total Xylenes	----	2	µg/L	<2	<2	<2	----	<2
^ Sum of BTEX	----	1	µg/L	<1	<1	<1	----	<1
Naphthalene	91-20-3	5	µg/L	<5	<5	<5	----	<5
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	2	%	**108**	**94.9**	**112**	----	**109**
Toluene-D8	2037-26-5	2	%	**115**	**97.6**	**117**	----	**110**
4-Bromofluorobenzene	460-00-4	2	%	**112**	**99.4**	**113**	----	**111**

Analytical Results

Sub-Matrix: **GROUNDWATER** (Matrix: **WATER**)			Client sample ID	**GW18**	**GW18s**	**GW21**	**GW21s**	**----**
			Client sampling date / time	12-Dec-2017 00:00	12-Dec-2017 00:00	12-Dec-2017 00:00	12-Dec-2017 00:00	----
Compound	*CAS Number*	*LOR*	*Unit*	**ET1701860-006**	**ET1701860-007**	**ET1701860-008**	**ET1701860-009**	--------
				Result	Result	Result	Result	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**14700**	**2000**	**17600**	**1790**	----
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	**37**	**70**	**14**	**1560**	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**643**	**891**	**859**	**360**	----
Total Alkalinity as CaCO3	----	1	mg/L	**643**	**891**	**859**	**360**	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**922**	**188**	**33**	**74**	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**6680**	**593**	**7830**	**571**	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**640**	**121**	**886**	**63**	----
Magnesium	7439-95-4	1	mg/L	**577**	**130**	**591**	**38**	----
Sodium	7440-23-5	1	mg/L	**2990**	**478**	**3880**	**428**	----
Potassium	7440-09-7	1	mg/L	**11**	<1	**22**	**2**	----
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	**3970**	**835**	**4650**	**314**	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Arsenic	7440-38-2	0.001	mg/L	**0.001**	**0.002**	**0.005**	**0.004**	----
Boron	7440-42-8	0.05	mg/L	**0.37**	**0.27**	**0.41**	**1.03**	----
Barium	7440-39-3	0.001	mg/L	**0.643**	**0.181**	**13.2**	**0.174**	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	**0.002**	<0.001	<0.001	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Copper	7440-50-8	0.001	mg/L	<0.001	**0.002**	<0.001	**0.374**	----
Manganese	7439-96-5	0.001	mg/L	**0.202**	**0.043**	**4.94**	**0.028**	----
Nickel	7440-02-0	0.001	mg/L	**0.002**	**0.015**	**0.003**	**0.042**	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)			Client sample ID	GW18	GW18s	GW21	GW21s	----
			Client sampling date / time	12-Dec-2017 00:00	12-Dec-2017 00:00	12-Dec-2017 00:00	12-Dec-2017 00:00	----
Compound	CAS Number	LOR	Unit	ET1701860-006	ET1701860-007	ET1701860-008	ET1701860-009	--------
				Result	Result	Result	Result	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Zinc	7440-66-6	0.005	mg/L	<0.005	0.018	0.012	0.011	----
Molybdenum	7439-98-7	0.001	mg/L	0.004	0.002	0.002	<0.001	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Uranium	7440-61-1	0.001	mg/L	<0.001	0.015	<0.001	0.001	----
Iron	7439-89-6	0.05	mg/L	2.41	0.12	1.74	<0.05	----
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.14	1.29	0.01	54.3	----
Arsenic	7440-38-2	0.001	mg/L	0.003	0.003	0.010	0.017	----
Boron	7440-42-8	0.05	mg/L	0.25	0.21	0.44	0.92	----
Barium	7440-39-3	0.001	mg/L	1.40	0.195	14.8	0.619	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	0.003	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	0.0007	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	0.011	<0.001	0.128	----
Chromium	7440-47-3	0.001	mg/L	0.001	0.008	0.001	0.187	----
Copper	7440-50-8	0.001	mg/L	0.011	0.020	0.003	3.02	----
Manganese	7439-96-5	0.001	mg/L	0.236	0.186	5.54	2.20	----
Nickel	7440-02-0	0.001	mg/L	0.006	0.022	0.005	0.446	----
Lead	7439-92-1	0.001	mg/L	<0.001	0.002	<0.001	0.040	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	0.02	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	0.01	<0.01	0.23	----
Zinc	7440-66-6	0.005	mg/L	0.079	0.028	0.383	0.924	----
Molybdenum	7439-98-7	0.001	mg/L	0.008	0.001	0.002	<0.001	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	0.004	----
Uranium	7440-61-1	0.001	mg/L	<0.001	0.014	<0.001	0.004	----
Iron	7439-89-6	0.05	mg/L	3.58	3.17	2.29	80.6	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	0.2	0.8	0.2	0.7	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	3.35	0.12	4.13	<0.01	----
EK057G: Nitrite as N by Discrete Analyser								

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)			Client sample ID	GW18	GW18s	GW21	GW21s	----
			Client sampling date / time	12-Dec-2017 00:00	12-Dec-2017 00:00	12-Dec-2017 00:00	12-Dec-2017 00:00	----
Compound	CAS Number	LOR	Unit	ET1701860-006	ET1701860-007	ET1701860-008	ET1701860-009	--------
				Result	Result	Result	Result	----
EK057G: Nitrite as N by Discrete Analyser - Continued								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	**0.03**	<0.01	**0.74**	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	**0.03**	<0.01	**0.74**	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**3.2**	**0.2**	**4.4**	**0.3**	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**3.2**	**0.2**	**4.4**	**1.0**	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.05**	**0.24**	**0.92**	**0.21**	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	**0.12**	**0.15**	**0.21**	----
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	**220**	**38.4**	**239**	**24.8**	----
Total Cations	----	0.01	meq/L	**210**	**37.5**	**262**	**24.9**	----
Ionic Balance	----	0.01	%	**2.49**	**1.20**	**4.68**	**0.20**	----
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	<20	<20	<20	----
C10 - C14 Fraction	----	50	µg/L	<50	<50	<50	<50	----
C15 - C28 Fraction	----	100	µg/L	<100	<100	<100	<100	----
C29 - C36 Fraction	----	50	µg/L	<50	<50	<50	<50	----
^ **C10 - C36 Fraction (sum)**	----	50	µg/L	<50	<50	<50	<50	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	<20	<20	----
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	20	µg/L	<20	<20	<20	<20	----
>C10 - C16 Fraction	----	100	µg/L	<100	<100	<100	<100	----
>C16 - C34 Fraction	----	100	µg/L	<100	<100	<100	<100	----
>C34 - C40 Fraction	----	100	µg/L	<100	<100	<100	<100	----
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L	<100	<100	<100	<100	----
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L	<100	<100	<100	<100	----
EP080: BTEXN								

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)			Client sample ID	GW18	GW18s	GW21	GW21s	----
			Client sampling date / time	12-Dec-2017 00:00	12-Dec-2017 00:00	12-Dec-2017 00:00	12-Dec-2017 00:00	----
Compound	CAS Number	LOR	Unit	ET1701860-006	ET1701860-007	ET1701860-008	ET1701860-009	--------
				Result	Result	Result	Result	----
EP080: BTEXN - Continued								
Benzene	71-43-2	1	µg/L	<1	<1	<1	<1	----
Toluene	108-88-3	2	µg/L	<2	<2	<2	<2	----
Ethylbenzene	100-41-4	2	µg/L	<2	<2	<2	<2	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	<2	<2	----
ortho-Xylene	95-47-6	2	µg/L	<2	<2	<2	<2	----
^ Total Xylenes	----	2	µg/L	<2	<2	<2	<2	----
^ Sum of BTEX	----	1	µg/L	<1	<1	<1	<1	----
Naphthalene	91-20-3	5	µg/L	<5	<5	<5	<5	----
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	2	%	**108**	**108**	**115**	**113**	----
Toluene-D8	2037-26-5	2	%	**118**	**116**	**115**	**114**	----
4-Bromofluorobenzene	460-00-4	2	%	**112**	**115**	**112**	**108**	----

Surrogate Control Limits

Sub-Matrix: **GROUNDWATER**

Compound	CAS Number	Recovery Limits (%) Low	High
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	71	137
Toluene-D8	2037-26-5	79	131
4-Bromofluorobenzene	460-00-4	70	128

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EW1800725**	Page	: 1 of 11
Client	: **PEMBROKE RESOURCES SOUTH PTY LTD**	Laboratory	: Environmental Division NSW South Coast
Contact	: MR ROHAN LAST	Contact	: Glenn Davies
Address	: LEVEL 19 GATEWAY BUILDING 1 MACQUARIE PLACE SYDNEY NSW, AUSTRALIA 2000	Address	: 1/19 Ralph Black Dr, North Wollongong 2500 4/13 Geary Pl, North Nowra 2541 Australia NSW
Telephone	: 02 9037 4708	Telephone	: 02 42253125
Project	: ENRS0600	Date Samples Received	: 21-Feb-2018 15:32
Order number	: ENRS0600	Date Analysis Commenced	: 21-Feb-2018
C-O-C number	: ----	Issue Date	: 01-Mar-2018 09:10
Sampler	: ML & TB		
Site	: Pembroke - Olive Downs		
Quote number	: BNBQ/333/16		
No. of samples received	: 9		
No. of samples analysed	: 9		

NATA

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Organics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW
Sanjeshni Jyoti	Senior Chemist Volatiles	Sydney Organics, Smithfield, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EG020: It is recognised that total concentration is less than dissolved for some metal analytes. However, the difference is within experimental variation of the methods.
- EK071G: LOR raised for Reactive Phosphorus on sample 2 & 6 due to sample matrix.
- EK055G: LOR raised for Ammonia on sample 3,5 due to sample matrix.
- EK061G:/EK067G/EK062G: LOR raised for TKN, Total P & TN on various samples due to sample matrix.
- EK055G: It has been noted that Ammonia is greater than TKN for sample No 6, however this difference is within the limits of experimental variation.

Analytical Results

Sub-Matrix: **GROUNDWATER** (Matrix: **WATER**)			Client sample ID	**GW1s**	**GW2**	**GW2s**	**GW8s**	**GW12**
			Client sampling date / time	19-Feb-2018 00:00	19-Feb-2018 00:00	19-Feb-2018 00:00	19-Feb-2018 00:00	19-Feb-2018 00:00
Compound	CAS Number	LOR	Unit	**EW1800725-001**	**EW1800725-002**	**EW1800725-003**	**EW1800725-004**	**EW1800725-005**
				Result	Result	Result	Result	Result
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**216**	**7590**	**27400**	**6340**	**18600**
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	**10**	**32**	**216**	**2570**	**26**
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**138**	**320**	**515**	**412**	**644**
Total Alkalinity as CaCO3	----	1	mg/L	**138**	**320**	**515**	**412**	**644**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**8**	<1	**1770**	**299**	**1300**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**42**	**4460**	**11900**	**2910**	**9060**
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**21**	**312**	**1040**	**107**	**404**
Magnesium	7439-95-4	1	mg/L	**9**	**114**	**1350**	**155**	**650**
Sodium	7440-23-5	1	mg/L	**43**	**2140**	**4560**	**1720**	**4460**
Potassium	7440-09-7	1	mg/L	**3**	**13**	**11**	**7**	**34**
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	**89**	**1250**	**7580**	**905**	**3680**
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	----	<0.01
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	----	<0.001
Arsenic	7440-38-2	0.001	mg/L	<0.001	**0.006**	<0.001	----	<0.001
Boron	7440-42-8	0.05	mg/L	**0.06**	**0.24**	**0.64**	----	**1.61**
Barium	7440-39-3	0.001	mg/L	**0.308**	**23.1**	**0.136**	----	**0.041**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	----	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	**0.0004**	----	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	**0.012**	----	**0.003**
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	**0.023**	----	**0.009**
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	----	**0.007**
Copper	7440-50-8	0.001	mg/L	**0.141**	**0.004**	**0.620**	----	**0.593**
Manganese	7439-96-5	0.001	mg/L	**0.046**	**3.19**	**1.26**	----	**0.010**
Molybdenum	7439-98-7	0.001	mg/L	<0.001	**0.002**	**0.001**	----	**0.001**
Nickel	7440-02-0	0.001	mg/L	**0.001**	**0.004**	**0.039**	----	**0.020**

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)			Client sample ID	GW1s	GW2	GW2s	GW8s	GW12
			Client sampling date / time	19-Feb-2018 00:00	19-Feb-2018 00:00	19-Feb-2018 00:00	19-Feb-2018 00:00	19-Feb-2018 00:00
Compound	CAS Number	LOR	Unit	EW1800725-001	EW1800725-002	EW1800725-003	EW1800725-004	EW1800725-005
				Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued								
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	----	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	----	<0.01
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	----	<0.01
Zinc	7440-66-6	0.005	mg/L	<0.005	**0.052**	**0.032**	----	**0.024**
Iron	7439-89-6	0.05	mg/L	<0.05	**4.35**	<0.05	----	<0.05
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.09**	**0.36**	**2.07**	----	**0.05**
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	**0.003**	----	**0.001**
Arsenic	7440-38-2	0.001	mg/L	<0.001	**0.007**	**0.001**	----	<0.001
Boron	7440-42-8	0.05	mg/L	<0.05	**0.22**	**0.70**	----	**1.79**
Barium	7440-39-3	0.001	mg/L	**0.319**	**19.7**	**0.166**	----	**0.042**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	----	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	**0.0005**	----	**0.0001**
Cobalt	7440-48-4	0.001	mg/L	<0.001	**0.004**	**0.021**	----	**0.003**
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	**0.026**	----	**0.010**
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	**0.010**	----	**0.012**
Copper	7440-50-8	0.001	mg/L	**0.149**	**0.020**	**0.920**	----	**0.574**
Manganese	7439-96-5	0.001	mg/L	**0.053**	**2.83**	**1.52**	----	**0.007**
Molybdenum	7439-98-7	0.001	mg/L	<0.001	**0.002**	**0.001**	----	**0.002**
Nickel	7440-02-0	0.001	mg/L	**0.001**	**0.010**	**0.055**	----	**0.020**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	**0.002**	----	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	----	<0.01
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	----	<0.01
Zinc	7440-66-6	0.005	mg/L	<0.005	**0.071**	**0.070**	----	**0.022**
Iron	7439-89-6	0.05	mg/L	**0.20**	**5.36**	**4.67**	----	<0.05
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	<0.0001
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	<0.0001
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.1**	<0.1	**0.5**	**0.2**	**0.3**
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.02**	**4.74**	<0.05	----	<0.05
EK057G: Nitrite as N by Discrete Analyser								

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)			Client sample ID	GW1s	GW2	GW2s	GW8s	GW12
			Client sampling date / time	19-Feb-2018 00:00	19-Feb-2018 00:00	19-Feb-2018 00:00	19-Feb-2018 00:00	19-Feb-2018 00:00
Compound	CAS Number	LOR	Unit	EW1800725-001	EW1800725-002	EW1800725-003	EW1800725-004	EW1800725-005
				Result	Result	Result	Result	Result
EK057G: Nitrite as N by Discrete Analyser - Continued								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	----	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.06**	**0.05**	**0.27**	----	**0.06**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.06**	**0.05**	**0.27**	----	**0.06**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	**6.5**	<0.5	----	<0.5
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	<0.1	**6.6**	<0.5	----	<0.5
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	**0.06**	**0.11**	----	<0.05
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	**0.01**	<0.05	**0.03**	----	<0.01
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	**4.11**	**132**	**383**	**96.5**	**296**
Total Cations	----	0.01	meq/L	**3.74**	**118**	**362**	**93.1**	**268**
Ionic Balance	----	0.01	%	**4.75**	**5.52**	**2.85**	**1.82**	**4.78**
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	<20	<20	----	<20
C10 - C14 Fraction	----	50	µg/L	<50	<50	<50	----	<50
C15 - C28 Fraction	----	100	µg/L	<100	<100	<100	----	<100
C29 - C36 Fraction	----	50	µg/L	<50	<50	<50	----	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L	<50	<50	<50	----	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	<20	----	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L	<20	<20	<20	----	<20
>C10 - C16 Fraction	----	100	µg/L	<100	<100	<100	----	<100
>C16 - C34 Fraction	----	100	µg/L	<100	<100	<100	----	<100
>C34 - C40 Fraction	----	100	µg/L	<100	<100	<100	----	<100
^ >C10 - C40 Fraction (sum)	----	100	µg/L	<100	<100	<100	----	<100
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L	<100	<100	<100	----	<100
EP080: BTEXN								

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)			Client sample ID	GW1s	GW2	GW2s	GW8s	GW12
			Client sampling date / time	19-Feb-2018 00:00	19-Feb-2018 00:00	19-Feb-2018 00:00	19-Feb-2018 00:00	19-Feb-2018 00:00
Compound	CAS Number	LOR	Unit	EW1800725-001	EW1800725-002	EW1800725-003	EW1800725-004	EW1800725-005
				Result	Result	Result	Result	Result
EP080: BTEXN - Continued								
Benzene	71-43-2	1	µg/L	<1	<1	<1	----	<1
Toluene	108-88-3	2	µg/L	<2	<2	<2	----	<2
Ethylbenzene	100-41-4	2	µg/L	<2	<2	<2	----	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	<2	----	<2
ortho-Xylene	95-47-6	2	µg/L	<2	<2	<2	----	<2
^ Total Xylenes	----	2	µg/L	<2	<2	<2	----	<2
^ Sum of BTEX	----	1	µg/L	<1	<1	<1	----	<1
Naphthalene	91-20-3	5	µg/L	<5	<5	<5	----	<5
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	2	%	**111**	**120**	**109**	----	**125**
Toluene-D8	2037-26-5	2	%	**92.9**	**96.6**	**89.9**	----	**110**
4-Bromofluorobenzene	460-00-4	2	%	**92.2**	**96.6**	**90.3**	----	**110**

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)			Client sample ID	GW18	GW18s	GW21	GW21s	----
			Client sampling date / time	19-Feb-2018 00:00	19-Feb-2018 00:00	19-Feb-2018 00:00	19-Feb-2018 00:00	----
Compound	CAS Number	LOR	Unit	EW1800725-006	EW1800725-007	EW1800725-008	EW1800725-009	--------
				Result	Result	Result	Result	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	7690	1980	18400	2190	----
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	5	354	11	2680	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	237	904	518	369	----
Total Alkalinity as CaCO3	----	1	mg/L	237	904	518	369	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	54	202	298	80	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	4300	670	9170	859	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	162	108	1030	68	----
Magnesium	7439-95-4	1	mg/L	82	128	762	46	----
Sodium	7440-23-5	1	mg/L	2280	452	3390	517	----
Potassium	7440-09-7	1	mg/L	8	<1	20	1	----
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	742	797	5710	359	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.01	<0.01	<0.01	<0.01	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Arsenic	7440-38-2	0.001	mg/L	0.002	<0.001	0.001	0.003	----
Boron	7440-42-8	0.05	mg/L	0.29	0.30	0.43	1.11	----
Barium	7440-39-3	0.001	mg/L	6.54	0.157	1.79	0.220	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Uranium	7440-61-1	0.001	mg/L	<0.001	0.014	0.002	0.002	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.002	<0.001	----
Copper	7440-50-8	0.001	mg/L	0.004	0.003	<0.001	0.037	----
Manganese	7439-96-5	0.001	mg/L	0.236	0.005	3.36	0.044	----
Molybdenum	7439-98-7	0.001	mg/L	0.002	0.001	<0.001	0.001	----
Nickel	7440-02-0	0.001	mg/L	0.003	0.003	0.008	0.034	----

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)			Client sample ID	GW18	GW18s	GW21	GW21s	----
			Client sampling date / time	19-Feb-2018 00:00	19-Feb-2018 00:00	19-Feb-2018 00:00	19-Feb-2018 00:00	----
Compound	CAS Number	LOR	Unit	EW1800725-006	EW1800725-007	EW1800725-008	EW1800725-009	--------
				Result	Result	Result	Result	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	**0.01**	<0.01	<0.01	----
Zinc	7440-66-6	0.005	mg/L	**0.016**	**0.016**	**0.008**	**0.012**	----
Iron	7439-89-6	0.05	mg/L	**0.49**	<0.05	**0.11**	<0.05	----
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.03**	**2.12**	**0.02**	**13.8**	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	**0.001**	<0.001	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	**0.001**	**0.002**	**0.006**	----
Boron	7440-42-8	0.05	mg/L	**0.33**	**0.32**	**0.48**	**1.08**	----
Barium	7440-39-3	0.001	mg/L	**6.39**	**0.212**	**1.92**	**0.323**	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	**0.0002**	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	**0.007**	<0.001	**0.034**	----
Uranium	7440-61-1	0.001	mg/L	<0.001	**0.015**	**0.003**	**0.002**	----
Chromium	7440-47-3	0.001	mg/L	<0.001	**0.009**	**0.003**	**0.049**	----
Copper	7440-50-8	0.001	mg/L	**0.007**	**0.009**	**0.075**	**0.305**	----
Manganese	7439-96-5	0.001	mg/L	**0.214**	**0.138**	**3.15**	**0.825**	----
Molybdenum	7439-98-7	0.001	mg/L	**0.003**	<0.001	<0.001	<0.001	----
Nickel	7440-02-0	0.001	mg/L	**0.002**	**0.012**	**0.010**	**0.143**	----
Lead	7439-92-1	0.001	mg/L	<0.001	**0.003**	**0.002**	**0.011**	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	**0.02**	<0.01	**0.05**	----
Zinc	7440-66-6	0.005	mg/L	**0.022**	**0.033**	**0.089**	**0.054**	----
Iron	7439-89-6	0.05	mg/L	**0.47**	**4.43**	**0.45**	**25.4**	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.4**	**0.8**	**0.1**	**0.7**	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**4.60**	<0.01	**1.89**	**0.01**	----
EK057G: Nitrite as N by Discrete Analyser								

Analytical Results

Sub-Matrix: GROUNDWATER
(Matrix: WATER)

Compound	CAS Number	LOR	Unit	GW18	GW18s	GW21	GW21s	----
Client sampling date / time				19-Feb-2018 00:00	19-Feb-2018 00:00	19-Feb-2018 00:00	19-Feb-2018 00:00	----
				EW1800725-006	EW1800725-007	EW1800725-008	EW1800725-009	--------
				Result	Result	Result	Result	----
EK057G: Nitrite as N by Discrete Analyser - Continued								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.02**	**0.04**	<0.01	**2.26**	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.02**	**0.04**	<0.01	**2.26**	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**4.3**	<0.1	**2.5**	**0.6**	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	**4.3**	<0.1	**2.5**	**2.9**	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.04**	**0.20**	**0.20**	**0.59**	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.05	**0.14**	**0.10**	**0.21**	----
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	**127**	**41.2**	**275**	**33.3**	----
Total Cations	----	0.01	meq/L	**114**	**35.6**	**262**	**29.7**	----
Ionic Balance	----	0.01	%	**5.36**	**7.27**	**2.45**	**5.68**	----
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	<20	<20	<20	----
C10 - C14 Fraction	----	50	µg/L	<50	<50	<50	<50	----
C15 - C28 Fraction	----	100	µg/L	<100	<100	<100	<100	----
C29 - C36 Fraction	----	50	µg/L	<50	<50	<50	<50	----
^ C10 - C36 Fraction (sum)	----	50	µg/L	<50	<50	<50	<50	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	<20	<20	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L	<20	<20	<20	<20	----
>C10 - C16 Fraction	----	100	µg/L	<100	<100	<100	<100	----
>C16 - C34 Fraction	----	100	µg/L	<100	<100	<100	<100	----
>C34 - C40 Fraction	----	100	µg/L	<100	<100	<100	<100	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L	<100	<100	<100	<100	----
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L	<100	<100	<100	<100	----
EP080: BTEXN								

Analytical Results

Sub-Matrix: GROUNDWATER
(Matrix: WATER)

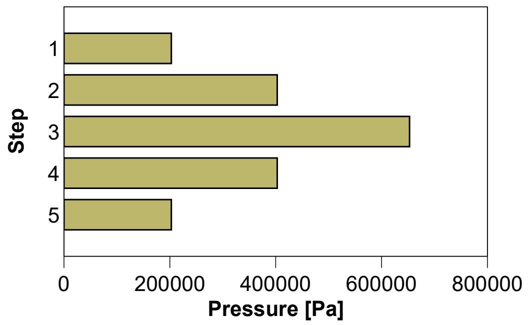
			Client sample ID	GW18	GW18s	GW21	GW21s	----
			Client sampling date / time	19-Feb-2018 00:00	19-Feb-2018 00:00	19-Feb-2018 00:00	19-Feb-2018 00:00	----
Compound	CAS Number	LOR	Unit	EW1800725-006	EW1800725-007	EW1800725-008	EW1800725-009	--------
				Result	Result	Result	Result	----
EP080: BTEXN - Continued								
Benzene	71-43-2	1	µg/L	<1	<1	<1	<1	----
Toluene	108-88-3	2	µg/L	<2	<2	<2	<2	----
Ethylbenzene	100-41-4	2	µg/L	<2	<2	<2	<2	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	<2	<2	----
ortho-Xylene	95-47-6	2	µg/L	<2	<2	<2	<2	----
^ Total Xylenes	----	2	µg/L	<2	<2	<2	<2	----
^ Sum of BTEX	----	1	µg/L	<1	<1	<1	<1	----
Naphthalene	91-20-3	5	µg/L	<5	<5	<5	<5	----
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	2	%	**115**	**104**	**120**	**123**	----
Toluene-D8	2037-26-5	2	%	**94.1**	**86.4**	**97.9**	**100**	----
4-Bromofluorobenzene	460-00-4	2	%	**96.0**	**88.8**	**97.2**	**100**	----

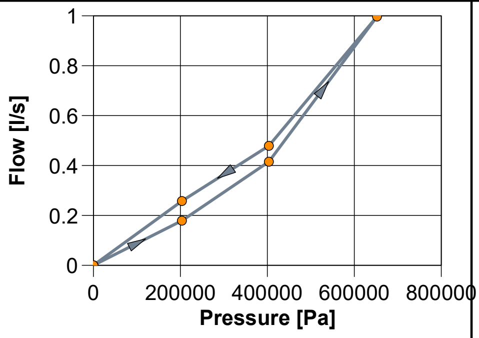
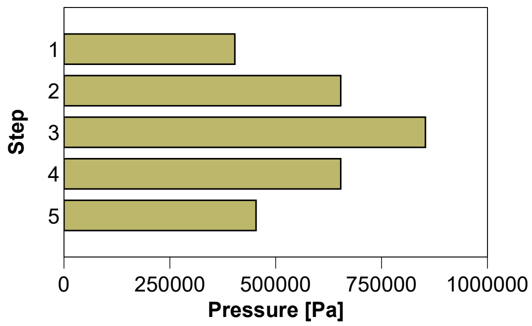
Surrogate Control Limits

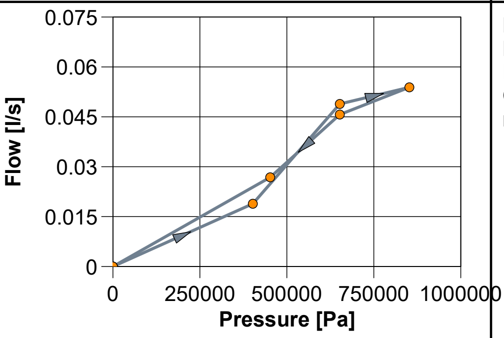
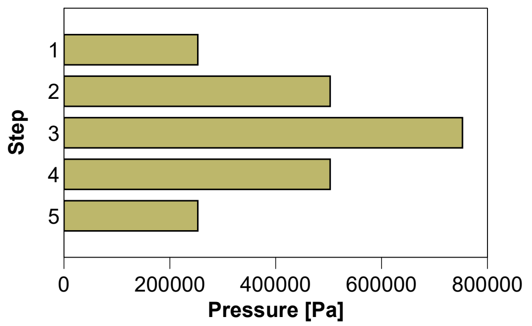
Sub-Matrix: **GROUNDWATER**

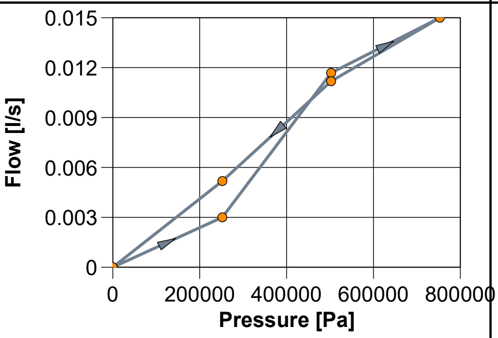
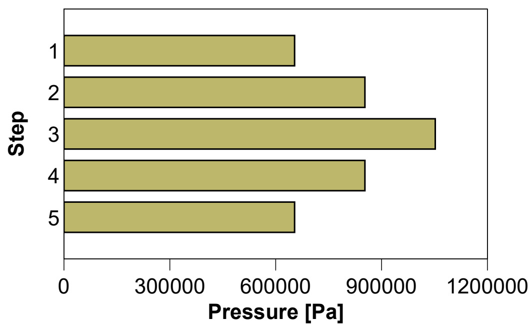
Compound	*CAS Number*	*Recovery Limits (%)* Low	*Recovery Limits (%)* High
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	71	137
Toluene-D8	2037-26-5	79	131
4-Bromofluorobenzene	460-00-4	70	128

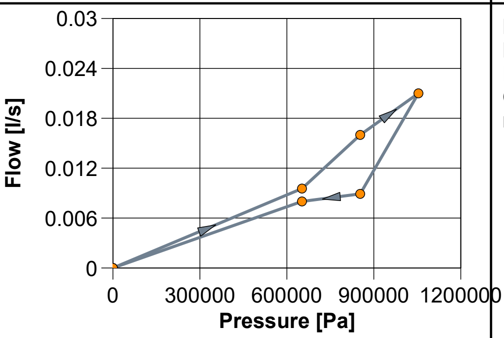
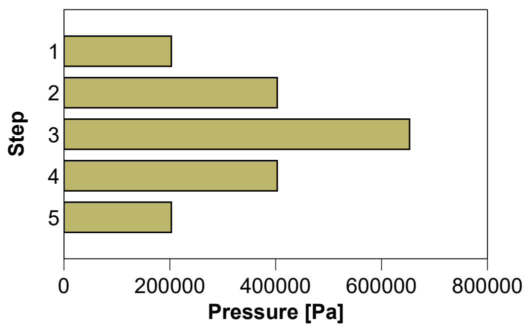
Attachment A3 – Hydraulic Testing Analysis

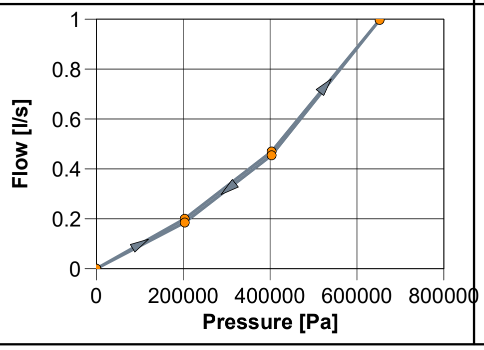
<table>
<tr><th>Test Interval
Top
Bottom</th><th>Graphs</th><th>Result</th></tr>
<tr><td>52.00 m
164.00 m</td><td>

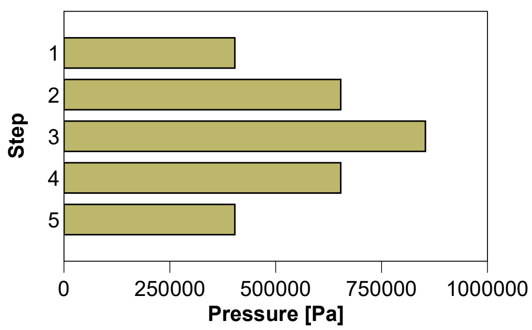
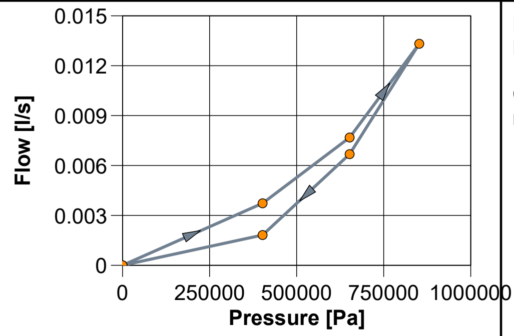
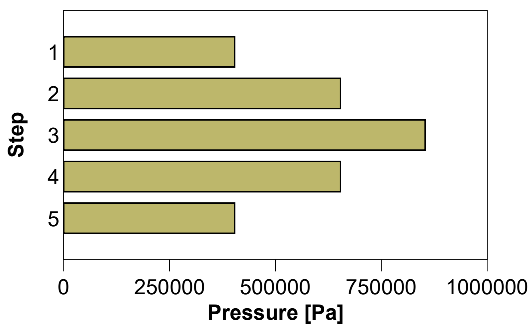
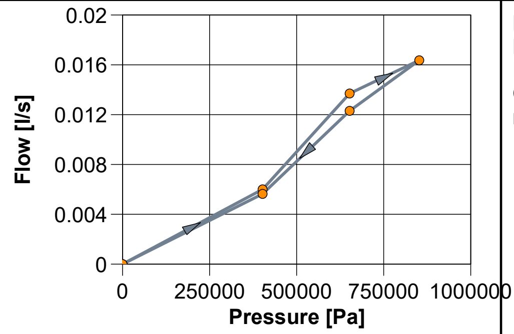
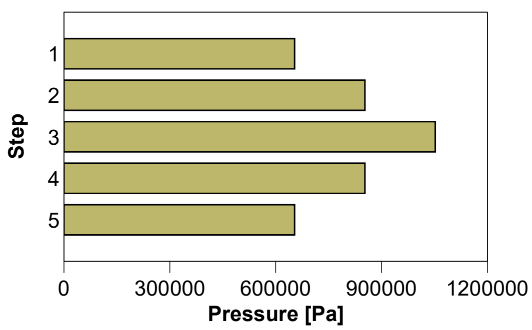
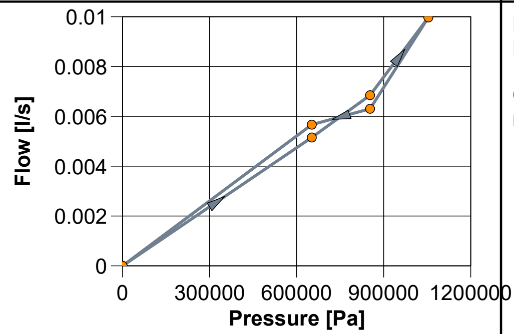
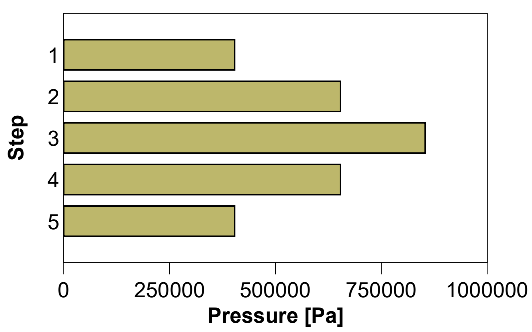
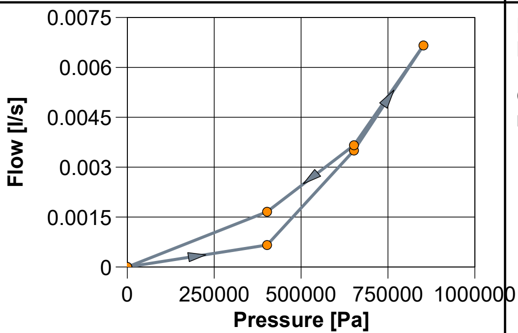
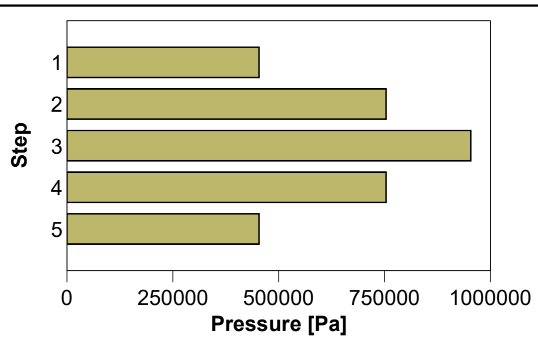
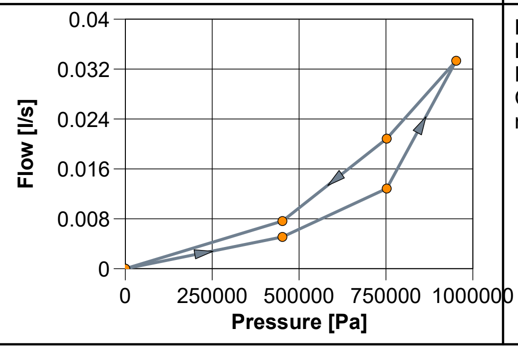

</td><td>Laminar
Lugeon: 0.4
Hydraulic
Conductivity: 7.51E-3
m/d</td></tr>
<tr><td>58.00 m
64.00 m</td><td>

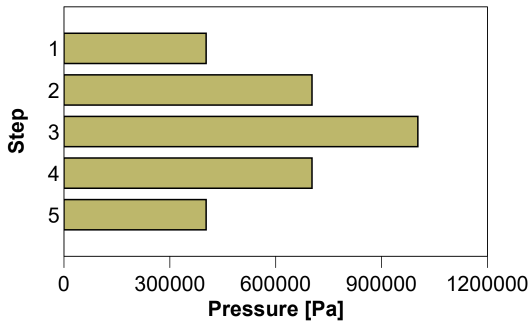

</td><td>Laminar
Lugeon: 0.5
Hydraulic
Conductivity: 5.19E-3
m/d</td></tr>
<tr><td>70.00 m
76.00 m</td><td>

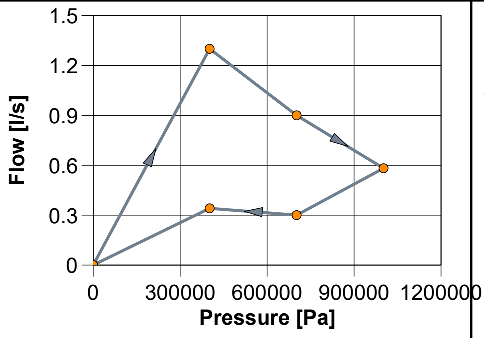
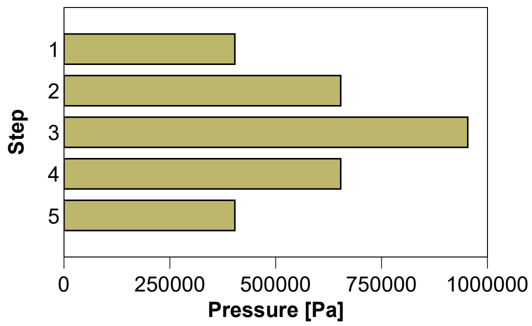

</td><td>Laminar
Lugeon: 0.1
Hydraulic
Conductivity:
1.50E-3 m/d</td></tr>
<tr><td>82.00 m
88.00 m</td><td>

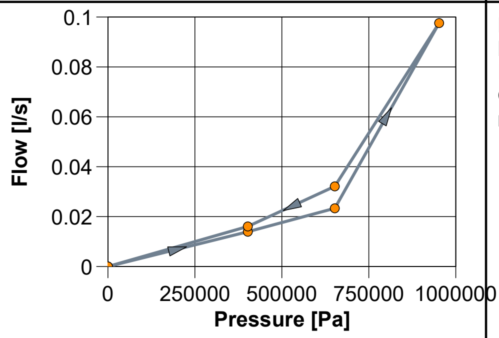
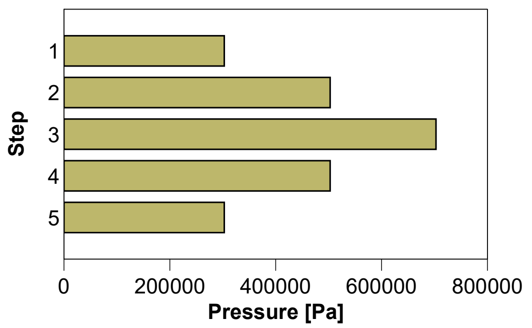

</td><td>Laminar
Lugeon: 0.1
Hydraulic
Conductivity: 1.34E-3
m/d</td></tr>
<tr><td>97.00 m
101.00 m</td><td>

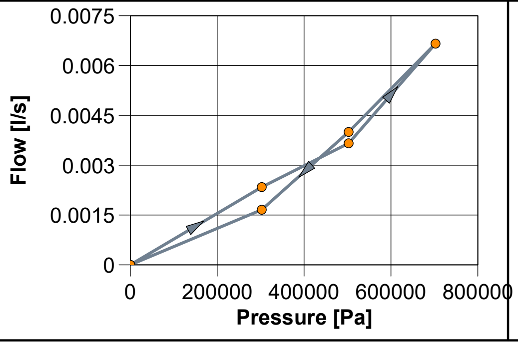

</td><td>Laminar
Lugeon: 12.3
Hydraulic
Conductivity: 1.15E-1
m/d</td></tr>
<tr><td></td><td></td><td></td></tr>
</table>

<table>
<tr><th>Test Interval
Top
Bottom</th><th>Graphs</th><th>Result</th></tr>
<tr><td>106.00 m
110.00 m</td><td></td><td>Dilation
Lugeon: 0.1
Hydraulic
Conductivity: 9.71E-4
m/d</td></tr>
<tr><td>112.00 m
118.00 m</td><td></td><td>Laminar
Lugeon: 0.1
Hydraulic
Conductivity: 1.46E-3
m/d</td></tr>
<tr><td>124.00 m
128.00 m</td><td></td><td>Laminar
Lugeon: 0.1
Hydraulic
Conductivity: 9.93E-4
m/d</td></tr>
<tr><td>130.00 m
134.00 m</td><td></td><td>Dilation
Lugeon: 0.0
Hydraulic
Conductivity: 1.73E-4
m/d</td></tr>
<tr><td>136.00 m
140.00 m</td><td></td><td>Dilation
Lugeon: 0.1
Hydraulic
Conductivity: 1.21E-3
m/d</td></tr>
</table>

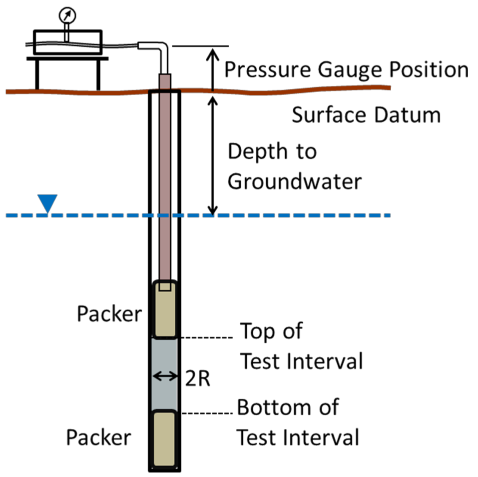
<table>
<tr><th>Test Interval
Top
Bottom</th><th>Graphs</th><th>Result</th></tr>
<tr><td>142.00 m
146.00 m</td><td>


</td><td>Dilation
Lugeon: 0.1
Hydraulic
Conductivity: 1.21E-3
m/d</td></tr>
<tr><td>148.00 m
164.00 m</td><td>


</td><td>Dilation
Lugeon: 0.1
Hydraulic
Conductivity: 1.21E-3
m/d</td></tr>
<tr><td>160.00 m
164.00 m</td><td>

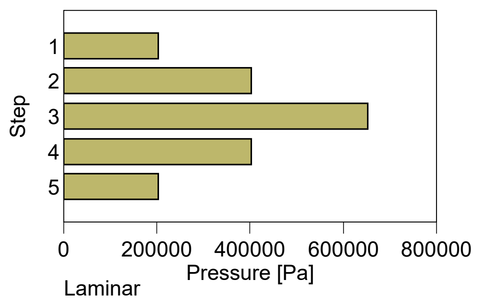

</td><td>Laminar
Lugeon: 0.1
Hydraulic
Conductivity: 8.15E-4
m/d</td></tr>
</table>

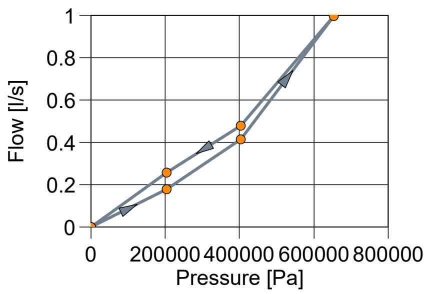
Location: CR04	Lugeon Test: 52-164	Tested bore: 97 - 101
Test Conducted by: A Fulton / Matt Lemke		Test Date: 16/09/2017
Analysis Performed by: A Fulton		Analysis Date: 22/09/2017
Lithology:		

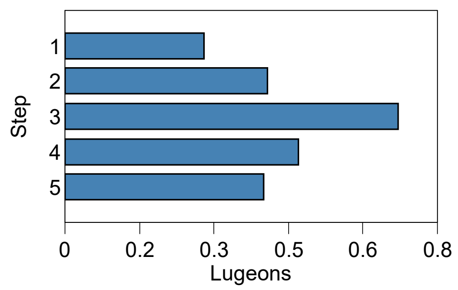


Top of Test Interval: 52.00 m
Bottom of Test Interval: 164.00 m
Length of Test Interval: 112.00 m
Gauge Position: 1.50 m
Depth to Groundwater: 13.00 m
Radius of Test Section: 0.06 m

Step	Pressure [Pa]	Flow Meter Readings [l/s]					Average Flow Rate [l/s]	Hydraulic Conductivity		
		1	2	3	4	5		[m/d]	[m/d]	Lugeon
1	203000.0	0.200	0.183	0.180	0.167	0.170	0.180	4.71×10^{-3}	0.005	0.3
2	403000.0	0.475	0.408	0.408	0.392	0.392	0.415	6.87×10^{-3}	0.007	0.4
3	653000.0	1.119	1.069	0.919	0.936	0.936	0.996	1.13×10^{-2}	0.011	0.7
4	403000.0	0.487	0.504	0.484	0.458	0.463	0.479	7.94×10^{-3}	0.008	0.5
5	203000.0	0.260	0.260	0.253	0.260	0.258	0.258	6.74×10^{-3}	0.007	0.4
							Average	7.51×10^{-3}	0.008	0.4

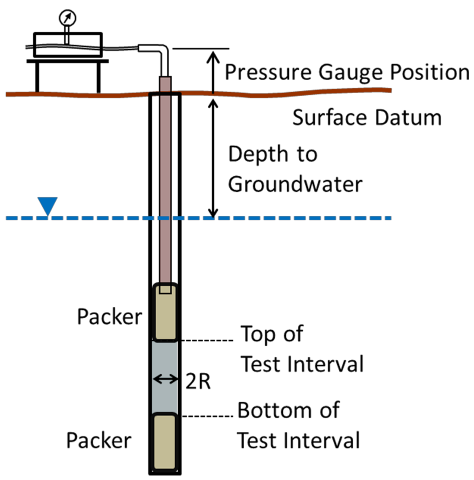






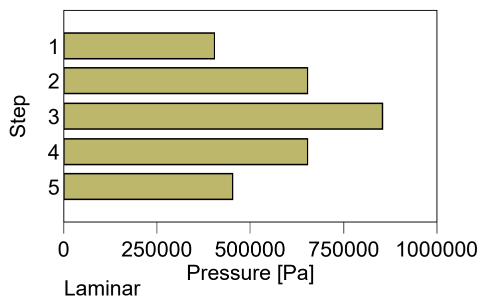
Laminar
Lugeon: 0.4
Hydraulic Conductivity: 7.51E-3 m/d

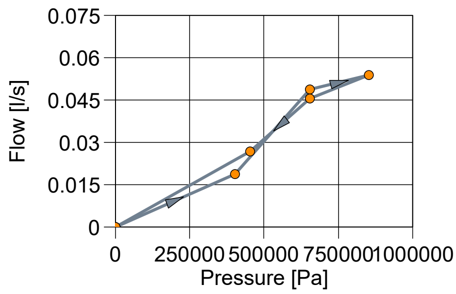
Location: CR04	Lugeon Test: 58-64	Tested bore: 97 - 101
Test Conducted by: A Fulton / Matt Lemke		Test Date: 16/09/2017
Analysis Performed by: A Fulton		Analysis Date: 22/09/2017
Lithology:		

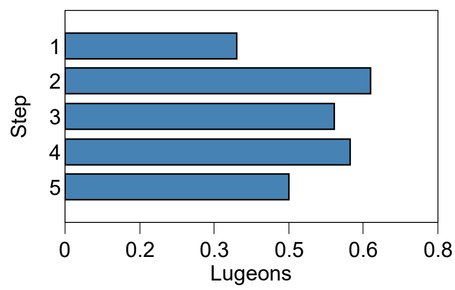


Top of Test Interval: 58.00 m
Bottom of Test Interval: 64.00 m
Length of Test Interval: 6.00 m
Gauge Position: 1.50 m
Depth to Groundwater: 13.00 m
Radius of Test Section: 0.06 m

Step	Pressure [Pa]	Flow Meter Readings [l/s]					Average Flow Rate [l/s]	Hydraulic Conductivity		
		1	2	3	4	5		[m/d]	[m/d]	Lugeon
1	403000.0	0.020	0.020	0.020	0.015	0.019	0.019	3.56×10^{-3}	0.004	0.3
2	653000.0	0.043	0.050	0.051	0.050	0.051	0.049	6.31×10^{-3}	0.006	0.6
3	853000.0	0.053	0.059	0.055	0.052	0.050	0.054	5.56×10^{-3}	0.006	0.5
4	653000.0	0.053	0.038	0.047	0.045	0.045	0.046	5.90×10^{-3}	0.006	0.6
5	453000.0	0.029	0.024	0.027	0.027	0.027	0.027	4.63×10^{-3}	0.005	0.5
							Average	5.19×10^{-3}	0.005	0.5

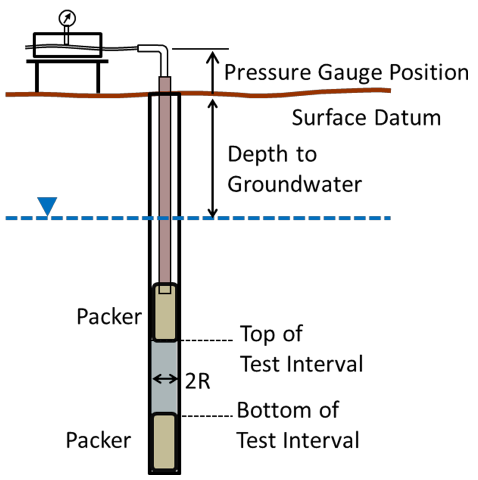






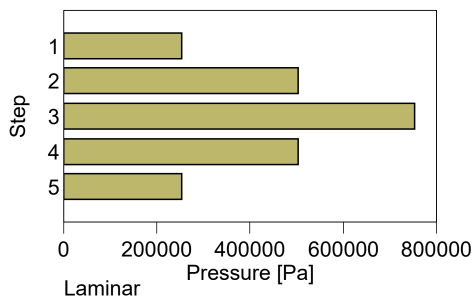
Laminar
Lugeon: 0.5
Hydraulic Conductivity: 5.19E-3 m/d

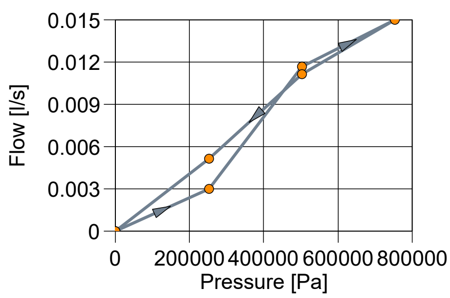
Location: CR04	Lugeon Test: 70-76	Tested bore: 97 - 101
Test Conducted by: A Fulton / Matt Lemke		Test Date: 16/09/2017
Analysis Performed by: A Fulton		Analysis Date: 22/09/2017
Lithology:		

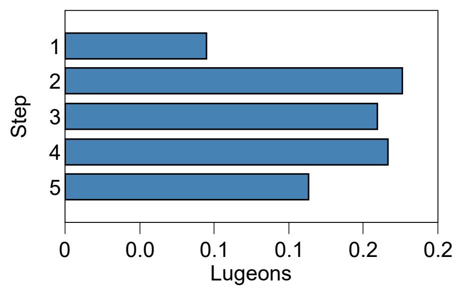


Top of Test Interval: 70.00 m
Bottom of Test Interval: 76.00 m
Length of Test Interval: 6.00 m
Gauge Position: 1.50 m
Depth to Groundwater: 13.00 m
Radius of Test Section: 0.06 m

Step	Pressure [Pa]	Flow Meter Readings [l/s]					Average Flow Rate [l/s]	Hydraulic Conductivity		
		1	2	3	4	5		[m/d]	[m/s]	Lugeon
1	253000.0	0.010	-0.013	-0.002	0.005	0.015	0.003	7.80×10^{-4}	0.000	0.1
2	503000.0	0.009	0.011	0.012	0.012	0.014	0.012	1.86×10^{-3}	0.000	0.2
3	753000.0	0.022	0.008	0.012	0.015	0.018	0.015	1.72×10^{-3}	0.000	0.2
4	503000.0	0.018	0.004	0.008	0.011	0.015	0.011	1.78×10^{-3}	0.000	0.2
5	253000.0	0.003	0.003	0.006	0.004	0.009	0.005	1.34×10^{-3}	0.000	0.1
							Average	1.50×10^{-3}	0.000	0.1

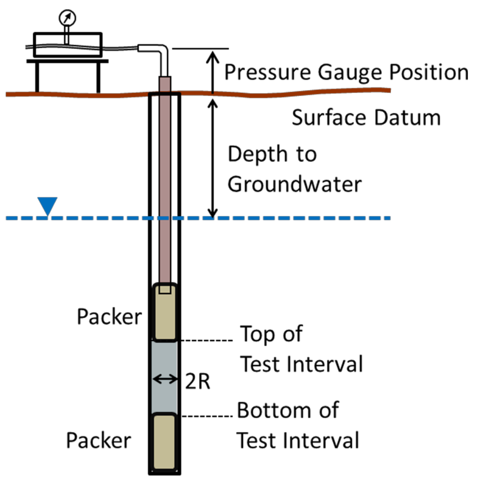






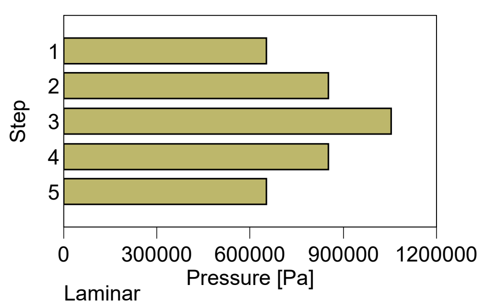
Laminar
Lugeon: 0.1
Hydraulic Conductivity: 1.50E-3 m/d

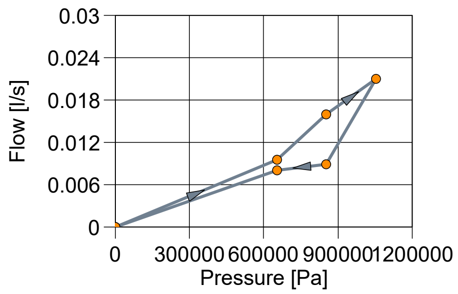
Location: CR04	Lugeon Test: 82-88	Tested bore: 97 - 101
Test Conducted by: A Fulton / Matt Lemke		Test Date: 16/09/2017
Analysis Performed by: A Fulton		Analysis Date: 22/09/2017
Lithology:		

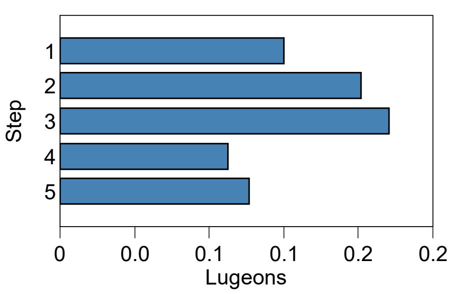


Top of Test Interval: 82.00 m
Bottom of Test Interval: 88.00 m
Length of Test Interval: 6.00 m
Gauge Position: 1.00 m
Depth to Groundwater: 13.00 m
Radius of Test Section: 0.06 m

Step	Pressure [Pa]	Flow Meter Readings [l/s]					Average Flow Rate [l/s]	Hydraulic Conductivity		
		1	2	3	4	5		[m/d]	[m/d]	Lugeon
1	653000.0	0.009	0.006	0.009	0.009	0.014	0.010	1.24×10^{-3}	0.001	0.1
2	853000.0	0.013	0.015	0.017	0.017	0.018	0.016	1.66×10^{-3}	0.002	0.2
3	1053000.0	0.023	0.022	0.020	0.022	0.018	0.021	1.81×10^{-3}	0.002	0.2
4	853000.0	0.008	0.010	0.009	0.008	0.010	0.009	9.27×10^{-4}	0.001	0.1
5	653000.0	0.007	0.012	0.006	0.009	0.006	0.008	1.04×10^{-3}	0.001	0.1
							Average	1.34×10^{-3}	0.001	0.1

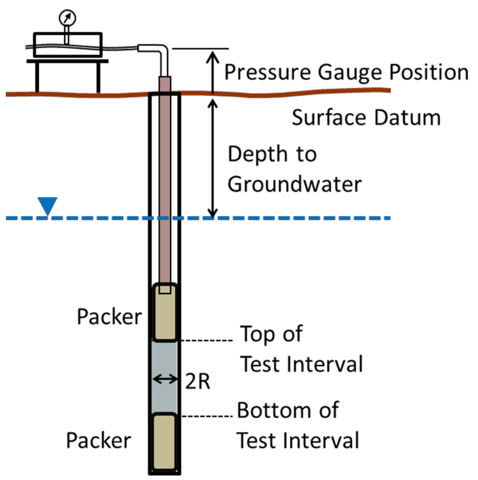






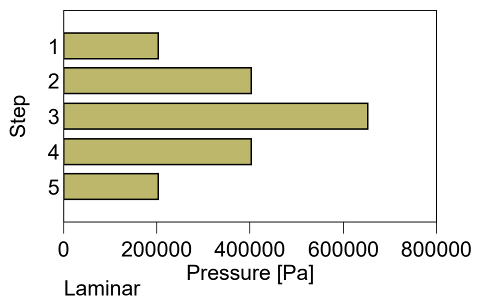
Laminar
Lugeon: 0.1
Hydraulic Conductivity: 1.34E-3 m/d

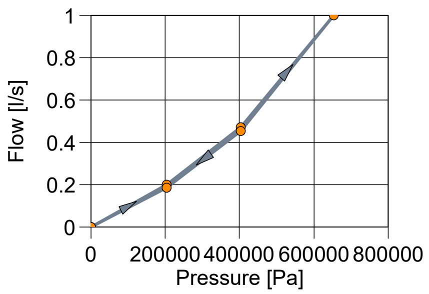
Location: CR04	Lugeon Test: 97 - 101	Tested bore: 97 - 101
Test Conducted by:		Test Date: 15/09/2017
Analysis Performed by: A Fulton		Analysis Date: 22/09/2017
Lithology:		

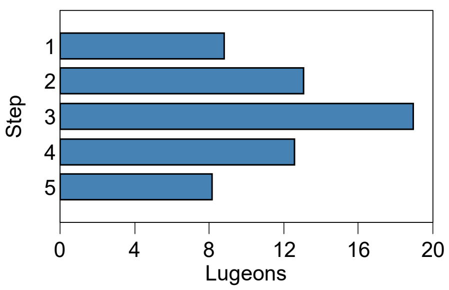


Top of Test Interval: 97.00 m
Bottom of Test Interval: 101.00 m
Length of Test Interval: 4.00 m
Gauge Position: 1.00 m
Depth to Groundwater: 13.00 m
Radius of Test Section: 0.06 m

Step	Pressure [Pa]	Flow Meter Readings [l/s]					Average Flow Rate [l/s]	Hydraulic Conductivity		
		1	2	3	4	5		[m/d]	[cm/s]	Lugeon
1	203000.0	0.200	0.200	0.200	0.200	0.200	0.200	8.26×10^{-2}	0.000	8.8
2	403000.0	0.470	0.470	0.470	0.470	0.470	0.470	1.22×10^{-1}	0.000	13.0
3	653000.0	0.998	0.998	0.998	0.998	0.998	0.998	1.77×10^{-1}	0.000	18.9
4	403000.0	0.453	0.453	0.453	0.453	0.453	0.453	1.18×10^{-1}	0.000	12.6
5	203000.0	0.185	0.185	0.185	0.185	0.185	0.185	7.64×10^{-2}	0.000	8.2
							Average	1.15×10^{-1}	0.000	12.3

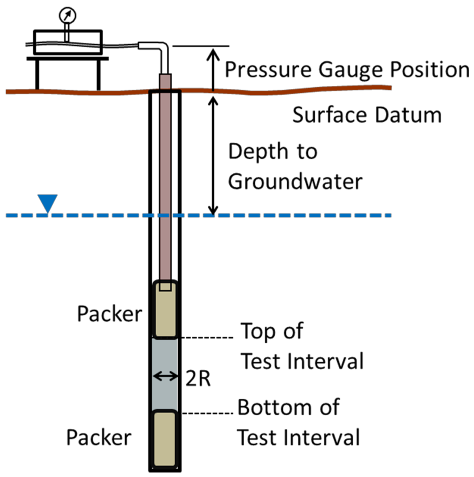






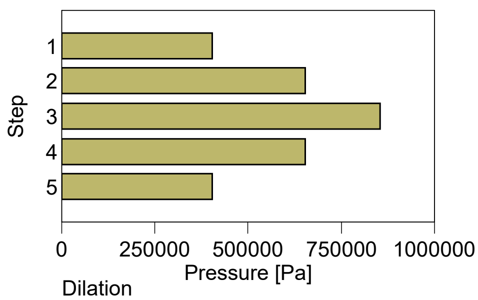
Laminar
Lugeon: 12.3
Hydraulic Conductivity: 1.15E-1 m/d

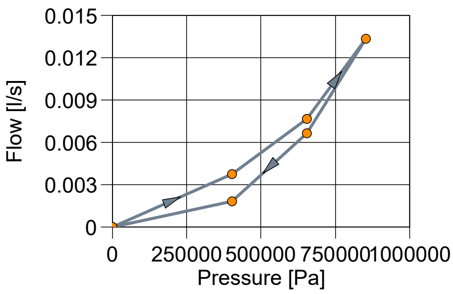
Location: CR04	Lugeon Test: 106-110	Tested bore: 97 - 101
Test Conducted by: Matt Lemke		Test Date: 15/09/2017
Analysis Performed by: A Fulton		Analysis Date: 22/09/2017
Lithology:		

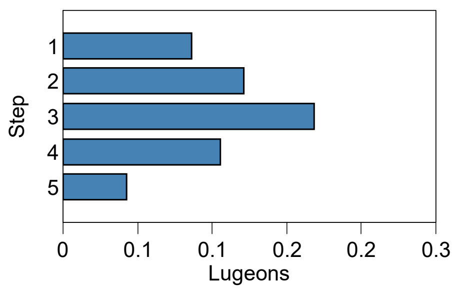


Top of Test Interval: 106.00 m
Bottom of Test Interval: 110.00 m
Length of Test Interval: 4.00 m
Gauge Position: 1.00 m
Depth to Groundwater: 13.00 m
Radius of Test Section: 0.06 m

Step	Pressure [Pa]	Flow Meter Readings [l/s]					Average Flow Rate [l/s]	Hydraulic Conductivity		
		1	2	3	4	5		[m/d]	[m/s]	Lugeon
1	403000.0	0.007	0.000	0.001	0.001	0.009	0.004	9.71×10^{-4}	0.000	0.1
2	653000.0	0.005	0.012	0.012	0.005	0.005	0.008	1.36×10^{-3}	0.000	0.1
3	853000.0	0.012	0.018	0.018	0.012	0.007	0.013	1.89×10^{-3}	0.000	0.2
4	653000.0	0.002	0.007	0.007	0.008	0.010	0.007	1.19×10^{-3}	0.000	0.1
5	403000.0	0.003	0.001	0.001	0.004	0.001	0.002	4.77×10^{-4}	0.000	0.1
							Average	1.18×10^{-3}	0.000	0.1

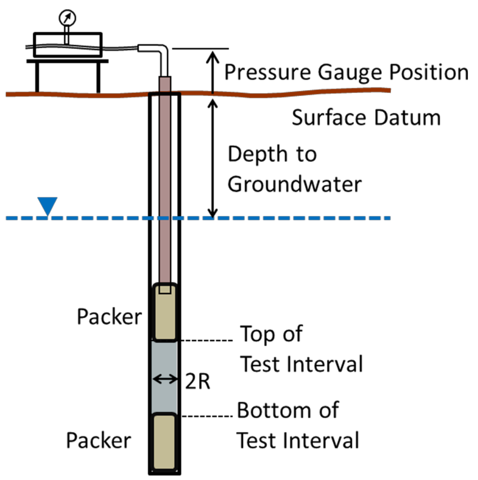






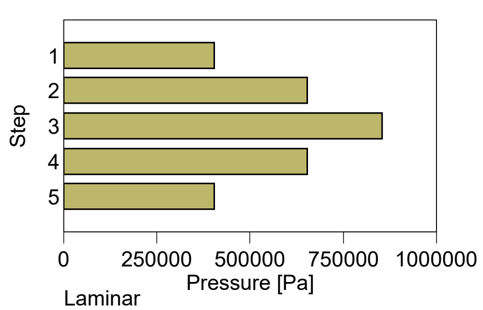
Dilation
Lugeon: 0.1
Hydraulic Conductivity: 9.71E-4 m/d

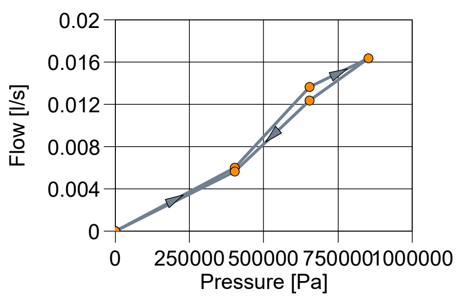
Location: CR04	Lugeon Test: 112-118	Tested bore: 97 - 101
Test Conducted by: Matt Lemke		Test Date: 15/09/2017
Analysis Performed by: A Fulton		Analysis Date: 22/09/2017
Lithology:		

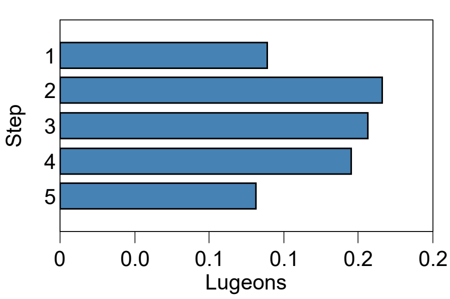


Top of Test Interval: 112.00 m
Bottom of Test Interval: 118.00 m
Length of Test Interval: 6.00 m
Gauge Position: 1.00 m
Depth to Groundwater: 13.00 m
Radius of Test Section: 0.06 m

Step	Pressure [Pa]	Flow Meter Readings [l/s]					Average Flow Rate [l/s]	Hydraulic Conductivity		
		1	2	3	4	5		[m/d]	[m/s]	Lugeon
1	403000.0	0.003	0.005	0.005	0.008	0.008	0.006	1.14×10^{-3}	0.000	0.1
2	653000.0	0.012	0.012	0.012	0.018	0.015	0.014	1.78×10^{-3}	0.000	0.2
3	853000.0	0.018	0.017	0.022	0.015	0.010	0.016	1.70×10^{-3}	0.000	0.2
4	653000.0	0.013	0.012	0.013	0.013	0.010	0.012	1.60×10^{-3}	0.000	0.2
5	403000.0	0.006	0.004	0.007	0.004	0.007	0.006	1.08×10^{-3}	0.000	0.1
							Average	1.46×10^{-3}	0.000	0.1

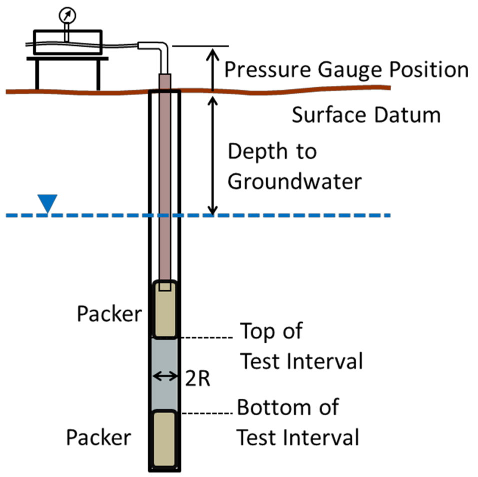






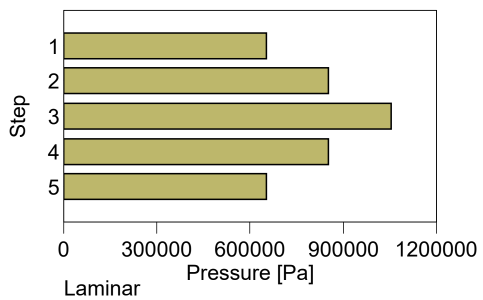
Laminar
Lugeon: 0.1
Hydraulic Conductivity: 1.46E-3 m/d

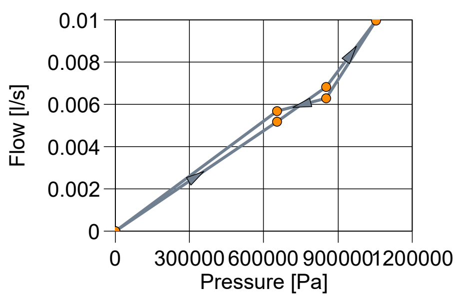
Location: CR04	Lugeon Test: 124-128	Tested bore: 97 - 101
Test Conducted by: Matt Lemke		Test Date: 15/09/2017
Analysis Performed by: A Fulton		Analysis Date: 22/09/2017
Lithology:		

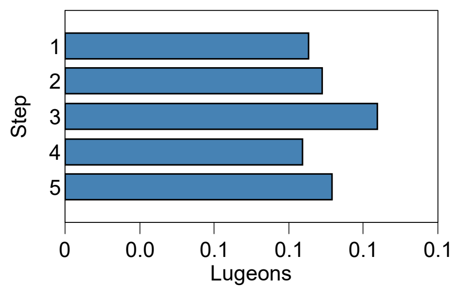


Top of Test Interval: 124.00 m
Bottom of Test Interval: 128.00 m
Length of Test Interval: 4.00 m
Gauge Position: 1.00 m
Depth to Groundwater: 13.00 m
Radius of Test Section: 0.06 m

Step	Pressure [Pa]	Flow Meter Readings [l/s]					Average Flow Rate [l/s]	Hydraulic Conductivity		
		1	2	3	4	5		[m/d]	[m/s]	Lugeon
1	653000.0	0.005	0.005	0.006	0.005	0.005	0.005	9.18×10^{-4}	1.063×10^{-8}	0.1
2	853000.0	0.007	0.007	0.007	0.007	0.007	0.007	9.69×10^{-4}	1.122×10^{-8}	0.1
3	1053000.0	0.022	0.006	0.007	0.009	0.005	0.010	1.18×10^{-3}	1.361×10^{-8}	0.1
4	853000.0	0.009	0.007	0.008	0.001	0.007	0.006	8.94×10^{-4}	1.034×10^{-8}	0.1
5	653000.0	0.006	0.005	0.007	0.006	0.004	0.006	1.01×10^{-3}	1.166×10^{-8}	0.1
							Average	9.93×10^{-4}	1.149×10^{-8}	0.1

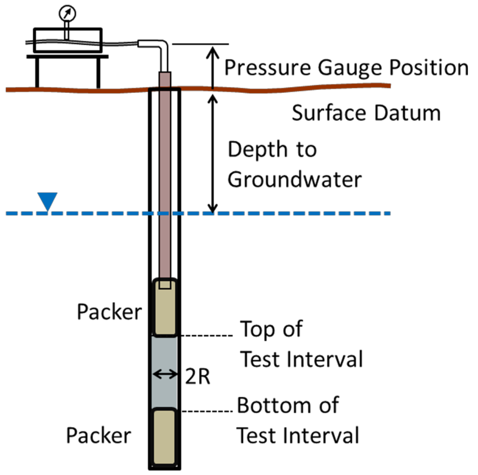






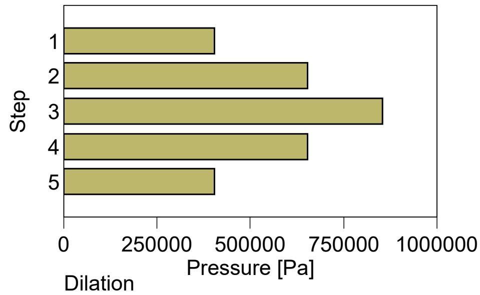
Laminar
Lugeon: 0.1
Hydraulic Conductivity: 9.93E-4 m/d

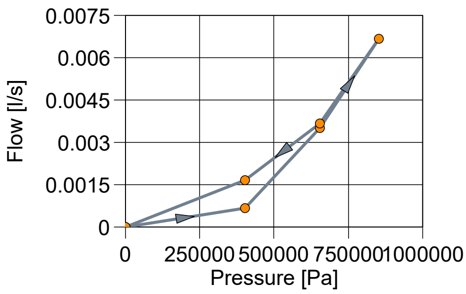
Location: CR04	Lugeon Test: 130-134	Tested bore: 97 - 101
Test Conducted by: Matt Lemke		Test Date: 15/09/2017
Analysis Performed by: A Fulton		Analysis Date: 22/09/2017
Lithology:		

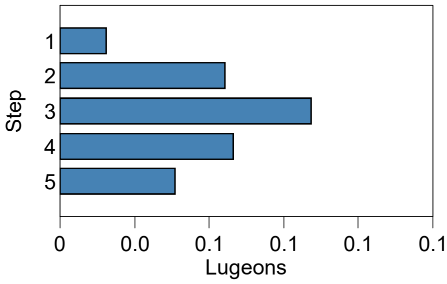


Top of Test Interval: 130.00 m
Bottom of Test Interval: 134.00 m
Length of Test Interval: 4.00 m
Gauge Position: 1.00 m
Depth to Groundwater: 13.00 m
Radius of Test Section: 0.06 m

Step	Pressure [Pa]	Flow Meter Readings [l/s]					Average Flow Rate [l/s]	Hydraulic Conductivity		
		1	2	3	4	5		[m/d]	[m/s]	Lugeon
1	403000.0	0.002	0.000	0.000	0.002	0.000	0.001	1.73×10^{-4}	2.006×10^{-9}	0.0
2	653000.0	0.001	0.001	0.004	0.006	0.006	0.003	6.22×10^{-4}	7.201×10^{-9}	0.1
3	853000.0	0.008	0.002	0.008	0.007	0.008	0.007	9.46×10^{-4}	1.095×10^{-8}	0.1
4	653000.0	0.007	0.003	0.003	0.002	0.003	0.004	6.52×10^{-4}	7.544×10^{-9}	0.1
5	403000.0	0.001	0.001	0.003	0.001	0.001	0.002	4.33×10^{-4}	5.016×10^{-9}	0.0
							Average	5.65×10^{-4}	6.543×10^{-9}	0.1

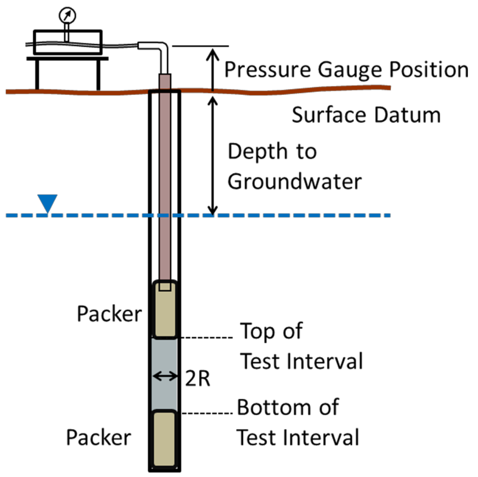






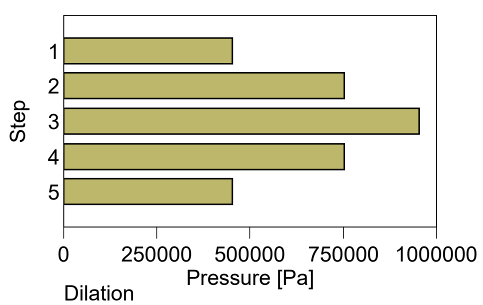
Dilation
Lugeon: 0.0
Hydraulic Conductivity: 1.73E-4 m/d

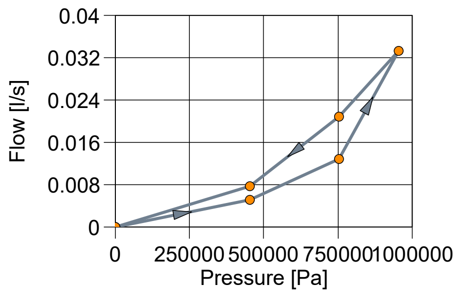
Location: CR04	Lugeon Test: 136-140	Tested bore: 97 - 101
Test Conducted by: Matt Lemke		Test Date: 14/09/2017
Analysis Performed by: A Fulton		Analysis Date: 22/09/2017
Lithology:		

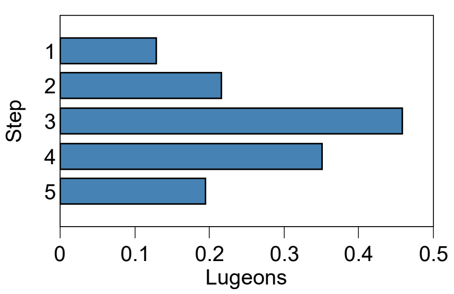


Top of Test Interval: 136.00 m
Bottom of Test Interval: 140.00 m
Length of Test Interval: 4.00 m
Gauge Position: 1.00 m
Depth to Groundwater: 13.00 m
Radius of Test Section: 0.06 m

Step	Pressure [Pa]	Flow Meter Readings [l/s]					Average Flow Rate [l/s]	Hydraulic Conductivity		
		1	2	3	4	5		[m/d]	[m/s]	Lugeon
1	453000.0	0.005	0.002	0.004	0.005	0.009	0.005	1.21×10^{-3}	1.400×10^{-8}	0.1
2	753000.0	0.011	0.008	0.015	0.015	0.016	0.013	2.03×10^{-3}	2.344×10^{-8}	0.2
3	953000.0	0.032	0.030	0.033	0.033	0.038	0.033	4.29×10^{-3}	4.971×10^{-8}	0.5
4	753000.0	0.036	0.031	0.023	0.008	0.006	0.021	3.29×10^{-3}	3.805×10^{-8}	0.4
5	453000.0	0.003	0.012	0.010	0.007	0.007	0.008	1.82×10^{-3}	2.112×10^{-8}	0.2
							Average	2.53×10^{-3}	2.926×10^{-8}	0.3

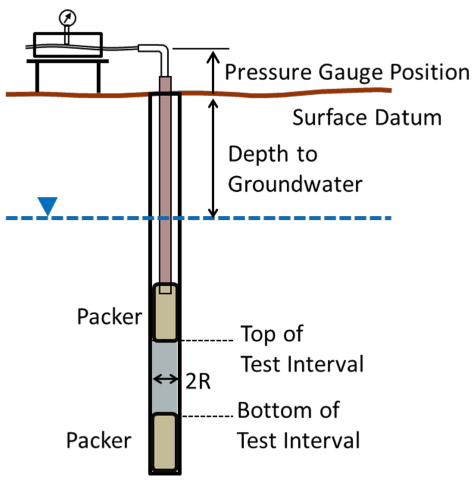






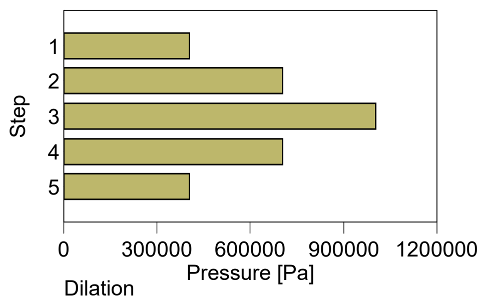
Dilation
Lugeon: 0.1
Hydraulic Conductivity: 1.21E-3 m/d

Location: CR04	Lugeon Test: 142-146	Tested bore: 97 - 101
Test Conducted by: Matt Lemke		Test Date: 14/09/2017
Analysis Performed by: A Fulton		Analysis Date: 22/09/2017
Lithology:		

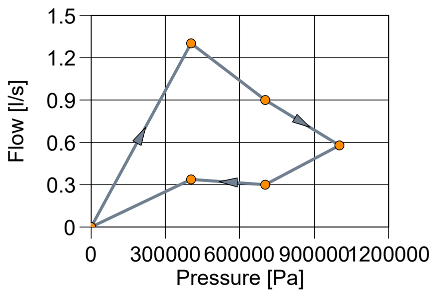


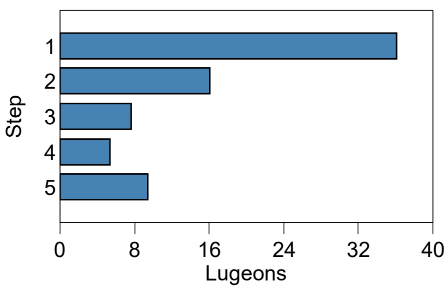
Top of Test Interval: 142.00 m
Bottom of Test Interval: 146.00 m
Length of Test Interval: 4.00 m
Gauge Position: 1.00 m
Depth to Groundwater: 13.00 m
Radius of Test Section: 0.06 m

Step	Pressure [Pa]	Flow Meter Readings [l/s]					Average Flow Rate [l/s]	Hydraulic Conductivity		
		1	2	3	4	5		[m/d]	[m/s]	Lugeon
1	403000.0	0.500	1.000	1.000	2.000	2.000	1.300	3.38×10^{-1}	3.912×10^{-6}	36.1
2	703000.0	0.800	1.300	0.800	0.600	1.000	0.900	1.50×10^{-1}	1.741×10^{-6}	16.1
3	1003000.0	0.780	0.780	0.280	0.580	0.480	0.580	7.15×10^{-2}	8.270×10^{-7}	7.6
4	703000.0	0.140	0.140	0.340	0.440	0.440	0.300	5.02×10^{-2}	5.805×10^{-7}	5.4
5	403000.0	0.100	0.300	0.200	0.700	0.400	0.340	8.84×10^{-2}	1.023×10^{-6}	9.4
							Average	1.40×10^{-1}	1.617×10^{-6}	14.9

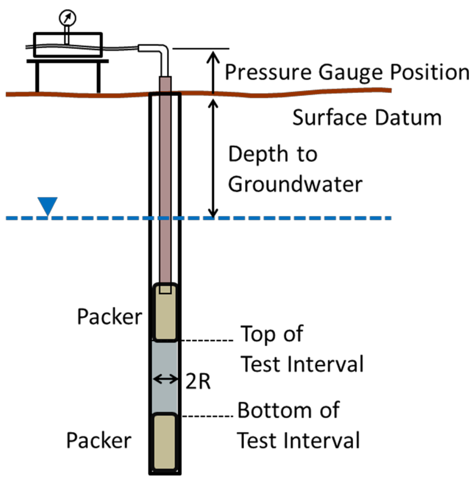


Dilation
Lugeon: 0.1
Hydraulic Conductivity: 1.21E-3 m/d



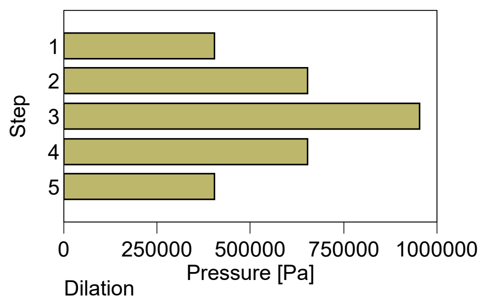


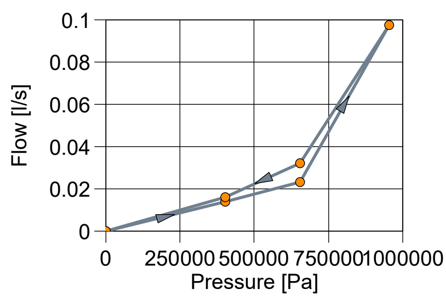
Location: CR04	Lugeon Test: 148-164	Tested bore: 97 - 101
Test Conducted by: Matt Lemke		Test Date: 14/09/2017
Analysis Performed by: A Fulton		Analysis Date: 22/09/2017
Lithology:		

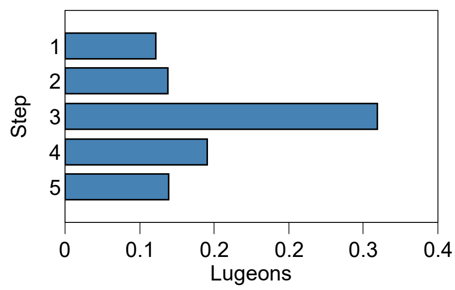


Top of Test Interval: 148.00 m
Bottom of Test Interval: 164.00 m
Length of Test Interval: 16.00 m
Gauge Position: 1.00 m
Depth to Groundwater: 13.00 m
Radius of Test Section: 0.06 m

Step	Pressure [Pa]	Flow Meter Readings [l/s]					Average Flow Rate [l/s]	Hydraulic Conductivity		
		1	2	3	4	5		[m/d]	[m/s]	Lugeon
1	403000.0	0.004	0.004	0.021	0.021	0.021	0.014	1.21×10^{-3}	1.404×10^{-8}	0.1
2	653000.0	0.033	0.030	0.020	0.017	0.017	0.023	1.38×10^{-3}	1.599×10^{-8}	0.1
3	953000.0	0.102	0.102	0.102	0.086	0.094	0.098	4.19×10^{-3}	4.844×10^{-8}	0.3
4	653000.0	0.029	0.035	0.033	0.029	0.035	0.032	1.91×10^{-3}	2.205×10^{-8}	0.2
5	403000.0	0.013	0.017	0.017	0.017	0.017	0.016	1.39×10^{-3}	1.604×10^{-8}	0.1
							Average	2.01×10^{-3}	2.331×10^{-8}	0.2

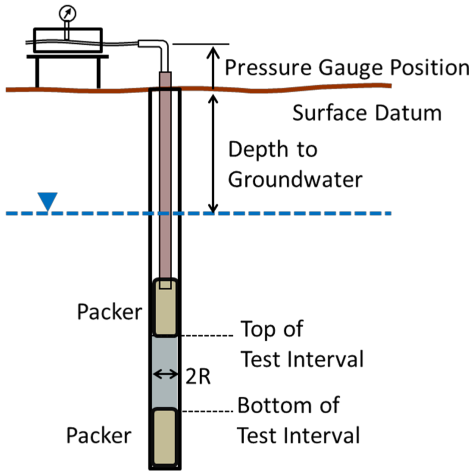






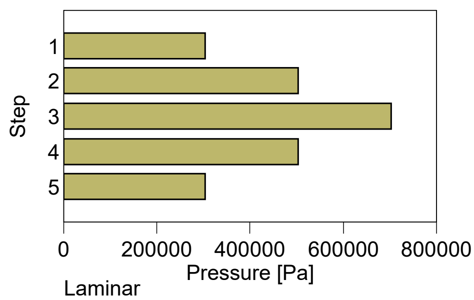
Dilation
Lugeon: 0.1
Hydraulic Conductivity: 1.21E-3 m/d

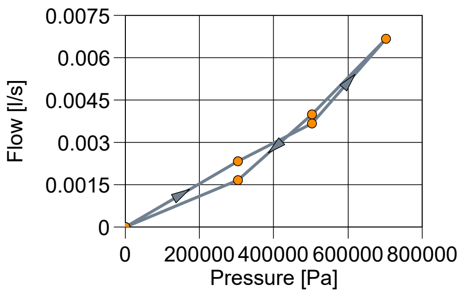
Location: CR04	Lugeon Test: 160-164	Tested bore: 97 - 101
Test Conducted by: Matt Lemke		Test Date: 14/09/2017
Analysis Performed by: A Fulton		Analysis Date: 22/09/2017
Lithology:		

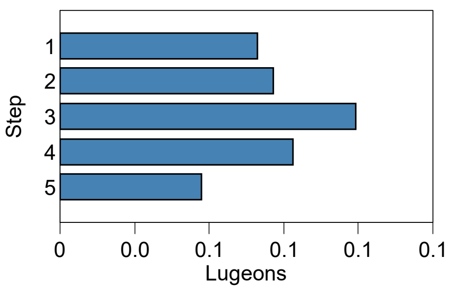


Top of Test Interval: 160.00 m
Bottom of Test Interval: 164.00 m
Length of Test Interval: 4.00 m
Gauge Position: 1.00 m
Depth to Groundwater: 13.00 m
Radius of Test Section: 0.06 m

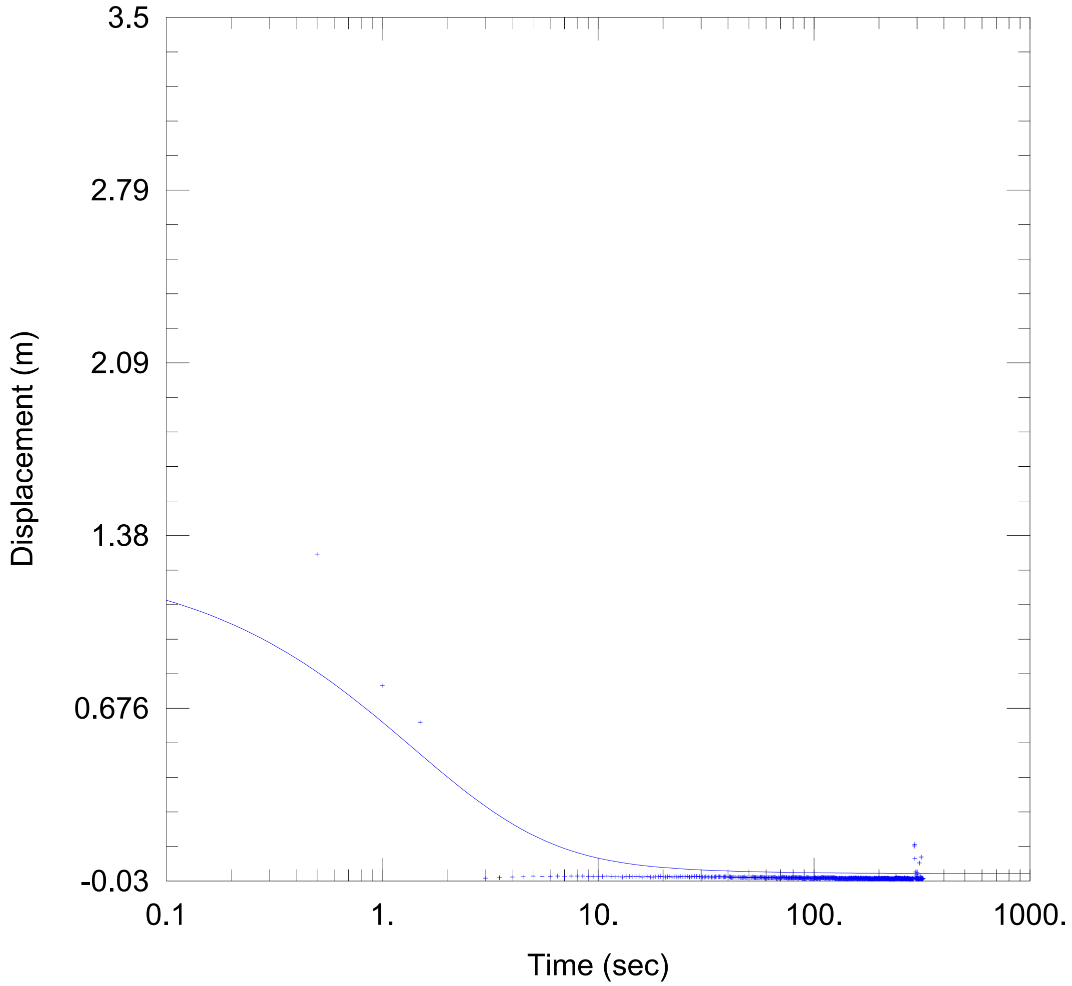
Step	Pressure [Pa]	Flow Meter Readings [l/s]					Average Flow Rate [l/s]	Hydraulic Conductivity		
		1	2	3	4	5		[m/d]	[m/s]	Lugeon
1	303000.0	0.002	0.002	0.003	0.002	0.003	0.002	7.44×10^{-4}	8.617×10^{-9}	0.1
2	503000.0	0.003	0.003	0.003	0.003	0.005	0.004	8.04×10^{-4}	9.311×10^{-9}	0.1
3	703000.0	0.005	0.008	0.007	0.007	0.007	0.007	1.11×10^{-3}	1.290×10^{-8}	0.1
4	503000.0	0.004	0.004	0.004	0.004	0.004	0.004	8.78×10^{-4}	1.016×10^{-8}	0.1
5	303000.0	0.002	0.002	0.002	0.002	0.002	0.002	5.32×10^{-4}	6.155×10^{-9}	0.1
							Average	8.15×10^{-4}	9.428×10^{-9}	0.1







Laminar
Lugeon: 0.1
Hydraulic Conductivity: 8.15E-4 m/d



WELL TEST ANALYSIS

Data Set: C:\Users\matt\Desktop\ENRS0600 AQTESOLV\GW01\GW1s T3 Falling KGS.aqt
Date: 09/05/17   Time: 15:18:19

PROJECT INFORMATION

Company: ENRS
Client: Pembroke Resources
Project: ENRS0600
Location: Olive Downs
Test Well: GW12s

AQUIFER DATA

Saturated Thickness: 6.026 m

WELL DATA (GW1s)

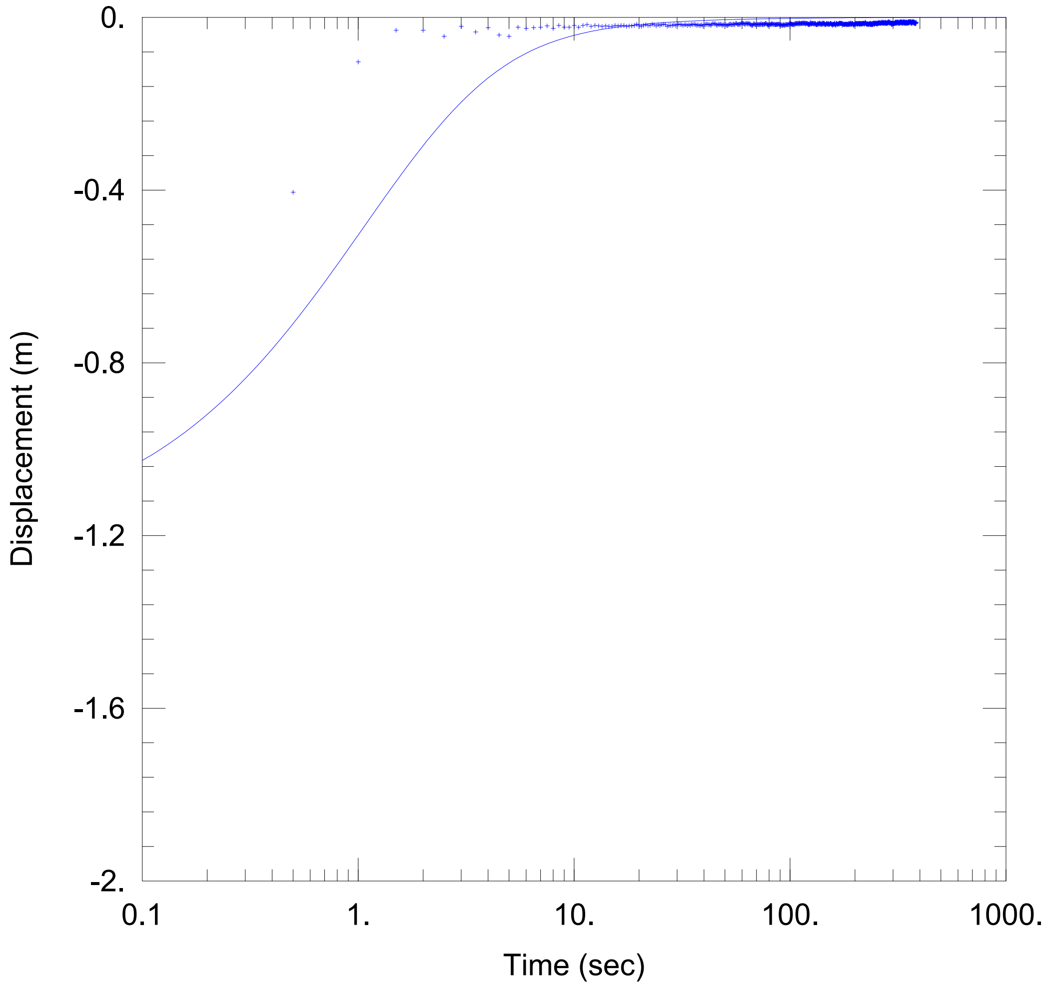
Initial Displacement: 1.306 m
Total Well Penetration Depth: 6.026 m
Casing Radius: 0.025 m

Static Water Column Height: 23.1 m
Screen Length: 6. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 7.675E-5 m/sec
Kz/Kr = 1.
Ss = 0.004329 m^{-1}



WELL TEST ANALYSIS

Data Set: C:\Users\matt\Desktop\ENRS0600 AQTESOLV\GW01\GW1s T1 Rising KGS.aqt
Date: 09/05/17 Time: 15:23:38

PROJECT INFORMATION

Company: ENRS
Client: Pembroke Resources
Project: ENRS0600
Location: Olive Downs
Test Well: GW12s

AQUIFER DATA

Saturated Thickness: 6.026 m

WELL DATA (GW1s)

Initial Displacement: -1.236 m
Total Well Penetration Depth: 6.026 m
Casing Radius: 0.025 m

Static Water Column Height: 23.1 m
Screen Length: 6. m
Well Radius: 0.025 m

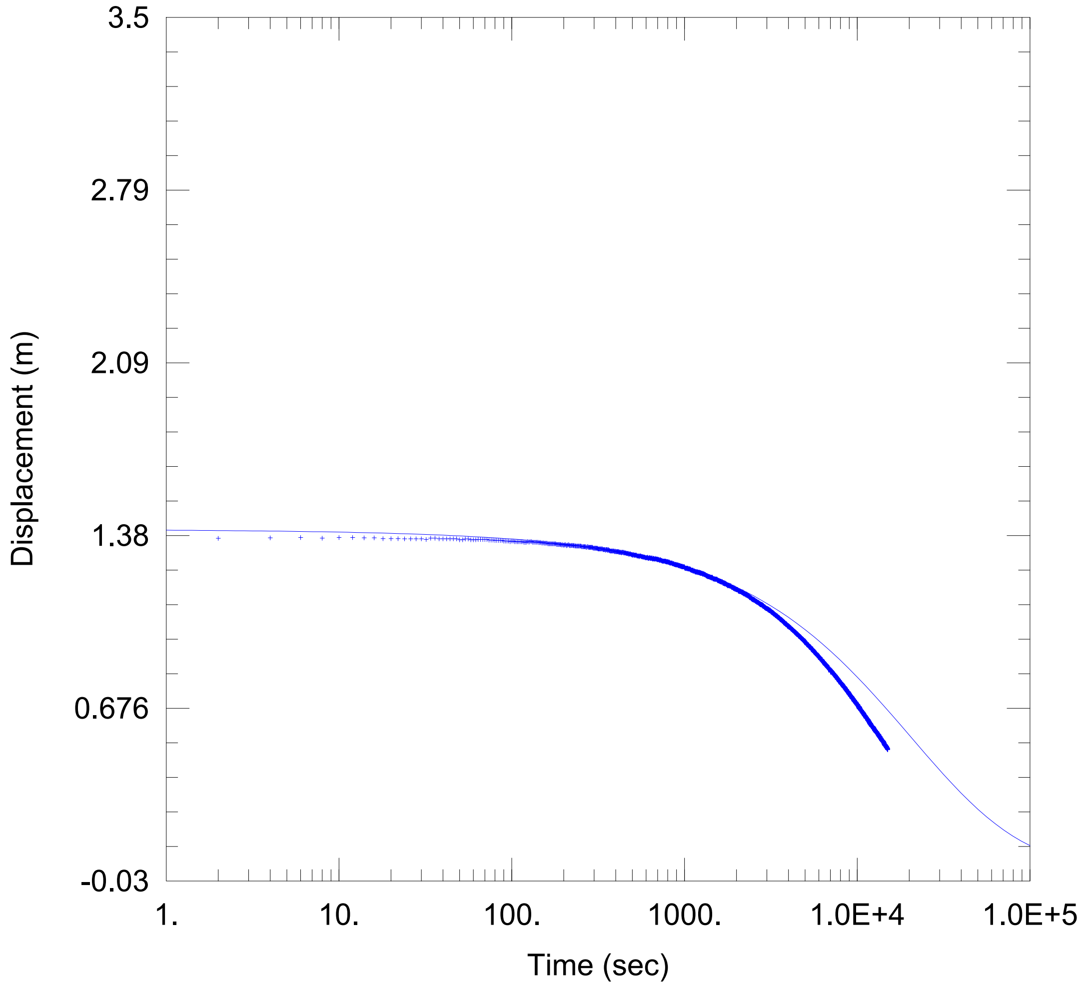
SOLUTION

Aquifer Model: Unconfined

Kr = 0.0001005 m/sec
Kz/Kr = 1.

Solution Method: KGS Model

Ss = 0.004329 m^{-1}



WELL TEST ANALYSIS

Data Set: C:\Users\matt\Desktop\ENRS0600 AQTESOLV\GW02d\GW02d T1 Falling KGS.aqt
Date: 09/05/17 Time: 14:41:33

PROJECT INFORMATION

Company: ENRS
Client: Pembroke Resources
Project: ENRS0600
Location: Olive Downs
Test Well: GW12s

AQUIFER DATA

Saturated Thickness: 9. m

WELL DATA (GW02d)

Initial Displacement: 1.407 m
Total Well Penetration Depth: 123.1 m
Casing Radius: 0.025 m

Static Water Column Height: 123.1 m
Screen Length: 9. m
Well Radius: 0.025 m

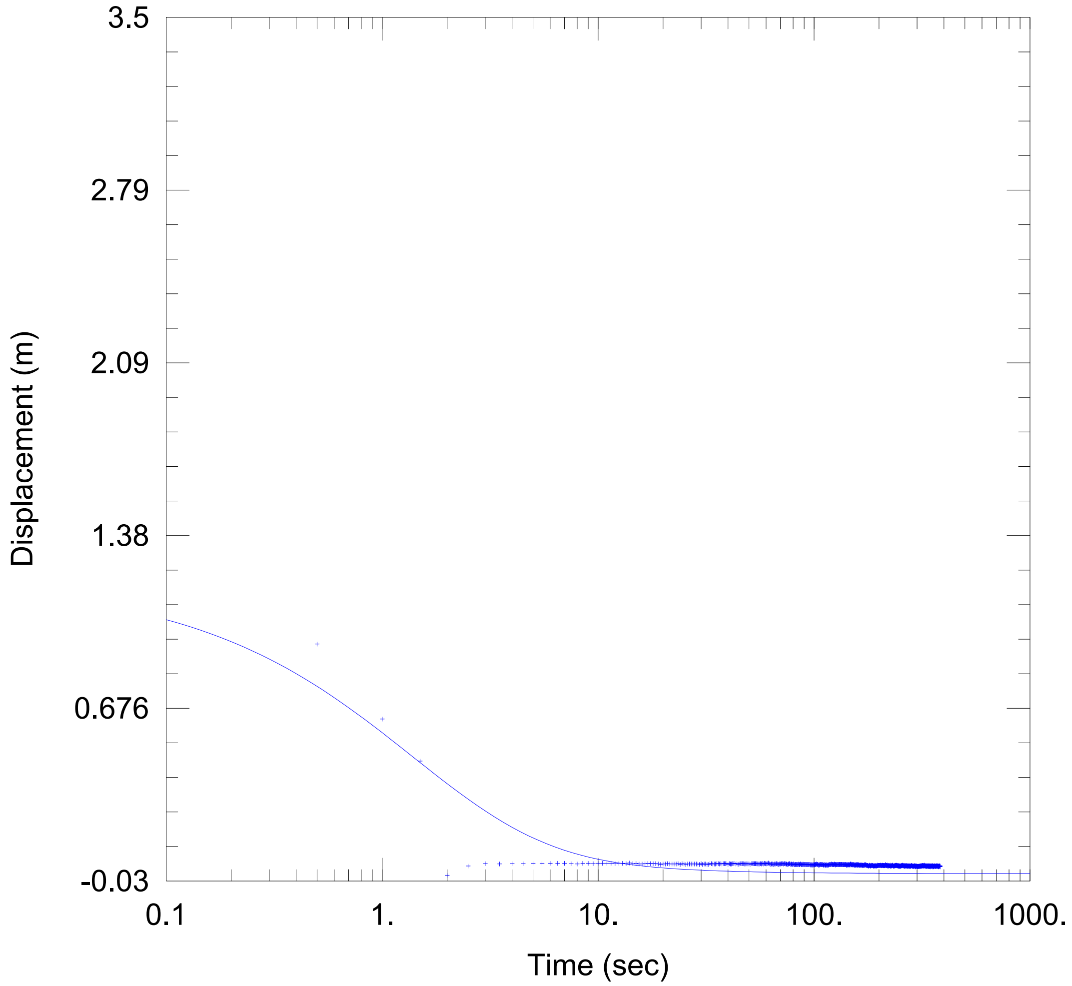
SOLUTION

Aquifer Model: Confined

Solution Method: KGS Model

Kr = 5.983E-9 m/sec
Kz/Kr = 1.

Ss = 0.003839 m^{-1}



WELL TEST ANALYSIS

Data Set: C:\Users\matt\Desktop\ENRS0600 AQTESOLV\GW01\GW1s T1 Falling KGS.aqt
Date: 09/05/17 Time: 15:15:23

PROJECT INFORMATION

Company: ENRS
Client: Pembroke Resources
Project: ENRS0600
Location: Olive Downs
Test Well: GW12s

AQUIFER DATA

Saturated Thickness: 6.026 m

WELL DATA (GW1s)

Initial Displacement: 1.213 m
Total Well Penetration Depth: 6.026 m
Casing Radius: 0.025 m

Static Water Column Height: 23.1 m
Screen Length: 6. m
Well Radius: 0.025 m

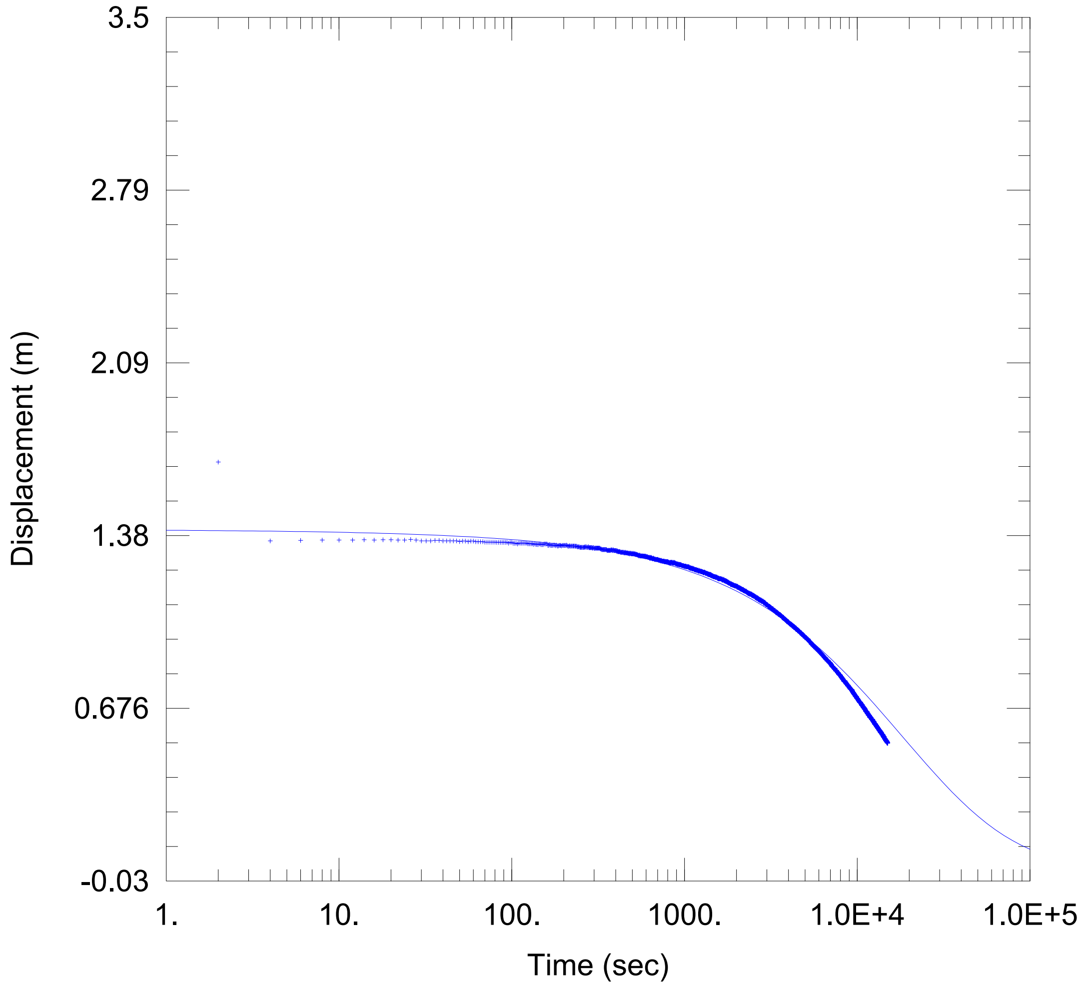
SOLUTION

Aquifer Model: Unconfined

Solution Method: KGS Model

Kr = 7.675E-5 m/sec
Kz/Kr = 1.

Ss = 0.004329 m^{-1}



WELL TEST ANALYSIS

Data Set: C:\Users\matt\Desktop\ENRS0600 AQTESOLV\GW02d\GW02d T2 Falling KGS.aqt
Date: 09/05/17 Time: 14:45:18

PROJECT INFORMATION

Company: ENRS
Client: Pembroke Resources
Project: ENRS0600
Location: Olive Downs
Test Well: GW12s

AQUIFER DATA

Saturated Thickness: 9. m

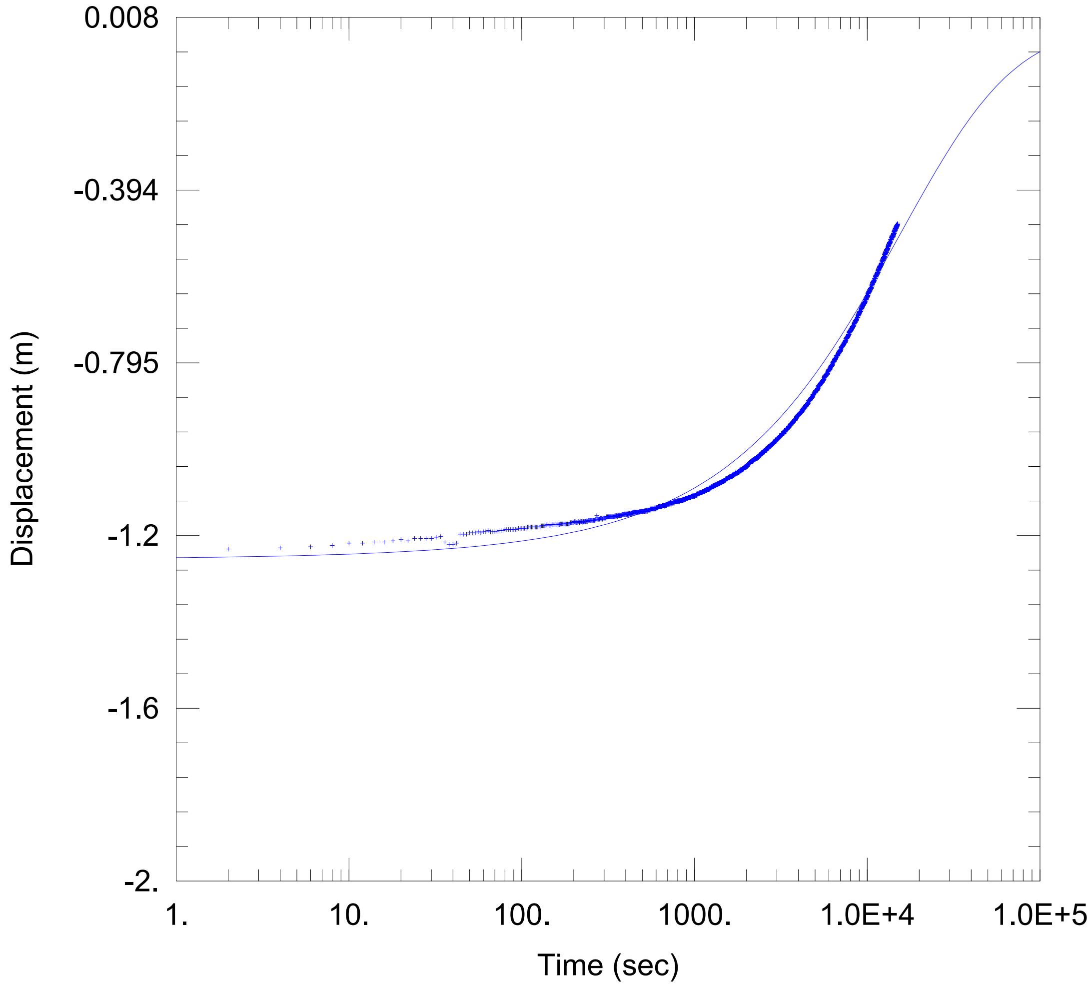
WELL DATA (GW02d)

Initial Displacement: 1.407 m
Total Well Penetration Depth: 123.1 m
Casing Radius: 0.025 m
Static Water Column Height: 123.1 m
Screen Length: 9. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Confined
Solution Method: KGS Model

Kr = 6.656E-9 m/sec
Ss = 0.003839 m^{-1}
Kz/Kr = 1.



WELL TEST ANALYSIS

Data Set: C:\Users\matt\Desktop\ENRS0600 AQTESOLV\GW02d\GW02d T1 Rising KGS.aqt
Date: 09/05/17 Time: 15:02:13

PROJECT INFORMATION

Company: ENRS
Client: Pembroke Resources
Project: ENRS0600
Location: Olive Downs
Test Well: GW12s

AQUIFER DATA

Saturated Thickness: 9. m

WELL DATA (GW02d)

Initial Displacement: -1.252 m
Total Well Penetration Depth: 123.1 m
Casing Radius: 0.025 m

Static Water Column Height: 123.1 m
Screen Length: 9. m
Well Radius: 0.025 m

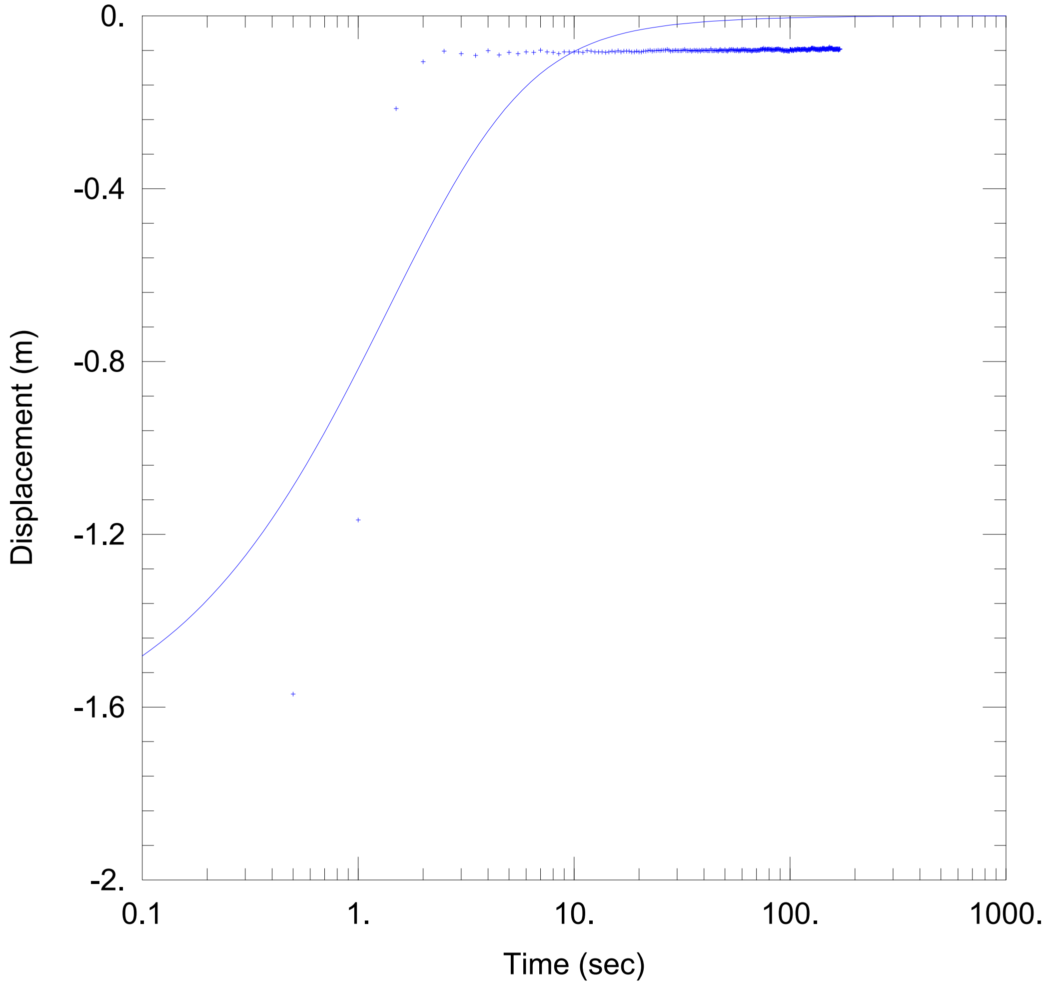
SOLUTION

Aquifer Model: Confined

Solution Method: KGS Model

Kr = 7.675E-9 m/sec
Kz/Kr = 1.

Ss = 0.004329 m^{-1}



WELL TEST ANALYSIS

Data Set: C:\Users\matt\Desktop\ENRS0600 AQTESOLV\GW01\GW1s T4 Rising KGS.aqt
Date: 09/05/17 Time: 15:24:56

PROJECT INFORMATION

Company: ENRS
Client: Pembroke Resources
Project: ENRS0600
Location: Olive Downs
Test Well: GW12s

AQUIFER DATA

Saturated Thickness: 6.026 m

WELL DATA (GW1s)

Initial Displacement: -1.734 m
Total Well Penetration Depth: 6.026 m
Casing Radius: 0.025 m

Static Water Column Height: 23.1 m
Screen Length: 6. m
Well Radius: 0.025 m

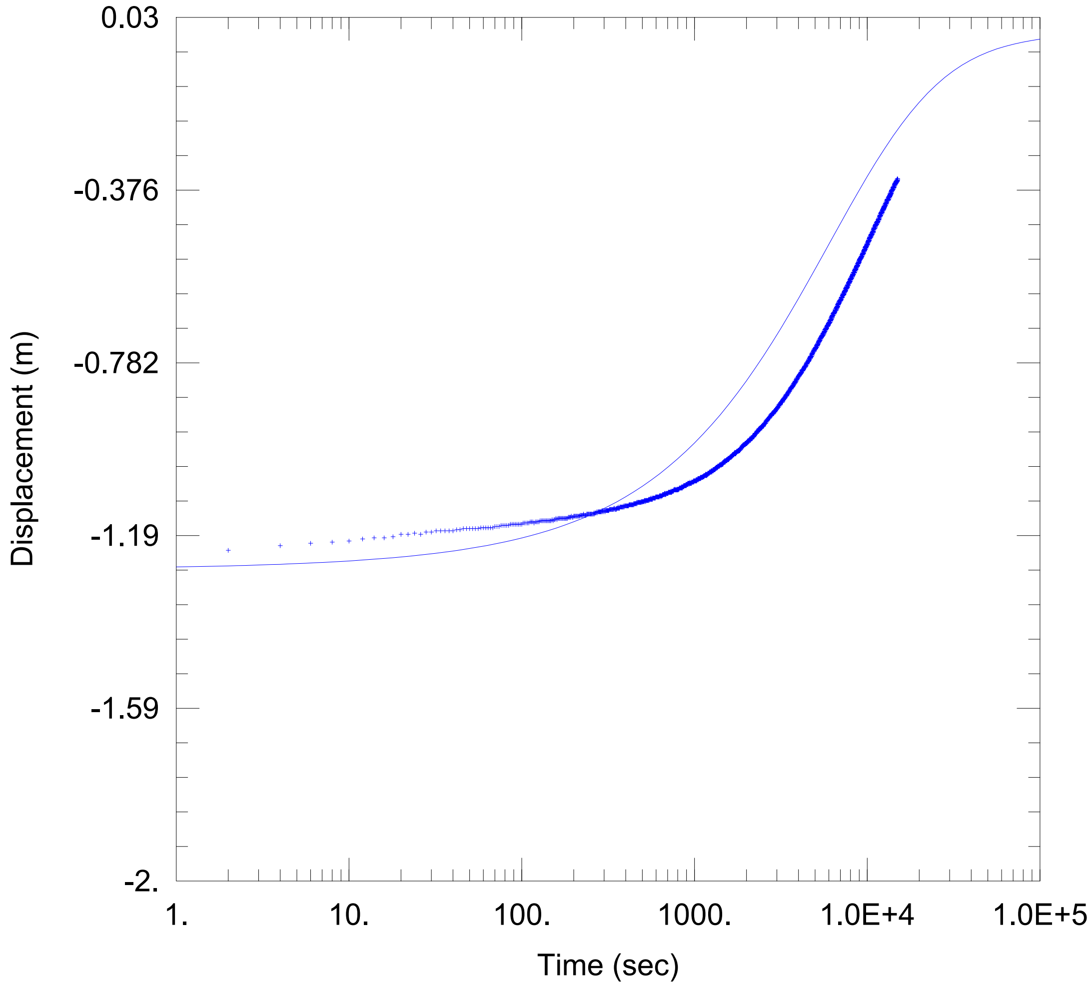
SOLUTION

Aquifer Model: Unconfined

Solution Method: KGS Model

Kr = 7.785E-5 m/sec
Kz/Kr = 1.

Ss = 0.004329 m^{-1}



WELL TEST ANALYSIS

Data Set: C:\Users\matt\Desktop\ENRS0600 AQTESOLV\GW02d\GW02d T2 Rising KGS.aqt
Date: 09/05/17 Time: 15:08:58

PROJECT INFORMATION

Company: ENRS
Client: Pembroke Resources
Project: ENRS0600
Location: Olive Downs
Test Well: GW12s

AQUIFER DATA

Saturated Thickness: 9. m

WELL DATA (GW02d)

Initial Displacement: -1.268 m
Total Well Penetration Depth: 123.1 m
Casing Radius: 0.025 m

Static Water Column Height: 123.1 m
Screen Length: 9. m
Well Radius: 0.025 m

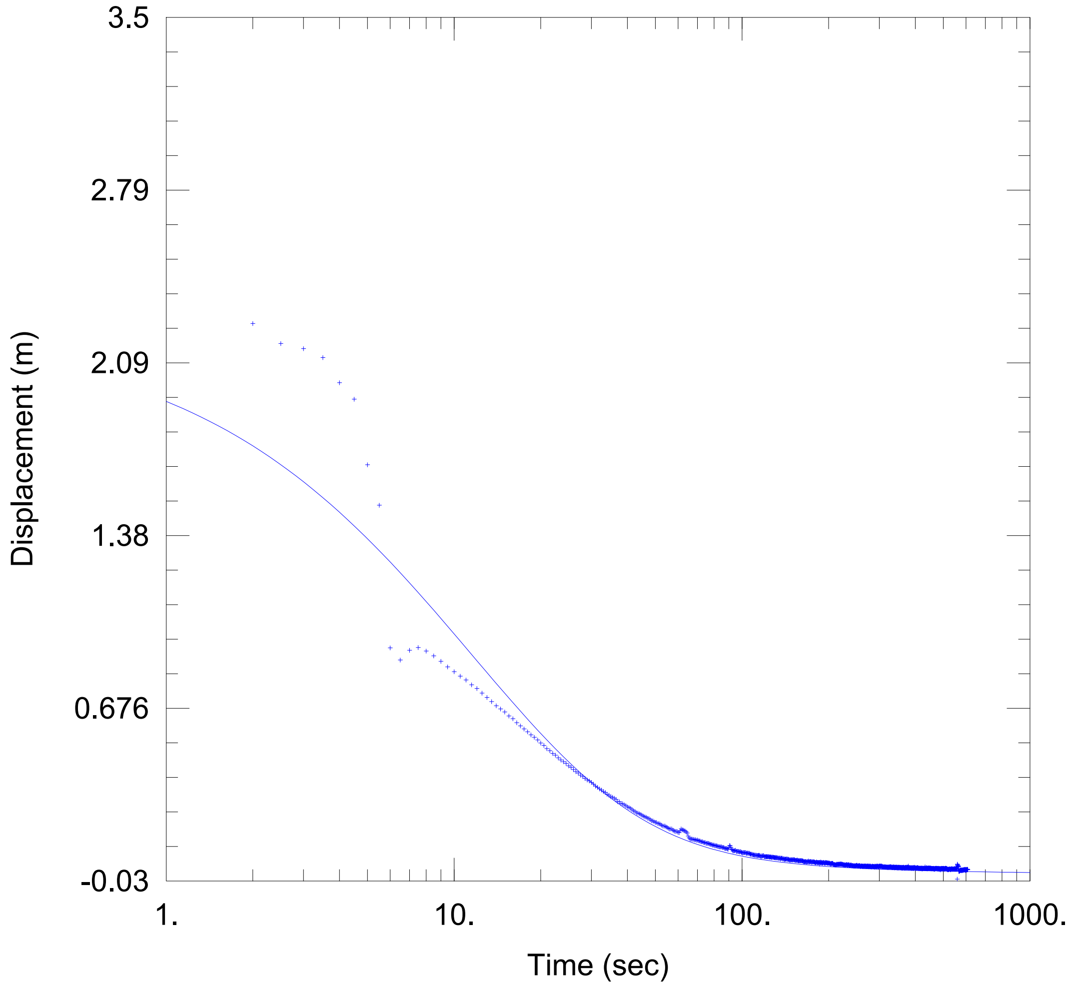
SOLUTION

Aquifer Model: Confined

Solution Method: KGS Model

Kr = 1.979E-8 m/sec
Kz/Kr = 1.

Ss = 0.004329 m^{-1}



WELL TEST ANALYSIS

Data Set: C:\Users\matt\Desktop\ENRS0600 AQTESOLV\GW12s\GW12s T1 Falling KGS.aqt
Date: 09/05/17 Time: 11:41:33

PROJECT INFORMATION

Company: ENRS
Client: Pembroke Resources
Project: ENRS0600
Location: Olive Downs
Test Well: GW12s

AQUIFER DATA

Saturated Thickness: 29.1 m

WELL DATA (GW12s)

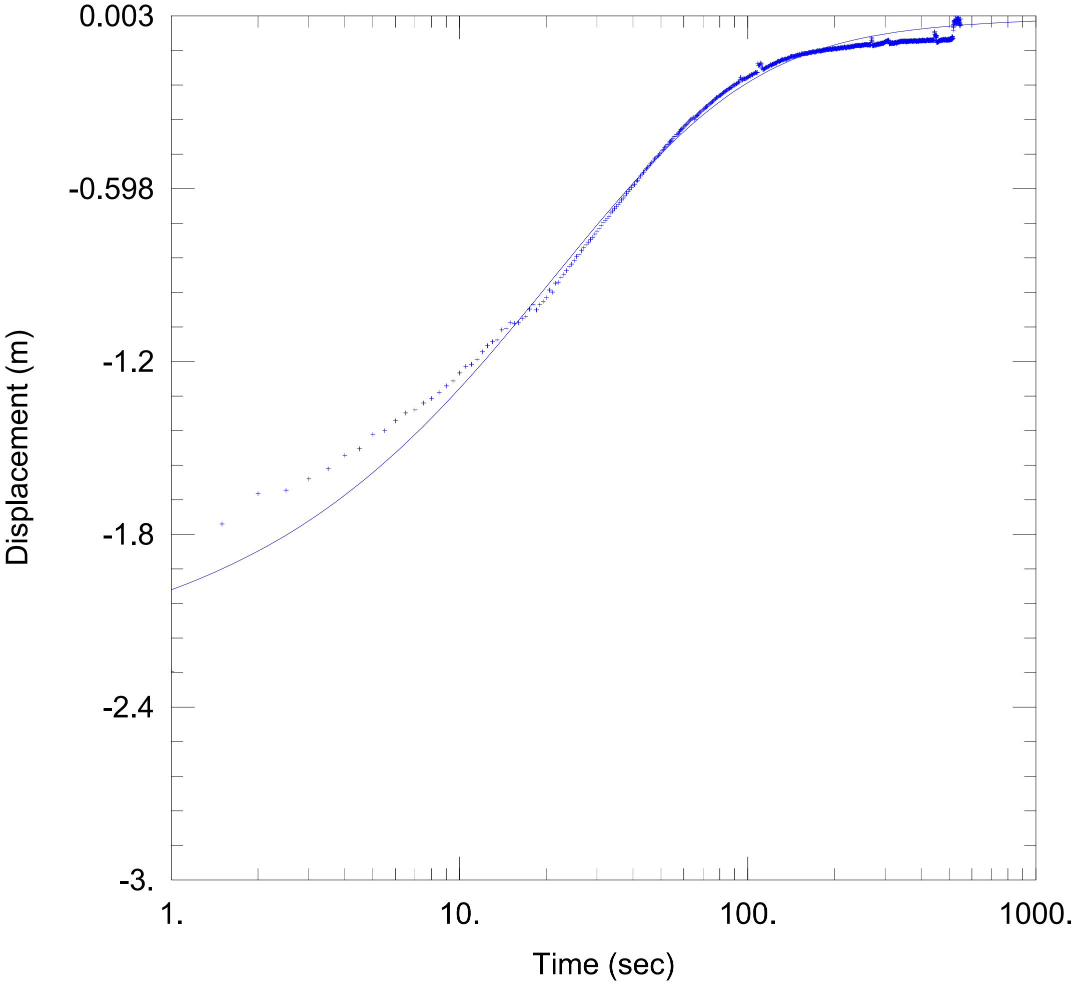
Initial Displacement: 2.248 m
Total Well Penetration Depth: 29.1 m
Casing Radius: 0.025 m

Static Water Column Height: 29.1 m
Screen Length: 12. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 5.786E-6 m/sec
Kz/Kr = 1.
Ss = 0.000755 m^{-1}



WELL TEST ANALYSIS

Data Set: C:\Users\matt\Desktop\ENRS0600 AQTESOLV\GW12s\GW12s T1 Rising KGS.aqt
Date: 09/05/17 Time: 12:04:14

PROJECT INFORMATION

Company: ENRS
Client: Pembroke Resources
Project: ENRS0600
Location: Olive Downs
Test Well: GW12s

AQUIFER DATA

Saturated Thickness: 29.1 m

WELL DATA (GW12s)

Initial Displacement: -2.275 m
Total Well Penetration Depth: 29.1 m
Casing Radius: 0.025 m

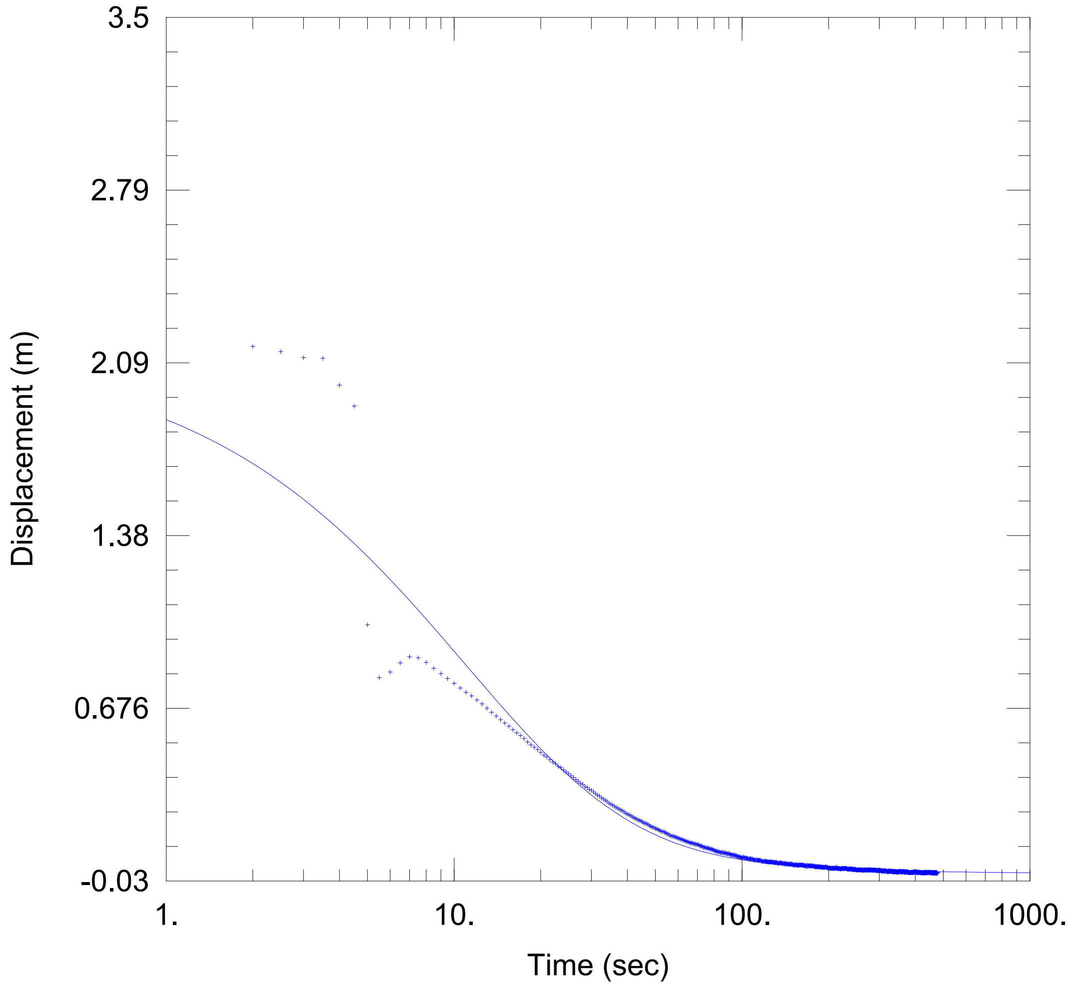
Static Water Column Height: 29.1 m
Screen Length: 12. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

K_r = 2.038E-6 m/sec
K_z/K_r = 1.

S_s = 0.004329 m^{-1}



WELL TEST ANALYSIS

Data Set: C:\Users\matt\Desktop\ENRS0600 AQTESOLV\GW12s\GW12s T2 Falling KGS.aqt
Date: 09/05/17 Time: 11:44:13

PROJECT INFORMATION

Company: ENRS
Client: Pembroke Resources
Project: ENRS0600
Location: Olive Downs
Test Well: GW12s

AQUIFER DATA

Saturated Thickness: 29.1 m

WELL DATA (GW12s)

Initial Displacement: 2.155 m
Total Well Penetration Depth: 29.1 m
Casing Radius: 0.025 m

Static Water Column Height: 29.1 m
Screen Length: 12. m
Well Radius: 0.025 m

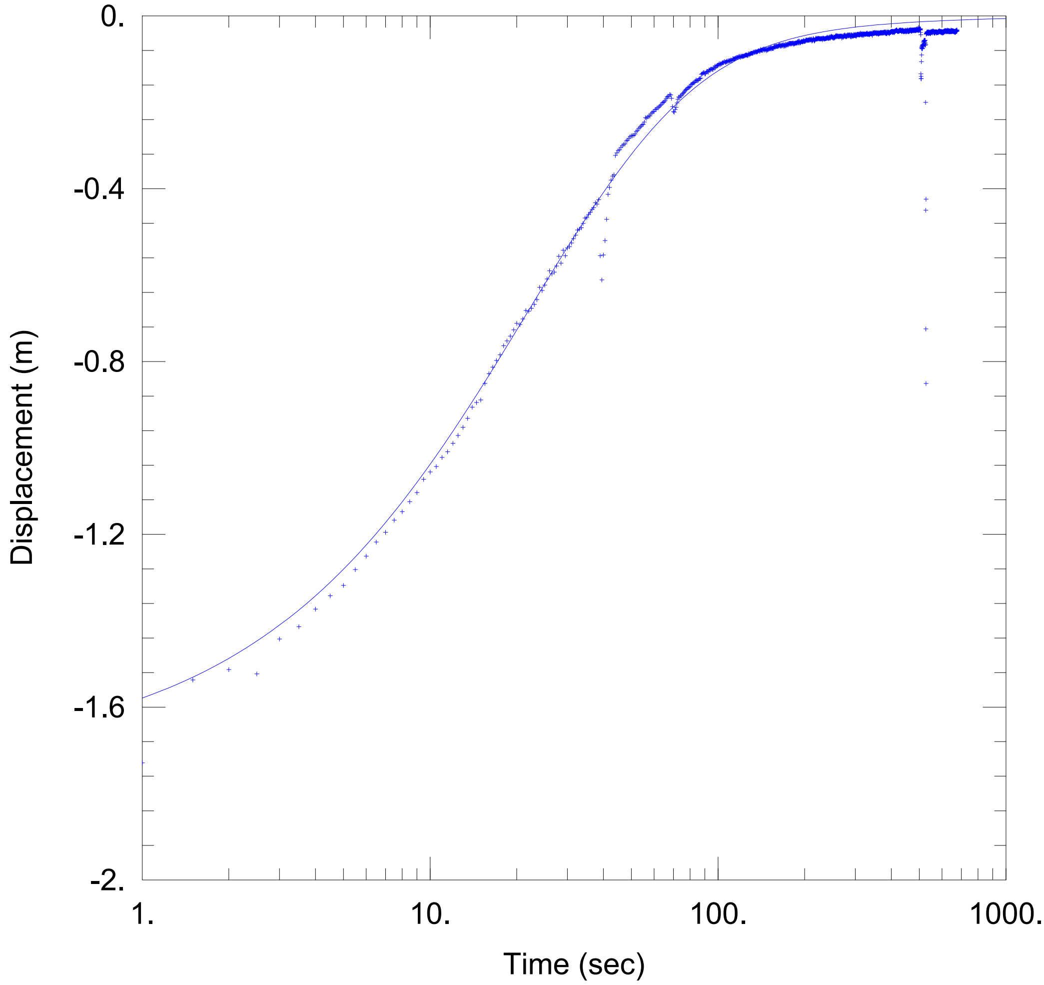
SOLUTION

Aquifer Model: Unconfined

Solution Method: KGS Model

Kr = 6.8E-6 m/sec
Kz/Kr = 1.

Ss = 0.0004313 m^{-1}



WELL TEST ANALYSIS

Data Set: C:\Users\matt\Desktop\ENRS0600 AQTESOLV\GW12s\GW12s T2 Rising KGS.aqt
Date: 09/05/17 Time: 12:06:41

PROJECT INFORMATION

Company: ENRS
Client: Pembroke Resources
Project: ENRS0600
Location: Olive Downs
Test Well: GW12s

AQUIFER DATA

Saturated Thickness: 29.1 m

WELL DATA (GW12s)

Initial Displacement: -1.729 m
Total Well Penetration Depth: 29.1 m
Casing Radius: 0.025 m

Static Water Column Height: 29.1 m
Screen Length: 12. m
Well Radius: 0.025 m

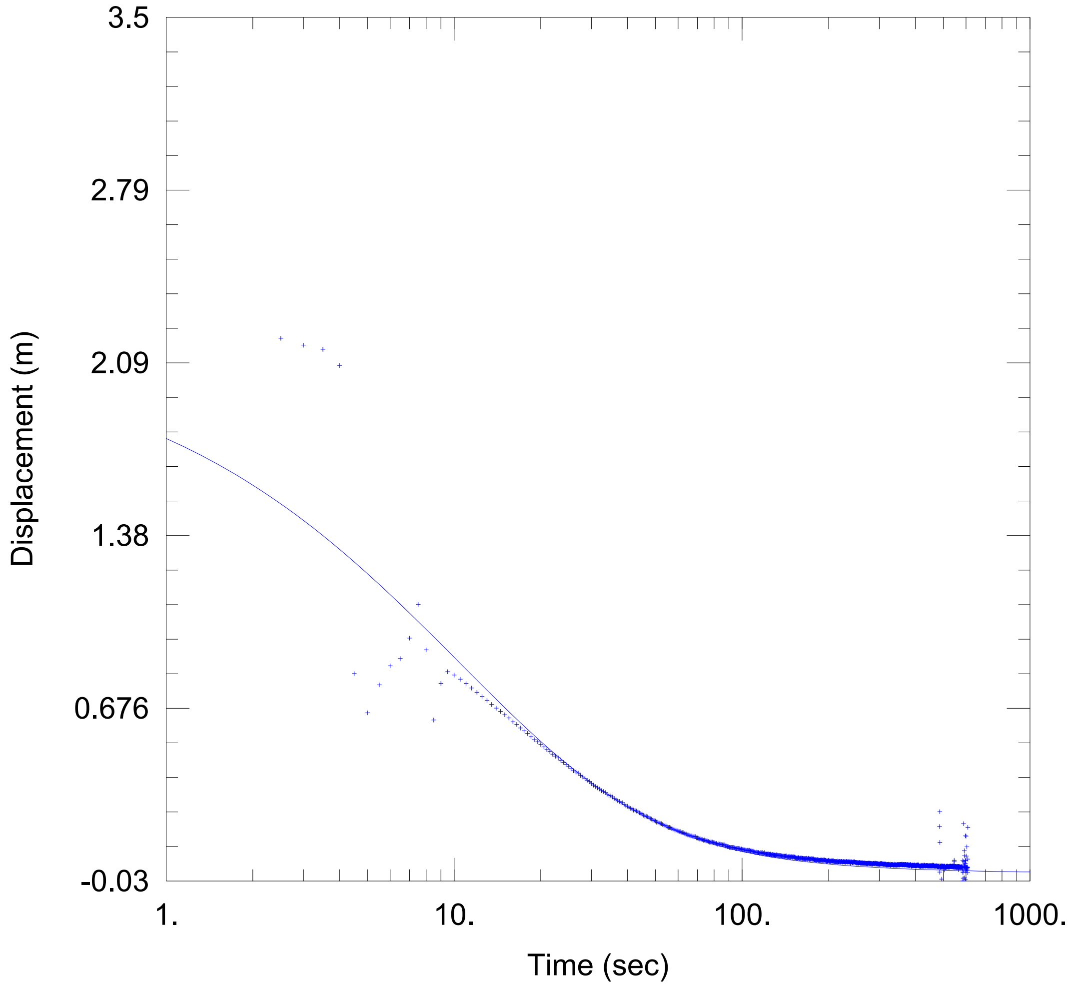
SOLUTION

Aquifer Model: Unconfined

Kr = 3.377E-6 m/sec
Kz/Kr = 1.

Solution Method: KGS Model

Ss = 0.0004572 m^{-1}



WELL TEST ANALYSIS

Data Set: C:\Users\matt\Desktop\ENRS0600 AQTESOLV\GW12s\GW12s T3 Falling KGS.aqt
Date: 09/05/17 Time: 11:47:14

PROJECT INFORMATION

Company: ENRS
Client: Pembroke Resources
Project: ENRS0600
Location: Olive Downs
Test Well: GW12s

AQUIFER DATA

Saturated Thickness: 29.1 m

WELL DATA (GW12s)

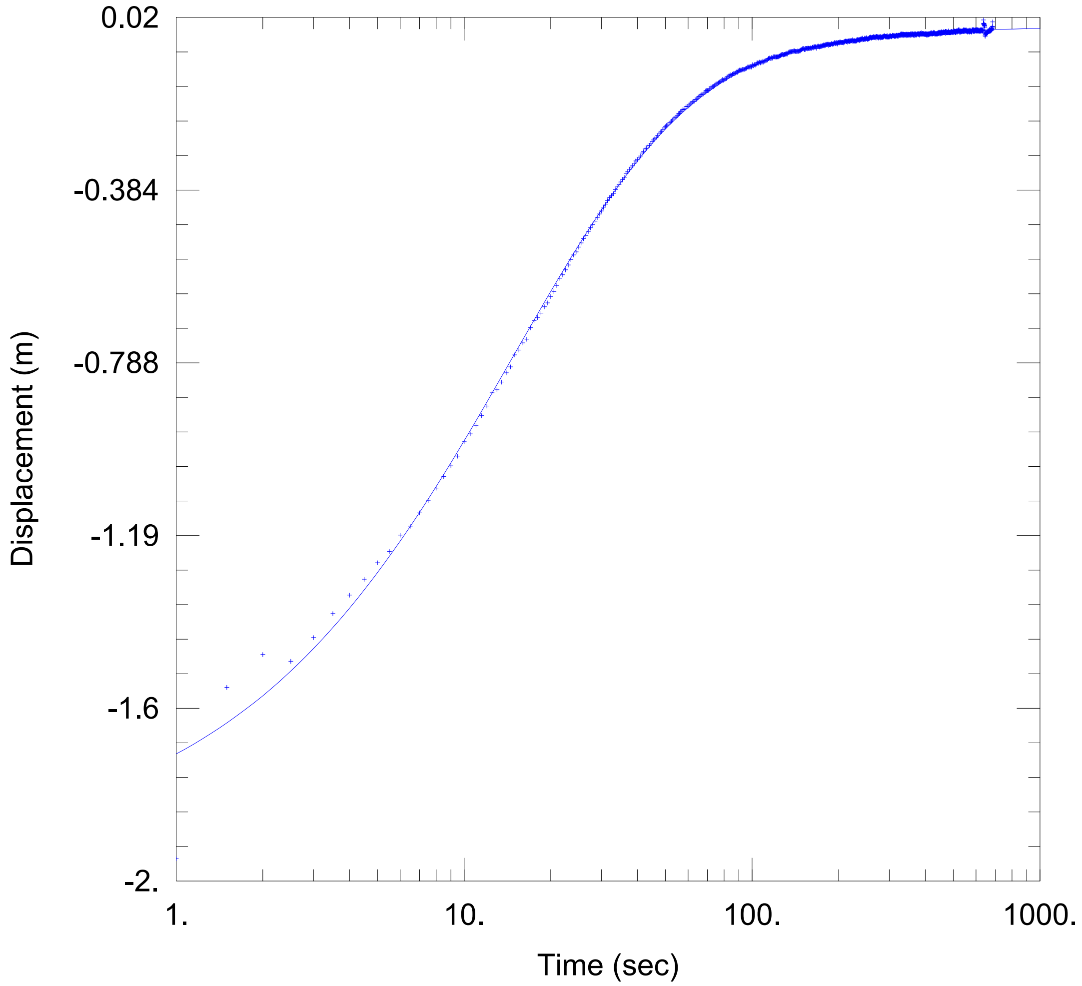
Initial Displacement: 2.189 m
Total Well Penetration Depth: 29.1 m
Casing Radius: 0.025 m

Static Water Column Height: 29.1 m
Screen Length: 12. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 4.229E-6 m/sec
Kz/Kr = 1.
Ss = 0.004329 m^{-1}



WELL TEST ANALYSIS

Data Set: C:\Users\matt\Desktop\ENRS0600 AQTESOLV\GW12s\GW12s T3 Rising KGS.aqt
Date: 09/05/17 Time: 12:08:53

PROJECT INFORMATION

Company: ENRS
Client: Pembroke Resources
Project: ENRS0600
Location: Olive Downs
Test Well: GW12s

AQUIFER DATA

Saturated Thickness: 29.1 m

WELL DATA (GW12s)

Initial Displacement: -1.948 m
Total Well Penetration Depth: 29.1 m
Casing Radius: 0.025 m

Static Water Column Height: 29.1 m
Screen Length: 12. m
Well Radius: 0.025 m

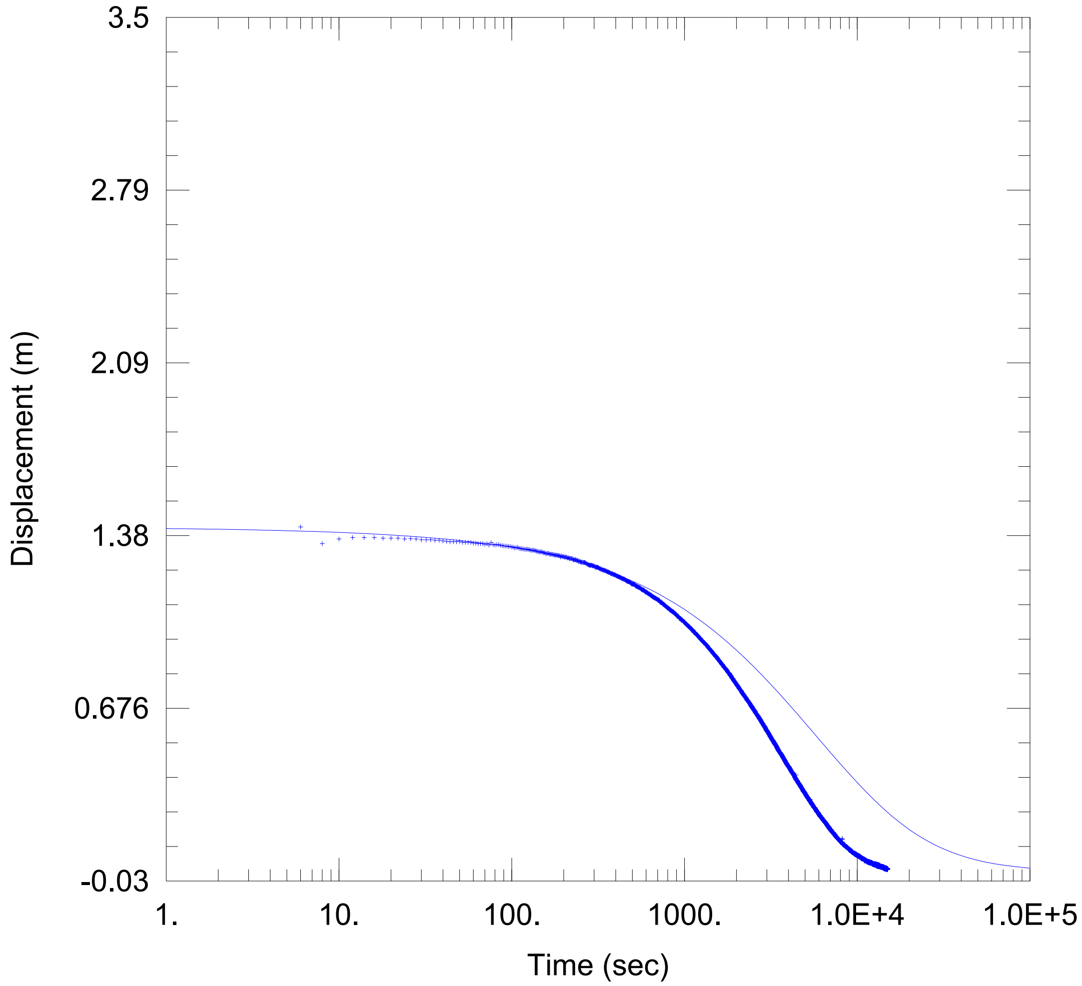
SOLUTION

Aquifer Model: Unconfined

Solution Method: KGS Model

Kr = 4.188E-6 m/sec
Kz/Kr = 1.

Ss = 0.001093 m^{-1}



WELL TEST ANALYSIS

Data Set: C:\Users\matt\Desktop\ENRS0600 AQTESOLV\GW18d\GW18d T1 Falling KGS.aqt
Date: 09/05/17 Time: 12:17:24

PROJECT INFORMATION

Company: ENRS
Client: Pembroke Resources
Project: ENRS0600
Location: Olive Downs
Test Well: GW12s

AQUIFER DATA

Saturated Thickness: 9. m

WELL DATA (GW18d)

Initial Displacement: 1.417 m
Total Well Penetration Depth: 173.6 m
Casing Radius: 0.025 m

Static Water Column Height: 173.6 m
Screen Length: 9. m
Well Radius: 0.025 m

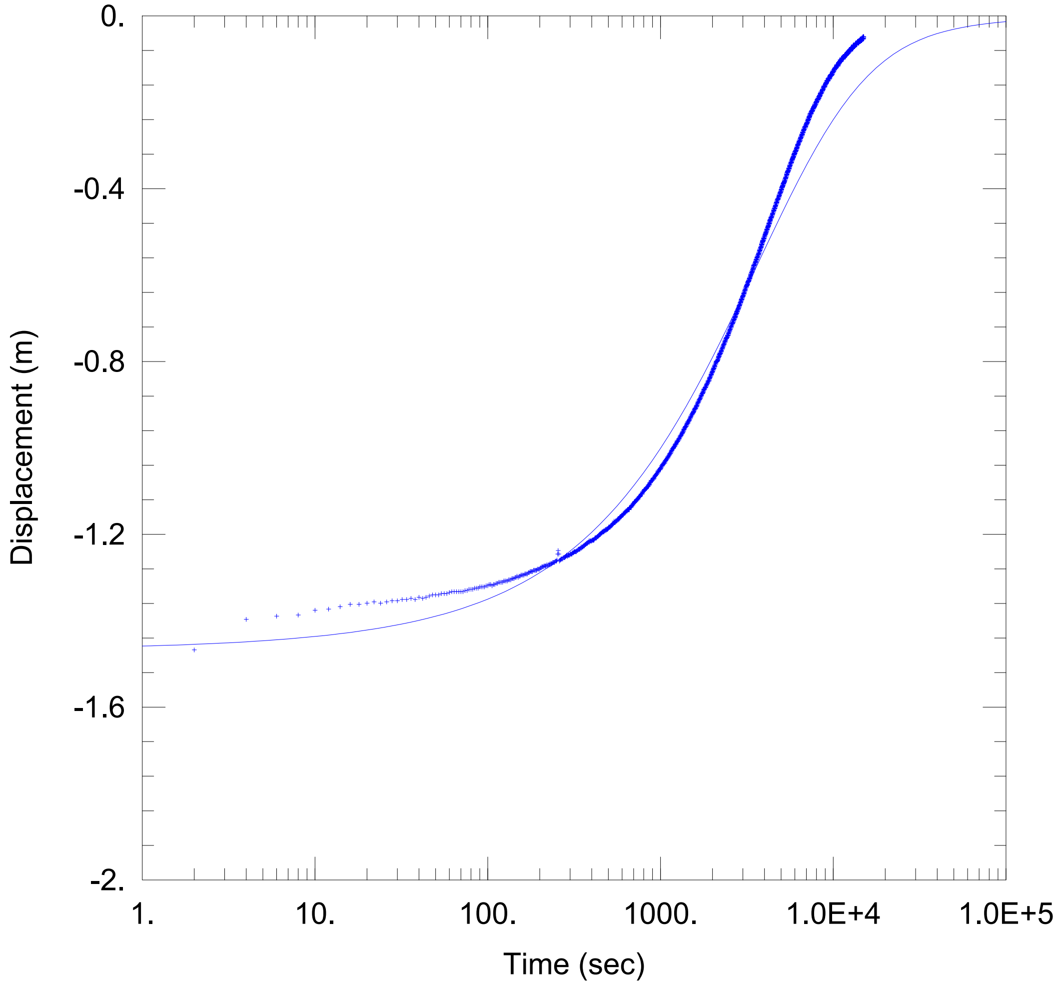
SOLUTION

Aquifer Model: Confined

Solution Method: KGS Model

Kr = 2.003E-8 m/sec
Kz/Kr = 1.

Ss = 0.003839 m^{-1}



WELL TEST ANALYSIS

Data Set: C:\Users\matt\Desktop\ENRS0600 AQTESOLV\GW18d\GW18d T1 Rising KGS.aqt
Date: 09/05/17 Time: 12:31:06

PROJECT INFORMATION

Company: ENRS
Client: Pembroke Resources
Project: ENRS0600
Location: Olive Downs
Test Well: GW12s

AQUIFER DATA

Saturated Thickness: 9. m

WELL DATA (GW18d)

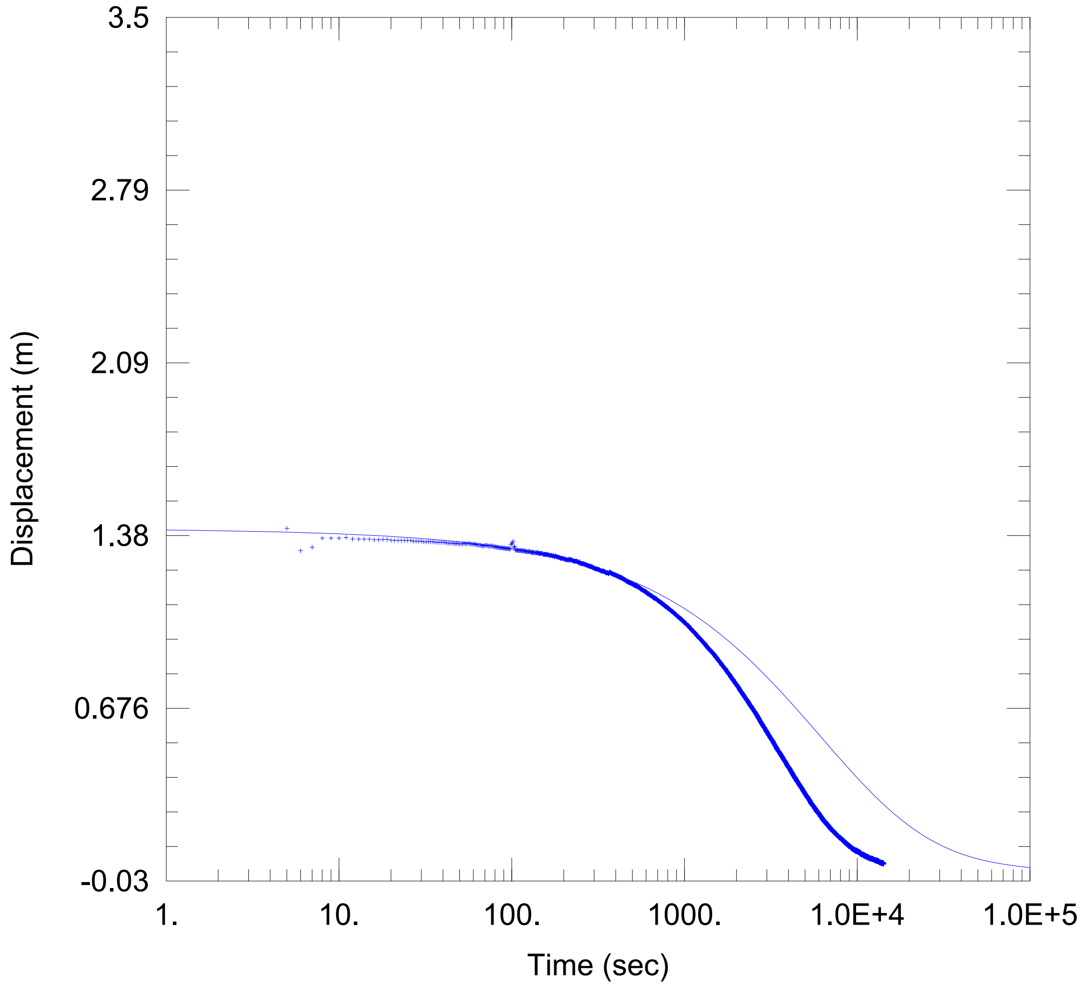
Initial Displacement: -1.468 m
Total Well Penetration Depth: 173.6 m
Casing Radius: 0.025 m

Static Water Column Height: 173.6 m
Screen Length: 9. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Confined
Kr = 3.154E-8 m/sec
Kz/Kr = 1.

Solution Method: KGS Model
Ss = 0.004329 m^{-1}



WELL TEST ANALYSIS

Data Set: C:\Users\matt\Desktop\ENRS0600 AQTESOLV\GW18d\GW18d T2 Falling KGS.aqt
Date: 09/05/17 Time: 12:21:44

PROJECT INFORMATION

Company: ENRS
Client: Pembroke Resources
Project: ENRS0600
Location: Olive Downs
Test Well: GW12s

AQUIFER DATA

Saturated Thickness: 9. m

WELL DATA (GW18d)

Initial Displacement: 1.411 m
Total Well Penetration Depth: 173.6 m
Casing Radius: 0.025 m

Static Water Column Height: 173.6 m
Screen Length: 9. m
Well Radius: 0.025 m

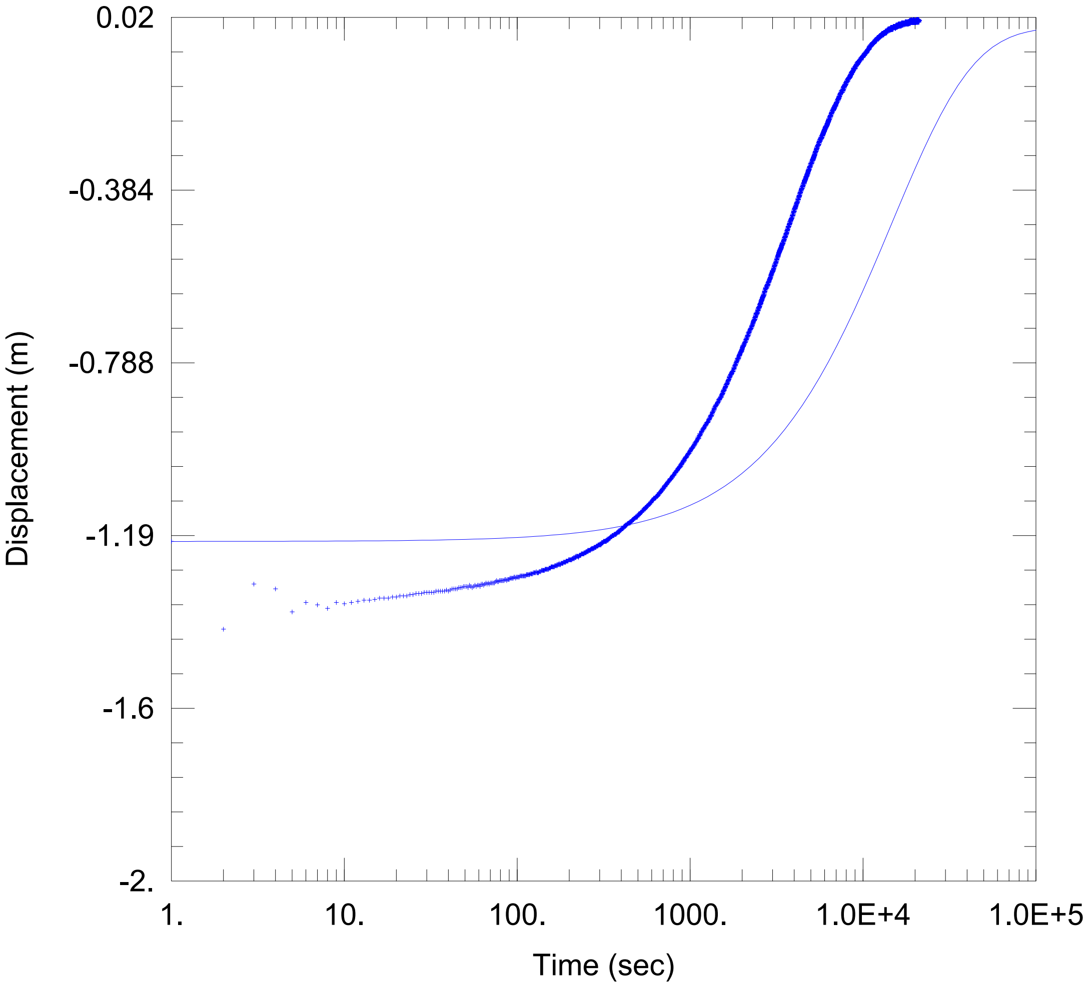
SOLUTION

Aquifer Model: Confined

Solution Method: KGS Model

Kr = 1.834E-8 m/sec
Kz/Kr = 1.

Ss = 0.004329 m^{-1}



WELL TEST ANALYSIS

Data Set: C:\Users\matt\Desktop\ENRS0600 AQTESOLV\GW18d\GW18d T2 Rising KGS.aqt
Date: 09/05/17 Time: 12:38:35

PROJECT INFORMATION

Company: ENRS
Client: Pembroke Resources
Project: ENRS0600
Location: Olive Downs
Test Well: GW12s

AQUIFER DATA

Saturated Thickness: 9. m

WELL DATA (GW18d)

Initial Displacement: -1.206 m
Total Well Penetration Depth: 173.6 m
Casing Radius: 0.025 m

Static Water Column Height: 173.6 m
Screen Length: 9. m
Well Radius: 0.025 m

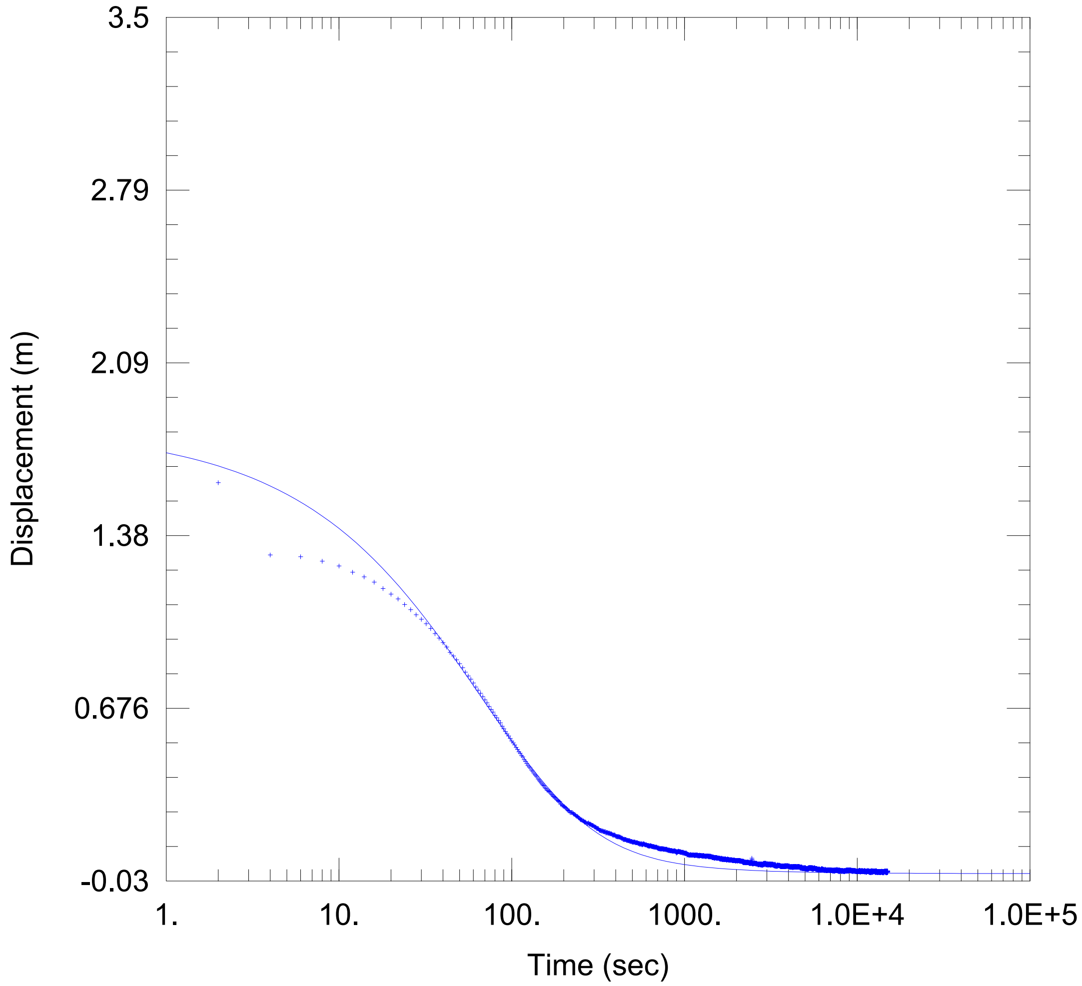
SOLUTION

Aquifer Model: Confined

Solution Method: KGS Model

Kr = 3.6E-8 m/sec
Kz/Kr = 1.

Ss = 4.329E-12 m^{-1}



WELL TEST ANALYSIS

Data Set: C:\Users\matt\Desktop\ENRS0600 AQTESOLV\GW21d\GW21d T1 Falling KGS.aqt
Date: 09/05/17
Time: 14:09:35

PROJECT INFORMATION

Company: ENRS
Client: Pembroke Resources
Project: ENRS0600
Location: Olive Downs
Test Well: GW12s

AQUIFER DATA

Saturated Thickness: 9. m

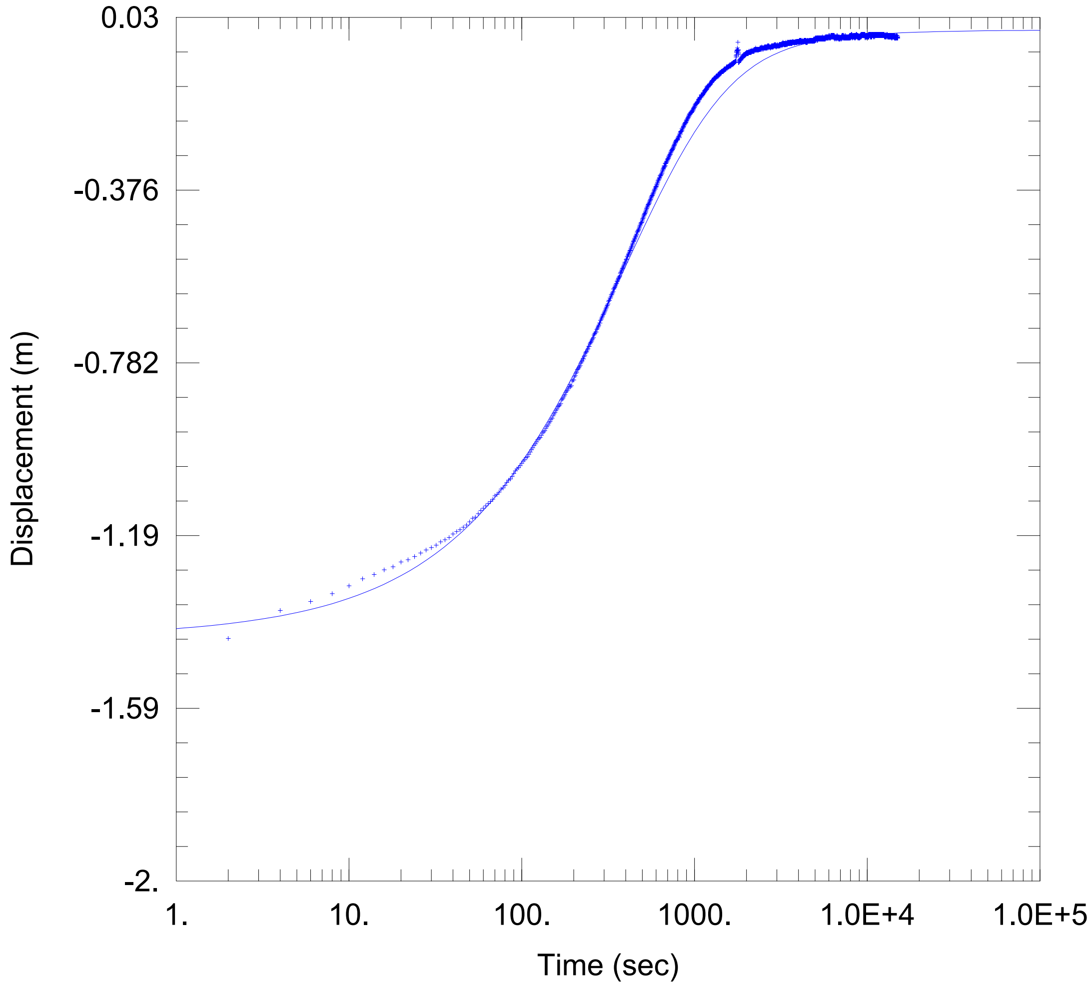
WELL DATA (GW21d)

Initial Displacement: 1.829 m
Total Well Penetration Depth: 126.9 m
Casing Radius: 0.025 m
Static Water Column Height: 130.9 m
Screen Length: 9. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Confined
Solution Method: KGS Model

Kr = 1.215E-6 m/sec
Kz/Kr = 1.
Ss = 0.004329 m^{-1}



WELL TEST ANALYSIS

Data Set: C:\Users\matt\Desktop\ENRS0600 AQTESOLV\GW21d\GW21d T1 Rising KGS.aqt
Date: 09/05/17 Time: 14:12:05

PROJECT INFORMATION

Company: ENRS
Client: Pembroke Resources
Project: ENRS0600
Location: Olive Downs
Test Well: GW12s

AQUIFER DATA

Saturated Thickness: 9. m

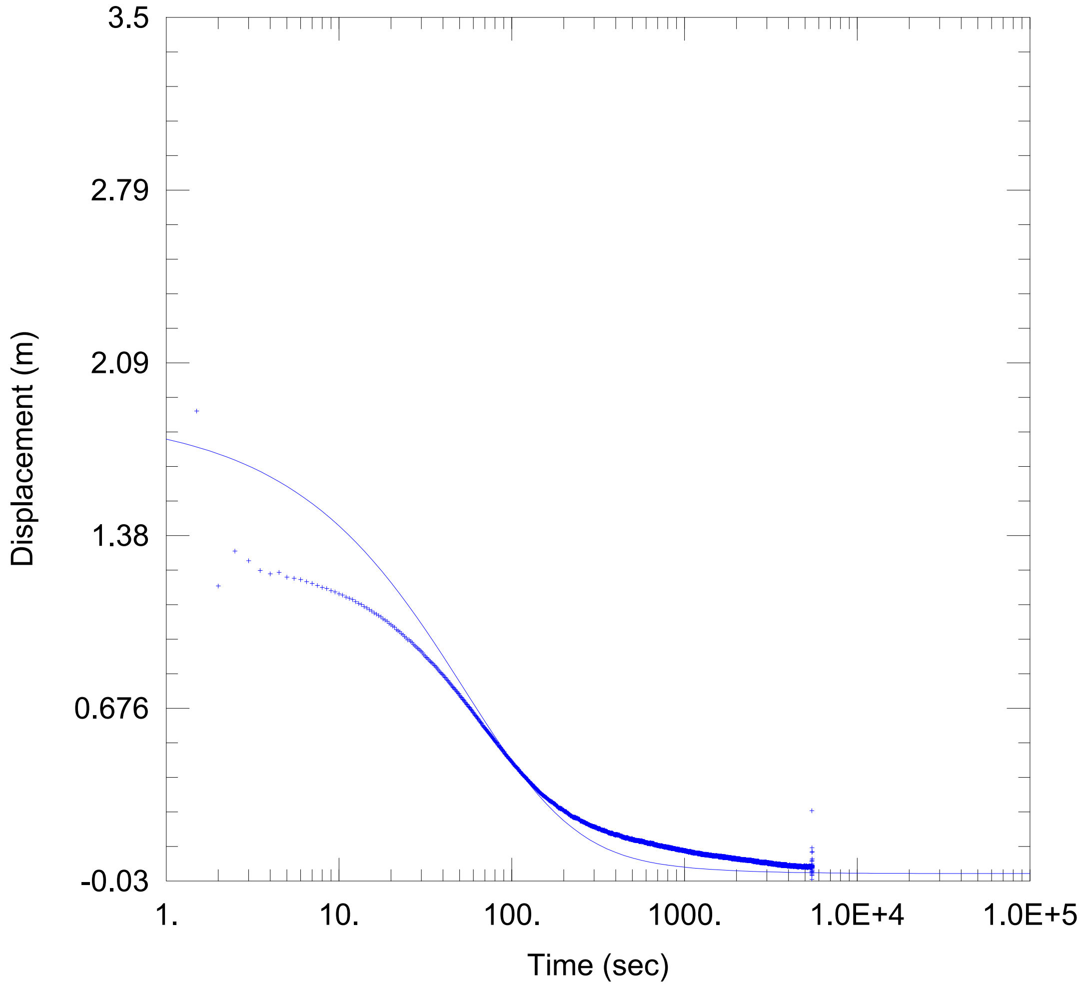
WELL DATA (GW21d)

Initial Displacement: -1.43 m
Total Well Penetration Depth: 130.9 m
Casing Radius: 0.025 m
Static Water Column Height: 130.9 m
Screen Length: 9. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Confined
Solution Method: KGS Model

Kr = 4.201E-7 m/sec
Kz/Kr = 1.
Ss = 0.002356 m^{-1}



WELL TEST ANALYSIS

Data Set: C:\Users\matt\Desktop\ENRS0600 AQTESOLV\GW21d\GW21d T2 Falling KGS.aqt
Date: 09/05/17
Time: 14:06:18

PROJECT INFORMATION

Company: ENRS
Client: Pembroke Resources
Project: ENRS0600
Location: Olive Downs
Test Well: GW12s

AQUIFER DATA

Saturated Thickness: 9. m

WELL DATA (GW21d)

Initial Displacement: 1.891 m
Total Well Penetration Depth: 130.9 m
Casing Radius: 0.025 m

Static Water Column Height: 130.9 m
Screen Length: 9. m
Well Radius: 0.025 m

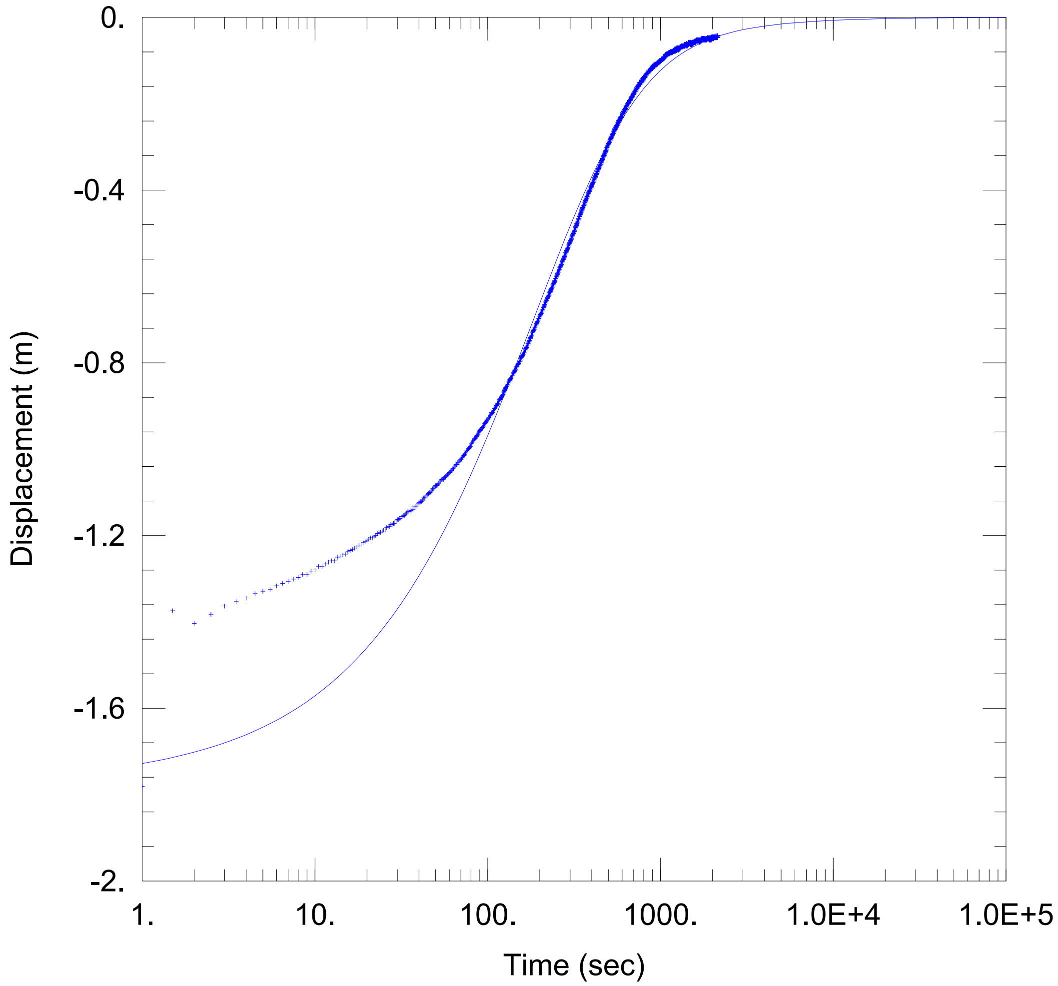
SOLUTION

Aquifer Model: Confined

Kr = 2.657E-6 m/sec
Kz/Kr = 1.

Solution Method: KGS Model

Ss = 0.004329 m^{-1}



WELL TEST ANALYSIS

Data Set: C:\Users\matt\Desktop\ENRS0600 AQTESOLV\GW21d\GW21d T2 Rising KGS.aqt
Date: 09/05/17 Time: 14:20:31

PROJECT INFORMATION

Company: ENRS
Client: Pembroke Resources
Project: ENRS0600
Location: Olive Downs
Test Well: GW12s

AQUIFER DATA

Saturated Thickness: 9. m

WELL DATA (GW21d)

Initial Displacement: -1.781 m
Total Well Penetration Depth: 130.9 m
Casing Radius: 0.025 m

Static Water Column Height: 130.9 m
Screen Length: 9. m
Well Radius: 0.025 m

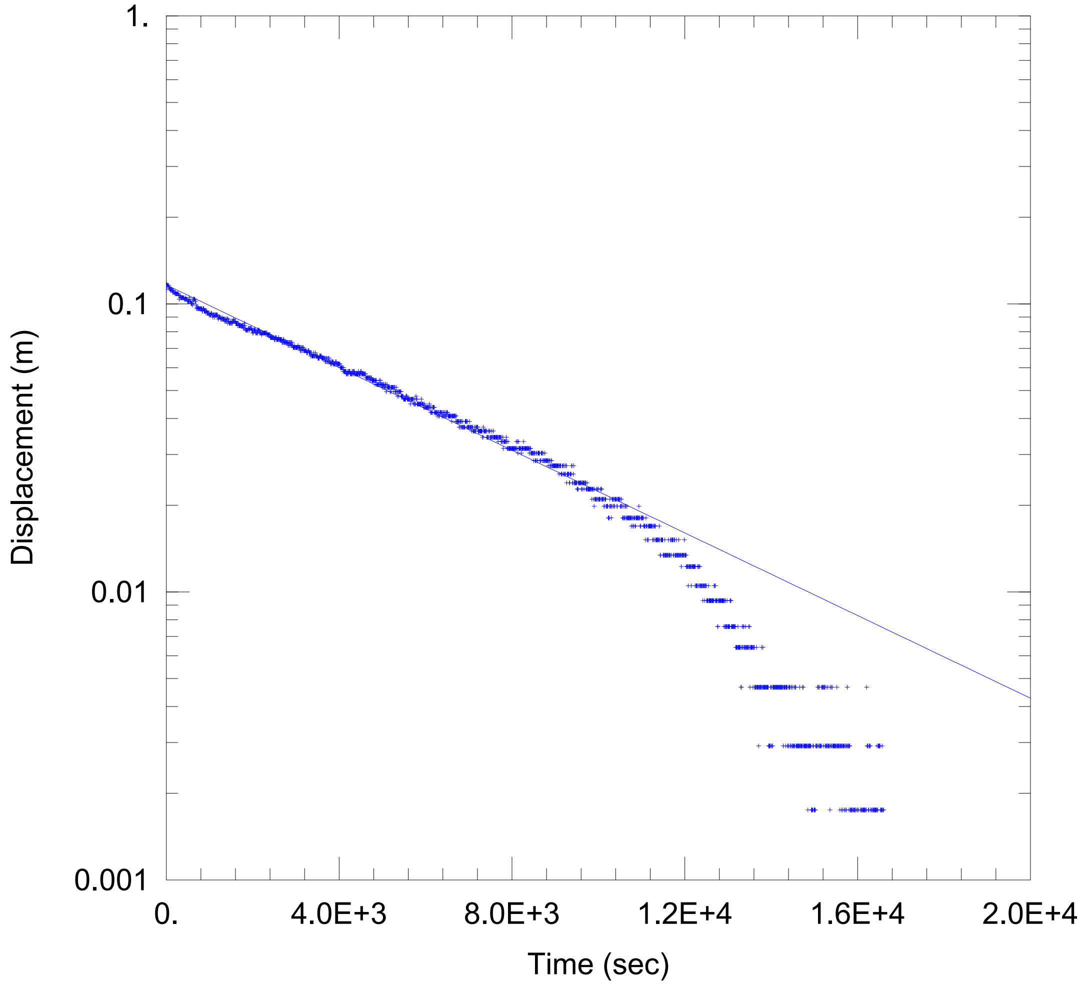
SOLUTION

Aquifer Model: Confined

Solution Method: KGS Model

Kr = 7.838E-7 m/sec
Kz/Kr = 1.

Ss = 0.004329 m^{-1}



WELL TEST ANALYSIS

Data Set: C:\Users\matt\Desktop\ENRS0600 AQTESOLV\GW21s\GW21s T1 Falling Bouwer Rice.aqt
Date: 09/05/17 Time: 14:23:46

PROJECT INFORMATION

Company: ENRS
Client: Pembroke Resources
Project: ENRS0600
Location: Olive Downs
Test Well: GW12s

AQUIFER DATA

Saturated Thickness: 0.965 m Anisotropy Ratio (Kz/Kr): 1.

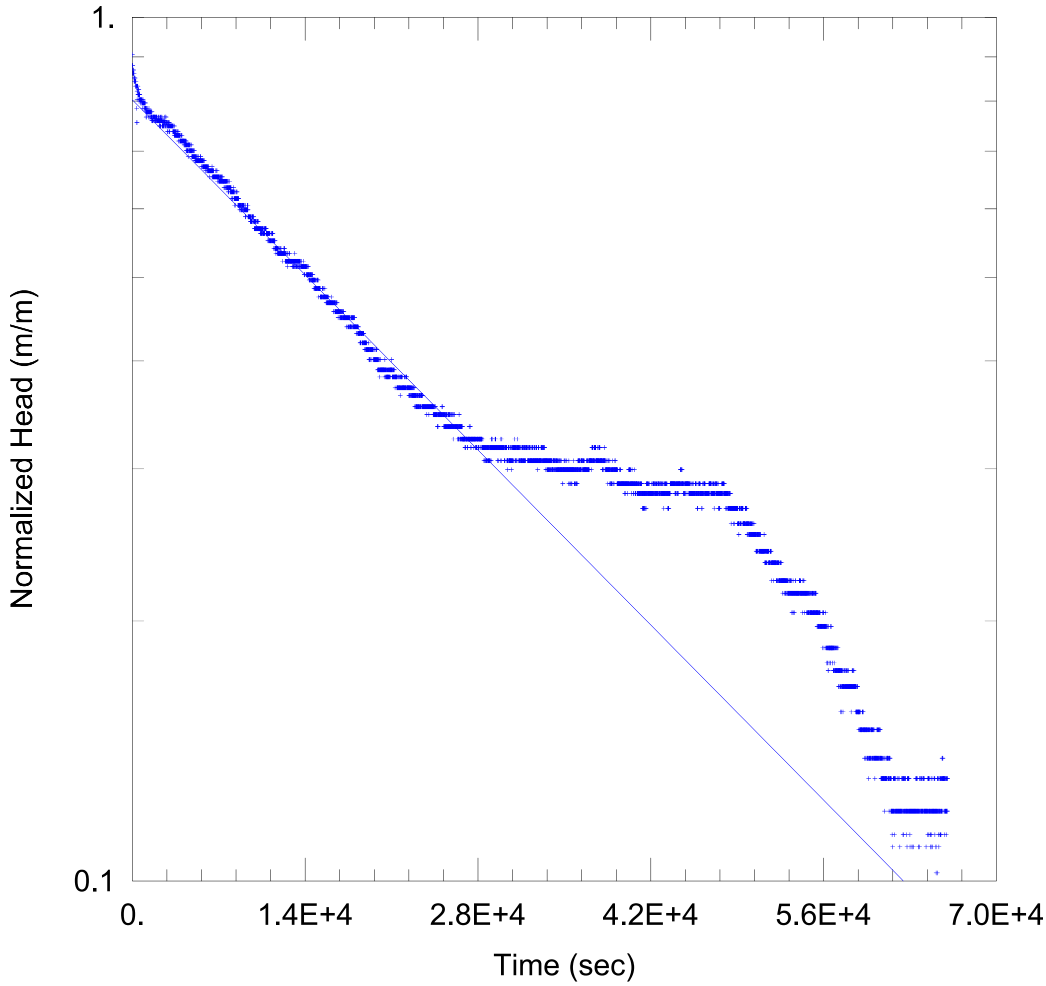
WELL DATA (GW21s)

Initial Displacement: 0.1126 m
Total Well Penetration Depth: 6. m
Casing Radius: 0.025 m
Static Water Column Height: 0.965 m
Screen Length: 6. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 3.699E-8 m/sec y0 = 0.1164 m



WELL TEST ANALYSIS

Data Set: C:\Users\matt\Desktop\ENRS0600 AQTESOLV\GW21s\GW21s T1 Rising Bouwer Rice.aqt
Date: 09/05/17 Time: 14:29:23

PROJECT INFORMATION

Company: ENRS
Client: Pembroke Resources
Project: ENRS0600
Location: Olive Downs
Test Well: GW12s

AQUIFER DATA

Saturated Thickness: 0.965 m Anisotropy Ratio (Kz/Kr): 1.

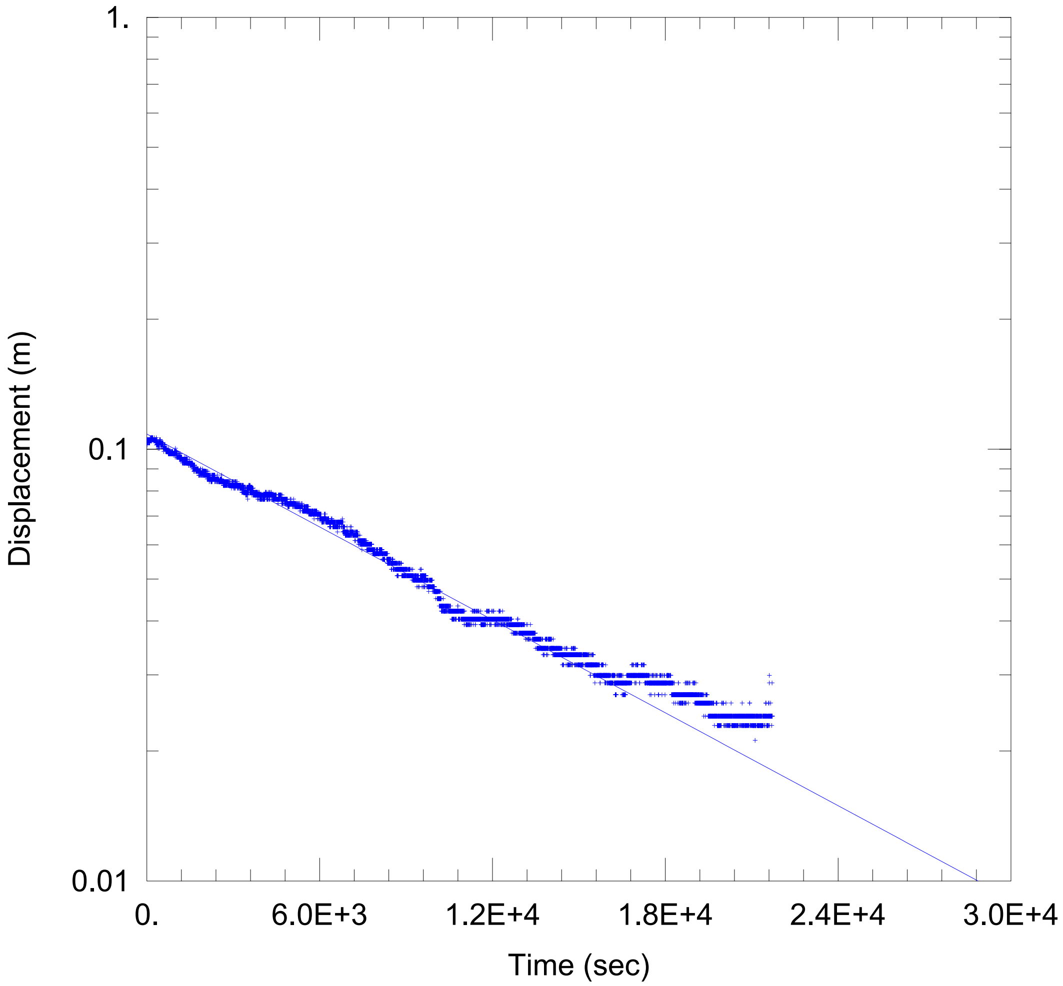
WELL DATA (GW21s)

Initial Displacement: -0.1598 m Static Water Column Height: 0.965 m
Total Well Penetration Depth: 6. m Screen Length: 6. m
Casing Radius: 0.025 m Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 7.463E-9 m/sec y0 = -0.1282 m



WELL TEST ANALYSIS

Data Set: C:\Users\matt\Desktop\ENRS0600 AQTESOLV\GW21s\GW21s T2 Falling Bouwer Rice.aqt
Date: 09/05/17 Time: 14:25:16

PROJECT INFORMATION

Company: ENRS
Client: Pembroke Resources
Project: ENRS0600
Location: Olive Downs
Test Well: GW12s

AQUIFER DATA

Saturated Thickness: 0.965 m
Anisotropy Ratio (Kz/Kr): 1.

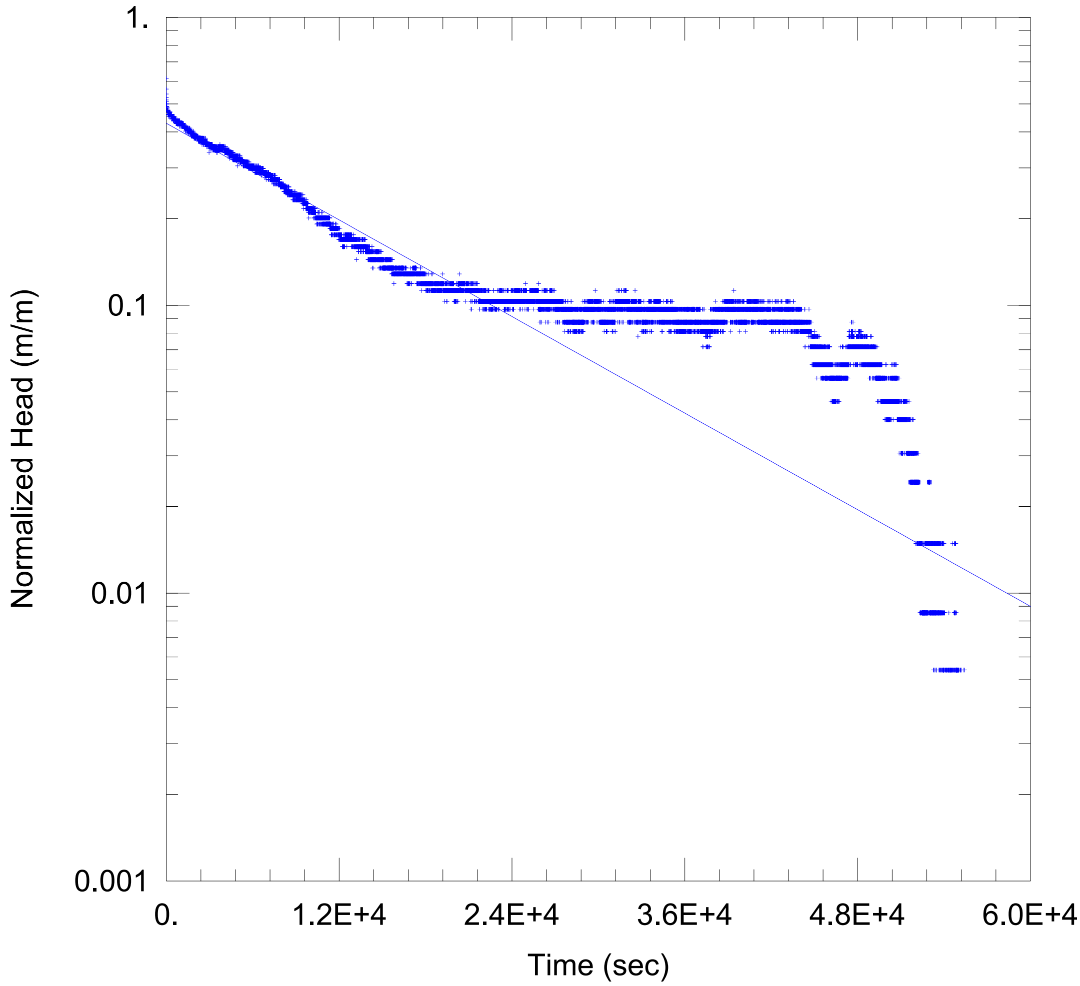
WELL DATA (GW21s)

Initial Displacement: 0.1034 m
Total Well Penetration Depth: 6. m
Casing Radius: 0.025 m
Static Water Column Height: 0.965 m
Screen Length: 6. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.849E-8 m/sec
y0 = 0.1084 m



WELL TEST ANALYSIS

Data Set: C:\Users\matt\Desktop\ENRS0600 AQTESOLV\GW21s\GW21s T2 Rising Bouwer Rice.aqt
Date: 09/05/17 Time: 14:31:59

PROJECT INFORMATION

Company: ENRS
Client: Pembroke Resources
Project: ENRS0600
Location: Olive Downs
Test Well: GW12s

AQUIFER DATA

Saturated Thickness: 0.965 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GW21s)

Initial Displacement: -0.185 m
Total Well Penetration Depth: 6. m
Casing Radius: 0.025 m
Static Water Column Height: 0.965 m
Screen Length: 6. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 1.442E-8 m/sec y0 = -0.07925 m

Attachment A4 – TEM Survey

AgTEM groundwater investigation for Olive Downs Coking Coal Project – July

July 2017
For Pembroke resources

By Dr David Allen.
David@GroundwaterImaging.com.au 0418964097

GROUNDWATER IMAGING

Main points

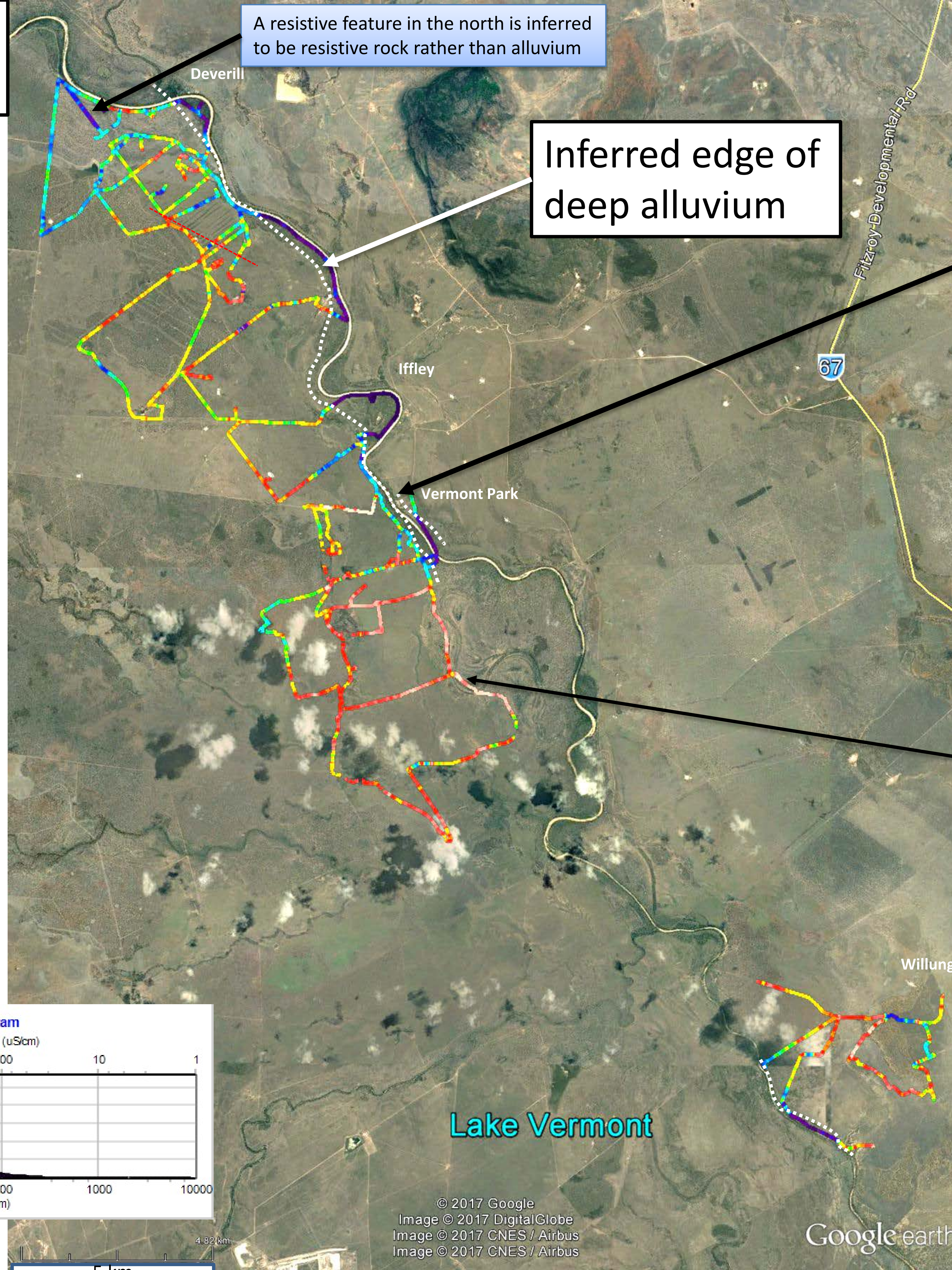
- The Olive Downs Coking Coal Project is consistently covered by a layer of alluvium 8 or more metres thick. There is an increase in thickness of alluvium to around 30m thick in a narrow corridor along the river. This corridor is restricted almost to the river width itself in places.
- Saline moisture, found in discrete parts of the alluvium, is likely to be sourced from groundwater up-flow from faults in underlying rock. A secondary concentration of salinity is suggested at depressions on the plains above, or in the vicinity of, saline groundwater upflow sites.
- The salinity of moisture within the alluvium appears to be affected by underlying rock structure and the groundwater pressure within it.
- Below the alluvium, variation in EC reveals numerous subtle dipping structures as well as lithological variations. Clearly the rock is complexly folded and faulted. Considerable study of the AgTEM data with cross comparison with drilling results is suggested for interpretation of the considerable volume of information available in this data representing strata below the alluvium. After line clearing, densification of the dataset may be appropriate coupled with depth of investigation enhancement for the purposes of assisting with mapping the coal measures. Below the alluvium, the AgTEM data appears to be mapping groundwater salinity variation controlled by structure and lithology rather than the lithology directly.
- The reader should attempt to interpret the images themselves comparing to what they know and find at the property as that is the best way to build confidence in interpretation. Take particular note of features consistent across multiple survey lines.
- Data is also supplied in KMZ files for self-viewing in Google Earth or other Earth model viewers.

Modelled Resistivity at 20m deep

Low resistivity, prevalent at this depth largely represents saline weathered rock. The mid range resistivities appear to indicate either alluvium of around 20m deep, alluvium contaminated with saline moisture or fresh non-saline rock.

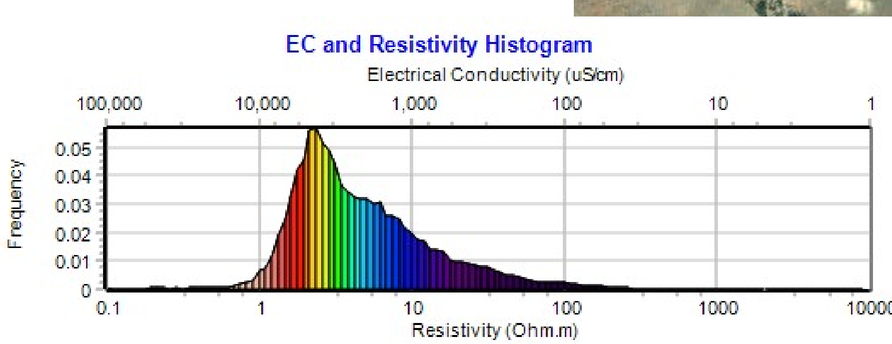
Alluvium of >20m thickness occurs only in a narrow corridor along the existing path of the Isaac River.

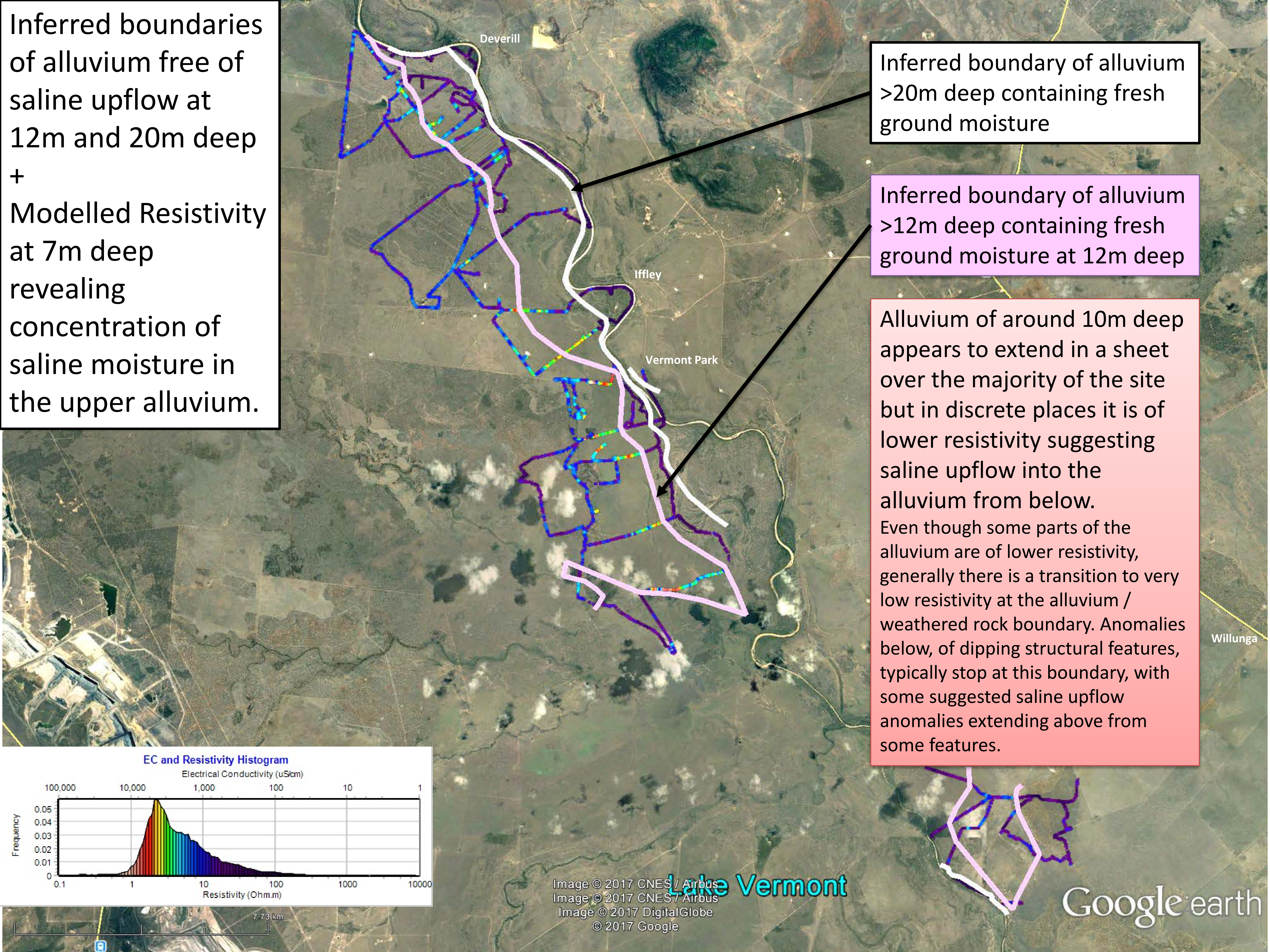
A resistive region in the NW is interpreted, not as alluvium, but as resistive rock – possibly a lava flow or an anticline of sedimentary rock of lower salinity.

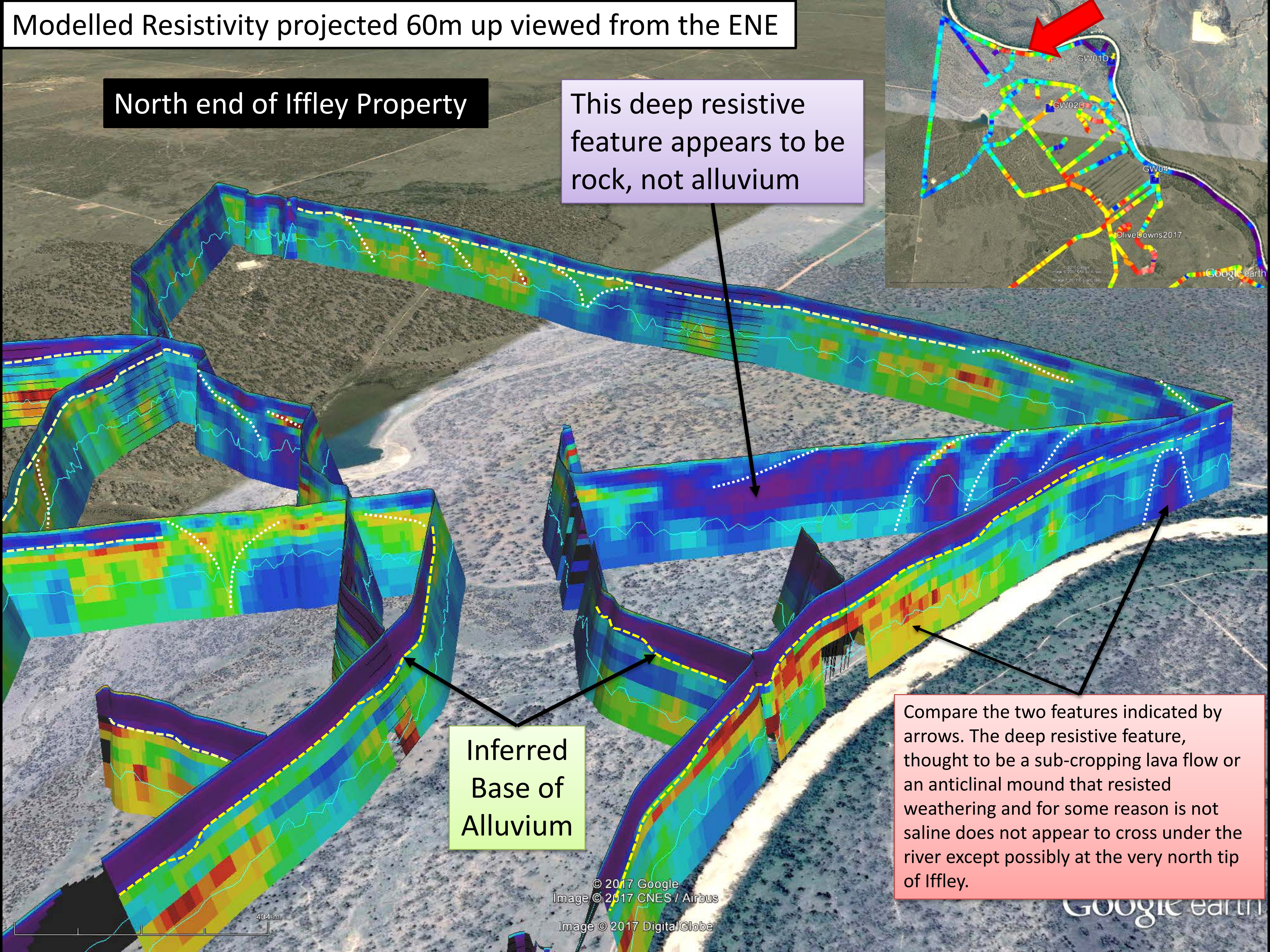


Suggested very narrow restriction of alluvium >20m deep

Alluvium appear to be less than 20m deep even under geomorphologically obvious prior river channels.




Inferred boundaries of alluvium free of saline upflow at 12m and 20m deep
+
Modelled Resistivity at 7m deep revealing concentration of saline moisture in the upper alluvium.
Inferred boundary of alluvium >20m deep containing fresh ground moisture
Inferred boundary of alluvium >12m deep containing fresh ground moisture at 12m deep
Alluvium of around 10m deep appears to extend in a sheet over the majority of the site but in discrete places it is of lower resistivity suggesting saline upflow into the alluvium from below.
Even though some parts of the alluvium are of lower resistivity, generally there is a transition to very low resistivity at the alluvium / weathered rock boundary. Anomalies below, of dipping structural features, typically stop at this boundary, with some suggested saline upflow anomalies extending above from some features.
Deverill
Iffley
Vermont Park
Willunga
Lake Vermont
EC and Resistivity Histogram
Electrical Conductivity (uS/cm)
100,000
10,000
1,000
100
10
1
Frequency
0.05
0.04
0.03
0.02
0.01
0
0.1
1
10
100
1000
10000
Resistivity (Ohm.m)
7.73 km
Image © 2017 CNES / Airbus
Image © 2017 CNES / Airbus
Image © 2017 DigitalGlobe
© 2017 Google
Google earth


Modelled Resistivity projected 60m up viewed from the ENE
North end of Iffley Property
This deep resistive feature appears to be rock, not alluvium
Inferred Base of Alluvium
Compare the two features indicated by arrows. The deep resistive feature, thought to be a sub-cropping lava flow or an anticlinal mound that resisted weathering and for some reason is not saline does not appear to cross under the river except possibly at the very north tip of Iffley.
GW01D
GW02D
GW04
OliveDowns2017
© 2017 Google
Image © 2017 CNES / Airbus
Image © 2017 DigitalGlobe
404 m
Google earth

Contents

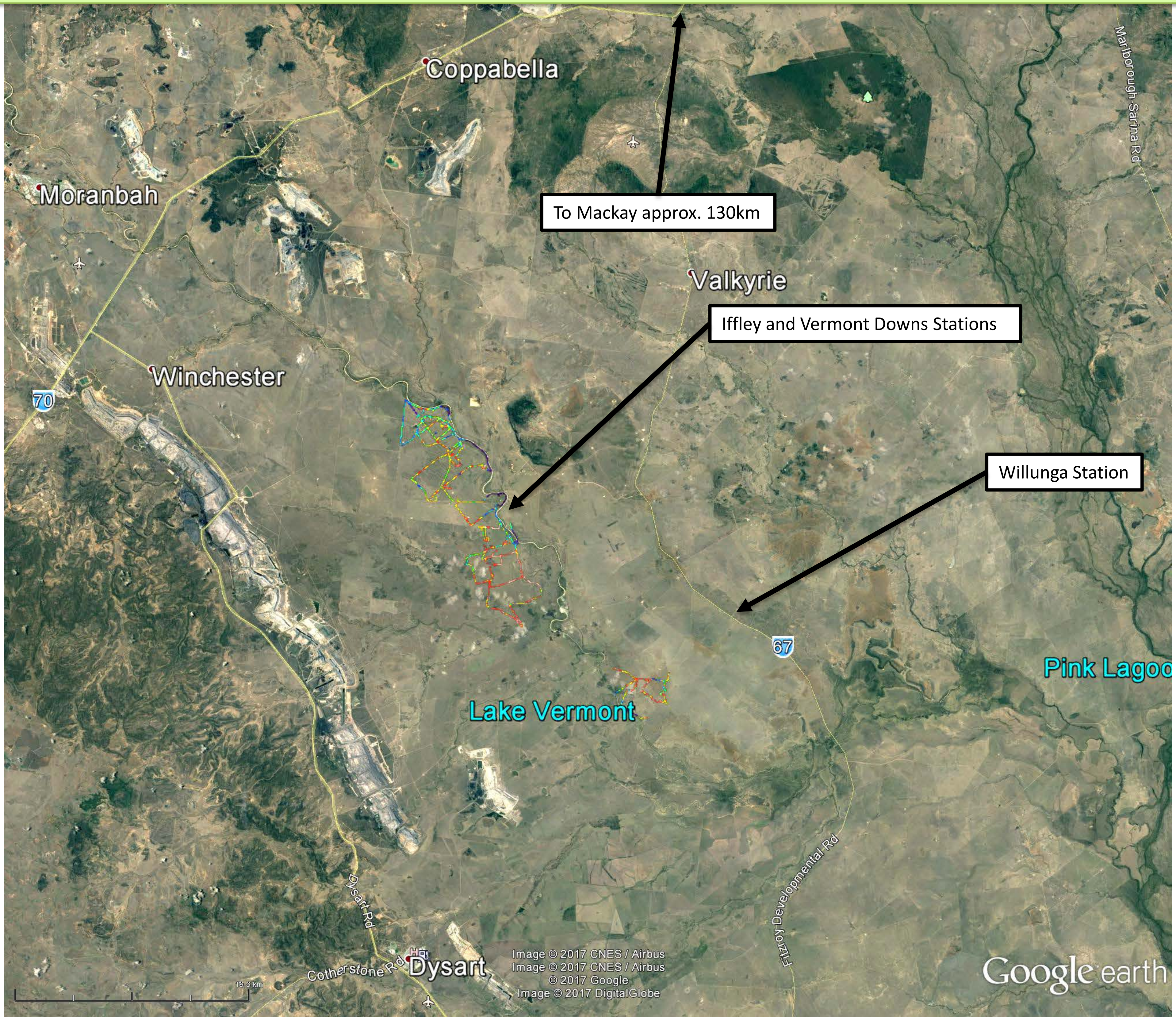
Context and Aim

- The survey was conducted in an area with alluvium over coal measures. The alluvium is largely sandy and resistive contrasting with clayey coal measures and associated strata beneath.
- The survey aims to define alluvium thickness, lithological variation and groundwater salinity distribution. Groundwater interaction with underlying sedimentary rock is to be identified where feasible.

Method Summary

- Variation in the depth, lithology, saturation and groundwater salinity of the geological facies at the site has been mapped using towed transient electromagnetics, drill chip lithology, outcrop, soils and float rock appraisal. 3D graphics has been applied to relate the various sources of information.

Location



Coppabella
Moranbah
To Mackay approx. 130km
Valkyrie
Iffley and Vermont Downs Stations
Winchester
70
Willunga Station
67
Pink Lagoo
Lake Vermont
Marlborough-Sarina Rd
Fitzroy Developmental Rd
Dysart Rd
Cotherstone Rd
Dysart
Image © 2017 CNES / Airbus
Image © 2017 CNES / Airbus
© 2017 Google
Image © 2017 DigitalGlobe
Google earth

Geophysical Methods Introduction

- A quick and comprehensive way of looking at a shallow (0 to 100m deep) groundwater resource is to image it with towed transient electromagnetic devices. The resultant EC image will reveal, in a blurred manner, the proportion of ions in solution in the groundwater and rock at various depth – usually this means that dry ground, good aquifers and fresh basement rock show as electrically resistive and contrast with clays and saline aquifers that show as electrically conductive. Determining exactly what each feature represents is then a matter of interpretation which is usually solved by comparison with borehole logs and a bit of logic (eg. basement rock will be at the base, an unsaturated zone will be at the top and prior river channels will be shaped concave-up).

Why use Electrical Conductivity Imaging for Groundwater Investigation

- reveal spatial details not observable by any more economically viable means
- EC responds clearly and conclusively to recharge pathways and saline groundwater.

LOW EC	**HIGH EC**
• Lack of Clays	• Clays
• Low Saturation	• High Saturation
• Fresh pore water	• Saline pore water
• Impervious fresh rock	• Weathered rock

Results Presentation

- TEM data has been presented as depth slices in Google Earth
- In order to understand the TEM data, it has also been plotted in 3D. This helps with observation of the geometry of features in vertical transects.
- The curtain images (actually triangular prisms) plotted in 3D are simply projected 30 to 60m up from the Google Earth DEM. The data is plotted against depth but draped over the Google Earth DEM.
- In Google Earth 3D oblique orientation, other data is presented in combination with the TEM depth slices including outcrop photos, lithology logs and TEM transects. Interpretation comments are added.
- 3D presentations of data at individual sites along with bore lithology graphics and photos are presented.

Base of alluvium – bores vs TEM

Bore

- GW16 s-10m d-clay 17.5m
- GW18 s-clay 12.5m d-12m
- GW12 s-clay 11m d-sandstone 55m
- GW08 s>13 clay 12m d-53m
- 136090 30m
- GW06 s-clay 6m d-10m
- GW02 s-2.5m? d-15m
- GW01 s- clay 18m d-13/29m
- GW04 clay 15m claystone 30m
- GW21 s-6m d-5.5m

TEM – transition to high EC

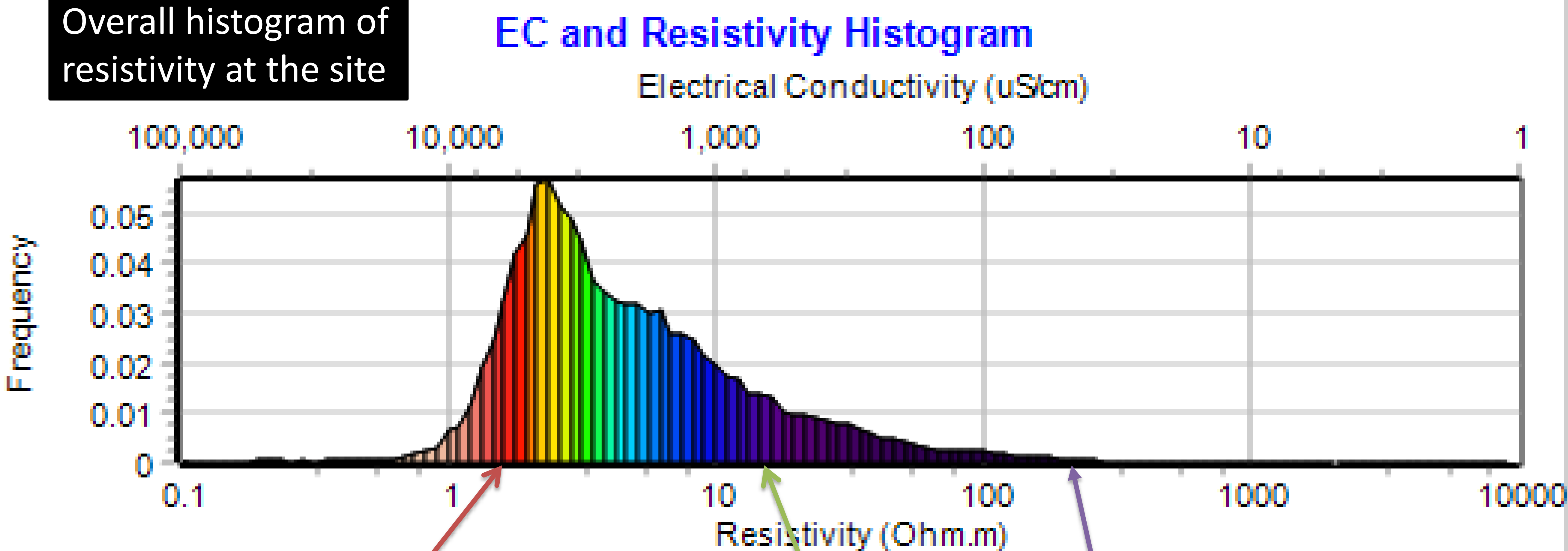
- 12m
- 12m
- No TEM nearby
- 12m with transition to 24m
- 30m – some distance away
- 10m
- 16m
- 20m
- 15m
- No TEM nearby

Depicting base of alluvium from bore lithologies is subjective, particularly as the clayey Rewan Formation is under much of the alluvium. Depth to clay, where indicated, has been used as base of alluvium in most cases. Clay transitions into claystone.

Resistivity scale used in Google Earth Images

The inverse of Resistivity is Electrical Conductivity (EC).

Overall histogram of resistivity at the site



Saline moisture typically in weathered rock and clay

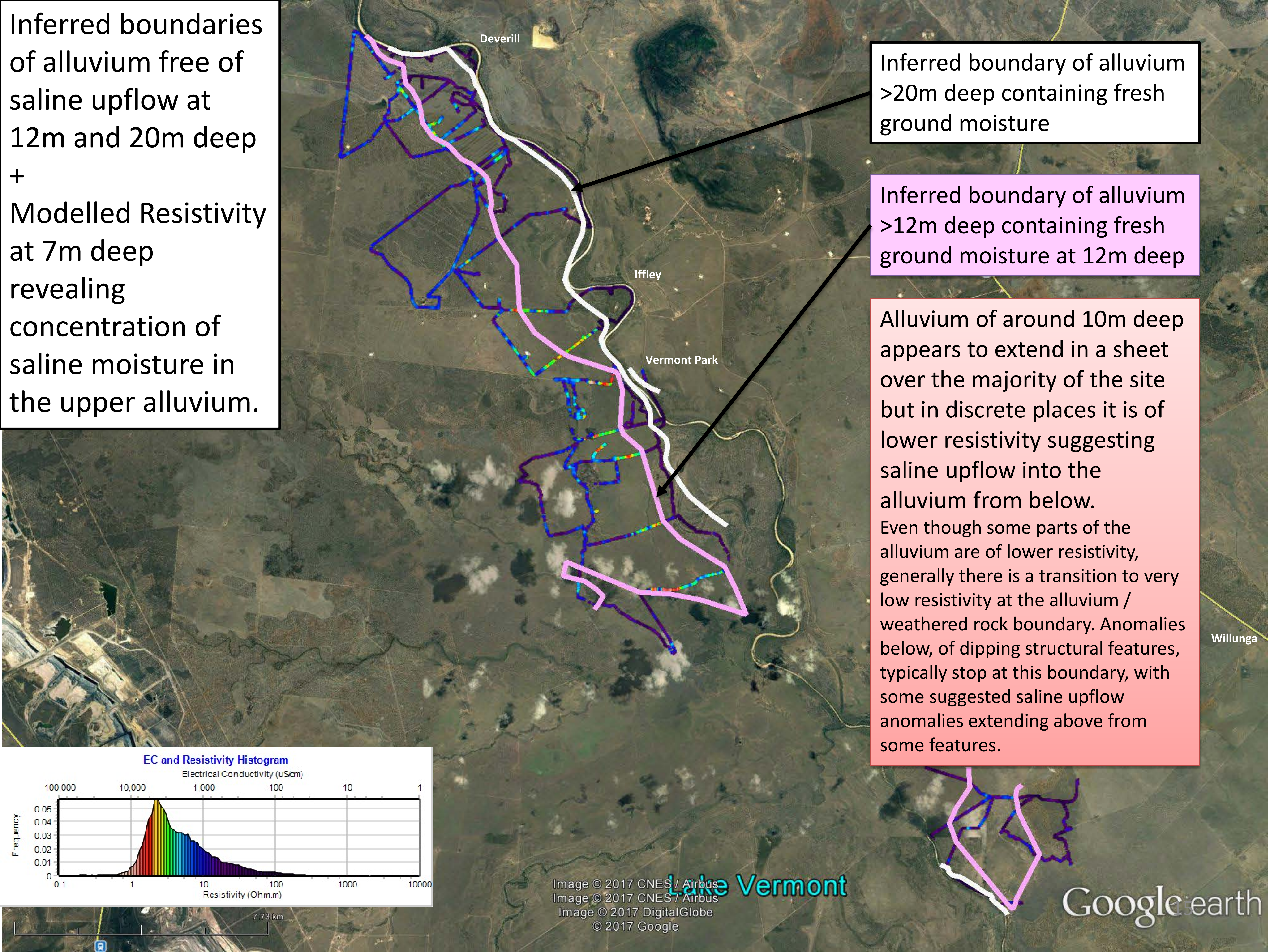
Fresh ground moisture typically in sand and gravel

Impermeable hard rock such as granite and limestone.
Air filled gravel, pebbles or cobbles.

Treat modelled resistivities in these datasets as relative, not absolute.

Full set of depth slices with common colour stretch

The AgTEM4 prototype 2016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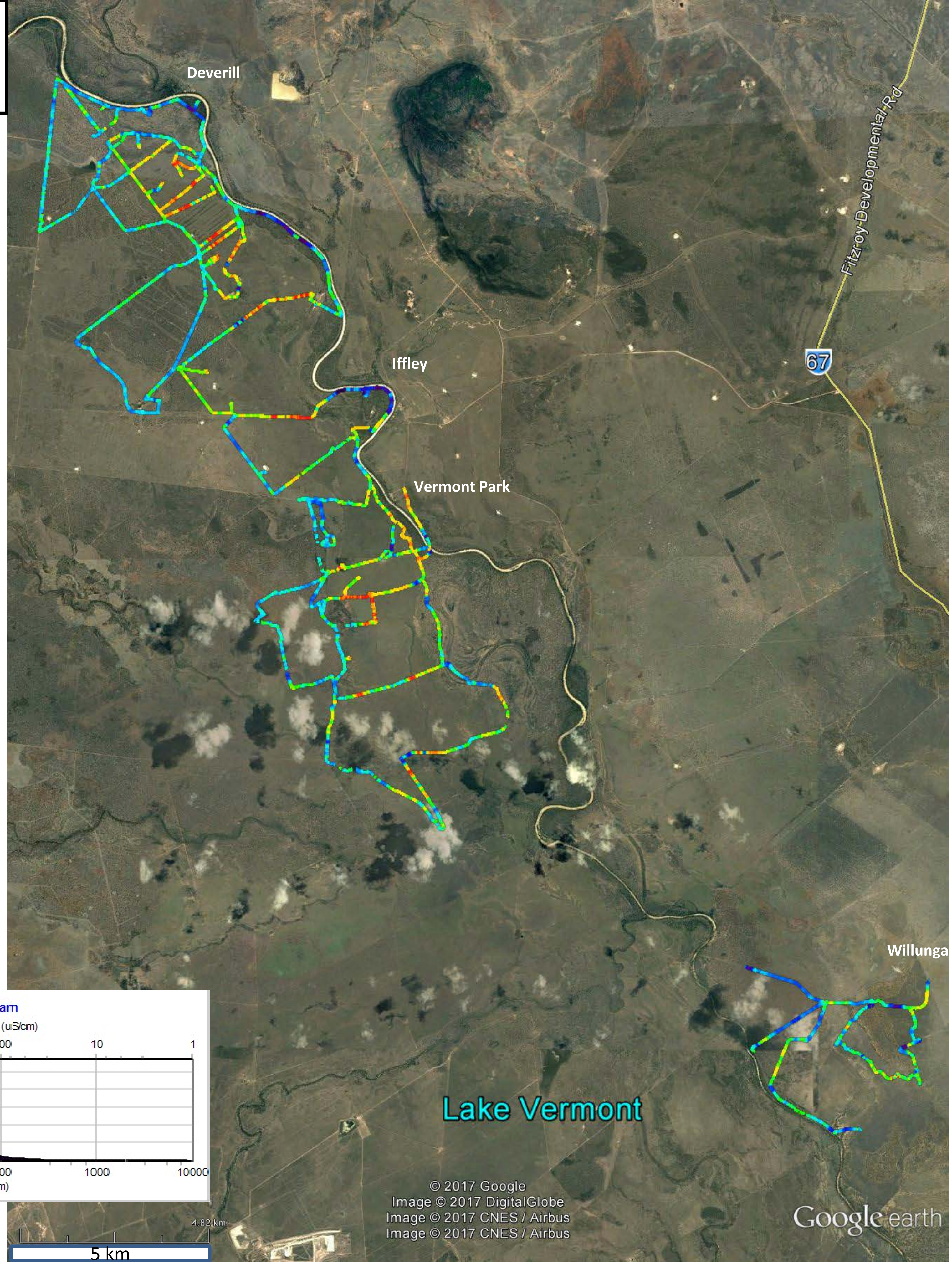
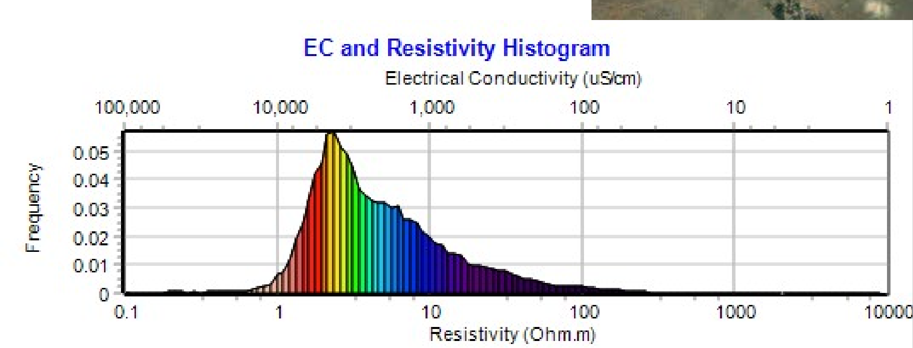
Deverill
Iffley
Vermont Park
Willunga
Lake Vermont
EC and Resistivity Histogram
Electrical Conductivity (uS/cm)
100,000
10,000
1,000
100
10
1
Frequency
0.05
0.04
0.03
0.02
0.01
0
0.1
1
10
100
1000
10000
Resistivity (Ohm.m)
7.73 km
Image © 2017 CNES / Airbus
Image © 2017 CNES / Airbus
Image © 2017 DigitalGlobe
© 2017 Google
Google earth

Modelled Resistivity at 0.3m deep

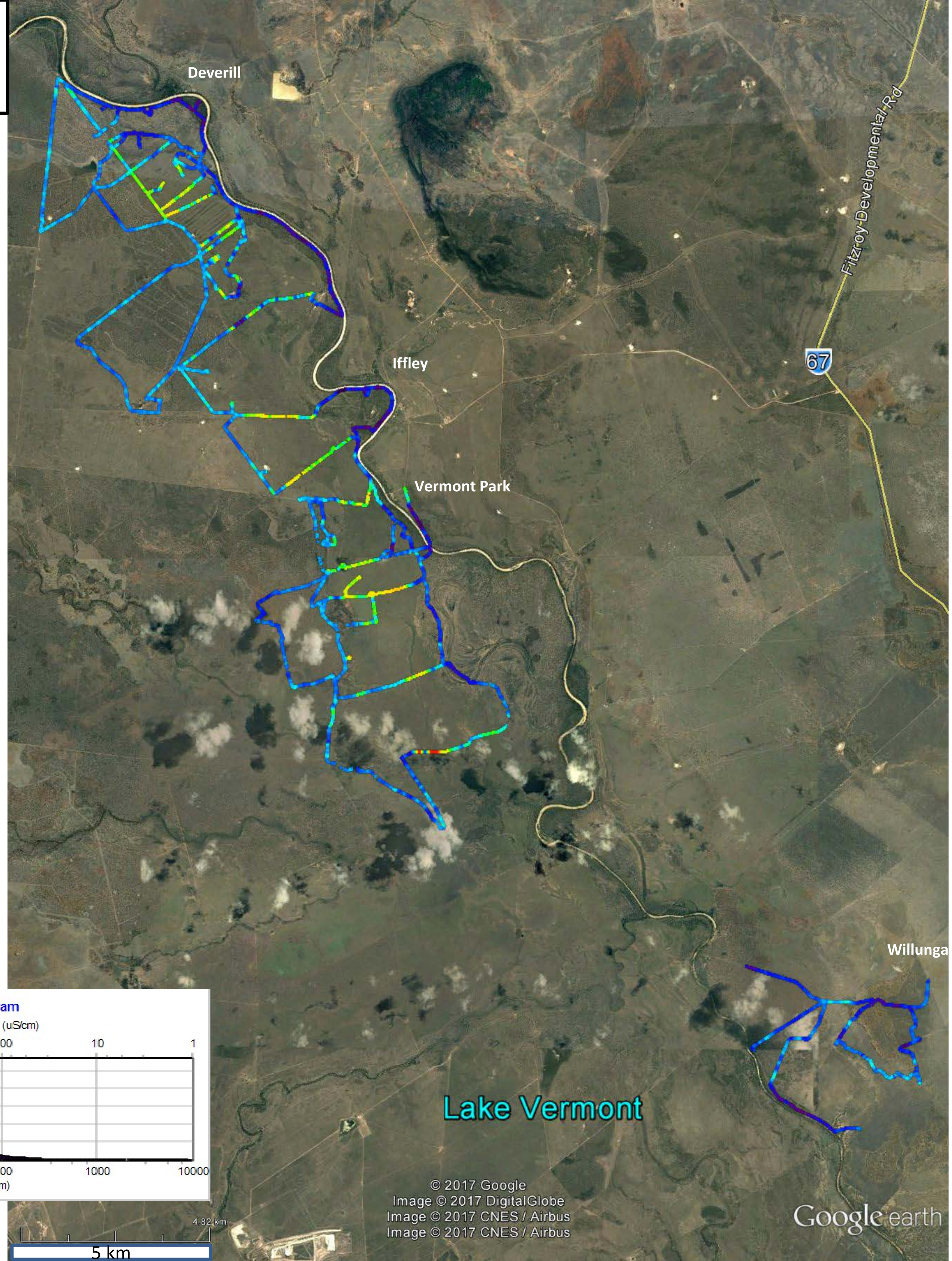
At this depth, low resistivity features clearly indicate salt concentrated in topsoil in depressions, principally in the melon hole plains.

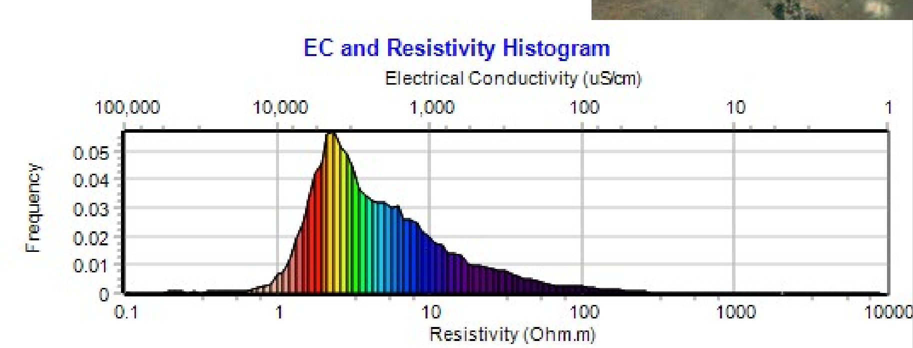




Modelled Resistivity at 1m deep

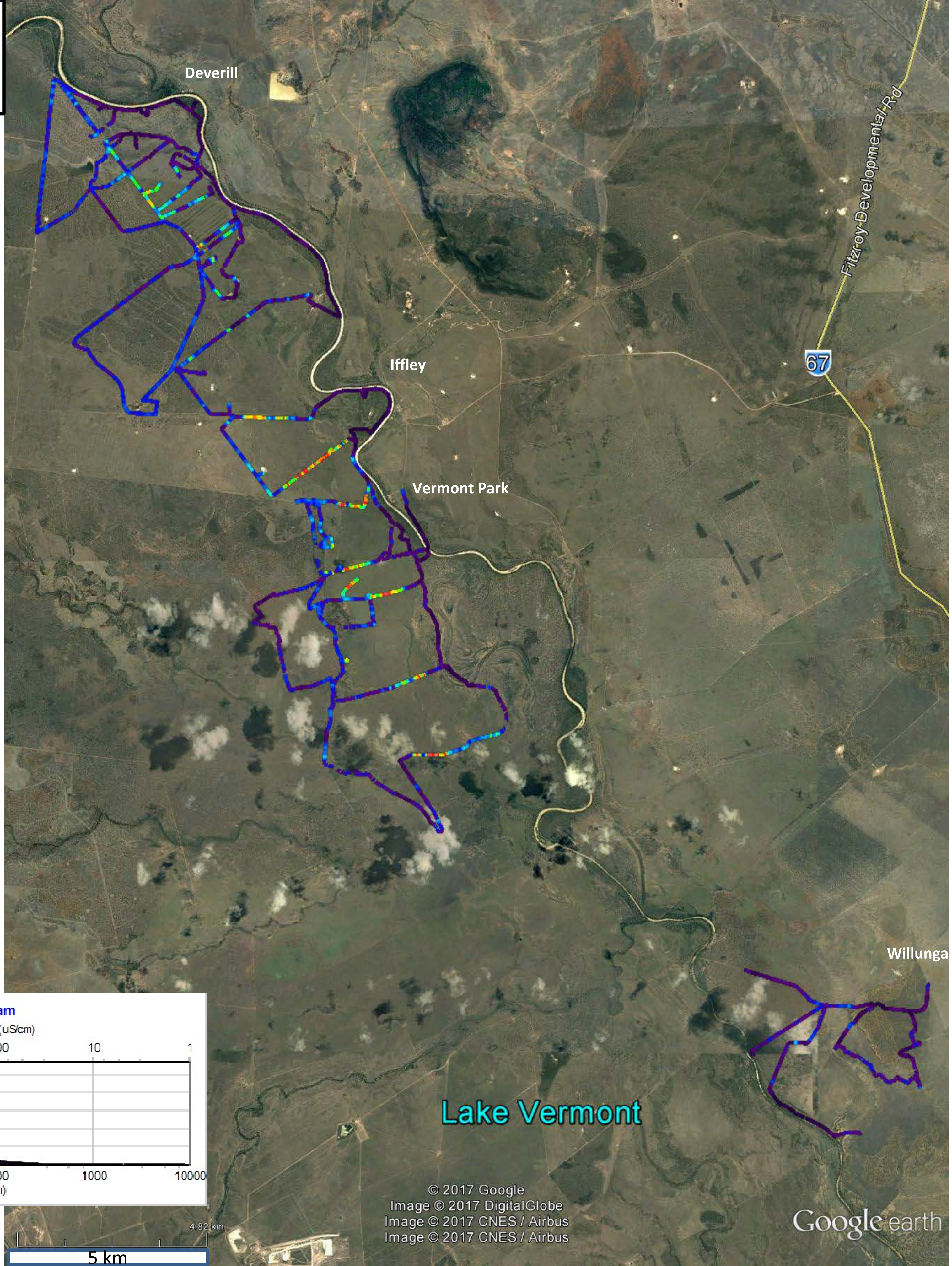
At this depth, low resistivity features clearly indicate salt concentrated in subsoil, principally in the melon hole plains.

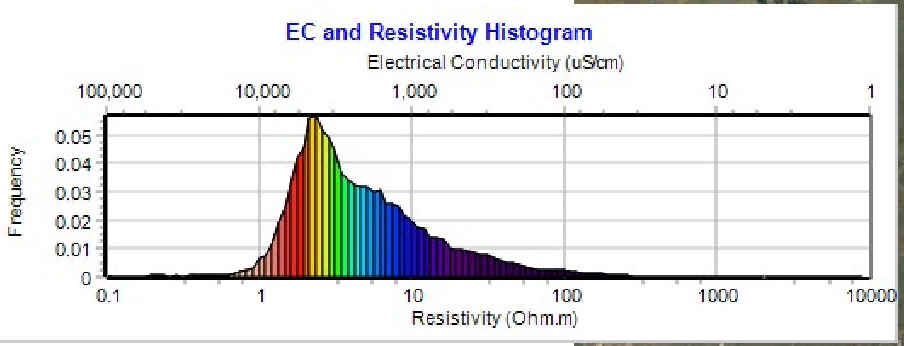




Modelled Resistivity at 4m deep

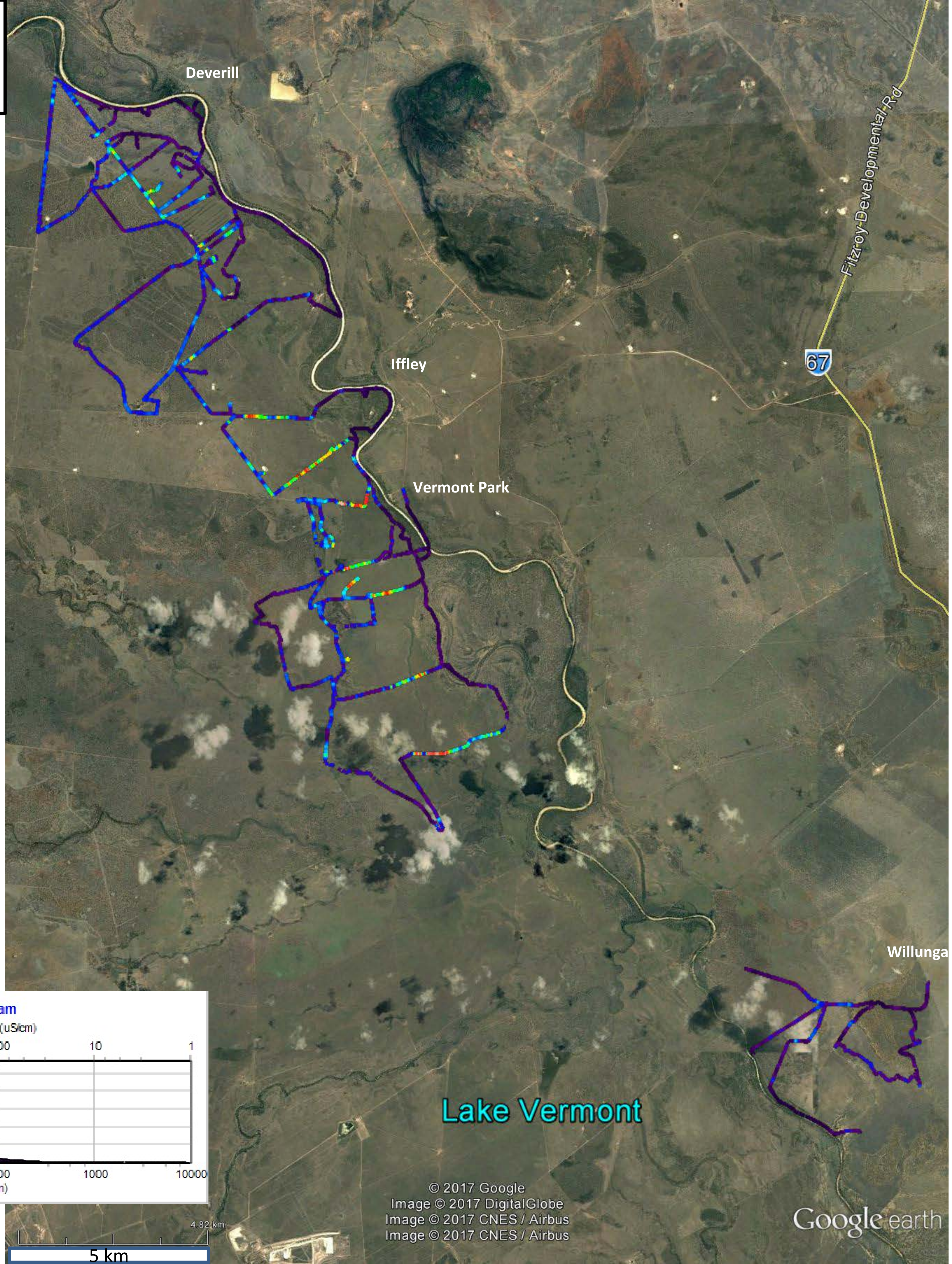
At this depth, low resistivity features clearly indicate salt concentrated deeper in subsoil, inferred to be focused above upflowing sources in the rock below.

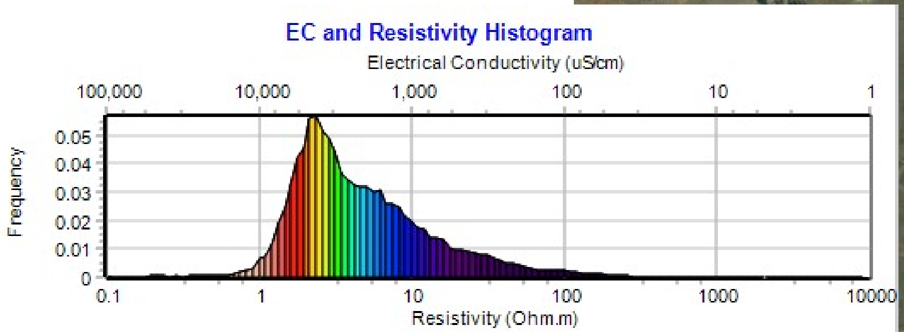




Modelled Resistivity at 7m deep

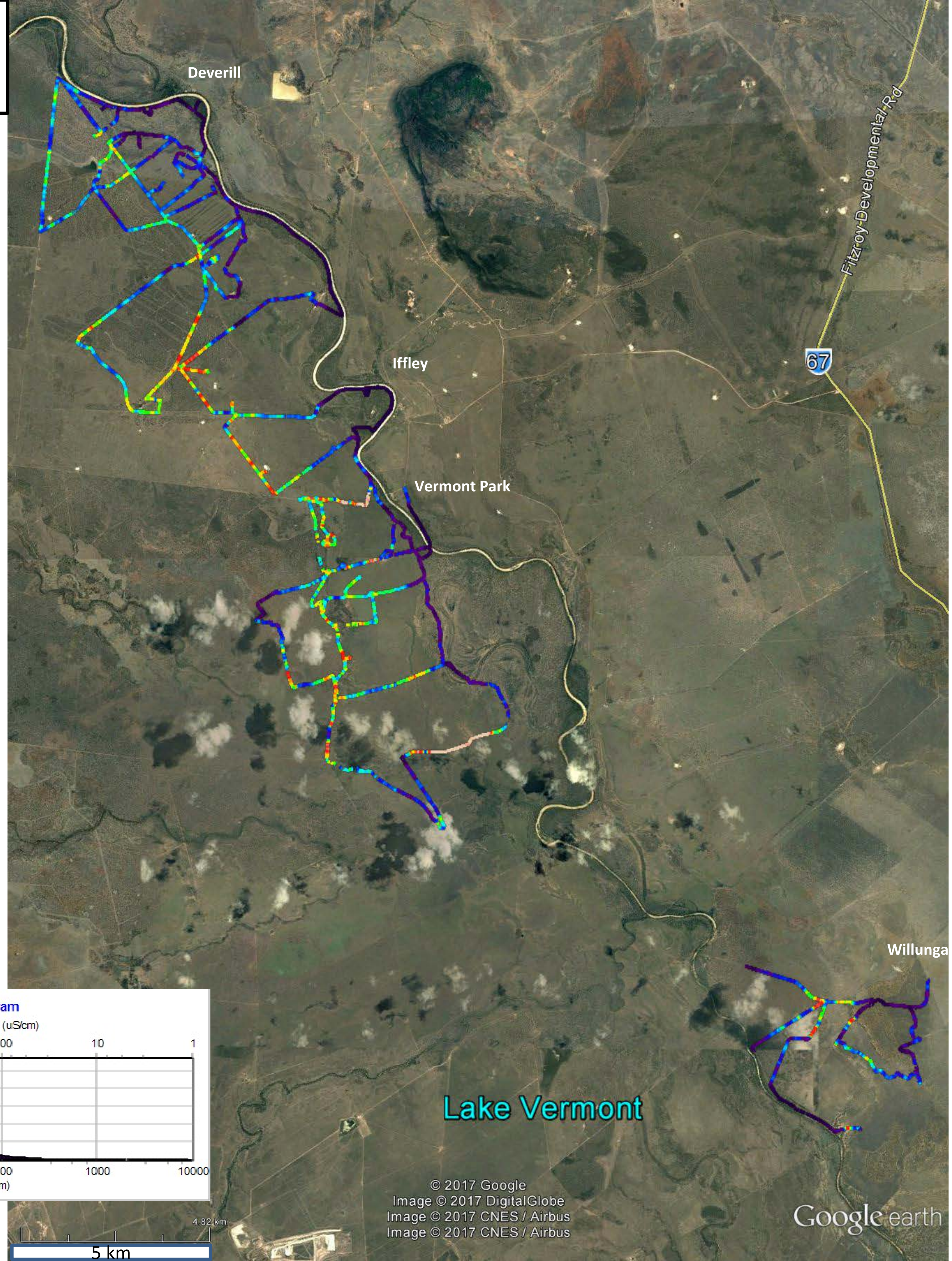
At this depth, low resistivity features indicate salt concentrated deep in alluvium, inferred to be focused above upflowing sources in the rock below.
In places, low resistivity may also represent shallow subcrop of saline sediment.

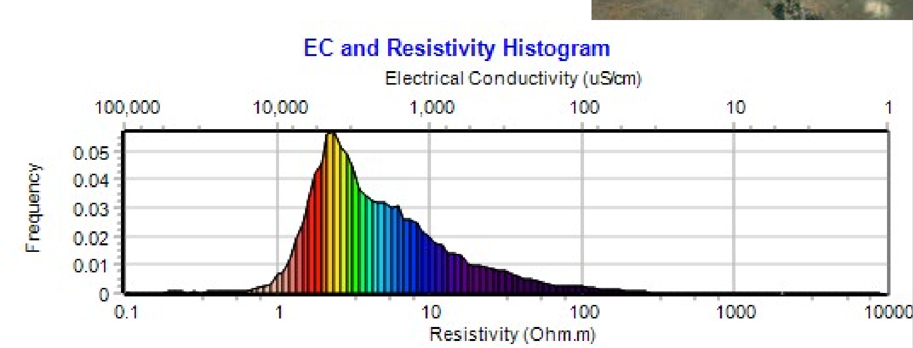




Modelled Resistivity at 12m deep

Low resistivity, prevalent at this depth largely represents saline subcrop. The highest resistivities indicate deep alluvium and the mid range resistivities appear to indicate either alluvium of around 12m deep, alluvium contaminated with saline moisture or fresh non-saline rock.



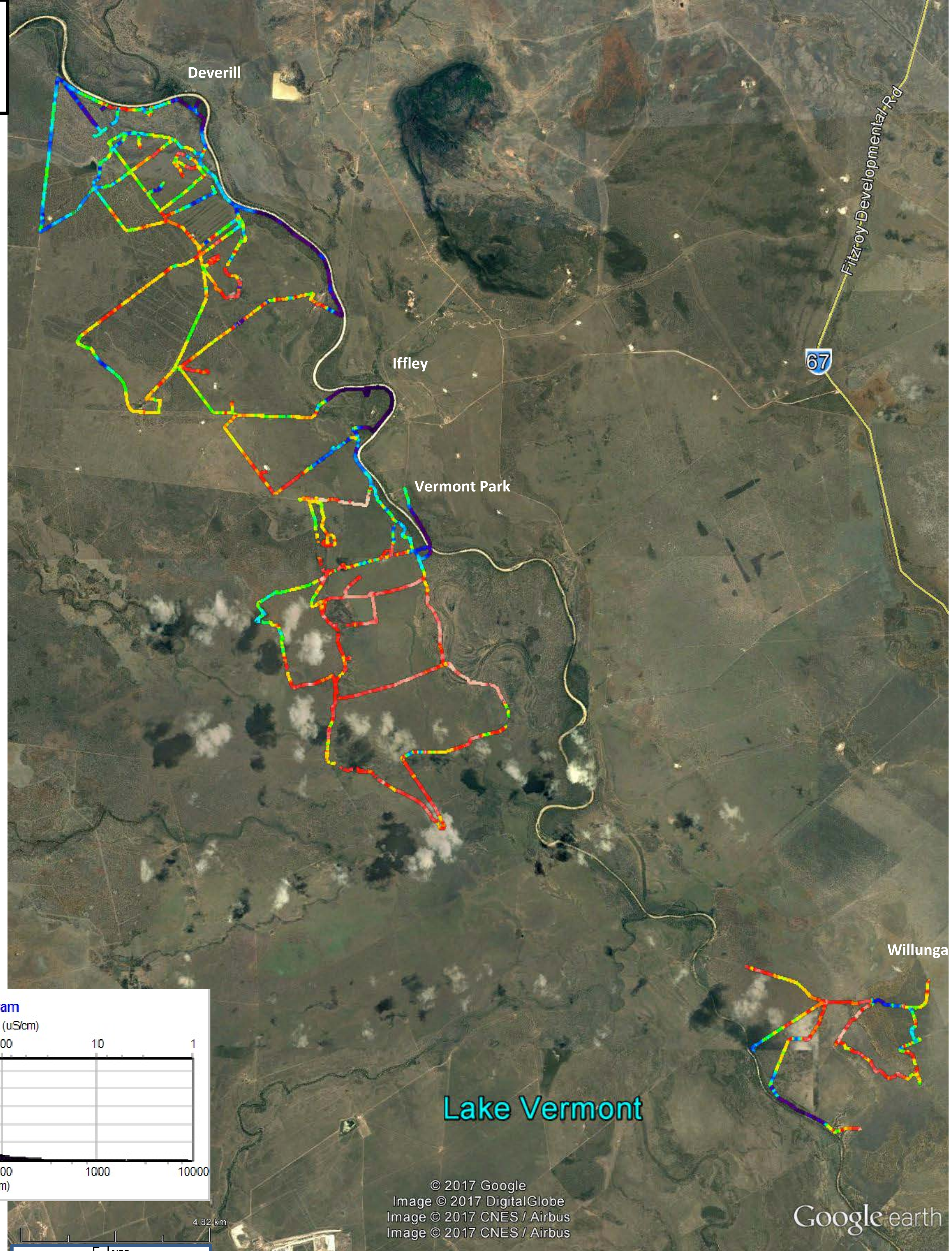


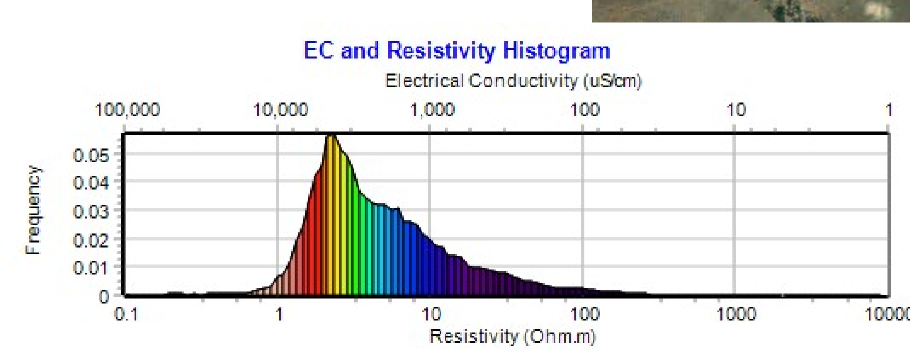
Modelled Resistivity at 20m deep

Low resistivity, prevalent at this depth largely represents saline weathered rock. The mid range resistivities appear to indicate either alluvium of around 20m deep, alluvium contaminated with saline moisture or fresh non-saline rock.

Alluvium of >20m thickness occurs only in a narrow corridor along the existing path of the Isaac River.

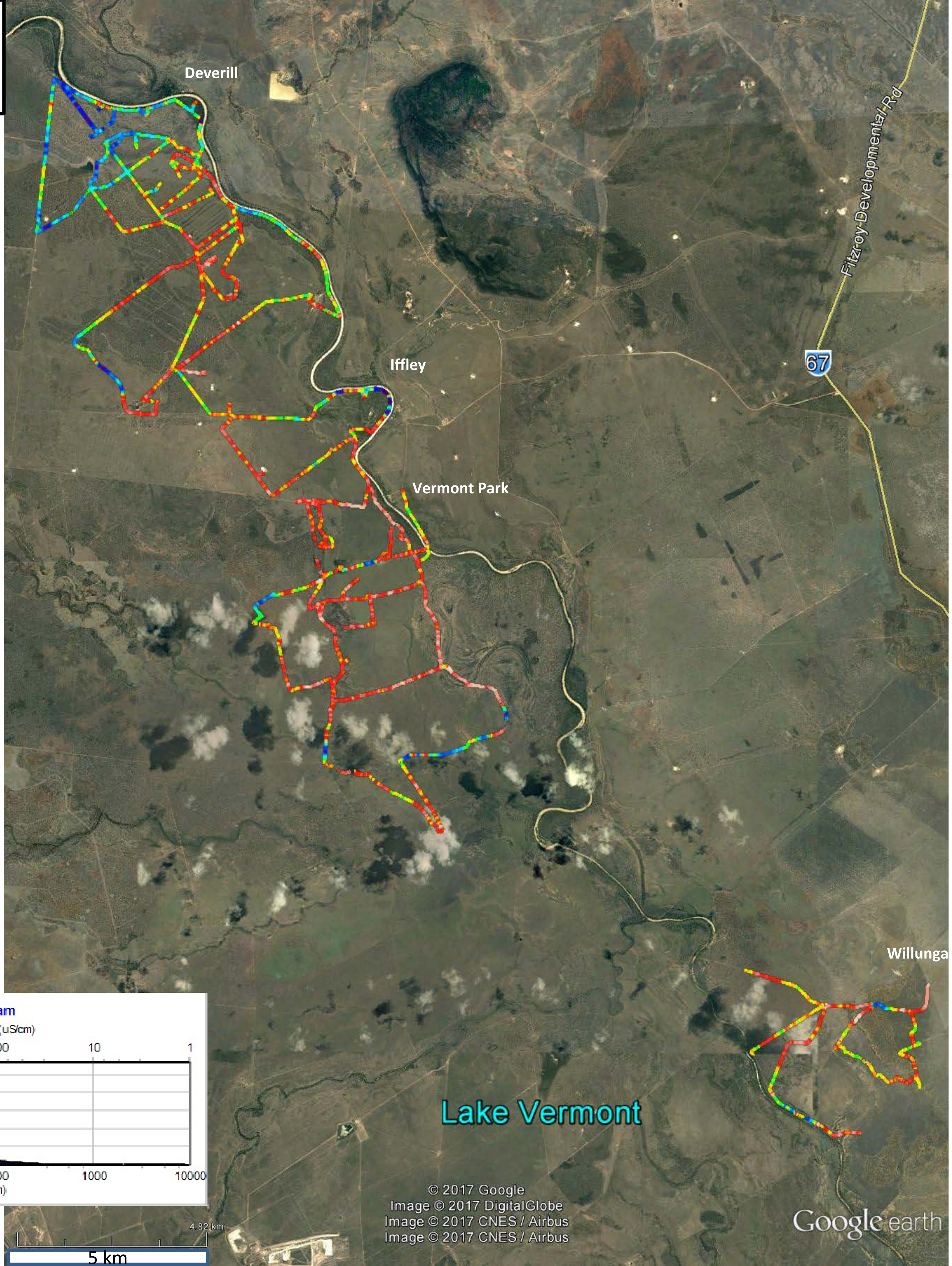
A resistive region in the NW is interpreted, not as alluvium, but as resistive rock – possibly a lava flow or an anticline of sedimentary rock of lower salinity.

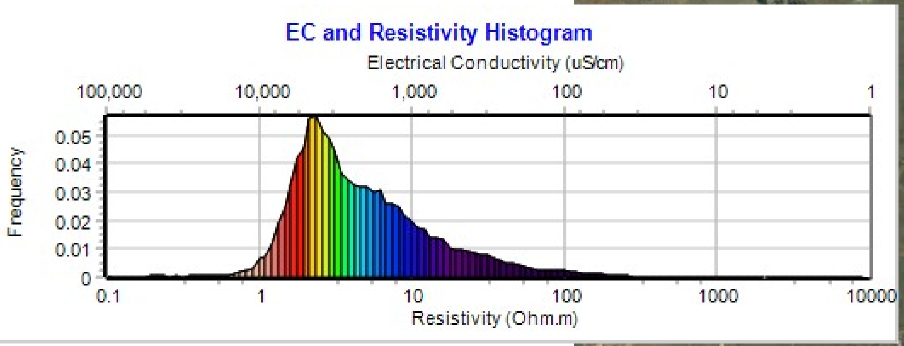




Modelled Resistivity at 28m deep

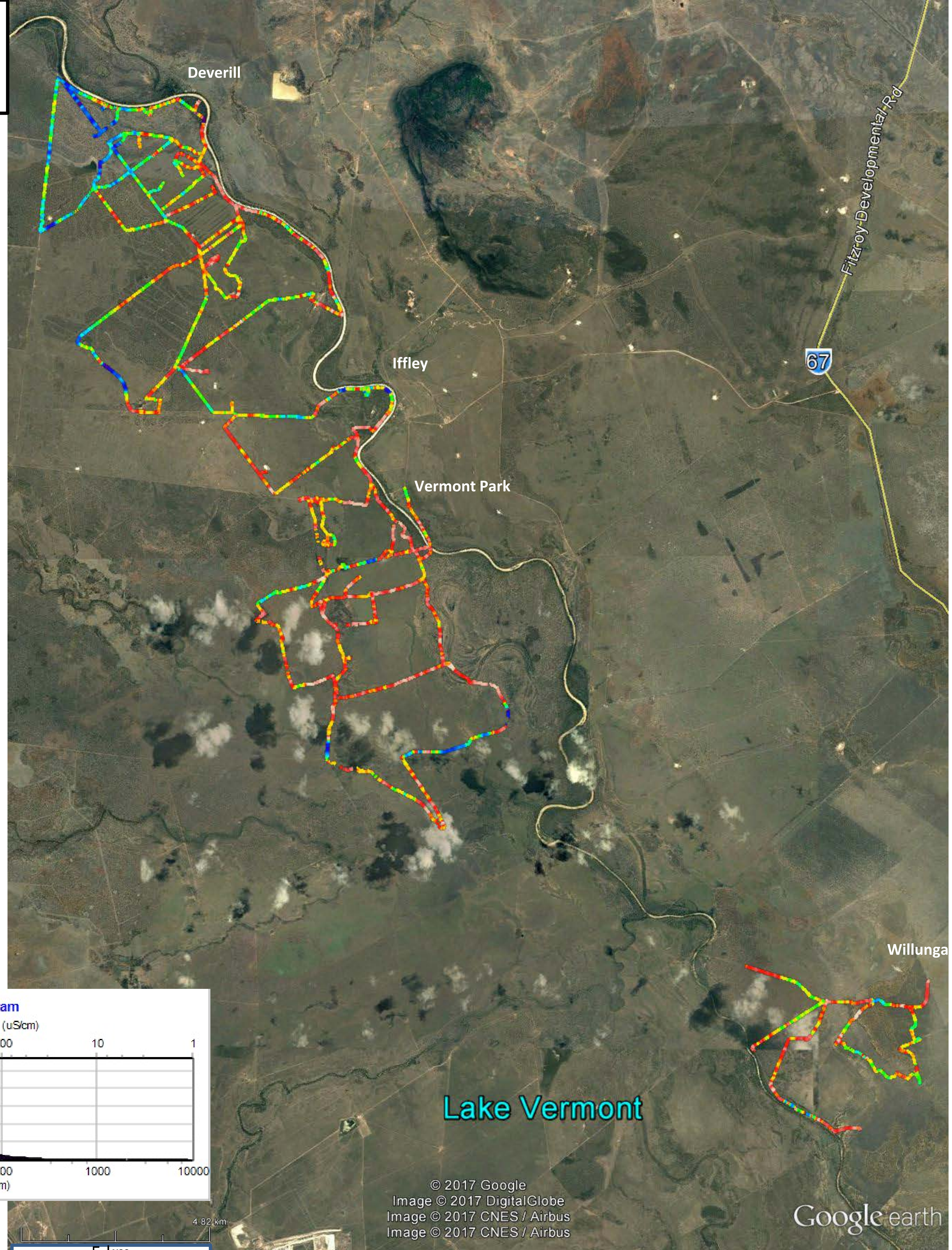
Low resistivity, prevalent at this depth largely represents saline rock. The mid and high range resistivities appear to indicate fresh non-saline rock.

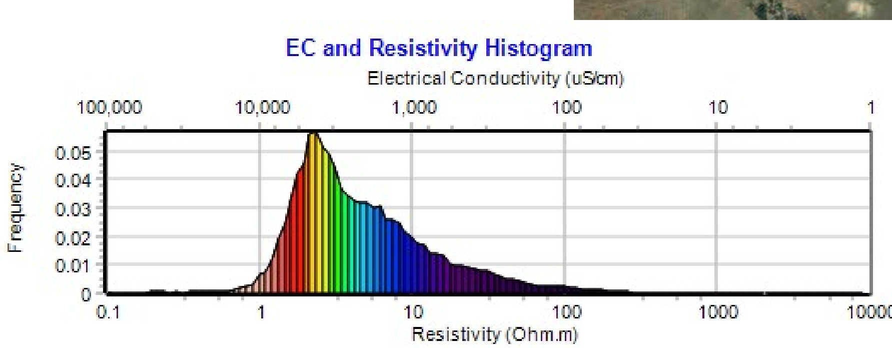




Modelled Resistivity at 36m deep

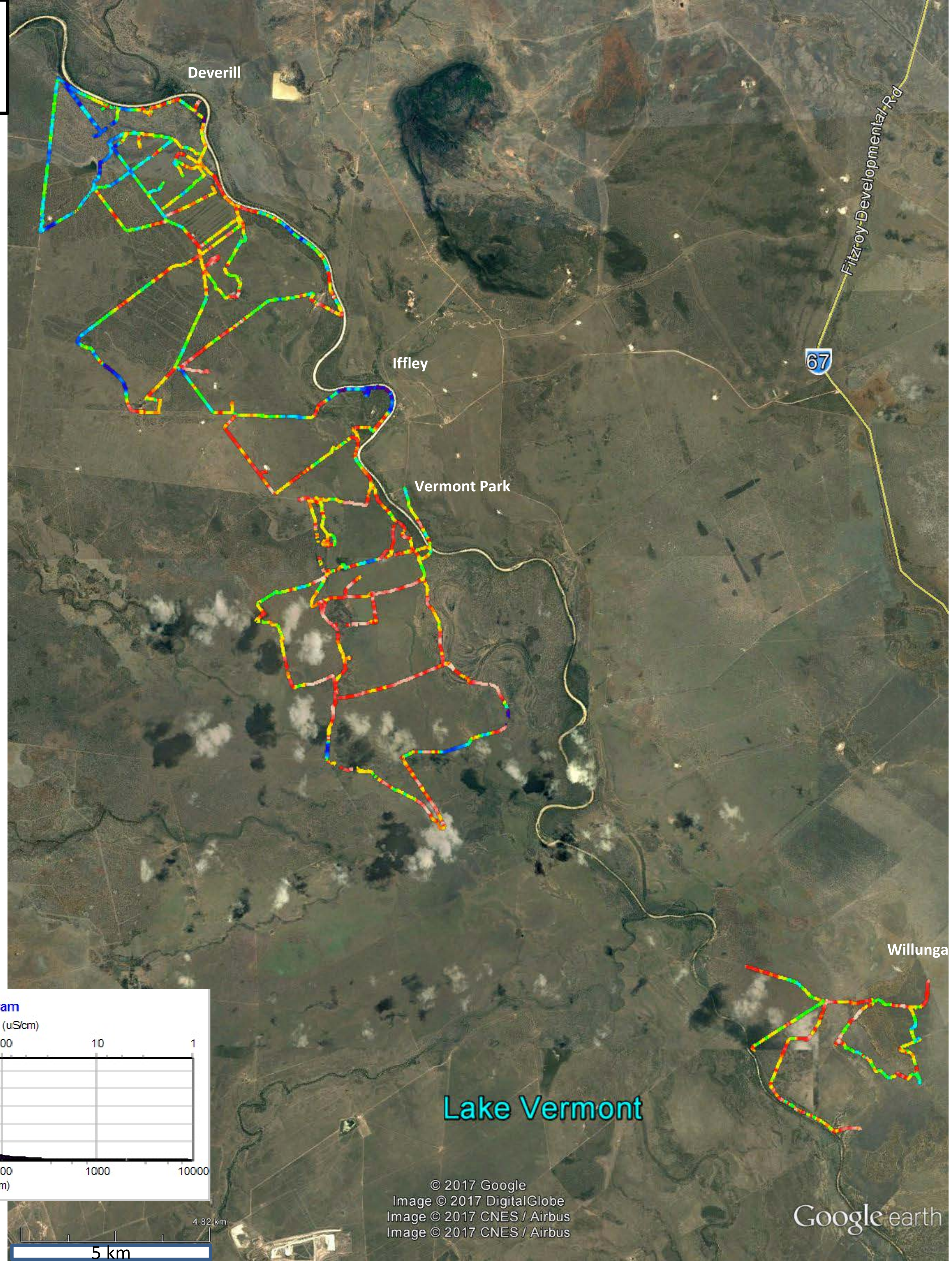
Low resistivity, prevalent at this depth largely represents saline rock. The mid and high range resistivities appear to indicate fresh non-saline rock.

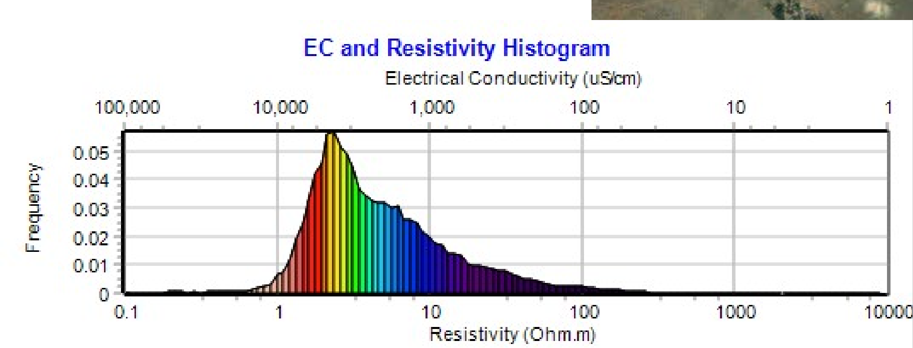




Modelled Resistivity at 45m deep

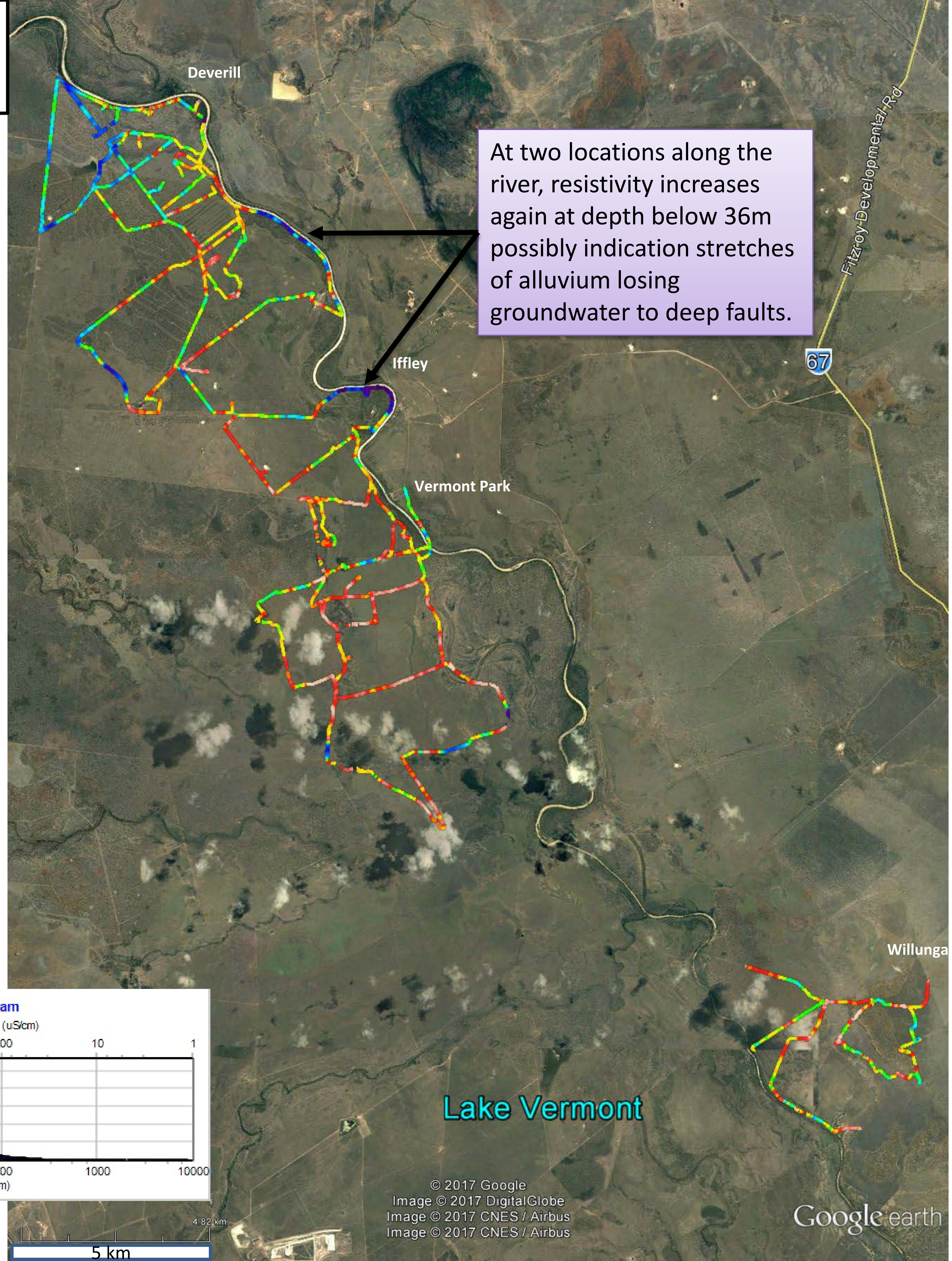
Data at this depth is generally below the estimated depth of investigation and is of questionable usefulness except where it reveals features that are not simply extrapolation from modelling above. Low resistivity, prevalent at this depth largely represents saline rock. The mid and high range resistivities appear to indicate fresh non-saline rock.

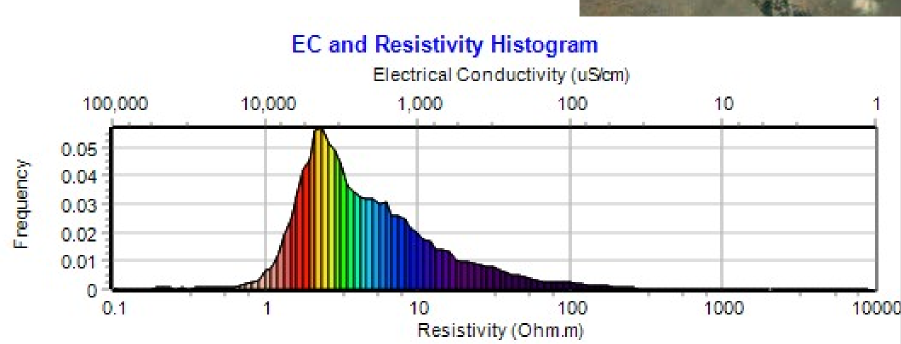




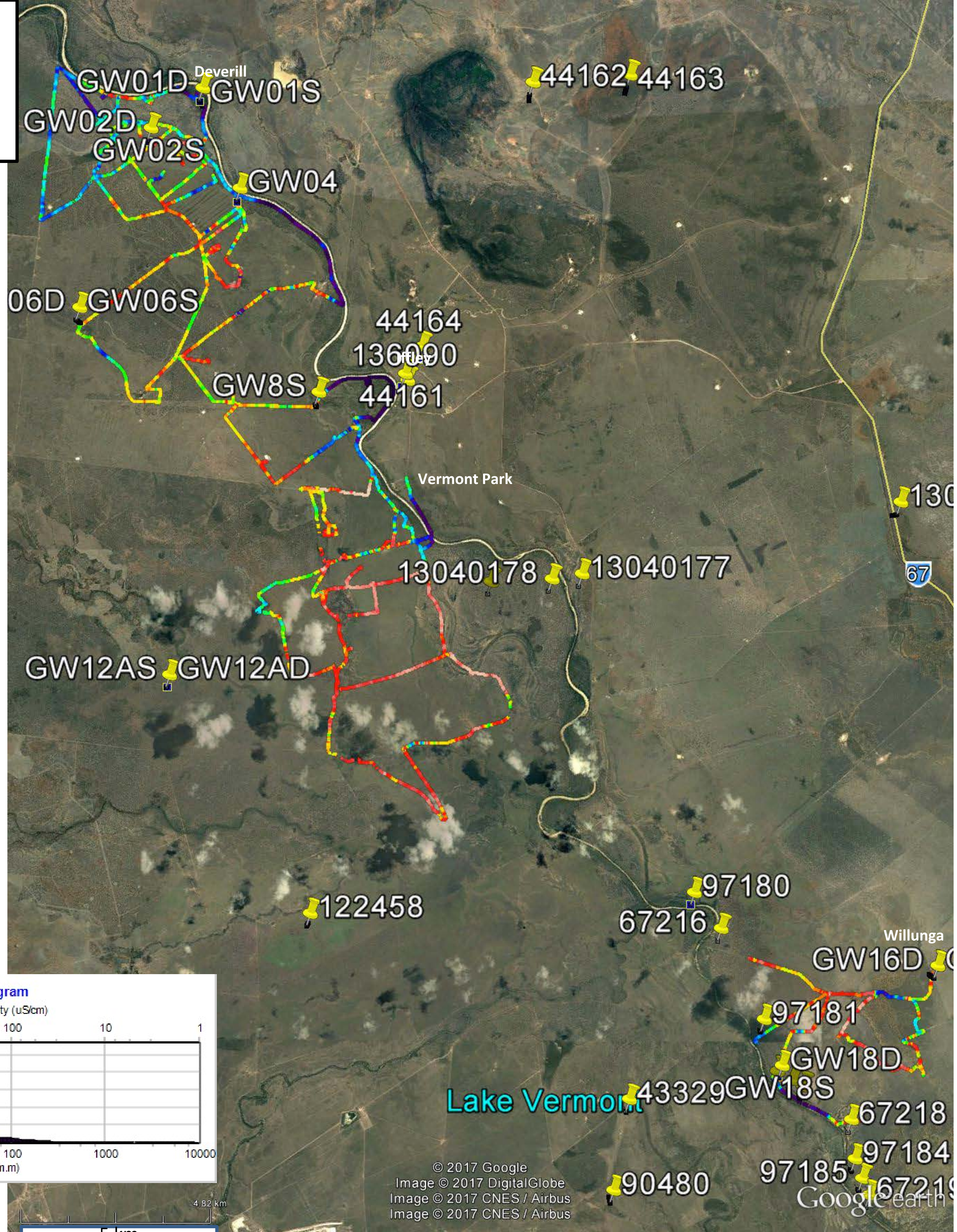
Modelled Resistivity at 58m deep

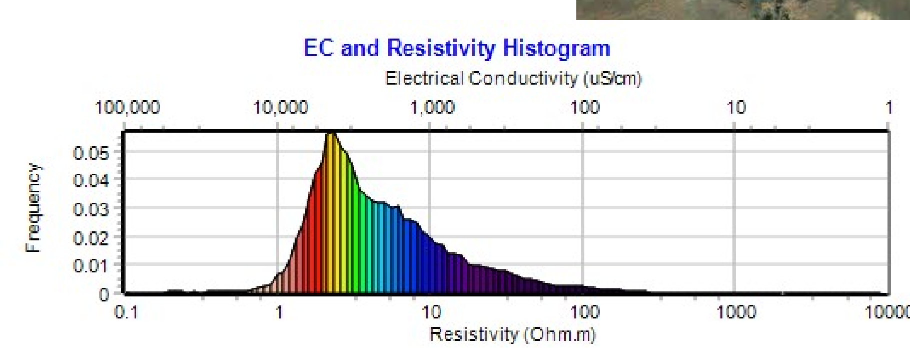
Data at this depth is generally below the estimated depth of investigation and is of questionable usefulness except where it reveals features that are not simply extrapolation from modelling above. Low resistivity, prevalent at this depth largely represents saline rock. The mid and high range resistivities appear to indicate fresh non-saline rock.



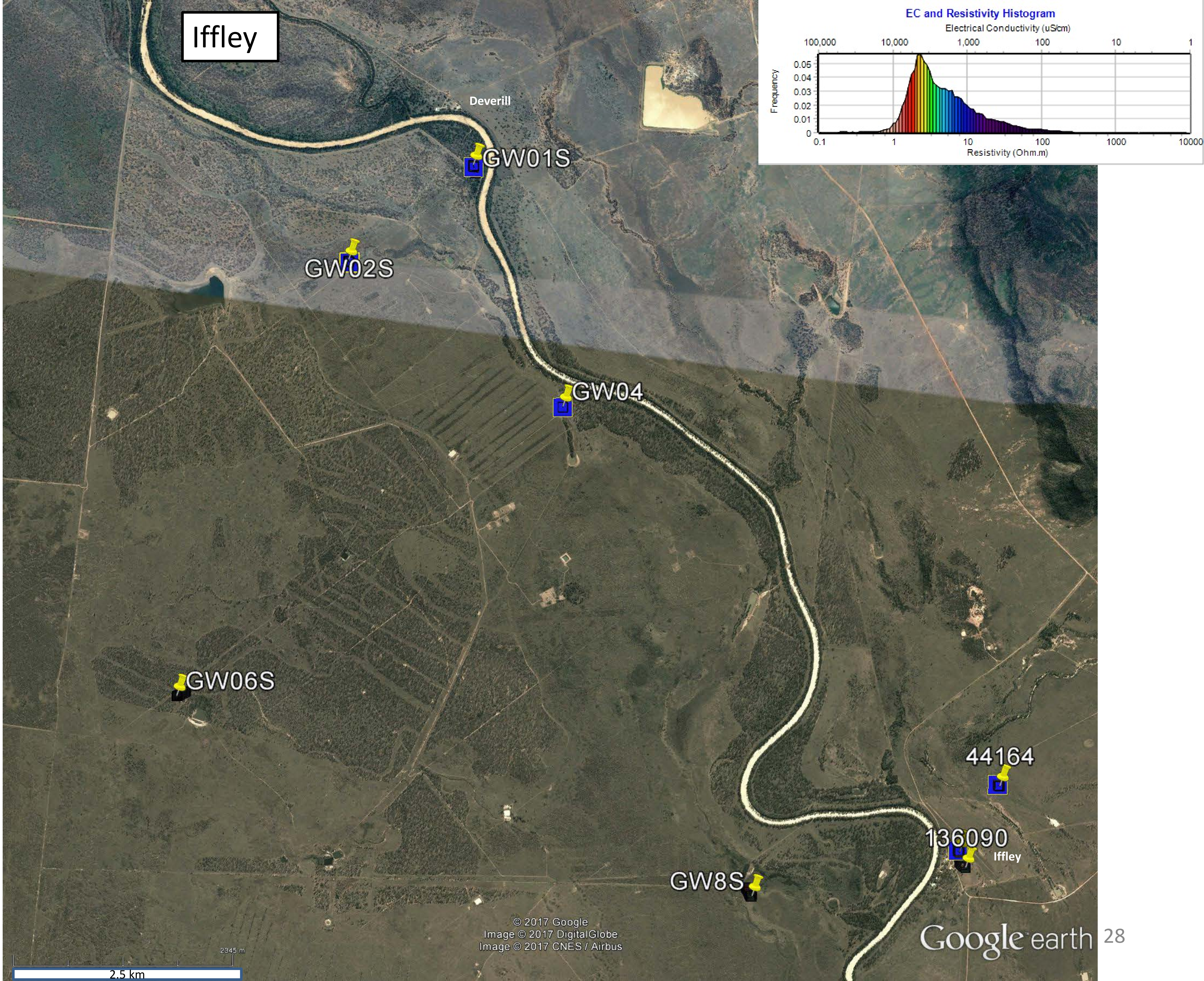


Bore locations + Modelled Resistivity at 20m deep.

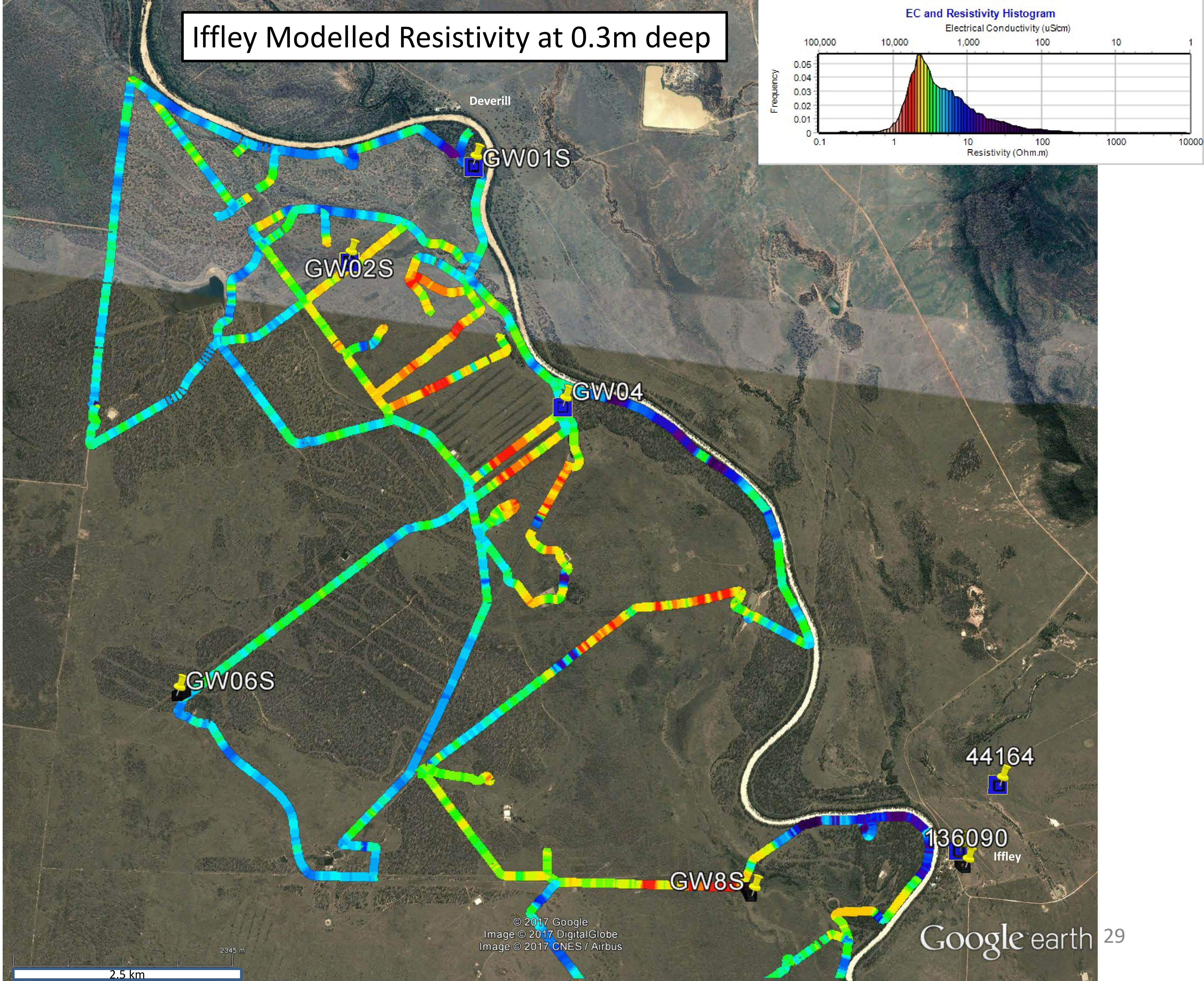




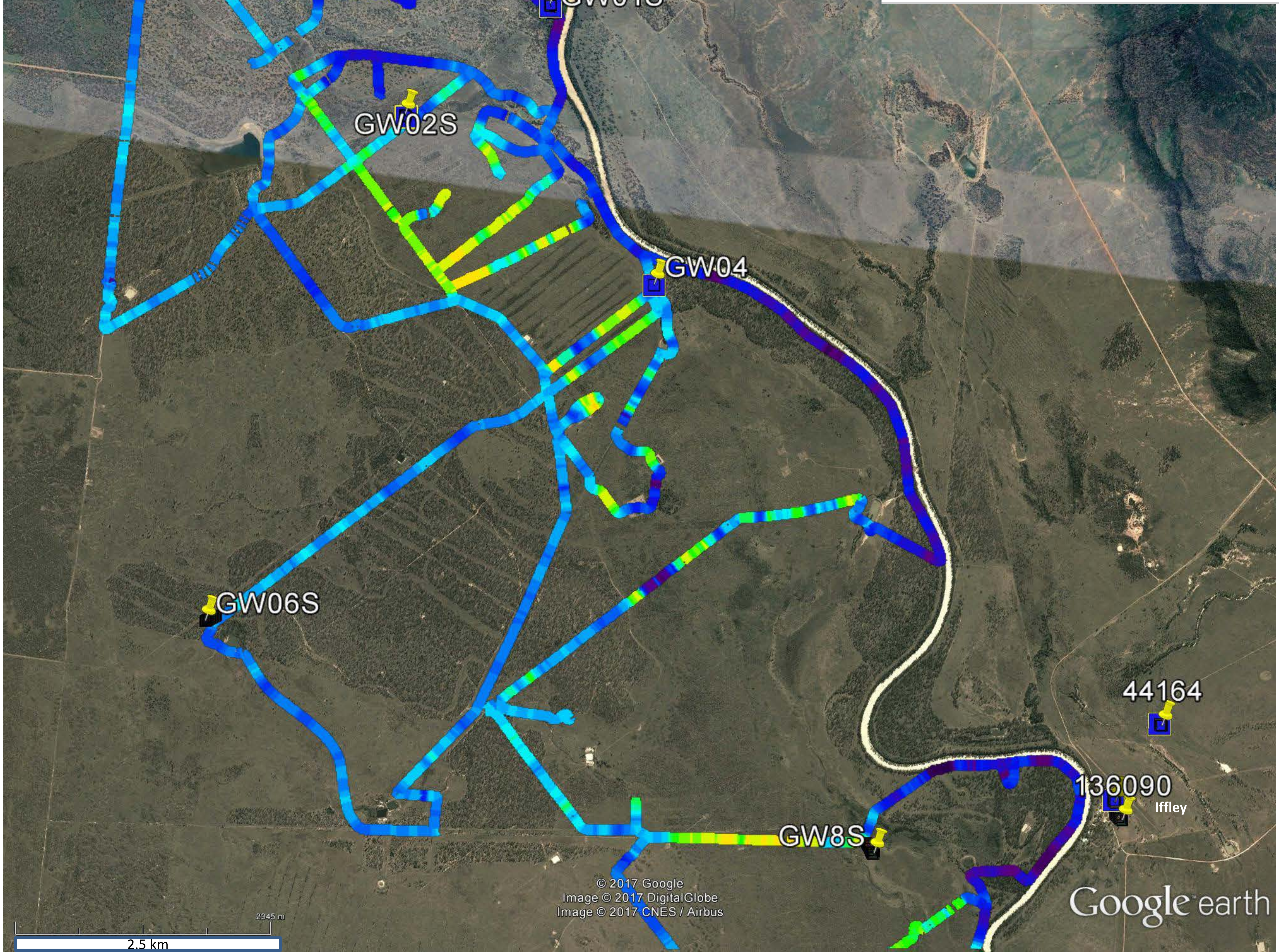
More detailed depth slice images

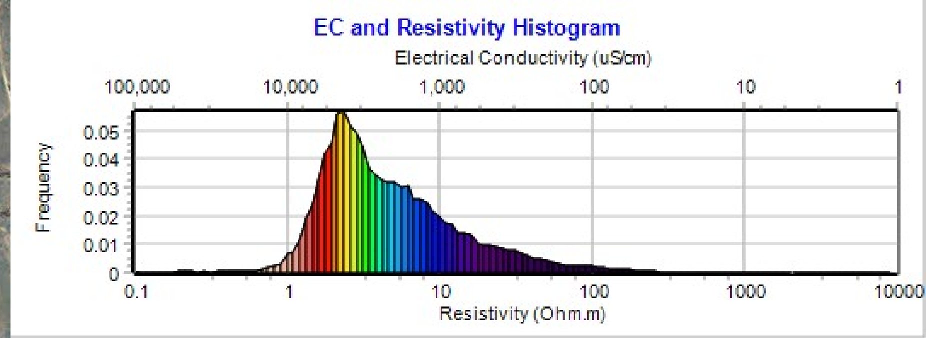

Iffley
Deverill
GW01S
GW02S
GW04
GW06S
44164
136090
Iffley
GW8S
© 2017 Google
Image © 2017 DigitalGlobe
Image © 2017 CNES / Airbus
Google earth
2345 m
2.5 km
EC and Resistivity Histogram
Electrical Conductivity (uS/cm)
100,000
10,000
1,000
100
10
1
Frequency
0.05
0.04
0.03
0.02
0.01
0
0.1
1
10
100
1000
10000
Resistivity (Ohm.m)

Iffley Modelled Resistivity at 0.3m deep

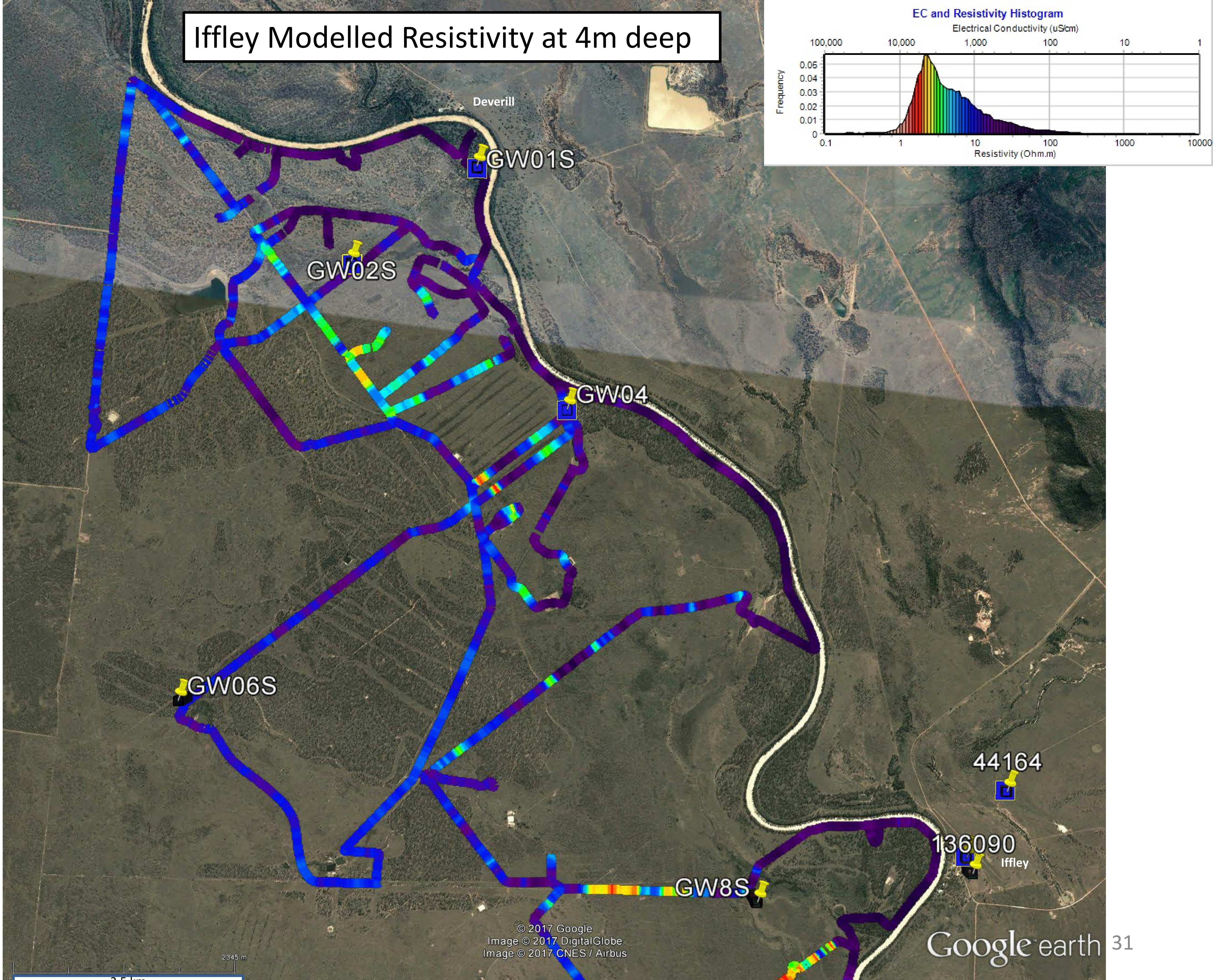


Iffley Modelled Resistivity at 1m deep

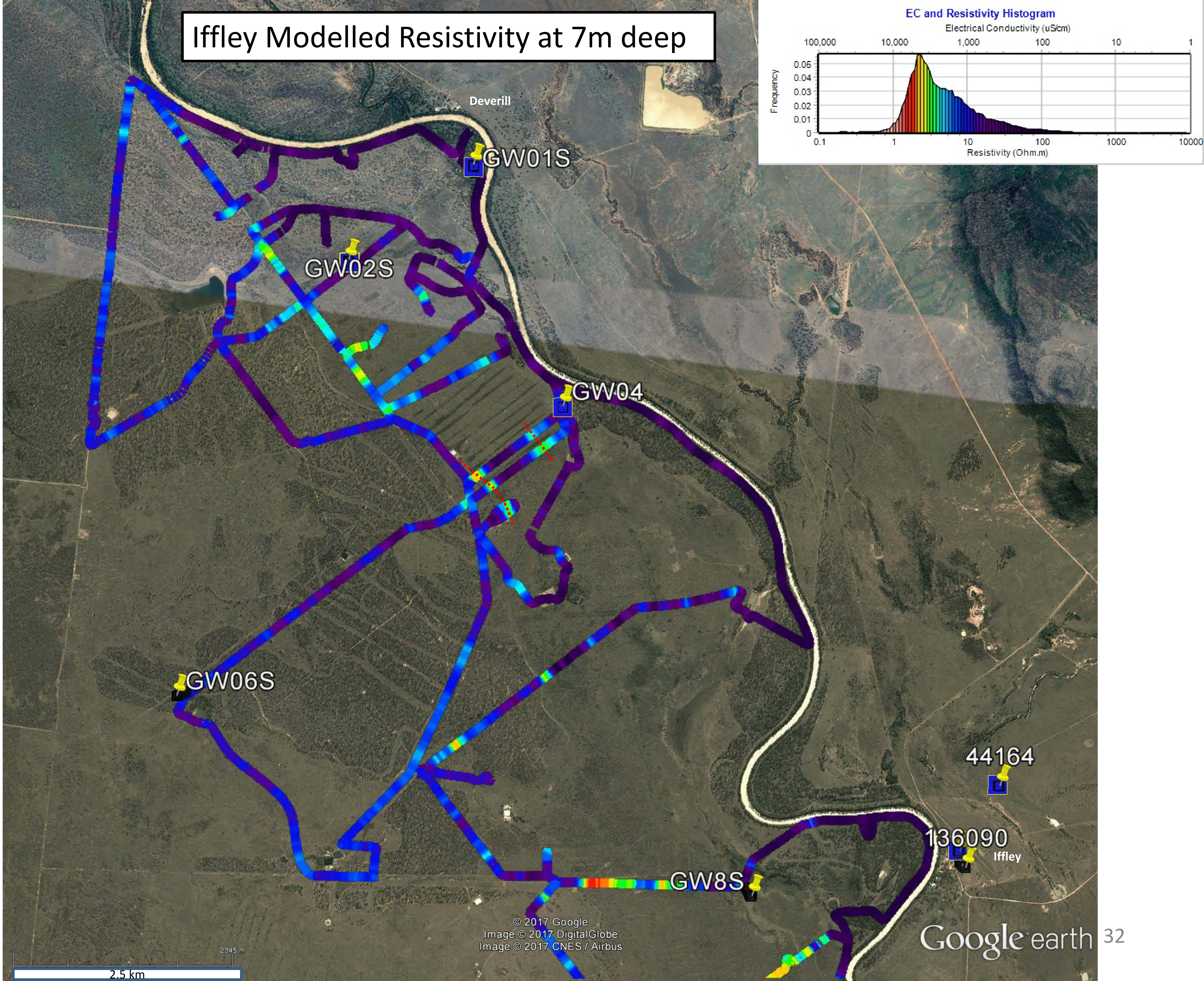




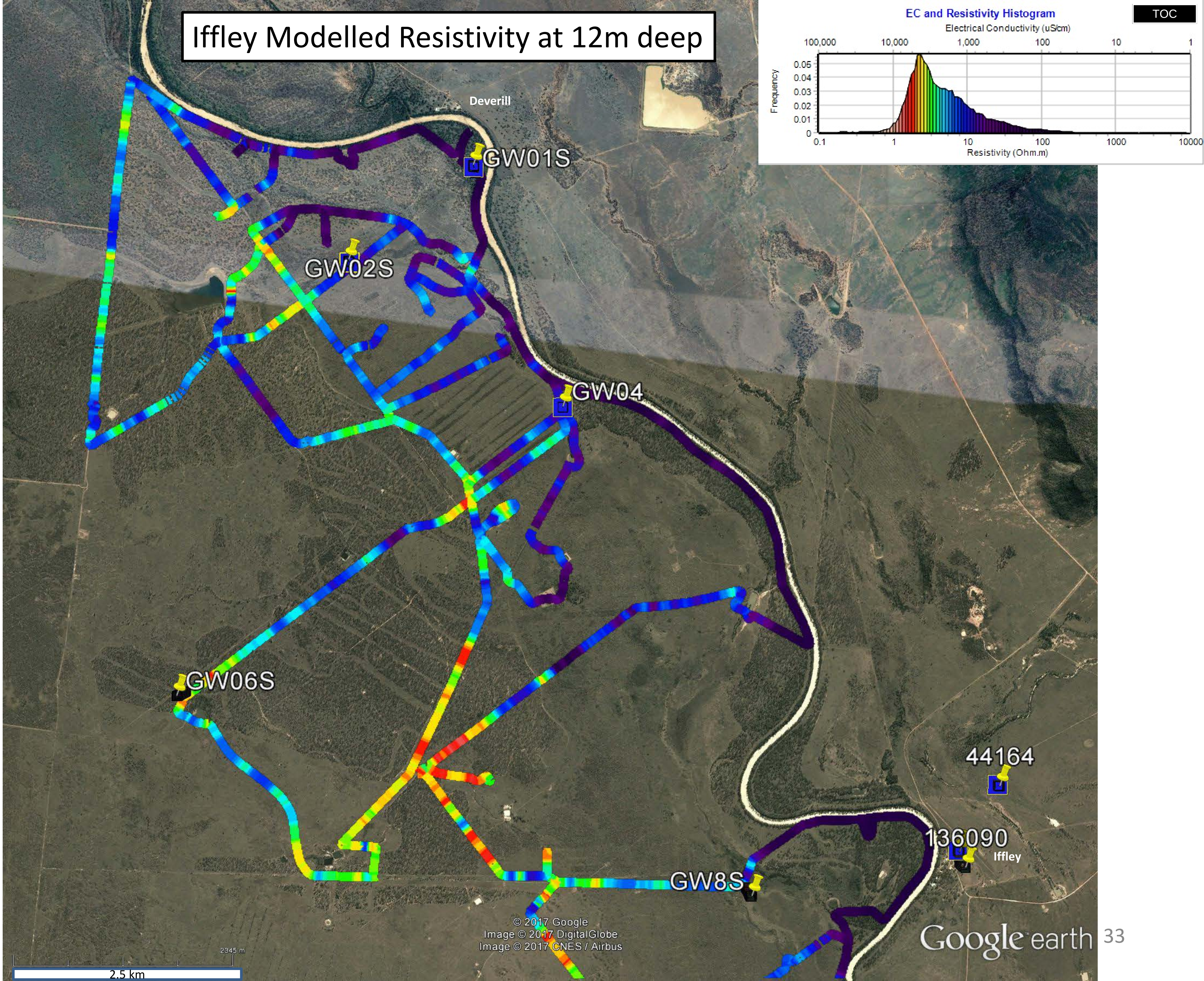
Iffley Modelled Resistivity at 4m deep



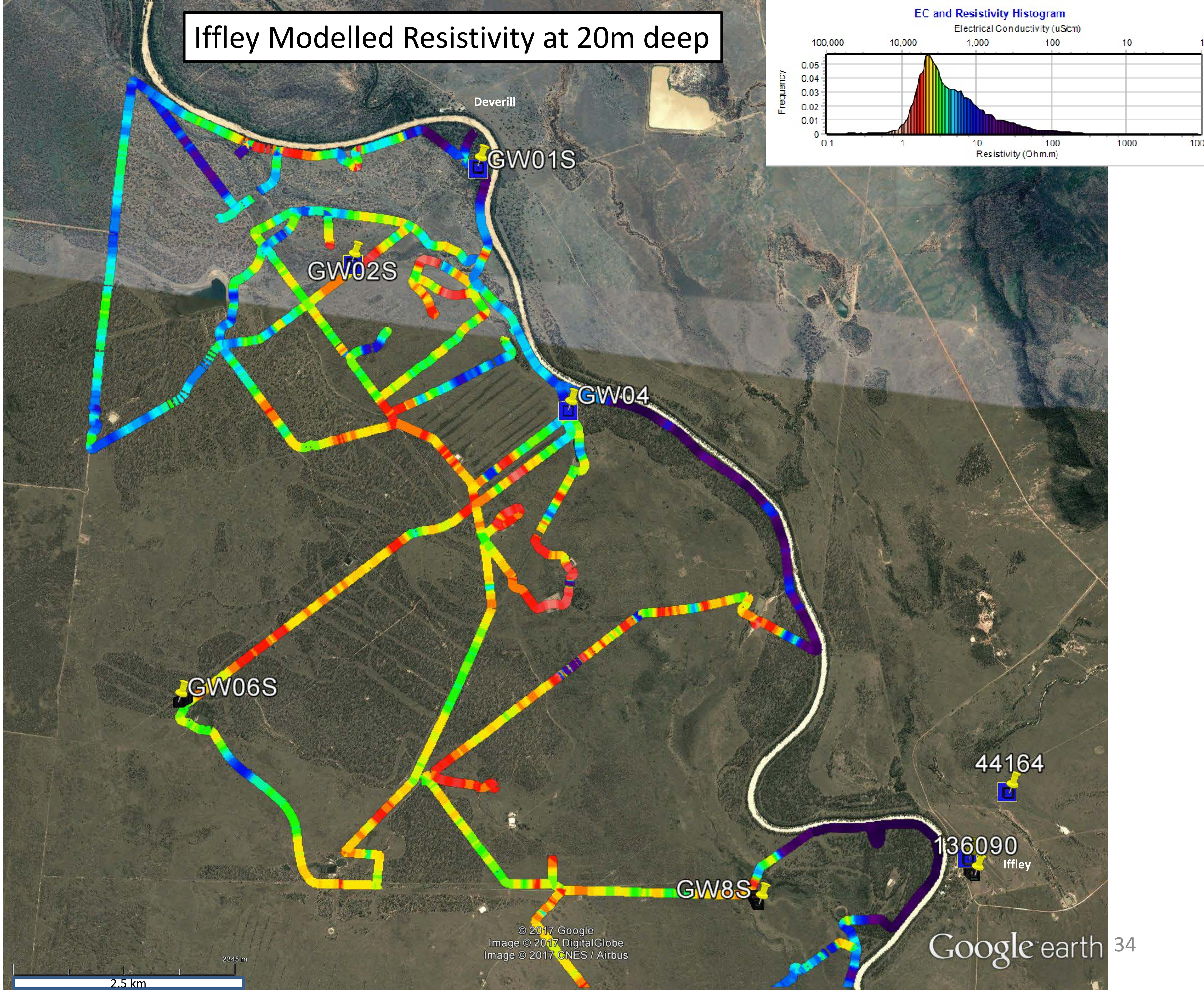
Iffley Modelled Resistivity at 7m deep



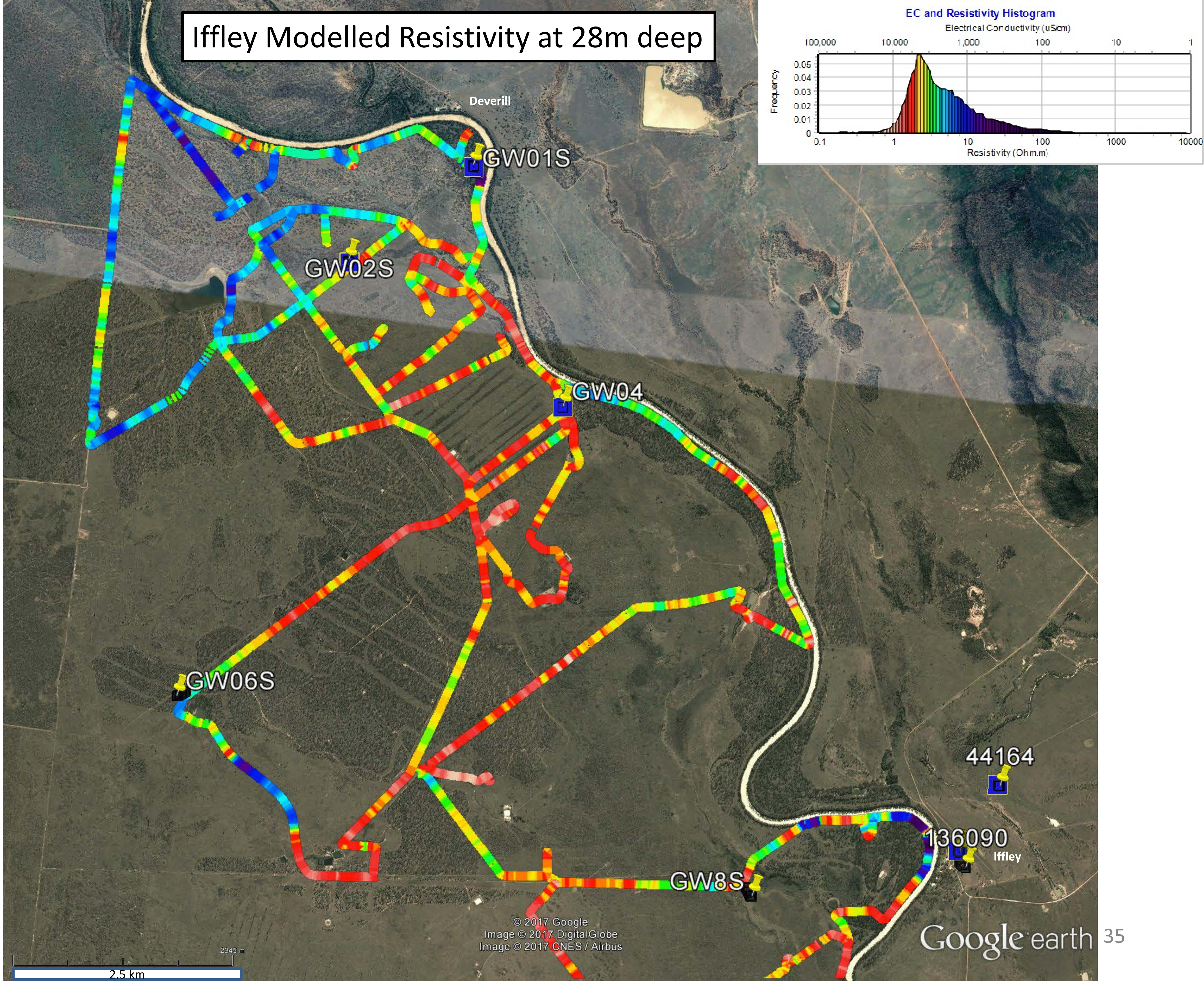
Iffley Modelled Resistivity at 12m deep



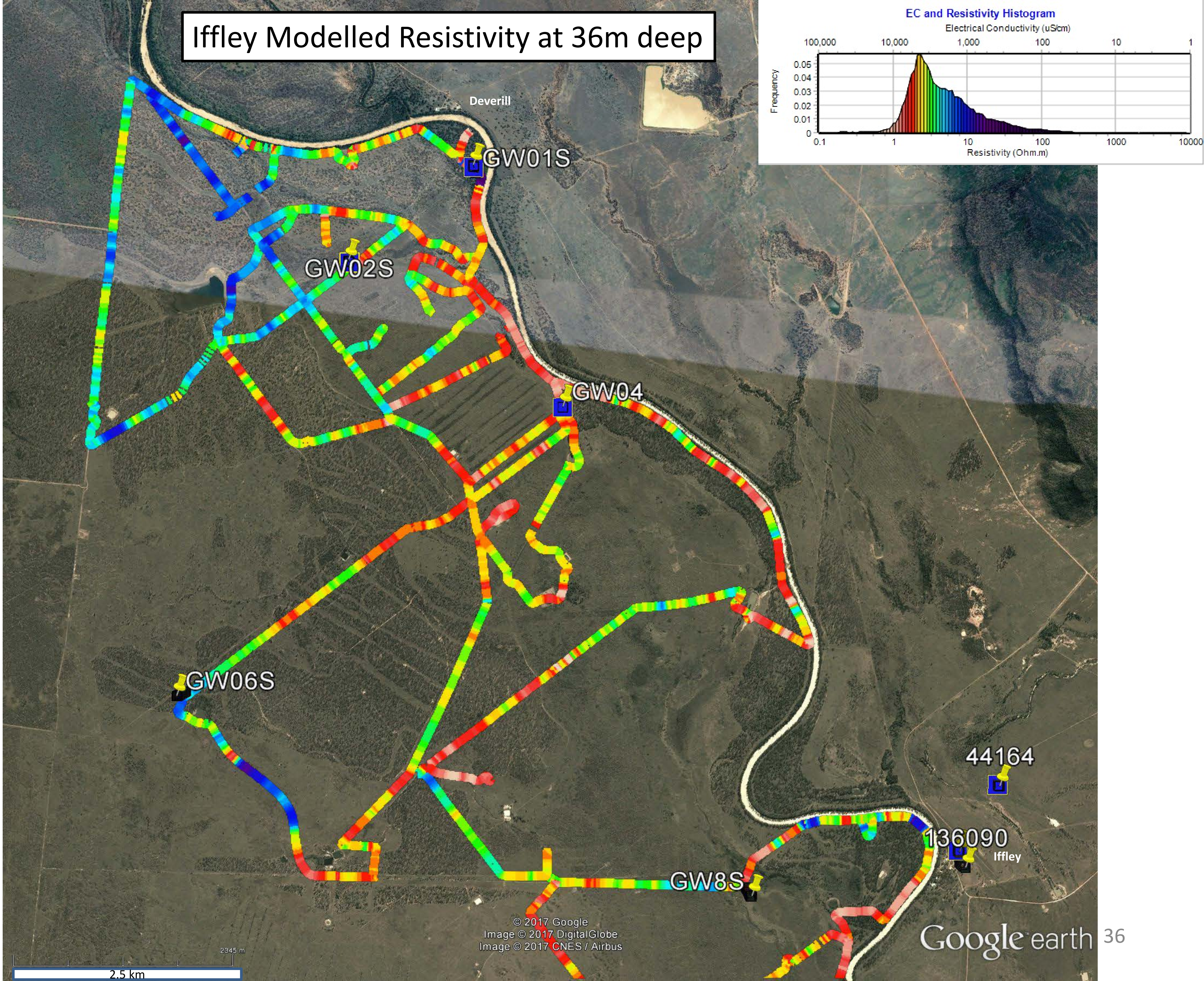
Iffley Modelled Resistivity at 20m deep



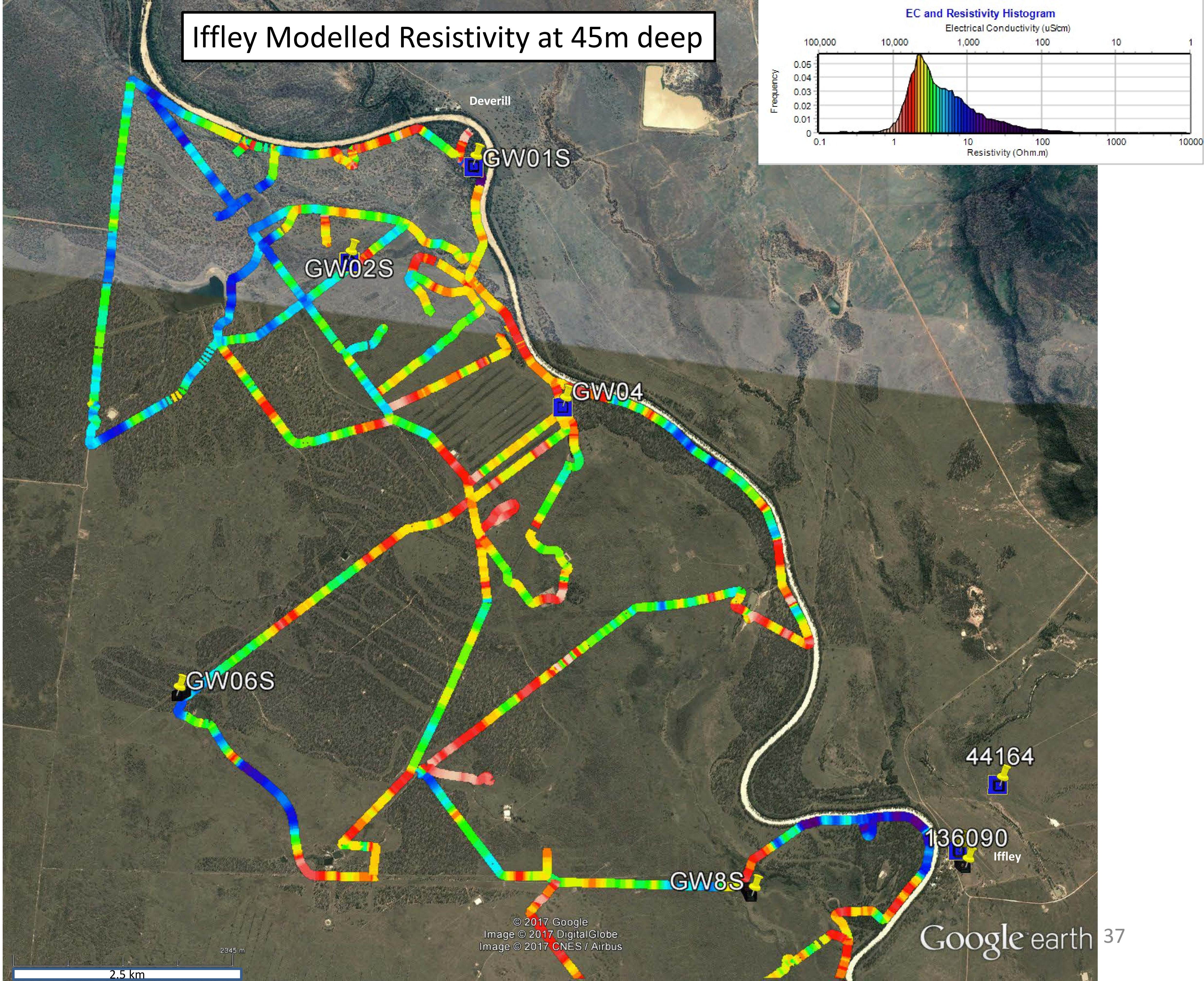
Iffley Modelled Resistivity at 28m deep



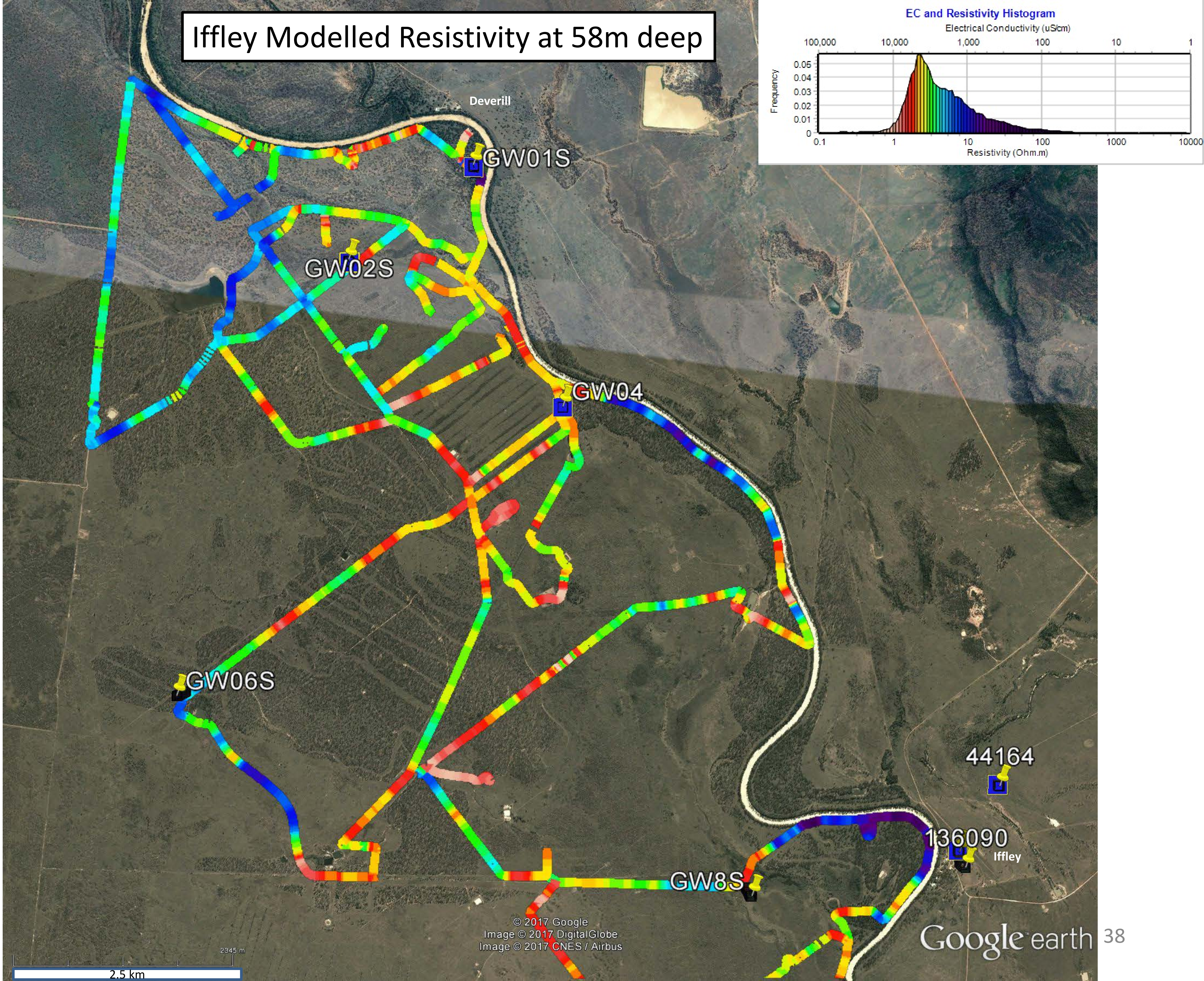
Iffley Modelled Resistivity at 36m deep



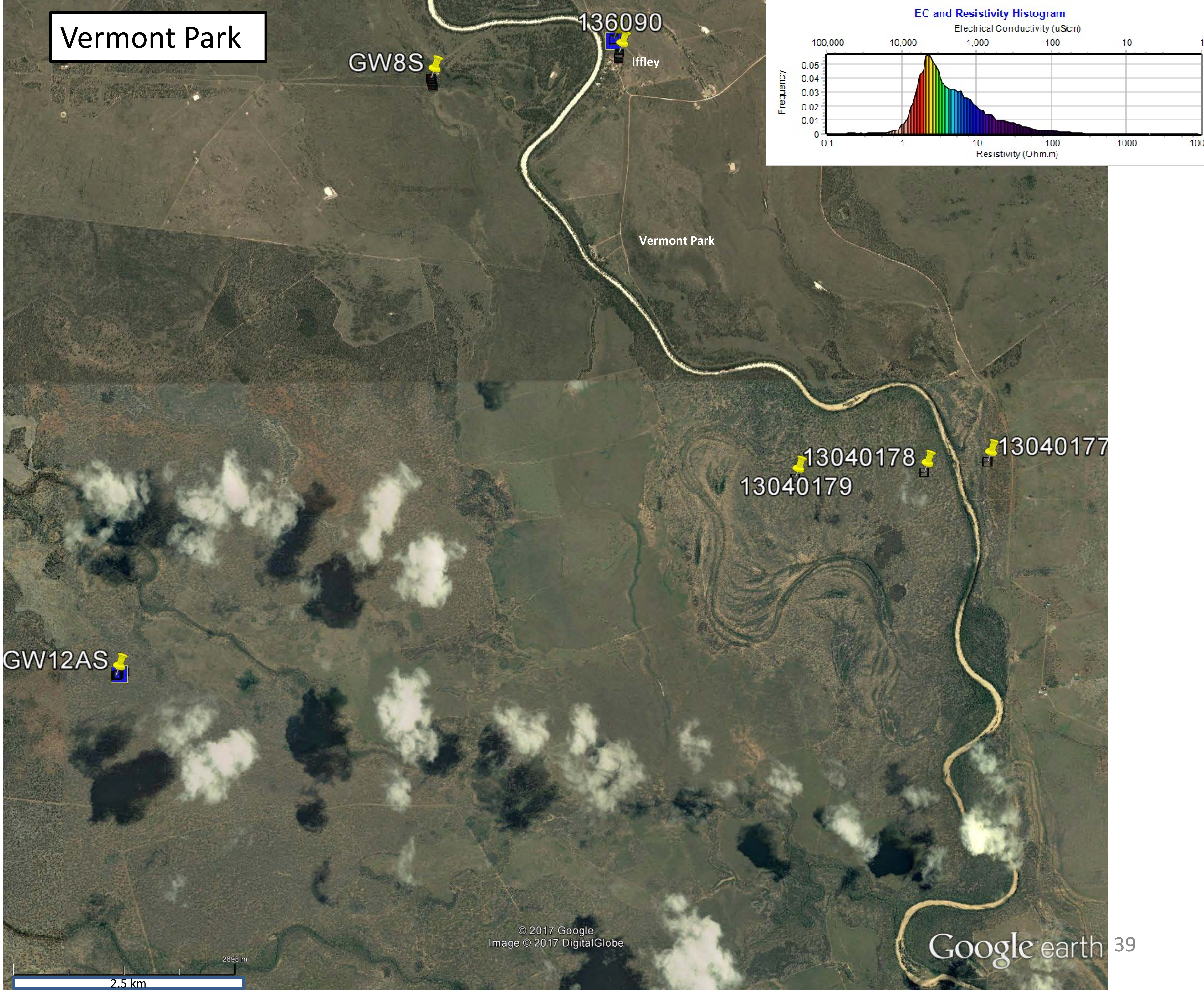
Iffley Modelled Resistivity at 45m deep



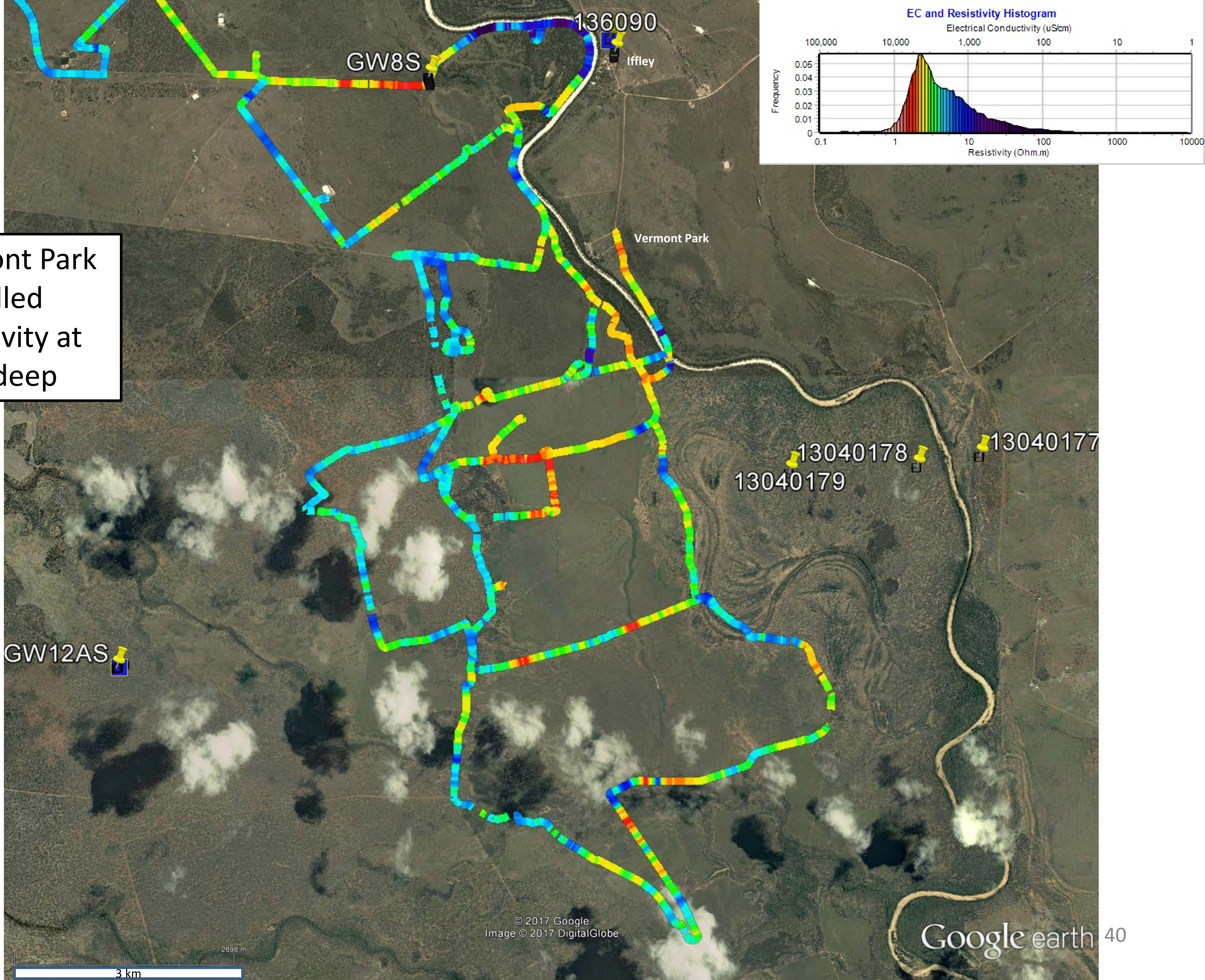
Iffley Modelled Resistivity at 58m deep



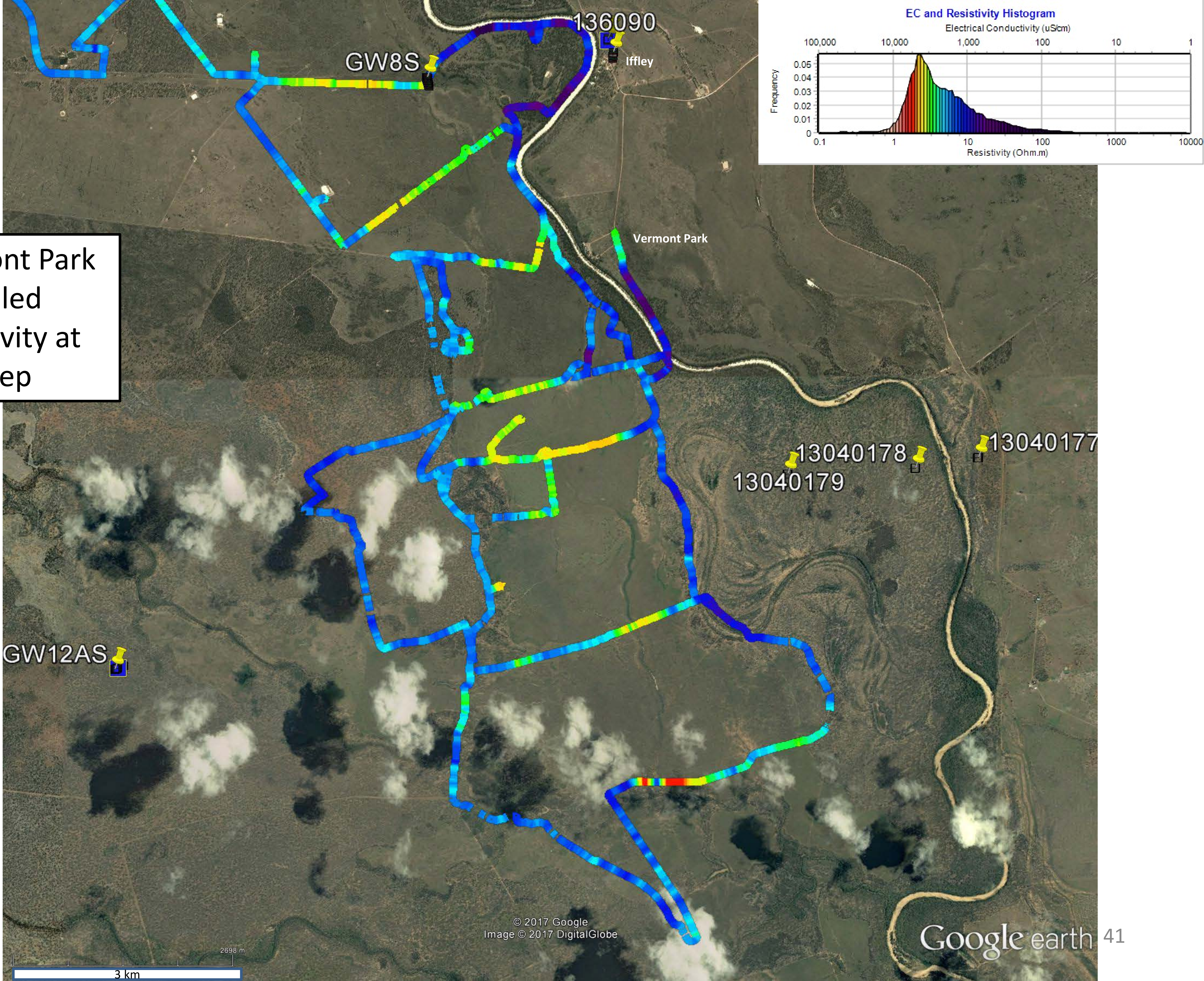
Vermont Park



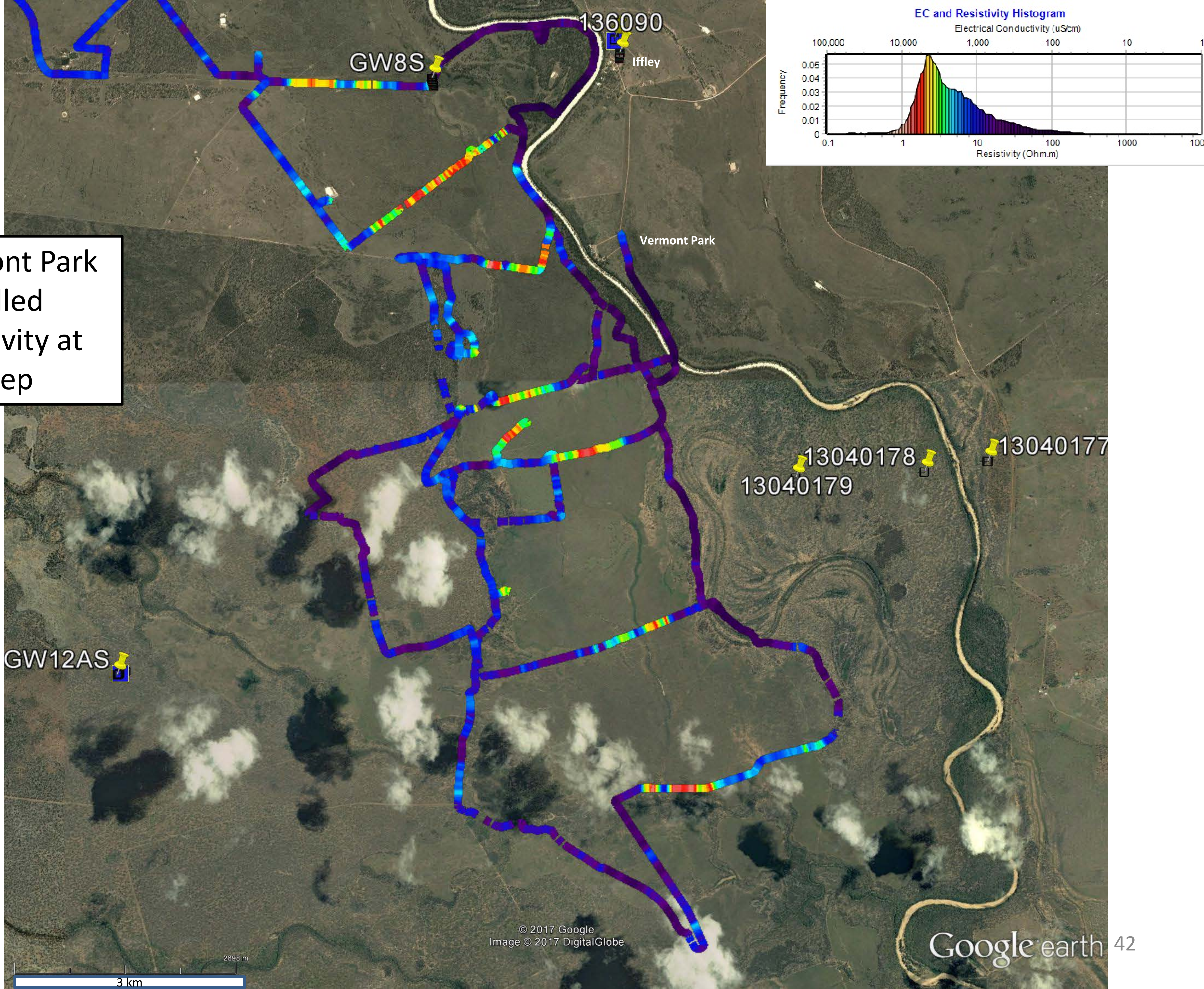
Vermont Park Modelled Resistivity at 0.3m deep



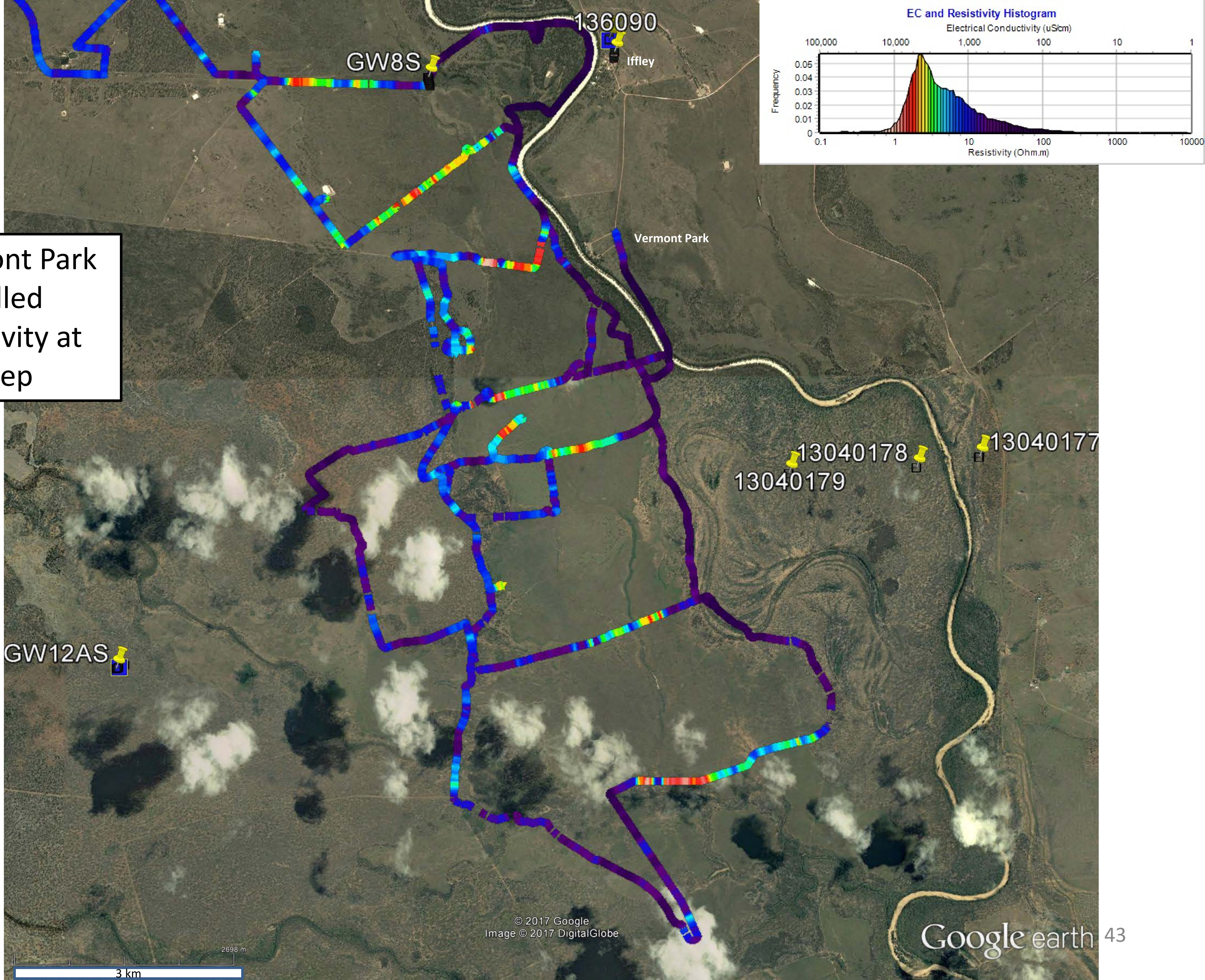
Vermont Park Modelled Resistivity at 1m deep



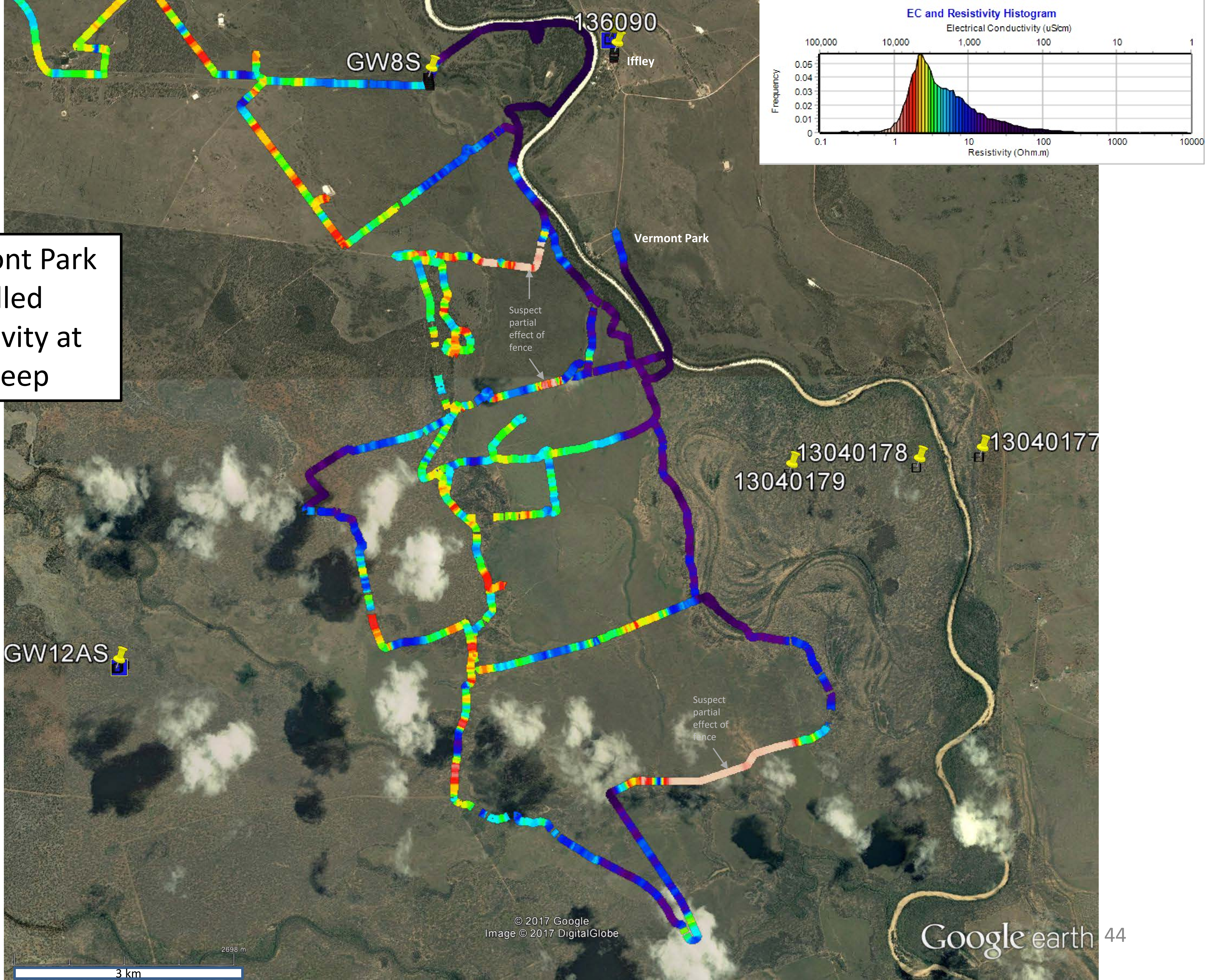
Vermont Park Modelled Resistivity at 4m deep



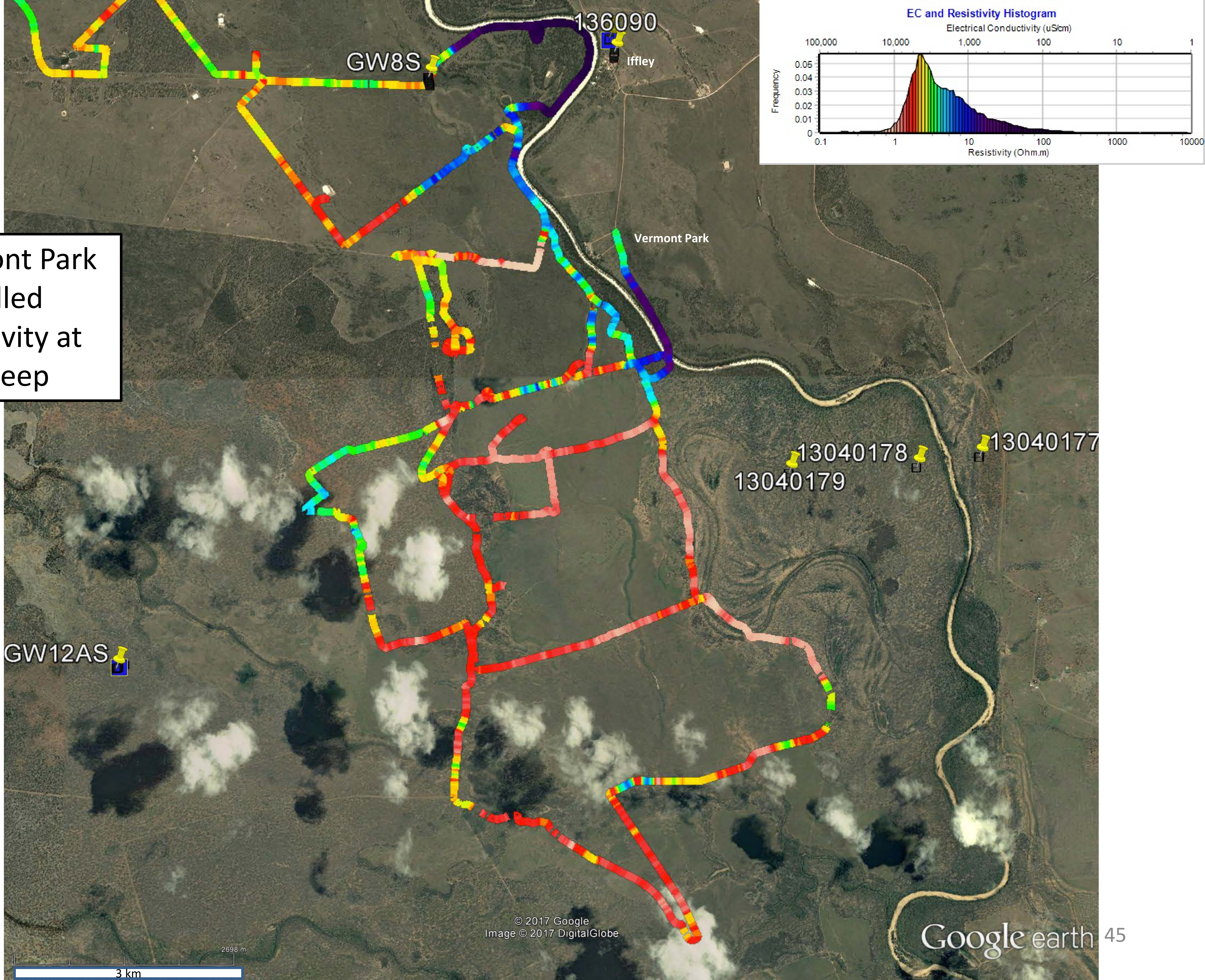
Vertmont Park Modelled Resistivity at 7m deep



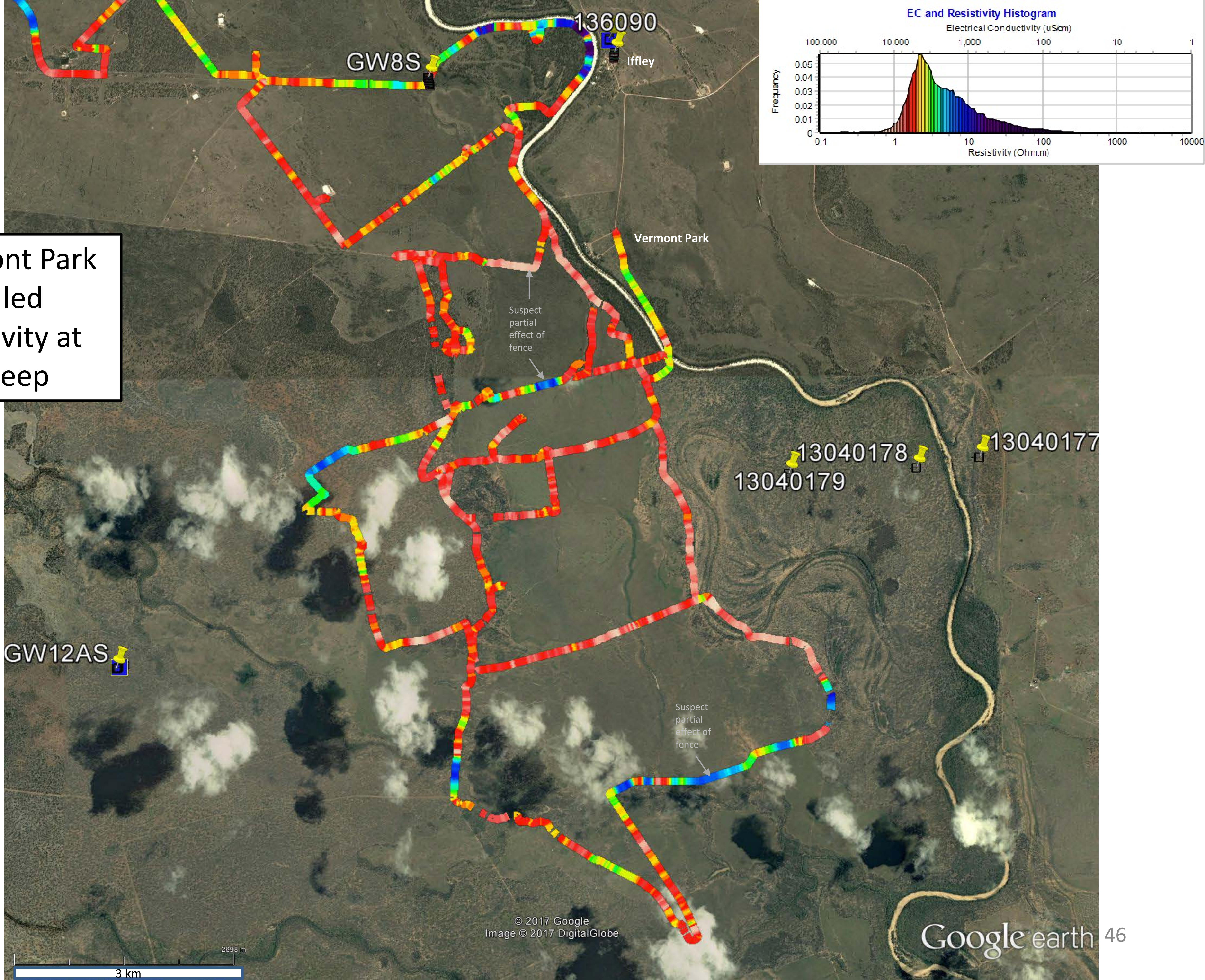
Vermont Park Modelled Resistivity at 12m deep



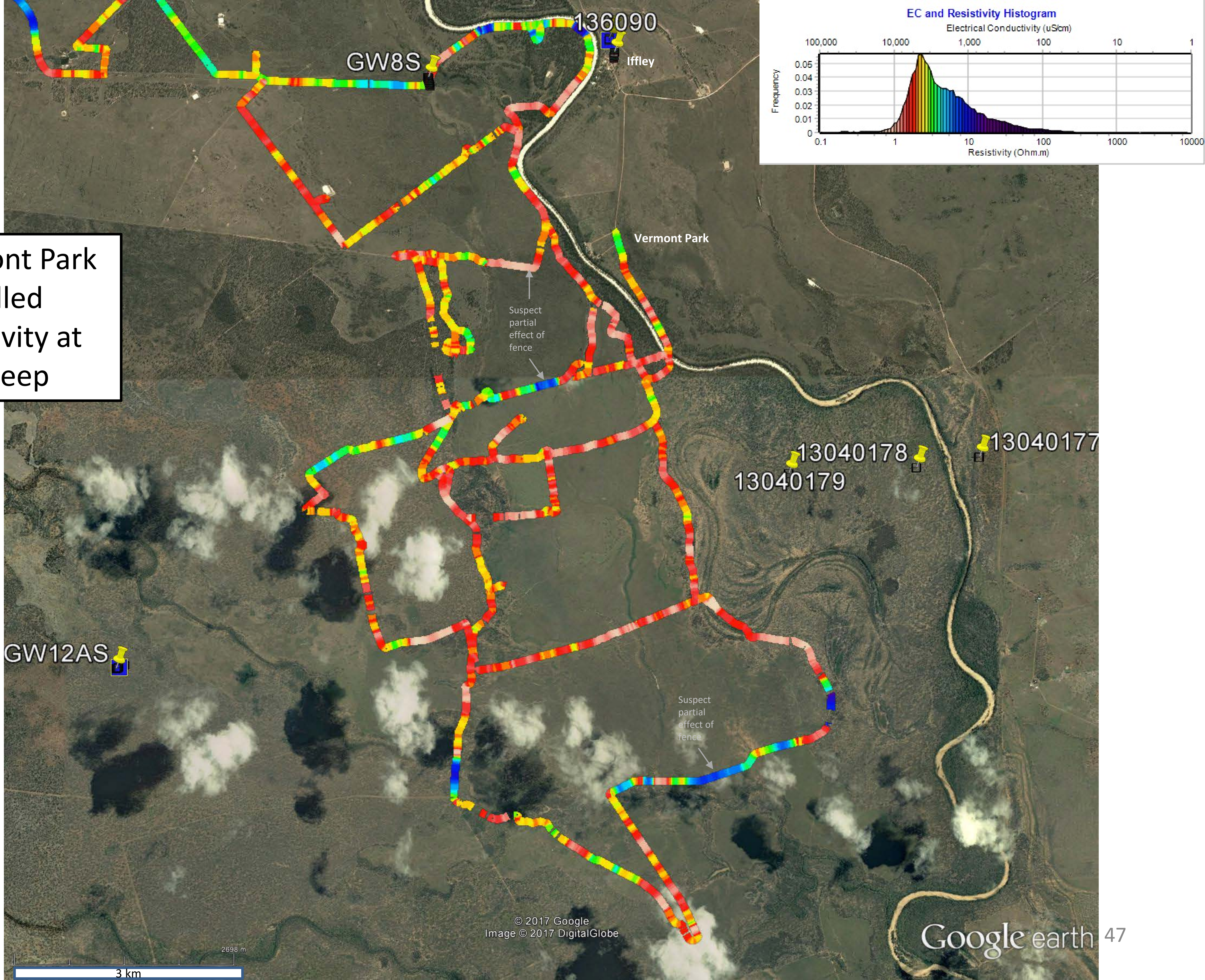
Vermont Park Modelled Resistivity at 20m deep



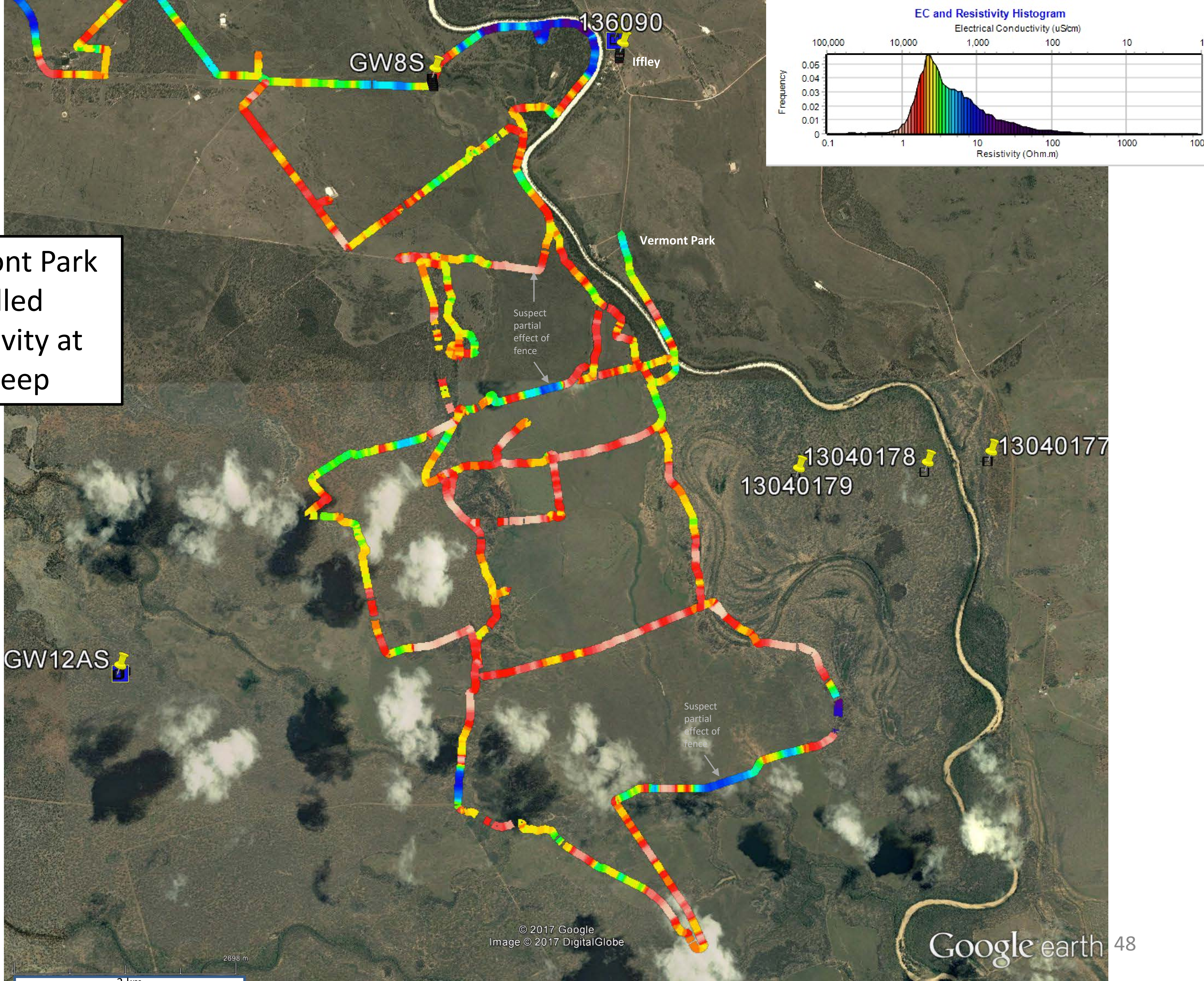
Vermont Park Modelled Resistivity at 28m deep



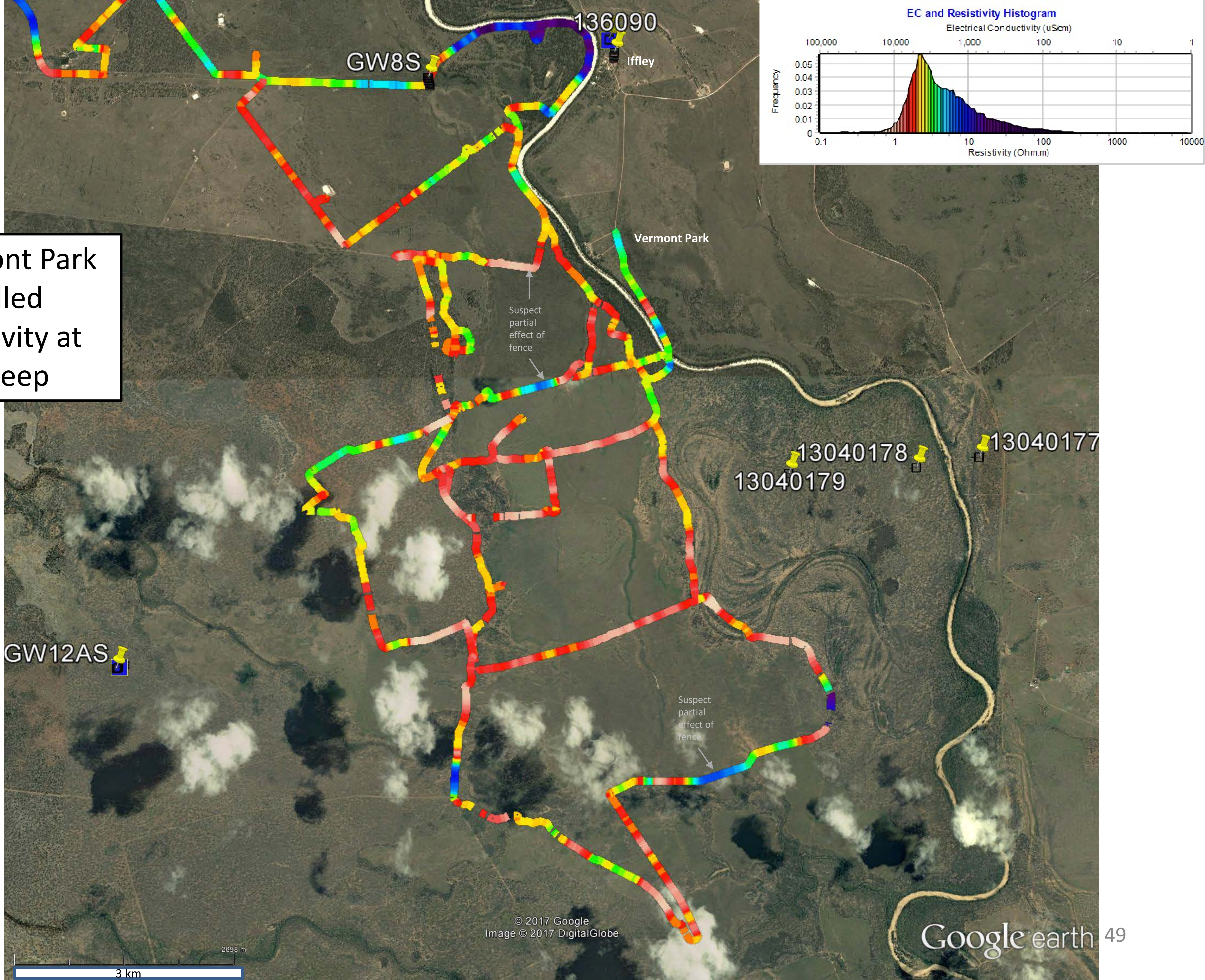
Vermont Park Modelled Resistivity at 36m deep



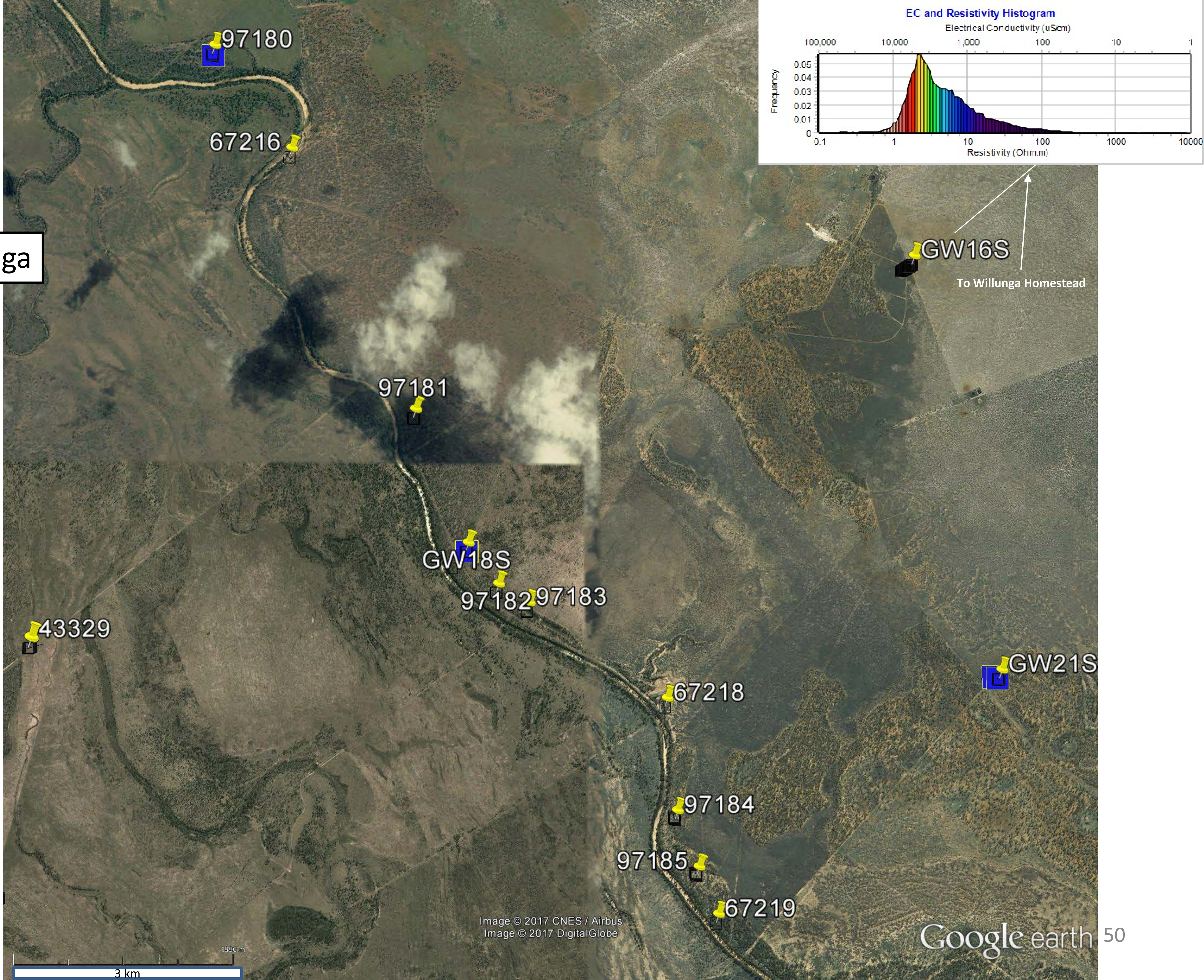
Vermont Park Modelled Resistivity at 45m deep



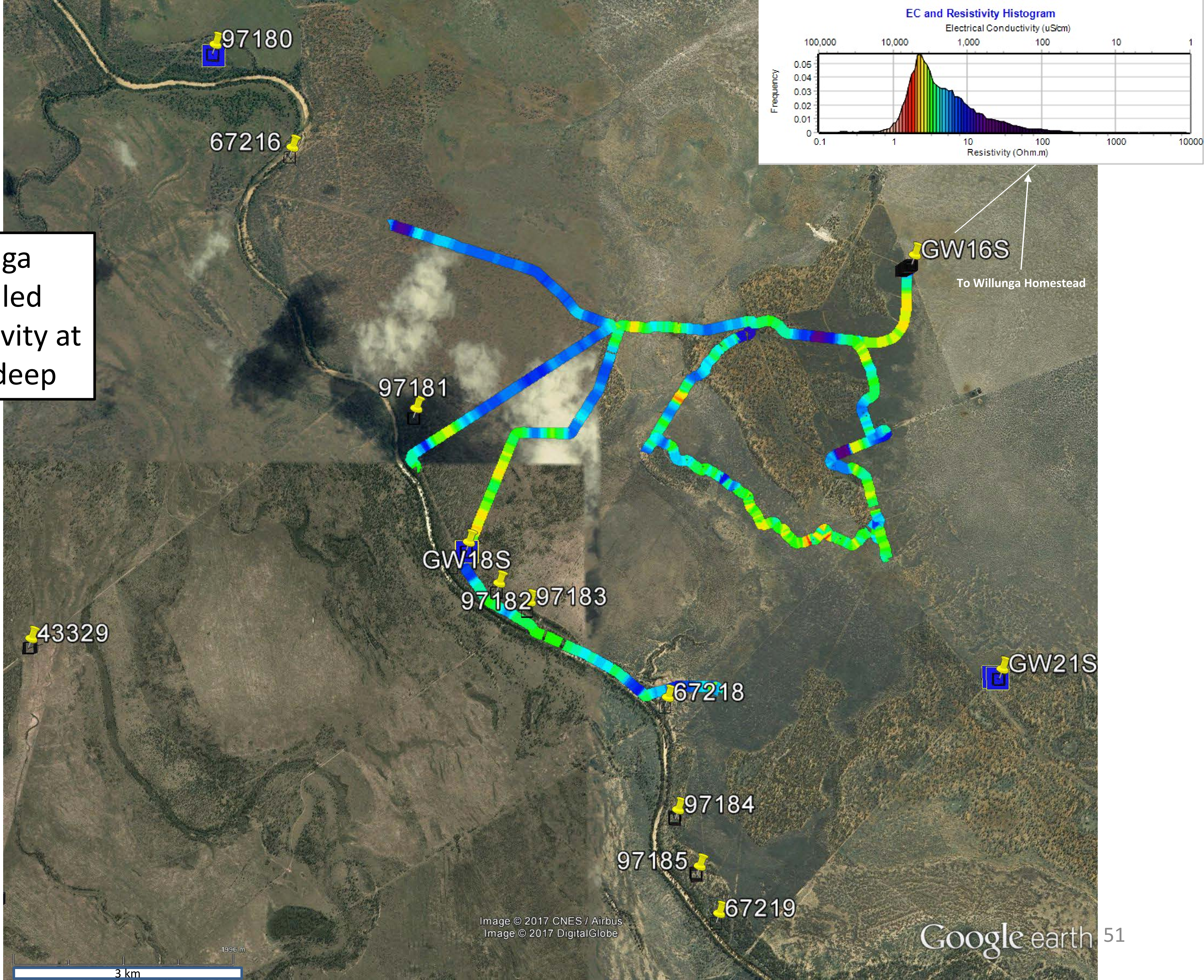
Vermont Park Modelled Resistivity at 58m deep



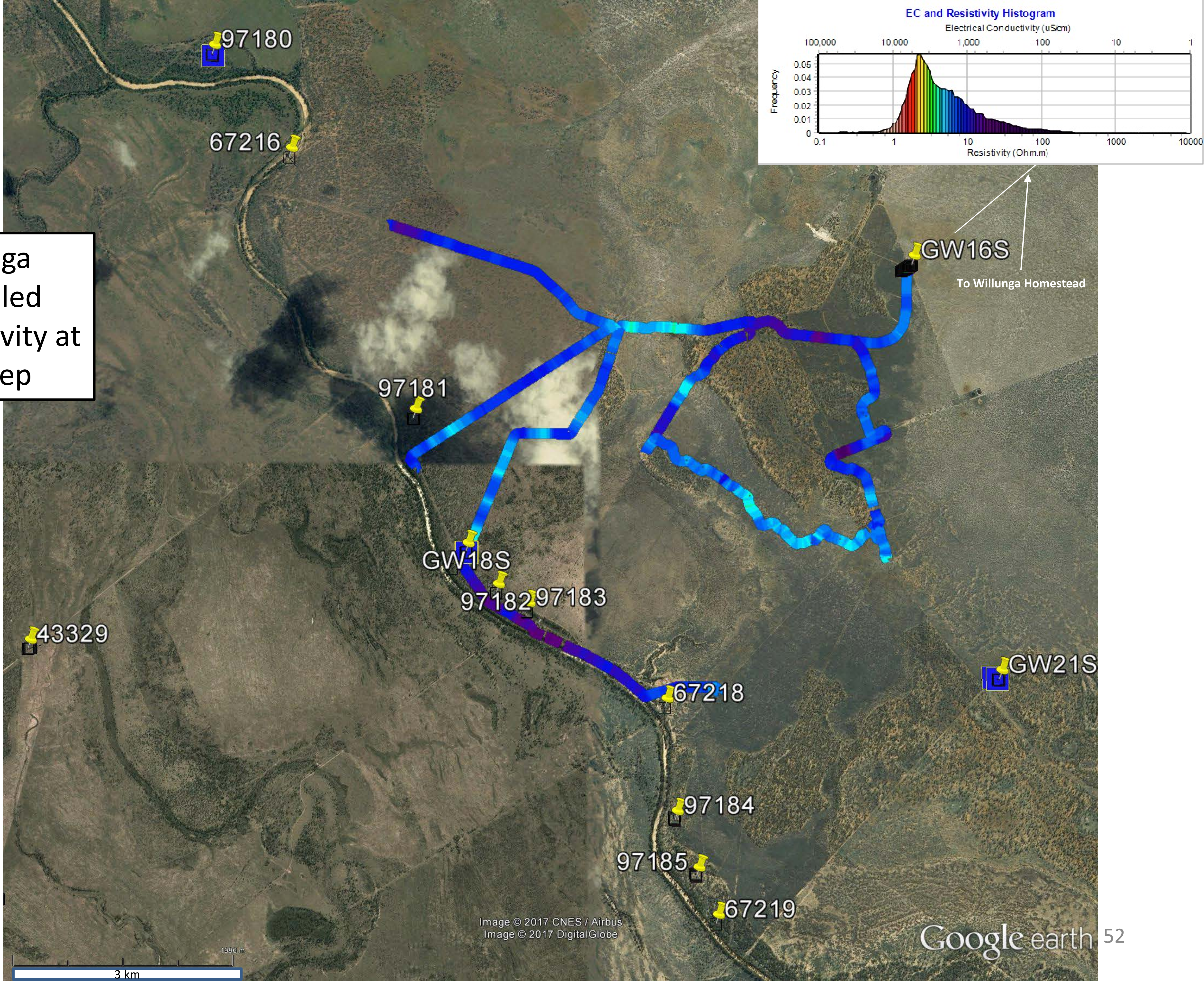
Willunga


97180
67216
97181
GW16S
To Willunga Homestead
GW18S
97182
97183
43329
GW21S
67218
97184
97185
67219
Image © 2017 CNES / Airbus
Image © 2017 DigitalGlobe
Google earth
3 km
EC and Resistivity Histogram
Electrical Conductivity (uS/cm)
100,000
10,000
1,000
100
10
1
Frequency
0.05
0.04
0.03
0.02
0.01
0
0.1
1
10
100
1000
10000
Resistivity (Ohm.m)

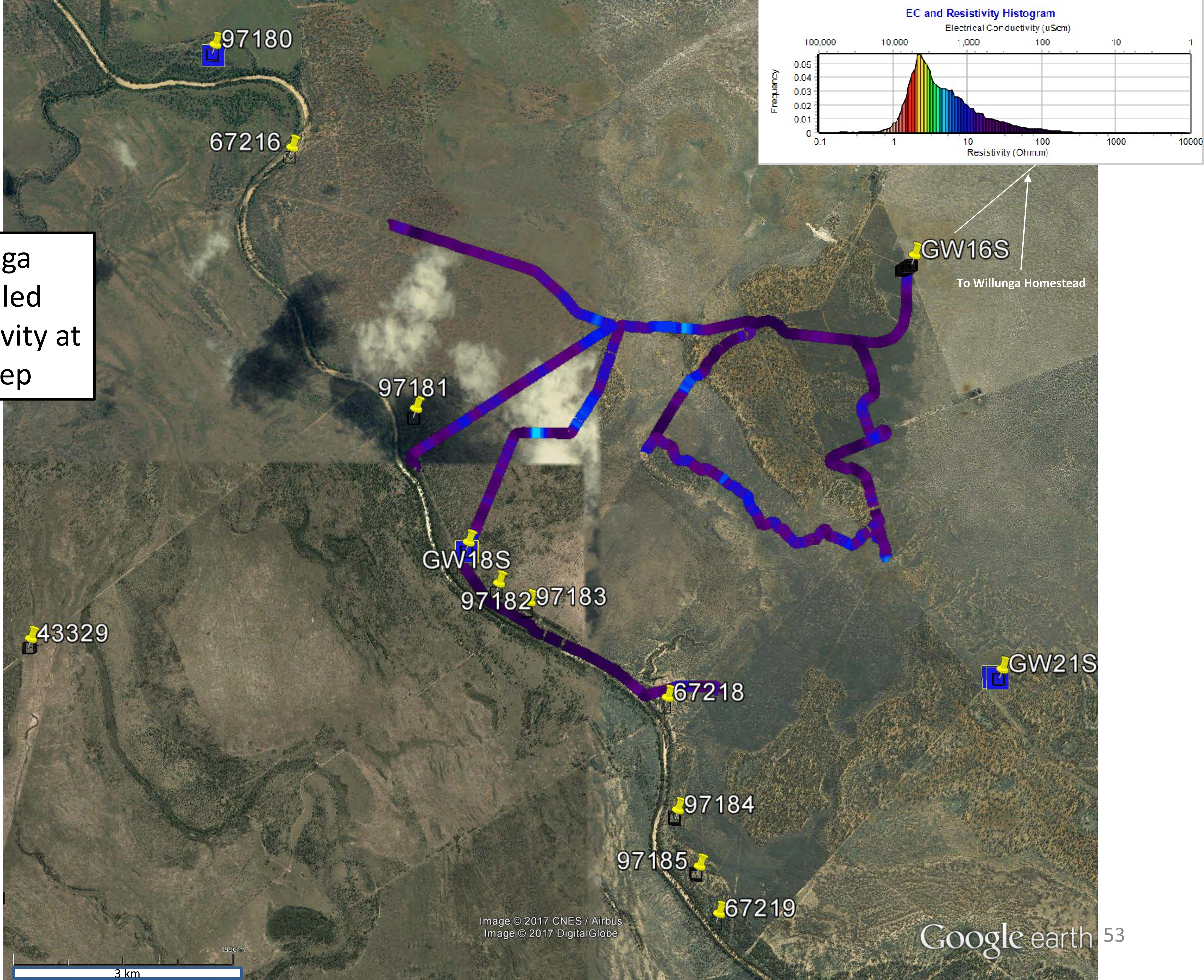
Willunga Modelled Resistivity at 0.3m deep



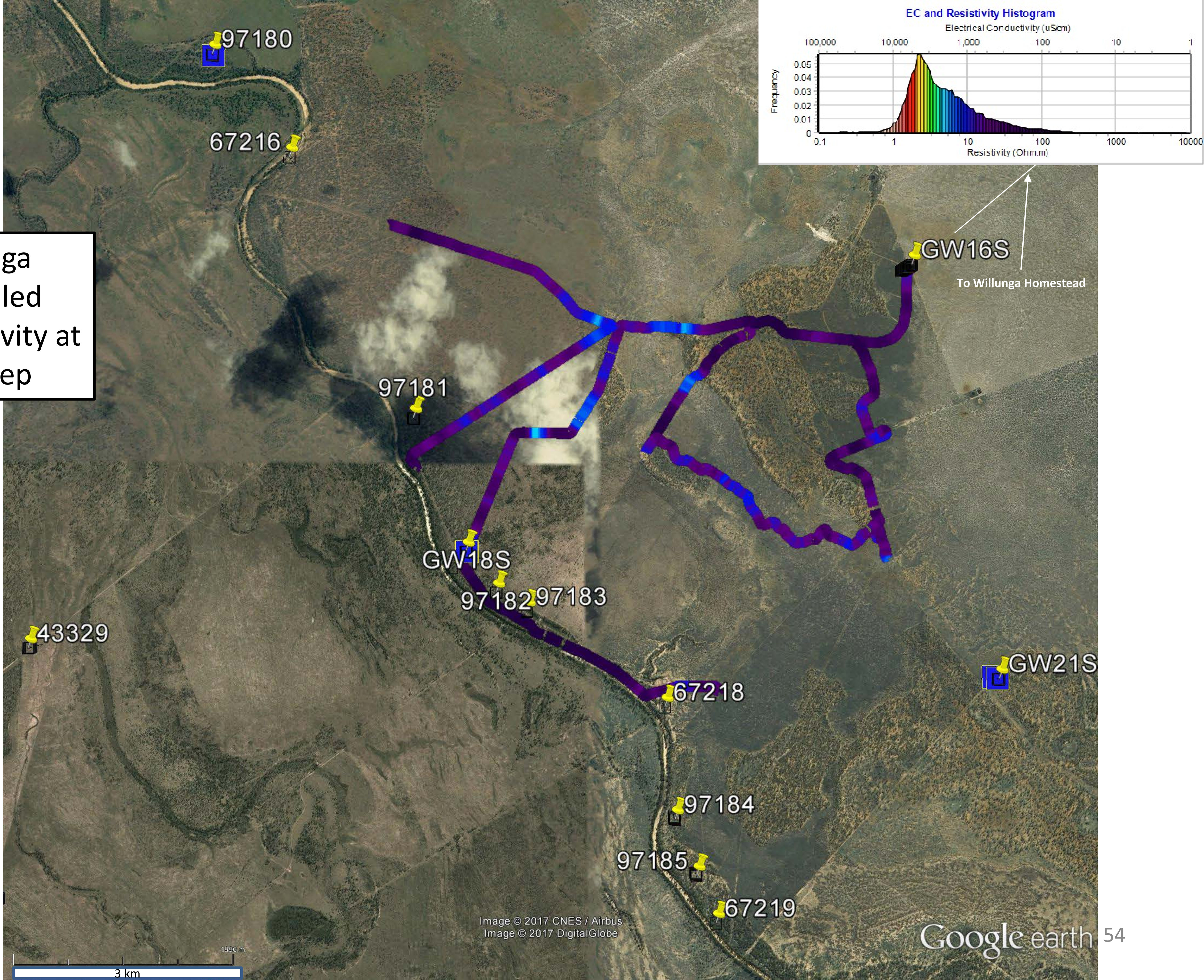
Willunga Modelled Resistivity at 1m deep



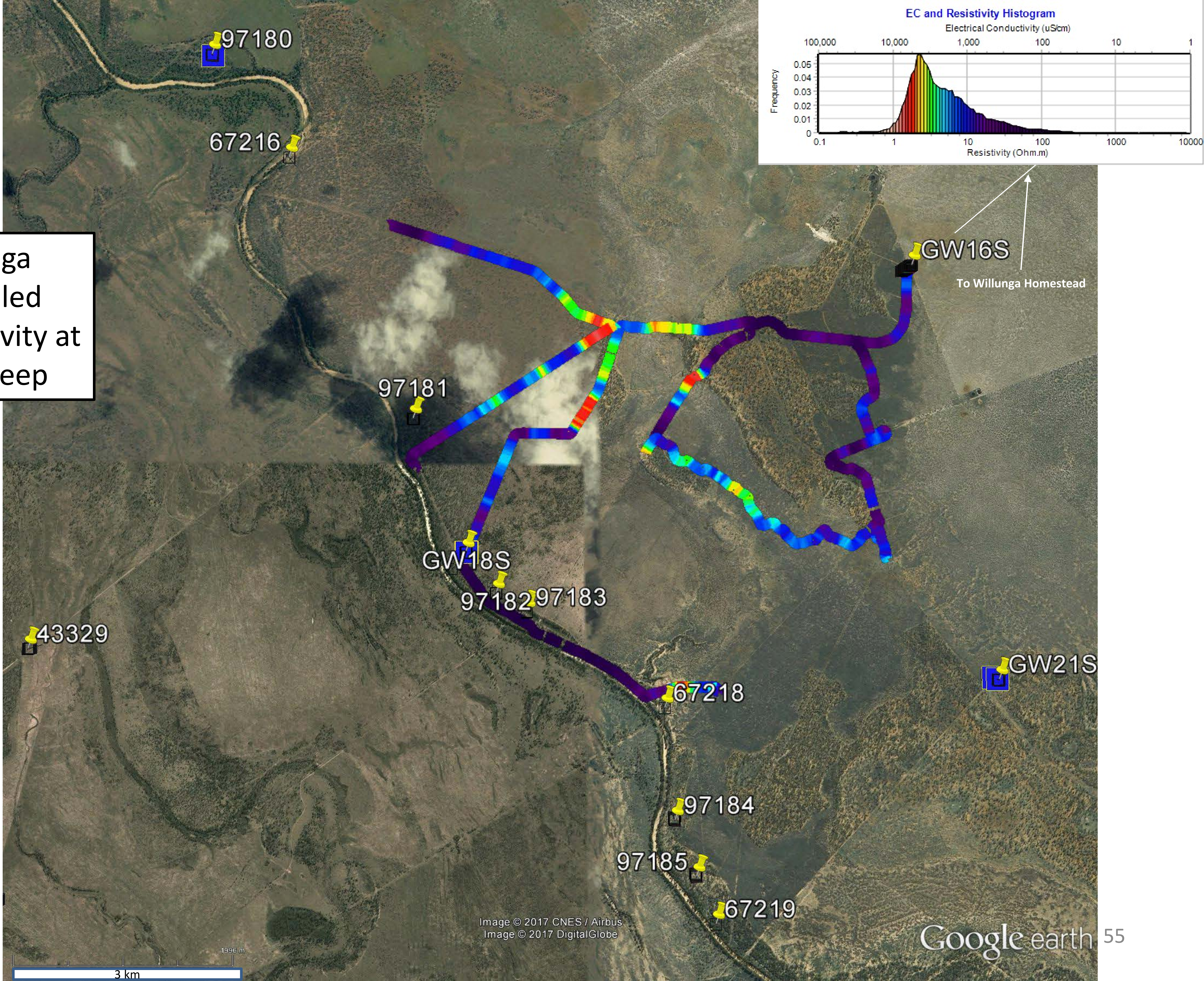
Willunga Modelled Resistivity at 4m deep



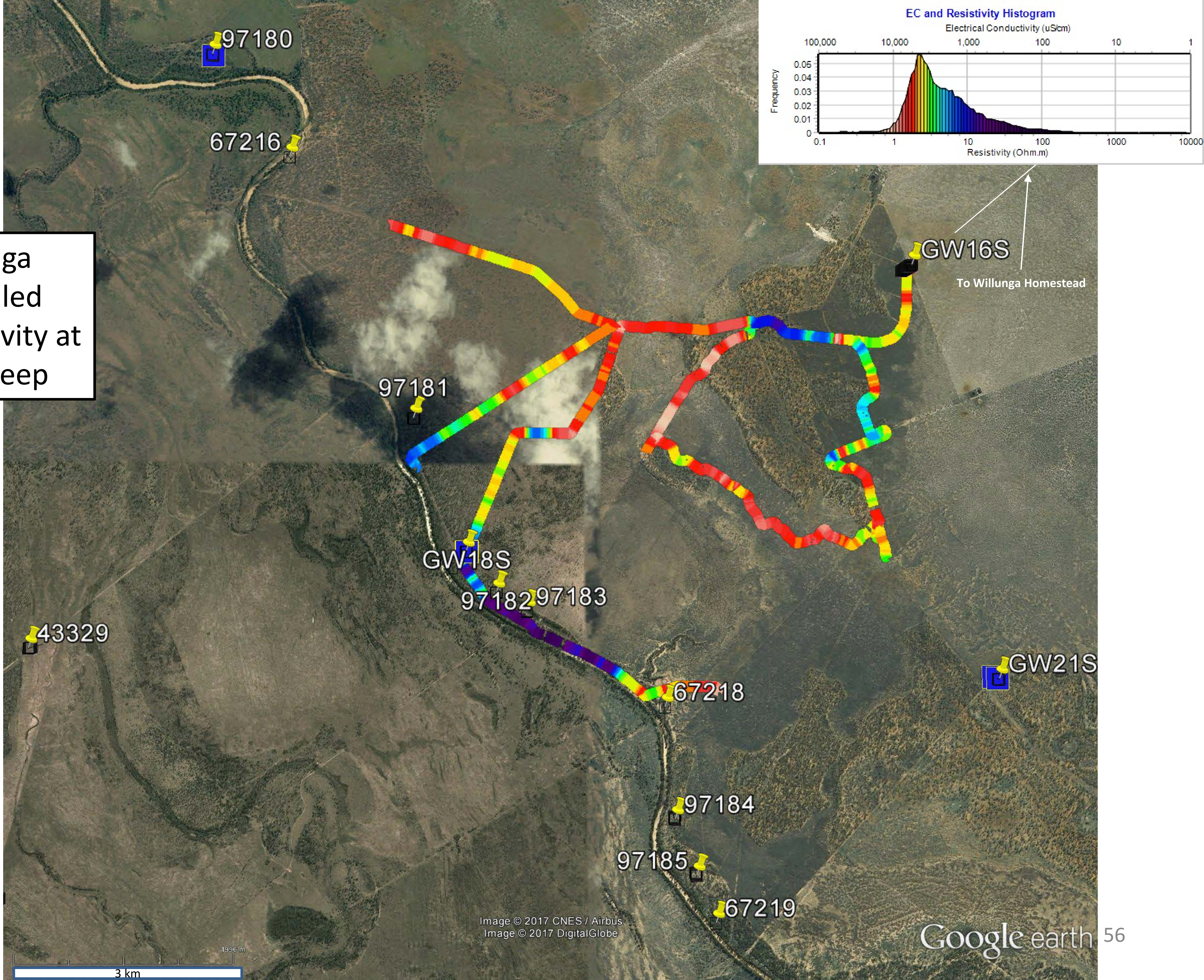
Willunga Modelled Resistivity at 7m deep



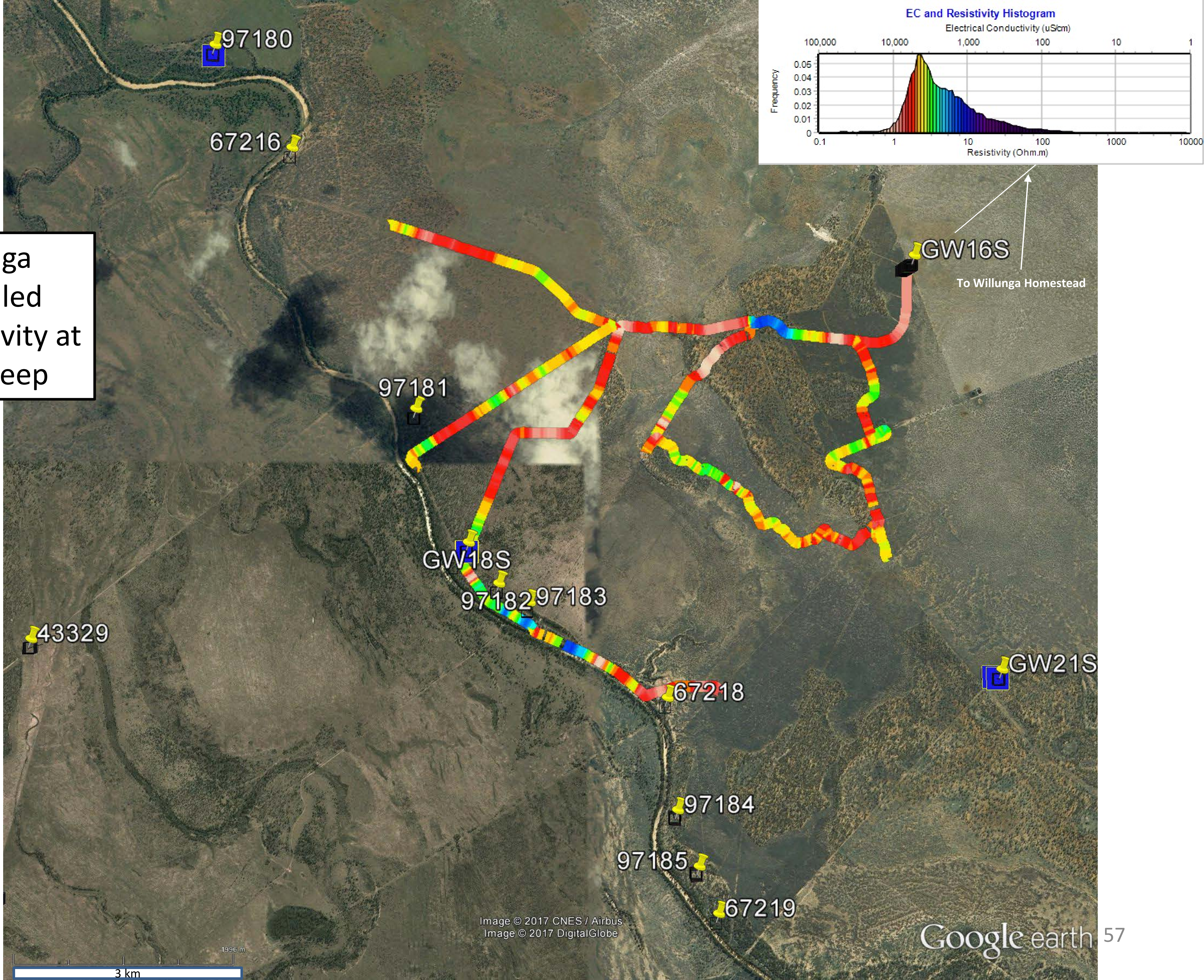
Willunga Modelled Resistivity at 12m deep



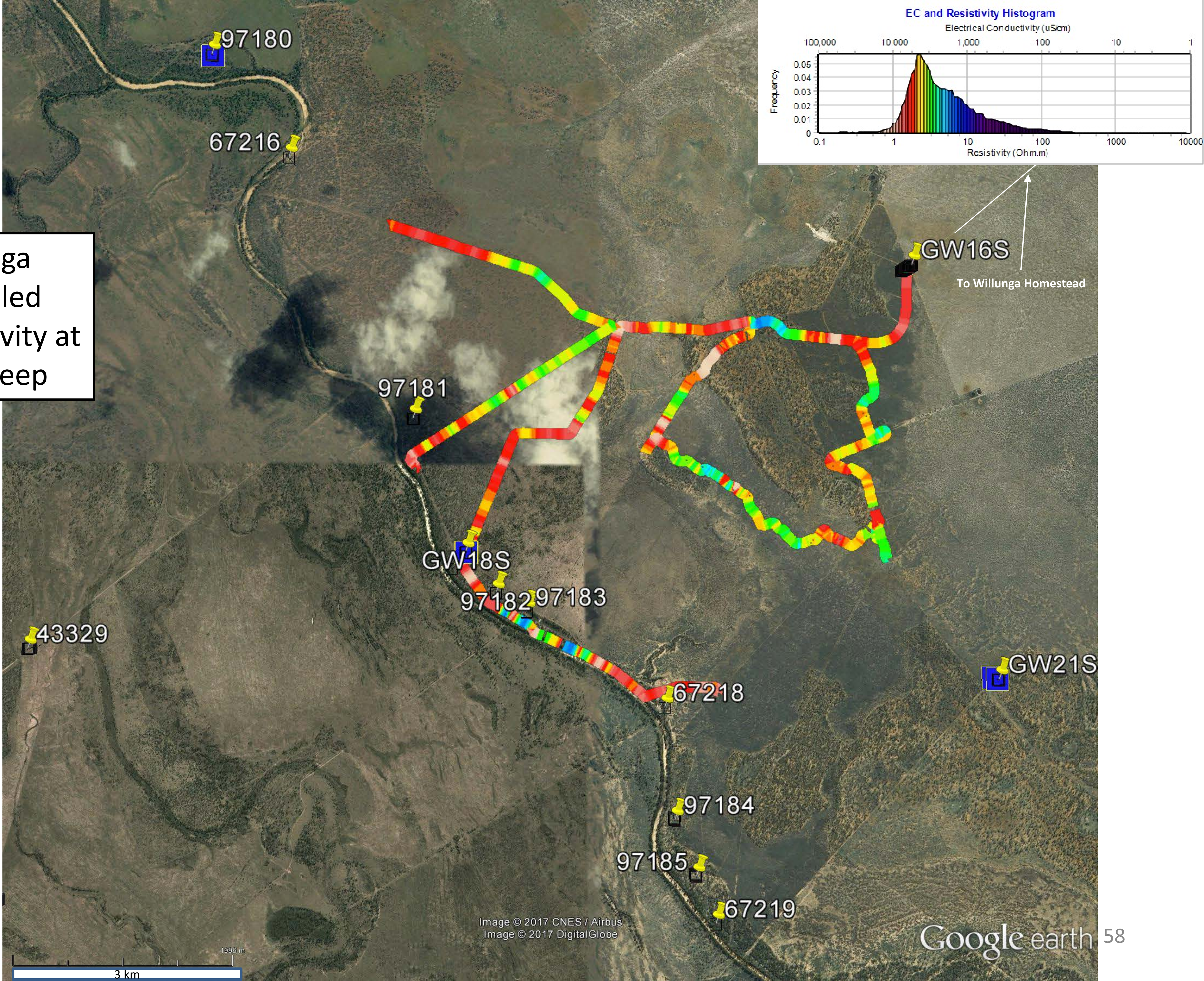
Willunga Modelled Resistivity at 20m deep



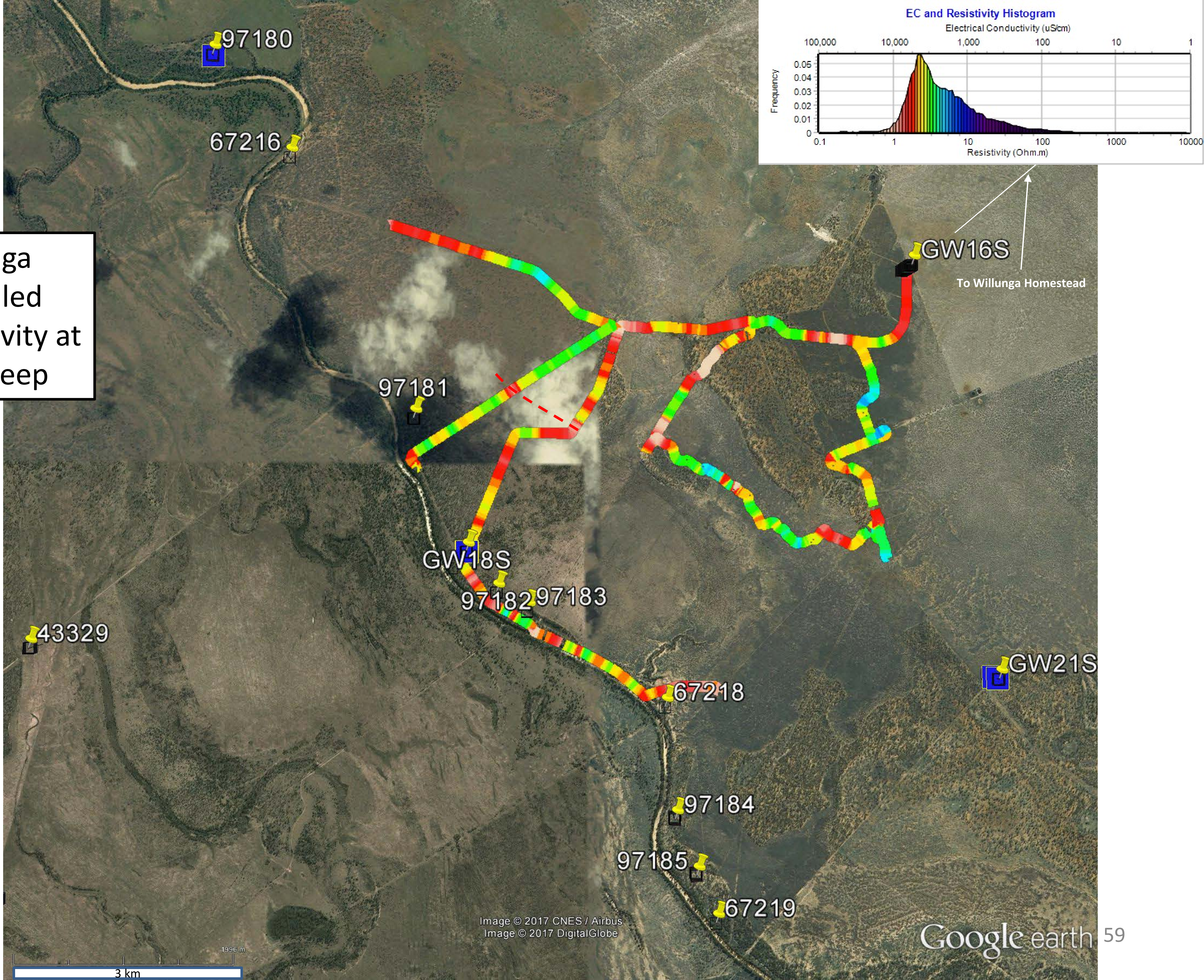
Willunga Modelled Resistivity at 28m deep



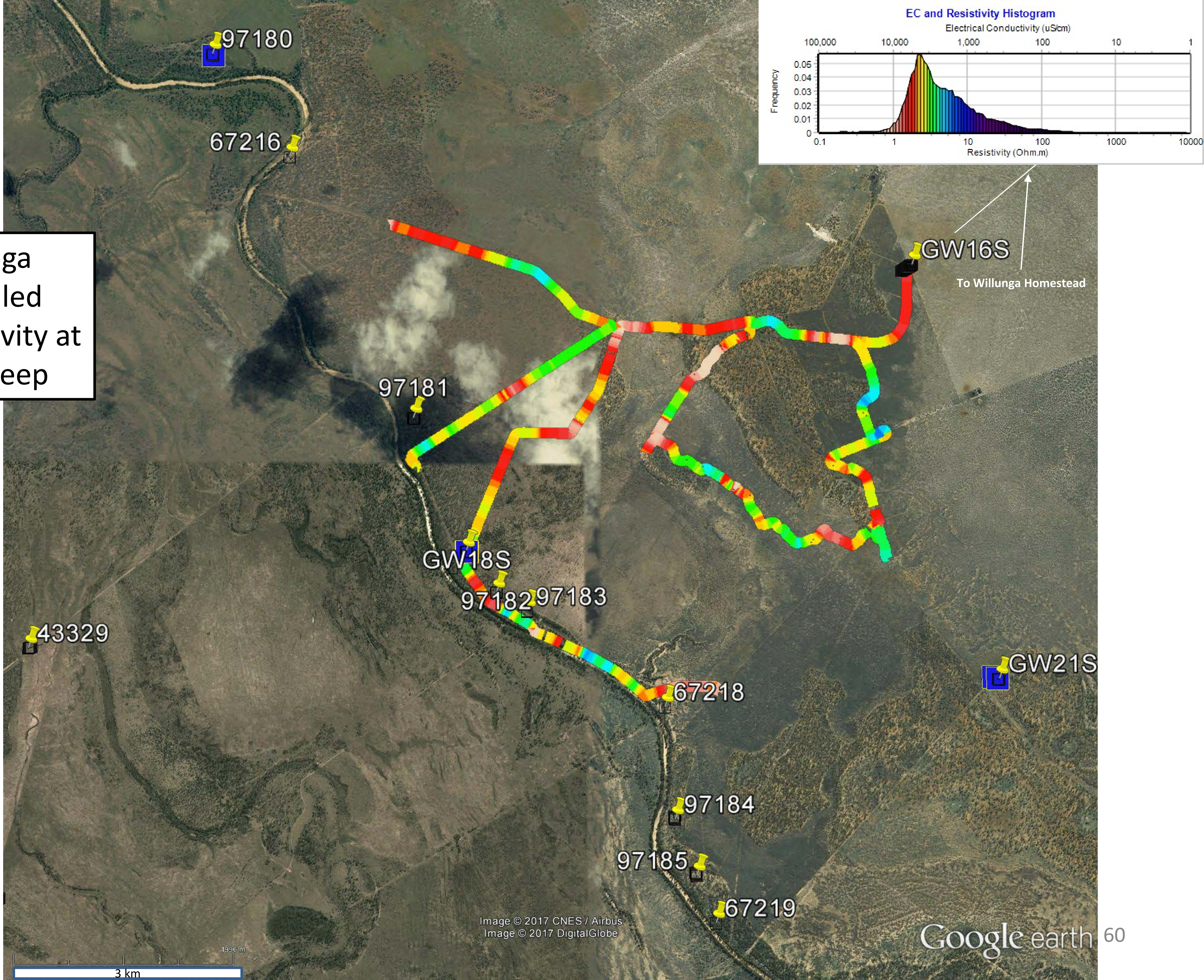
Willunga Modelled Resistivity at 36m deep



Willunga Modelled Resistivity at 45m deep



Willunga Modelled Resistivity at 58m deep



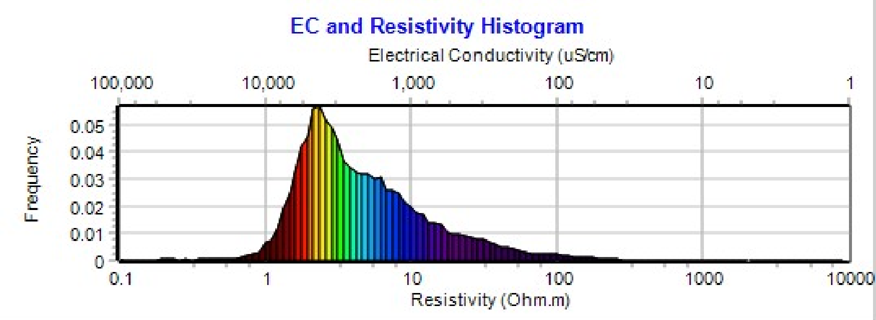
3D Curtain Images

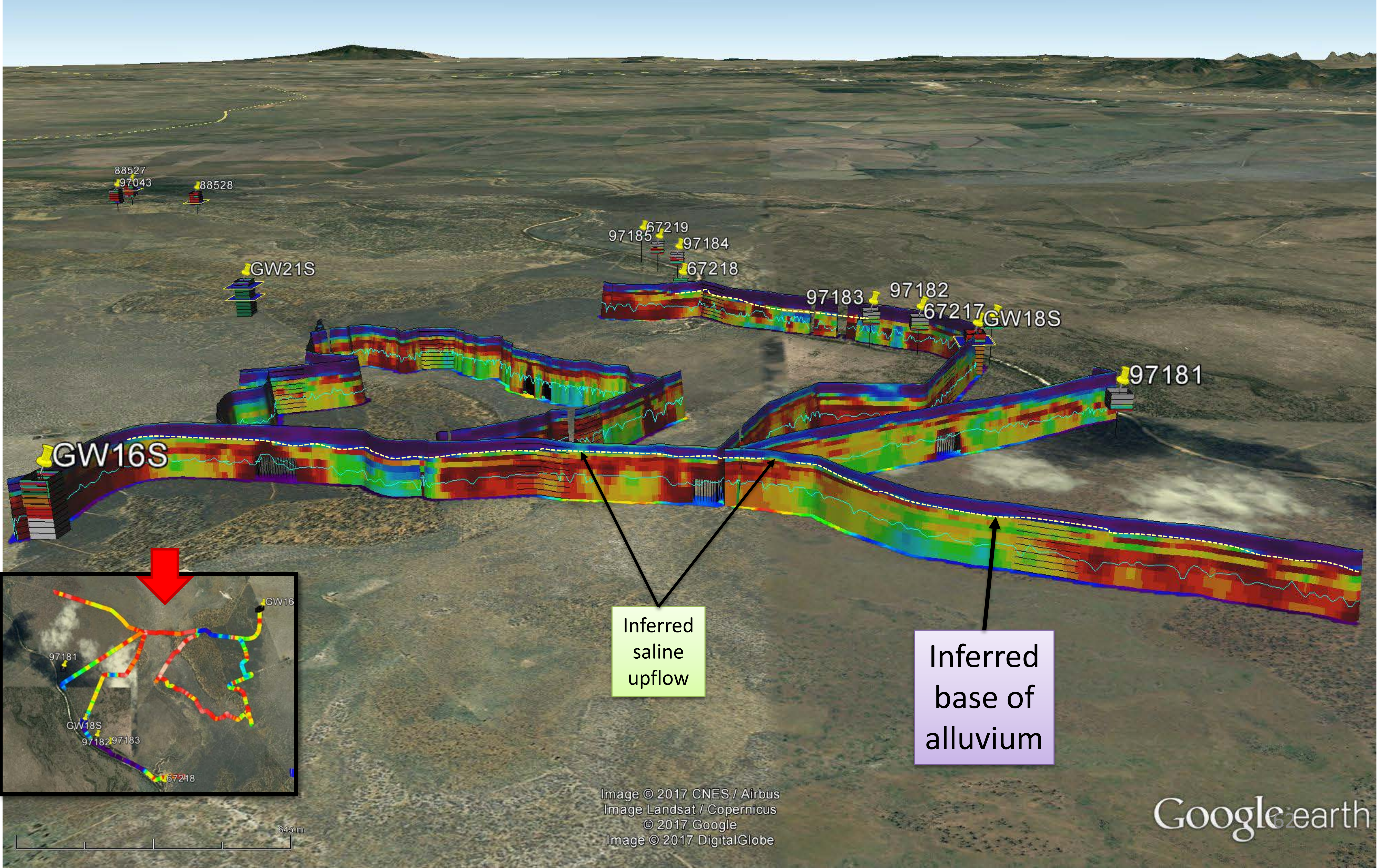
arranged from south to north.

Modelled Resistivity Projected 60m Up

Willunga viewed from the north

Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.

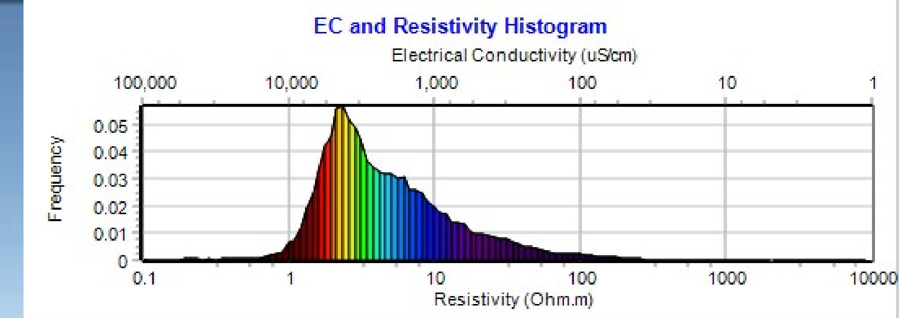


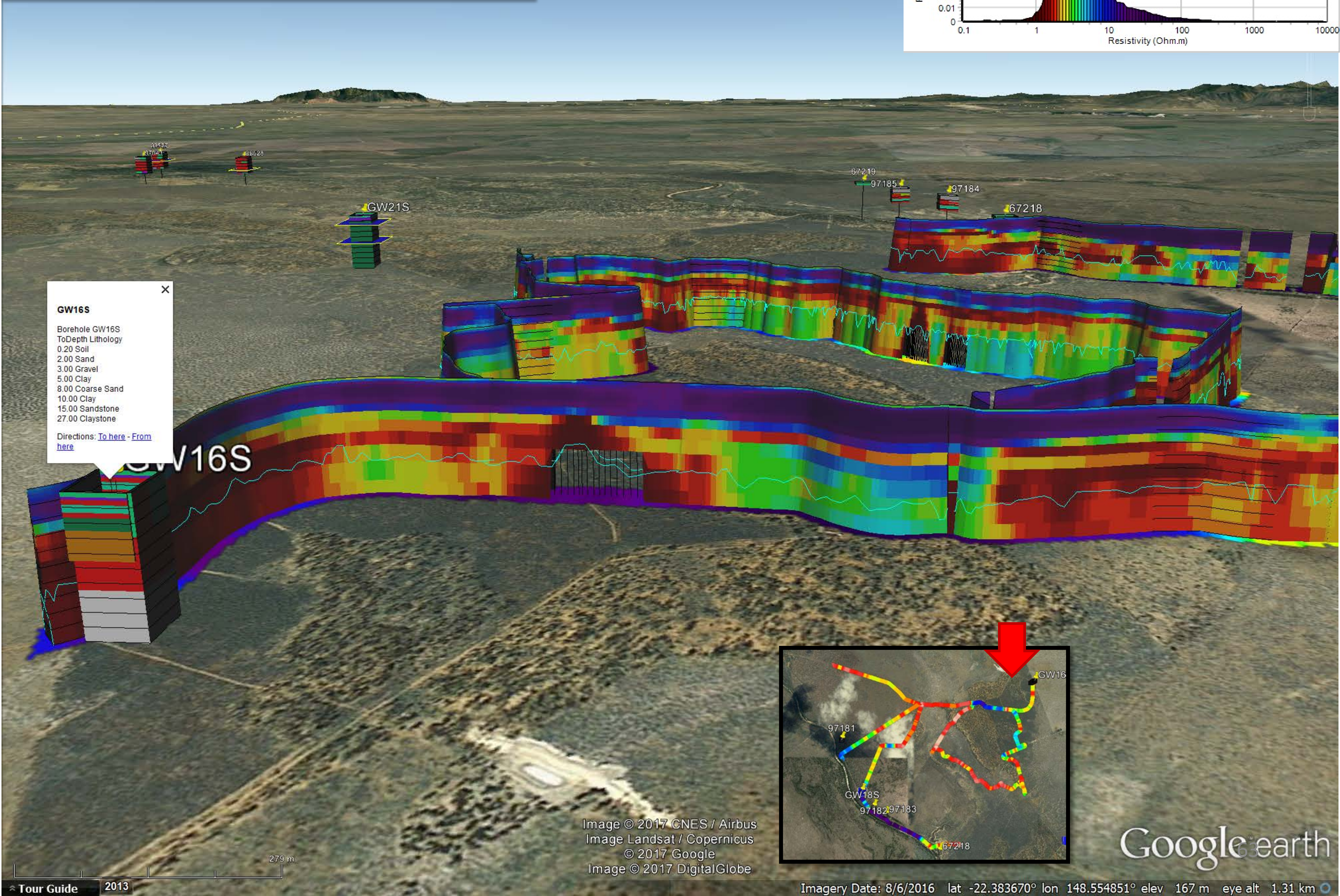


Modelled Resistivity Projected 60m Up

Willunga east viewed from the north

Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.

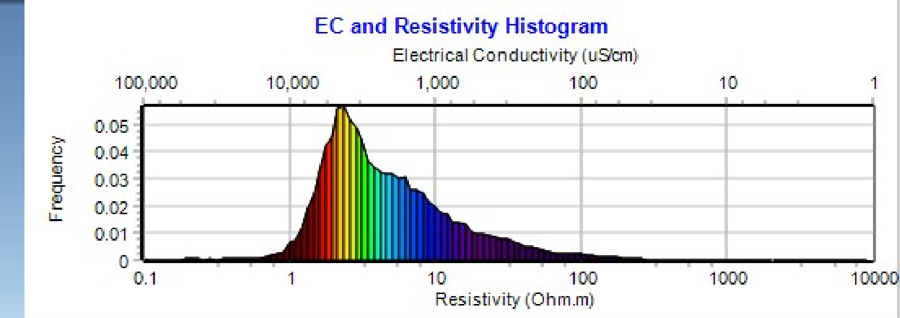


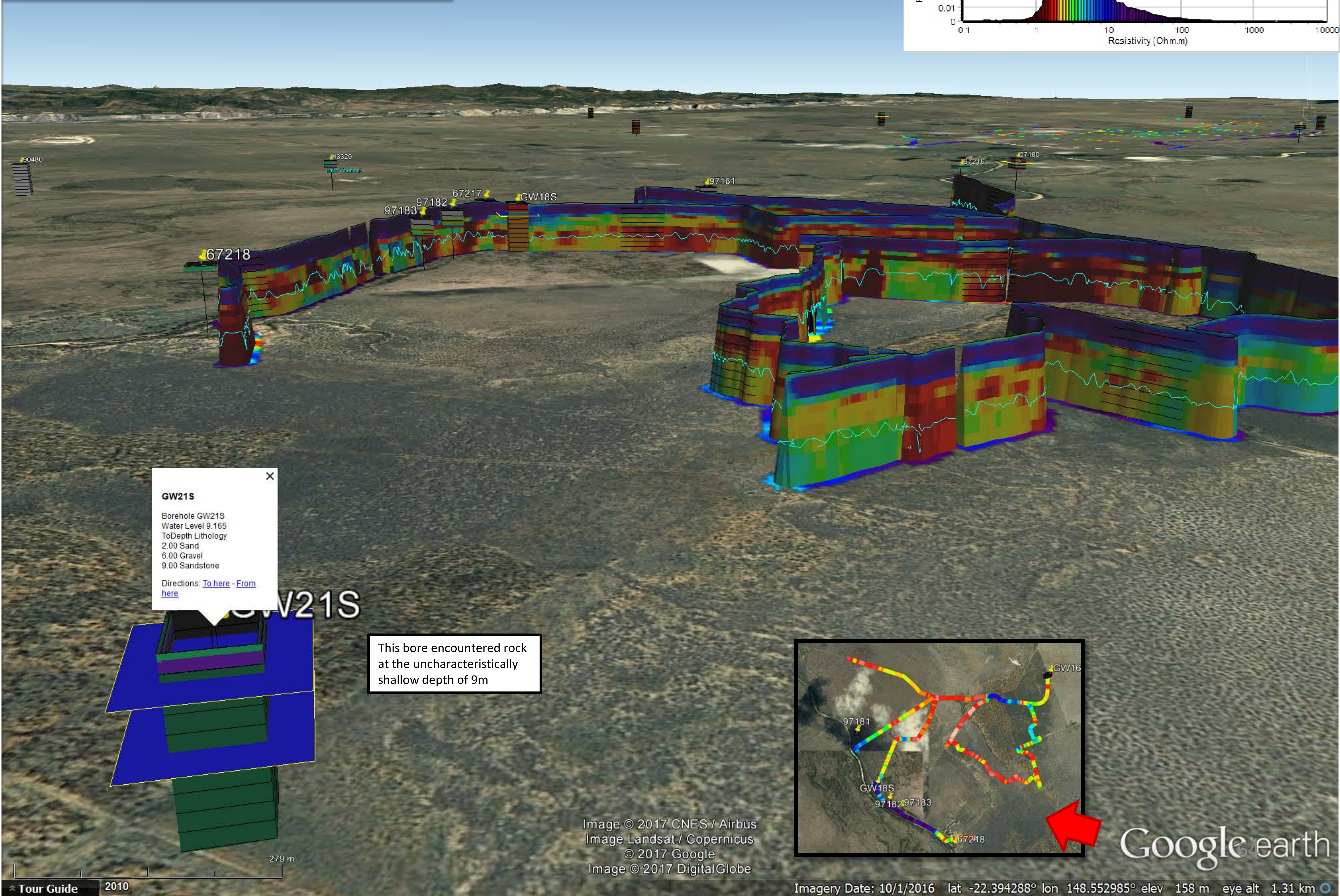


Modelled Resistivity Projected 60m Up

Willunga viewed from the east

Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.



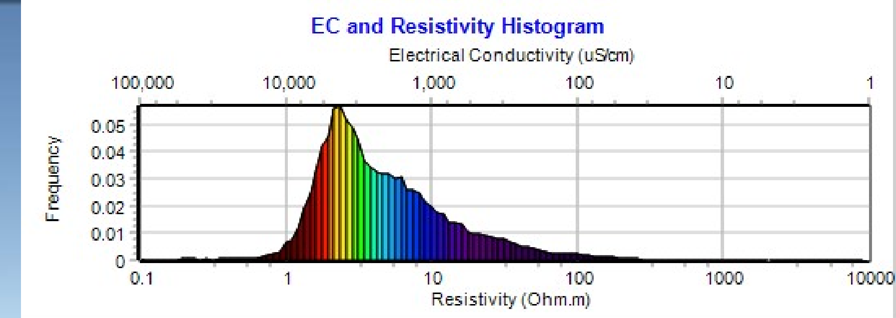


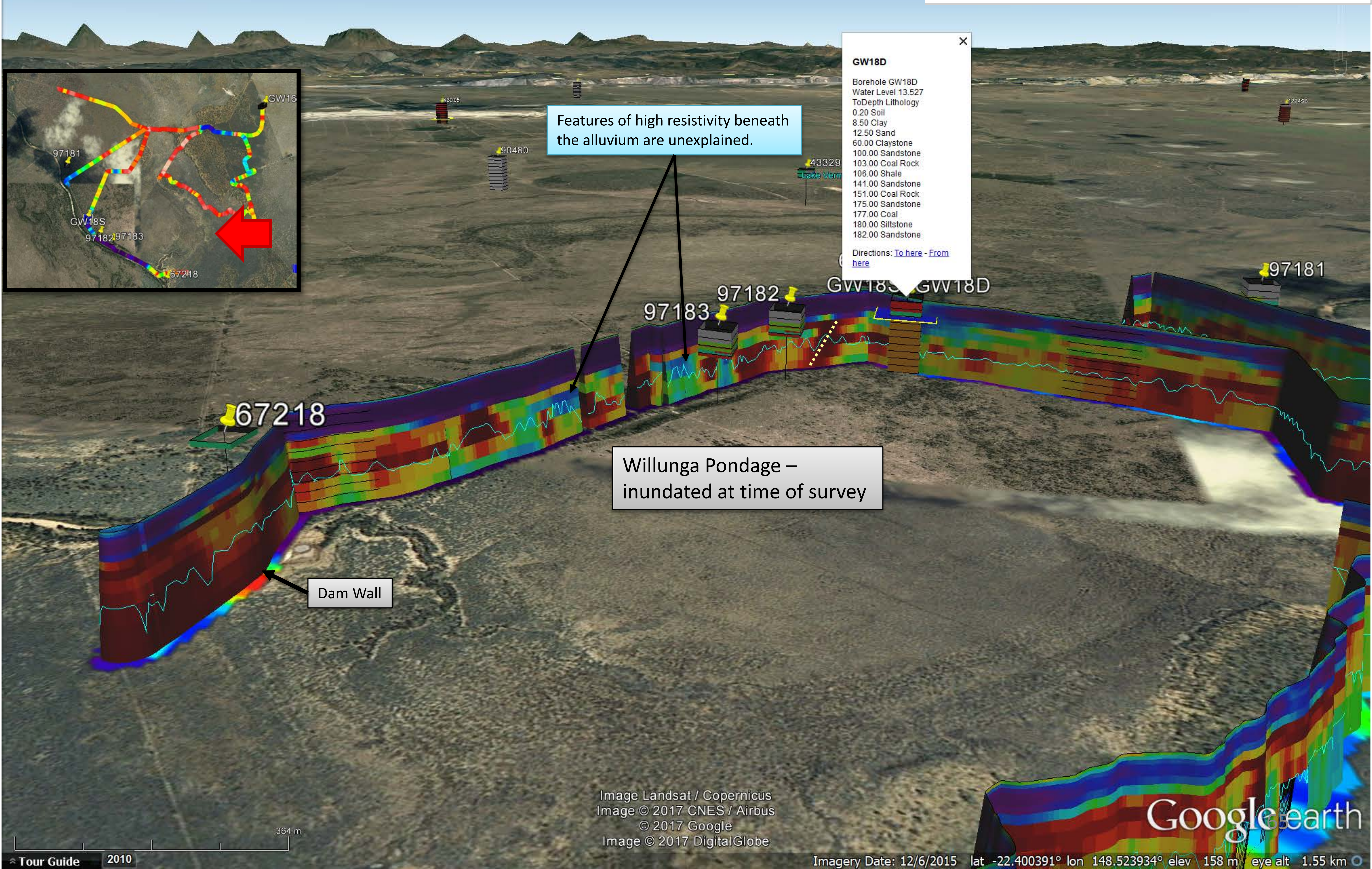
This bore encountered rock at the uncharacteristically shallow depth of 9m

Modelled Resistivity Projected 60m Up

Willunga pondage viewed from the east

Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.

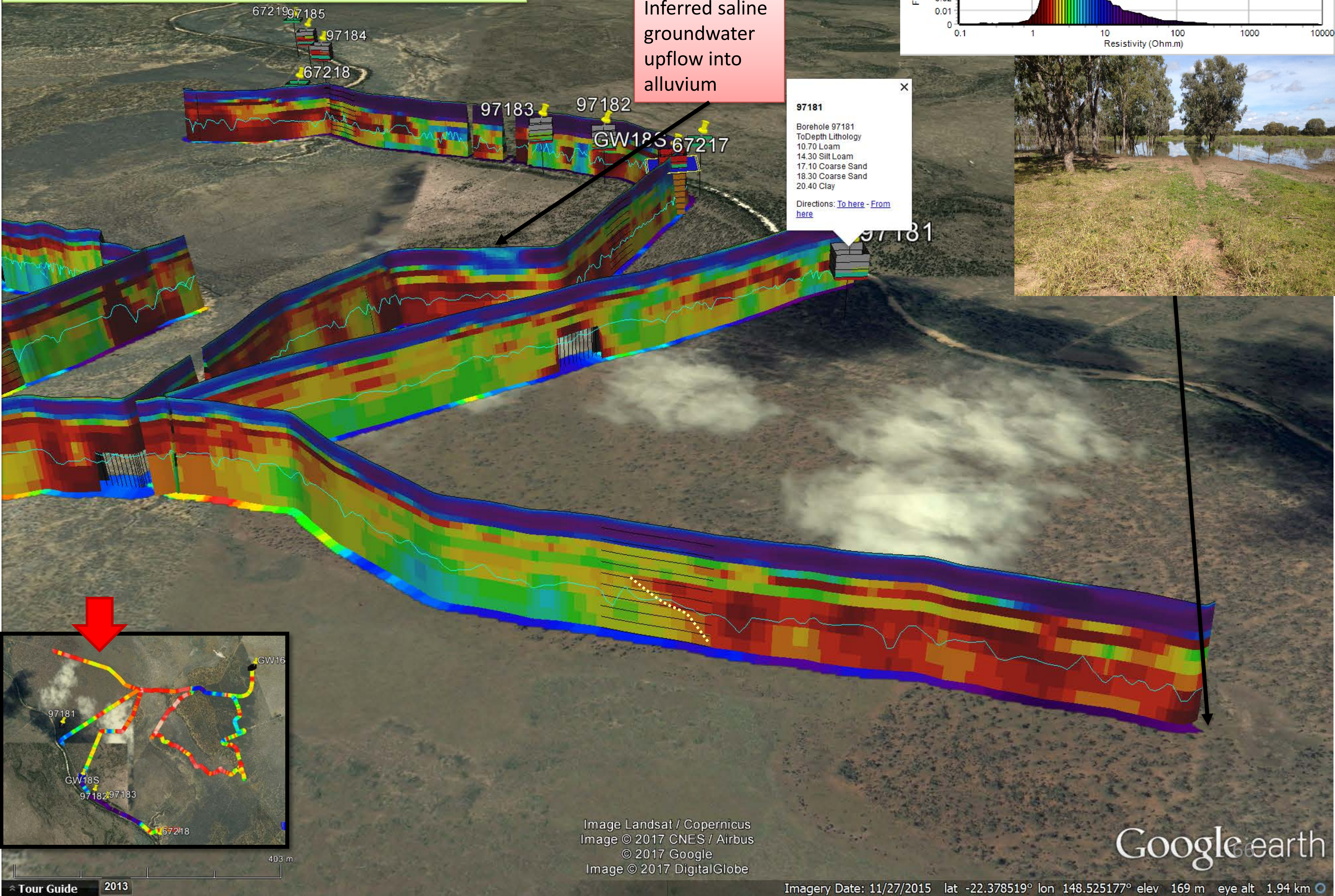


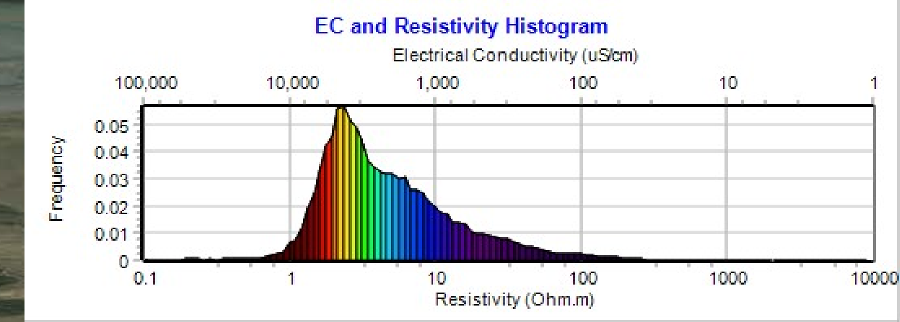


Modelled Resistivity Projected 60m Up

Willunga west viewed from the north

Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.

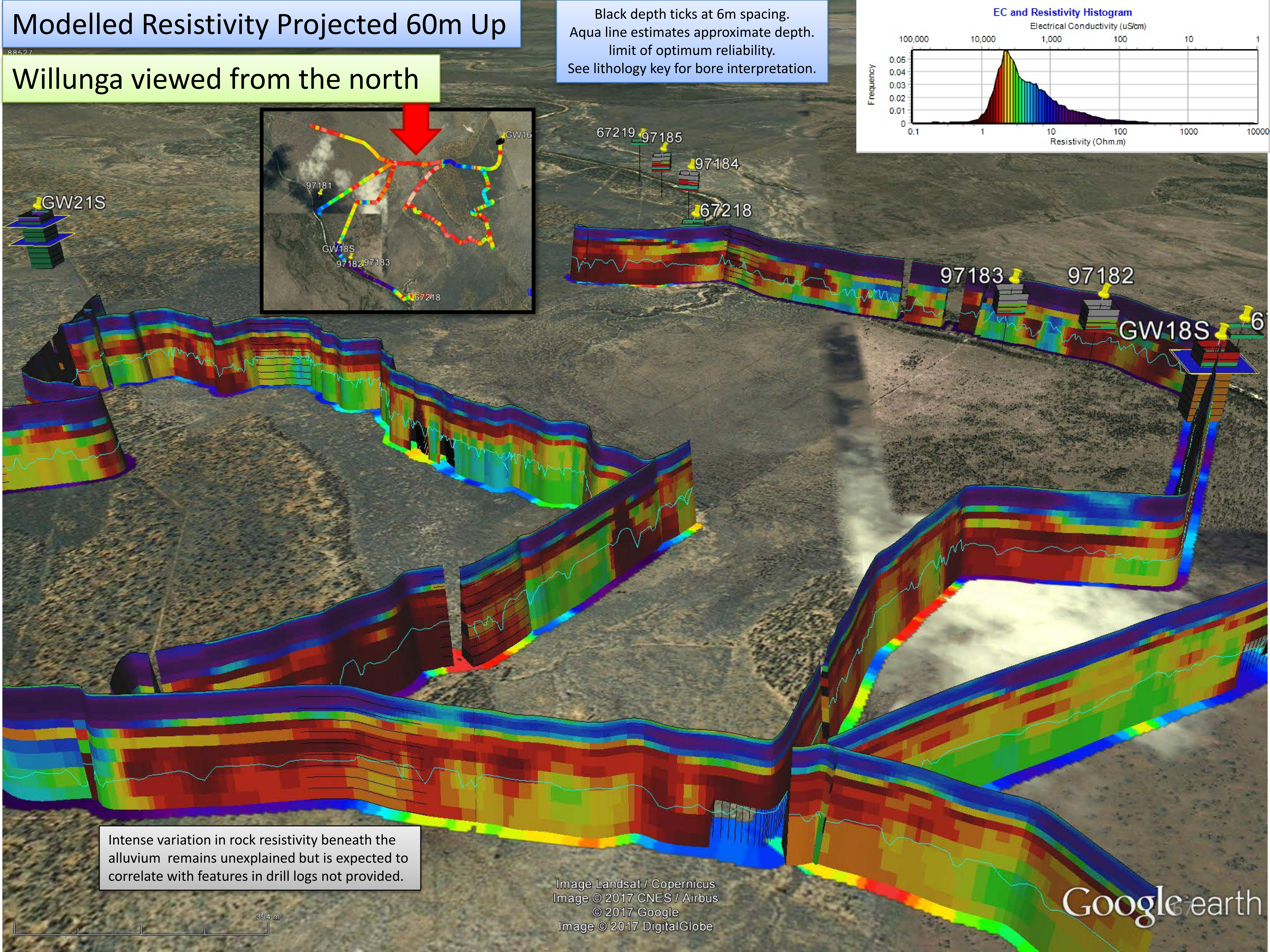




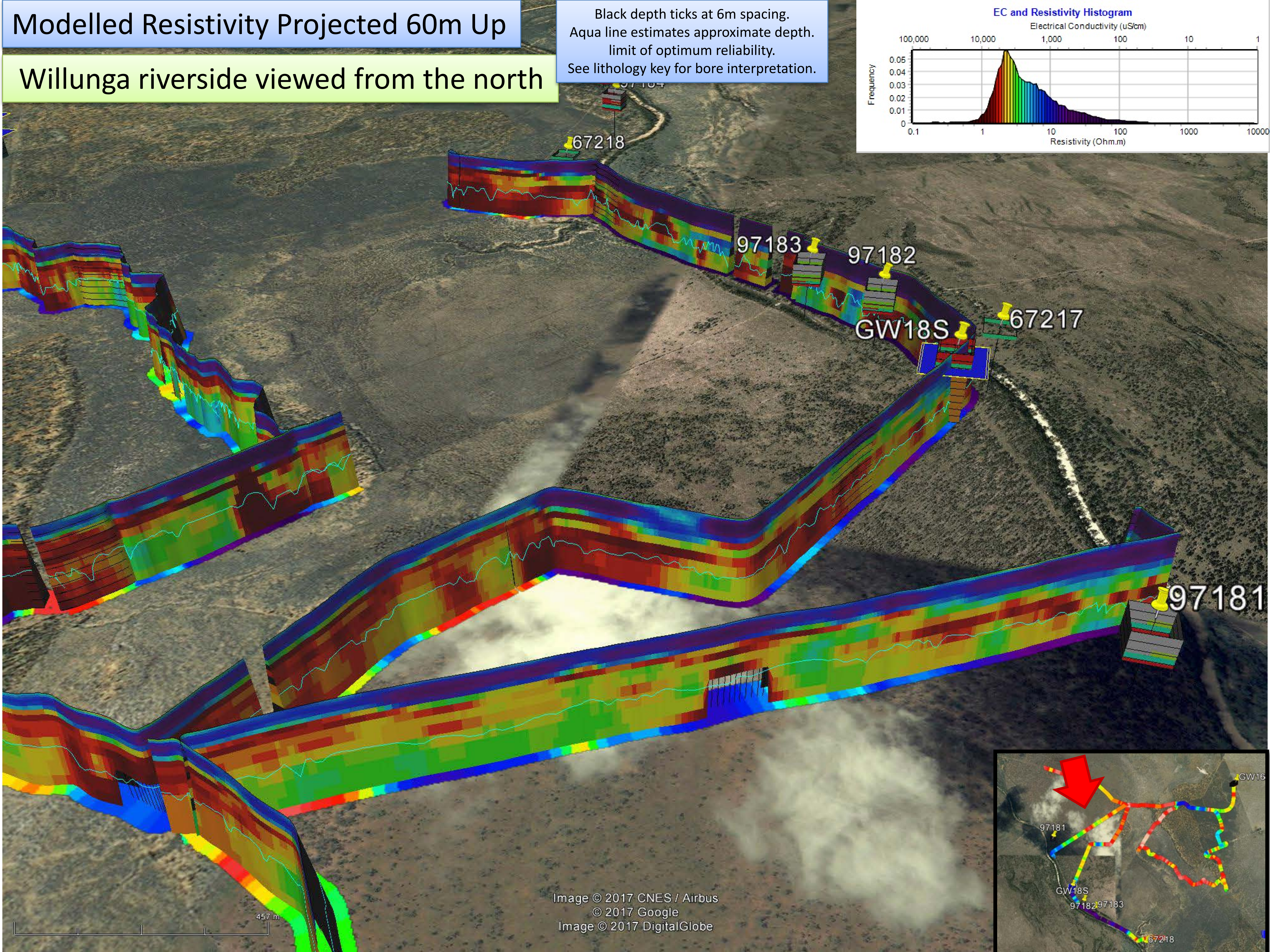
Modelled Resistivity Projected 60m Up

Willunga viewed from the north

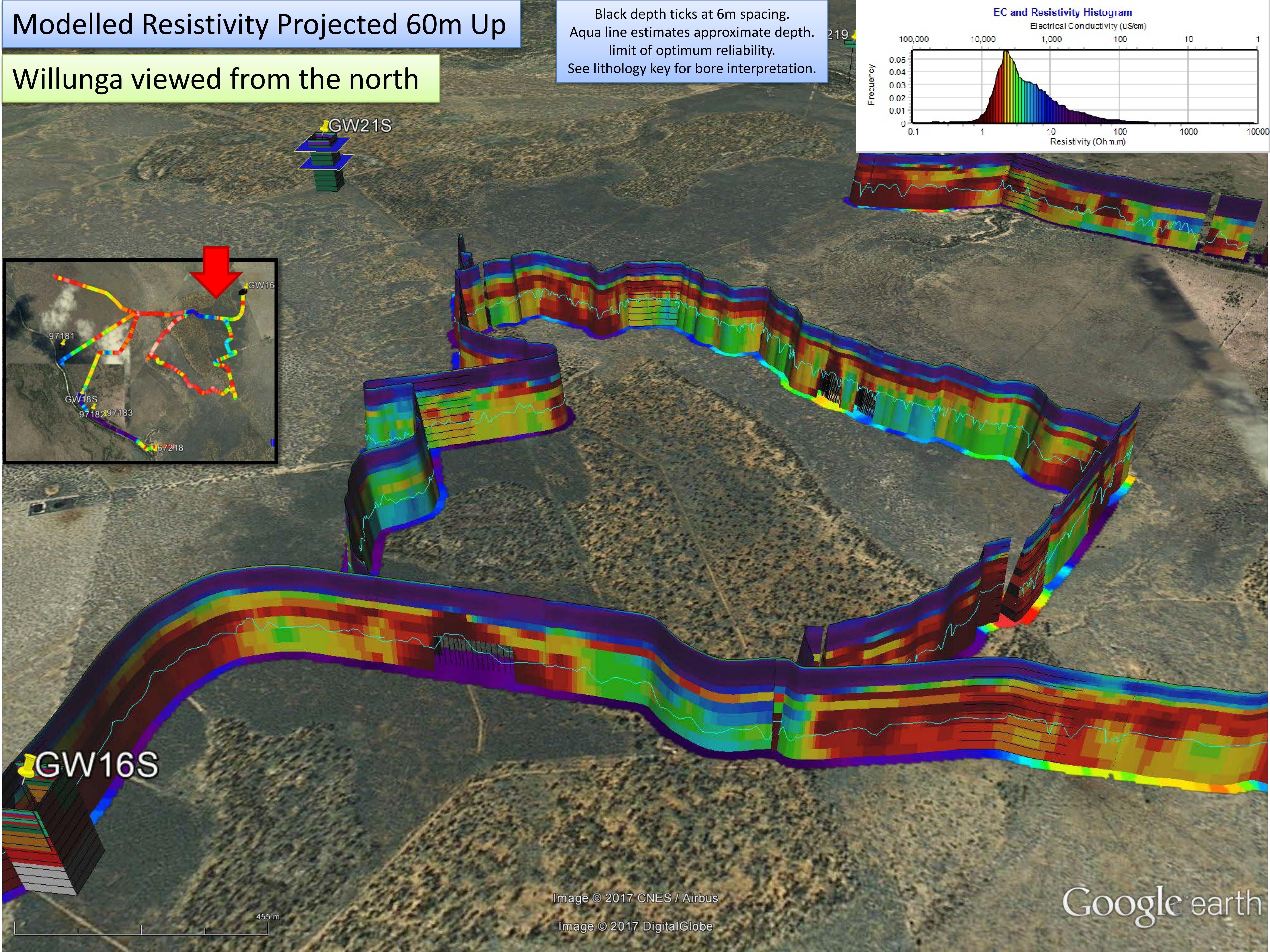
Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.



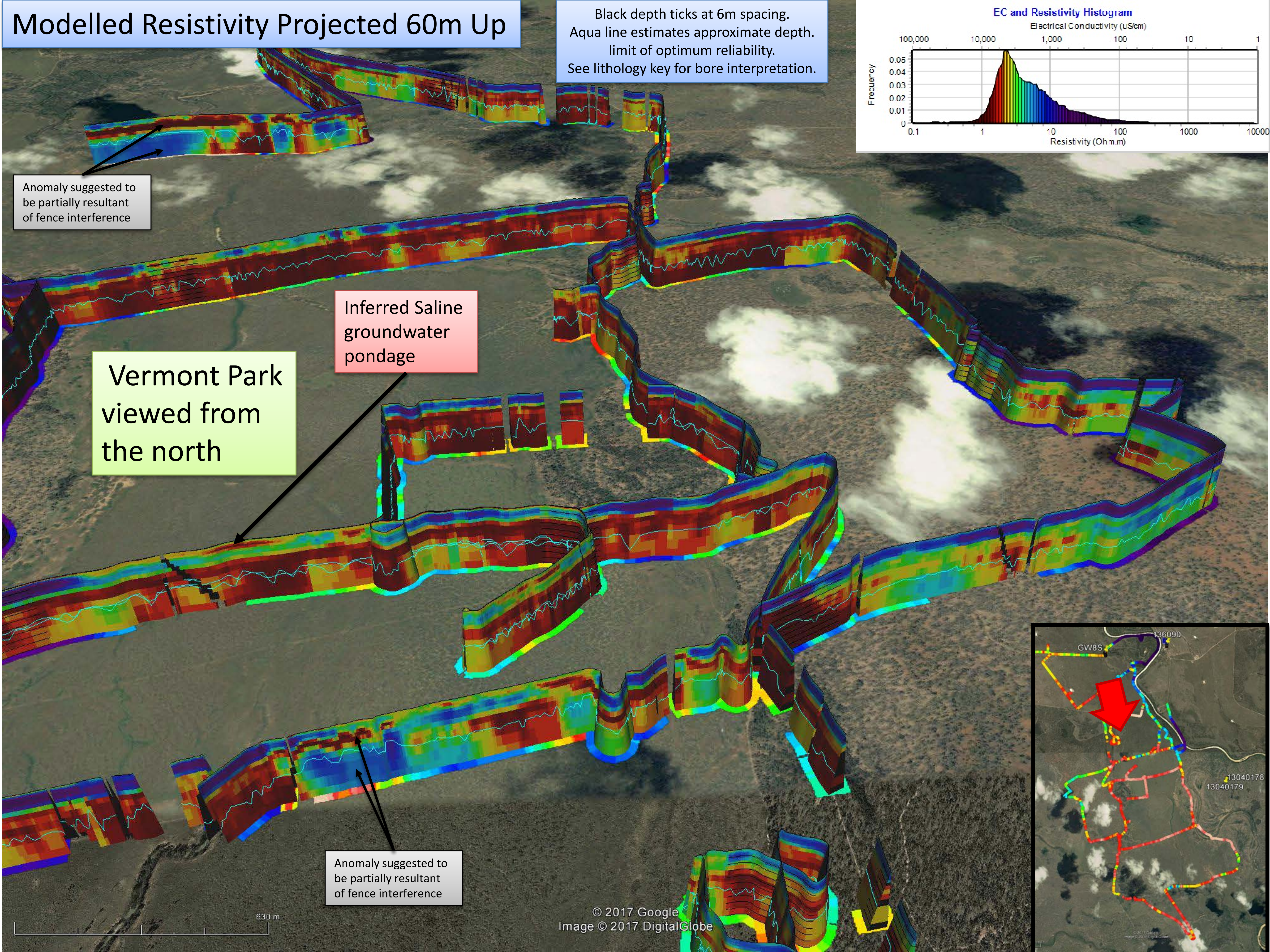
Intense variation in rock resistivity beneath the alluvium remains unexplained but is expected to correlate with features in drill logs not provided.



Modelled Resistivity Projected 60m Up
Willunga riverside viewed from the north
Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.
EC and Resistivity Histogram
Electrical Conductivity (uS/cm)
100,000
10,000
1,000
100
10
1
Frequency
0.05
0.04
0.03
0.02
0.01
0
0.1
1
10
100
1000
10000
Resistivity (Ohm.m)
67218
97183
97182
67217
GW18S
97181
457 m
Image © 2017 CNES / Airbus
© 2017 Google
Image © 2017 DigitalGlobe
GW16
97181
GW18S
97182
97183
67218



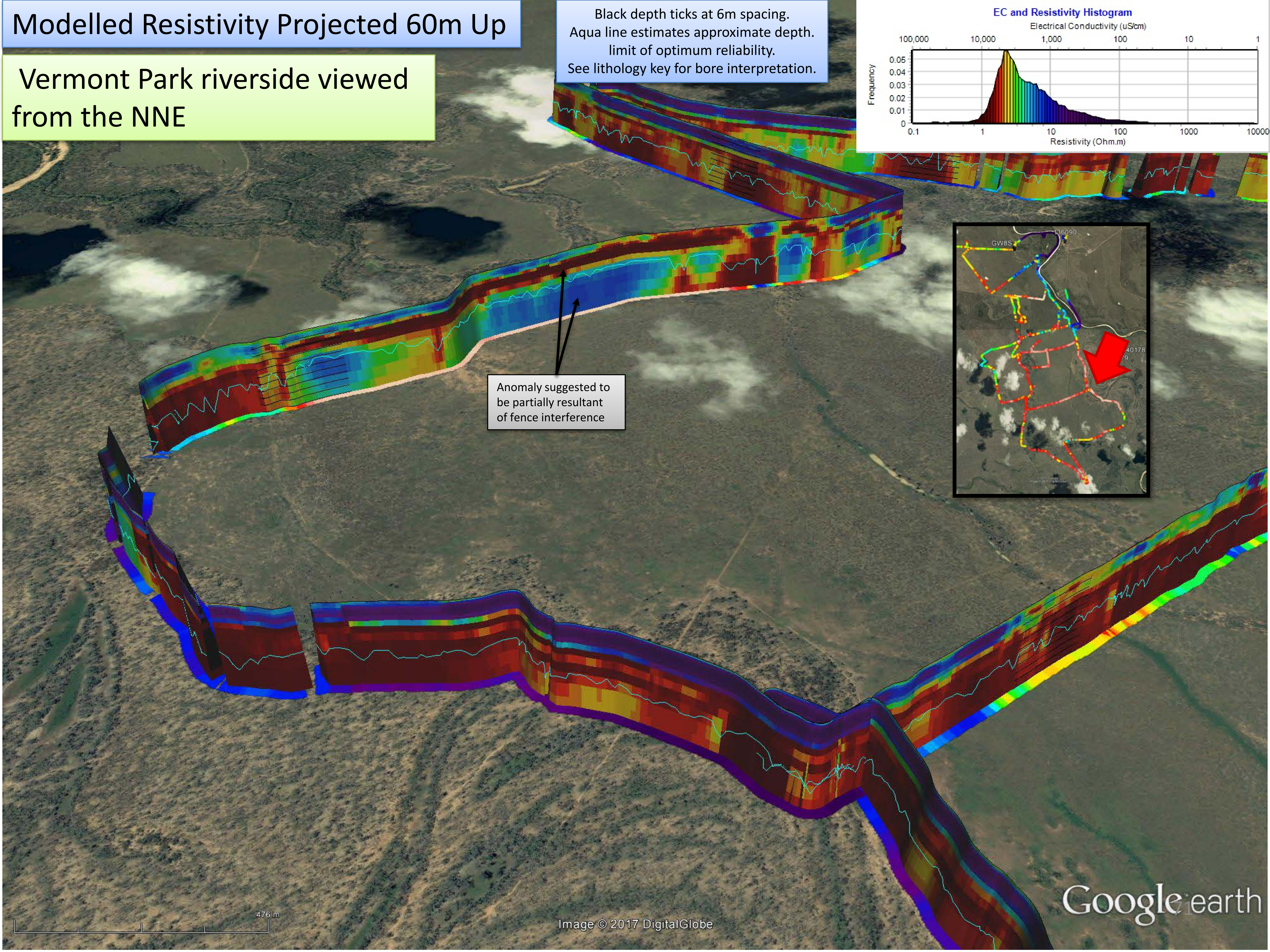
Modelled Resistivity Projected 60m Up
Willunga viewed from the north
Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.
EC and Resistivity Histogram
Electrical Conductivity (uS/cm)
100,000 10,000 1,000 100 10 1
Frequency
0.05 0.04 0.03 0.02 0.01 0
0.1 1 10 100 1000 10000
Resistivity (Ohm.m)
GW21S
GW16
97181
GW18S
97182
97183
GW16S
Image © 2017 CNES / Airbus
Image © 2017 DigitalGlobe
455 m
Google earth


Modelled Resistivity Projected 60m Up
Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.
EC and Resistivity Histogram
Electrical Conductivity (uS/cm)
100,000
10,000
1,000
100
10
1
Frequency
0.05
0.04
0.03
0.02
0.01
0
0.1
1
10
100
1000
10000
Resistivity (Ohm.m)
Anomaly suggested to be partially resultant of fence interference
Inferred Saline groundwater pondage
Vermont Park viewed from the north
136090
GW8S
13040178
13040179
Anomaly suggested to be partially resultant of fence interference
630 m
© 2017 Google
Image © 2017 DigitalGlobe

Modelled Resistivity Projected 60m Up

Vermont Park riverside viewed from the NNE

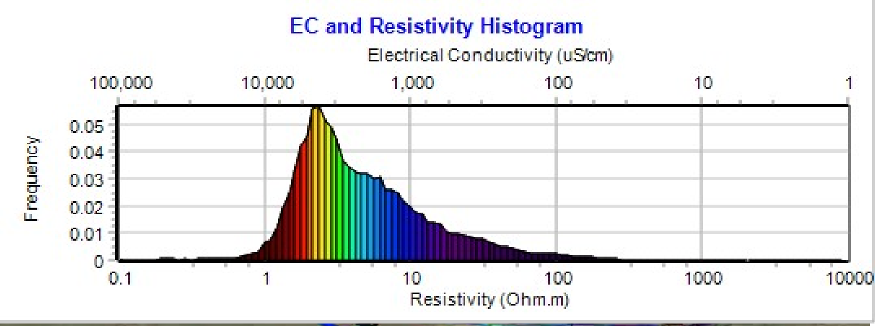
Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.

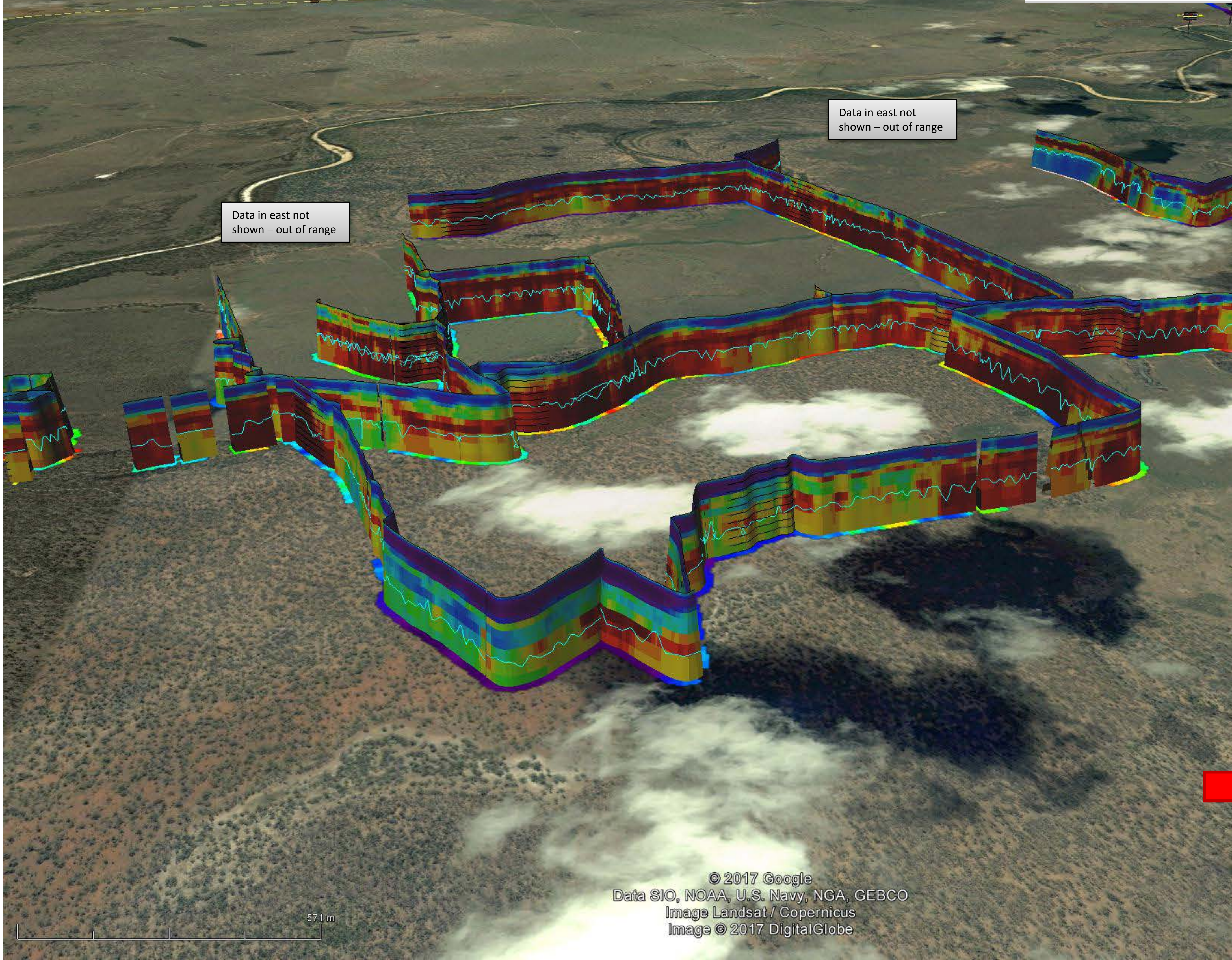


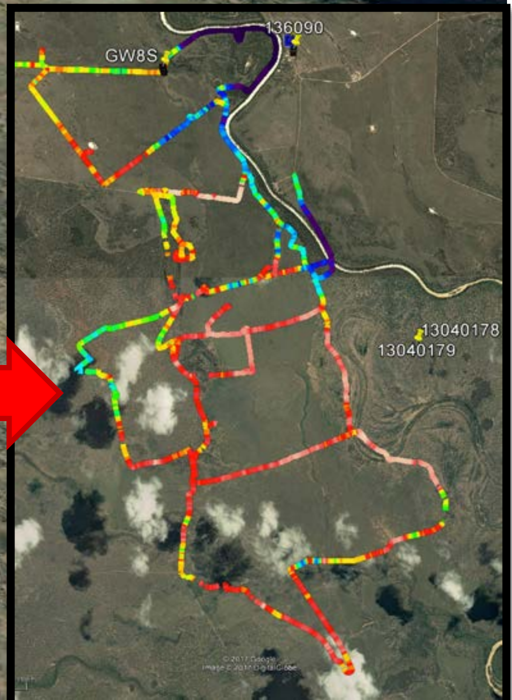
Modelled Resistivity Projected 60m Up

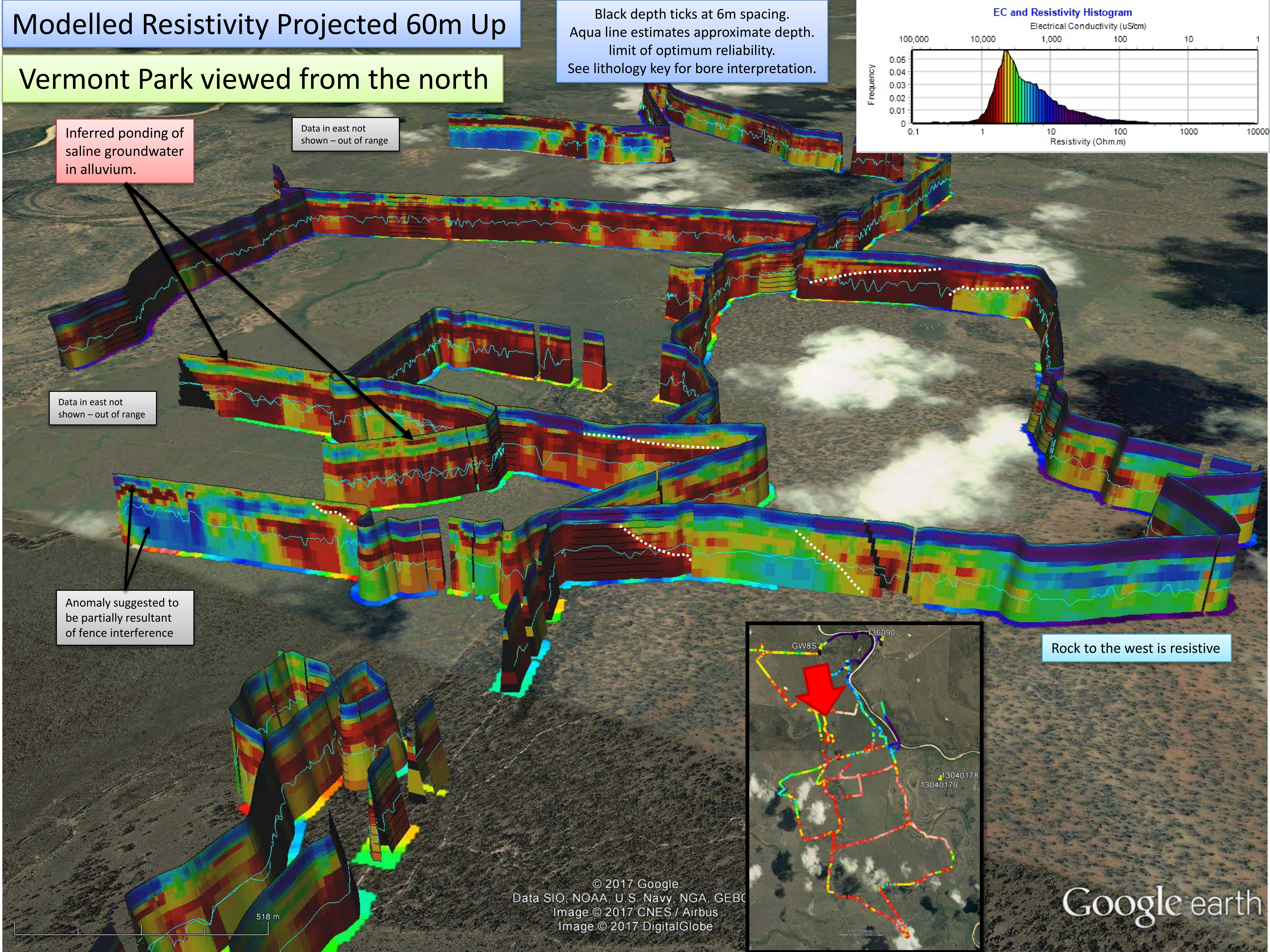
Vermont Park viewed from the west

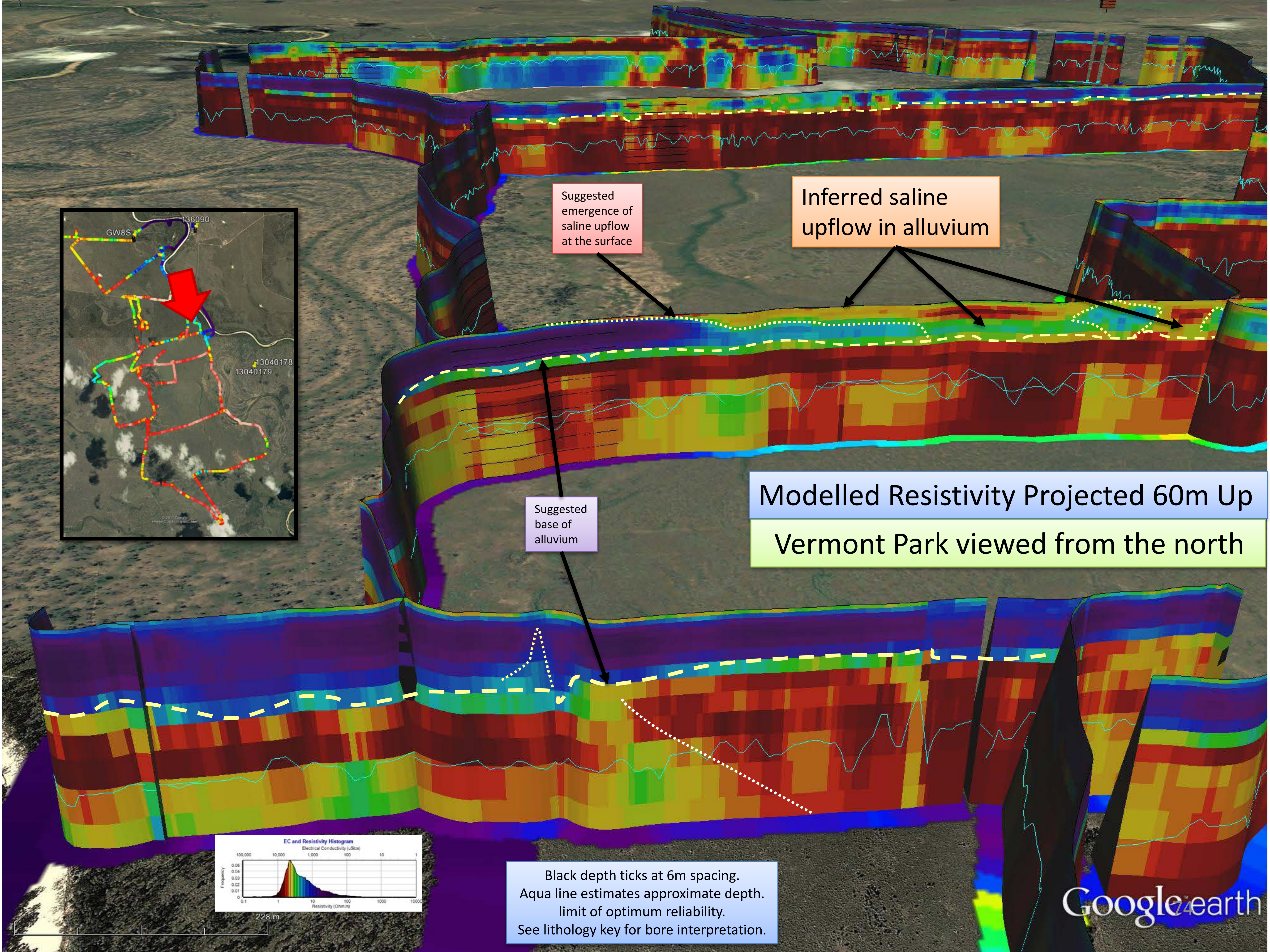
Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.



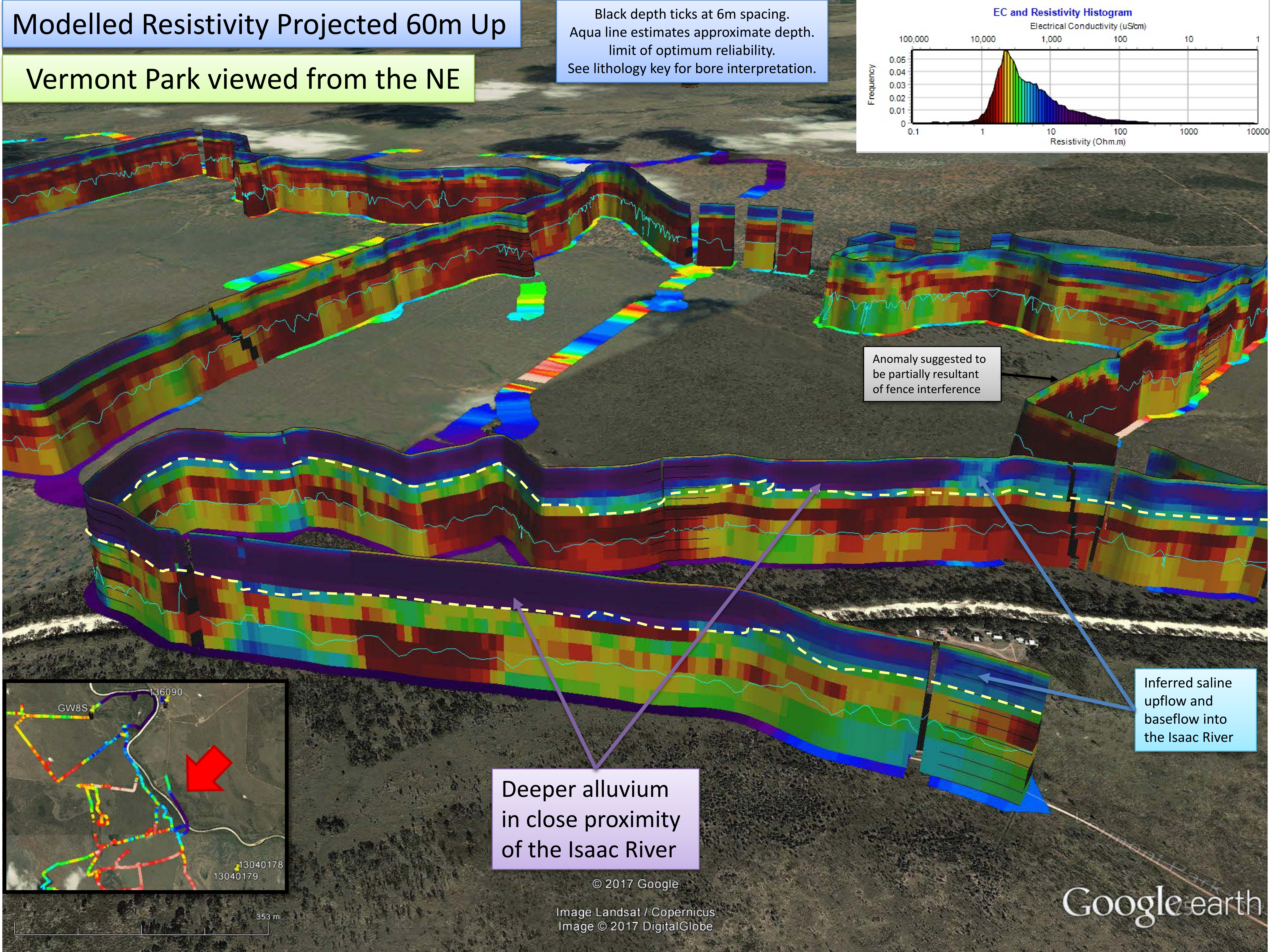




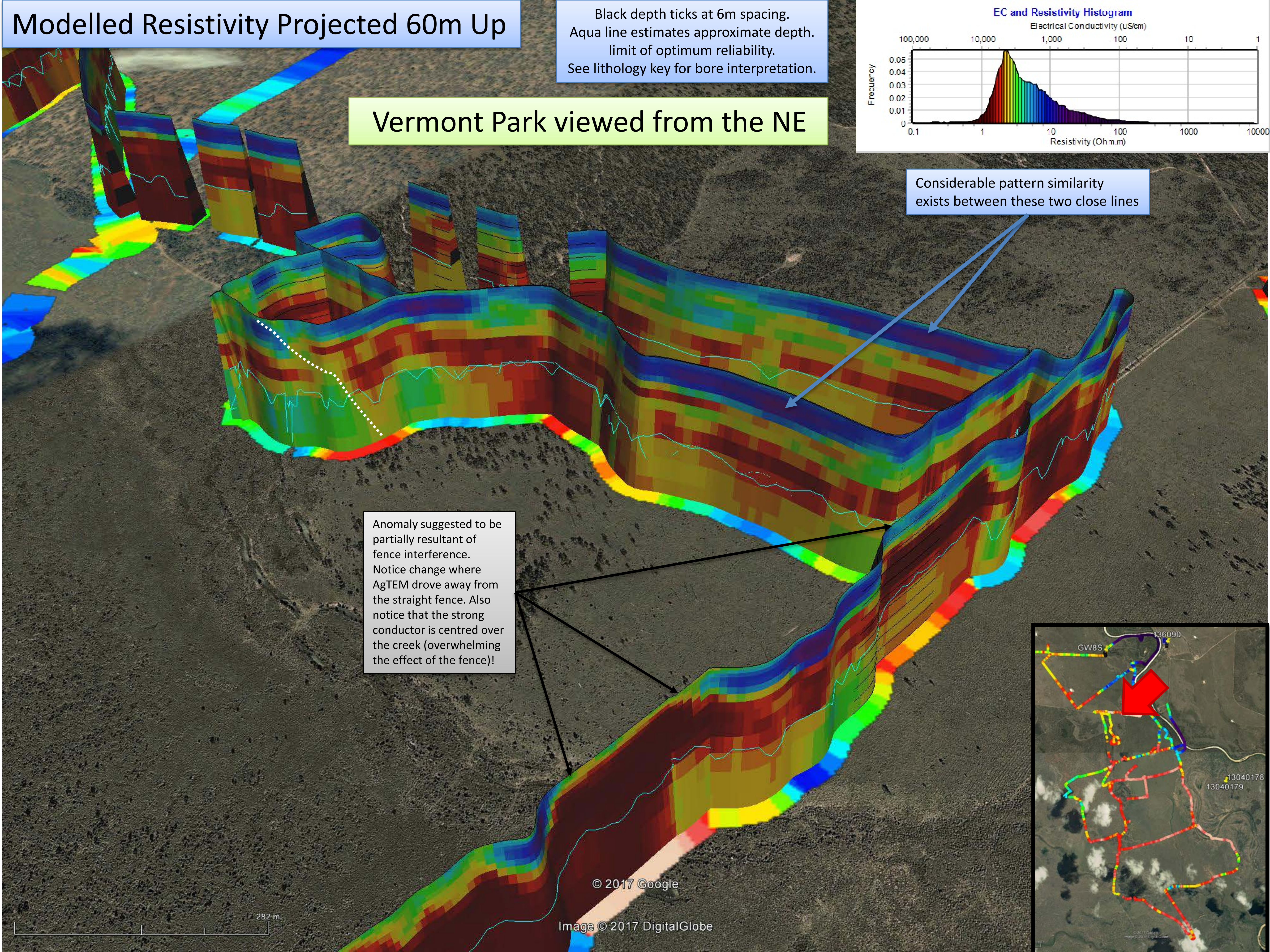

Modelled Resistivity Projected 60m Up
Vermont Park viewed from the north
Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.
EC and Resistivity Histogram
Electrical Conductivity (uS/cm)
100,000
10,000
1,000
100
10
1
Frequency
0.05
0.04
0.03
0.02
0.01
0
0.1
1
10
100
1000
10000
Resistivity (Ohm.m)
Inferred ponding of saline groundwater in alluvium.
Data in east not shown – out of range
Data in east not shown – out of range
Anomaly suggested to be partially resultant of fence interference
Rock to the west is resistive
GW8S
136090
13040178
13040179
518 m
© 2017 Google
Data SIO, NOAA, U.S. Navy, NGA, GEBC
Image © 2017 CNES / Airbus
Image © 2017 DigitalGlobe
Google earth

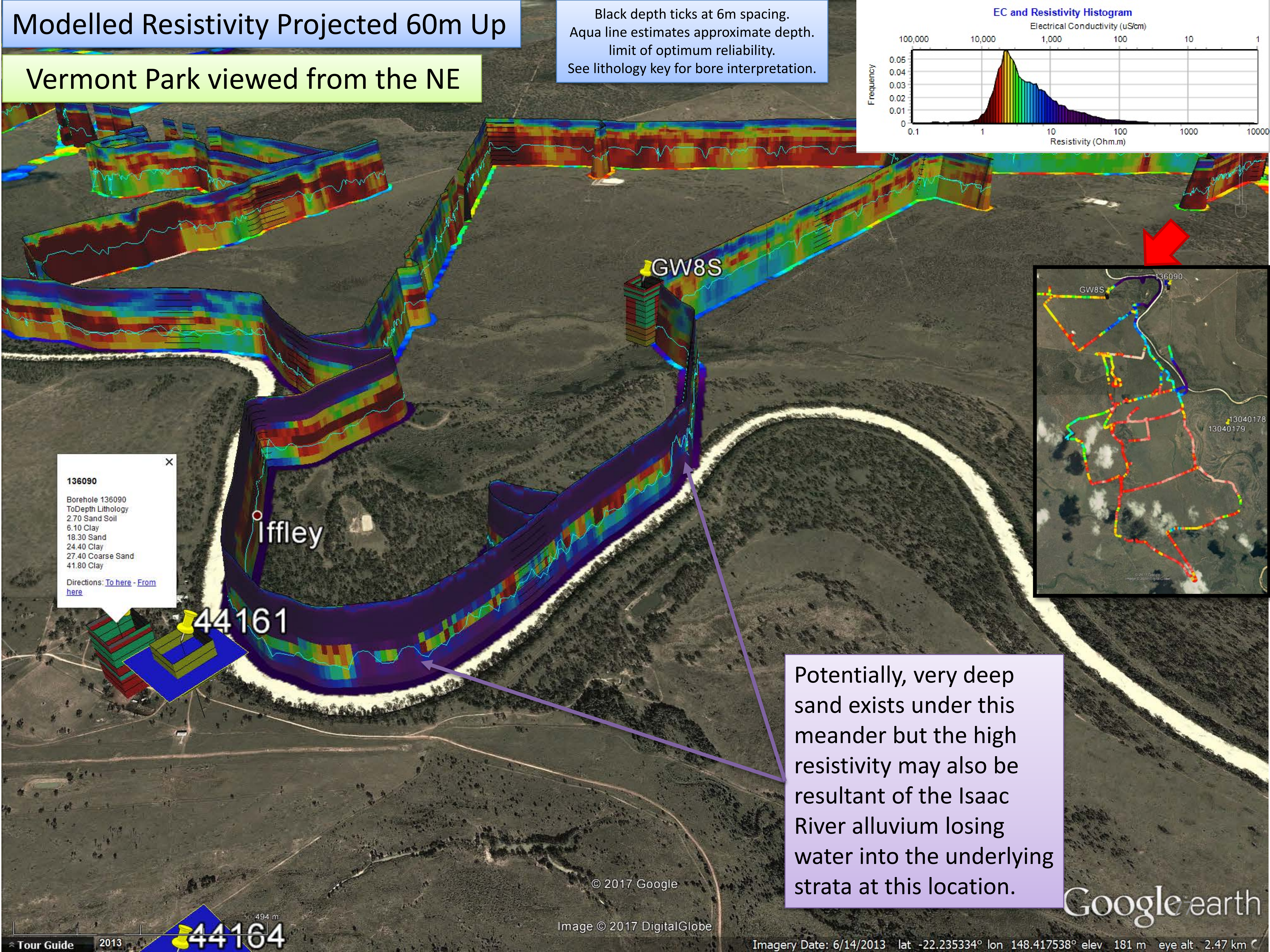


Suggested emergence of saline upflow at the surface
Inferred saline upflow in alluvium
136090
GW8S
13040178
13040179
Modelled Resistivity Projected 60m Up
Vermont Park viewed from the north
Suggested base of alluvium
EC and Resistivity Histogram
Electrical Conductivity (uS/m)
Frequency
Resistivity (Ohm.m)
228 m
Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.
Google earth



Modelled Resistivity Projected 60m Up
Vermont Park viewed from the NE
Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.
EC and Resistivity Histogram
Electrical Conductivity (uS/cm)
100,000
10,000
1,000
100
10
1
Frequency
0.05
0.04
0.03
0.02
0.01
0
0.1
1
10
100
1000
10000
Resistivity (Ohm.m)
Anomaly suggested to be partially resultant of fence interference
Inferred saline upflow and baseflow into the Isaac River
Deeper alluvium in close proximity of the Isaac River
GW8S
136090
13040178
13040179
353 m
© 2017 Google
Image Landsat / Copernicus
Image © 2017 DigitalGlobe
Google earth

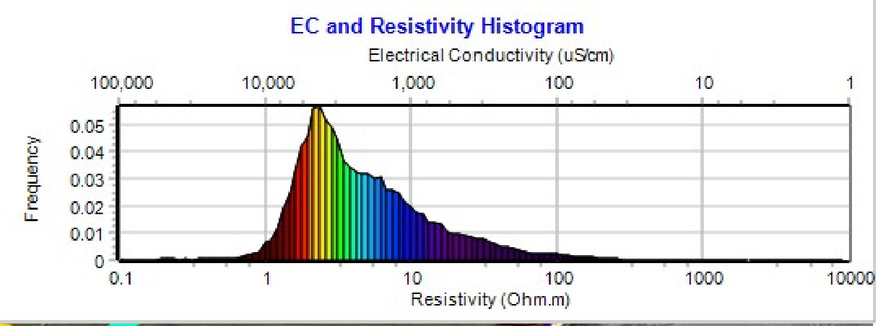

Modelled Resistivity Projected 60m Up
Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.
Vermont Park viewed from the NE
EC and Resistivity Histogram
Electrical Conductivity (uS/cm)
100,000
10,000
1,000
100
10
1
Frequency
0.05
0.04
0.03
0.02
0.01
0
0.1
1
10
100
1000
10000
Resistivity (Ohm.m)
Considerable pattern similarity exists between these two close lines
Anomaly suggested to be partially resultant of fence interference. Notice change where AgTEM drove away from the straight fence. Also notice that the strong conductor is centred over the creek (overwhelming the effect of the fence)!
GW8S
136090
13040178
13040179
© 2017 Google
Image © 2017 DigitalGlobe
282 m

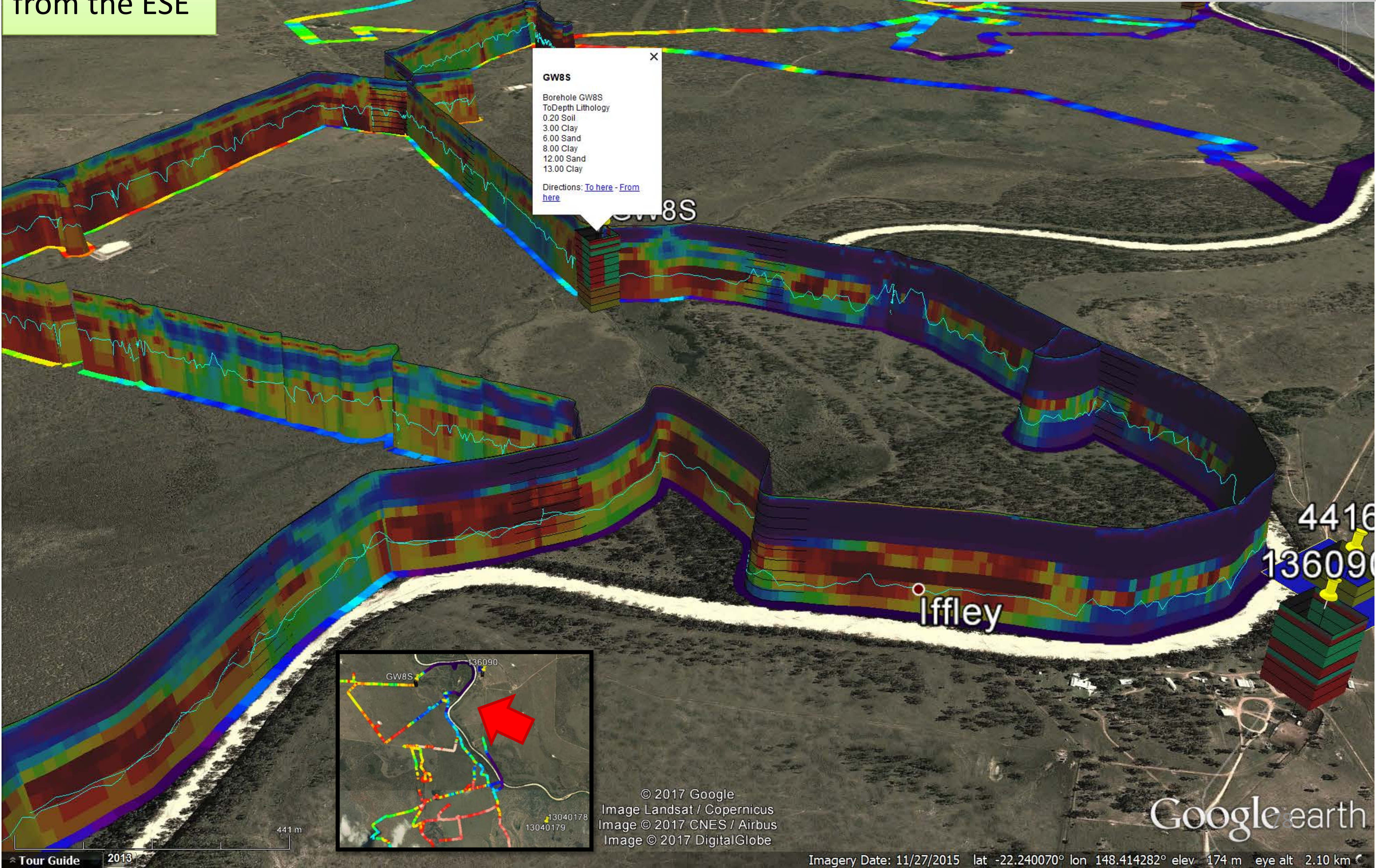

Modelled Resistivity Projected 60m Up
Vermont Park viewed from the NE
Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.
EC and Resistivity Histogram
Electrical Conductivity (uS/cm)
100,000
10,000
1,000
100
10
1
Frequency
0.05
0.04
0.03
0.02
0.01
0
0.1
1
10
100
1000
10000
Resistivity (Ohm.m)
GW8S
136090
13040178
13040179
136090
Borehole 136090
ToDepth Lithology
2.70 Sand Soil
6.10 Clay
18.30 Sand
24.40 Clay
27.40 Coarse Sand
41.80 Clay
Directions: To here - From here
Iffley
44161
44164
Potentially, very deep sand exists under this meander but the high resistivity may also be resultant of the Isaac River alluvium losing water into the underlying strata at this location.
© 2017 Google
Image © 2017 DigitalGlobe
Google earth
494 m
Tour Guide
2013
Imagery Date: 6/14/2013 lat -22.235334° lon 148.417538° elev 181 m eye alt 2.47 km

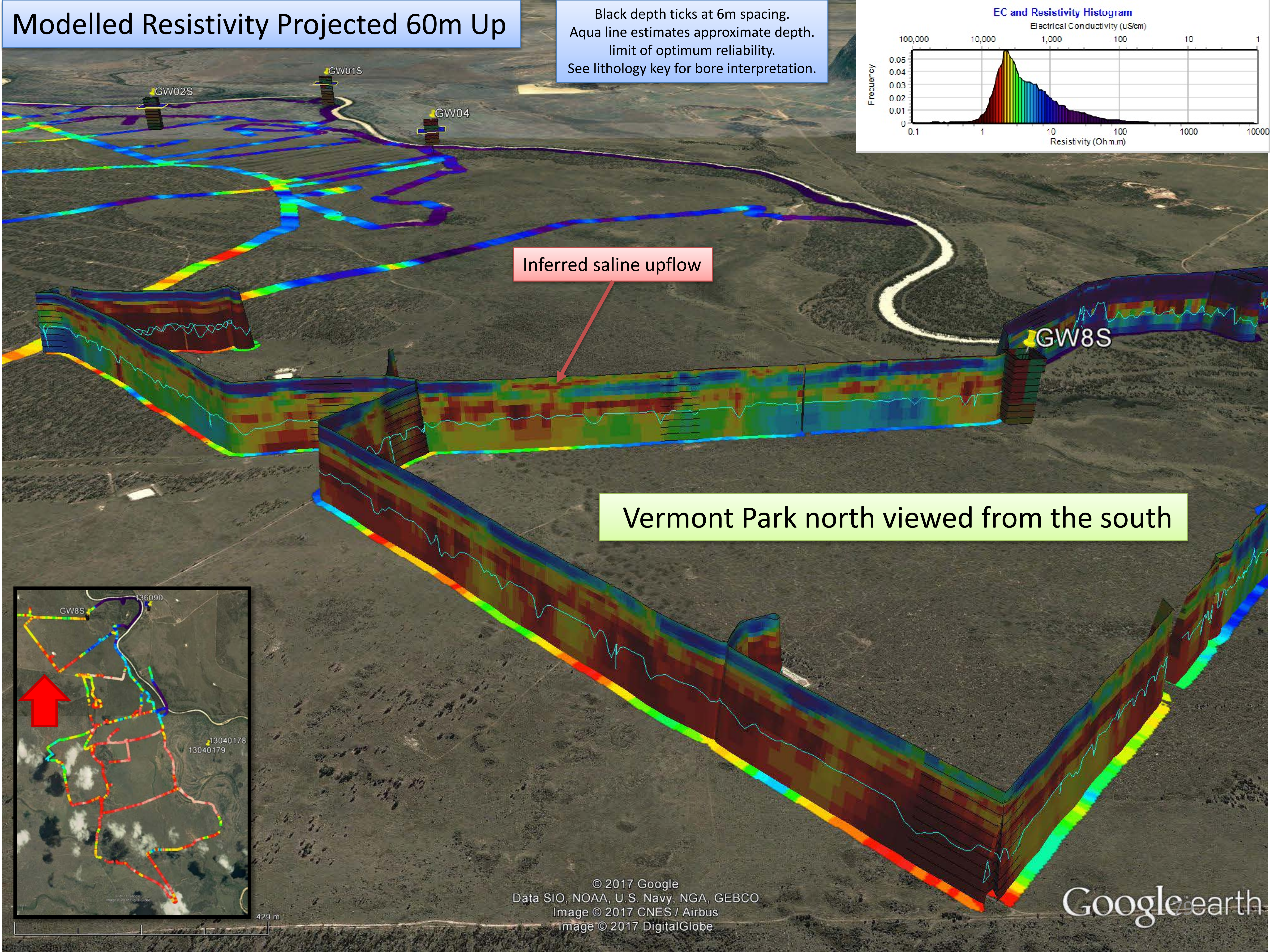
Modelled Resistivity Projected 60m Up

Vermont Park north viewed from the ESE

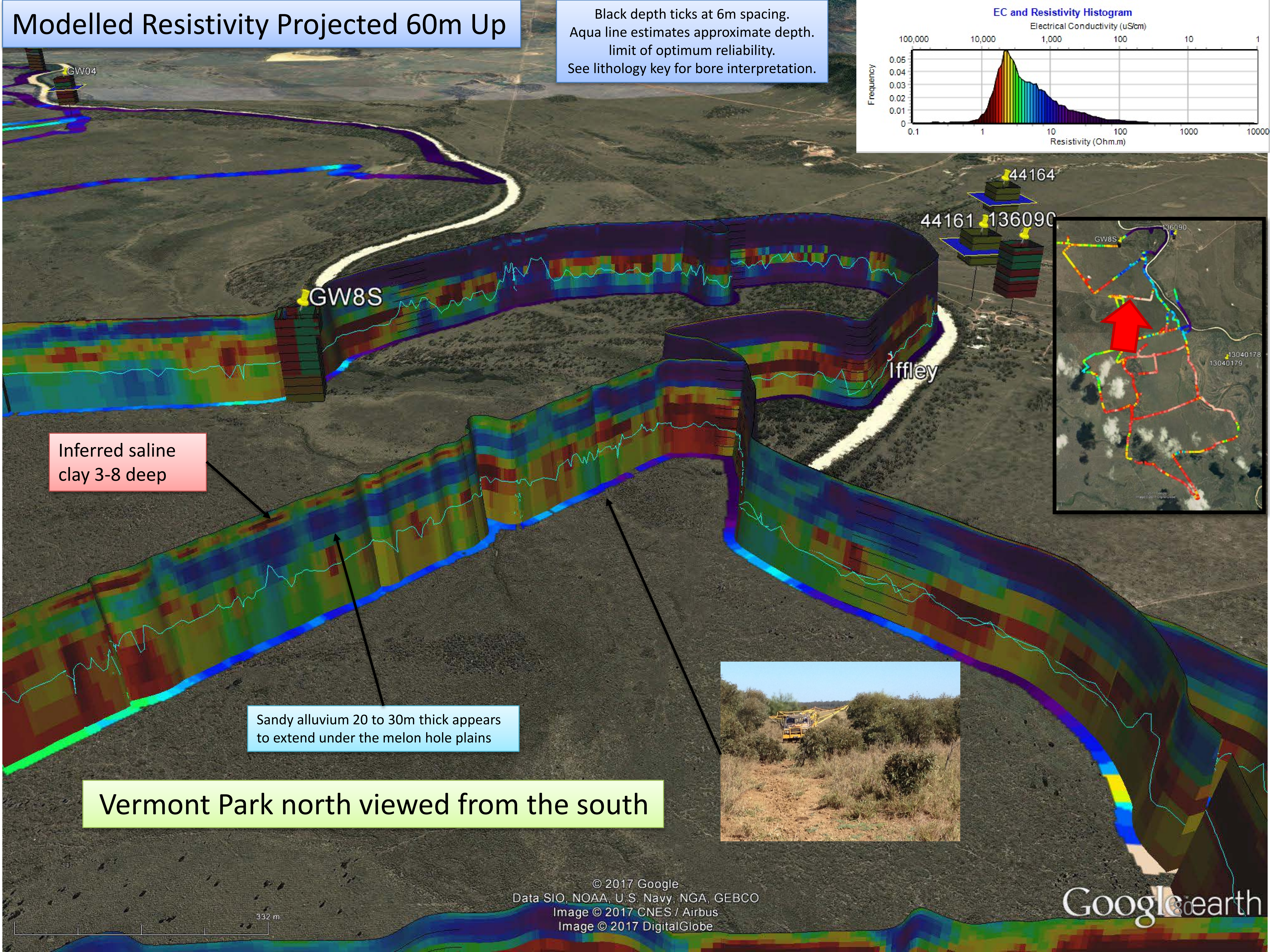
Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.





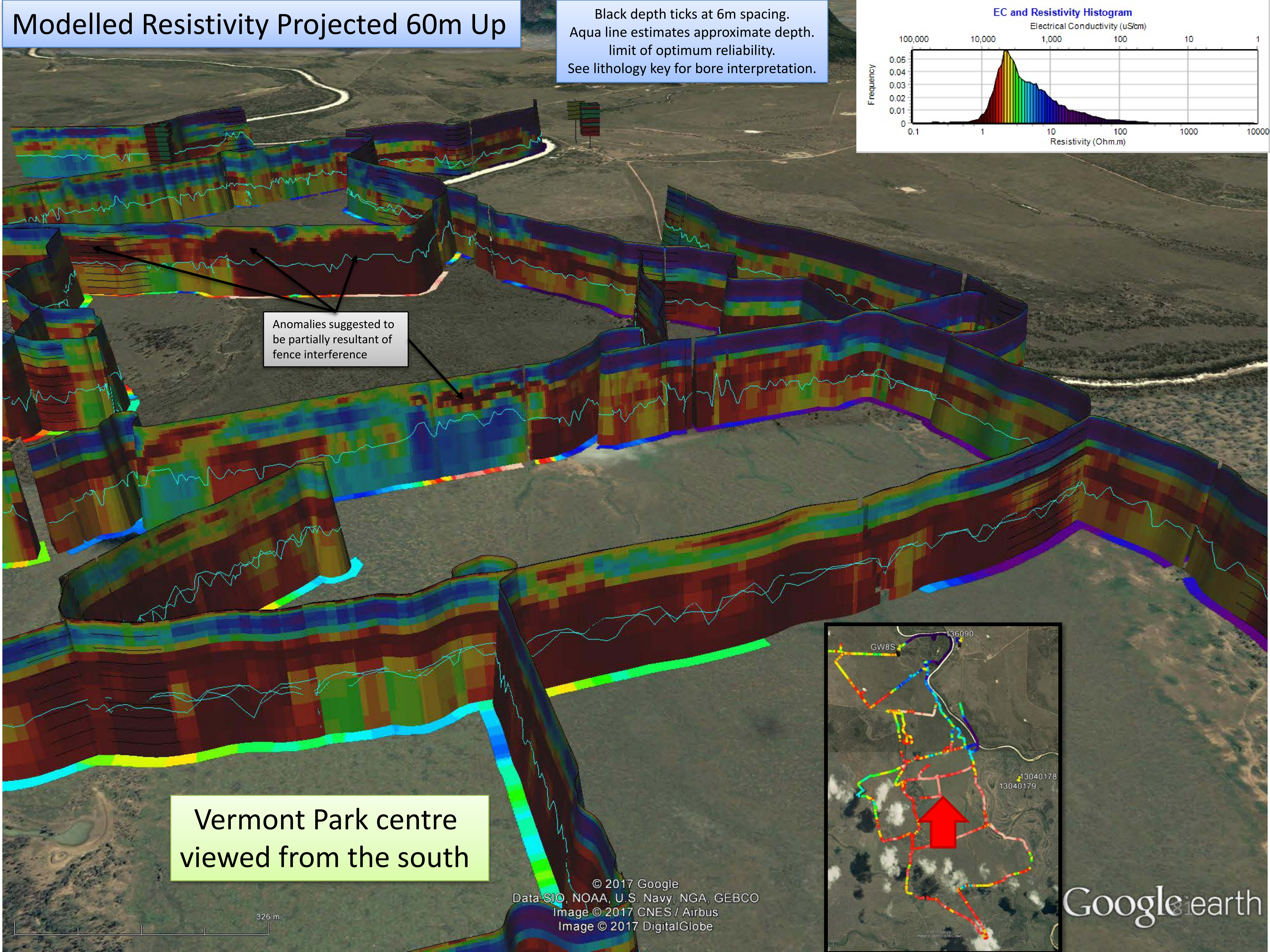


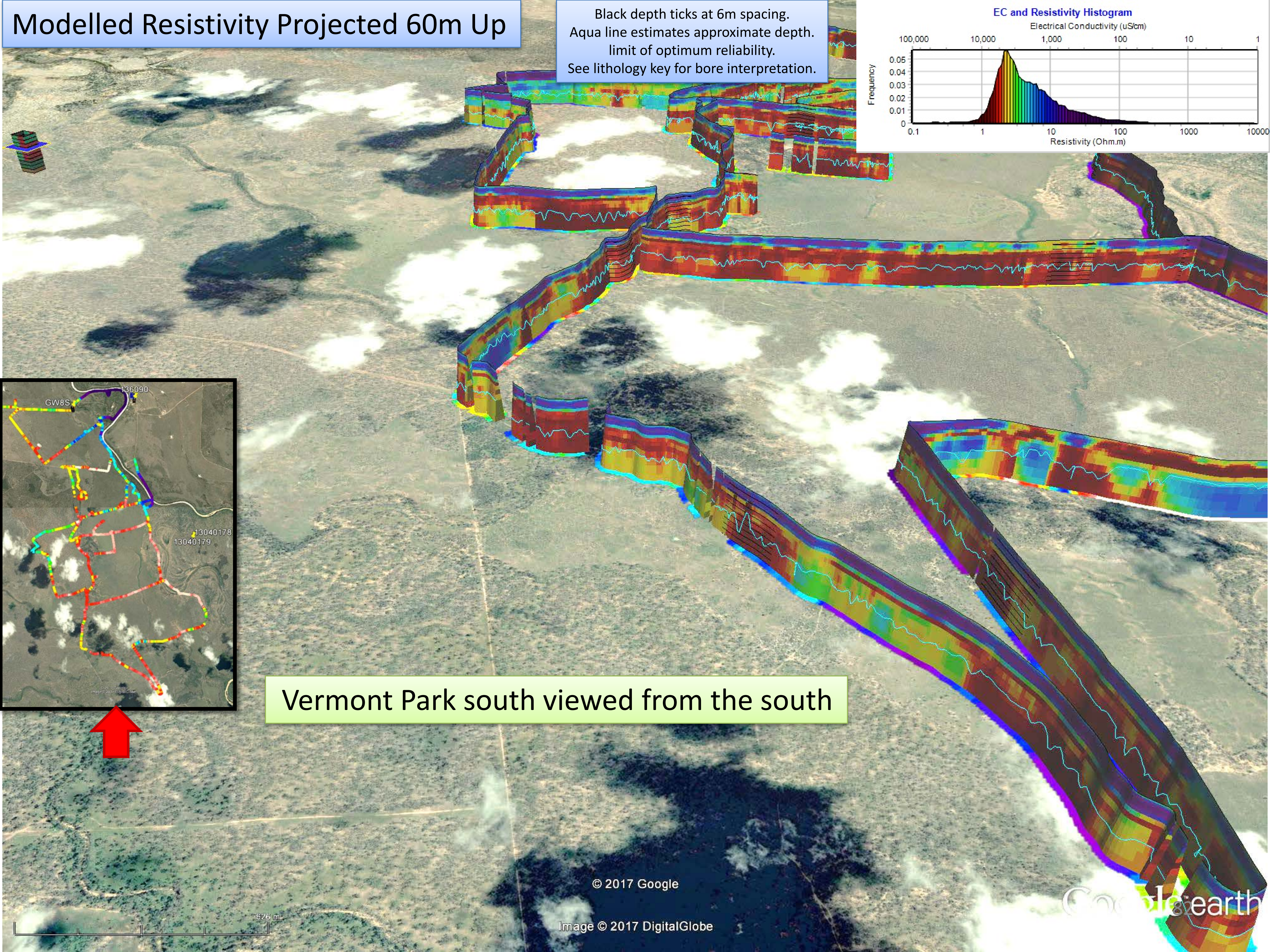
Modelled Resistivity Projected 60m Up
Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.
EC and Resistivity Histogram
Electrical Conductivity (uS/cm)
100,000
10,000
1,000
100
10
1
Frequency
0.05
0.04
0.03
0.02
0.01
0
0.1
1
10
100
1000
10000
Resistivity (Ohm.m)
GW02S
GW01S
GW04
Inferred saline upflow
GW8S
Vermont Park north viewed from the south
GW8S
136090
13040178
13040179
429 m
© 2017 Google
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2017 CNES / Airbus
Image © 2017 DigitalGlobe
Google earth



Modelled Resistivity Projected 60m Up
Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.
EC and Resistivity Histogram
Electrical Conductivity (uS/cm)
100,000 10,000 1,000 100 10 1
Frequency
0.05 0.04 0.03 0.02 0.01 0
0.1 1 10 100 1000 10000
Resistivity (Ohm.m)
GW04
GW8S
44164
44161
136090
Iffley
13040178
13040179
Inferred saline clay 3-8 deep
Sandy alluvium 20 to 30m thick appears to extend under the melon hole plains
Vermont Park north viewed from the south
332 m
© 2017 Google
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2017 CNES / Airbus
Image © 2017 DigitalGlobe
Google earth

Modelled Resistivity Projected 60m Up

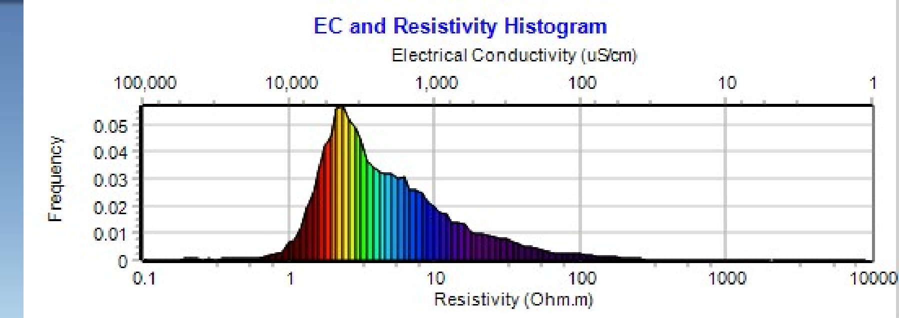


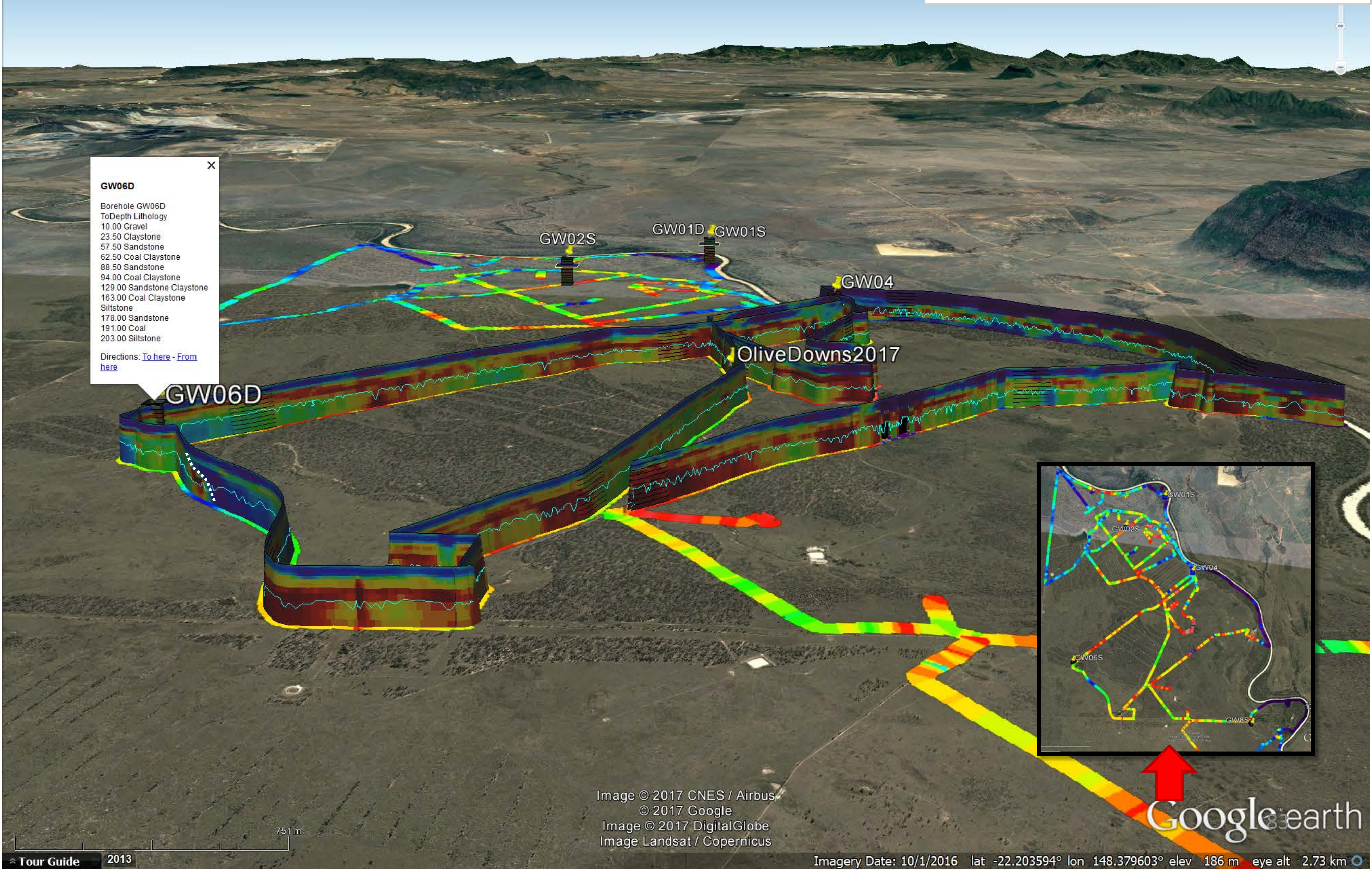

Modelled Resistivity Projected 60m Up
Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.
EC and Resistivity Histogram
Electrical Conductivity (uS/cm)
100,000
10,000
1,000
100
10
1
Frequency
0.05
0.04
0.03
0.02
0.01
0
0.1
1
10
100
1000
10000
Resistivity (Ohm.m)
GW8S
136090
13040178
13040179
626 m
Vermont Park south viewed from the south
© 2017 Google
Image © 2017 DigitalGlobe
Google earth

Modelled Resistivity Projected 60m Up

Iffley viewed from the south

Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.

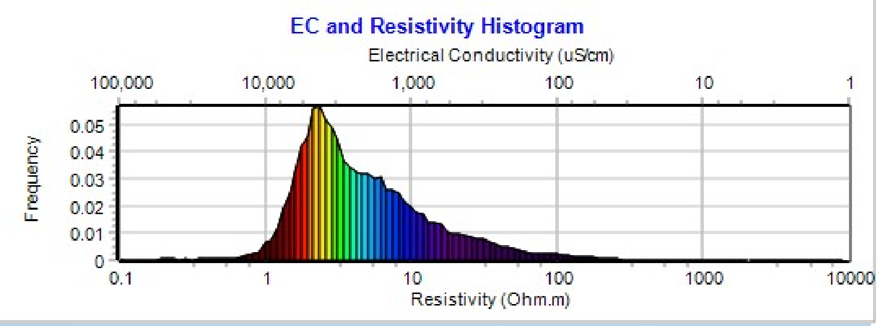


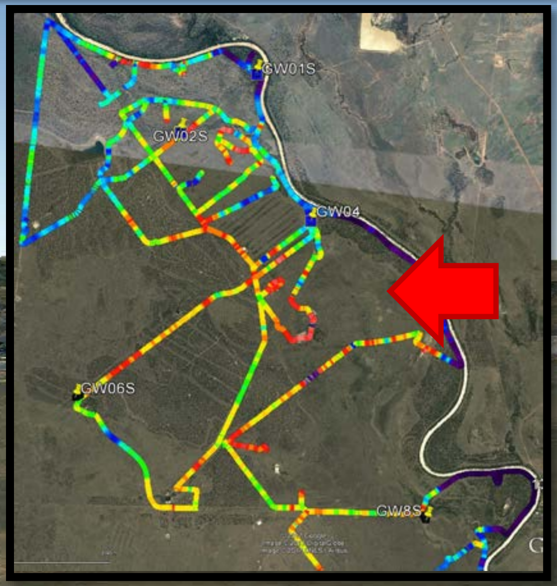


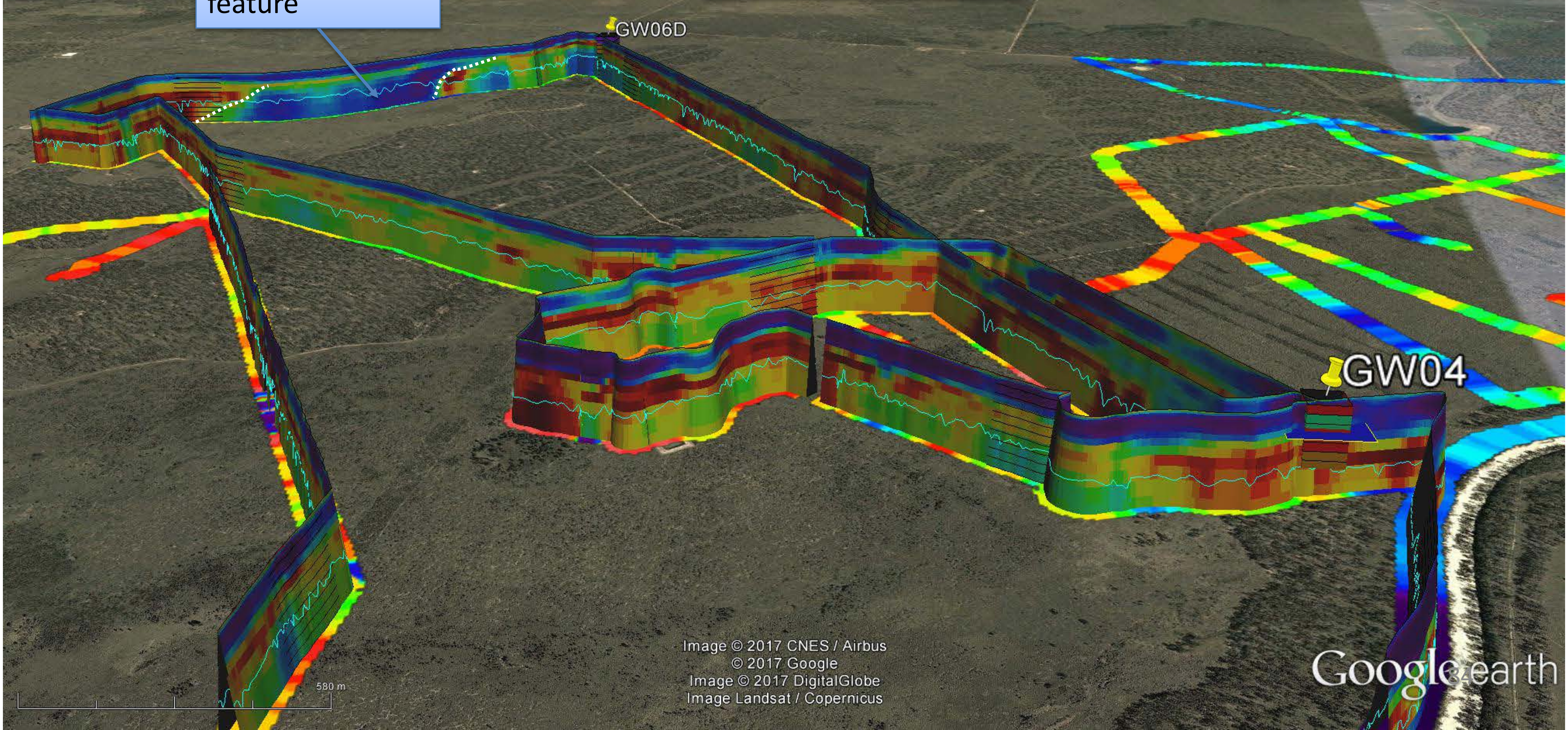
Modelled Resistivity Projected 60m Up

Iffley viewed from the east

Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.



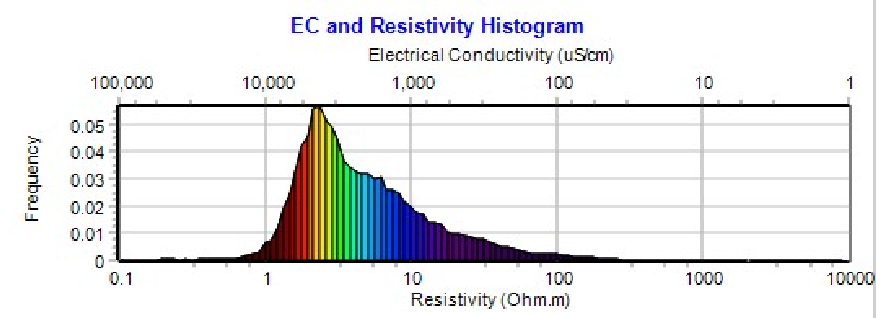


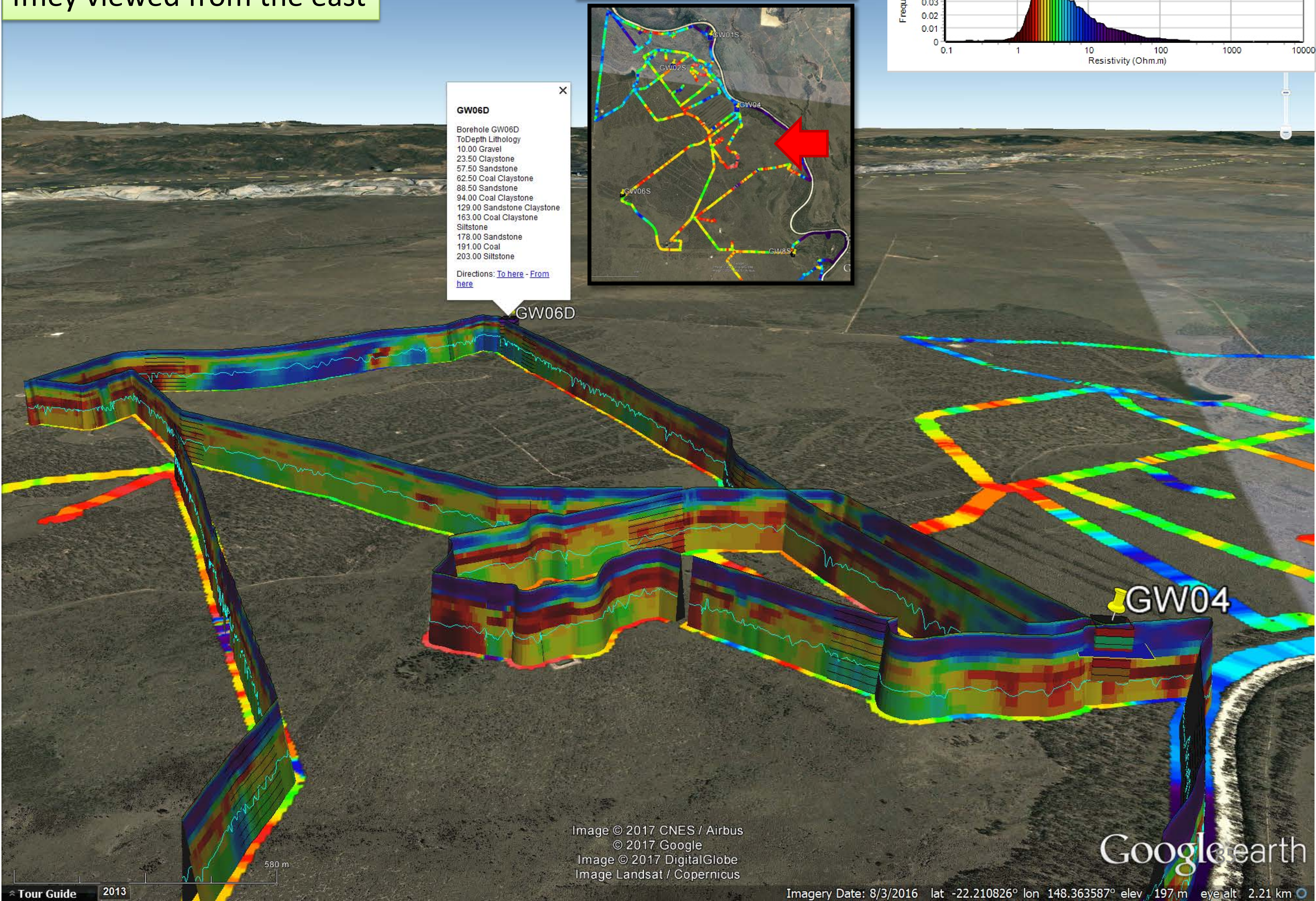


Modelled Resistivity Projected 60m Up

Iffley viewed from the east

Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.

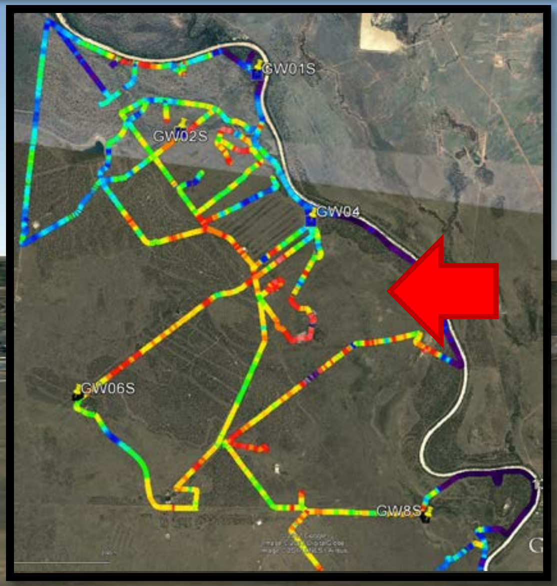


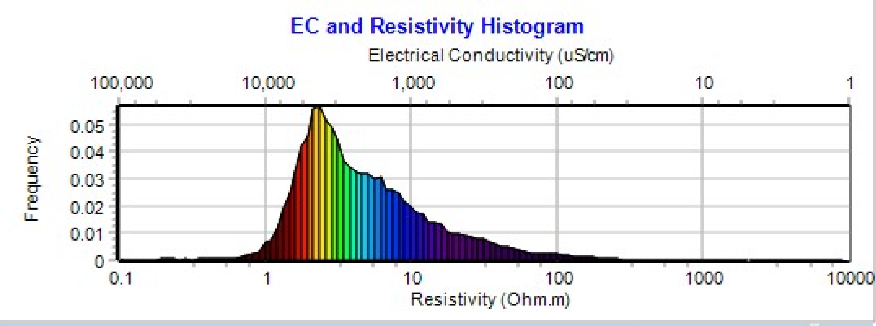


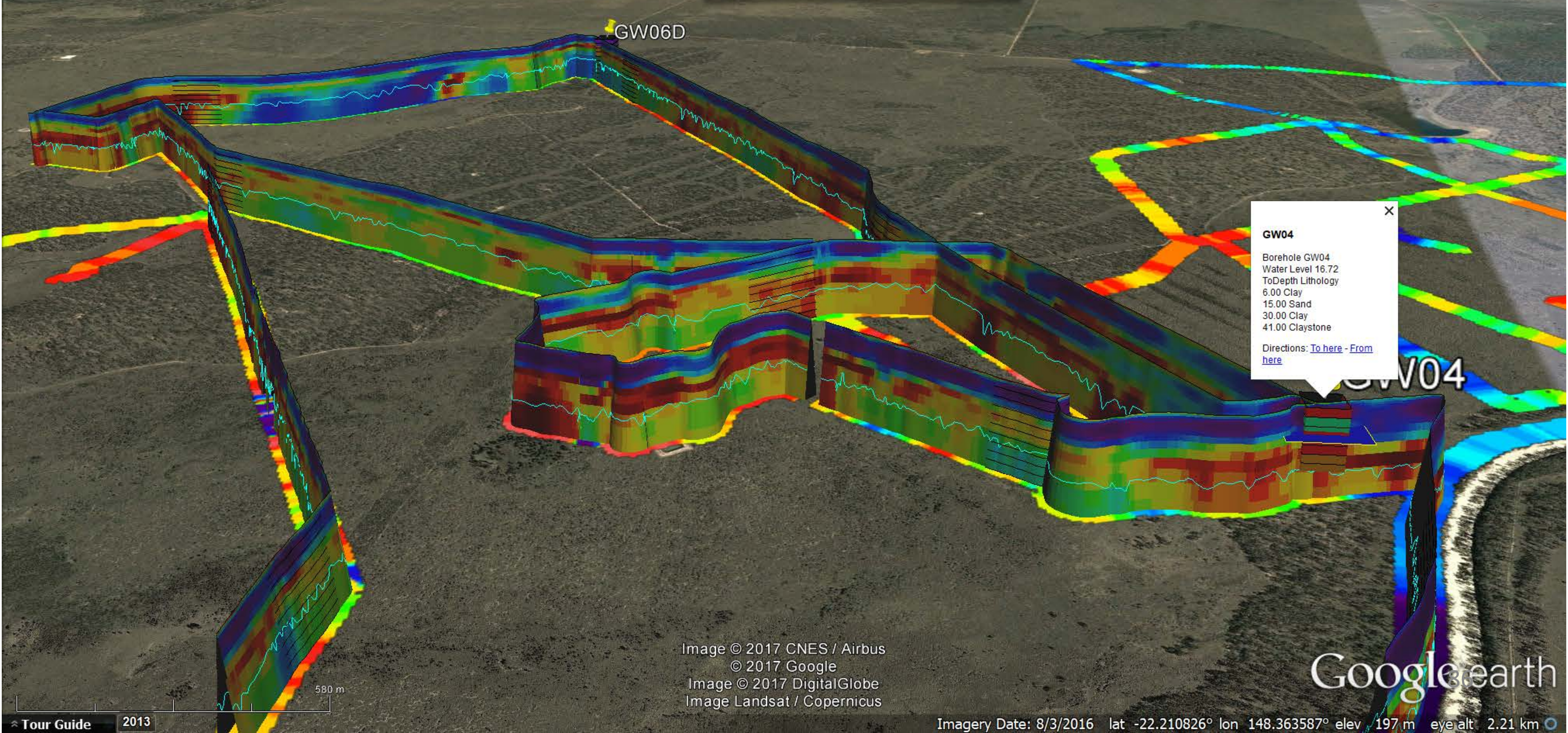
Modelled Resistivity Projected 60m Up

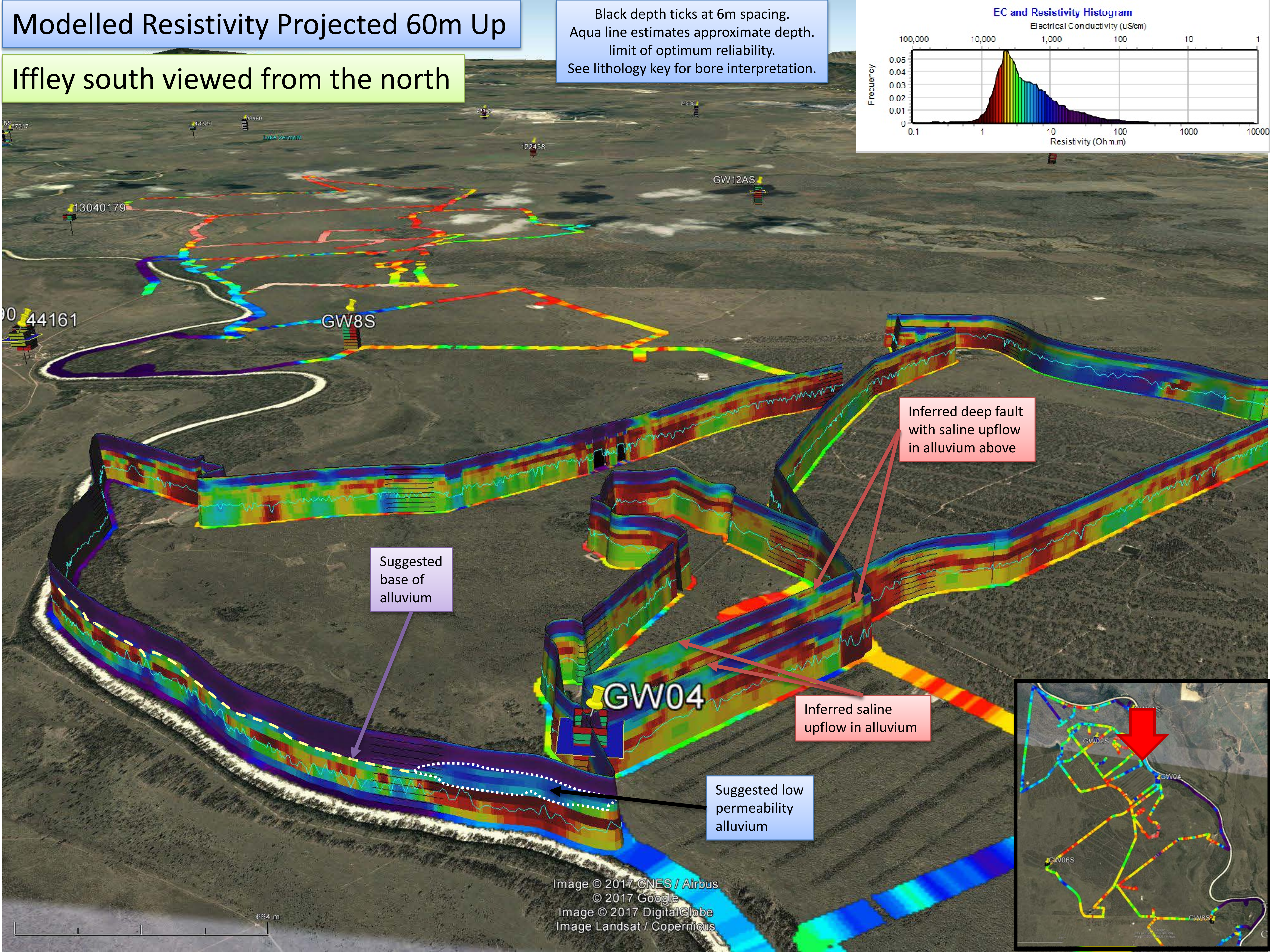
Iffley viewed from the east

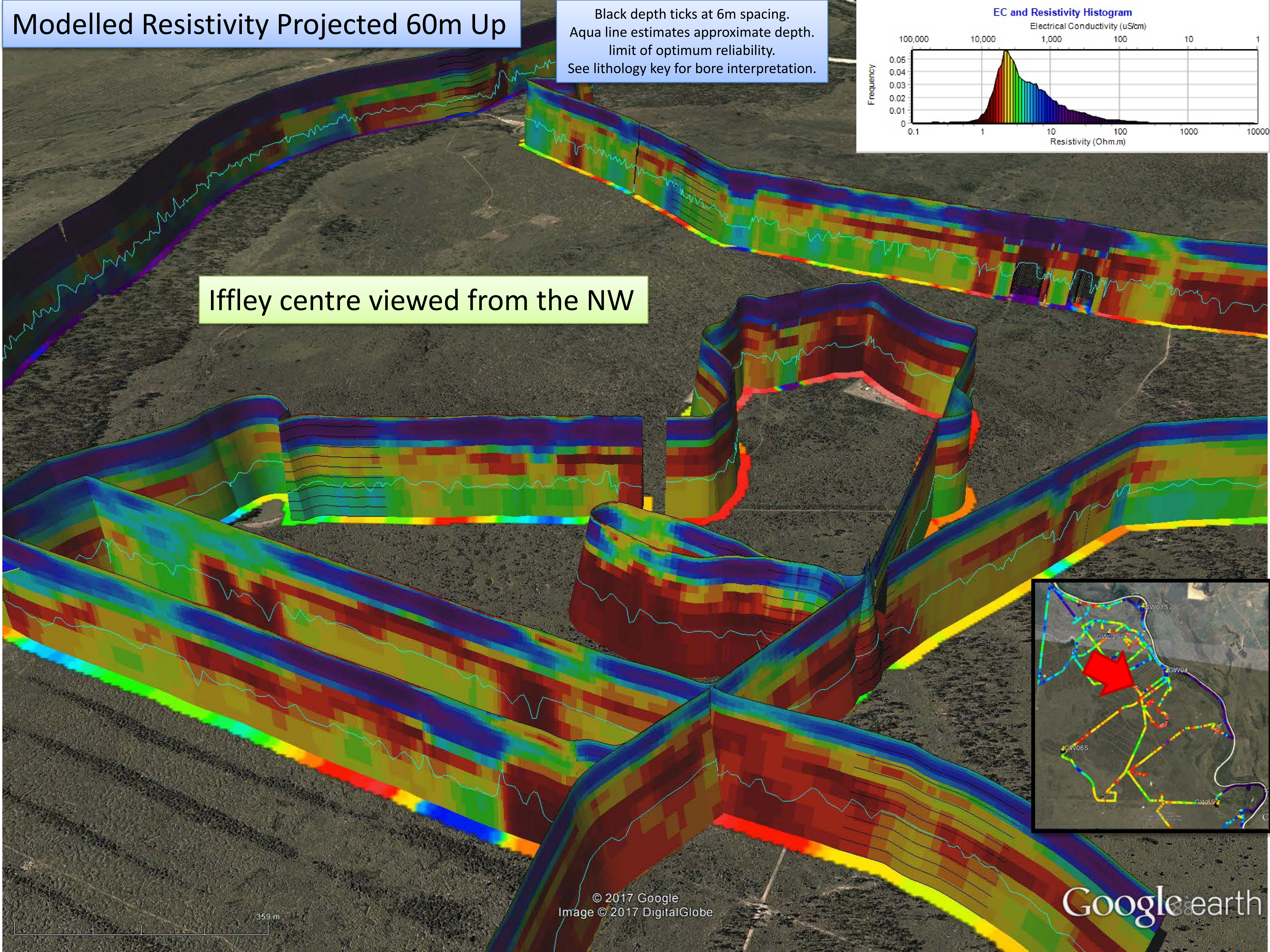
Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.



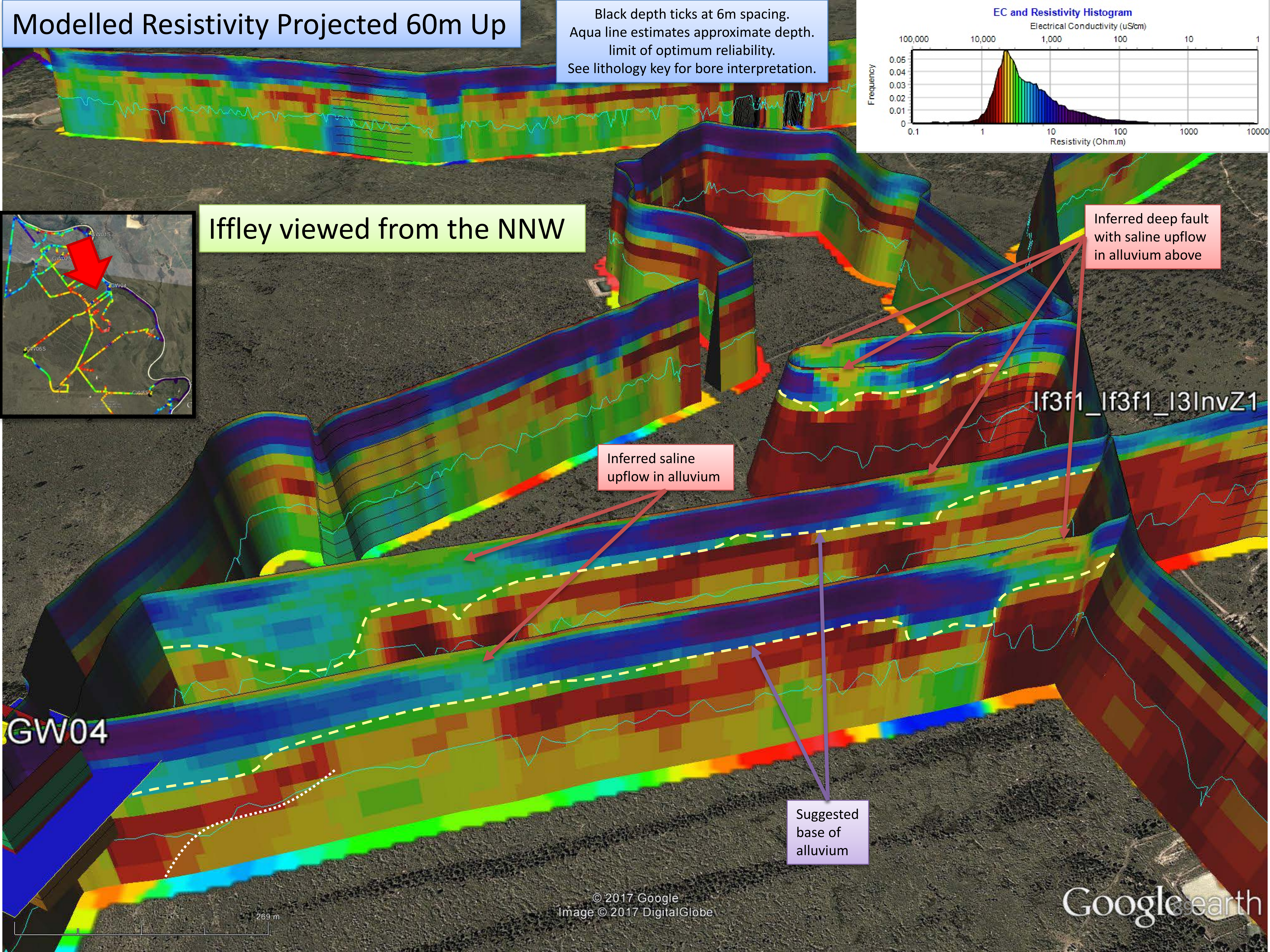


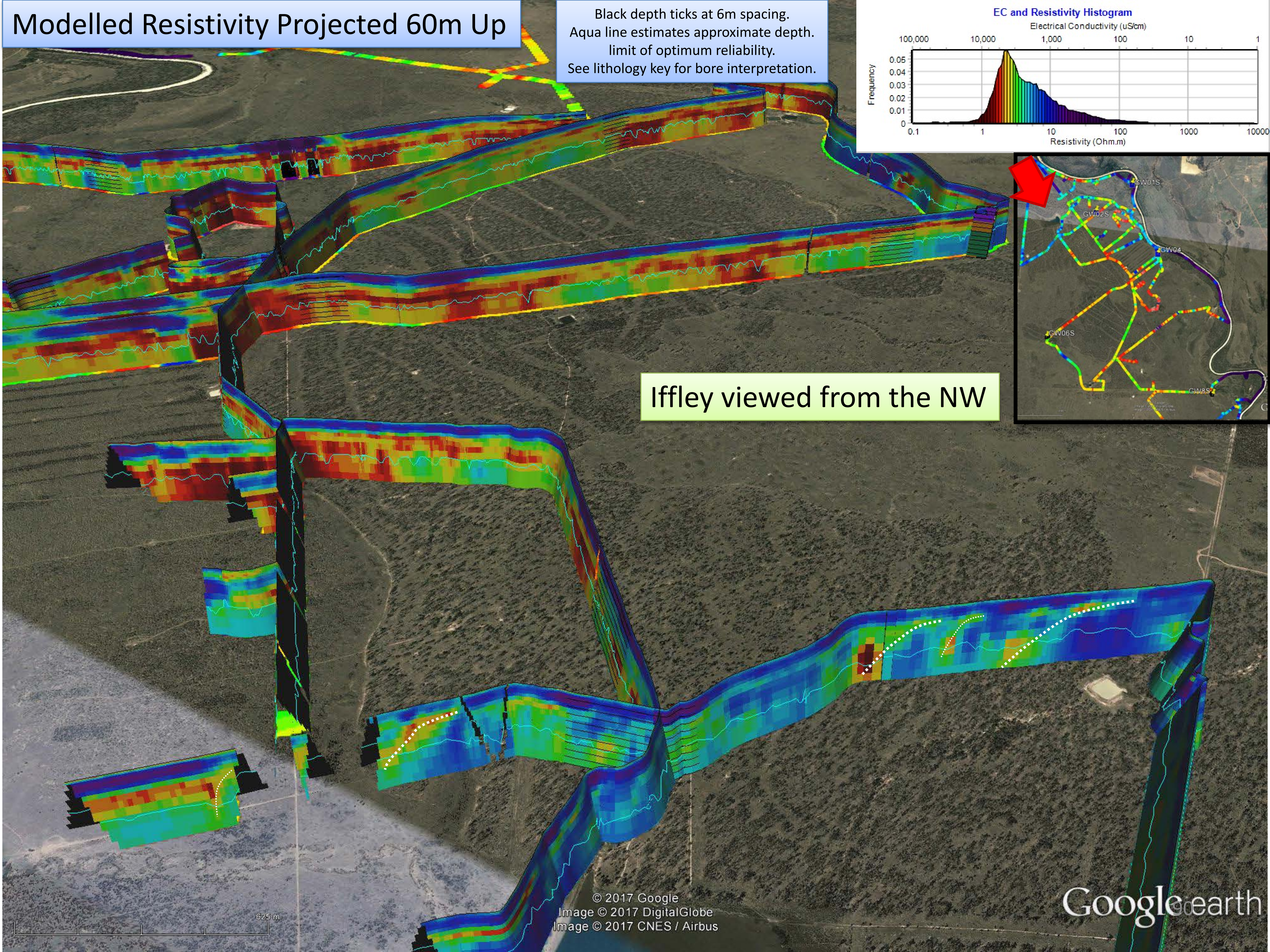



Modelled Resistivity Projected 60m Up
Iffley south viewed from the north
Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.
EC and Resistivity Histogram
Electrical Conductivity (uS/cm)
100,000
10,000
1,000
100
10
1
Frequency
0.05
0.04
0.03
0.02
0.01
0
0.1
1
10
100
1000
10000
Resistivity (Ohm.m)
122458
GW12AS
13040179
44161
GW8S
Inferred deep fault with saline upflow in alluvium above
Suggested base of alluvium
GW04
Inferred saline upflow in alluvium
Suggested low permeability alluvium
Image © 2017 CNES / Airbus
© 2017 Google
Image © 2017 DigitalGlobe
Image Landsat / Copernicus
664 m
GW02S
GW04
GW06S
GW8S

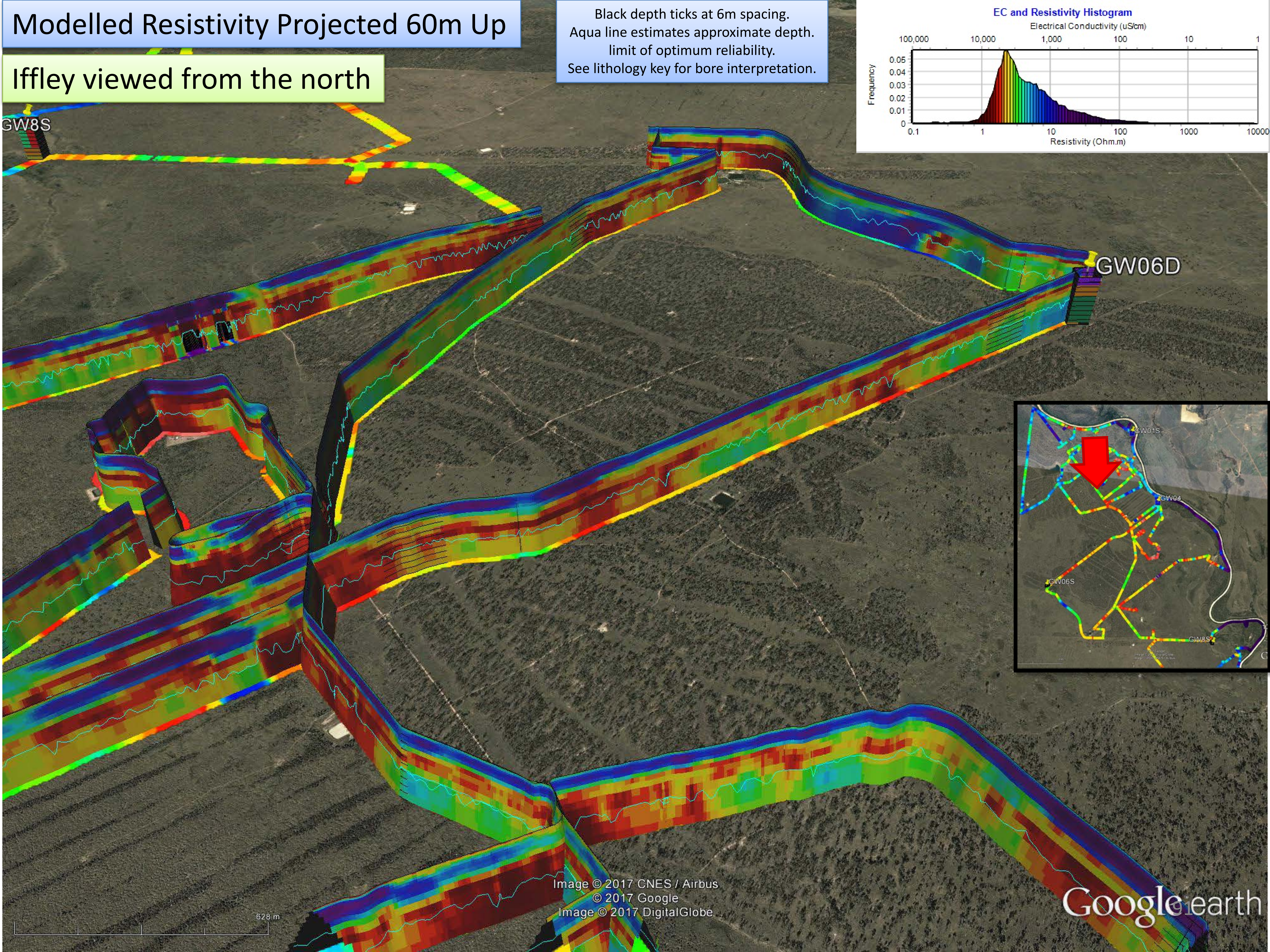


Modelled Resistivity Projected 60m Up
Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.
EC and Resistivity Histogram
Electrical Conductivity (uS/cm)
100,000
10,000
1,000
100
10
1
Frequency
0.05
0.04
0.03
0.02
0.01
0
0.1
1
10
100
1000
10000
Resistivity (Ohm.m)
Iffley centre viewed from the NW
SW01S
GW02S
SW04
GW06S
GW8S
© 2017 Google
Image © 2017 DigitalGlobe
359 m
Google earth


Modelled Resistivity Projected 60m Up
Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.
EC and Resistivity Histogram
Electrical Conductivity (uS/cm)
100,000
10,000
1,000
100
10
1
Frequency
0.05
0.04
0.03
0.02
0.01
0
0.1
1
10
100
1000
10000
Resistivity (Ohm.m)
Iffley viewed from the NNW
Inferred deep fault with saline upflow in alluvium above
If3f1_If3f1_I3InvZ1
Inferred saline upflow in alluvium
GW04
Suggested base of alluvium
269 m
© 2017 Google
Image © 2017 DigitalGlobe
Google earth



Modelled Resistivity Projected 60m Up
Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.
EC and Resistivity Histogram
Electrical Conductivity (uS/cm)
100,000
10,000
1,000
100
10
1
Frequency
0.05
0.04
0.03
0.02
0.01
0
0.1
1
10
100
1000
10000
Resistivity (Ohm.m)
GW01S
GW02S
GW04
GW06S
GW8S
Iffley viewed from the NW
625 m
© 2017 Google
Image © 2017 DigitalGlobe
Image © 2017 CNES / Airbus
Google earth

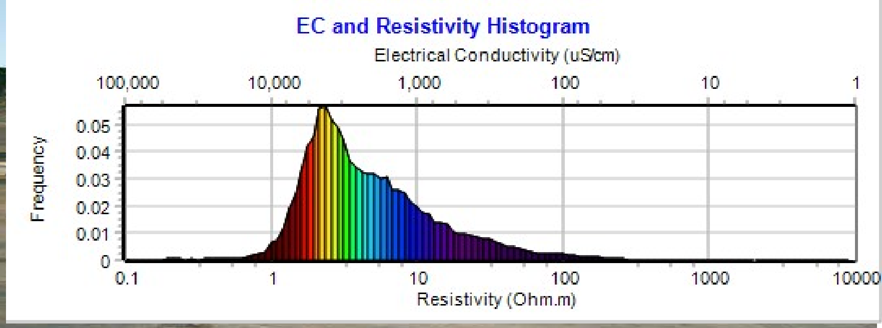


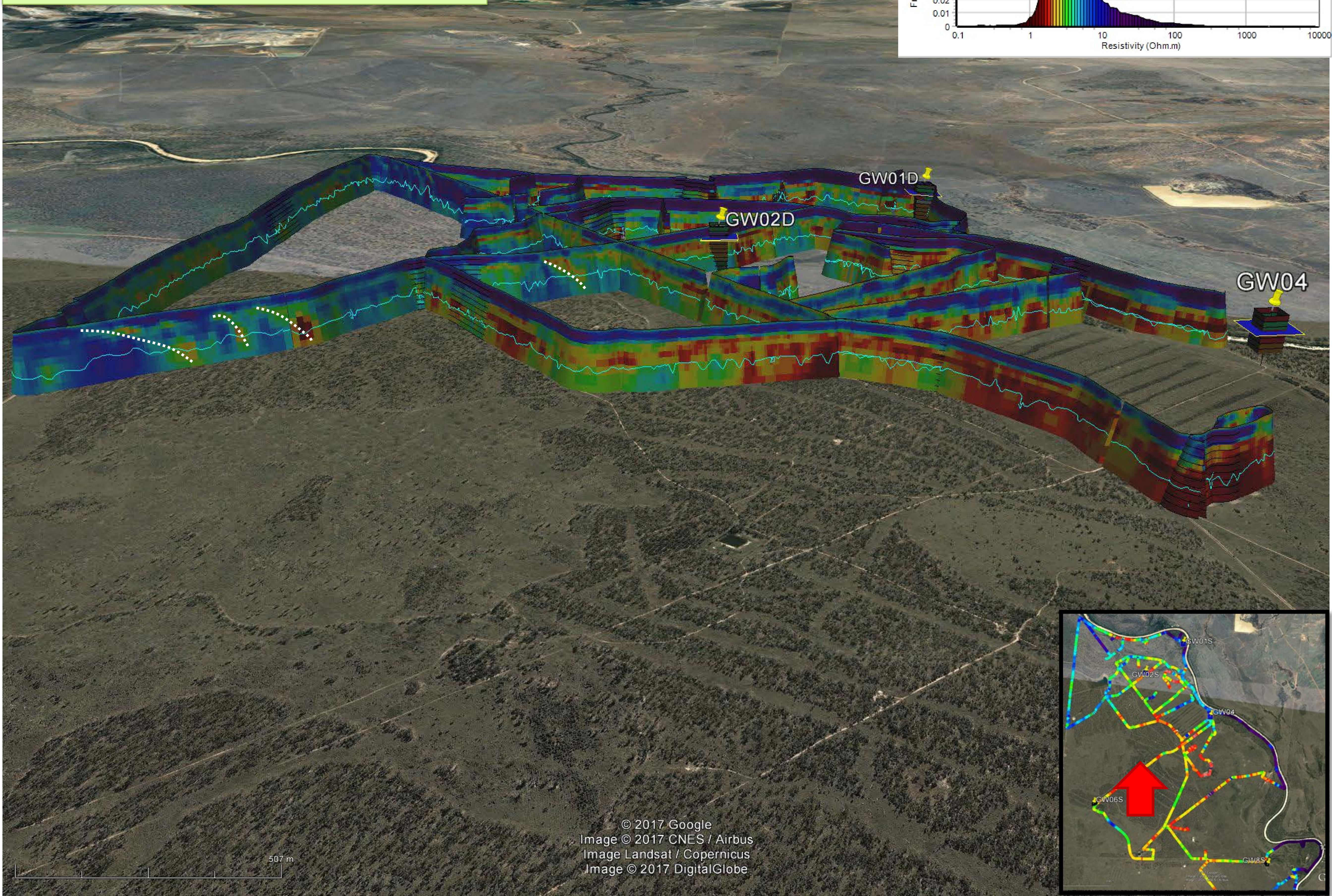
Modelled Resistivity Projected 60m Up
Iffley viewed from the north
Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.
EC and Resistivity Histogram
Electrical Conductivity (uS/cm)
100,000
10,000
1,000
100
10
1
Frequency
0.05
0.04
0.03
0.02
0.01
0
0.1
1
10
100
1000
10000
Resistivity (Ohm.m)
GW8S
GW06D
SW01S
GW04
GW06S
GW8S
628 m
Image © 2017 CNES / Airbus
© 2017 Google
Image © 2017 DigitalGlobe
Google earth

Modelled Resistivity Projected 60m Up

Iffley north viewed from the south

Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.

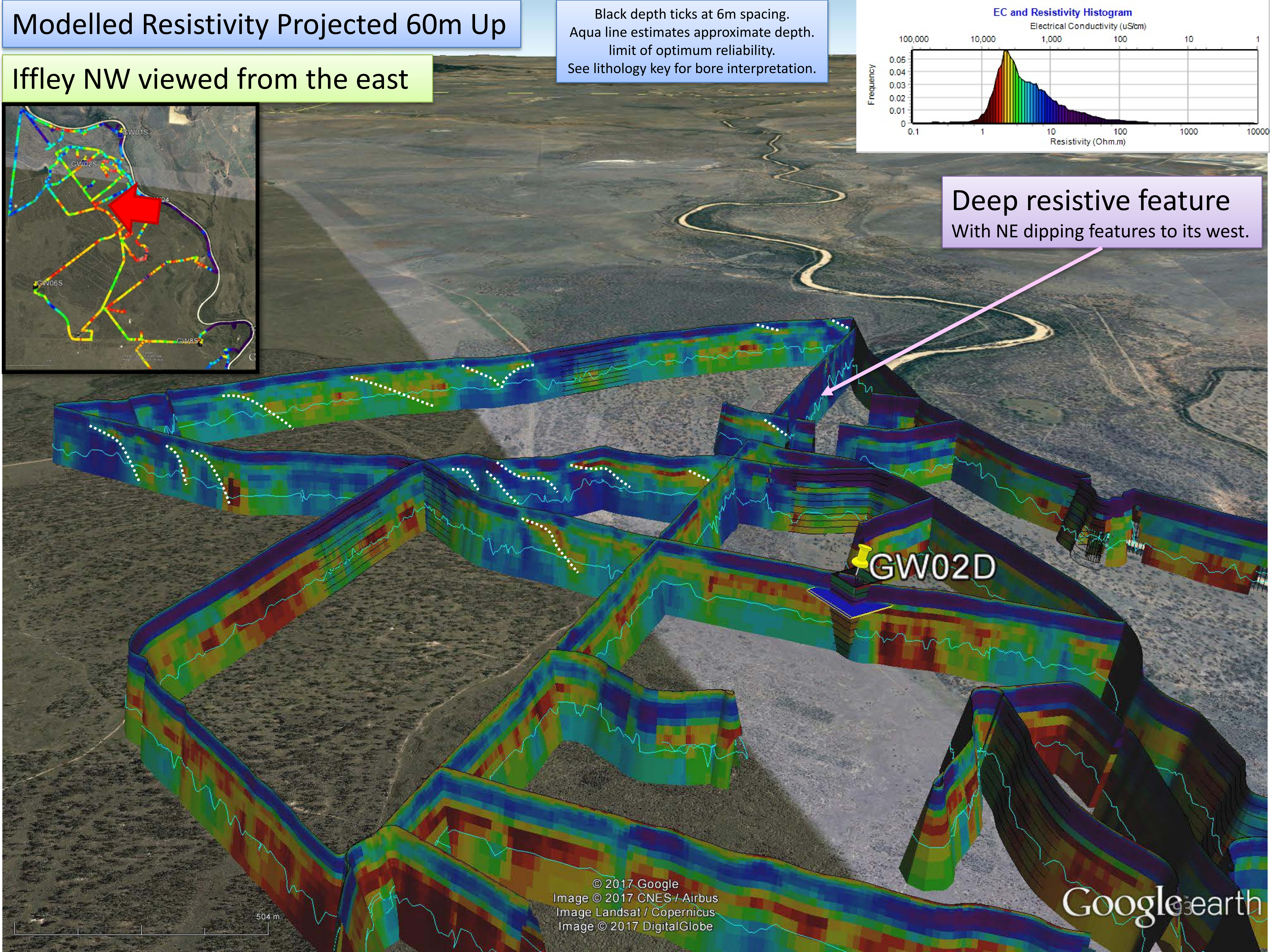




Modelled Resistivity Projected 60m Up

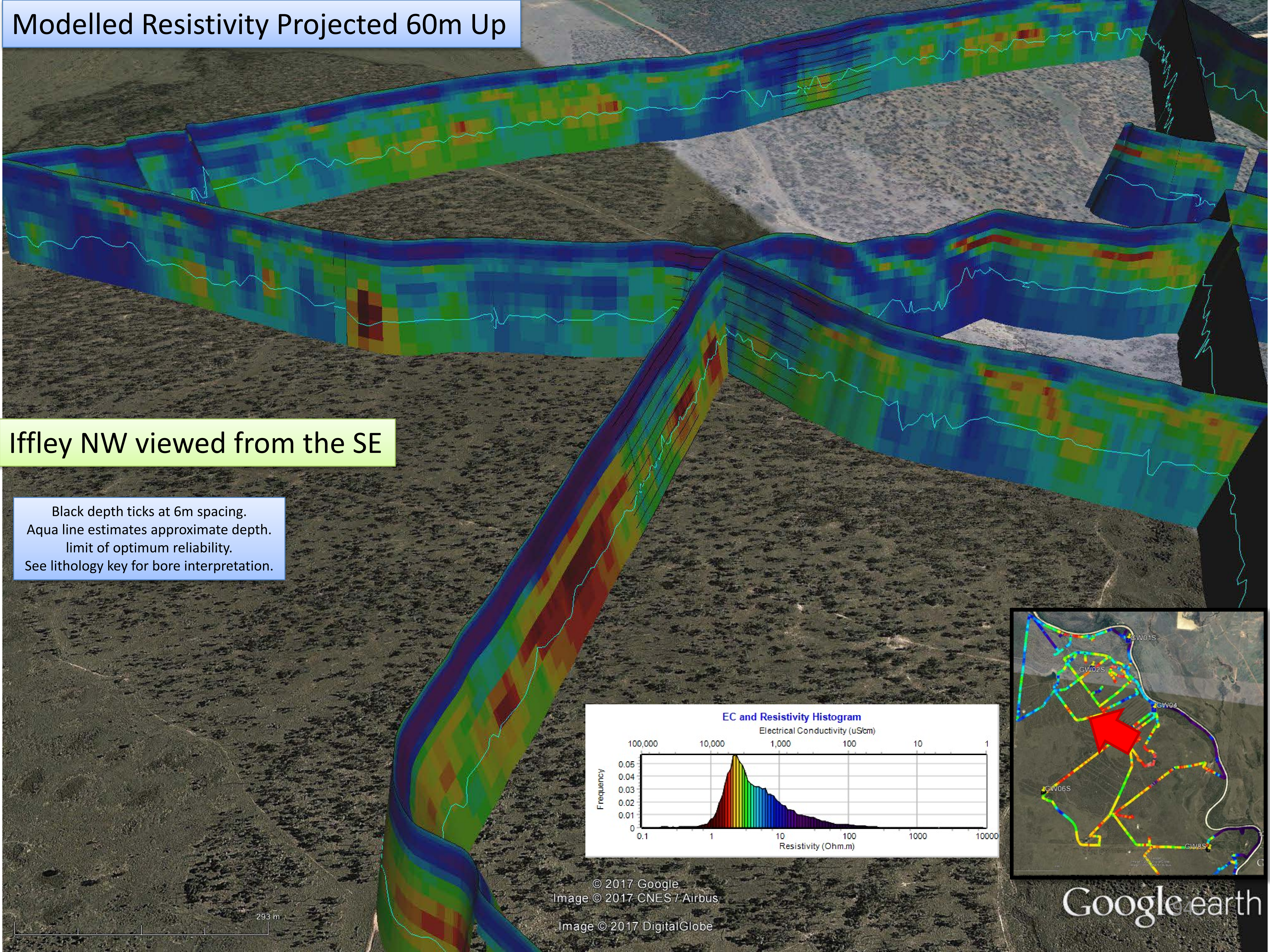
Iffley NW viewed from the east

Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.



Deep resistive feature

With NE dipping features to its west.

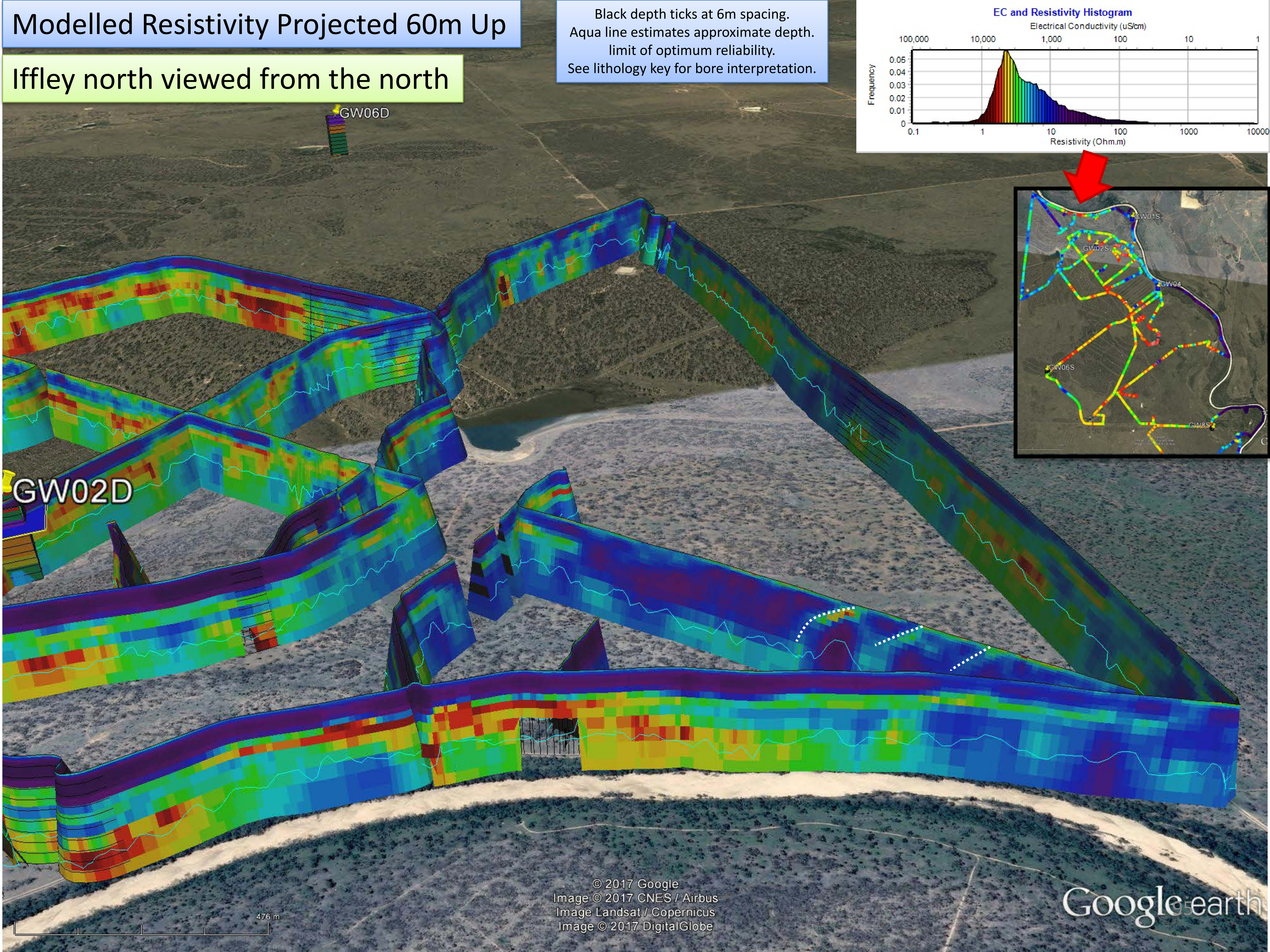


Modelled Resistivity Projected 60m Up
Iffley NW viewed from the SE
Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.
EC and Resistivity Histogram
Electrical Conductivity (uS/cm)
100,000 10,000 1,000 100 10 1
Frequency
0.05 0.04 0.03 0.02 0.01 0
0.1 1 10 100 1000 10000
Resistivity (Ohm.m)
GW01S
GW02S
GW04
GW06S
GW8S
© 2017 Google
Image © 2017 CNES / Airbus
Image © 2017 DigitalGlobe
293 m
Google earth

Modelled Resistivity Projected 60m Up

Iffley north viewed from the north

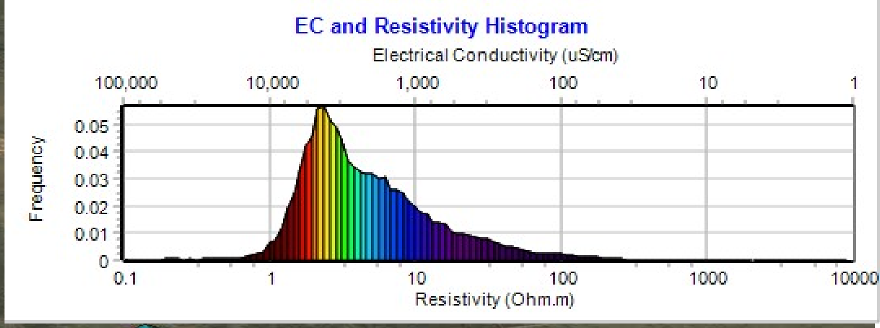
Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.

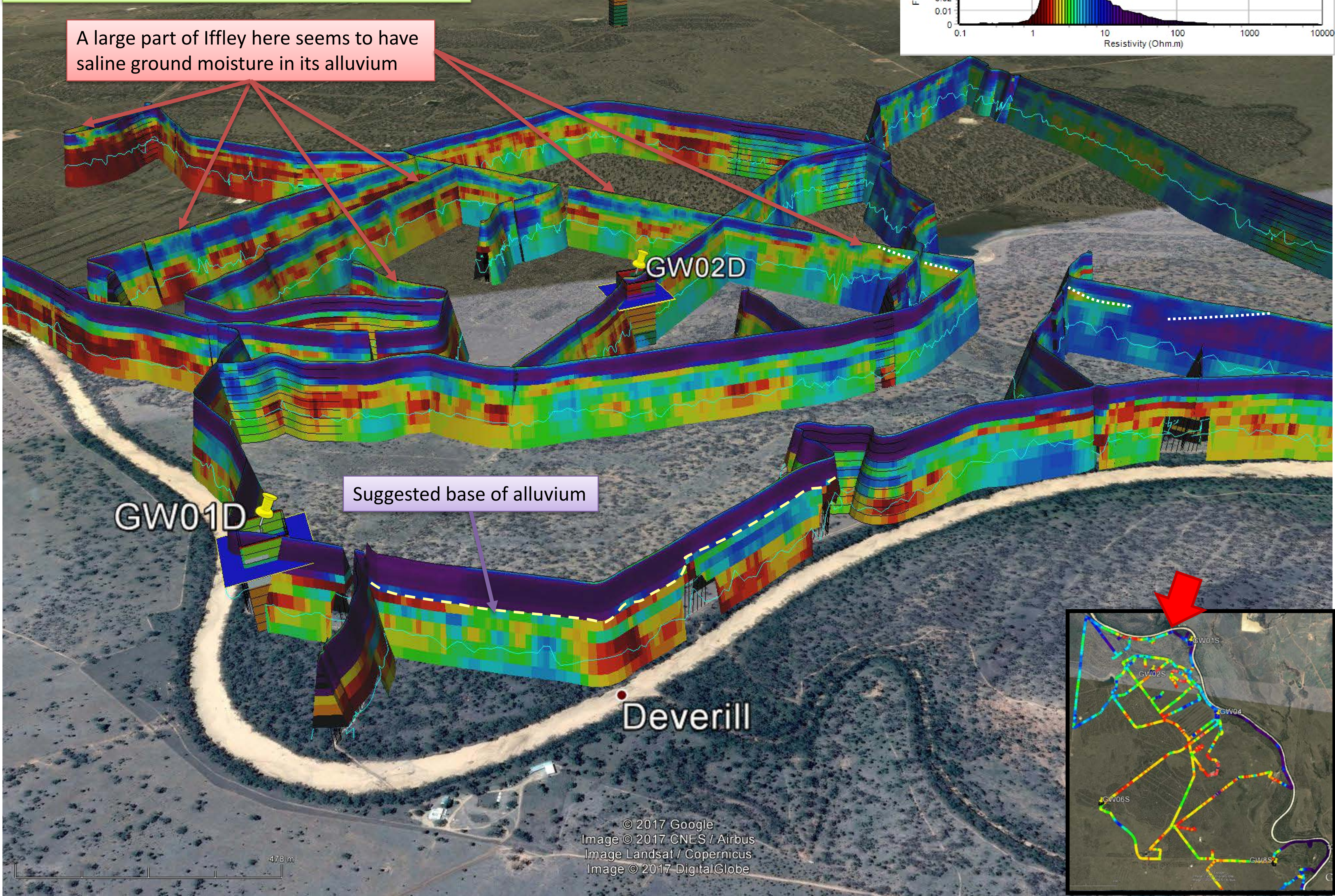


Modelled Resistivity Projected 60m Up

Iffley north viewed from the NNE

Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.

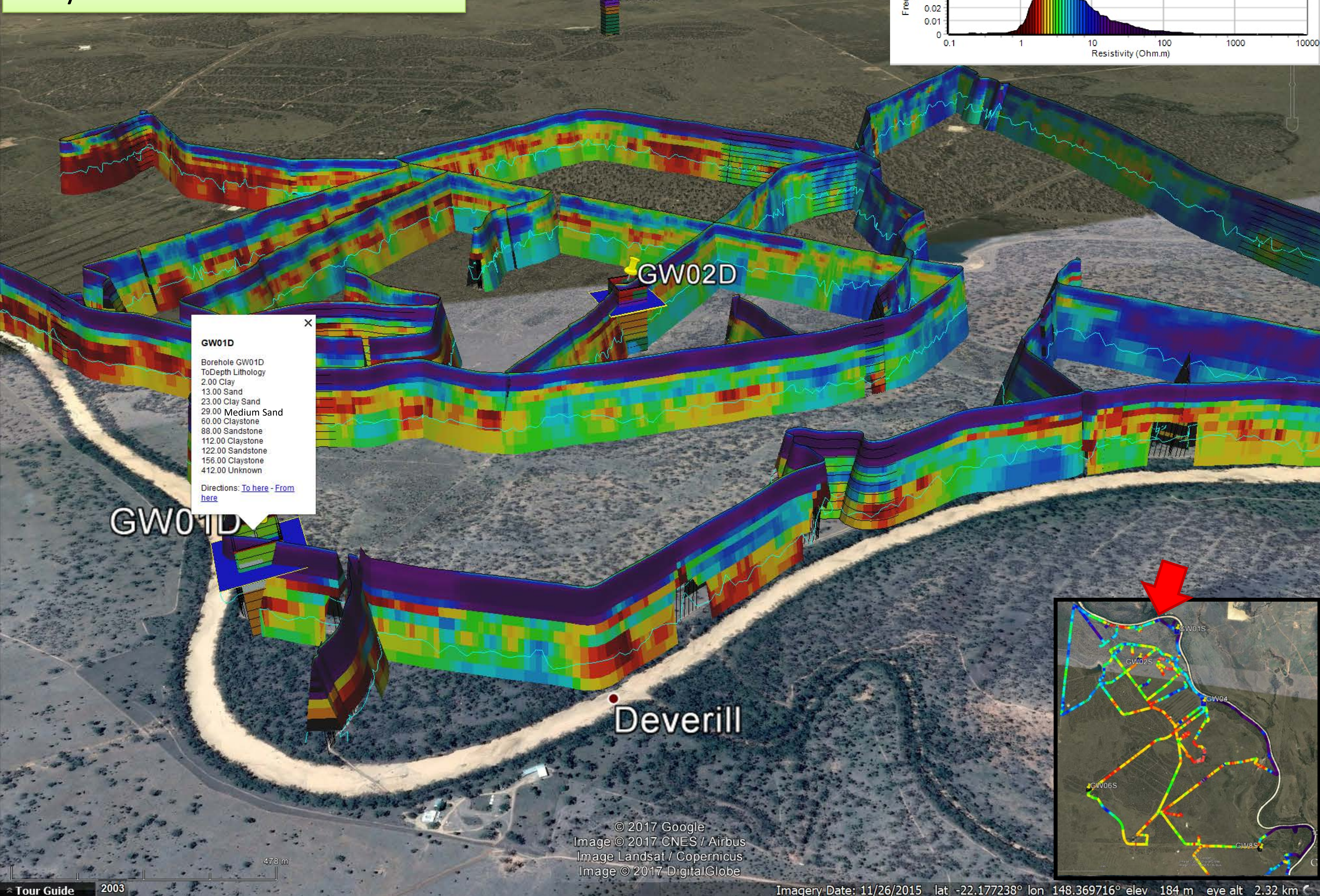


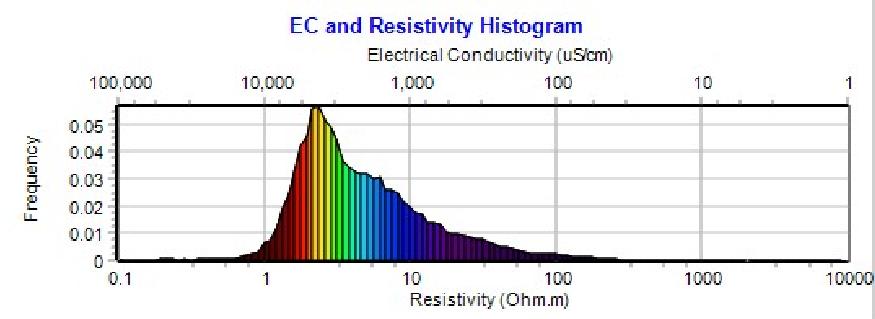


Modelled Resistivity Projected 60m Up

Iffley north viewed from the NNE

Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.

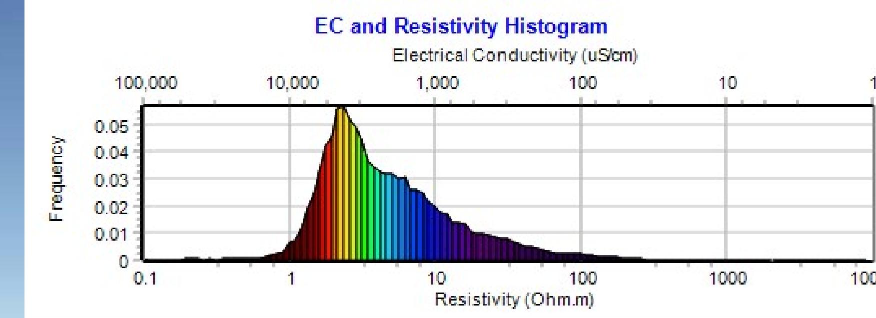


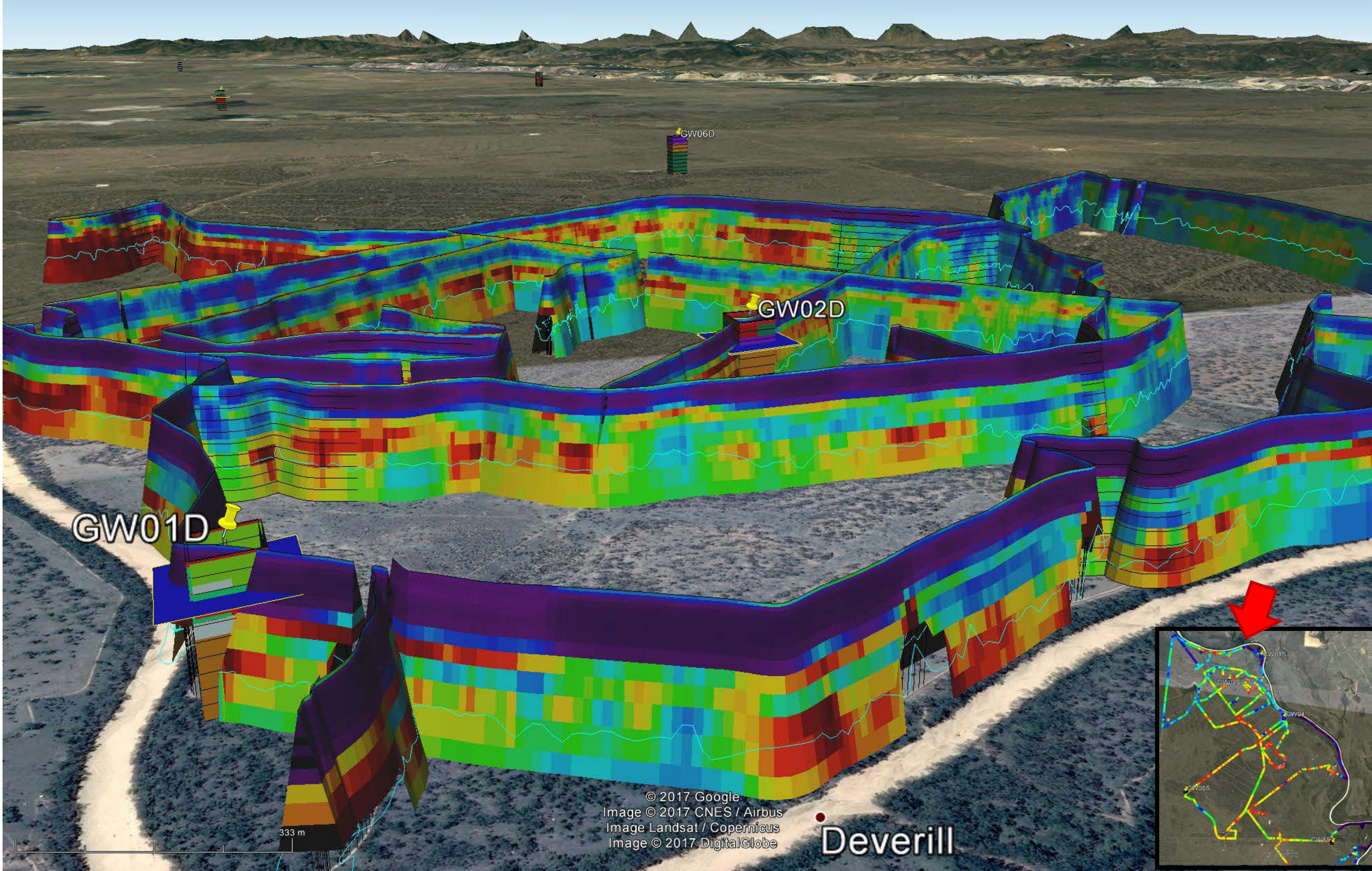


Modelled Resistivity Projected 60m Up

Iffley north viewed from the NNE

Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.

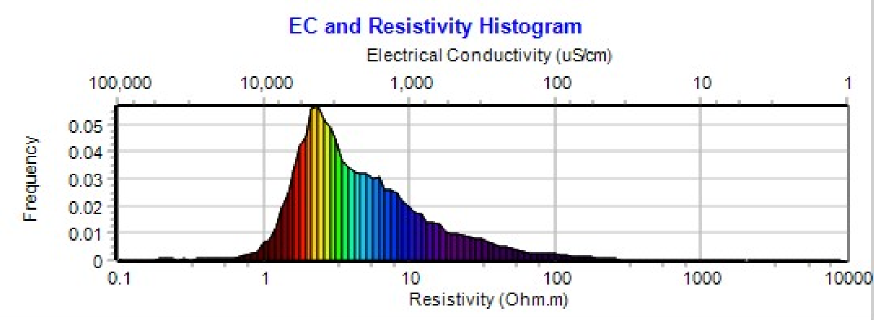


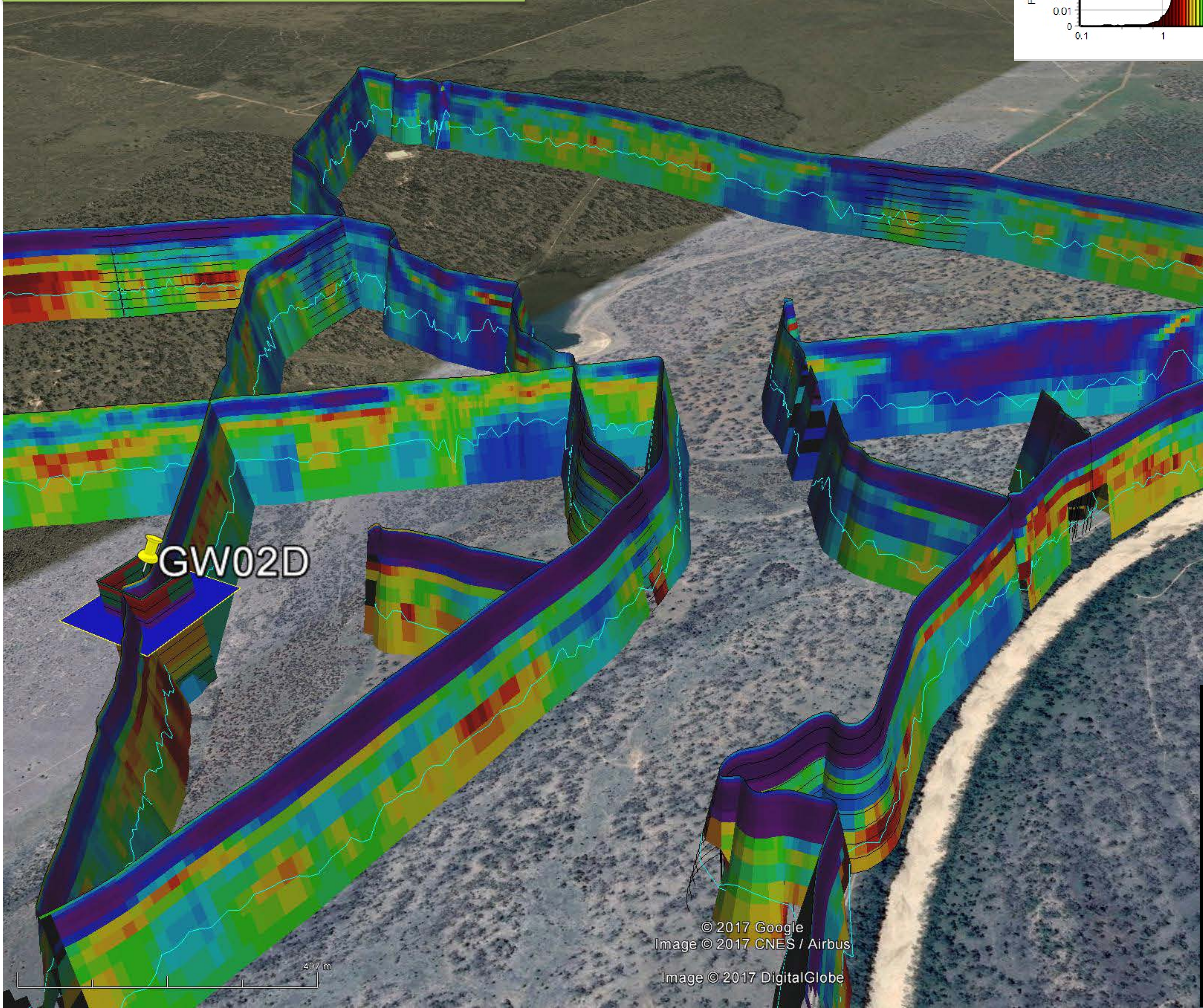


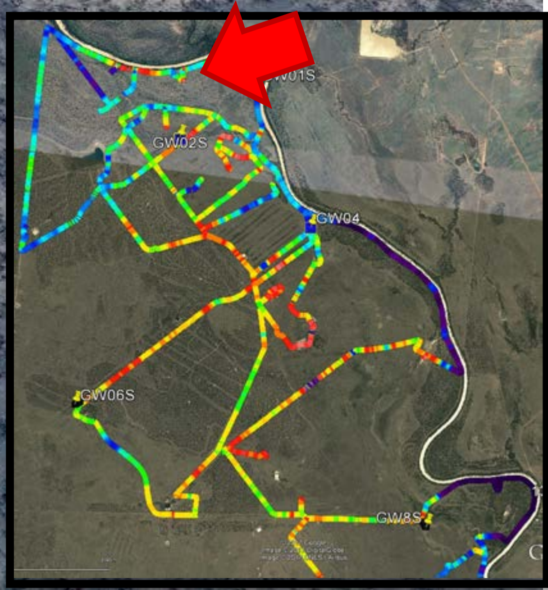
Modelled Resistivity Projected 60m Up

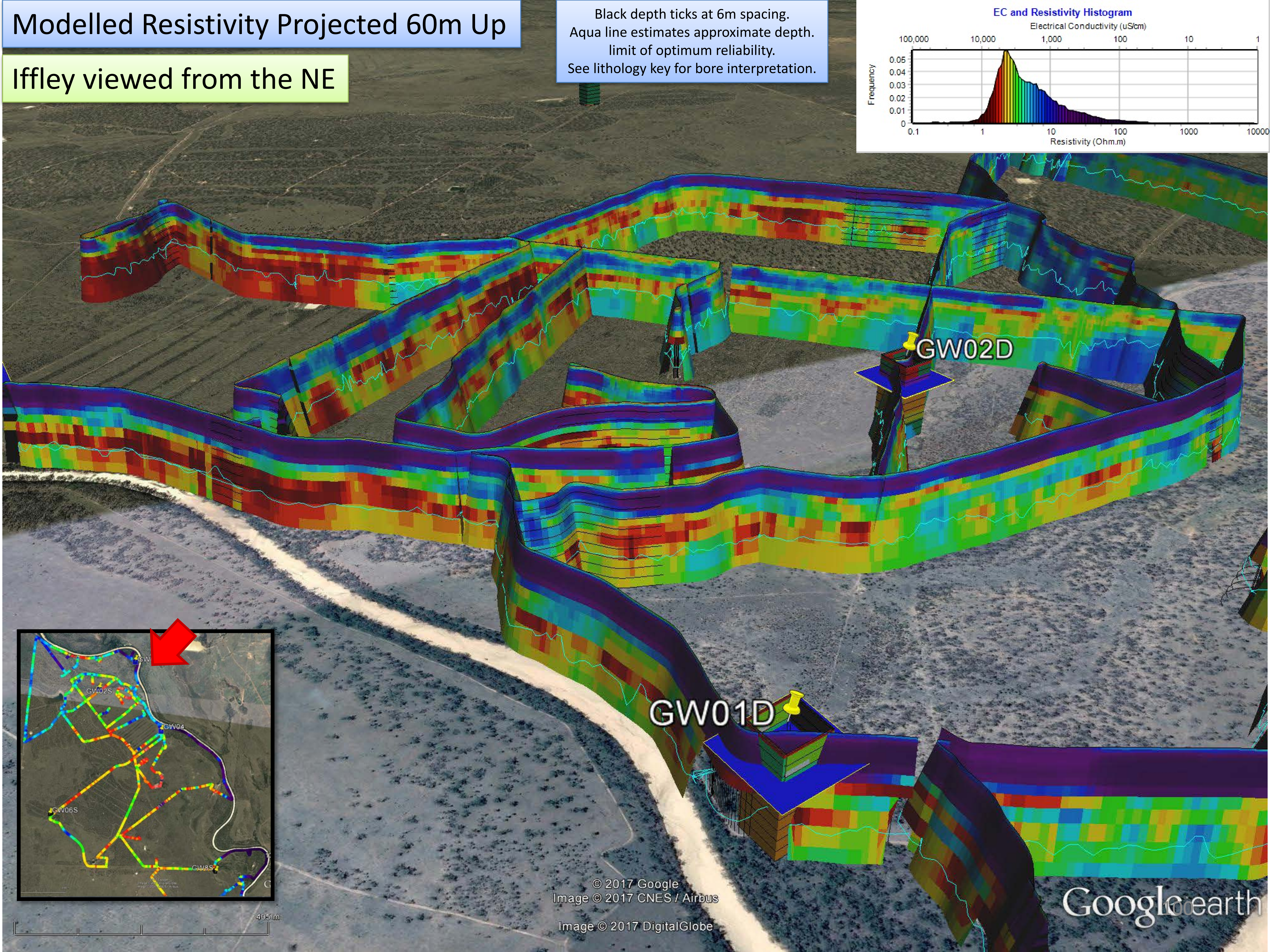
Iffley north viewed from the ENE

Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.







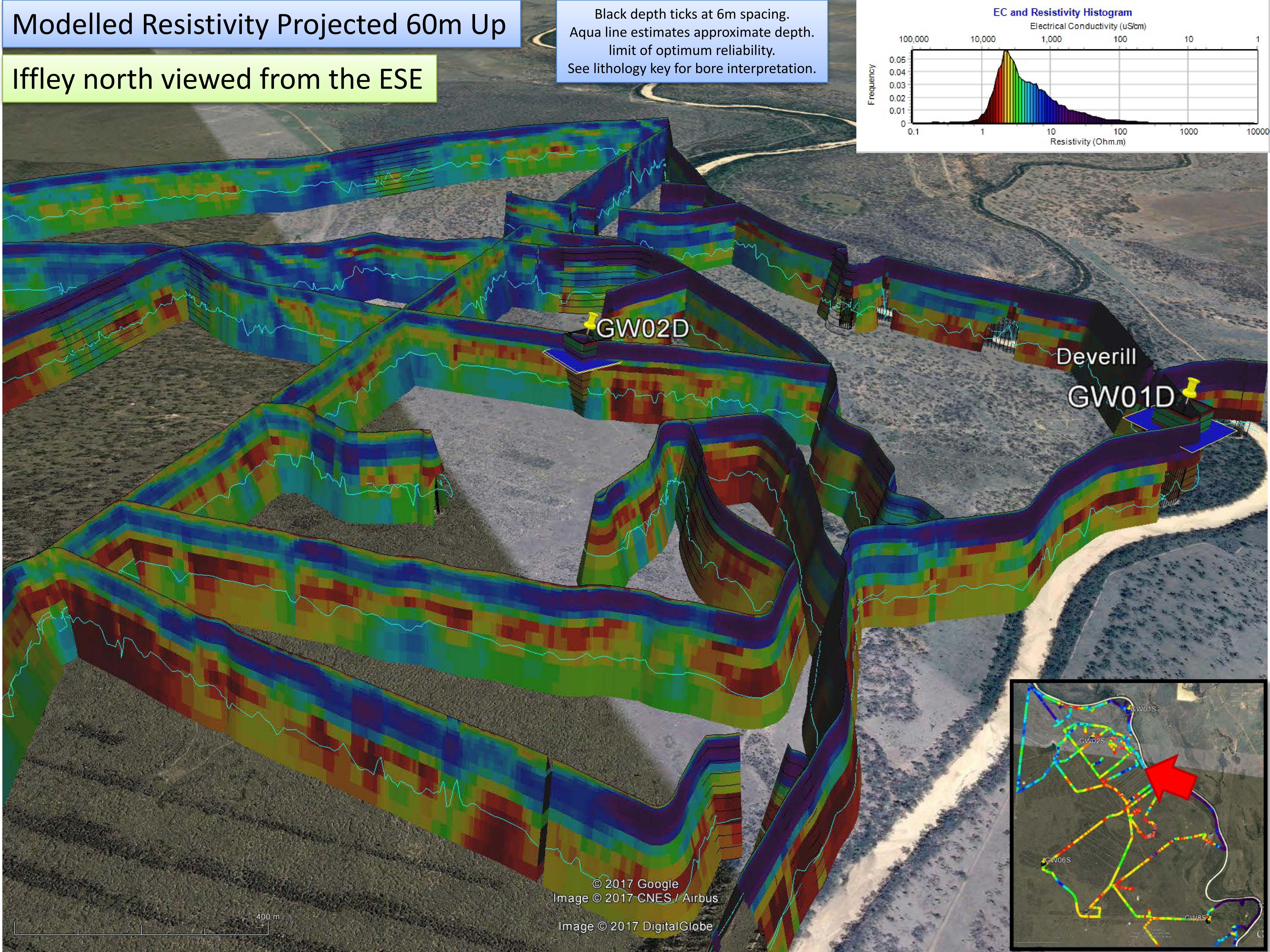


Modelled Resistivity Projected 60m Up
Iffley viewed from the NE
Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.
EC and Resistivity Histogram
Electrical Conductivity (uS/cm)
100,000 10,000 1,000 100 10 1
Frequency
0.05 0.04 0.03 0.02 0.01 0
0.1 1 10 100 1000 10000
Resistivity (Ohm.m)
GW02D
GW01D
GW02S
GW04
GW06S
405 m
© 2017 Google
Image © 2017 CNES / Airbus
Image © 2017 DigitalGlobe
Google earth

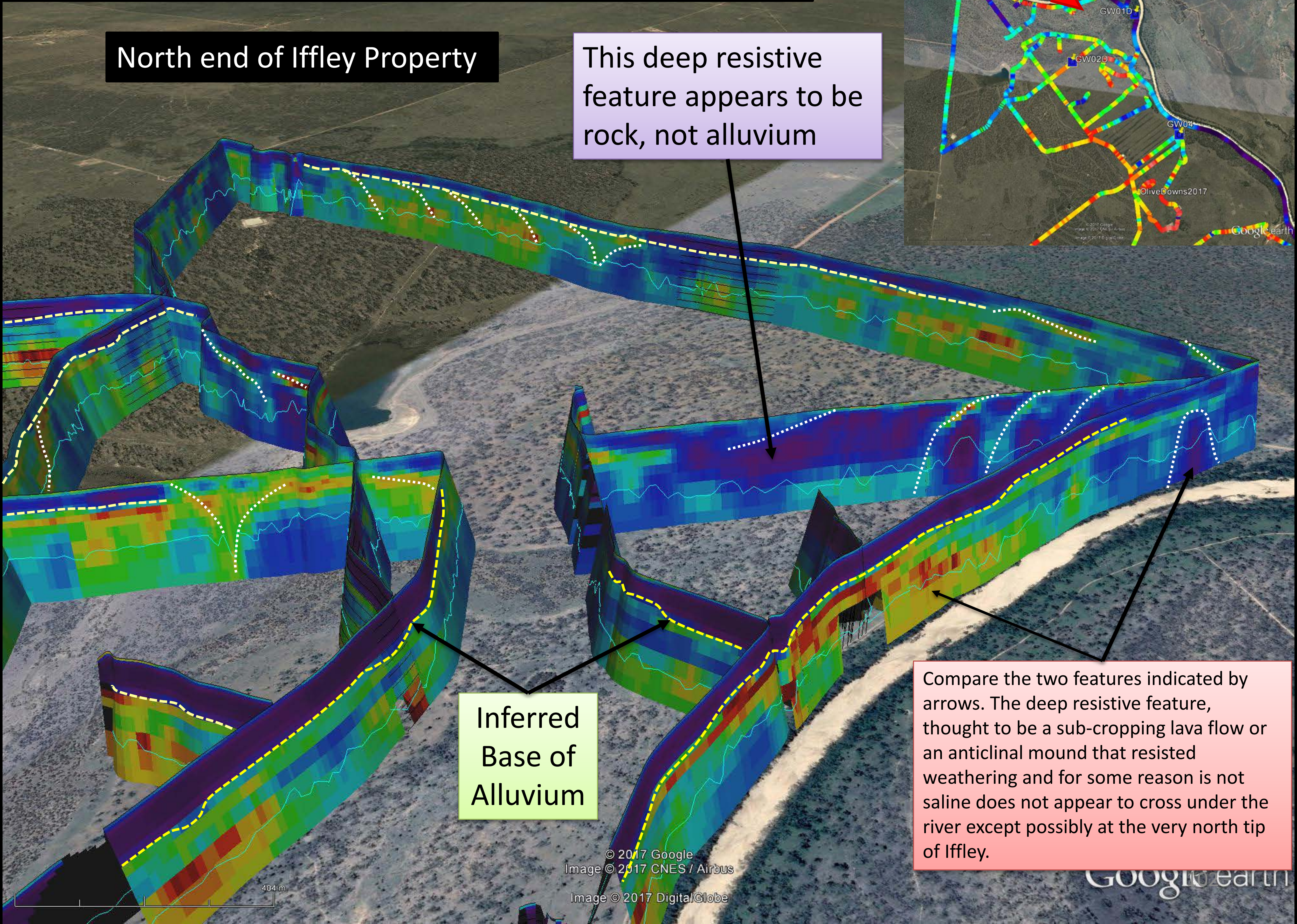
Modelled Resistivity Projected 60m Up

Iffley north viewed from the ESE

Black depth ticks at 6m spacing.
Aqua line estimates approximate depth.
limit of optimum reliability.
See lithology key for bore interpretation.



Modelled Resistivity projected 60m up viewed from the ENE



Conclusion

- The Olive Downs Lease is consistently covered by a layer of alluvium typically of 10 to 15m thickness, extending to around 30m thick in a narrow band along the Isaac River.
- Within the alluvium, saline ground moisture is present in a band running west of the river. This saline ground moisture is associated with faults and various dipping strata subcrops in the rock beneath.
- In the north of Iffley, there is a change of character in the strata beneath the alluvium suggesting igneous intrusion or different lithologies from the rest of the site.
- Subcrop salinities are highly variable across the site and could be used to map more structure given increased data coverage.

Appendices

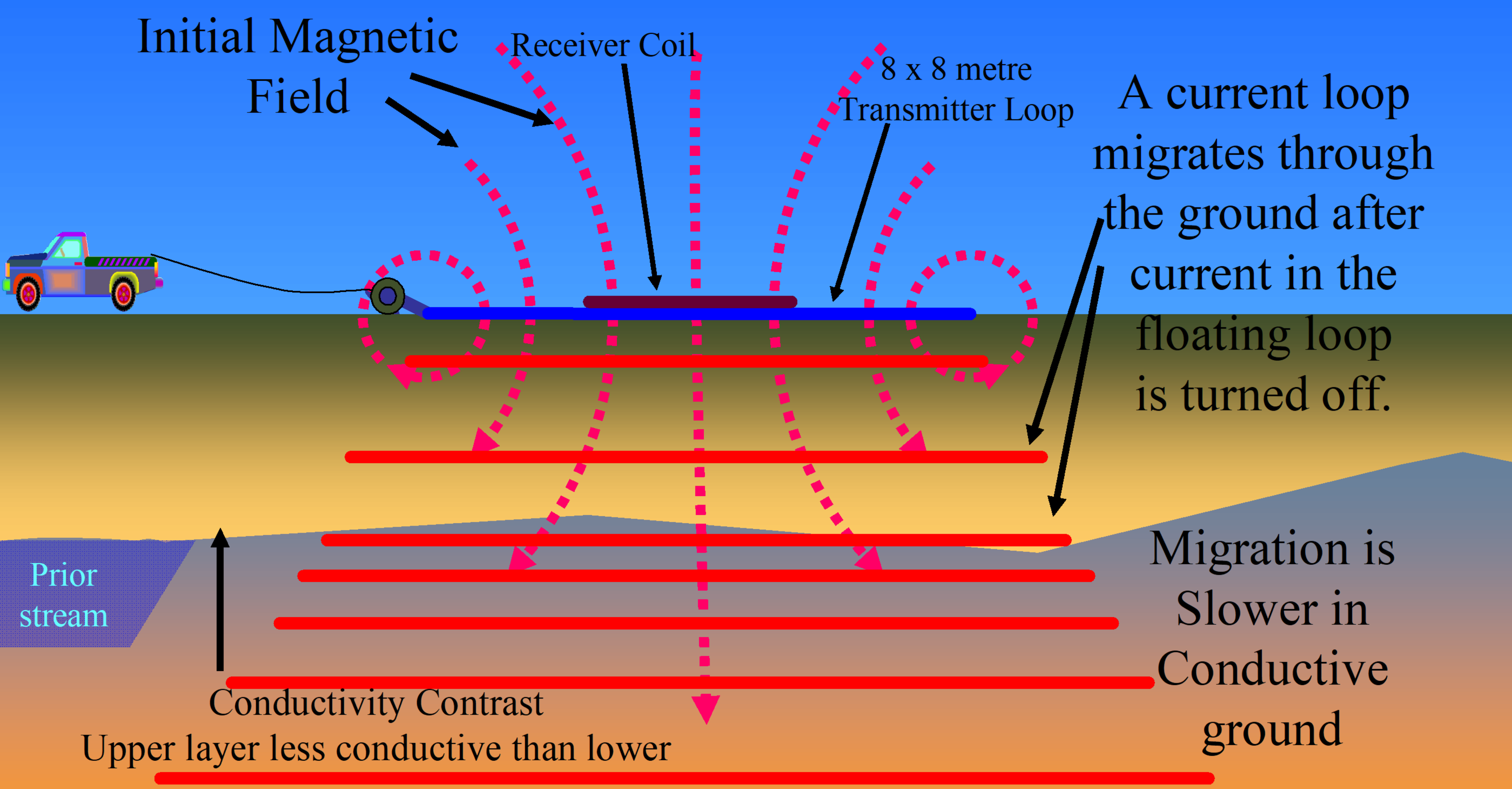
- Production Report
- Identifying depths on ribbon images
- Towed Transient Electromagnetic schematic
- TEM platform configuration schematics
- TerraTEM specifications

Production Report

Date	Charge	Details
18/07/2017	James Mobilization	James flies Adelaide to Brisbane
19/07/2017	Mobilization	Drive Dubbo to St George. James doing Standard 11 in Brisbane.
20/07/2017	Mobilization	Drive St George to Emerald. James doing Standard 11 in Brisbane.
21/07/2017	Mobilization, Induction, Setup	Drive Emerald to Moranbah, James flies Brisbane to Moranbah. Collect hire vehicle and proceed to Vermont Park. Conduct inductions and commence AgTEM assembly.
22/07/2017	Production	Scout with client representatives until 11.30am, flat tyre. Continue to setup and test AgTEM. Survey along river from Vermont Park into Iffley then to centre of iffley.
23/07/2017	Production	AgTEM survey on Iffley
24/07/2017	Production	AgTEM survey on Iffley. Cease using and leave experimental Slingram front loop on Iffley due to wear and tear crossing rough melon hole terrain.
25/07/2017	Production	AgTEM survey on Vermont Park, flat tyre.
26/07/2017	Production	AgTEM survey on Vermont Park south, west and north.
27/07/2017	Production	Forced to finish job in a hurry – adjust plans to hire risk rapid reconnaissance. Float AgTEM to Willunga. AgTEM survey on Willunga. Float AgTEM back to Vermont Park. Long day.
28/07/2017	¼ Production	Retrieve hired Hilux from Vermont Park – return it to Moranbah. Attempt to retrieve AgTEM front loop from Iffley but find it to be stolen (assume renegade pig hunters) – attempt investigation. Continue to pack AgTEM for long distance travel. Verify data integrity. Rest after frantic rush.
29/07/2017	Demobilization	Continue to pack then drive Vermont Park to Emerald
30/07/2017 onward	Demobilization	Continue back to Dubbo. James flies to Adelaide.

Total TEM production distance to date excluding gaps >60m =
166.8 km Total – slow going in melon hole country and tree lined tracks.

Towed Transient Electromagnetic System



Small AgTEM prototype for shallower surveys

USA patented.

The trailer must be largely non-metallic for TEM survey.

Booms holding the large horizontal transmitter loop are held in place by elastic cords that yield and spring back upon tree or rock impact.

The drawbar is an arrangement of fibreglass tube and tensioned kevlar ropes.

TEM Method Details

- A schematic of a towed transient electromagnetic survey system is provided on the next slide. Electrical current is pulsed through a large transmitter loop and each pulse induces a ‘smoke ring’ of current in the ground below as it turns on and off. As the ‘smoke ring’ dissipates out into the ground its magnetic field decays and it is the decay of this magnetic field, along with the decay of the magnetic field resulting from the transmitter loop, that is detected by various receiver loops. The decay is abated by conductive layers and enhanced by resistive layers in the substrate.
- The system used on this job, photographed on the previous page, had a 2 turn 6.5 x 5m transmitter loop with a centrally located receiver loop under the indented front of the transmitter loop and in a null coupled arrangement. The system was operated using a Monash Geoscope TerraTEM with an accelerated transmitter (to see shallower features) called TEMTx32, the continuous acquisition option, a Trimble AgGPS114 receiving Omnistar DGPS corrections and several truck batteries for power supply. The system was towed by a Landrover Defender separated from the equipment by a 5.5m fibreglass boom and rope assembly. The receiver loop had a 330 ohm damping resistor across it as did the transmitter loop and 16.5 Amps was driven though the two turn Tx loop. The receiver also had a pre-amp with a 60 kHz low pass filter invoked.
- Processing of this data involves numerous steps presented in a the next slides. The main steps are removal of movement noise, primary field stripping, cleaning of the data (removal of data mainly affected by metallic objects etc.), spatial smoothing, modeling to transform the voltage versus time data to smoothness constrained layers of resistivity versus depth, more data cleaning, gridding and presentation. The principle step is the transformation (matrix inversion) which is carried out using the Aarhus Hydrogeophysics Group algorithm EM1DInv.

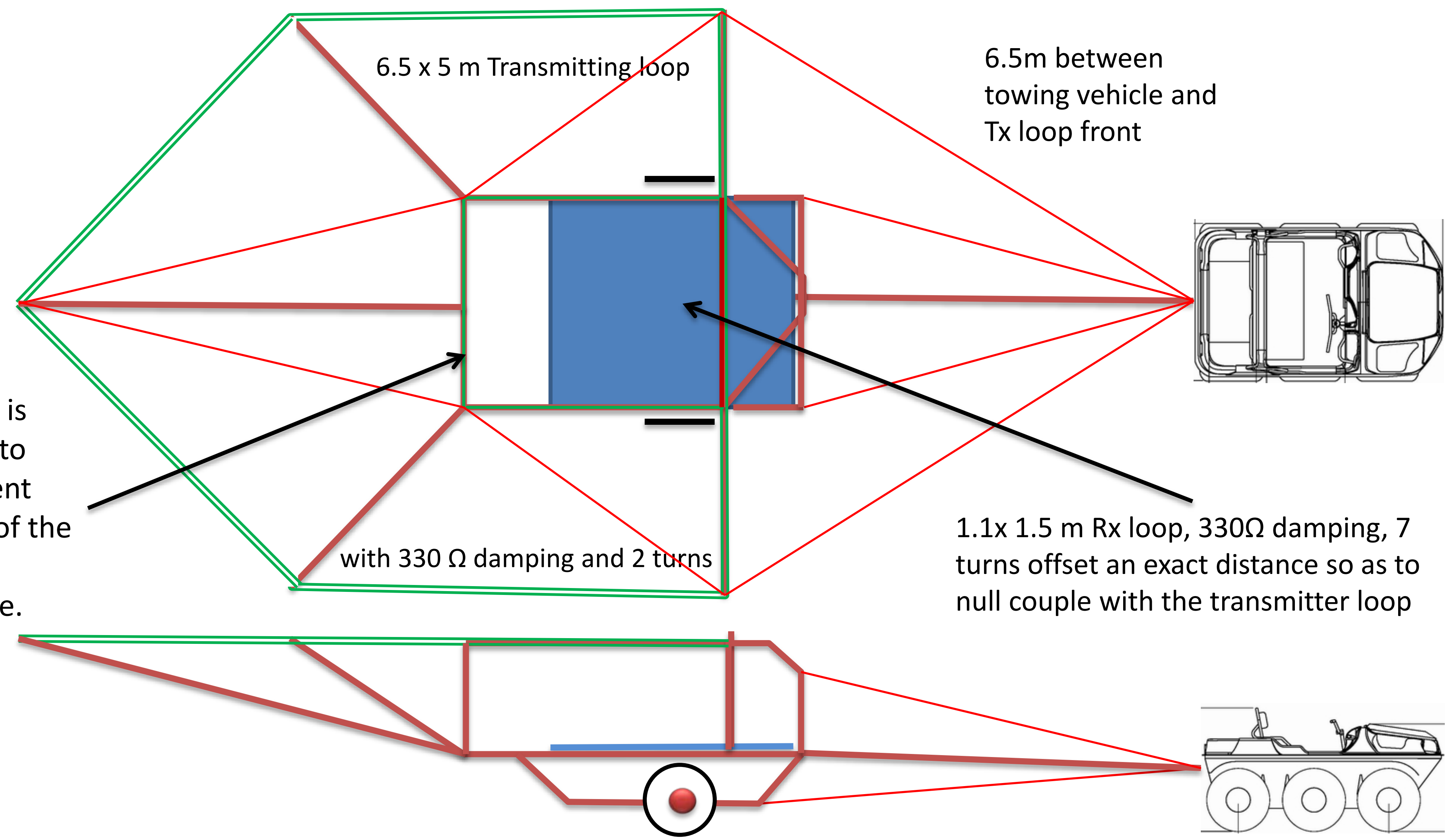
Transient EM equipment configuration

6.5 x 5 m transmitting loop towed TEM system

Plan view

One turn of the transmitter loop is tucked in over the receiver loop to facilitate more compact placement and less dimensional sensitivity of the placement of the null coupled receiver loop within the structure.

Vertical section



Exact loop dimensions

To avoid intellectual property loss, the exact loop dimensions have been displayed separately in a file SoilImagerJustTheLoops.png which is not openly distributed.

Transmitter loop suspension arms are attached elastically to prevent attrition upon impact with trees. Arms may be raised from the towing vehicle and fold inwards for obstacle avoidance and for compact transport when not surveying. The trailer draw-bar is detached for between-job transport. The trailer is lightweight and can be lifted by one person. Attrition is also avoided by addition of a breakaway pin. **Australian Patent Pending.**

General Processing Sequence

Define System Geometry

–

1. Quality control and data parsing during acquisition
    1. At the beginning of each day, select a reference sounding and plot it along with all incoming data.
    2. Watch all incoming data constantly making comparison with the reference sounding.
    3. Cancel acquisition or note problems as noise sources, metal artefacts, or equipment malfunctions are encountered. Alter course across ground to both more clearly define noise and artefacts and to subsequently avoid them.
    4. Each night, convert BIN file into TEM and TXT files and back them up.
    5. Each night, display selected channels of the data in plan view to appraise layout of geological features and any present geophysical artefacts.
2. Acquire system response from data obtained (stacked then averaged) in a very resistive area. If a very resistive area is not available then a larger hand laid loop is laid, ideally at the most resistive low horizontal gradient location in the survey area, a sounding taken (generally in slingram mode to avoid in-loop enhanced effects such as system response itself, induced polarization and super-para-magnetic effect. Then data from that loop is inverted to give a modelled response which is then used to calculate the equivalent response for the cart configuration. That response is then subtracted from the actual measured cart response at that site to give approximate system response of the cart.
3. Determine EM1DInv inversion software initial model, constrains and control parameters.
4. –
5. Operations performed on TEM files
    1. Basetrend removal (optional – only possible on moderately to highly resistive areas). This removes movement noise from the receiver coil moving through the magnetic field of the earth slowly. Some large mat receiver loops and other structures that do not vibrate do not create much movement noise. Basetrend removal is conducted by using a timebase of acquisition much longer than necessary so as to sample basetrend during acquisition by regression analysis of the part of the stacked records beyond where the decays drop well into the noise envelope.
    2. Adjust magnitude according to primary field response (optional). This is not appropriate and not done with nulled coils but is useful when using slingram coils.
    3. Reject records with low or high primary field response as they are clearly suffering from equipment malfunction (eg. Receiver loop blown over by wind) (optional). This may be conducted automatically or manually by visualizing a primary field channel on a map display and culling all soundings showing anomalous primary field.
6. Convert TEM file into a relational voltage database (*Volt.DBF, *XVolt.DBF,*YVolt.DBF)
7. Normalize data using average magnitude of log10(data) from a small receiver placed directly on the transmitter loop wires (*YVolt.DBF) (This is optional as the data is already normalized according to current monitored (every 10 soundings in 2014 version of TerraTEM firmware)).
8. Remove system response, optionally taking magnitude of transmitted data (proportional to *YVolts.DBF) into account for every sounding - again this option is not appropriate for nulled coils.
9. –
10. Display voltage data, in map view, coloured to represent magnitude of a particular channel. Simultaneously view decay plots of picked soundings, along with a reference sounding.
    1. Interactively remove geophysical artefacts by clicking on points or data segments.
    2. Display automatically updates - repeat a.
    3. Repeat a,b. until satisfied that data is suitably cleaned.
    4. Interactively clip channel count on soundings with procedure as for a., b. and c. (optional).
11. Smooth voltage data horizontally. Trapezoidal filtering is ideal (optional). Note well that this step is conducted after removal of artefacts which would have spread their mess throughout the data if smoothed.
12. Calculate noise levels from sounding tails and specify ready for inversion. Should telecom cable or powerline noise be encountered, then this step will lead to recovery of shallow information without unduly corrupting deeper information!
13. Determine valid time range for inversion input from each sounding using noise levels specified in step 14.
14. Resample data to time-smooth and create AarhusInv inversion input files.
15. Run AarhusInv on each sounding, conjunctively inverting both in-loop and out-of-loop data (if obtained). This is scheduled using batch files and runs overnight, or even over several days or weeks.
16. Run AarhusInv again with lateral constraint (optional – also time consuming).
17. Read inversion output files to create relational *Ohmm.dbf files.
18. View *Ohmm.dbf files in plan view.
    1. Colour proportional to curve fitting RMS error and view to determine an appropriate cut-off RMS threshold. Exercise caution in determining the threshold as data in resistive areas will still be valid at much higher threshold than in conductive areas.
    2. Reject soundings with RMS error greater than the threshold level determined in a..
    3. Colour proportional to resistivity of successively deeper layers. Interactively remove or depth-limit soundings containing artefacts by clicking on points or data segments.
19. View *Ohmm.dbf in 3D – check data more, switching back and forth to 2D view to remove further artefacts.
20. Horizontally smooth the *Ohmm.dbf file to clean up erratic variation in inverted data.
21. Horizontally shift *Ohmm.dbf files to account for GPS antenna offset.
22. –
23. Divide day *Ohmm.dbf files into logical segments (where appropriate) and recombine into *Ohmm.dbf files covering logical geographic extents.
24. Calculate resistivity distribution histograms and combine to make a master histogram for the area.
25. –
26. Re-load regional *Ohmm.dbf files and colour with master histogram equalization (quantization).
27. Query state bore databases and generate a subset of bore data for the area.
28. Interpret the drillers logs into lithological categories.
29. View bore log graphics with the resistivity data for each region.
30. Create graphics of histograms and lithological keys for posting externally.
31. Pack regional *ohm.dbf files and augment with shapefile indexes, projection files etc.
32. Create 3D polygon KML and shapefiles for each region (both resistivity and lithological files).
33. Slice each regional resistivity file into depths and output as *.csv with columns of logarithmically transformed resistivity for external gridding in packages such as Golden Software Surfer 12.
34. Create any other appropriate theme datasets (eg. Depth to maximum resistivity) and 3D graphics (eg. Voxler).
35. Grid and display depth slices, stacked if required in 3D space (Surfer).
36. Organize and refine KML files in Google Earth and select enhanced snapshot views. Combine into a folder and collectively output as a new KMZ file. The KMZ files are compact - Email to interested parties.
37. Collect all graphics in MS Powerpoint (A3 resolution!) and create a report. Make a summary report in MS Word (optional). Generate PDF report.
38. Package job DVD and printing, mailing etc.

Transient EM equipment specifications

Alpha Geo Instruments

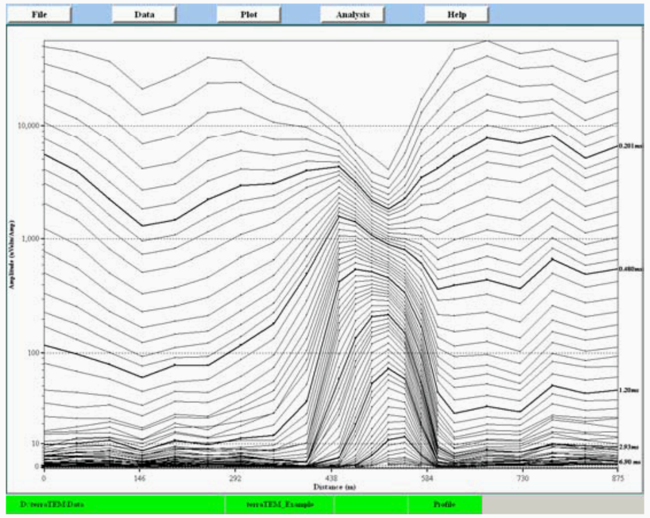
terraTEM
Time-Domain EM Surveying System

terraTEM Features

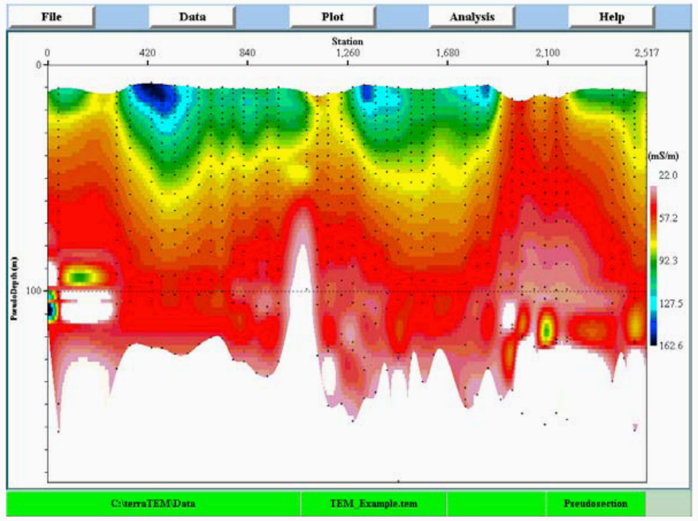
- Transmitter and receiver in one unit
- Single or 3 channel receiver with 10 amp. transmitter
- High speed sampling at 500 kHz for superior near surface resolution
- Easy to use touch screen with auto set-up and smart menus
- Large 15" LCD display for data visualisation
- Fast and easy data transfer via USB port
- Integrated 12 channel GPS system for seamless station positioning (option)
- Integrated PC for data visualisation, data processing, and interpretation in field using built-in software
- Rugged construction with external 24 V battery power pack and charger
- Several optional extras to broaden capability
- Designed and built in Australia

Screen Dumps

The following are a number of screen views from the **terraTEM** system.



Full control of all aspects of data display, post-survey filtering, and decay curve analysis



Multiple display formats, including gridding and raster images (options)

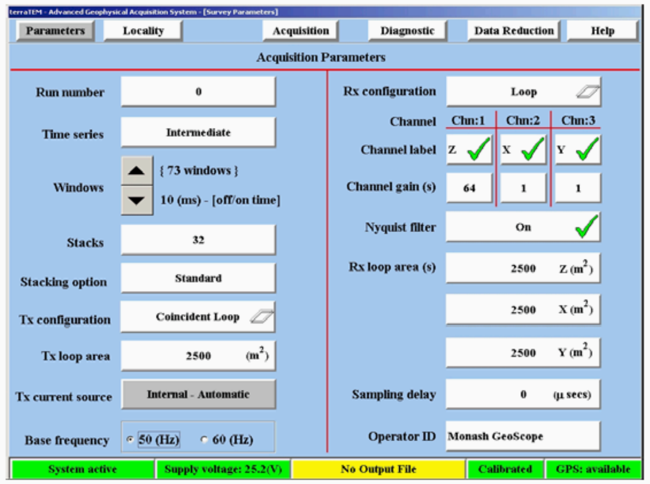
The **terraTEM** is designed, developed and manufactured by **Monash GeoScope**

Monash GeoScope

Applications

The **terraTEM** can be used for various applications including the following:

- Mineral exploration
- Near surface including geo-technical and engineering investigations
- Groundwater and salinity studies
- Environmental surveys



Easy access to all parameters, multiple binning and stacking options; smart menu system.

Internal GPS, for positional accuracy (option)

General Specifications

	terraTEM	Options
Transmitter Output	10 Amps. (max.)	**Enhanced Transmitter**
Receivers	1 Channel	**3 Channels (simultaneous)**
High Resolution Sampling Rates	500 kHz	-
User Selectable Multiple Time Gates	-	**Option**
Data Visualisation and Processing in field	Standard Software	**Enhanced Software**
Storage Device – 1 GB Flash Disk	Standard	-
GPS Receiver – 12 channel	-	**Option**
Communications – Port for Data Transfer	USB and RS-232 Standard	-
External Synchronisation	-	**Option**
Continuous Recording (with external GPS Interface)	-	**Option**
Extra Stacking Options and Gain Functions	**10 Selectable Gain Settings from 1 to 8,000**	**Auto Gain**
Vectem 3 Interface Module (for down-hole surveying)	-	**Option**
Interface Options (third party devices)	-	**Option**
Dimensions: Console: 530 x 350 x 160 mm. 13 kg. Battery Box: 280 x 250 x 180 mm. 12 kg.		
Operating Temperature: -10 to 40 degrees C.		

Further Information

For further information regarding this product, either technical or sales, please contact:

Alpha Geo Instruments

Unit 1, 43 Stanley Street, Peakhurst. N.S.W. 2210. Australia
Phone +61 (0) 2 9584 7555 **Fax** +61 (0) 2 9584 7599
e-mail info@alpha-geo.com **website** www.alpha-geo.com

Your Distributor:

terraTEM
Technical Specifications

Transmitter

Output	15 Amp. (max.)
On/Off Period	Adjustable 10 ms (50 Hz) or 8.33 ms (60 Hz) increments

Receiver

Sampling	500 kHz per channel, fixed
Inputs	+/- 40 V maximum continuous voltage.
Gain	User selectable fixed gains Other Gains Optional
Resolution	Maximum 28 bits, effective
Functions Measured	Tx/Rx loop resistance, Tx current, Tx turn-off time, battery voltage, automatic gain/offset calibration, transient response

Console

Display	LCD TFT, 15 inch
Touch Screen	Splashproof
Storage	1 GB flash RAM

External Interfaces

Communications	USB and Serial port for data transfer

Equipment Supplied

- Console
- Loop connectors
- Battery Pack (24 volts), complete with connector cable (overseas batteries not included)
- Battery charger
- USB flash disk (for data transfer)
- Operations manual

Sensor Attachments Available

Surface Receiver	RVR-1 or cable loop
Downhole	Vectem 3 or equivalent

Physical

Housing	Aluminium "Zero" case
Console: Weight	13 kgs.
Dimensions	530 x 350 x 160 mm.
Battery Pack: Weight	12 kgs.
Dimensions	280 x 250 x 180 mm.
Operating Temperature	-10 to 40 degrees C.

Options

GPS Receiver	12 channel receiver
Multi-channel Receiver	3 channel simultaneous A/D
External Transmitter Interface	External synchronisation option (for use with TEMTX-32, Zonge high powered transmitters)
Vectem 3 Interface	Internal interface module
Continuous Recording	Continuous recording of unit with external GPS interface using NMEA standard
Software Packages	Extra Stacking Options, Sferics Rejection and Gains, Spectral Analysis and Digital Signal Processing User-defined time series

Further Information

For further information regarding this product, either technical or sales, please contact:

Alpha Geo Instruments

Unit 1, 43 Stanley Street, Peakhurst. N.S.W. 2210. Australia
Phone +61 (0) 2 9584 7555 **Fax** +61 (0) 2 9584 7599
e-mail info@alpha-geo.com **website** www.alpha-geo.com

Your Distributor:

How do I interpret the imaging

Image types and the common colour scale

Imagery has been presented as both 3D ribbons and 2D map views. Both are presented with and without satellite imagery backgrounds. The same EC colour scale has been used for all the imagery so that it is all directly comparable. This scale was derived by binning all the data in a histogram of EC and then spreading the colour evenly over the histogram (equal area colour distribution).

2D map imagery is of three types:

- EC slices at constant depth below the canal water surface;
- EC slices at constant depth below the canal bed; and
- Maximum EC of any layer intersected. This type is designed to give, **as low EC anomalies**, a rough indication of the most likely prolific seepage pathways.

Background satellite imagery has been added to many images using Google Earth. It is useful for locating seepage pathways in relation to features on the ground. For instance, particular types of trees, or anomalous crop vigore may indicate groundwater seeped from a nearby seepage pathway. Salinity scalds, evident on the imagery, may also be related to seepage pathways.

Files have been supplied so that users can image the data themselves in Google Earth, HydroGeoImager (available from the author), ESRI products or other products capable of reading dBase files, ESRI Shapefiles or CSV ASCII files.

Hints on use of these images

This document is a Microsoft Powerpoint Presentation supplied on the attached CD. Cutting and pasting these images from this document to other computer programs is best done by selecting the actual images rather than the slides because powerpoint desamples cut and pasted slides. Alternatively you may print to a hi-res PDF file.

In powerpoint, you will get an animation effect as you page through the depth slice image slides (back and forth as you please). It is much easier to compare the slices using this animation effect than it is on paper.

Data files and GIS integration

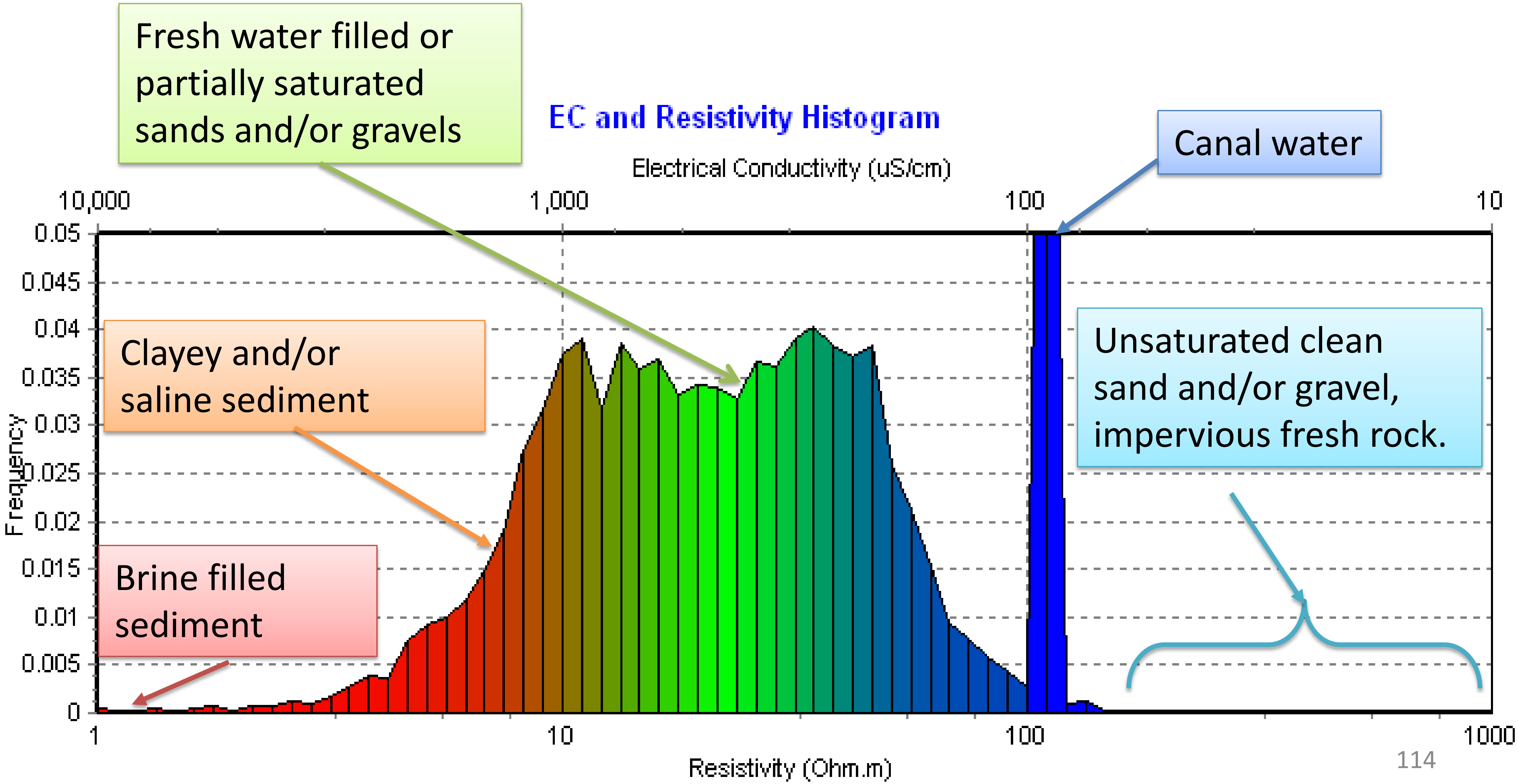
Accompanying data files in dBase IV format can be loaded in and out of MS Excel. The format has been chosen because it is easy to load into ESRI ArcView products. The final data is labelled *Ohmm.dbf and is of course in units of Ohm.m, the reciprocal of Siemens per metre. Each resistivity column is accompanied by a depth column indicating the base of the layer of that resistivity. Simple queries can be used to make a multitude of meaningful themes for adding to GIS images. Google Maps and Google Earth may be used for viewing some themes in the KMZ files supplied (zipped KML files). CSV (Comma Separated Variable) files of depth below bed slices also are supplied and may readily be loaded into most packages including Golden Software Surfer and ESRI ArcMap.

Where exactly am I looking?

In most cases, data may be located by identifying features such as fences and trees on the satellite imagery, however, accurate locations may be attained by loading files into Google Maps, Google Earth, ESRI products such as ArcMap or free ArcExplorer or even by loading the dBase files into Microsoft Excel. The viewer will find functions in most of these products that allow them to save sites they click with the mouse to a text file of co-ordinates which can then be loaded into a GPS receiver or printed as a list.

Imagery color scale and histogram calculated for all data collected from all canals in the Irrigation Scheme

EC has been represented by a colour scale ranging from red, through green to blue with red representing the higher EC values. A histogram of EC values of all the data collected was generated and colour was distributed across that histogram so that each colour in the colour scale representing EC filled an equal area of the histogram. This has resulted in all important features in the datasets being visible.

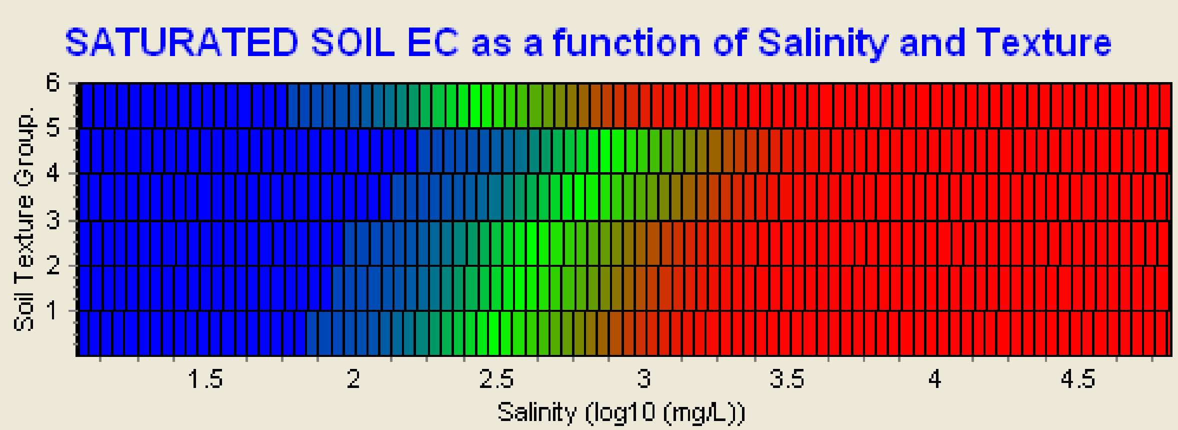


Understanding the 3D graphics

Sediment texture and Pore Water Salinity

6: Water
5: Sands <10%Clay
4: Sandy Loams 10-25% Clay
3: Loams 25-30% Clay
2: Clay Loams, Light Clay 30-45% Clay
1: Medium, Heavy Clays >45% Clay

For any histogram of EC, we can show what colour is generated by various combinations of soil texture and salinity in saturated sediment using an empirically derived algorithm.



and using a Salinity conversion factor mg/L / uS/cm of 0.64.
After Slavich & Petterson - Aust J. Soil Res., 1993, 31, 73-81

Bore Lithology Graphics

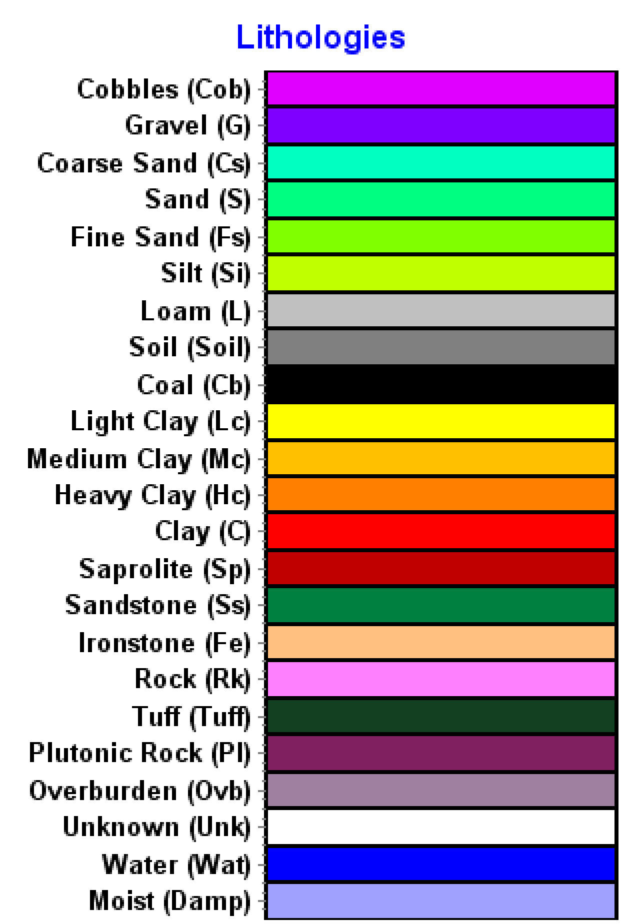
In the images, bore logs are displayed graphically using lithology keys such as the one given here.

Lithologies have been extracted from drillers written logs using an automated text interpreter. Due regard to the limitations and quality of this source of data and the interpretation process must be given.

Many lithologies have been presented with composite codes – eg. a Sandy Light Clay hosting water would display the codes for Sand, Light Clay and Water. Alternatively the driller may have given a water level. In this case the water level would be displayed at a horizontal blue plane.

Beware that the images are either not elevation corrected, or, if displayed in Google Earth, corrected only using the coarse Google Earth DEM. Because rivers are normally incised, imagery beneath them should normally be compared to lithologies about 10m lower in the bore logs.

In Google Earth, you can turn the icons and lithology key on/off. If you click on an Icon it displays a text box of any available bore details (water level, salinity, lithologies etc.).

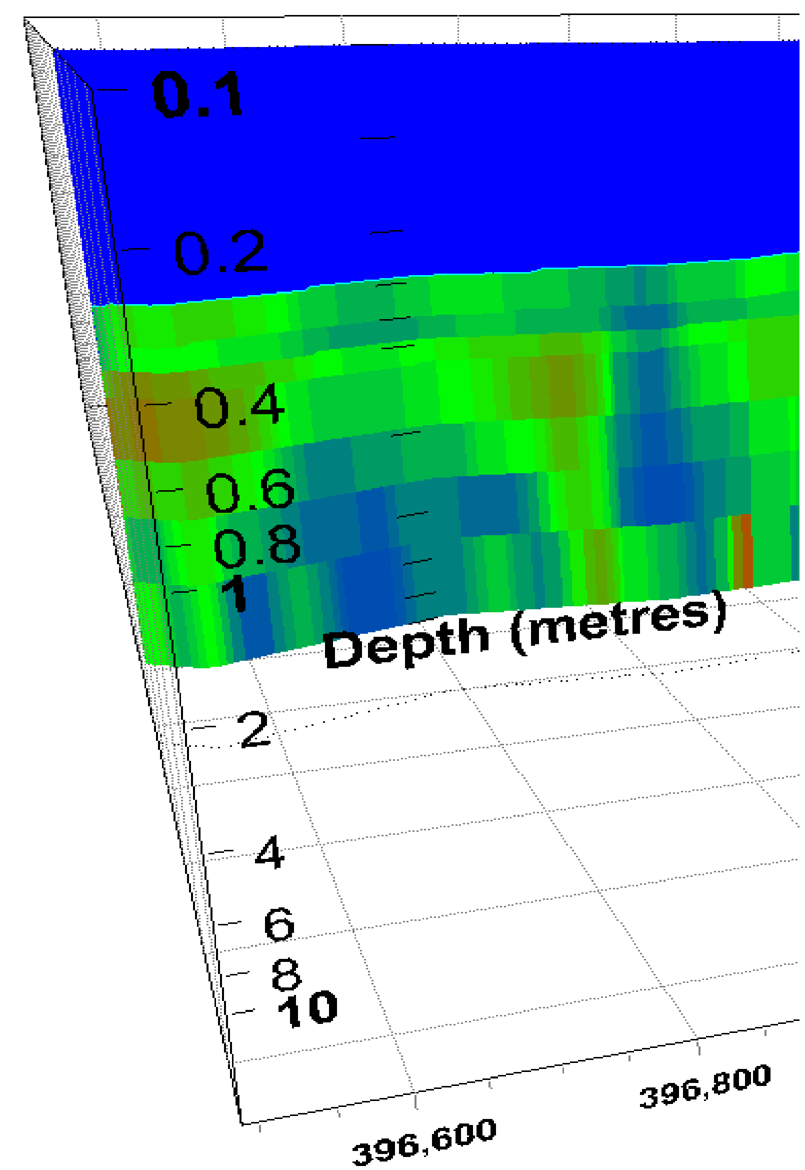


Identifying depths on ribbons

The 3D imagery may have either linear or log (as shown here) depth scales. It is labelled on the south-west corner of the 3D viewing space (as shown). Notice here that the increments are logarithmic. Logarithmic depth plotting is often used so that deep data can be examined at the same time as detailed shallow (near canal bed) data. The geophysical data loses resolution with increasing depth and so this type of depth scale presents all the data in a way that is easy to see.

Look on the ribbon behind the depth scale and you will see a column of black ticks. These correspond to the ticks on the annotated depth scale. Notice that they bunch up at 1m. Black dots mark the projection of the ribbon onto the base plane of the viewing space which is 20 m below the surface. When lithological logs are also displayed, a linear depth scale is preferred as the lithology does not blur out with depth.

The canal bed is marked with an aqua line.



Attachment A5 – Landholder Bore Census

GROUNDWATER BORE CENSUS

OLIVE DOWNS COKING COAL PROJECT

Prepared For:	**Pembroke Olive Downs Pty Ltd**
Project Number:	**ENRS0600**
Date:	**2nd May 2018**

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1 x PDF	ENRS0600_Olive Downs Bore Census	Rev.1	28th Feb. 2018	Resource Strategies
1 x PDF	ENRS0600_Olive Downs Bore Census.r2	Rev.2	26th April 2018	Resource Strategies
1 x PDF	ENRS0600_Olive Downs Bore Census.r3	Rev.3	2nd May 2018	Resource Strategies

TABLE OF CONTENTS

LIST OF TABLES, FIGURES & APPENDICES

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

Environment & Natural Resource Solutions (ENRS Pty Ltd) was commissioned as independent groundwater consultants in July 2017 by Pembroke Olive Downs Pty Ltd to complete a bore census for the Olive Downs Coking Coal Project (the Project).

This groundwater bore census report documents the results of a desktop data review supported by site inspections, field measurements and meetings with landowners and property managers. The report has been prepared with general consideration of the Queensland (Qld) Department of Environment and Heritage Protection (DEHP) (2017) minimum requirements for undertaking a baseline assessment on a water bore under Section 413 of the Water Act 2000.

1.1 OBJECTIVES

The overall purpose of the scope of works was to complete a census of existing bores in the Project area and surrounds including ground-truthing to assist with the development of the Environmental Impact Statement (EIS) groundwater model.

1.2 SCOPE OF WORK

The scope of work comprised the following tasks:

- Review of the Project description to delineate the census area;
- Desktop review of any previous reports and Qld Government registered bore records;
- Preparation of landowner property maps to support site inspection (summary of available contact details, boundaries, access routes, and potential bore sites);
- Landowner notifications to schedule site inspections;
- Site inspections to meet with landowners and inspect bores:
  - Meet with landowner, review property maps and identify any existing or historical bores, associated bore records and access routes;
  - Record location of any existing bores (easting and northing);
  - Photograph bore sites;
  - Gauge base of borehole and depth to groundwater;
  - Measure borehead gases (if any);
  - Field measurement of water quality (e.g. pH, Electrical Conductivity);
  - Collect representative water samples (where practical) and submit to National Association of Testing Authorities (NATA) accredited laboratory for testing;
  - Document bore construction, equipment, purpose, and pumping regime;
- Compile census results and prepare database; and
- Document census methodology, results, and prepare groundwater bore census report.

1.3 PERSONNEL QUALIFICATIONS

The groundwater bore census was undertaken by experienced personnel with tertiary qualifications in Hydrogeology, supported by professional technical staff. As required by the QLD DEHP (2017) minimum requirements for undertaking a baseline assessment, the supervising Hydrogeologist has attained more than two (2) years experience in groundwater level monitoring and sampling, including monitoring of water levels in bores equipped with pumping infrastructure, and has practical knowledge of water bore construction infrastructure.

Position	Name	Qualification/Experience
Supervising Hydrogeologist	Rohan Last	BSc (2000), MSc Hydrogeology (2004) >15 years drilling, sampling and monitoring experience
Field Supervisor	Matt Lemcke	BSc (2013) Geology, currently undertaking postgraduate studies in Hydrogeology >5 years sampling and environmental monitoring experience
Supporting Personnel	Andrew Fulton	BSc, MSc Hydrogeology >20 years drilling, sampling and monitoring experience
Supporting Personnel	Tamika Flannigan	BSc. >2 years environmental experience including inhouse training for groundwater monitoring

Considerable assistance was also received from landowners who provided borehole information and their time to locate and inspect bores.

2.0 CENSUS AREA

The initial targeted extent of the groundwater bore census was selected to encompass an adequate buffer including the Project area and surrounds extending approximately ten (10) kilometres in all directions from the Mining Lease Application (MLA) areas. The initial targeted extent of the groundwater bore census area is depicted on **Figure 1**.

3.0 DESKTOP DATA REVIEW

Preparation of the census database included the review and collation of information from various data sources including (where available): previous reports; Qld Government registered bore database;; aerial imagery; and landowner records.

3.1 PREVIOUS REPORTS

Results of past bore census results presented in the Lake Vermont Northern Extension Groundwater Impact Assessment (JBT Consulting 2016) were considered during the identification of the bore census investigation areas which included Vermont Park, Meadowbrook, Lake Vermont and Mockingbird Downs (the location of the existing Lake Vermont mine).

Besides summary assessment information presented in the Bowen Gas Project EIS, no other publicly accessible previous 'baseline assessment' bore reports were available for review at the time of the census. However, ENRS understand the area has likely been the subject of baseline assessments by the Coal Seam Gas (CSG) industry.

3.2 REGISTERED BORE DATABASE

A search of the registered groundwater bore database maintained by the Qld Department of Natural Resources, Mines and Energy (DNRME) was conducted. Where available, data includes summary reports on bore location, construction, geology, and aquifer details as derived from Drillers Logs (where available).

3.3 AERIAL IMAGERY

A search of online imagery from Qld globe and Google Earth was conducted to assist with the preparation of property maps. Imagery was inspected to validate the presence and location of groundwater sites, infrastructure, access routes and boundaries.

3.4 LANDOWNER RECORDS

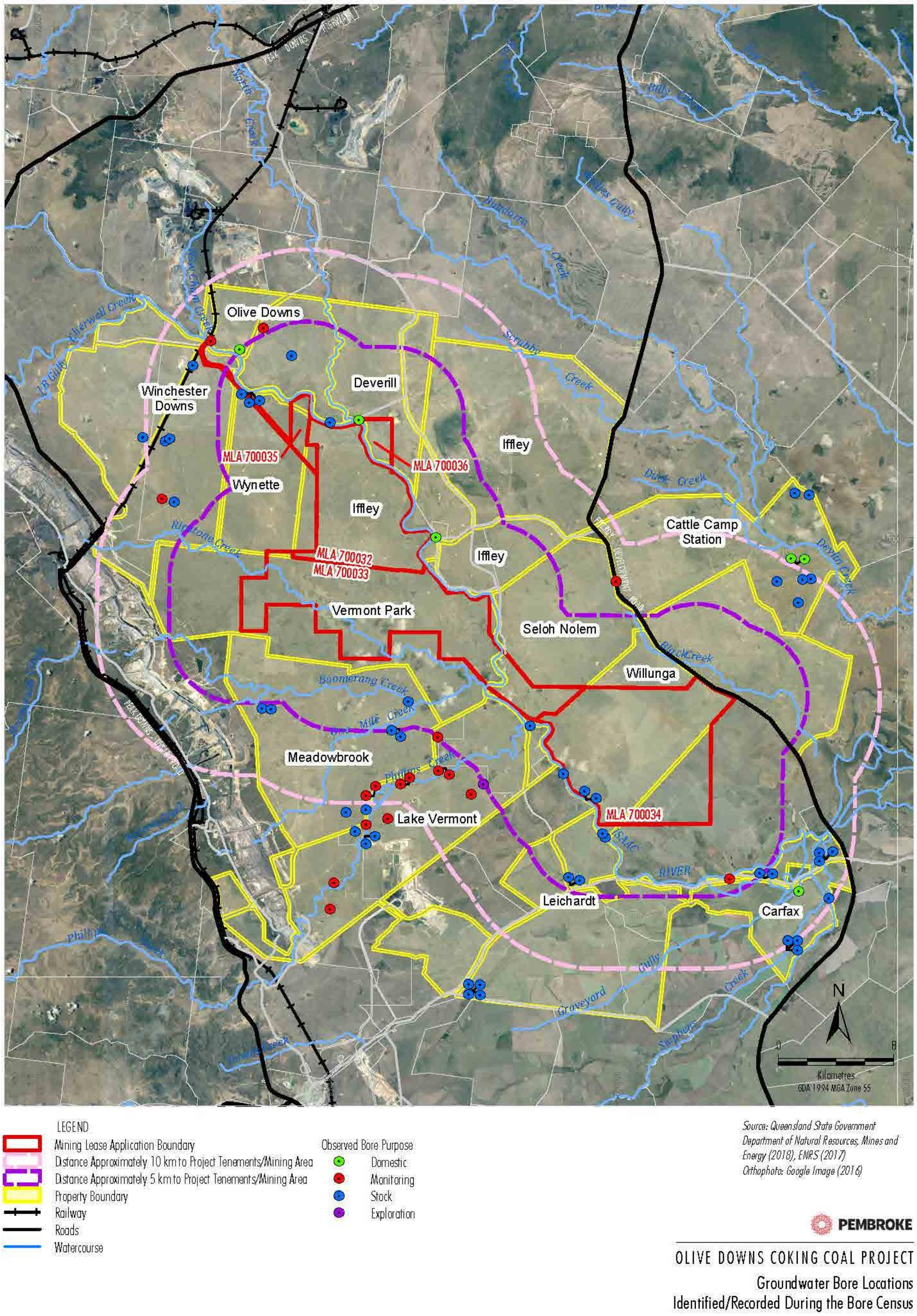
Considerable information was provided by landowners and property managers, including details of: historical use and existing bores (if any); construction logs; equipment and pumping regimes; yield and water quality.

4.0 CENSUS METHODOLOGY

4.1 BORE CENSUS INVESTIGATION AREA

The desktop review culminated in a bore location map with a five (5) kilometre (km) radius (Stage 1) and 10 km (Stage 2) radius from the extents of the MLAs. It is noted that whilst undertaking the Stage 1 bore census many of the potential bores identified during the desktop review were unable to be located in the field and were subsequently confirmed by the landowners not to have existed. Hence, the Stage 2 bore census was conducted to cover all of the potential bores identified on properties that fell within the 10 km buffer of the MLA extents, where accessible. The Stage 1 and Stage 2 bore census investigation areas are depicted on **Figure 1**.

Figure 1: Bore Census Coverage



4.2 LAND ACCESS PERMITS

Prior to census inspections landowners were notified to ensure the necessary approvals and permits were in place. No properties were accessed outside the approved times.

4.3 PROPERTY MAPS

Prior to the census inspections, individual property maps were prepared utilising existing data sources to map all potential bore sites. The maps provided a valuable tool to direct site inspections and confirm which bores were actually present on the ground. It is noted than many bores mapped from the Qld Government registered bore database were confirmed not to exist during landowner meetings.

4.4 LANDOWNER MEETINGS

When possible upon arrival at each property, the bore census team met with the landowner/property representative to provide an overview of the process and document information provided by the landowner/property representative. When a face to face meeting was not possible telephone conversations were used as an alternative.

From information obtained in the meeting, the property map was annotated with the assistance of the landowner to confirm which bores were present or did not exist. Sites were then visited to ground truth their location and survey the bore details and water quality (where accessible). General information and feedback obtained from the landowners was incorporated into the database where relevant.

4.5 BORE LOCATION SURVEY

The location of each bore inspected was surveyed by ENRS using a hand-held GPS to record the easting and northing. In general, a hand-held unit is expected to be accurate to within five (5) metres where supported by sufficient satellite coverage. Records were saved digitally by ENRS within the GPS unit and recorded manually on designated field sheets.

4.6 BOREHEAD PHOTOGRAPH

Digital photos were taken at each bore census site with the GPS location embedded within the file. Multiple photos were taken to record the bore head and surrounding infrastructure, if any. Where the bore was equipped, the photo frame was set to include the complete infrastructure.

4.7 BORE CONSTRUCTION LOG

A key aim of the census was to document the bore construction at each site. Where available, a copy of the Driller's Log was provided by the landowner. Where a Driller's Log was not available, the existing bore details, namely: location; depth; date and construction, were applied to correlate the site data with a registered bore number/detail where possible.

Where the available information collected in the field confirmed the correlation with a registered number, the database summary report was utilised to provide additional details of bore construction.

4.8 DEPTH MEASUREMENTS

Where the bore condition and equipment provided down hole access, the depth of the bore was gauged using a groundwater interface probe. The water level dipper comprised a metre tape reel with a weighted probe. The probe is approximately 12 millimetre (mm) in diameter, however in the majority of situations where a bore is equipped with a pump it is not possible to insert the dipper into the bore as either: (1) the bore head is sealed; (2) there is insufficient access; or (3) there is a high risk that the dipper will become entangled between the pump column and electrical cables which may require removing the entire pump column.

Field notes were made where access was restricted or the depth of the bore and groundwater level could not be gauged. The depth to groundwater (DTW) was gauged and recorded in designated field sheets. The stick-up height of the bore casing above ground level was measured and recorded to facilitate an accurate calculation of the groundwater depth relative to ground level.

4.9 WATER QUALITY

4.9.1 Gas Screening

Prior to opening of any borehead fastening, a calibrated multigas probe was activated to obtain a sample of gas readings inside the borehead prior to any purging or disturbance. Where practical, levels were recorded for concentrations of CH_4, H_2S, CO, and O_2. No detections for gases were reported during the census to trigger any further sampling or investigation.

4.9.2 Field Testing

Groundwater quality was tested in the field where conditions permitted access. Sampling was conducted by the preferred methods in the following order:

1. Existing pump operated to purge bore by removing at least three (3) to five (5) bore volumes prior to collection of sample;
2. Existing pump operated to purge bore for as long as practical prior to collecting sample;
3. Bailer lowered manually in unequipped bores to collect grab sample; and
4. Sample obtained from tap or break in pump line.

Field testing was conducted immediately after sampling to record physical water parameters. A multi-probe water quality meter was used to measure the following parameters:

- Temperature;
- Electrical Conductivity (Salinity - EC);
- pH (Acidity);

- Dissolved Oxygen (DO); and
- Oxygen reduction potential (Redox / Eh).

Electrical Conductivity (EC) provides a measure of the total concentration of ion species and is widely used to assess the levels of dissolved salts in water (salinity). In general, drinking water is less than 800 µS/cm whilst sea water is 56,000 µS/cm.

Potential Hydrogen (pH) determines the balance between positive hydrogen ions (H+) and negative hydroxyl ions (OH-) and provides a test of water acidity (low pH) or alkalinity (high pH). Most natural freshwaters have a pH in the range 6.5 to 8.0 (ANZECC 2000) although groundwater can vary significantly due to bore construction and the host geology.

4.9.3 Sampling & Laboratory Analysis

Where further chemical testing was conducted, groundwater samples were collected from selected bores following adequate purging to obtain a representative sample. Groundwater samples for dissolved metal analysis were field filtered, using a disposable 0.45 µm membrane filter, prior to collection in acid preserved containers. Samples were sealed in laboratory prepared sampling containers appropriate for the analysis and clearly labelled with the sample identification. All samples were stored on ice immediately after their collection and transported to the laboratory under Chain of Custody (COC) documentation in general accordance with AS:5667 Sampling of Groundwaters (1998). A NATA registered laboratory was contracted to undertake the laboratory analysis in accordance with the NATA approved methods.

5.0 QUALITY ASSURANCE & QUALITY CONTROL

5.1 FIELD PROTOCOLS

The Quality Assurance and Quality Control (QA/QC) protocols used during the census fieldwork are shown below in **Table 1**.

Table 1: Field QA/QC

Protocol	Description
Census Team	Personnel comprised qualified environmental professionals & technical staff trained in conducting groundwater bore surveys.
Field Records	Bore data recorded both digitally and manually in designated field sheets.
Sample Equipment	All field testing equipment calibrated prior to operation. Sample equipment decontaminated between sample sites.
Chain of Custody Forms	All samples (if any) logged and transferred under appropriately completed Chain of Custody (COC) forms.

5.2 LABORATORY ANALYTICAL METHODS

Where chemical testing was undertaken, analysis of samples was conducted by a NATA accredited laboratory. QA/QC results are documented in the Laboratory Certificates of Analysis (COA).

5.3 DATA INTEGRITY ASSESSMENT

This bore census has utilised formal sources of information made publicly available by the Qld Government. These formal sources have been supplemented by information provided by the client, landowner, and observations made by ENRS professionals during site inspections.

Review and comparison of the groundwater records has been conducted to assess for and identify any significant data gaps or inconsistencies to trigger further investigations. Based on the sources and content obtained during the census, the data results may be considered to provide a reliable and satisfactory level of accuracy to support the record of groundwater bores for the development of the EIS groundwater model. Notwithstanding, the bore census findings for individual privately owned properties have been provided to the landowners for confirmation.

5.4 QA/QC DISCUSSION

The QA/QC indicators complied with the required standards. It is therefore concluded that the QA/QC results are adequate, and the quality of the census data is acceptable for use. A summary of the Data Quality performance is provided in **Table 2**.

Table 2: Data Quality Objectives and Criteria

Data Quality Objective (DQO)	Evaluation Criteria	Status
Documentation completeness	Completion of field records, equipment calibration, Site photos.	✓
Data comparability	Use of appropriate techniques for gauging, sampling, storage and transportation of samples. Use of NATA certified laboratory.	✓
Data representativeness	Census inspection covered all areas within a suitable radius surrounding the Project area.	✓
Precision & accuracy	Experienced and qualified field personnel. Appropriate field techniques & calibrated equipment.	✓

6.0 BORE CENSUS SUMMARY

6.1 REGISTERED BORE RECORDS AND PROPERTIES ACCESSED

The desktop review identified a number of registered bores on the Qld Government groundwater database with records distributed across Stages 1 and 2 of the bore census investigation area (Figure 1).

Twelve (12) properties were accessed and surveyed during the bore census between September 2017 and November 2017. The properties included:

- Iffley and Deverill (Pembroke-owned);
- Lake Vermont and Wynette (other resource company-owned); and
- Willunga, Seloh Nolem / Vermont Park, Leichardt, Meadowbrook, Olive Downs, Carfax, Cattle Camp Station and Winchester Downs (privately owned properties).

The total survey coverage for the 12 properties accessed was approximately 161,188ha.

6.2 LANDOWNER RECORDS

ENRS survey personnel met with the following landowners and/or representatives:

Property	Landowner representative
Iffley and Deverill	Adam Keytes
Willunga and Cattle Camp	Geoffrey & Richard Bethel
Seloh Nolem/Vermont Park	Roy Rogers
Wynette and Lake Vermont	Robert Berry
Meadowbrook	John Fingers
Winchester Downs	Ken Braithwaite
Olive Downs	Karen Braithwaite

ENRS survey personnel also held telephone conversations with the following landowner representatives:

Property	Landowner representative
Carfax	Bruce Pownall
Leichardt	Judy Pownall

6.3 EXISTING BORES (SUMMARY)

The following sub-sections provides a summary of the key information obtained during the bore census site inspections and ground truthing. Further details area provided in **Appendix A** (Bore Census Database) and **Appendix B** (Bore Census Bore Cards).

6.3.1 Ground Surfaces Elevations

Ground surface elevations as recorded by handheld GPS averaged 173.5 mAHD, with the lowest point surveyed being 135 mAHD (Carfax – Unknown Bore 2) and the highest point surveyed being 215 mAHD (Winchester Downs – 162460).

6.3.2 Observed Bore Purpose

Four (4) primary observed bore purposes were noted during the bore census:

- Domestic supply (six (6) bores surveyed):
  - Cattle Camp – 161572
  - Cattle Camp – 161573
  - Olive Downs – Bore 9
  - Carfax – 90076
  - Deverill – 141677
  - Iffley - 136090
- Exploration bore (one (1) bore surveyed);
- Groundwater monitoring bore (seventeen (17) bores surveyed); and
- Stock watering supply (forty-seven (47) bores surveyed).

During site inspections twenty-six (25) bores were identified as equipped bores with pumping equipment deployed downhole, which either restricted or prevented field gauging of total bore depth, standing water level (SWL) and water quality measurements.

6.3.3 Borehead Gas Measurements

During the field survey borehead gas readings were conducted using a multigas probe where access permitted. When a bore presented with a removable cap a gas sample line was inserted into the well head with minimal exposure to the atmosphere. If the bore was not capped at the time of inspection the gas sample line was inserted into the borehead and a temporary cover emplaced to reduce the influence of atmospheric exposure. A summary of borehead gas readings is presented in the following sub-sections.

6.3.3.1 Methane (CH_4)

Methane is produced by anaerobic decay of organic matter and is a major component of common coal seam gas.

Borehead gas readings for methane only reported concentrations above the detectable limit (0.1%) in three (3) of the surveyed bores. These concentrations were

0.4% (Carfax – 151344/1), 0.6% (Wynette – Bore 3) and 2.4% (Winchester Downs – 15).

6.3.3.2 Hydrogen Sulphide (H_2S)

Hydrogen sulphide is commonly present in bore water due the presence of sulphate reducing bacteria and may also be a component of common coal seam gas.

Borehead gas readings for hydrogen sulphide only reported concentrations above the detectable limit (1ppm) in seven (7) boreheads.

Of these, the only borehead to present with gas concentrations above 2ppm was Meadowbrook – 122458/1 with a H_2S concentration of 26ppm.

6.3.3.3 Carbon Monoxide (CO)

Carbon monoxide is produced from the partial oxidation of carbon containing compounds and is commonly present at background atmospheric concentrations of ~0.1ppmv.

Borehead gas readings for carbon monoxide only reported concentrations above the detectable limit (1ppm) in six (6) boreheads. In these boreheads carbon monoxide concentrations ranged from 2ppm (Cattle Camp – 161572, Cattle Camp – 161573, Winchester Downs – 162460, Leichardt – Unknown 1) to 18ppm (Cattle Camp – 161574).

6.3.4 Water Quality

During the field survey, groundwater samples were collected where access permitted for the purpose of recording field parameters. A summary of water quality field parameters is presented below.

6.3.4.1 Electrical Conductivity (EC)

EC is a measure of the total dissolved solids and salinity. In general, fresh waters will have an EC of less than 1,470 µS/cm and the upper threshold for beef cattle stock watering is approximately 6,250 µS/cm (ANZECC 2000).

The EC of groundwaters surveyed during the bore census varied greatly with location and the depth of the bore. The average EC value of bores surveyed was 2,374 µS/cm with a minimum EC value of 140 µS/cm (Leichardt – Unknown 2) and a maximum value of 16,610 µS/cm (Lake Vermont – Unknown 1).

It should be noted that the primary method utilised for collecting groundwater samples during the field survey was by bailer grab samples as the purging of bores was not practical. As a result, the potential exists for the water present in the bore to be both stagnant and stratified. Furthermore, eighteen (18) boreholes were observed not to be fitted with a surface cap at the time of survey. This allows for the potential dilution of groundwater by rainfall.

6.3.4.2 pH

pH is a measure of hydrogen activity. pH determines the balance between positive hydrogen ions (H+) and negative hydroxyl ions (OH-) and provides a test of water acidity (low pH) or alkalinity (high pH). Most natural freshwaters have a pH in the range 6.5 to 8.0. Changes in pH may affect the physiological functioning of biota and affect the toxicity of contaminants. Both increases and decreases in pH can result in adverse effects, although decreases are likely to cause more significant problems.

Low pH indicates acidic conditions which may increase the mobility of heavy metals, whilst high pH indicates alkaline conditions.

The pH of groundwaters surveyed during the bore census are within the range of anticipated naturally occurring values. The average pH value of bores surveyed is pH 7.03 with a minimum pH of 5.98 (Winchester Downs – 141382) and a maximum pH of 8.2 (Cattle Camp – 161572).

6.3.4.3 Oxidisation Reduction Potential (Redox)

Oxidation Reduction Potential (ORP) is a measure of the capacity to either release electrons (positive=oxidation) or gain electrons (negative=reduction). Redox reactions govern the biological degradation of some contaminants and the mobility of many compounds such as nitrogen and sulphur. Microorganisms, such as bacteria, obtain energy for growth by transferring electrons from an electron donor to an electron acceptor. Biodegradation of potential organic contaminants will rapidly deplete DO levels. Once DO levels are depleted, anaerobic microorganisms will typically use available electron acceptors in the following order: nitrate, Mn(IV), Fe(III) hydroxide, sulfate, and carbon dioxide. Interpretation of ORP is also affected by ionic concentrations, as indicated by salinity.

The ORP of groundwaters surveyed during the bore census vary greatly. The average ORP of bores surveyed is -30.7 mV with a minimum ORP of -320 mV (Meadowbrook – Bullock Paddock) and a maximum ORP of 187.2 (Lake Vermont – Yard Bore 1).

6.4 DISCUSSION

Groundwater resources across the Project area and surrounds recorded a wide range in depth, yield and conductivity values, associated with the borehole location, depth and construction. From review of Qld Government groundwater database records and data collected during the bore census survey the following discussion is provided:

- Isaac River Alluvium - through the centre of the census investigation area the primary source of lower salinity groundwater is associated with bores constructed in alluvium deposits along the Isaac River. In general, bores targeting this resource are approximately 20 metres in depth with a SWL noted to be commensurate with surface water level observed in the Isaac River. Water samples collected from bores targeting the Isaac Alluvium recorded an average EC reading of 924 µS/cm with a minimum of 199 µS/cm (Carfax 13040180) and a maximum of 2,903 µS/cm (Wynette – Bore 2);

- Sedimentary Rock Aquifers - In the north eastern portion of the census investigation area the primary source of groundwater are deep sedimentary units. Bores targeting this resource are generally in excess of 80m depth with screened intervals ranging from 46m to 53m below ground level (Cattle Camp – 161573) and 77m to 161m below ground level (Cattle Camp – 161572). Water samples collected from bores in this region recorded an average EC reading of 973 µS/cm with a minimum of 499 µS/cm (Cattle Camp – 161575) and a maximum of 2,208 µS/cm (Cattle Camp – 161578);

- Other bores in the census investigation area were noted to target either natural drainage lines or coal seams that were reported during historic exploration programs; and
- From discussions and meetings with various landowners and property managers it is apparent that away from the Isaac River finding groundwater within an acceptable conductivity range and with adequate supply to warrant equipping for pumping is difficult. It is further noted that from review of the Qld Government database records for bores that were unable to be located or known not to exist, that many of these were likely to be test bores that encountered groundwater of high salinity and/or groundwater of low yield and the bore was subsequently abandoned.

7.0 CONCLUSIONS & RECOMMENDATIONS

Based on the findings and borehole data obtained during the scope of works the following conclusions and recommendations are provided:

- A groundwater bore census was completed between September 2017 and November 2017 which included survey of 12 properties within the Project area and surrounds with a total coverage of approximately 161,188ha;
- The bore census database combines staged results from desktop reviews, communications with landowners and property managers, site inspections and borehead surveys, and supplemented by Driller's Logs, records and registered bore reports (where available);
- Eight (8) of the twelve (12) properties accessed are privately owned;
- Four (4) primary observed bore purposes were noted during the bore census, including:
  - Six (6) domestic supply bores;
  - Forty-seven (47) stock supply bores;
  - Seventeen (17) groundwater monitoring bores; and
  - One (1) exploration bore.
- The census methodology QA/QC indicators complied with the required standards. Hence, the census results are considered adequate and the quality of the census data is acceptable for development of the EIS groundwater model;
- A summary of the census records is tabled in **Appendix A** with supporting information including bore census cards provided in **Appendix B**; and
- This report must be read in conjunction with the Statement of Limitations in **Section 9.0.**

8.0 REFERENCES

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9.0 LIMITATIONS

This report and the associated services performed by ENRS are in accordance with the scope of services set out in the contract between ENRS and the Client. The scope of services was defined by the requests of the Client, and primarily by the availability of access to Site.

ENRS derived the data in this report primarily from visual inspections, and, limited sample collection and analysis made on the dates indicated. In preparing this report, ENRS has relied upon, and presumed accurate, certain information provided by government authorities, the Client and others identified herein. The report has been prepared on the basis that while ENRS believes all the information in it is deemed reliable and accurate at the time of preparing the report, it does not warrant its accuracy or completeness and to the full extent allowed by law excludes liability in contract, tort or otherwise, for any loss or damage sustained by the Client arising from or in connection with the supply or use of the whole or any part of the information in the report through any cause whatsoever.

Limitations also apply to analytical methods used in the identification of substances (or parameters). These limitations may be due to non-homogenous material being sampled (i.e. the sample to be analysed may not be representative), low concentrations, the presence of 'masking' agents and the restrictions of the approved analytical technique. As such, non-statistically significant sampling results can only be interpreted as 'indicative' and not used for quantitative assessments.

The data, findings, observations, conclusions and recommendations in the report are based solely upon the state of Site at the time of the investigation. The passage of time, manifestation of latent conditions or impacts of future events (e.g. changes in legislation, scientific knowledge, land uses, etc) may render the report inaccurate. In those circumstances, ENRS shall not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance on, the contents of the report.

This report has been prepared on behalf of and for the exclusive use of the Client, and is subject to and issued in connection with the provisions of the agreement between ENRS and the Client. ENRS accepts no liability or responsibility whatsoever and expressly disclaims any responsibility for or in respect of any use of or reliance upon this report by any third party or parties.

It is the responsibility of the Client to accept if the Client so chooses any recommendations contained within and implement them in an appropriate, suitable and timely manner.

Appendix A:

Bore Census Database

Survey Date	Property	Bore_ID	Local Bore Name	Ref No/GW Number	Survey Personnel	Easting	Northing	Elevation mAHD (handheld)	Observed Purpose	TD_(mbTOC) Field Measured	Stick_up_(m) Field Measured	SWL_(mbTOC) Field Measured	EC (µS/cm)	Temperature (°C)	pH	ORP (mv)	DO (%)	CH_4	H_2S	CO	O_2	Meeting With Land Representative
15/11/2017	Carfax	Carfax - 13040180	-	13040180	ML + TF	667825	7516351	147	monitoring	28	0	16.24	199	26	7.54	-75.3	20.6	0	0	0	20.3	phone call
15/11/2017	Carfax	Carfax - Unknown Bore 2	Unknown Bore 2	-	ML + TF	670294	7516425	135	stock	-	1.35	-	-	-	-	-	-	0	0	0	19.1	phone call
15/11/2017	Carfax	Carfax - Unknown Bore 1	Unknown Bore 1	-	ML + TF	670295	7516420	145	stock	17.8	0.3	13.765	343	27.5	6.01	-76	19.6	0	0	1	19.3	phone call
15/11/2017	Carfax	Carfax - 90074/2	3 Mile - 2	90074	ML + TF	671877	7511442	157	stock	-	0.29	-	-	-	-	-	-	-	-	-	-	phone call
15/11/2017	Carfax	Carfax - 90074/3	3 Mile - 3	90074	ML + TF	671883	7511437	153	stock	-	0.35	-	-	-	-	-	-	-	-	-	-	phone call
15/11/2017	Carfax	Carfax - 90074/1	3 Mile - 1	90074	ML + TF	671886	7511445	157	stock	-	0.46	-	-	-	-	-	-	-	-	-	-	phone call
15/11/2017	Carfax	Carfax - 90076	House Bore	90076	ML + TF	672641	7515517	144	stock and domestic	-	0.515	-	-	-	-	-	-	-	-	-	-	phone call
15/11/2017	Carfax	Carfax - 103515	-	103515	ML + TF	674298	7517580	143	stock	-	0.39	-	-	-	-	-	-	-	-	-	-	phone call
15/11/2017	Carfax	Carfax - 103082	2nd Bridge Bore	103082	ML + TF	674586	7517730	148	stock	-	1.2	-	-	-	-	-	-	-	-	-	-	phone call
15/11/2017	Carfax	Carfax - 90075	Bridge Bore	90075	ML + TF	674591	7517833	144	stock	-	0.29	-	-	-	-	-	-	-	-	-	-	phone call
15/11/2017	Carfax	Carfax - 90440	Spelt Paddock Bore	90440	ML + TF	674723	7515024	156	stock	-	0.35	-	-	-	-	-	-	-	-	-	-	phone call
11/09/2017	Cattle camp	Cattle camp - 13040286	-	13040286	ML + TF	659986	7536977	165	Monitoring	-	0.41	-	-	-	-	-	-	-	-	-	-	no
30/09/2017	Cattle camp	Cattle Camp Gully	Cattle Camp Gully	-	ML + TF	671137	7536973	154	Stock	89.8	0.4	7.31	900	26.82	7.7	-132.3	19.3	0	1	1	19.3	yes
30/09/2017	Cattle camp	Cattle camp - 161 575	Rosewood	161 575	ML + TF	672394	7543106	198	Stock	83.5	0.36	28.07	499	27.98	6.71	103	23.6	0	0	6	18.2	yes
30/09/2017	Cattle camp	Cattle camp - 161573	House Supply	161573	ML + TF	672562	7538229	175	Domestic	57.8	0.33	37	710	28.72	6.84	98.6	28.5	0	0	2	19.5	yes
30/09/2017	Cattle camp	Cattle camp - 161572	House Bore	161572	ML + TF	672572	7538233	178	Domestic	184.65	0.28	37.715	631	27.9	8.2	47.3	49.3	0	0	2	19.5	yes
30/09/2017	Cattle camp	Cattle camp - 161578	Powerline	161578	ML + TF	672586	7535520	191	Stock	114	0.58	47.435	2,208	28.97	7.05	-238.90	21.50	0	0	1	19.6	yes
2/10/2017	Cattle camp	Cattle camp - 88992	Mandle Brot Bore	88992	ML + TF	672888	7537124	156	Stock	-	0.42	-	-	-	-	-	-	-	-	-	-	yes
30/09/2017	Cattle camp	Cattle camp - 161574	KP	161574	ML + TF	673374	7543006	203	Stock	121.9	0.5	25.75	889	27.63	7.39	-195.3	22.6	0	0	18	17.9	yes
1/10/2017	Cattle camp	Cattle camp - 111719	Bore Behind Dam	111719	ML + TF	673489	7537157	149	Stock	-	0.45	-	-	-	-	-	-	-	-	-	-	yes
12/09/2017	Deverill	Deverill - 141677	-	141677	ML + AF	642164	7548178	191	Domestic	10.05	0.45	Dry	-	-	-	-	-	0	0	0	18.4	yes
12/09/2017	Iffley	Iffley - 136090	Homestead Bore	136090	ML + AF	647486	7540034	183	Domestic	22.68	0.28	12.71	2187	26.37	6.62	83.7	55.4	0	0	0	20	Yes
12/11/2017	Lake Vermont	Lake Vermont - 158011	-	158011	ML + TF	640150	7514275	194	Monitoring	33.18	0.79	18.3	6340	25.9	7.03	-205	35.5	0	2	0	21.4	yes
12/11/2017	Lake Vermont	Lake Vermont - 165325	-	165325	ML + TF	640412	7516077	188	Monitoring	18.58	0.87	17.203	1439	27.9	6.96	33.2	27.4	0	0	1	13.4	yes
12/11/2017	Lake Vermont	Lake Vermont - Powerline bore	Powerline bore	-	ML + TF	641899	7519646	190	stock	-	0.34	-	1443	26.4	7.28	120.8	54.6	-	-	-	-	yes
12/11/2017	Lake Vermont	Lake Vermont - Yard Bore 1	Yard Bore 1	-	ML + TF	642611	7519351	185	stock	96	0.34	21.385	1512	25.6	7.49	187.2	58.9	0	0	0	20.4	yes
12/11/2017	Lake Vermont	Lake Vermont - Yard Bore 2	Yard Bore 2	-	ML + TF	642617	7519347	190	stock	-	0.04	-	-	-	-	-	-	-	-	-	-	yes
12/11/2017	Lake Vermont	Lake Vermont - 158010	-	158010	ML + TF	642638	7520120	186	Monitoring	35.2	0.9	17.915	1236	27.1	6.95	9.1	31.1	0	0	0	21.4	yes
12/11/2017	Lake Vermont	Lake Vermont - 158481 (VWP)	-	158481	ML + TF	643243	7522128	185	Monitoring	-	0.8	-	-	-	-	-	-	-	-	-	-	yes
12/11/2017	Lake Vermont	Lake Vermont - 158485	-	158485	ML + TF	643243	7522125	181	Monitoring	22.95	0.78	14.257	560	28.9	7.19	-12.1	25.6	0	0	0	21	yes
12/11/2017	Lake Vermont	Lake Vermont - 165122 (VWP)	-	165122	ML + TF	644182	7520541	181	Monitoring	-	0.7	-	-	-	-	-	-	-	-	-	-	yes
11/11/2017	Lake Vermont	Lake Vermont - 158483	-	158483	ML + TF	645638	7522932	171	Monitoring	20.71	0.74	DRY	-	-	-	-	-	0	0	1	16.1	yes
11/11/2017	Lake Vermont	Lake Vermont - 158482(VWP)	-	158482	ML + TF	645638	7522933	174	Monitoring	-	0.8	-	-	-	-	-	-	-	-	-	-	yes
11/11/2017	Lake Vermont	Lake Vermont - 165123 (VWP)	-	165123	ML + TF	647629	7526188	164	Monitoring	-	0.74	-	-	-	-	-	-	-	-	-	-	yes
11/11/2017	Lake Vermont	Lake Vermont - 158484	-	158484	ML + TF	648152	7524058	163	Monitoring	19.45	0.85	18.116	1401	26.8	7.18	112.8	62.8	0	0	1	13.5	yes
11/11/2017	Lake Vermont	Lake Vermont - 165124 (VWP)	-	165124	ML + TF	648156	7524044	163	Monitoring	-	0.49	-	-	-	-	-	-	-	-	-	-	yes

Survey Date	Property	Bore_ID	Local Bore Name	Ref No/GW Number	Survey Personnel	Easting	Northing	Elevation mAHD (handheld)	Observed Purpose	TD_(mbTOC) Field Measured	Stick_up_(m) Field Measured	SWL_(mbTOC) Field Measured	EC (µS/cm)	Temperature (°C)	pH	ORP (mv)	DO (%)	CH_4	H_2S	CO	O_2	Meeting With Land Representative
11/11/2017	Lake Vermont	Lake Vermont - 158480 (VWP)	-	158480	ML + TF	649913	7522233	166	Monitoring	-	-	-	-	-	-	-	-	-	-	-	-	yes
11/11/2017	Lake Vermont	Lake Vermont - Unknown 1	-		ML + TF	650783	7522929	160	exploration	131	0.16	30.965	16610	27.9	6.56	49.9	30.6	0	0	1	19.8	yes
11/11/2017	Lake Vermont	Lake Vermont - River Bore	River Bore	-	ML + TF	654027	7526947	166	stock	39	0.55	14.614	616	26.1	6.5	43	37	0	0	0	19	yes
14/11/2017	Leichardt	Leichardt - 136091/1	-	136091	ML + TF	650061	7508592	174	Stock	77	0.18	45.087	1662	27.3	6.79	-84.9	30.6	0	0	1	20.2	yes
14/11/2017	Leichardt	Leichardt - 136091/2	-	136091	ML + TF	650091	7508608	171	Stock	-	0.32	-	-	-	-	-	-	-	-	-	-	yes
14/11/2017	Leichardt	Leichardt - 136091/4	-	136091	ML + TF	650106	7508653	168	Stock	56	0.34	45.407	4419	27.2	7.06	58.4	15.6	0	0	1	19.4	yes
14/11/2017	Leichardt	Leichardt - 136091/3	-	136091	ML + TF	650116	7508649	186	Stock	85	0.47	46.65	4750	27.6	6.85	-119.4	30.1	0	0	1	19.1	yes
14/11/2017	Leichardt	Leichardt - Unknown 1	Yard Bore Large	-	ML + TF	656849	7515959	149	Stock	74	0.27	11.705	1324	26.6	6.95	99.2	46	0	0	2	19.8	yes
14/11/2017	Leichardt	Leichardt - Unknown 2	Yard Bore Small	-	ML + TF	656850	7515962	149	Stock	178	0.13	11.26	140	26.2	6.85	106.8	37.1	0	0	1	19	yes
18/11/2017	Meadowbrook	Meadowbrook - 132631	Iffley	132631	ML + TF	635452	7528174	200	stock	*328	0.59	-	-	-	-	-	-	-	-	-	-	yes
18/11/2017	Meadowbrook	Meadowbrook - Bullock Paddock	Bullock Paddock	-	ML + TF	636052	7528117	185	stock	50.2	0.3	21.625	6212	28.5	7.39	-320	1.4	0	1	0	20.2	yes
18/11/2017	Meadowbrook	Meadowbrook - Power Bore	Power Bore	-	ML + TF	641260	7520977	186	stock	-	0.46	16.5	-	-	-	-	-	0	0	0	19.9	yes
18/11/2017	Meadowbrook	Meadowbrook - Black Tank	Black Tank	-	ML + TF	642742	7521198	173	stock	-	0.385	-	-	-	-	-	-	0	0	1	19.2	Yes
18/11/2017	Meadowbrook	Meadowbrook - 122458/2	Rolfies #2	122458	ML + TF	644971	7526779	174	stock	103	0.15	21.74	8666	28.2	7.32	-267.7	2.5	0	1	1	18.8	yes
18/11/2017	Meadowbrook	Meadowbrook - 122458/1	Rolfies #1	122458	ML + TF	644973	7526776	172	stock	52.2	0.72	22.335	5098	28.2	7.29	-290	30.7	0	26	0	19.7	yes
18/11/2017	Meadowbrook	Meadowbrook - Swamp Bore	Swamp Bore	-	ML + TF	645595	7528661	171	stock	85	0.25	17.523	1078	27.7	7	-62	34	0	1	0	20.1	yes
13/11/2017	Olive Downs	Olive Downs - 162439	MB8	-	ML + TF	631866	7553657	196	Monitoring	12.578	0.7	12.517	-	-	-	-	-	0	0	1	10.7	Yes
13/11/2017	Olive Downs	Olive Downs - Bore 9	House Bore	162439	ML + TF	633886	7553064	189	Domestic	-	0.19	-	935.8	32	7.01	39.1	24.5	-	-	-	-	yes
13/11/2017	Olive Downs	Olive Downs - 162472	-	162472	ML + TF	635533	7554547	193	Monitoring	91.2	0.9	23.33	-	-	-	-	-	0	0	1	20.7	yes
13/11/2017	Olive Downs	Olive Downs - Bore 7	Saltwater Bore	-	ML + TF	637518	7552628	192	Stock	16.75	0.39	15.695	994	25.3	6.75	-109.9	24	0	0	0	20.2	yes
13/11/2017	Olive Downs	Olive Downs - Bore 8	5 Mile Bore	-	ML + TF	640186	7547990	188	Stock	-	0.1	-	-	-	-	-	-	-	-	-	-	yes
13/09/2017	Willunga	Willunga - 97181	Pisscutter	97181	ML + AF	656325	7523641	167	stock	19.77	0.8	12.69	298	26.31	6.93	90.1	30.96	0	0	1	19.9	yes
17/09/2017	Willunga	Willunga - 97182	Blue Pump 5"	97182	ML + AF	657944	7521843	165	stock	20.92	0.65	13.13	472.5	26.26	7.24	-142.1	26.53	0	0	0	19.9	yes
17/09/2017	Willunga	Willunga - 97183	Blue Pump 8"	97183	ML + AF	657950	7521838	165	stock	-	0.7	-	-	-	-	-	-	0	0	0	19.2	yes
17/09/2017	Willunga	Willunga - 97184	Leichardt Bore	97184	ML + AF	659014	7519480	163	stock	20.63	0.78	14.615	598.5	25.68	6.79	45.9	32.51	0	0	1	19.6	yes
17/09/2017	Willunga	Willunga - 97185	Bottom Bore	97185	ML + AF	659239	7519220	164	stock	19.53	0.73	14.25	442.8	26.23	7.12	-95.6	24.4	0	0	1	20.1	yes
10/11/2017	Winchester Downs	Winchester Downs - 162460	Number One	162460	ML + TF	627204	7546953	215	stock	11.23	0.36	dry	-	-	-	-	-	0	0	2	10.5	yes
10/11/2017	Winchester Downs	Winchester Downs - 141382	-	141382	ML + TF	628494	7542693	205	Monitoring	51.3	0.5	14.929	2281	27	5.98	-176.8	35.7	0	0	1	18.3	yes
10/11/2017	Winchester Downs	Winchester Downs - 14	-	-	ML + TF	628742	7546690	202	Stock	14.4	0.27	3.59	3003	25.3	7.17	-135	34.5	0	0	0	19.4	yes
10/11/2017	Winchester Downs	Winchester Downs - 15	-	-	ML + TF	629039	7546882	204	stock	23.4	0.2	9.67	2063	25.4	7.5	-178.4	28	2.4	0	1	11.3	yes
10/11/2017	Winchester Downs	Winchester Downs - White Tank	White Tank	-	ML + TF	629347	7542483	212	Stock	53	0.48	17.133	1721	26.1	6.66	174.5	32.9	0	0	0	18.8	yes
10/11/2017	Winchester Downs	Winchester Downs - Lemon Tree	Lemon Tree	-	ML + TF	630655	7551954	195	stock	-	0.51	-	-	-	-	-	-	-	-	-	-	yes
29/09/2017	Wynette	Wynette - Bore 3	Bore 3	-	ML + TF	634785	7550009	187	stock	94	0.6	15.91	6677	26.79	7.44	43.5	28.3	0.6	0	0	19.8	yes
29/09/2017	Wynette	Wynette - Bore 2	Bore 2	-	ML + TF	634788	7550024	191	stock	19.85	0.61	15.97	2903	30.9	6.69	124	27.13	0	0	1	11.9	yes
29/09/2017	Wynette	Wynette - Bore 1	Bore 1	-	ML + TF	634791	7550019	189	stock	-	0.5	-	-	-	-	-	-	-	-	-	-	yes

Appendix B:

Bore Census Bore Cards

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	15/11/2017	**SURVEY PERSONNEL:**	ML + TF	**BORE ID:**	**Carfax - 13040180**

PART A: PROPERTY DETAILS

Property Name:	Carfax		
Local Bore Name:	-	**Ref No/GW Number:**	13040180
Easting (GDA94):	667825	**GPS Elevation:**	147
Northing:	7516351		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**28**	**Year Drilled:**	1970
Casing Stick Up (SU):	**0**	**Drilled By**	**IWSC**
Casing Material	**Steel**	**Internal Diameter**	200
Initial Water Quality Measurement (Driller Log)	6000 µS/cm		
Construction Summary (Driller Log)	**PVC Slotted 0-28.5**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**yes**	**Condition**	**good**	**Pump Type**	no
Power Source	**no**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	no
Headworks	**no**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**monitoring**	**Pumping Regime**	no
Storage Type	**no**	**Approximate Volume**	no

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**16.24**	**Date / Time of Measurement:**	8:20:00 AM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**0**	**O_2 %:**	**20.3**
Sample Collection Point	**bore**	**Sample Method**	**bailer**			**Purge Volume**	**2**		
Electrical Conductivity (µS/cm)	**199**	**Temp**	**26**	**pH**	**7.54**	**ORP**	**-75.3**	**DO (%)**	**20.6**

COMMENTS

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GROUNDWATER BORE REPORT CARD

Additional Notes

Bottom of well felt silty

SUPPORTING INFORMATION	**Drillers Log**	**yes**	**Meeting With Land Representative**	**phone call**	**Photo**	yes

PHOTOGRAPHIC RECORD

Photograph 1	**Carfax - 13040180**

Photograph 2	**Carfax - 13040180**

BORE REPORT

REG NUMBER 13040180

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-27-04	**MAP-SCALE**	104
OFFICE	Rockhampton	**SUB-AREA**	IR	**LONGITUDE**	148-37-51	**MAP-SERIES**	M
DATE LOG RECD		**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	667824	**MAP-NO**	8653
D/O FILE NO.	520/001(69)	**LOT**		**NORTHING**	7516333	**MAP NAME**	BOMBANDY
R/O FILE NO.	81-01045	**PLAN**		**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**	RD RSV ADJ P9	**ACCURACY**		**PRES EQUIPMENT**	NE
				GPS ACC			
GIS LAT	-22.45106271	**PARISH NAME**	6000-NO LONGER USED			**ORIGINAL BORE NO**	B1S1
GIS LNG	148.63092451	**COUNTY**				**BORE LINE**	BOM-BOMBANDY LINE
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	07/12/1970			**DATA OWNER**	DNR
STATUS	Existing	**DRILLERS NAME**	ERNST L				
ROLES	IN	**DRILL COMPANY**	IWSC				
	SM	**METHOD OF CONST.**	CABLE TOOL				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	07/12/1970	1	Polyvinyl Chloride	3.100	WT	60	0.00	28.50
A	07/12/1970	2	Perforated or Slotted Casing		AP	60		28.50

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	0.30	TOP SOIL
3	0.30	3.04	CLAYEY SAND
5	3.04	4.87	CLAYBOUND SAND
7	4.87	9.44	CLAY
9	9.44	11.58	SANDY CLAY
11	11.58	14.32	CLAY
13	14.32	18.28	SAND

BORE REPORT

REG NUMBER 13040180

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
15	18.28	21.79	CLAYEY SAND
17	21.79	24.53	SANDY CLAY
19	24.53	24.68	SAND
21	24.68	30.78	CLAYEY SAND
23	30.78	32.00	DECOMPOSED ROCK

STRATIGRAPHY DETAILS

SOURCE	RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
DNR	1	0.00	30.80	ISAAC RIVER ALLUVIUM

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	24.00	30.00	SAND	07/12/1970	-17.20	N	6000 US/CM		Y	UC	ISAAC RIVER ALLUVIUM

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

PIPE	DATE	ELEVATION	PRECISION	DATUM	MEASUREMENT POINT	SURVEY SOURCE
A	13/07/1971	145.08	SVY	STD	R	
X	13/07/1971	144.98	SVY	STD	N	

WATER ANALYSIS PART1

BORE REPORT

REG NUMBER 13040180

PIPE	DATE	RD	ANALYST	QAN	DEPTH (m)	RMK	SRC	COND (uS/cm)	pH	Si (mg/L)	TOTAL IONS (mg/L)	TOTAL SOLIDS (mg/L)	HARD	ALK	FIG. OF MERIT	SAR	RAH
A	17/05/1971	1	GCL	048750	31.00	BA	GB	6000	7.5		3659.30	3430.06	390	370	0.1	26.3	
A	25/07/1989	1	GCL	130767	31.00	PU	GB	4050	8.4	5	2653.00	2271.69	143	652		30.6	10.17
A	03/10/1990	1	GCL	136449		PU	GB	3980	8.5	3	2755.53	2364.23	123	673	0.1	34.7	10.99
A	15/07/1999	1	GCL	201500		PU	GB	5290	9.0	2	3598.61	3169.70	197	833	0.1	37.5	12.71

WATER ANALYSIS PART 2

PIPE	DATE	RD	Na	K	Ca	Mg	Mn	HCO3	Fe	CO3	Cl	F	NO3	SO4	Zn	Al	B	Cu
A	17/05/1971	1	1195.0		26.0	79.0		451.0			1710.0	0.30		198.0				
A	25/07/1989	1	840.0	4.3	11.0	28.0	0.05	760.0	0.05	17.0	980.0	0.10	2.5	10.0				
A	03/10/1990	1	886.0	4.1	5.7	26.5	0.00	776.1	0.00	22.0	1032.0	0.16	2.9	0.0				
A	15/07/1999	1	1209.5	5.3	3.9	45.5	0.01	848.1	0.00	82.3	1316.3	0.02	0.0	87.4	0.00	0.00	0.20	0.00

WATER LEVEL DETAILS

PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE
A	07/12/1970	-17.30	R		NR	A	13/07/1971	-17.05	R		NR	A	28/09/1971	-17.00	R		NR
A	17/11/1971	-17.05	R		NR	A	11/12/1974	-16.90	R		NR	A	16/04/1975	-16.68	R		NR
A	02/07/1975	-16.65	R		NR	A	07/10/1975	-16.67	R		NR	A	25/11/1975	-15.03	R		NR
A	06/04/1976	-14.01	R		NR	A	07/07/1976	-14.43	R		NR	A	21/09/1976	-16.40	R		NR
A	16/11/1976	-16.42	R		NR	A	23/02/1977	-16.40	R		NR	A	14/04/1977	-16.30	R		NR
A	28/06/1977	-16.34	R		NR	A	06/09/1977	-16.32	R		NR	A	06/12/1977	-16.25	R		NR
A	07/03/1978	-16.18	R		NR	A	27/06/1978	-16.10	R		NR	A	05/09/1978	-16.13	R		NR
A	01/12/1978	-16.37	R		NR	A	03/04/1979	-15.92	R		NR	A	02/08/1979	-15.90	R		NR
A	13/11/1979	-15.95	R		NR	A	11/03/1980	-15.41	R		NR	A	03/06/1980	-15.40	R		NR
A	09/09/1980	-15.45	R		NR	A	03/12/1980	-15.58	R		NR	A	24/02/1981	-15.32	R		NR
A	28/04/1981	-15.38	R		NR	A	28/07/1981	-15.32	R		NR	A	30/09/1981	-15.52	R		NR
A	01/12/1981	-15.50	R		NR	A	01/09/1982	-15.90	R		NR	A	10/08/1983	-12.65	R		NR
A	14/03/1984	-16.00	R		NR	A	04/09/1984	-16.00	R		NR	A	13/02/1985	-16.15	R		NR
A	12/09/1985	-15.70	R		NR	A	03/03/1986	-15.68	R		NR	A	09/07/1986	-15.70	R		NR
A	13/08/1987	-16.40	R		NR	A	25/07/1989	-15.76	R		NR	A	07/12/1989	-15.77	R		NR
A	04/10/1990	-15.75	R		NR	A	27/03/1991	-15.26	R		NR	A	14/08/1991	-15.28	R		NR
A	28/09/1994	-15.75	R		NR	A	27/03/1996	-16.00	R		NR	A	10/07/1996	-16.07	R		NR

GROUNDWATER DATABASE

BORE REPORT

REG NUMBER 13040180

PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE
A	01/10/1996	-16.06	R		NR	A	15/01/1997	-16.21	R		NR	A	28/05/1997	-16.25	R		NR
A	08/08/1997	-16.31	R		NR	A	12/11/1997	-16.39	R		NR	A	01/04/1998	-16.50	R		NR
A	20/07/1998	-16.58	R		NR	A	16/12/1998	-16.45	R		NR	A	15/07/1999	-16.49	R		NR
A	30/11/1999	-16.55	R		NR	A	28/03/2000	-16.65	R		NR	A	28/06/2000	-16.63	R		NR
A	20/02/2001	-16.65	R		NR	A	09/05/2001	-16.67	R		NR	A	20/07/2001	-16.76	R		NR
A	07/11/2001	-16.82	R		ACT	A	21/08/2002	-17.01	R		ACT	A	14/01/2003	-17.27	R		ACT
A	22/07/2003	-17.30	R		ACT	A	23/09/2003	-17.34	R		ACT	A	20/02/2004	-17.43	R		ACT
A	29/03/2004	-17.53	R		ACT	A	21/11/2005	-17.97	R		ACT	A	02/03/2006	-18.07	R		ACT
A	12/05/2006	-18.14	R		ACT	A	22/08/2006	-18.11	R		ACT	A	17/12/2006	-18.26	R		ACT
A	03/04/2007	-18.28	R		NR	A	26/07/2007	-18.27	R		NR	A	09/10/2007	-18.24	R		ACT
A	17/12/2007	-18.26	R		ACT	A	03/04/2008	-17.85	R		ACT	A	08/08/2008	-17.70	R		ACT
A	28/10/2008	-18.11	R		NR	A	17/12/2008	-17.66	R		ACT	A	01/04/2009	-17.60	R		ACT
A	11/06/2009	-17.61	R		ACT	A	01/12/2009	-17.65	R		ACT	A	31/05/2010	-17.57	R		ACT
A	12/05/2011	-16.10	R		ACT	A	25/10/2011	-16.49	R		ACT	A	16/01/2013	-16.61	R		ACT
A	09/04/2013	-16.50	R		ACT	A	01/08/2013	-16.43	R		ACT	A	19/11/2013	-16.42	R		ACT
A	05/02/2014	-15.34	R		NR	A	21/05/2014	-16.37	R		ACT	A	16/09/2014	-16.41	R		ACT
A	13/01/2015	-16.39	R		NR	A	14/04/2015	-16.38	R		ACT	A	08/07/2015	-16.43	R		ACT
A	22/09/2015	-16.44	R		ACT	A	12/01/2016	-16.48	R		ACT	A	24/05/2016	-16.44	R		ACT
A	02/08/2016	-16.34	R		ACT	A	08/11/2016	-16.34	R		ACT	A	07/02/2017	-16.33	R		ACT
A	06/06/2017	-16.22	R		ACT	A	12/09/2017	-16.26	R		ACT						

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

FIELD MEASUREMENTS

PIPE	DATE	DEPTH (m)	COND (uS/cm)	pH	TEMP (C)	NO3 (mg/L)	DO (mg/L)	Eh (mV)	ALK (mEq)	METH	SOURCE
A	09/07/1986		710							PU	GB
A	08/10/1986		700							PU	GB
A	25/07/1989		3110							PU	GB
A	04/10/1990		4320							PU	GB
A	14/08/1991		4400							PU	GB

BORE REPORT

REG NUMBER 13040180

PIPE	DATE	DEPTH (m)	COND (uS/cm)	pH	TEMP (C)	NO3 (mg/L)	DO (mg/L)	Eh (mV)	ALK (mEq)	METH	SOURCE
A	10/07/1996		3800							PU	
A	08/08/1997		7400							PU	
A	20/07/1998		7000							PU	
A	15/07/1999		5260	8.8	27.1					PG	GB
A	07/11/2001		6700	7.9	24.5					PG	GB
A	21/08/2002		6250	7.9	20.8					PG	GB
A	23/09/2003		6850	8.4	28.0					PG	GB

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

BORE REPORT

**** End of Report. Produced:** 14/11/2017 07:46:20 PM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**15/11/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Carfax - Unknown Bore 1**

PART A: PROPERTY DETAILS

Property Name:	Carfax		
Local Bore Name:	Unknown Bore 1	**Ref No/GW Number:**	-
Easting (GDA94):	670295	**GPS Elevation:**	145
Northing:	7516420		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**17.8**	**Year Drilled:**	-
Casing Stick Up (SU):	**0.3**	**Drilled By**	**-**
Casing Material	**Steel**	**Internal Diameter**	140
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**-**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**no**	**Condition**	**poor**	**Pump Type**	no
Power Source	**no**	**Bore Capped**	**no**	**Bore Equipped With Meter**	no
Headworks	**no**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**stock**	**Pumping Regime**	no
Storage Type	**tank**	**Approximate Volume**	60000

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**13.765**	**Date / Time of Measurement:**	11:20:00 AM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**1**	**O_2 %:**	**19.3**
Sample Collection Point	**bore**	**Sample Method**		**bailer**		**Purge Volume**			**2**
Electrical Conductivity (µS/cm)	**343**	**Temp**	**27.5**	**pH**	**6.01**	**ORP**	**-76**	**DO (%)**	**19.6**

COMMENTS

-

GROUNDWATER BORE REPORT CARD

Additional Notes

Near to powerline

SUPPORTING INFORMATION	Drillers Log	no	Meeting With Land Representative	phone call	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1 — **Carfax - Unknown Bore 1**

Photograph 2 — **Carfax - Unknown Bore 1**

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**15/11/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Carfax - Unknown Bore 2**

PART A: PROPERTY DETAILS

Property Name:	Carfax		
Local Bore Name:	Unknown Bore 2	**Ref No/GW Number:**	-
Easting (GDA94):	670294	**GPS Elevation:**	135
Northing:	7516425		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**-**	**Year Drilled:**	-
Casing Stick Up (SU):	**1.35**	**Drilled By**	**-**
Casing Material	**Steel**	**Internal Diameter**	153
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**-**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**no**	**Condition**	**poor**	**Pump Type**	likely piston (downhole)
Power Source	**no**	**Bore Capped**	**no**	**Bore Equipped With Meter**	no
Headworks	**no**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**stock**	**Pumping Regime**	no
Storage Type	**Tank**	**Approximate Volume**	60000

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**-**	**Date / Time of Measurement:**	11:35:00 AM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**0**	**O_2 %:**	**19.1**
Sample Collection Point	**bore**	**Sample Method**	**-**			**Purge Volume**	**-**		
Electrical Conductivity (µS/cm)	**-**	**Temp**	**-**	**pH**	**-**	**ORP**	**-**	**DO (%)**	**-**

COMMENTS

pump rods deployed down bore

GROUNDWATER BORE REPORT CARD

Additional Notes

Threaded steel casing; potentially drill rod. Not sample due to pump rods deployed/broken down bore

SUPPORTING INFORMATION	Drillers Log	no	Meeting With Land Representative	phone call	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Carfax - Unknown Bore 2**

Photograph 2 **Carfax - Unknown Bore 2**

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**15/11/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Carfax - 90075**

PART A: PROPERTY DETAILS

Property Name:	Carfax		
Local Bore Name:	Bridge Bore	**Ref No/GW Number:**	90075
Easting (GDA94):	674591	**GPS Elevation:**	144
Northing:	7517833		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**-**	**Year Drilled:**	1992
Casing Stick Up (SU):	**0.29**	**Drilled By**	**McCarthy Drilling**
Casing Material	**PVC**	**Internal Diameter**	Unknown
Initial Water Quality Measurement (Driller Log)	Good		
Construction Summary (Driller Log)	**PVC 0-29.0** **Slotted 17.0-29.0** **Open hole 29.0-35.0**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**yes**	**Condition**	**good**	**Pump Type**	Submersible
Power Source	**Powerline**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	no
Headworks	**steel manifold to 3" Poly**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**stock**	**Pumping Regime**	no
Storage Type	**Tank**	**Approximate Volume**	80000

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**-**	**Date / Time of Measurement:**	12:30:00 PM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**-**	**H_2S ppm:**	**-**	**CO ppm:**	**-**	**O_2 %:**	**-**
Sample Collection Point	**-**	**Sample Method**	**-**			**Purge Volume**	**-**		
Electrical Conductivity (µS/cm)	**-**	**Temp**	**-**	**pH**	**-**	**ORP**	**-**	**DO (%)**	**-**

COMMENTS

pump deployed

GROUNDWATER BORE REPORT CARD

Additional Notes

-

SUPPORTING INFORMATION	Drillers Log	yes	Meeting With Land Representative	phone call	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Carfax - 90075**

Photograph 2 **Carfax - 90075**

BORE REPORT

REG NUMBER 90075

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-26-05	**MAP-SCALE**	104
OFFICE	Rockhampton	**SUB-AREA**		**LONGITUDE**	148-41-46	**MAP-SERIES**	M
DATE LOG RECD		**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	674554	**MAP-NO**	8653
D/O FILE NO.	50-0030	**LOT**	1	**NORTHING**	7518068	**MAP NAME**	BOMBANDY
R/O FILE NO.		**PLAN**	RP884523	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**	P9	**ACCURACY**	SKET	**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.434825706	**PARISH NAME**	969-CARFAX			**ORIGINAL BORE NO**	BRIDGE BORE
GIS LNG	148.696091677	**COUNTY**	CAIRNS			**BORE LINE**	-
CHECKED	N						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	01/01/1992			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**	MCCARTHY				
ROLES	WS	**DRILL COMPANY**	MCCARTHY DRILLING				
		METHOD OF CONST.	ROTARY				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	01/01/1992	1	Plastic Casing			127	0.00	29.00
A	01/01/1992	2	Perforated or Slotted Casing			127	17.00	29.00
A	01/01/1992	3	Open Hole				29.00	35.00
A	01/01/1992	4	Gravel Pack					

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	6.00	SANDY LOAM
2	6.00	6.50	SAND
3	6.50	11.00	SANDSTONE
4	11.00	11.50	SANDY CLAY
5	11.50	35.00	SANDSTONE

BORE REPORT

REG NUMBER 90075

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	11.50	35.00	SDST	01/01/1993	-17.06	N	GOOD	0.63	Y	PS	BLACKWATER GROUP
			SSTO								

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

****** NO RECORDS FOUND ******

WATER ANALYSIS PART1

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE
X	22/07/1993	-17.07	N		NR												

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

BORE REPORT

REG NUMBER 90075

FIELD MEASUREMENTS

****** NO RECORDS FOUND ******

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

BORE REPORT

**** End of Report. Produced:** 14/11/2017 07:41:03 PM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**15/11/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Carfax - 103082**

PART A: PROPERTY DETAILS

Property Name:	Carfax		
Local Bore Name:	2nd Bridge Bore	**Ref No/GW Number:**	103082
Easting (GDA94):	674586	**GPS Elevation:**	148
Northing:	7517730		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	-	**Year Drilled:**	1997
Casing Stick Up (SU):	**1.2**	**Drilled By**	**McCarthy Drilling**
Casing Material	**PVC**	**Internal Diameter**	141 (OD)
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**Plastic Casing 0-30.0** **Slotted casing 20.0-27.0**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**yes**	**Condition**	**good**	**Pump Type**	Submersible
Power Source	**mains**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	no
Headworks	**2" steel to 2" poly.** **No sample tap**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**stock**	**Pumping Regime**	no
Storage Type	**Tank**	**Approximate Volume**	60000

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	-	**Date / Time of Measurement:**	12:52:00 PM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:	**CH_4 ppm:** -	**H_2S ppm:** -	**CO ppm:** -	**O_2 %:** -
Sample Collection Point -	**Sample Method** -		**Purge Volume** -	
Electrical Conductivity (µS/cm) -	**Temp** -	**pH** -	**ORP** -	**DO (%)** -

COMMENTS

pump deployed

GROUNDWATER BORE REPORT CARD

Additional Notes

-

SUPPORTING INFORMATION	**Drillers Log**	**yes**	**Meeting With Land Representative**	**phone call**	**Photo**	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Carfax - 103082**

Photograph 2 **Carfax - 103082**

BORE REPORT

REG NUMBER 103082

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-26-13	**MAP-SCALE**	104
OFFICE	Rockhampton	**SUB-AREA**		**LONGITUDE**	148-41-45	**MAP-SERIES**	M
DATE LOG RECD		**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	674522	**MAP-NO**	8653
D/O FILE NO.	50-0030	**LOT**	1	**NORTHING**	7517822	**MAP NAME**	BOMBANDY
R/O FILE NO.		**PLAN**	RP884523	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**	SKET	**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.437047938	**PARISH NAME**	969-CARFAX			**ORIGINAL BORE NO**	2ND BUDGE BORE
GIS LNG	148.695813873	**COUNTY**	CAIRNS			**BORE LINE**	-
CHECKED	N						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	08/10/1997			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**	MCCARTHY DM				
ROLES	WS	**DRILL COMPANY**	MCCARTHY DRILLING				
		METHOD OF CONST.	ROTARY				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	08/10/1997	1	Plastic Casing	5.900	WT	141	0.00	30.00
A	08/10/1997	2	Perforated or Slotted Casing		AP	141	20.00	27.00

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	0.50	TOOPSOIL
2	0.50	9.50	CLAY (DARK BROWN)
3	9.50	16.00	BASALT (BROWN WEATHERED)
4	16.00	21.00	BASALT (GREY)
5	21.00	26.00	JOINTED ROCK
6	26.00	30.00	SANDSTONE

STRATIGRAPHY DETAILS

BORE REPORT

REG NUMBER 103082

****** NO RECORDS FOUND ******

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	21.00	26.00	SDST SSTO	08/10/1997	-18.00	N		0.40	Y	FR	BLACKWATER GROUP

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

****** NO RECORDS FOUND ******

WATER ANALYSIS PART1

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

****** NO RECORDS FOUND ******

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

FIELD MEASUREMENTS

****** NO RECORDS FOUND ******

BORE REPORT

REG NUMBER 103082

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

**** End of Report. Produced:** 14/11/2017 07:39:31 PM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**15/11/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Carfax - 103515**

PART A: PROPERTY DETAILS

Property Name:	Carfax		
Local Bore Name:	-	**Ref No/GW Number:**	103515
Easting (GDA94):	674298	**GPS Elevation:**	143
Northing:	7517580		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**-**	**Year Drilled:**	1999
Casing Stick Up (SU):	**0.39**	**Drilled By**	**Depco**
Casing Material	**PVC**	**Internal Diameter**	141 (OD)
Initial Water Quality Measurement (Driller Log)	1100 µS/cm		
Construction Summary (Driller Log)	**Plastic Casing 0-43.90** **Slotted casing 19.2-43.9**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**yes**	**Condition**	**good**	**Pump Type**	Submersible
Power Source	**Genset**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	no
Headworks	**2" steel to 2" poly.** **No sample tap**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**stock**	**Pumping Regime**	no
Storage Type	**no**	**Approximate Volume**	no

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**-**	**Date / Time of Measurement:**	1:01:00 PM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**-**	**H_2S ppm:**	**-**	**CO ppm:**	**-**	**O_2 %:**	**-**
Sample Collection Point	**-**	**Sample Method**	**-**			**Purge Volume**	**-**		
Electrical Conductivity (µS/cm)	**-**	**Temp**	**-**	**pH**	**-**	**ORP**	**-**	**DO (%)**	**-**

COMMENTS

pump deployed

GROUNDWATER BORE REPORT CARD

Additional Notes

-

SUPPORTING INFORMATION	**Drillers Log**	**yes**	**Meeting With Land Representative**	**phone call**	**Photo**	yes

PHOTOGRAPHIC RECORD

Photograph 1	**Carfax - 103515**

Photograph 2	**Carfax - 103515**

BORE REPORT

REG NUMBER 103515

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-26-22	**MAP-SCALE**	104
OFFICE	Emerald	**SUB-AREA**		**LONGITUDE**	148-41-39	**MAP-SERIES**	M
DATE LOG RECD		**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	674342	**MAP-NO**	8653
D/O FILE NO.	50-0030	**LOT**	1	**NORTHING**	7517545	**MAP NAME**	BOMBANDY
R/O FILE NO.		**PLAN**	RP884523	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**	SKET	**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.439465577	**PARISH NAME**	969-CARFAX			**ORIGINAL BORE NO**	
GIS LNG	148.694107581	**COUNTY**	CAIRNS			**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	17/10/1999			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**	RIDDELL W				
ROLES	WS	**DRILL COMPANY**	DEPCO				
		METHOD OF CONST.	ROTARY RIG				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	17/10/1999	1	Plastic Casing	5.900	WT	141	0.00	43.90
A	17/10/1999	2	Perforated or Slotted Casing		AP	141	19.20	43.90

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	1.90	TOP SOIL
2	1.90	13.10	CLAY
3	13.10	17.00	WEATHERED ROCK
4	17.00	22.40	WEATHERED SANDSTONE
5	22.40	31.00	SANDSTONE
6	31.00	33.20	VERY HARD BAND SID
7	33.20	37.60	SANDSTONE

BORE REPORT

REG NUMBER 103515

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
8	37.60	38.90	SHALE AND COKED COAL
9	38.90	43.90	SANDSTONE

STRATIGRAPHY DETAILS
**** NO RECORDS FOUND ****

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	19.20	43.89	SDST	17/10/1999	-18.29	N	1100 US/CM	1.30	Y	PS	BLENHEIM FORMATION

PUMP TEST DETAILS PART 1
**** NO RECORDS FOUND ****

PUMP TEST DETAILS PART 2
**** NO RECORDS FOUND ****

BORE CONDITION
**** NO RECORDS FOUND ****

ELEVATION DETAILS
**** NO RECORDS FOUND ****

WATER ANALYSIS PART1
**** NO RECORDS FOUND ****

WATER ANALYSIS PART 2
**** NO RECORDS FOUND ****

WATER LEVEL DETAILS
**** NO RECORDS FOUND ****

WIRE LINE LOG DETAILS

BORE REPORT

REG NUMBER 103515

**** NO RECORDS FOUND ****

FIELD MEASUREMENTS

**** NO RECORDS FOUND ****

SPECIAL WATER ANALYSIS

**** NO RECORDS FOUND ****

BORE REPORT

**** End of Report. Produced:** 14/11/2017 07:36:48 PM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**15/11/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Carfax - 90074/1**

PART A: PROPERTY DETAILS

Property Name:	Carfax		
Local Bore Name:	3 Mile - 1	**Ref No/GW Number:**	90074
Easting (GDA94):	671886	**GPS Elevation:**	157
Northing:	7511445		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**-**	**Year Drilled:**	-
Casing Stick Up (SU):	**0.46**	**Drilled By**	**-**
Casing Material	**Unknown**	**Internal Diameter**	Unknown
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**-**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**no**	**Condition**	**unknown**	**Pump Type**	no
Power Source	**no**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	no
Headworks	**Bore encased in concrete filled 44 gal drum**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**stock**	**Pumping Regime**	no
Storage Type	**dam**	**Approximate Volume**	100000

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**-**	**Date / Time of Measurement:**	3:25:00 PM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**-**	**H_2S ppm:**	**-**	**CO ppm:**	**-**	**O_2 %:**	**-**
Sample Collection Point	**-**	**Sample Method**	**-**			**Purge Volume**	**-**		
Electrical Conductivity (µS/cm)	**-**	**Temp**	**-**	**pH**	**-**	**ORP**	**-**	**DO (%)**	**-**

COMMENTS

-

GROUNDWATER BORE REPORT CARD

Additional Notes

-

SUPPORTING INFORMATION	Drillers Log	yes*	Meeting With Land Representative	phone call	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1 | **Carfax - 90074/1**

Photograph 2 | **Carfax - 90074/1**

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	15/11/2017	SURVEY PERSONNEL:	ML + TF	BORE ID:	Carfax - 90074/2

PART A: PROPERTY DETAILS

Property Name:	Carfax		
Local Bore Name:	3 Mile - 2	**Ref No/GW Number:**	90074
Easting (GDA94):	671877	**GPS Elevation:**	157
Northing:	7511442		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	-	**Year Drilled:**	-
Casing Stick Up (SU):	0.29	**Drilled By**	-
Casing Material	Unknown	**Internal Diameter**	Unknown
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	-		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	yes	**Condition**	good	**Pump Type**	Submersible
Power Source	solar	**Bore Capped**	yes	**Bore Equipped With Meter**	no
Headworks	2" riser to 1" poly				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	stock	**Pumping Regime**	no
Storage Type	dam	**Approximate Volume**	100000

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	-	**Date / Time of Measurement:**	3:30:00 PM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	-	**H_2S ppm:**	-	**CO ppm:**	-	**O_2 %:**	-
Sample Collection Point	-	**Sample Method**	-			**Purge Volume**	-		
Electrical Conductivity (µS/cm)	-	**Temp**	-	**pH**	-	**ORP**	-	**DO (%)**	-

COMMENTS

-

GROUNDWATER BORE REPORT CARD

Additional Notes					
-					
SUPPORTING INFORMATION	**Drillers Log** yes*	**Meeting With Land Representative**	phone call	**Photo**	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Carfax - 90074/2**

Photograph 2 **Carfax - 90074/2**

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	15/11/2017	SURVEY PERSONNEL:	ML + TF	BORE ID:	Carfax - 90074/3

PART A: PROPERTY DETAILS

Property Name:	Carfax		
Local Bore Name:	3 Mile - 3	**Ref No/GW Number:**	90074
Easting (GDA94):	671883	**GPS Elevation:**	153
Northing:	7511437		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	-	**Year Drilled:**	1963
Casing Stick Up (SU):	0.35	**Drilled By**	Fallinsky A
Casing Material	steel	**Internal Diameter**	120
Initial Water Quality Measurement (Driller Log)	Good		
Construction Summary (Driller Log)	Steel casing 0-44.8 Perforated casing 26.5-44.8		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	no	**Condition**	unknown	**Pump Type**	likely piston (downhole)
Power Source	windmill	**Bore Capped**	no	**Bore Equipped With Meter**	no
Headworks	windmill - not connected				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	stock	**Pumping Regime**	no
Storage Type	dam	**Approximate Volume**	100000

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	-	**Date / Time of Measurement:**	3:41:00 PM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	-	**H_2S ppm:**	-	**CO ppm:**	-	**O_2 %:**	-
Sample Collection Point	-	**Sample Method**	-			**Purge Volume**	-		
Electrical Conductivity (µS/cm)	-	**Temp**	-	**pH**	-	**ORP**	-	**DO (%)**	-

COMMENTS

-

GROUNDWATER BORE REPORT CARD

Additional Notes

3 bores present at site. From drillers construction log this is likely the original bore.

Windmill not connected/functional

SUPPORTING INFORMATION	**Drillers Log**	**yes**	**Meeting With Land Representative**	**phone call**	**Photo**	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Carfax - 90074/3**

Photograph 2 **Carfax - 90074/3**

BORE REPORT

REG NUMBER 90074

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-30-09	**MAP-SCALE**	104
OFFICE	Rockhampton	**SUB-AREA**		**LONGITUDE**	148-40-04	**MAP-SERIES**	M
DATE LOG RECD		**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	671554	**MAP-NO**	8653
D/O FILE NO.	50-0030	**LOT**	1	**NORTHING**	7510596	**MAP NAME**	BOMBANDY
R/O FILE NO.		**PLAN**	RP884523	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**	P9	**ACCURACY**	SKET	**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.5026042	**PARISH NAME**	969-CARFAX			**ORIGINAL BORE NO**	3 MILE BORE
GIS LNG	148.66775819	**COUNTY**	CAIRNS			**BORE LINE**	-
CHECKED	N						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	01/01/1963			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**	FALLINSKY A				
ROLES	WS	**DRILL COMPANY**					
		METHOD OF CONST.					

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	01/01/1963	1	Steel Casing			152	0.00	19.50
A	01/01/1963	2	Steel Casing			127	0.00	44.80
A	01/01/1963	3	Perforated or Slotted Casing			127	26.50	44.80

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	0.76	SOIL
2	0.76	2.74	BLACK CLAY
3	2.74	5.18	DRY SANDY CLAYS
4	5.18	12.80	BROWN SANDY CLAY - HARD
5	12.80	15.54	SOFT SANDY CLAY - MOIST
6	15.54	17.07	DRY SAND WITH BELTS OF CLAY

BORE REPORT

REG NUMBER 90074

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
7	17.07	26.52	BROWN SANDY CLAY WITH ROCK BANDS
8	26.52	40.23	MUDSTONE (JOINTED AT 40M)
9	40.23	46.33	JOINTED MUDSTONE

STRATIGRAPHY DETAILS

**** NO RECORDS FOUND ****

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	40.23	46.33	SDST SSTO	01/01/1963	-18.30	N	GOOD	0.45	Y	PS	BLACKWATER GROUP

PUMP TEST DETAILS PART 1

**** NO RECORDS FOUND ****

PUMP TEST DETAILS PART 2

**** NO RECORDS FOUND ****

BORE CONDITION

**** NO RECORDS FOUND ****

ELEVATION DETAILS

**** NO RECORDS FOUND ****

WATER ANALYSIS PART1

**** NO RECORDS FOUND ****

WATER ANALYSIS PART 2

**** NO RECORDS FOUND ****

WATER LEVEL DETAILS

PIPE	DATE	PIPE	DATE	N/R	RMK

BORE REPORT

REG NUMBER 90074

PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE
X	22/07/1993	-18.28	N		NR												

WIRE LINE LOG DETAILS

**** NO RECORDS FOUND ****

FIELD MEASUREMENTS

**** NO RECORDS FOUND ****

SPECIAL WATER ANALYSIS

**** NO RECORDS FOUND ****

BORE REPORT

**** End of Report. Produced:** 14/11/2017 07:23:26 PM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	15/11/2017	SURVEY PERSONNEL:	ML + TF	BORE ID:	Carfax - 90440

PART A: PROPERTY DETAILS

Property Name:	Carfax		
Local Bore Name:	Spelt Paddock Bore	**Ref No/GW Number:**	90440
Easting (GDA94):	674723	**GPS Elevation:**	156
Northing:	7515024		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	-	**Year Drilled:**	1995
Casing Stick Up (SU):	0.35	**Drilled By**	McCarthy Drilling
Casing Material	PVC	**Internal Diameter**	125
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	Plastic casing 0-39.0 Perforated 21.0-36.0 Open hole 39.0-42.0		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	yes	**Condition**	good	**Pump Type**	Submersible
Power Source	Powerline	**Bore Capped**	yes	**Bore Equipped With Meter**	no
Headworks	2" Steel manifold to 2" Poly. No sample tap				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	stock	**Pumping Regime**	float actuated pressure switch
Storage Type	tank	**Approximate Volume**	40000

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	-	**Date / Time of Measurement:**	5:10:00 PM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:	CH_4 ppm:	-	H_2S ppm:	-	CO ppm:	-	O_2 %:	-		
Sample Collection Point	-	**Sample Method**	-	**Purge Volume**	-					
Electrical Conductivity (µS/cm)	-	**Temp**	-	**pH**	-	**ORP**	-	**DO (%)**	-	

COMMENTS

-

GROUNDWATER BORE REPORT CARD

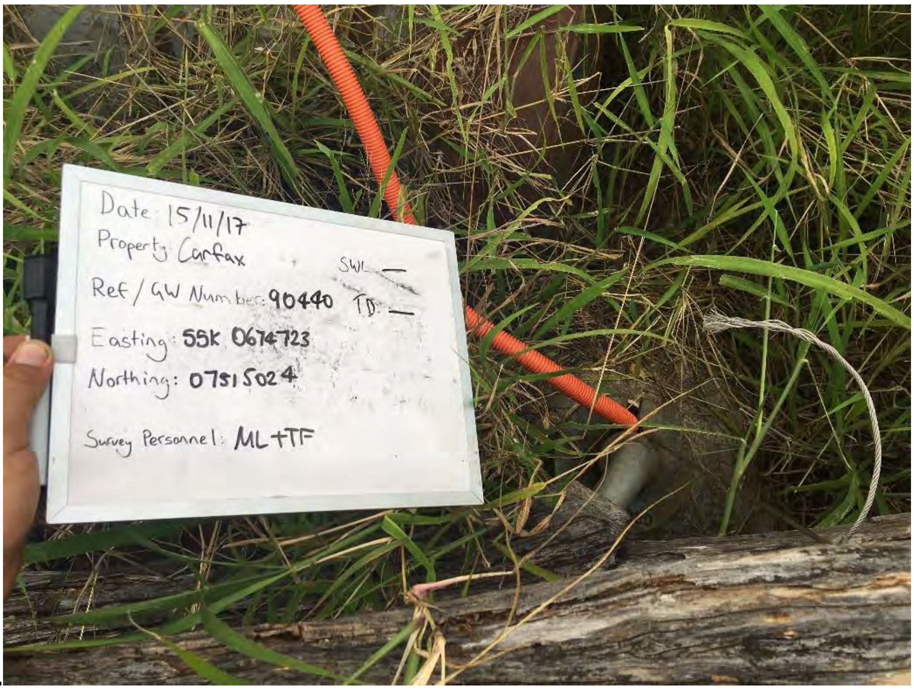
Additional Notes

-

SUPPORTING INFORMATION	Drillers Log	yes	Meeting With Land Representative	phone call	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Carfax - 90440**



Photograph 2 **Carfax - 90440**

BORE REPORT

REG NUMBER 90440

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-27-17	**MAP-SCALE**	104
OFFICE	Rockhampton	**SUB-AREA**		**LONGITUDE**	148-41-43	**MAP-SERIES**	M
DATE LOG RECD		**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	674443	**MAP-NO**	8653
D/O FILE NO.	50-0030	**LOT**	1	**NORTHING**	7515854	**MAP NAME**	BOMBANDY
R/O FILE NO.	50-0030	**PLAN**	RP884523	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**	L1 RP884523	**ACCURACY**	SKET	**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.4548259	**PARISH NAME**	969-CARFAX			**ORIGINAL BORE NO**	SPELL PADDOCK BORE
GIS LNG	148.695258253	**COUNTY**	CAIRNS			**BORE LINE**	-
CHECKED	N						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	10/11/1995			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**	MCCARTHY D				
ROLES	WS	**DRILL COMPANY**	MCCARTHY DRILLING				
		METHOD OF CONST.	ROTARY				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	10/11/1995	1	Plastic Casing	5.900	WT	141	0.00	39.00
A	10/11/1995	2	Perforated or Slotted Casing		AP	141	21.00	36.00
A	10/11/1995	3	Open Hole				39.00	42.00

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	14.00	SAND WITH MINOR CLAY BANDS
2	14.00	21.00	CLAY BROWN
3	21.00	37.00	JOINTED ROCK WATER
4	37.00	42.00	SANDSTONE

STRATIGRAPHY DETAILS

DNR	1	0.00	BLACKWATER GROUP

BORE REPORT

REG NUMBER 90440

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	21.00	36.00	SDST	10/11/1995	-18.30	N		1.00	Y	FR	BLACKWATER GROUP

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

****** NO RECORDS FOUND ******

WATER ANALYSIS PART1

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

****** NO RECORDS FOUND ******

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

FIELD MEASUREMENTS

****** NO RECORDS FOUND ******

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

BORE REPORT

**** End of Report. Produced:** 14/11/2017 07:30:02 PM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	15/11/2017	SURVEY PERSONNEL:	ML + TF	BORE ID:	Carfax - 90076

PART A: PROPERTY DETAILS

Property Name:	Carfax		
Local Bore Name:	House Bore	**Ref No/GW Number:**	90076
Easting (GDA94):	672641	**GPS Elevation:**	144
Northing:	7515517		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	-	**Year Drilled:**	1968
Casing Stick Up (SU):	**0.515**	**Drilled By**	-
Casing Material	**Steel**	**Internal Diameter**	Unknown
Initial Water Quality Measurement (Driller Log)	Good		
Construction Summary (Driller Log)	**Steel casing 0-39.6** **Perforated 21.0-39.6**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**yes**	**Condition**	**good**	**Pump Type**	Submersible
Power Source	**Powerline**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	no
Headworks	**2" Steel manifold to 2" Poly. No sample tap**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**stock and domestic**	**Pumping Regime**	no
Storage Type	**no**	**Approximate Volume**	no

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	-	**Date / Time of Measurement:**	4:40:00 PM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	-	**H_2S ppm:**	-	**CO ppm:**	-	**O_2 %:**	-
Sample Collection Point	-	**Sample Method**	-			**Purge Volume**	-		
Electrical Conductivity (µS/cm)	-	**Temp**	-	**pH**	-	**ORP**	-	**DO (%)**	-

COMMENTS

manual control switch

GROUNDWATER BORE REPORT CARD

Additional Notes

-

SUPPORTING INFORMATION	Drillers Log	yes	Meeting With Land Representative	phone call	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Carfax - 90076**

Photograph 2 **Carfax - 90076**

BORE REPORT

REG NUMBER 90076

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-27-30	**MAP-SCALE**	104
OFFICE	Rockhampton	**SUB-AREA**		**LONGITUDE**	148-40-31	**MAP-SERIES**	M
DATE LOG RECD		**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	672380	**MAP-NO**	8653
D/O FILE NO.	50-0030	**LOT**	1	**NORTHING**	7515478	**MAP NAME**	BOMBANDY
R/O FILE NO.		**PLAN**	RP884523	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**	P9	**ACCURACY**	SKET	**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.458437083	**PARISH NAME**	969-CARFAX			**ORIGINAL BORE NO**	HOUSE BORE
GIS LNG	148.675258423	**COUNTY**	CAIRNS			**BORE LINE**	-
CHECKED	N						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	19/09/1968			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**					
ROLES	WS	**DRILL COMPANY**					
		METHOD OF CONST.					

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	19/09/1968	1	Steel Casing			152	0.00	29.60
A	19/09/1968	2	Steel Casing			127	0.00	39.60
A	19/09/1968	3	Perforated or Slotted Casing			127	21.00	39.60

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	0.61	TOPSOIL
2	0.61	6.71	HARD SANDY CLAY
3	6.71	8.84	SANDY CLAY (FALLING IN)
4	8.84	13.41	SANDY CLAY MEDIUM HARD
5	13.41	14.02	CONGLOMERATE
6	14.02	16.46	SANDY CLAY

BORE REPORT

REG NUMBER 90076

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
7	16.46	17.07	SANDSTONE *
8	17.07	30.18	BANDS OF CLAY AND SILT
9	30.18	30.48	BAND OF GRAVEL
10	30.48	39.62	BANDS OF CLAY AND SILT

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	16.46	17.07	SDST SSTO	01/01/1993	-10.80	N	GOOD	1.00	Y	PS	BLACKWATER GROUP

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

****** NO RECORDS FOUND ******

WATER ANALYSIS PART1

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

BORE REPORT

REG NUMBER 90076

PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE
X	22/07/1993	-10.76	N		NR												

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

FIELD MEASUREMENTS

****** NO RECORDS FOUND ******

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

BORE REPORT

**** End of Report. Produced:** 14/11/2017 07:34:12 PM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	30/09/2017	SURVEY PERSONNEL:	ML + TF	BORE ID:	Cattle Camp Gully

PART A: PROPERTY DETAILS

Property Name:	Cattle camp		
Local Bore Name:	Cattle Camp Gully	**Ref No/GW Number:**	-
Easting (GDA94):	671137	**GPS Elevation:**	154
Northing:	7536973		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**89.8**	**Year Drilled:**	~1930
Casing Stick Up (SU):	**0.4**	**Drilled By**	**B.G Wilson**
Casing Material	**Steel**	**Internal Diameter**	135
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**Steel Casing 0-260ft** **Open Hole 260ft-315ft**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**no**	**Condition**	**Fair**	**Pump Type**	piston (not deployed)
Power Source	**motor**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	no
Headworks	**no**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Stock**	**Pumping Regime**	no
Storage Type	**no**	**Approximate Volume**	no

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**7.31**	**Date / Time of Measurement:**	2:00:00 PM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**1**	**CO ppm:**	**1**	**O_2 %:**	**19.3**
Sample Collection Point	**bore**	**Sample Method**	**bailer**			**Purge Volume**	**2**		
Electrical Conductivity (µS/cm)	**900**	**Temp**	**26.82**	**pH**	**7.7**	**ORP**	**-132.3**	**DO (%)**	**19.3**

COMMENTS

-

GROUNDWATER BORE REPORT CARD

Additional Notes

-

SUPPORTING INFORMATION	Drillers Log	yes	Meeting With Land Representative	yes	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1	**Cattle Camp Gully**

Photograph 2	**Cattle Camp Gully**

Bore details.

Cattle Camp Gully Bore put down by B. G.? Wilson at 12 shillings per ft. £194 - 17 - 6 324 ft. deep, good fresh water.

Remarks. Soil to 3ft. Rotten sandstone to 60 ft. First water 60 ft.
Clay & Slippery Back to 195 ft.
Seam of coal between 195 & 200 ft.
Black shale to 214 ft. Sandstone to 276 ft 88992
~~Second stream~~ Black shale to 324 ft. ...rot Bore
Second stream about 290 ft, 3 rd stream about 315 ft.
Total depth 324 ft.
Water rises to within 18 ft of surface pumps down to 110 ft & holds & holds x6
pumping 540 gals per hr. w/- 8 gal sand pumps. Bore cased with 6 inch casing to 260 ft. 260 ft 6" casing at 7/- per ft. = £91-0-0
Equipping bore w/- 4" casing & wooden pump rods.

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**30/09/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Cattle camp - 161578**

PART A: PROPERTY DETAILS

Property Name:	Cattle camp		
Local Bore Name:	Powerline	**Ref No/GW Number:**	161578
Easting (GDA94):	672586	**GPS Elevation:**	191
Northing:	7535520		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**114**	**Year Drilled:**	-
Casing Stick Up (SU):	**0.58**	**Drilled By**	**-**
Casing Material	**PVC**	**Internal Diameter**	125
Initial Water Quality Measurement (Driller Log)	potable		
Construction Summary (Driller Log)	**PVC 0-142.0** **PVC Slotted 96.0-142.0**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**no**	**Condition**	**Good**	**Pump Type**	no
Power Source	**no**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	no
Headworks	**no**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Stock**	**Pumping Regime**	no
Storage Type	**no**	**Approximate Volume**	no

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**47.435**	**Date / Time of Measurement:**	1:20:00 PM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**1**	**O_2 %:**	**19.6**
Sample Collection Point	**bore**	**Sample Method**	**bailer**			**Purge Volume**	**2**		
Electrical Conductivity (µS/cm)	**2,208**	**Temp**	**28.97**	**pH**	**7.05**	**ORP**	**-238.90**	**DO (%)**	**21.50**

COMMENTS

-

GROUNDWATER BORE REPORT CARD

Additional Notes					
-					
SUPPORTING INFORMATION	**Drillers Log**	**yes**	**Meeting With Land Representative**	**yes**	**Photo**	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Cattle camp - 161578**

Photograph 2 **Cattle camp - 161578**

BORE REPORT

REG NUMBER 161578

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-16-38	**MAP-SCALE**	
OFFICE	Rockhampton	**SUB-AREA**		**LONGITUDE**	148-40-34	**MAP-SERIES**	
DATE LOG RECD		**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	672691	**MAP-NO**	
D/O FILE NO.		**LOT**	4	**NORTHING**	7535518	**MAP NAME**	
R/O FILE NO.		**PLAN**	KL109	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**		**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.27733206	**PARISH NAME**	6000-NO LONGER USED			**ORIGINAL BORE NO**	
GIS LNG	148.67613184	**COUNTY**				**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**				**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**					
ROLES	WS	**DRILL COMPANY**					
		METHOD OF CONST.					

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	20/01/2017	1	Polyvinyl Chloride	7.650	WT	140	0.00	142.00
A	20/01/2017	2	Perforated or Slotted Casing	3.000	AP	140	96.00	142.00
X	20/01/2017	3	Grout			184	0.00	6.50
X	20/01/2017	4	Cuttings or other fill between casing and hc			184	6.50	90.00

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	3.00	RED LOAMY CLAY
2	3.00	3.50	HARD YELLOW ROCK
3	3.50	30.00	RED AND YELLOW BAKED CLAY
4	30.00	46.00	BASALT: FRESH, BLUE
5	46.00	54.00	WHITE CLAY ROCK

BORE REPORT

REG NUMBER 161578

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
6	54.00	62.00	YELLOW CLAY ROCK
7	62.00	66.00	GREY SHALE: SILTY
8	66.00	98.00	RED, WHITE AND YELLOW CLAY BANDS
9	98.00	132.00	SANDSTONE
10	132.00	156.00	GREY SHALE

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	98.00	132.00	SDST	20/01/2017	-50.00	N	POTABLE	0.85	Y	PS	DUARINGA FORMATION

PUMP TEST DETAILS PART 1

PIPE	DATE	REC NO.	RN OF PUMP-BORE	TOP (m)	BOTTOM (m)	DIST (m)	METH	TEST TYPES	PUMP TYPE	SUCTION SET (m)	Q PRIOR TO TEST (l/s)	DUR OF Q PR (min)	PRES ON ARRIV (m)	Q ON ARRIV (l/s)
A	20/01/2017	1	161578	98.00	132.00		PUM		AIR	96.00				

PUMP TEST DETAILS PART 2

PIPE	DATE	REC	TEST DUR (mins)	SWL (m)	RECOV. TIME (mins)	RESID. DD (m)	MAX DD or P RED (m)	Q at MAX DD (l/s)	TIME TO MAX DD (mins)	Max Q (l/s)	CALC STAT HD (m)	DESIGN YIELD (l/s)	DESIGN BP (m)	SUCT. SET (m)	TMSY (m2/DAY)	STOR
A	20/01/2017	1	120	-50.00			46.00	0.85						96.00		

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

****** NO RECORDS FOUND ******

WATER ANALYSIS PART1

BORE REPORT

REG NUMBER 161578

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

****** NO RECORDS FOUND ******

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

FIELD MEASUREMENTS

PIPE	DATE	DEPTH (m)	COND (uS/cm)	pH	TEMP (C)	NO3 (mg/L)	DO (mg/L)	Eh (mV)	ALK (mEq)	METH	SOURCE
A	20/01/2017		1446	7.1						PU	GB

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

BORE REPORT

**** End of Report. Produced:** 29/01/2018 07:25:22 PM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**30/09/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Cattle camp - 111719**

PART A: PROPERTY DETAILS

Property Name:	Cattle camp		
Local Bore Name:	Bore Behind Dam	**Ref No/GW Number:**	111719
Easting (GDA94):	673489	**GPS Elevation:**	149
Northing:	7537157		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**-**	**Year Drilled:**	2002
Casing Stick Up (SU):	**0.45**	**Drilled By**	**McCarthy Drilling**
Casing Material	**PVC**	**Internal Diameter**	Unknown
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**PVC 0-66.0** **Slotted 52.0-60.0**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**Yes**	**Condition**	**Good**	**Pump Type**	Submersible
Power Source	**mains**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	flow gauge and power meter
Headworks	**Steel taps with 2" HDPE output**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Stock**	**Pumping Regime**	no
Storage Type	**no**	**Approximate Volume**	no

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**-**	**Date / Time of Measurement:**	12:52:00 PM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**-**	**H_2S ppm:**	**-**	**CO ppm:**	**-**	**O_2 %:**	**-**
Sample Collection Point	**-**	**Sample Method**	**-**			**Purge Volume**	**-**		
Electrical Conductivity (µS/cm)	**-**	**Temp**	**-**	**pH**	**-**	**ORP**	**-**	**DO (%)**	**-**

COMMENTS

Pump deployed

GROUNDWATER BORE REPORT CARD

Additional Notes

Sample tap ceased

SUPPORTING INFORMATION	Drillers Log	yes	Meeting With Land Representative	yes	Photo	Yes

PHOTOGRAPHIC RECORD

Photograph 1 **Cattle camp - 111719**

Photograph 2 **Cattle camp - 111719**

BORE REPORT

REG NUMBER 111719

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-15-43	**MAP-SCALE**	104
OFFICE	Rockhampton	**SUB-AREA**		**LONGITUDE**	148-40-58	**MAP-SERIES**	M
DATE LOG RECD		**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	673385	**MAP-NO**	8653
D/O FILE NO.	515/030/2723	**LOT**	4	**NORTHING**	7537221	**MAP NAME**	BOMBANDY
R/O FILE NO.		**PLAN**	KL109	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**		**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.26188327	**PARISH NAME**	1312-COXENDEAN			**ORIGINAL BORE NO**	MAHOOD
GIS LNG	148.682681595	**COUNTY**	KILLARNEY			**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	21/05/2002			**DATA OWNER**	DNR
STATUS	Existing	**DRILLERS NAME**	MCCARTHY D				
ROLES	WS	**DRILL COMPANY**	MCCARTHY DRILLING				
		METHOD OF CONST.	ROTARY				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	21/05/2002	1	Polyvinyl Chloride	5.900	WT	140	0.00	66.00
A	21/05/2002	2	Perforated or Slotted Casing				52.00	60.00
A	21/05/2002	3	Gravel Pack	12.000	GR	165	0.00	66.00

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	0.50	TOP SOIL
2	0.50	2.50	CLAY
3	2.50	20.00	WEATHERED ROCK
4	20.00	24.00	WEATHERED ROCK
5	24.00	31.00	WEATHERED BASALT
6	31.00	49.00	SANDSTONE WEATHERED

BORE REPORT

REG NUMBER 111719

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
7	49.00	58.00	BROKEN BASALT *
8	58.00	66.00	SANDSTONE (SOFT)

STRATIGRAPHY DETAILS

**** NO RECORDS FOUND ****

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	54.00	60.00	BSLT			N	BRACKISH	1.39	Y	FR	TERTIARY - UNDEFINED

PUMP TEST DETAILS PART 1

**** NO RECORDS FOUND ****

PUMP TEST DETAILS PART 2

**** NO RECORDS FOUND ****

BORE CONDITION

**** NO RECORDS FOUND ****

ELEVATION DETAILS

**** NO RECORDS FOUND ****

WATER ANALYSIS PART1

**** NO RECORDS FOUND ****

WATER ANALYSIS PART 2

**** NO RECORDS FOUND ****

WATER LEVEL DETAILS

**** NO RECORDS FOUND ****

WIRE LINE LOG DETAILS

BORE REPORT

REG NUMBER **111719**

****** NO RECORDS FOUND ******

FIELD MEASUREMENTS

****** NO RECORDS FOUND ******

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

**** End of Report. Produced:** 29/01/2018 07:26:06 PM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**30/09/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Cattle camp - 88992**

PART A: PROPERTY DETAILS

Property Name:	Cattle camp		
Local Bore Name:	Mandle Brot Bore	**Ref No/GW Number:**	88992
Easting (GDA94):	672888	**GPS Elevation:**	156
Northing:	7537124		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**-**	**Year Drilled:**	1993
Casing Stick Up (SU):	**0.42**	**Drilled By**	**Depco**
Casing Material	**PVC**	**Internal Diameter**	Unknown
Initial Water Quality Measurement (Driller Log)	980 µS/cm		
Construction Summary (Driller Log)	**PVC 0-35.0** **PVC Slotted 35.0-59.0**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**Yes**	**Condition**	**Fair**	**Pump Type**	Submersible
Power Source	**mains**	**Bore Capped**	**Yes**	**Bore Equipped With Meter**	flow gauge
Headworks	**Steel taps with 2" HDPE output**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Stock**	**Pumping Regime**	no
Storage Type	**no**	**Approximate Volume**	no

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**-**	**Date / Time of Measurement:**	12:35:00 PM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**-**	**H_2S ppm:**	**-**	**CO ppm:**	**-**	**O_2 %:**	**-**
Sample Collection Point	**-**	**Sample Method**	**-**			**Purge Volume**	**-**		
Electrical Conductivity (µS/cm)	**-**	**Temp**	**-**	**pH**	**-**	**ORP**	**-**	**DO (%)**	**-**

COMMENTS

Pump deployed

GROUNDWATER BORE REPORT CARD

Additional Notes

-

SUPPORTING INFORMATION	Drillers Log	yes	Meeting With Land Representative	yes	Photo	Yes

PHOTOGRAPHIC RECORD

Photograph 1 **Cattle camp - 88992**

Photograph 2 **Cattle camp - 88992**

BORE REPORT

REG NUMBER 88992

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-15-42	**MAP-SCALE**	103
OFFICE	Rockhampton	**SUB-AREA**		**LONGITUDE**	148-40-36	**MAP-SERIES**	M
DATE LOG RECD		**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	672757	**MAP-NO**	8653
D/O FILE NO.	515/030/2723	**LOT**	4	**NORTHING**	7537240	**MAP NAME**	BOMBANDY
R/O FILE NO.	30-2723	**PLAN**	KL109	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**	P4	**ACCURACY**	SKET	**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.261769741	**PARISH NAME**	1312-COXENDEAN			**ORIGINAL BORE NO**	
GIS LNG	148.676582533	**COUNTY**	KILLARNEY			**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	09/08/1993			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**	WEST K				
ROLES	WS	**DRILL COMPANY**	DEPCO				
		METHOD OF CONST.	ROTARY				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	09/08/1993	1	Polyvinyl Chloride	5.900	WT	141	0.00	59.00
A	09/08/1993	2	Perforated or Slotted Casing	3.000	AP	141	35.00	59.00

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	1.00	TOP
2	1.00	11.50	SANDSTONE
3	11.50	13.00	CLAY LAYERS
4	13.00	24.00	WEATHERED BASALT
5	24.00	30.00	FRESH BASALT
6	30.00	59.00	FRESH BASALT AND CLAY BANDS
7	59.00	62.00	CLAY

BORE REPORT

REG NUMBER 88992

STRATIGRAPHY DETAILS

SOURCE	RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
DNR	1	0.00		BLACKWATER GROUP

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	39.00	59.00	BSLT	09/08/1993	-31.00	N	980 US/CM	0.75	Y	VS	BASALT

PUMP TEST DETAILS PART 1
****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2
****** NO RECORDS FOUND ******

BORE CONDITION
****** NO RECORDS FOUND ******

ELEVATION DETAILS
****** NO RECORDS FOUND ******

WATER ANALYSIS PART1
****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2
****** NO RECORDS FOUND ******

WATER LEVEL DETAILS
****** NO RECORDS FOUND ******

WIRE LINE LOG DETAILS
****** NO RECORDS FOUND ******

FIELD MEASUREMENTS

BORE REPORT

REG NUMBER 88992

**** NO RECORDS FOUND ****

SPECIAL WATER ANALYSIS

**** NO RECORDS FOUND ****

BORE REPORT

**** End of Report. Produced:** 29/01/2018 07:26:44 PM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**30/09/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Cattle camp - 161572**

PART A: PROPERTY DETAILS

Property Name:	Cattle camp		
Local Bore Name:	House Bore	**Ref No/GW Number:**	161572
Easting (GDA94):	672572	**GPS Elevation:**	178
Northing:	7538233		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**184.65**	**Year Drilled:**	2016
Casing Stick Up (SU):	**0.28**	**Drilled By**	**Depco**
Casing Material	**PVC**	**Internal Diameter**	125
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**PVC 0-77.0** **PVC Slotted 77.0-161.0** **PVC 161.0-173.0**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**No**	**Condition**	**Good**	**Pump Type**	no
Power Source	**no**	**Bore Capped**	**Yes**	**Bore Equipped With Meter**	no
Headworks	**no**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Domestic**	**Pumping Regime**	no
Storage Type	**no**	**Approximate Volume**	no

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**37.715**	**Date / Time of Measurement:**	11:42:00 AM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**2**	**O_2 %:**	**19.5**
Sample Collection Point	**bore**	**Sample Method**	**bailer**			**Purge Volume**	**2**		
Electrical Conductivity (µS/cm)	**631**	**Temp**	**27.9**	**pH**	**8.2**	**ORP**	**47.3**	**DO (%)**	**49.3**

COMMENTS

-

GROUNDWATER BORE REPORT CARD

Additional Notes

-

SUPPORTING INFORMATION	**Drillers Log**	**yes**	**Meeting With Land Representative**	**yes**	**Photo**	Yes

PHOTOGRAPHIC RECORD

Photograph 1 **Cattle camp - 161572**

Photograph 2 **Cattle camp - 161572**

BORE REPORT

REG NUMBER 161572

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-15-10	**MAP-SCALE**	
OFFICE	Rockhampton	**SUB-AREA**		**LONGITUDE**	148-40-29	**MAP-SERIES**	
DATE LOG RECD	03-FEB-17	**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	672567	**MAP-NO**	
D/O FILE NO.		**LOT**	4	**NORTHING**	7538236	**MAP NAME**	
R/O FILE NO.		**PLAN**	KL109	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**		**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.25279986	**PARISH NAME**	6000-NO LONGER USED			**ORIGINAL BORE NO**	
GIS LNG	148.67463656	**COUNTY**				**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	21/12/2016			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**	FARNES, DYLAN				
ROLES	WS	**DRILL COMPANY**	DEPCO DRILLING PTY LTD				
		METHOD OF CONST.	ROTARY AIR				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	21/12/2016	1	Polyvinyl Chloride	7.650	WT	140	0.00	77.00
A	21/12/2016	2	Perforated or Slotted Casing	4.000	AP	140	77.00	161.00
A	21/12/2016	3	Polyvinyl Chloride	7.650	WT	140	161.00	173.00
X	21/12/2016	4	Grout			197	0.00	54.00
X	21/12/2016	5	Centraliser				0.00	173.00

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	2.00	SILTY SAND: RED
2	2.00	24.00	MUDSTONE: RED
3	24.00	50.00	WEATHERED BASALT: BLUE
4	50.00	78.00	SHALE: BLUE

BORE REPORT

REG NUMBER 161572

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
5	78.00	174.00	SANDSTONE: FINE, BLUE, WITH BANDS OF SHALE

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	78.00	174.00	SDST SHLE	21/12/2016	-42.00	N	POTABLE	0.50	Y	PS	DUARINGA FORMATION

PUMP TEST DETAILS PART 1

PIPE	DATE	REC NO.	RN OF PUMP-BORE	TOP (m)	BOTTOM (m)	DIST (m)	METH	TEST TYPES	PUMP TYPE	SUCTION SET (m)	Q PRIOR TO TEST (l/s)	DUR OF Q PR (min)	PRES ON ARRIV (m)	Q ON ARRIV (l/s)
A	21/12/2016	1	161572	78.00	174.00		PUM		AIR	64.00				

PUMP TEST DETAILS PART 2

PIPE	DATE	REC	TEST DUR (mins)	SWL (m)	RECOV. TIME (mins)	RESID. DD (m)	MAX DD or P RED (m)	Q at MAX DD (l/s)	TIME TO MAX DD (mins)	Max Q (l/s)	CALC STAT HD (m)	DESIGN YIELD (l/s)	DESIGN BP (m)	SUCT. SET (m)	TMSY (m2/DAY)	STOR
A	21/12/2016	1	60	-42.00			22.00	0.50						64.00		

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

****** NO RECORDS FOUND ******

WATER ANALYSIS PART1

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

BORE REPORT

REG NUMBER 161572

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

****** NO RECORDS FOUND ******

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

FIELD MEASUREMENTS

****** NO RECORDS FOUND ******

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

**** End of Report. Produced:** 29/01/2018 07:27:58 PM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**30/09/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Cattle camp - 161573**

PART A: PROPERTY DETAILS

Property Name:	Cattle camp		
Local Bore Name:	House Supply	**Ref No/GW Number:**	161573
Easting (GDA94):	672562	**GPS Elevation:**	175
Northing:	7538229		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**57.8**	**Year Drilled:**	2016
Casing Stick Up (SU):	**0.33**	**Drilled By**	**Depco**
Casing Material	**PVC**	**Internal Diameter**	125
Initial Water Quality Measurement (Driller Log)	potable		
Construction Summary (Driller Log)	**PVC 0-46.0** **PVC 46.0-53.0**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**No**	**Condition**	**Good**	**Pump Type**	no
Power Source	**no**	**Bore Capped**	**Yes**	**Bore Equipped With Meter**	no
Headworks	**no**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Domestic**	**Pumping Regime**	no
Storage Type	**no**	**Approximate Volume**	no

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**37**	**Date / Time of Measurement:**	11:15:00 AM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**2**	**O_2 %:**	**19.5**
Sample Collection Point	**bore**	**Sample Method**		**bailer**		**Purge Volume**	**2**		
Electrical Conductivity (µS/cm)	**710**	**Temp**	**28.72**	**pH**	**6.84**	**ORP**	**98.6**	**DO (%)**	**28.5**

COMMENTS

-

GROUNDWATER BORE REPORT CARD

Additional Notes

-

SUPPORTING INFORMATION	Drillers Log	yes	Meeting With Land Representative	yes	Photo	Yes

PHOTOGRAPHIC RECORD

Photograph 1 **Cattle camp - 161573**

Photograph 2 **Cattle camp - 161573**

BORE REPORT

REG NUMBER 161573

REGISTRATION DETAILS

		BASIN	1304	LATITUDE	22-15-10	MAP-SCALE	
OFFICE	Rockhampton	SUB-AREA		LONGITUDE	148-40-28	MAP-SERIES	
DATE LOG RECD	03-FEB-17	SHIRE	3980-ISAAC REGIONAL	EASTING	672546	MAP-NO	
D/O FILE NO.		LOT	4	NORTHING	7538227	MAP NAME	
R/O FILE NO.		PLAN	KL109	ZONE	55	PROG SECTION	
H/O FILE NO.		ORIGINAL DESCRIPTION		ACCURACY		PRES EQUIPMENT	
				GPS ACC			
GIS LAT	-22.25288323	PARISH NAME	6000-NO LONGER USED			ORIGINAL BORE NO	
GIS LNG	148.67443381	COUNTY				BORE LINE	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	DATE DRILLED	21/12/2016			DATA OWNER	
STATUS	Existing	DRILLERS NAME	WHITE, LEE				
ROLES	WS	DRILL COMPANY	DEPCO				
		METHOD OF CONST.	ROTARY AIR				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	21/12/2016	1	Polyvinyl Chloride	7.650	WT	140	0.00	53.00
A	21/12/2016	2	Perforated or Slotted Casing	3.000	AP	140	46.00	53.00
X	21/12/2016	3	Grout			184	0.00	6.00
X	21/12/2016	4	Cuttings or other fill between casing and hc			184	6.00	40.00
X	21/12/2016	5	Centraliser				6.00	48.00

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	1.00	RED SANDY CLAY
2	1.00	1.50	HARD YELLOW ROCK
3	1.50	18.00	RED CLAY, ROCK, WEATHERED
4	18.00	30.00	RED AND YELLOW CLAY, ROCK, WEATHERED

BORE REPORT

REG NUMBER 161573

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
5	30.00	35.00	BLUE BASALT
6	35.00	36.00	GREY AND YELLOW SHALE
7	36.00	45.00	WEATHERED BASALT
8	45.00	54.00	WEATHERED BASALT, FRACTURED
9	54.00	60.00	YELLOW MUDSTONE

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	45.00	54.00	BSLT			N	POTABLE	0.60	Y	FR	DUARINGA FORMATION

PUMP TEST DETAILS PART 1

PIPE	DATE	REC NO.	RN OF PUMP-BORE	TOP (m)	BOTTOM (m)	DIST (m)	METH	TEST TYPES	PUMP TYPE	SUCTION SET (m)	Q PRIOR TO TEST (l/s)	DUR OF Q PR (min)	PRES ON ARRIV (m)	Q ON ARRIV (l/s)
A	21/12/2016	1	161573	45.00	54.00		PUM		AIR	50.00				

PUMP TEST DETAILS PART 2

PIPE	DATE	REC	TEST DUR (mins)	SWL (m)	RECOV. TIME (mins)	RESID. DD (m)	MAX DD or P RED (m)	Q at MAX DD (l/s)	TIME TO MAX DD (mins)	Max Q (l/s)	CALC STAT HD (m)	DESIGN YIELD (l/s)	DESIGN BP (m)	SUCT. SET (m)	TMSY (m2/DAY)	STOR
A	21/12/2016	1	120	-38.00			12.00	0.60						50.00		

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

****** NO RECORDS FOUND ******

WATER ANALYSIS PART1

BORE REPORT

REG NUMBER **161573**

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

****** NO RECORDS FOUND ******

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

FIELD MEASUREMENTS

PIPE	DATE	DEPTH (m)	COND (uS/cm)	pH	TEMP (C)	NO3 (mg/L)	DO (mg/L)	Eh (mV)	ALK (mEq)	METH	SOURCE
A	21/12/2016		693	7.8						PU	GB

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

BORE REPORT

**** End of Report. Produced:** 29/01/2018 07:27:24 PM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	30/09/2017	SURVEY PERSONNEL:	ML + TF	BORE ID:	Cattle camp - 161 575

PART A: PROPERTY DETAILS

Property Name:	Cattle camp		
Local Bore Name:	Rosewood	**Ref No/GW Number:**	161 575
Easting (GDA94):	672394	**GPS Elevation:**	198
Northing:	7543106		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**83.5**	**Year Drilled:**	2017
Casing Stick Up (SU):	**0.36**	**Drilled By**	**Depco**
Casing Material	**PVC**	**Internal Diameter**	125
Initial Water Quality Measurement (Driller Log)	320ppm		
Construction Summary (Driller Log)	**PVC 0-60.0** **PVC Slotted 60.0-84.0**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**No**	**Condition**	**Good**	**Pump Type**	no
Power Source	**no**	**Bore Capped**	**Yes**	**Bore Equipped With Meter**	no
Headworks	**no**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Stock**	**Pumping Regime**	no
Storage Type	**no**	**Approximate Volume**	no

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**28.07**	**Date / Time of Measurement:**	10:15:00 AM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**6**	**O_2 %:**	**18.2**
Sample Collection Point	**bore**	**Sample Method**	**bailer**			**Purge Volume**	**2**		
Electrical Conductivity (µS/cm)	**499**	**Temp**	**27.98**	**pH**	**6.71**	**ORP**	**103**	**DO (%)**	**23.6**

COMMENTS

-

GROUNDWATER BORE REPORT CARD

Additional Notes

-

SUPPORTING INFORMATION	**Drillers Log**	**yes**	**Meeting With Land Representative**	**yes**	**Photo**	Yes

PHOTOGRAPHIC RECORD

Photograph 1	**Cattle camp - 161 575**

Photograph 2	**Cattle camp - 161 575**

BORE REPORT

REG NUMBER 161575

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-12-31	**MAP-SCALE**	
OFFICE	Rockhampton	**SUB-AREA**		**LONGITUDE**	148-40-21	**MAP-SERIES**	
DATE LOG RECD	03-FEB-17	**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	672392	**MAP-NO**	
D/O FILE NO.		**LOT**	4	**NORTHING**	7543123	**MAP NAME**	
R/O FILE NO.		**PLAN**	KL109	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**		**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.20868556	**PARISH NAME**	6000-NO LONGER USED			**ORIGINAL BORE NO**	
GIS LNG	148.67241516	**COUNTY**				**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	16/01/2017			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**	WHITE, LEE				
ROLES	WS	**DRILL COMPANY**	DEPCO				
		METHOD OF CONST.					

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	16/01/2017	1	Polyvinyl Chloride	7.650	WT	140	0.00	84.00
A	16/01/2017	2	Perforated or Slotted Casing	3.000	AP	140	60.00	84.00
X	16/01/2017	3	Grout			184	0.00	6.00
X	16/01/2017	4	Cuttings or other fill between casing and hc			184	6.00	56.00
X	16/01/2017	5	Centraliser				6.00	54.00

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	3.00	RED SANDY CLAY
2	3.00	6.00	RED CLAY AND IRONSTONE
3	6.00	48.00	RED AND WHITE LAYERED CLAY BANDS
4	48.00	60.00	YELLOW CLAY

BORE REPORT

REG NUMBER 161575

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
5	60.00	78.00	WHITE AND GREY FRACTURED ROCK, TRACES OF SAND
6	78.00	84.00	SHALE

STRATIGRAPHY DETAILS

**** NO RECORDS FOUND ****

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	60.00	78.00	XXXX	16/01/2017	-30.00	N	320 PPM	1.50	Y	FR	DUARINGA FORMATION

PUMP TEST DETAILS PART 1

PIPE	DATE	REC NO.	RN OF PUMP-BORE	TOP (m)	BOTTOM (m)	DIST (m)	METH	TEST TYPES	PUMP TYPE	SUCTION SET (m)	Q PRIOR TO TEST (l/s)	DUR OF Q PR (min)	PRES ON ARRIV (m)	Q ON ARRIV (l/s)
A	16/01/2017	1	161575	60.00	78.00		PUM		AIR	60.00				

PUMP TEST DETAILS PART 2

PIPE	DATE	REC	TEST DUR (mins)	SWL (m)	RECOV. TIME (mins)	RESID. DD (m)	MAX DD or P RED (m)	Q at MAX DD (l/s)	TIME TO MAX DD (mins)	Max Q (l/s)	CALC STAT HD (m)	DESIGN YIELD (l/s)	DESIGN BP (m)	SUCT. SET (m)	TMSY (m2/DAY)	STOR
A	16/01/2017	1	120	-30.00			30.00	0.75						60.00		

BORE CONDITION

**** NO RECORDS FOUND ****

ELEVATION DETAILS

**** NO RECORDS FOUND ****

WATER ANALYSIS PART1

**** NO RECORDS FOUND ****

WATER ANALYSIS PART 2

BORE REPORT

REG NUMBER 161575

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

****** NO RECORDS FOUND ******

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

FIELD MEASUREMENTS

PIPE	DATE	DEPTH (m)	COND (uS/cm)	pH	TEMP (C)	NO3 (mg/L)	DO (mg/L)	Eh (mV)	ALK (mEq)	METH	SOURCE
A	16/01/2017		499	7.2						PU	GB

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

BORE REPORT

**** End of Report. Produced:** 29/01/2018 07:19:17 PM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	30/09/2017	**SURVEY PERSONNEL:**	ML + TF	**BORE ID:**	**Cattle camp - 161574**

PART A: PROPERTY DETAILS

Property Name:	Cattle camp		
Local Bore Name:	KP	**Ref No/GW Number:**	161574
Easting (GDA94):	673374	**GPS Elevation:**	203
Northing:	7543006		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**121.9**	**Year Drilled:**	2017
Casing Stick Up (SU):	**0.5**	**Drilled By**	**Depco**
Casing Material	**PVC**	**Internal Diameter**	125
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**PVC 0-120.0** **PVC Slotted 90.0-120.0**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**No**	**Condition**	**Good**	**Pump Type**	no
Power Source	**no**	**Bore Capped**	**Yes**	**Bore Equipped With Meter**	no
Headworks	**no**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Stock**	**Pumping Regime**	no
Storage Type	**no**	**Approximate Volume**	no

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**25.75**	**Date / Time of Measurement:**	9:30:00 AM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:	**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**18**	**O_2 %:**	**17.9**	
Sample Collection Point	**bore**	**Sample Method**	**bailer**		**Purge Volume**	**2**			
Electrical Conductivity (µS/cm)	**889**	**Temp**	**27.63**	**pH**	**7.39**	**ORP**	**-195.3**	**DO (%)**	**22.6**

COMMENTS

-

GROUNDWATER BORE REPORT CARD

Additional Notes

-

SUPPORTING INFORMATION	Drillers Log	yes	Meeting With Land Representative	yes	Photo	Yes

PHOTOGRAPHIC RECORD

Photograph 1 **Cattle camp - 161574**

Photograph 2 **Cattle camp - 161574**

BORE REPORT

REG NUMBER 161574

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-12-35	**MAP-SCALE**	
OFFICE	Rockhampton	**SUB-AREA**		**LONGITUDE**	148-40-55	**MAP-SERIES**	
DATE LOG RECD	03-FEB-17	**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	673376	**MAP-NO**	
D/O FILE NO.		**LOT**	4	**NORTHING**	7543002	**MAP NAME**	
R/O FILE NO.		**PLAN**	KL109	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**		**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.2096799	**PARISH NAME**	6000-NO LONGER USED			**ORIGINAL BORE NO**	
GIS LNG	148.68197106	**COUNTY**				**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	14/01/2017			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**	WHITE, LEE				
ROLES	WS	**DRILL COMPANY**	DEPCO				
		METHOD OF CONST.	ROTARY AIR				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	14/01/2017	1	Polyvinyl Chloride	7.650	WT	140	0.00	120.00
A	14/01/2017	2	Perforated or Slotted Casing	3.000	AP	140	90.00	120.00
X	14/01/2017	3	Grout			184	0.00	9.00
X	14/01/2017	4	Cuttings or other fill between casing and hc			184	9.00	86.00

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	1.00	RED LOAMY CLAY
2	1.00	8.00	RED WEATHERED SILTSTONE
3	8.00	12.00	RED CLAY
4	12.00	78.00	RED, WHITE AND YELLOW LAYERED CLAY
5	78.00	89.00	SHALE: GREY

BORE REPORT

REG NUMBER 161574

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
6	89.00	114.00	SANDSTONE
7	114.00	120.00	SHALE: 2M COAL

STRATIGRAPHY DETAILS

**** NO RECORDS FOUND ****

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	96.00		SDST	14/01/2017	-30.00	N	POTABLE	1.10	Y	PS	BACK CREEK GROUP

PUMP TEST DETAILS PART 1

PIPE	DATE	REC NO.	RN OF PUMP-BORE	TOP (m)	BOTTOM (m)	DIST (m)	METH	TEST TYPES	PUMP TYPE	SUCTION SET (m)	Q PRIOR TO TEST (l/s)	DUR OF Q PR (min)	PRES ON ARRIV (m)	Q ON ARRIV (l/s)
A	14/01/2017	1	161574				PUM			90.00				

PUMP TEST DETAILS PART 2

PIPE	DATE	REC	TEST DUR (mins)	SWL (m)	RECOV. TIME (mins)	RESID. DD (m)	MAX DD or P RED (m)	Q at MAX DD (l/s)	TIME TO MAX DD (mins)	Max Q (l/s)	CALC STAT HD (m)	DESIGN YIELD (l/s)	DESIGN BP (m)	SUCT. SET (m)	TMSY (m2/DAY)	STOR
A	14/01/2017	1	120	-30.00				1.10						90.00		

BORE CONDITION

**** NO RECORDS FOUND ****

ELEVATION DETAILS

**** NO RECORDS FOUND ****

WATER ANALYSIS PART1

**** NO RECORDS FOUND ****

WATER ANALYSIS PART 2

BORE REPORT

REG NUMBER 161574

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

****** NO RECORDS FOUND ******

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

FIELD MEASUREMENTS

PIPE	DATE	DEPTH (m)	COND (uS/cm)	pH	TEMP (C)	NO3 (mg/L)	DO (mg/L)	Eh (mV)	ALK (mEq)	METH	SOURCE
A	14/01/2017		811	7.1						PU	GB

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

BORE REPORT

**** End of Report. Produced:** 29/01/2018 07:16:41 PM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**30/09/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Cattle camp - 13040286**

PART A: PROPERTY DETAILS

Property Name:	Cattle camp		
Local Bore Name:	-	**Ref No/GW Number:**	13040286
Easting (GDA94):	659986	**GPS Elevation:**	165
Northing:	7536977		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**-**	**Year Drilled:**	2004
Casing Stick Up (SU):	**0.41**	**Drilled By**	**NRM**
Casing Material	**Unknown**	**Internal Diameter**	Unknown
Initial Water Quality Measurement (Driller Log)	5100 µS/cm		
Construction Summary (Driller Log)	**PVC 0-94.3** **PVC Slotted 94.3-100.3** **PVC 100.3-106.3**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**Yes**	**Condition**	**Good**	**Pump Type**	N/A
Power Source	**Unknown**	**Bore Capped**	**Yes**	**Bore Equipped With Meter**	N/A
Headworks	**N/A**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Monitoring**	**Pumping Regime**	N/A
Storage Type	**N/A**	**Approximate Volume**	N/A

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**-**	**Date / Time of Measurement:**	2:30:00 PM
Pumping History	N/A		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**-**	**H_2S ppm:**	**-**	**CO ppm:**	**-**	**O_2 %:**	**-**
Sample Collection Point	**-**	**Sample Method**	**-**			**Purge Volume**	**-**		
Electrical Conductivity (µS/cm)	**-**	**Temp**	**-**	**pH**	**-**	**ORP**	**-**	**DO (%)**	**-**

COMMENTS

*Measurement obtained from DNR online output. Data provided in MBGL

GROUNDWATER BORE REPORT CARD

Additional Notes

Data Available online

SUPPORTING INFORMATION	Drillers Log	yes	Meeting With Land Representative	no	Photo	Yes

PHOTOGRAPHIC RECORD

Photograph 1 **Cattle camp - 13040286**

Photograph 2 **Cattle camp - 13040286**

BORE REPORT

REG NUMBER 13040286

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-15-56	**MAP-SCALE**	
OFFICE	Rockhampton	**SUB-AREA**		**LONGITUDE**	148-33-10	**MAP-SERIES**	
DATE LOG RECD		**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	659983	**MAP-NO**	
D/O FILE NO.		**LOT**		**NORTHING**	7536966	**MAP NAME**	
R/O FILE NO.		**PLAN**		**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**	FITZROY DEVELOPMENT ROAD 2	**ACCURACY**	GPS	**PRES EQUIPMENT**	NE
				GPS ACC	25		
GIS LAT	-22.265556	**PARISH NAME**	4116-RYTON			**ORIGINAL BORE NO**	NAP ISAAC RIVER SITE 5
GIS LNG	148.552778	**COUNTY**	RYTON			**BORE LINE**	-
CHECKED	N						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	05/09/2004			**DATA OWNER**	NAP
STATUS	Existing	**DRILLERS NAME**	W MCLEAN				
ROLES	IN	**DRILL COMPANY**	NRM				
	SM	**METHOD OF CONST.**	ROTARY AIR				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	07/09/2004	1	Polyvinyl Chloride	3.300	WT	60	0.00	94.30
A	07/09/2004	2	Perforated or Slotted Casing	1.000	AP	60	94.30	100.30
A	07/09/2004	3	Polyvinyl Chloride	3.300	WT	60	100.30	106.30
X	07/09/2004	4	Grout				0.00	6.00
X	07/09/2004	5	Cuttings or other fill between casing and hc				6.00	60.00
X	07/09/2004	6	Bentonite Seal				60.00	61.00
X	07/09/2004	7	Gravel Pack	10.000	GR		61.00	107.00

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	1.00	ROAD AGGREGATE
2	1.00	4.00	PALE BROWN CLAYEY F SAND

BORE REPORT

REG NUMBER 13040286

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
3	4.00	6.00	PALE BROWN CLAYEY F-VC SAND
4	6.00	7.00	RED BROWN CLAYEY F-M SAND
5	7.00	10.00	PALE GREY SANDY CLAY
6	10.00	13.00	PALE GREY CLAYEY VF-F SAND
7	13.00	15.00	PALE BROWN CLAYEY VF-VC SAND & GRAVEL
8	15.00	16.00	RUST BROWN CLAYEY VF-F SAND
9	16.00	18.00	PALE GREY SANDY CLAY,
10			RUST BROWN MOTTLING
11	18.00	29.00	GREY SANDY CLAY, RUST BROWN MOTTLING
12	29.00	34.00	GREY CLAY, RED BROWN MOTTLING
13	34.00	36.00	PALE GREY SANDY CLAY,
14			RED BROWN MOTTLING
15	36.00	38.00	PALE GREY CLAYSTONE
16	38.00	44.00	PALE GREY CLAYSTONE WITH DARK RUST
17			RED FERRICRETE BANDS & MOTTLING
18	44.00	50.00	OFF WHITE SILTY CLAYSTONE
19	50.00	56.00	OFF WHITE CLAYEY VF-F SANDSTONE; DAMP
20	56.00	63.00	PALE BROWN CLAYSTONE,
21			RUST BROWN MOTTLING
22	63.00	70.00	YELLOW BROWN CLAYEY VF SANDSTONE
23	70.00	79.00	BROWN SHALE
24	79.00	94.00	DARK BROWN SHALE & SILTSTONE
25	94.00	101.00	GREY SILTSTONE & VF-M SANDSTONE
26	101.00	107.00	DARK BROWN SHALE & GREY SILTSTONE

STRATIGRAPHY DETAILS

SOURCE	RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
NAP	1	0.00	16.00	QUATERNARY - UNDEFINED
NAP	2	16.00	56.00	DUARINGA FORMATION
NAP	3	56.00	107.00	BLACKWATER GROUP

BORE REPORT

REG NUMBER 13040286

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	50.00	56.00	SDST			N			N	PS	DUARINGA FORMATION
2	94.00	100.00	SSTO			N			Y	PS	BLACKWATER GROUP

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

PIPE	DATE	ELEVATION	PRECISION	DATUM	MEASUREMENT POINT	SURVEY SOURCE
A	14/07/2006	171.85	SVY	AHD	R	DERM SURVEYORS
A	27/10/2015	171.92	SVY	AHD	R	ANSWERSG
X	04/10/2006	171.50	SVY	AHD	N	DERM SURVEYORS

WATER ANALYSIS PART1

PIPE	DATE	RD	ANALYST	QAN	DEPTH (m)	RMK	SRC	COND (uS/cm)	pH	Si (mg/L)	TOTAL IONS (mg/L)	TOTAL SOLIDS (mg/L)	HARD	ALK	FIG. OF MERIT	SAR	RAH
A	08/09/2004	1	DNR	050142	94.00	AI	GB	5100	7.2		2878.42	2766.59	633	183	0.3	15.0	

WATER ANALYSIS PART 2

PIPE	DATE	RD	Na	K	Ca	Mg	Mn	HCO3	Fe	CO3	Cl	F	NO3	SO4	Zn	Al	B	Cu
A	08/09/2004	1	865.0	14.9	89.9	99.0		220.0		< 1.0	1490.0	< 0.02	0.7	97.4				

WATER LEVEL DETAILS

PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE
A	07/04/2005	-44.80	R		NR	A	09/10/2005	-44.41	R		ACT	A	09/01/2006	-44.39	R		ACT

BORE REPORT

REG NUMBER 13040286

PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE
A	24/05/2006	-44.26	R		NR	A	18/12/2006	-44.52	R		ACT	A	09/10/2007	-44.43	R		ACT
A	27/10/2008	-44.63	R		NR	A	30/07/2009	-44.41	R		ACT	A	31/05/2010	-44.29	R		ACT
A	10/05/2011	-43.95	R		ACT	A	13/10/2011	-44.11	R		ACT	A	25/10/2011	-44.11	R		ACT
A	12/04/2012	-44.13	R		ACT	A	26/06/2012	-44.11	R		ACT	A	29/10/2012	-44.21	R		ACT
A	16/01/2013	-44.26	R		ACT	A	09/04/2013	-44.12	R		ACT	A	01/08/2013	-44.21	R		ACT
A	19/11/2013	-44.20	R		ACT	A	04/02/2014	-44.14	R		NR	A	21/05/2014	-44.14	R		ACT
A	16/09/2014	-44.14	R		ACT	A	13/01/2015	-44.04	R		NR	A	14/04/2015	-44.04	R		ACT
A	07/07/2015	-44.06	R		ACT	A	27/10/2015	-44.13	R		ACT	A	12/01/2016	-44.15	R	B	ACT
A	24/05/2016	-44.42	R		ACT	A	02/08/2016	-44.20	R		ACT	A	08/11/2016	-44.24	R		ACT
A	07/02/2017	-44.12	R		ACT	A	06/06/2017	-43.93	R		ACT	A	11/09/2017	-44.13	R		ACT
A	13/11/2017	-44.12	R		ACT												

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

FIELD MEASUREMENTS

PIPE	DATE	DEPTH (m)	COND (uS/cm)	pH	TEMP (C)	NO3 (mg/L)	DO (mg/L)	Eh (mV)	ALK (mEq)	METH	SOURCE
A	08/09/2004		5110		24.9					AI	GB
A	24/05/2006		8650		21.5					PU	GB
A	12/01/2016	100.00	7860	9.0	27.9					AI	GB

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

**** End of Report. Produced:** 29/01/2018 07:29:21 PM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	12/09/2017	**SURVEY PERSONNEL:**	**ML + AF**	**BORE ID:**	**Deverill - 141677**

PART A: PROPERTY DETAILS

Property Name:	Deverill		
Local Bore Name:	-	**Ref No/GW Number:**	141677
Easting (GDA94):	642164	**GPS Elevation:**	191
Northing:	7548178		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**10.05**	**Year Drilled:**	2009
Casing Stick Up (SU):	**0.45**	**Drilled By**	**Q.D.S**
Casing Material	**PVC**	**Internal Diameter**	125
Initial Water Quality Measurement (Driller Log)	potable		
Construction Summary (Driller Log)	**PVC 0-24.0** **Slotted 12.0-24.0**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**No**	**Condition**	**good**	**Pump Type**	no
Power Source	**near to mains**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	no
Headworks	**no**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Domestic**	**Pumping Regime**	no
Storage Type	**no**	**Approximate Volume**	no

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**Dry**	**Date / Time of Measurement:**	5:30:00 PM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**0**	**O_2 %:**	**18.4**
Sample Collection Point	**bore**	**Sample Method**	**-**			**Purge Volume**	**-**		
Electrical Conductivity (µS/cm)	**-**	**Temp**	**-**	**pH**	**-**	**ORP**	**-**	**DO (%)**	**-**

COMMENTS

-

GROUNDWATER BORE REPORT CARD

Additional Notes

Field Measurements don't correlate with drillers logs

SUPPORTING INFORMATION	Drillers Log	yes	Meeting With Land Representative	yes	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Deverill - 141677**

Photograph 2 **Deverill - 141677**

BORE REPORT

REG NUMBER 141677

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-09-57	**MAP-SCALE**	254
OFFICE	Mackay	**SUB-AREA**		**LONGITUDE**	148-22-39	**MAP-SERIES**	
DATE LOG RECD	03-FEB-10	**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	642041	**MAP-NO**	
D/O FILE NO.		**LOT**	18	**NORTHING**	7548177	**MAP NAME**	
R/O FILE NO.		**PLAN**	SP113322	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**		**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.165801	**PARISH NAME**	2618-KERLONG			**ORIGINAL BORE NO**	
GIS LNG	148.3776006	**COUNTY**	KILLARNEY			**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	13/12/2009			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**	EVETTS, COREY				
ROLES		**DRILL COMPANY**	Q. D. S.				
		METHOD OF CONST.	ROTARY MUD				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	13/12/2009	1	Polyvinyl Chloride	5.900	WT	127	0.00	24.00
A	13/12/2009	2	Perforated or Slotted Casing				12.00	24.00
A	13/12/2009	3	Gravel Pack	5.000	GR		6.00	24.00
X	13/12/2009	4	Grout			200	0.00	6.00

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	6.00	SANDY LOAM
2	6.00	10.00	CLAY
3	10.00	13.00	SAND
4	13.00	20.00	CLAY WITH GRAVEL BANDS
5	20.00	24.00	CLAY, WHITE

BORE REPORT

REG NUMBER 141677

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	13.00	20.00	CLAY GRAV			N	POTABLE	0.38	N	SC	NEW CHUM FORMATION

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

****** NO RECORDS FOUND ******

WATER ANALYSIS PART1

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

****** NO RECORDS FOUND ******

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

FIELD MEASUREMENTS

ALK (mEq)	METH	SOURCE

BORE REPORT

REG NUMBER 141677

PIPE	DATE	DEPTH (m)	COND (uS/cm)	pH	TEMP (C)	NO3 (mg/L)	DO (mg/L)	Eh (mV)	ALK (mEq)	METH	SOURCE
A	13/12/2009	24.00	779							PU	GB

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

**** End of Report. Produced:** 30/01/2018 06:47:57 AM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	12/092017	**SURVEY PERSONNEL:**	ML + AF	**BORE ID:**	**Iffley - 136090**

PART A: PROPERTY DETAILS

Property Name:	Iffley		
Local Bore Name:	Homestead Bore	**Ref No/GW Number:**	136090
Easting (GDA94):	647486	**GPS Elevation:**	183
Northing:	7540034		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**22.68**	**Year Drilled:**	2002
Casing Stick Up (SU):	**0.28**	**Drilled By**	**Depco**
Casing Material	**PVC**	**Internal Diameter**	125
Initial Water Quality Measurement (Driller Log)	690 (no units)		
Construction Summary (Driller Log)	**PVC 0-90.0** **Screen 84.0-90.0**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**yes**	**Condition**	**good**	**Pump Type**	Submersible
Power Source	**mains**	**Bore Capped**	**no**	**Bore Equipped With Meter**	no
Headworks	**2" HDPE outlet off steel manifold**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Domestic**	**Pumping Regime**	float actuated pressure switch
Storage Type	**Tank**	**Approximate Volume**	60000

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**12.71**	**Date / Time of Measurement:**	4:30:00 PM
Pumping History	Pumping at time of inspection		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**0**	**O_2 %:**	**20**
Sample Collection Point	**tank inlet**	**Sample Method**		**Bucket**		**Purge Volume**		**unknown**	
Electrical Conductivity (µS/cm)	**2187**	**Temp**	**26.37**	**pH**	**6.62**	**ORP**	**83.7**	**DO (%)**	**55.4**

COMMENTS

-

GROUNDWATER BORE REPORT CARD

Additional Notes

SWL measurements taken from adjacent disused bore. Pumping bore was operational at time of measurement. Drillers construction log doesn't match site observations

SUPPORTING INFORMATION	Drillers Log	Yes	Meeting With Land Representative	Yes	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Iffley - 136090**

Photograph 2 **Iffley - 136090**

BORE REPORT

REG NUMBER 136090

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-14-17	**MAP-SCALE**	
OFFICE	Rockhampton	**SUB-AREA**		**LONGITUDE**	148-25-55	**MAP-SERIES**	
DATE LOG RECD	04-FEB-03	**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	647570	**MAP-NO**	
D/O FILE NO.		**LOT**	1	**NORTHING**	7540125	**MAP NAME**	
R/O FILE NO.		**PLAN**	KL159	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**	GPS	**PRES EQUIPMENT**	
				GPS ACC	20		
GIS LAT	-22.2380556	**PARISH NAME**	1312-COXENDEAN			**ORIGINAL BORE NO**	
GIS LNG	148.4319444	**COUNTY**	KILLARNEY			**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	15/12/2002			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**	RIDDELL, WAYNE EDWARD				
ROLES	WS	**DRILL COMPANY**	DEPCO DRILLING				
		METHOD OF CONST.	ROTARY				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	15/12/2002	1	Polyvinyl Chloride	5.900	WT	140	0.00	90.00
A	15/12/2002	2	Screen			140	84.00	90.00
A	15/12/2002	3	Gravel Pack				0.00	41.76

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	2.74	SANDY TOPSOIL
2	2.74	6.10	CLAY
3	6.10	18.29	SAND
4	18.29	24.38	CLAY
5	24.38	27.43	COARSE SAND
6	27.43	41.76	RED AND GREY CLAY

BORE REPORT

REG NUMBER 136090

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	24.38	27.43	SAND	15/12/2002	-1.83	N	690	0.44	Y	UC	ISAAC RIVER ALLUVIUM

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

****** NO RECORDS FOUND ******

WATER ANALYSIS PART1

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

****** NO RECORDS FOUND ******

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

FIELD MEASUREMENTS

****** NO RECORDS FOUND ******

REG NUMBER 136090

SPECIAL WATER ANALYSIS

**** NO RECORDS FOUND ****

BORE REPORT

**** End of Report. Produced:** 30/01/2018 06:44:33 AM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	12/11/2017	**SURVEY PERSONNEL:**	ML + TF	**BORE ID:**	Lake Vermont - Powerline bore

PART A: PROPERTY DETAILS

Property Name:	Lake Vermont		
Local Bore Name:	Powerline bore	**Ref No/GW Number:**	-
Easting (GDA94):	641899	**GPS Elevation:**	190
Northing:	7519646		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	-	**Year Drilled:**	-
Casing Stick Up (SU):	0.34	**Drilled By**	-
Casing Material	PVC	**Internal Diameter**	125
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	-		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	yes	**Condition**	good	**Pump Type**	Submersible
Power Source	Powerline	**Bore Capped**	yes	**Bore Equipped With Meter**	no
Headworks	3" steel manifold onto 2" HDPE with sample tap				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	stock	**Pumping Regime**	no
Storage Type	no	**Approximate Volume**	no

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	-	**Date / Time of Measurement:**	8:05:00 AM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	-	**H_2S ppm:**	-	**CO ppm:**	-	**O_2 %:**	-
Sample Collection Point	Sample Tap	**Sample Method**	Bucket			**Purge Volume**	20		
Electrical Conductivity (µS/cm)	1443	**Temp**	26.4	**pH**	7.28	**ORP**	120.8	**DO (%)**	54.6

COMMENTS

Pump deployed

GROUNDWATER BORE REPORT CARD

Additional Notes -					
SUPPORTING INFORMATION	**Drillers Log** no	**Meeting With Land Representative**	yes	**Photo**	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Lake Vermont - Powerline bore**

Photograph 2 **Lake Vermont - Powerline bore**

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	12/11/2017	**SURVEY PERSONNEL:**	ML + TF	**BORE ID:**	Lake Vermont - Yard Bore 1

PART A: PROPERTY DETAILS

Property Name:	Lake Vermont		
Local Bore Name:	Yard Bore 1	**Ref No/GW Number:**	-
Easting (GDA94):	642611	**GPS Elevation:**	185
Northing:	7519351		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	96	**Year Drilled:**	~1930
Casing Stick Up (SU):	0.34	**Drilled By**	-
Casing Material	steel	**Internal Diameter**	120
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	-		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	no	**Condition**	poor	**Pump Type**	-
Power Source	mains	**Bore Capped**	no	**Bore Equipped With Meter**	no
Headworks	2" HDPE (not connected)				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	stock	**Pumping Regime**	no
Storage Type	tank	**Approximate Volume**	50000

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	21.385	**Date / Time of Measurement:**	8:42:00 AM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	0	**H_2S ppm:**	0	**CO ppm:**	0	**O_2 %:**	20.4
Sample Collection Point	bore	**Sample Method**	bailer			**Purge Volume**	2		
Electrical Conductivity (µS/cm)	1512	**Temp**	25.6	**pH**	7.49	**ORP**	187.2	**DO (%)**	58.9

COMMENTS

-

GROUNDWATER BORE REPORT CARD

Additional Notes

Bore no longer in use due to heavy corrosion in casing. Land owner noted that water is known to have a high sulphur content

SUPPORTING INFORMATION	**Drillers Log**	**no**	**Meeting With Land Representative**	**yes**	**Photo**	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Lake Vermont - Yard Bore 1**

Photograph 2 **Lake Vermont - Yard Bore 1**

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	12/11/2017	**SURVEY PERSONNEL:**	ML + TF	**BORE ID:**	**Lake Vermont - Yard Bore 2**

PART A: PROPERTY DETAILS

Property Name:	Lake Vermont		
Local Bore Name:	Yard Bore 2	**Ref No/GW Number:**	-
Easting (GDA94):	642617	**GPS Elevation:**	190
Northing:	7519347		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**-**	**Year Drilled:**	-
Casing Stick Up (SU):	**0.04**	**Drilled By**	**-**
Casing Material	**PVC**	**Internal Diameter**	125
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**-**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**yes**	**Condition**	**good**	**Pump Type**	Submersible
Power Source	**mains**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	no
Headworks	**3" steel manifold onto 2" HDPE**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**stock**	**Pumping Regime**	no
Storage Type	**tank**	**Approximate Volume**	50000

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**-**	**Date / Time of Measurement:**	9:00:00 AM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**-**	**H_2S ppm:**	**-**	**CO ppm:**	**-**	**O_2 %:**	**-**
Sample Collection Point	**-**	**Sample Method**	**-**			**Purge Volume**	**-**		
Electrical Conductivity (µS/cm)	**-**	**Temp**	**-**	**pH**	**-**	**ORP**	**-**	**DO (%)**	**-**

COMMENTS

Pump deployed

GROUNDWATER BORE REPORT CARD

Additional Notes

Tank overflow returns to Yard Bore #1

SUPPORTING INFORMATION	**Drillers Log**	**no**	**Meeting With Land Representative**	**yes**	**Photo**	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Lake Vermont - Yard Bore 2**

Photograph 2 **Lake Vermont - Yard Bore 2**

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**12/11/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Lake Vermont - 132627**

PART A: PROPERTY DETAILS

Property Name:	Lake Vermont		
Local Bore Name:	Green Tank	**Ref No/GW Number:**	132627
Easting (GDA94):	649621	**GPS Elevation:**	170
Northing:	7525089		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	-	**Year Drilled:**	2007
Casing Stick Up (SU):	-	**Drilled By**	**Depco**
Casing Material	-	**Internal Diameter**	-
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**PVC 0-70** **Slotted 35.0-40.0**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**no**	**Condition**	**unknown**	**Pump Type**	-
Power Source	**-**	**Bore Capped**	**-**	**Bore Equipped With Meter**	-
Headworks	**-**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**-**	**Pumping Regime**	-
Storage Type	**tank**	**Approximate Volume**	30000

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	-	**Date / Time of Measurement:**	10:10:00 AM
Pumping History	-		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**-**	**H_2S ppm:**	**-**	**CO ppm:**	**-**	**O_2 %:**	**-**
Sample Collection Point	**-**	**Sample Method**	**-**			**Purge Volume**	**-**		
Electrical Conductivity (µS/cm)	**-**	**Temp**	**-**	**pH**	**-**	**ORP**	**-**	**DO (%)**	**-**

COMMENTS

Unable to locate, likely buried

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	12/11/2017	SURVEY PERSONNEL:	ML + TF	BORE ID:	Lake Vermont - 158481 (VWP)

PART A: PROPERTY DETAILS

Property Name:	Lake Vermont		
Local Bore Name:	-	**Ref No/GW Number:**	158481
Easting (GDA94):	643243	**GPS Elevation:**	185
Northing:	7522128		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	-	**Year Drilled:**	2013
Casing Stick Up (SU):	0.8	**Drilled By**	**Hodge Drilling**
Casing Material	**Grouted VWP**	**Internal Diameter**	-
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**VWP 1 - 94.0** **VWP 2 - 74.0** **VWP 3 - 56.0** **VWP 4 - 38.0**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**yes**	**Condition**	**good**	**Pump Type**	N/A
Power Source	**N/A**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	N/A
Headworks	**no**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Monitoring**	**Pumping Regime**	N/A
Storage Type	**N/A**	**Approximate Volume**	N/A

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	-	**Date / Time of Measurement:**	4:20:00 PM
Pumping History	N/A		

PART F: WATER QUALITY

Well Head Gas Screening:	**CH_4 ppm:**	**-**	**H_2S ppm:**	**-**	**CO ppm:**	**-**	**O_2 %:**	**-**	
Sample Collection Point	**VWP Cable**	**Sample Method**	**VWP Reader**		**Purge Volume**	**-**			
Electrical Conductivity (µS/cm)	**-**	**Temp**	**-**	**pH**	**-**	**ORP**	**-**	**DO (%)**	**-**

COMMENTS

VWP - Readings taken but calibration information required to process

GROUNDWATER BORE REPORT CARD

Additional Notes

VWP Red - HZ 6025 / Temp 27.1

VWP Black - HZ 7093 / Temp 25.6

VWP Yellow - HZ 7062 - Temp 26.2

VWP Blue - HZ 6323 / Temp 27.9

SUPPORTING INFORMATION	Drillers Log	yes	Meeting With Land Representative	yes	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1 | **Lake Vermont - 158481 (VWP)**

Photograph 2 | **Lake Vermont - 158481 (VWP)**

BORE REPORT

REG NUMBER 158481

REGISTRATION DETAILS

BASIN 1304
LATITUDE 22-24-09
MAP-SCALE
OFFICE Emerald
SUB-AREA
LONGITUDE 148-23-26
MAP-SERIES
DATE LOG RECD 06-AUG-13
SHIRE 3980-ISAAC REGIONAL
EASTING 643132
MAP-NO
D/O FILE NO. 50-0699
LOT 4
NORTHING 7521949
MAP NAME
R/O FILE NO.
PLAN CNS382
ZONE 55
PROG SECTION
H/O FILE NO.
ORIGINAL DESCRIPTION
ACCURACY
PRES EQUIPMENT
GPS ACC
GIS LAT -22.40259288
PARISH NAME 4814-VERMONT
ORIGINAL BORE NO LV2226
GIS LNG 148.3905162
COUNTY CAIRNS
BORE LINE -
CHECKED Y
POLYGON
RN OF BORE REPLACED
FACILITY TYPE Sub-Artesian Facility
DATE DRILLED 11/07/2013
DATA OWNER DNR
STATUS Existing
DRILLERS NAME DITCHMEN, RAY
ROLES MM
DRILL COMPANY HODGE DRILLING
METHOD OF CONST. ROTARY AIR

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	11/07/2013	1	Vibrating Wire Piezometer					94.00
B	11/07/2013	2	Vibrating Wire Piezometer					74.00
C	11/07/2013	3	Vibrating Wire Piezometer					56.00
D	11/07/2013	4	Vibrating Wire Piezometer					38.00
D	11/07/2013	5	Grout			125	0.00	102.00
X	11/07/2013	6	Polyvinyl Chloride	5.900	WT	140	0.00	37.00

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	1.00	SOIL
2	1.00	20.00	LOAM
3	20.00	35.00	SAND AND GRAVEL

BORE REPORT

REG NUMBER 158481

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
4	35.00	37.00	CLAY
5	37.00	91.00	SANDSTONE
6	91.00	97.00	COAL
7	97.00	102.00	NO DATA

STRATIGRAPHY DETAILS

**** NO RECORDS FOUND ****

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	38.00	97.00	CLAY			N			Y	UC	TERTIARY - UNDEFINED
2	56.00		SDST			N			Y	PS	RANGAL COAL MEASURES
3	74.00		SDST			N			Y	PS	RANGAL COAL MEASURES
4	94.00		COAL			N			Y	PS	RANGAL COAL MEASURES

PUMP TEST DETAILS PART 1

**** NO RECORDS FOUND ****

PUMP TEST DETAILS PART 2

**** NO RECORDS FOUND ****

BORE CONDITION

**** NO RECORDS FOUND ****

ELEVATION DETAILS

PIPE	DATE	ELEVATION	PRECISION	DATUM	MEASUREMENT POINT	SURVEY SOURCE
D	05/06/2013	178.84	SVY	AHD	R	

WATER ANALYSIS PART1

**** NO RECORDS FOUND ****

BORE REPORT

REG NUMBER 158481

WATER ANALYSIS PART 2

**** NO RECORDS FOUND ****

WATER LEVEL DETAILS

**** NO RECORDS FOUND ****

WIRE LINE LOG DETAILS

**** NO RECORDS FOUND ****

FIELD MEASUREMENTS

**** NO RECORDS FOUND ****

SPECIAL WATER ANALYSIS

**** NO RECORDS FOUND ****

BORE REPORT

**** End of Report. Produced:** 31/01/2018 08:56:27 AM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	12/11/2017	**SURVEY PERSONNEL:**	ML + TF	**BORE ID:**	Lake Vermont - 158485

PART A: PROPERTY DETAILS

Property Name:	Lake Vermont		
Local Bore Name:	-	**Ref No/GW Number:**	158485
Easting (GDA94):	643243	**GPS Elevation:**	181
Northing:	7522125		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**22.95**	**Year Drilled:**	2013
Casing Stick Up (SU):	**0.78**	**Drilled By**	**Hodge Drilling**
Casing Material	**PVC**	**Internal Diameter**	50
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**PVC 0-22.0** **Perforated 16.0-22.0**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**yes**	**Condition**	**good**	**Pump Type**	N/A
Power Source	**N/A**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	N/A
Headworks	**Gal Steel Monument**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Monitoring**	**Pumping Regime**	N/A
Storage Type	**N/A**	**Approximate Volume**	N/A

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**14.257**	**Date / Time of Measurement:**	4:07:00 PM
Pumping History	N/A		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**0**	**O_2 %:**	**21**
Sample Collection Point	**bore**	**Sample Method**	**bailer**			**Purge Volume**	**2**		
Electrical Conductivity (µS/cm)	**560**	**Temp**	**28.9**	**pH**	**7.19**	**ORP**	**-12.1**	**DO (%)**	**25.6**

COMMENTS

-

GROUNDWATER BORE REPORT CARD

Additional Notes

-

SUPPORTING INFORMATION	Drillers Log	yes	Meeting With Land Representative	yes	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1	Lake Vermont - 158485

Photograph 2	Lake Vermont - 158485

BORE REPORT

REG NUMBER 158485

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-24-10	**MAP-SCALE**	
OFFICE	Emerald	**SUB-AREA**		**LONGITUDE**	148-23-26	**MAP-SERIES**	
DATE LOG RECD	06-AUG-13	**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	643132	**MAP-NO**	
D/O FILE NO.	50-0699	**LOT**	4	**NORTHING**	7521943	**MAP NAME**	
R/O FILE NO.		**PLAN**	CNS382	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**		**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.40264472	**PARISH NAME**	4814-VERMONT			**ORIGINAL BORE NO**	LV2371
GIS LNG	148.390523	**COUNTY**	CAIRNS			**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	28/06/2013			**DATA OWNER**	DNR
STATUS	Existing	**DRILLERS NAME**	DITCHMEN, RAY				
ROLES	MM	**DRILL COMPANY**	HODGE DRILLING				
		METHOD OF CONST.	ROTARY AIR				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	28/06/2013	1	Polyvinyl Chloride			50	0.00	22.00
A	28/06/2013	2	Perforated or Slotted Casing			50	16.00	22.00
A	28/06/2013	3	Gravel Pack	3.000	GR		14.00	22.00
A	28/06/2013	4	Grout			165	0.00	14.00

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	1.00	SOIL
2	1.00	6.00	SAND
3	6.00	8.00	LOAM
4	8.00	10.00	SAND
5	10.00	12.00	CLAY

BORE REPORT

REG NUMBER 158485

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
6	12.00	14.00	LOAM
7	14.00	22.00	CLAY (DRY)

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	16.00	22.00	CLAY						Y	UC	QUATERNARY - UNDEFINED

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

PIPE	DATE	ELEVATION	PRECISION	DATUM	MEASUREMENT POINT	SURVEY SOURCE
A	30/04/2013	178.92	SVY	AHD	R	

WATER ANALYSIS PART1

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

****** NO RECORDS FOUND ******

BORE REPORT

REG NUMBER 158485

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

FIELD MEASUREMENTS

****** NO RECORDS FOUND ******

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

BORE REPORT

**** End of Report. Produced:** 31/01/2018 09:05:55 AM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**12/11/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Lake Vermont - 165122 (VWP)**

PART A: PROPERTY DETAILS

Property Name:	Lake Vermont		
Local Bore Name:	-	**Ref No/GW Number:**	165122
Easting (GDA94):	644182	**GPS Elevation:**	181
Northing:	7520541		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**-**	**Year Drilled:**	2013
Casing Stick Up (SU):	**0.7**	**Drilled By**	**Hodge Drilling**
Casing Material	**Grouted VWP**	**Internal Diameter**	-
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**VWP 1 - 83.0** **VWP 2 - 71.0** **VWP 3 - 61.0** **VWP 4 - 40.0**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**yes**	**Condition**	**Good**	**Pump Type**	N/A
Power Source	**N/A**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	N/A
Headworks	**no**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Monitoring**	**Pumping Regime**	N/A
Storage Type	**N/A**	**Approximate Volume**	N/A

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**-**	**Date / Time of Measurement:**	4:22:00 PM
Pumping History	N/A		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**-**	**H_2S ppm:**	**-**	**CO ppm:**	**-**	**O_2 %:**	**-**
Sample Collection Point	**VWP Cable**	**Sample Method**		**VWP Reader**		**Purge Volume**	**-**		
Electrical Conductivity (µS/cm)	**-**	**Temp**	**-**	**pH**	**-**	**ORP**	**-**	**DO (%)**	**-**

COMMENTS

VWP - Readings taken but calibration information required to process

GROUNDWATER BORE REPORT CARD

Additional Notes

VWP Red - HZ 7650 / Temp 21.2

VWP Black - HZ 8804 / Temp 25.0

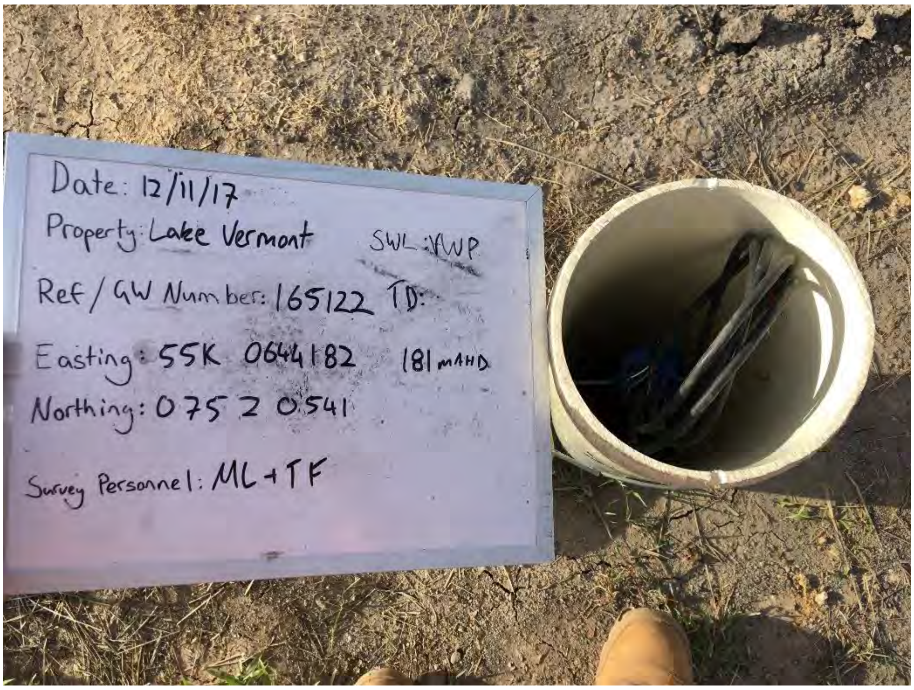
VWP Yellow - HZ 7320 - Temp 27.3

VWP Blue - HZ 7229 / Temp 26.5

SUPPORTING INFORMATION	Drillers Log	yes	Meeting With Land Representative	yes	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Lake Vermont - 165122 (VWP)**



Photograph 2 **Lake Vermont - 165122 (VWP)**

BORE REPORT

REG NUMBER 165122

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-25-01	**MAP-SCALE**	
OFFICE	Emerald	**SUB-AREA**		**LONGITUDE**	148-23-59	**MAP-SERIES**	
DATE LOG RECD		**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	644067	**MAP-NO**	
D/O FILE NO.		**LOT**	2	**NORTHING**	7520357	**MAP NAME**	
R/O FILE NO.		**PLAN**	SP260662	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**		**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.4168878601	**PARISH NAME**	4814-VERMONT			**ORIGINAL BORE NO**	LV2183
GIS LNG	148.3997413428	**COUNTY**				**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	06/05/2013			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**					
ROLES	MM	**DRILL COMPANY**	HODGE DRILLING				
		METHOD OF CONST.					

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	06/05/2013	1	Vibrating Wire Piezometer					83.00
B	06/05/2013	2	Vibrating Wire Piezometer					71.00
C	06/05/2013	3	Vibrating Wire Piezometer					61.00
D	06/05/2013	4	Vibrating Wire Piezometer					40.00
D	06/05/2013	5	Polyvinyl Chloride			100	0.00	91.00

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	1.00	SOIL, BROWN
2	1.00	2.00	CLAY, BROWN
3	2.00	6.00	SAND, BROWN, GRADING TO GREY AT BASE
4	6.00	8.00	CLAY

BORE REPORT

REG NUMBER 165122

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
5	8.00	9.00	LATERITE, ORANGE-RED
6	9.00	15.00	CLAY, SANDY, REDDISH CREAM
7	15.00	20.00	CLAY, SANDY, GREY
8	20.00	23.00	CLAY, BROWNISH ORANGE. BASE OF TERTIARY 23 MBGL
9	23.00	28.00	SILTSTONE, BROWNISH ORANGE
10	28.00	36.00	SANDSTONE, VERY FINE GRAINED, BROWNISH GREY, BASE OF REWAN AT 36 MBGL
11	36.00	39.00	MUDSTONE, DARK BROWNISH GREY
12	39.00	43.50	SANDSTONE, FINE GRAINED, MEDIUM GREY
13	43.50	44.00	COAL, BLACK
14	44.00	56.40	SANDSTONE, GREY, VERY FINE TO FINE GRAINED. BASE OF WEATHERING AT 47 MBGL
15	56.40	56.80	SILTSTONE, BROWNISH GREY
16	56.80	58.50	CARBONACEOUS MUDSTONE, DARK BLACKISH GREY
17	58.50	59.50	SILTSTONE, BLACKISH GREY, CARBONACEOUS
18	59.50	62.50	COAL, BLACK, LEICHHARDT SEAM
19	62.50	73.50	SILTSTONE, BLACKISH GREY, ABUNDANT SANDSTONE BANDS TOWARDS BASE
20	73.50	80.00	SANDSTONE, SILTY, GREY
21	80.00	86.50	COAL, VERMONT SEAM
22	86.50	87.50	MUDSTONE, DARK GREY
23	87.50	91.00	SANDSTONE, GREY, VERY FINE GRAINED TO MEDIUM GRAINED TOWARDS BASE

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	40.00		SDST			N			Y	PS	RANGAL COAL MEASURES
2	61.00		COAL			N			Y	PS	RANGAL COAL MEASURES
3	71.00		SSTO			N			Y	PS	RANGAL COAL MEASURES
4	83.00		COAL			N			Y	PS	RANGAL COAL MEASURES

BORE REPORT

REG NUMBER 165122

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

PIPE	DATE	ELEVATION	PRECISION	DATUM	MEASUREMENT POINT	SURVEY SOURCE
D	06/05/2013	185.16	EST	AHD	R	BOWEN COAL PTY LTD

WATER ANALYSIS PART1

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

****** NO RECORDS FOUND ******

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

FIELD MEASUREMENTS

****** NO RECORDS FOUND ******

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

BORE REPORT

**** End of Report. Produced:** 30/01/2018 06:57:12 AM ******

TOC

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	12/11/2017	**SURVEY PERSONNEL:**	ML + TF	**BORE ID:**	**Lake Vermont - 158011**

PART A: PROPERTY DETAILS

Property Name:	Lake Vermont		
Local Bore Name:	-	**Ref No/GW Number:**	158011
Easting (GDA94):	640150	**GPS Elevation:**	194
Northing:	7514275		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**33.18**	**Year Drilled:**	2012
Casing Stick Up (SU):	**0.79**	**Drilled By**	**Pioneer Drilling**
Casing Material	**PVC**	**Internal Diameter**	50
Initial Water Quality Measurement (Driller Log)	Brackish		
Construction Summary (Driller Log)	**PVC 0-32.0** **Slotted 24.5-30.5**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**yes**	**Condition**	**Good**	**Pump Type**	N/A
Power Source	**N/A**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	N/A
Headworks	**Steel Monument**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Monitoring**	**Pumping Regime**	N/A
Storage Type	**N/A**	**Approximate Volume**	N/A

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**18.3**	**Date / Time of Measurement:**	12:48:00 PM
Pumping History	N/A		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**2**	**CO ppm:**	**0**	**O_2 %:**	**21.4**
Sample Collection Point	**bore**	**Sample Method**	**bailer**			**Purge Volume**	**2**		
Electrical Conductivity (µS/cm)	**6340**	**Temp**	**25.9**	**pH**	**7.03**	**ORP**	**-205**	**DO (%)**	**35.5**

COMMENTS

-

GROUNDWATER BORE REPORT CARD

Additional Notes

Rotten egg odour

SUPPORTING INFORMATION	Drillers Log	yes	Meeting With Land Representative	yes	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1 — **Lake Vermont - 158011**

Photograph 2 — **Lake Vermont - 158011**

BORE REPORT

REG NUMBER 158011

REGISTRATION DETAILS

		BASIN	1304	LATITUDE	22-28-26	MAP-SCALE	
OFFICE	Emerald	SUB-AREA		LONGITUDE	148-21-40	MAP-SERIES	
DATE LOG RECD	20-JUL-12	SHIRE	3980-ISAAC REGIONAL	EASTING	640035	MAP-NO	
D/O FILE NO.		LOT	4	NORTHING	7514095	MAP NAME	
R/O FILE NO.		PLAN	CNS382	ZONE	55	PROG SECTION	
H/O FILE NO.		ORIGINAL DESCRIPTION		ACCURACY		PRES EQUIPMENT	
				GPS ACC			
GIS LAT	-22.47377903	PARISH NAME	4814-VERMONT			ORIGINAL BORE NO	MW36
GIS LNG	148.3611312	COUNTY	CAIRNS			BORE LINE	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	DATE DRILLED	06/07/2012			DATA OWNER	
STATUS	Existing	DRILLERS NAME	NEIVANDT, ROSS				
ROLES		DRILL COMPANY	PIONEER DRILLING				
		METHOD OF CONST.	ROTARY AIR				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	06/07/2012	1	Polyvinyl Chloride	6.000	WT	140	0.00	24.00
A	06/07/2012	2	Polyvinyl Chloride	5.000	WT	60	0.00	32.00
A	06/07/2012	3	Perforated or Slotted Casing	0.400	AP		24.50	30.50
X	06/07/2012	4	Grout			190	0.00	24.00
X	06/07/2012	5	Grout			130	0.00	23.00
X	06/07/2012	6	Bentonite Seal			130	23.00	24.00
X	06/07/2012	7	Gravel Pack			120	24.00	32.00

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	2.00	BLACK SOIL, CRACKING CLAY
2	2.00	6.00	CLAY: YELLOWISH BROWN, SILTY

BORE REPORT

REG NUMBER 158011

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
3	6.00	12.00	SILT: YELLOW BROWN, CLAYEY
4	12.00	22.00	GRAVLE: CLAYEY, SANDY, BANDED CLAYS, GREYISH YELLOWY BROWN
5	22.00	28.00	SILTSTONE: SANDY, GREY, MEDIUM HARD *
6	28.00	32.00	SANDSTONE:GREY, MEDIUM TO COARSE *

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	26.00	32.00	SSTO SDST			N	BRACKISH	0.09	Y	PS	FAIR HILL FORMATION

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

****** NO RECORDS FOUND ******

WATER ANALYSIS PART1

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

BORE REPORT

REG NUMBER 158011

****** NO RECORDS FOUND ******

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

FIELD MEASUREMENTS

PIPE	DATE	DEPTH (m)	COND (uS/cm)	pH	TEMP (C)	NO3 (mg/L)	DO (mg/L)	Eh (mV)	ALK (mEq)	METH	SOURCE
A	06/07/2012		7320	7.3						AI	GB

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

**** End of Report. Produced:** 30/01/2018 07:03:15 AM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	12/11/2017	**SURVEY PERSONNEL:**	ML + TF	**BORE ID:**	Lake Vermont - 165325

PART A: PROPERTY DETAILS

Property Name:	Lake Vermont		
Local Bore Name:	-	**Ref No/GW Number:**	165325
Easting (GDA94):	640412	**GPS Elevation:**	188
Northing:	7516077		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	18.58	**Year Drilled:**	2016
Casing Stick Up (SU):	0.87	**Drilled By**	Borat Longyear
Casing Material	PVC	**Internal Diameter**	50
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	PVC 0-18.0 Slotted 12.0-18.0		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	yes	**Condition**	Good	**Pump Type**	N/A
Power Source	N/A	**Bore Capped**	yes	**Bore Equipped With Meter**	N/A
Headworks	Gal Steel Monument				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	Monitoring	**Pumping Regime**	N/A
Storage Type	N/A	**Approximate Volume**	N/A

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	17.203	**Date / Time of Measurement:**	1:56:00 PM
Pumping History	N/A		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	0	**H_2S ppm:**	0	**CO ppm:**	1	**O_2 %:**	13.4
Sample Collection Point	bore	**Sample Method**	bailer			**Purge Volume**	2		
Electrical Conductivity (µS/cm)	1439	**Temp**	27.9	**pH**	6.96	**ORP**	33.2	**DO (%)**	27.4

COMMENTS

-

GROUNDWATER BORE REPORT CARD

Additional Notes

Concrete plinth damaged

SUPPORTING INFORMATION	Drillers Log	yes	Meeting With Land Representative	yes	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Lake Vermont - 165325**

Photograph 2 **Lake Vermont - 165325**

BORE REPORT

REG NUMBER 165325

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-27-27	**MAP-SCALE**	
OFFICE	Emerald	**SUB-AREA**		**LONGITUDE**	148-21-49	**MAP-SERIES**	
DATE LOG RECD	27-JUN-16	**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	640296	**MAP-NO**	
D/O FILE NO.		**LOT**	1	**NORTHING**	7515897	**MAP NAME**	
R/O FILE NO.		**PLAN**	SP260662	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**		**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.45748204	**PARISH NAME**	6000-NO LONGER USED			**ORIGINAL BORE NO**	PIEZO 3 (169240)
GIS LNG	148.36350795	**COUNTY**				**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	12/05/2016			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**	ALMOND, MICHAEL				
ROLES	MM	**DRILL COMPANY**	BOART LONGYEAR				
		METHOD OF CONST.	ROTARY AIR				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	12/05/2016	1	Polyvinyl Chloride	5.000	WT	60	0.00	12.00
A	12/05/2016	2	Perforated or Slotted Casing	1.000	AP	60	12.00	18.00
X	12/05/2016	3	Grout			124	0.00	9.00
X	12/05/2016	4	Bentonite Seal			124	9.00	11.00
X	12/05/2016	5	Gravel Pack	3.000	GR	124	11.00	18.50
X	12/05/2016	6	Centraliser				10.00	18.00

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	3.00	BROWN CLAY
2	3.00	5.00	BROWN SANDY CLAY
3	5.00	18.50	BROWN CLAY

BORE REPORT

REG NUMBER 165325

STRATIGRAPHY DETAILS

**** NO RECORDS FOUND ****

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	12.00	18.00	CLAY			N			N	PS	QUATERNARY - UNDEFINED

PUMP TEST DETAILS PART 1

**** NO RECORDS FOUND ****

PUMP TEST DETAILS PART 2

**** NO RECORDS FOUND ****

BORE CONDITION

**** NO RECORDS FOUND ****

ELEVATION DETAILS

**** NO RECORDS FOUND ****

WATER ANALYSIS PART1

**** NO RECORDS FOUND ****

WATER ANALYSIS PART 2

**** NO RECORDS FOUND ****

WATER LEVEL DETAILS

**** NO RECORDS FOUND ****

WIRE LINE LOG DETAILS

**** NO RECORDS FOUND ****

FIELD MEASUREMENTS

**** NO RECORDS FOUND ****

BORE REPORT

REG NUMBER 165325

SPECIAL WATER ANALYSIS

**** NO RECORDS FOUND ****

BORE REPORT

**** End of Report. Produced:** 30/01/2018 07:02:08 AM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	12/11/2017	**SURVEY PERSONNEL:**	ML + TF	**BORE ID:**	**Lake Vermont - 158010**

PART A: PROPERTY DETAILS

Property Name:	Lake Vermont		
Local Bore Name:	-	**Ref No/GW Number:**	158010
Easting (GDA94):	642638	**GPS Elevation:**	186
Northing:	7520120		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**35.2**	**Year Drilled:**	2012
Casing Stick Up (SU):	**0.9**	**Drilled By**	**Pioneer Drilling**
Casing Material	**PVC**	**Internal Diameter**	50
Initial Water Quality Measurement (Driller Log)	potable		
Construction Summary (Driller Log)	**PVC 0-34.5** **Slotted 27.0-33.0**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**Yes**	**Condition**	**Good**	**Pump Type**	N/A
Power Source	**N/A**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	N/A
Headworks	**Steel Monument**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Monitoring**	**Pumping Regime**	N/A
Storage Type	**N/A**	**Approximate Volume**	N/A

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**17.915**	**Date / Time of Measurement:**	3:27:00 PM
Pumping History	N/A		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**0**	**O_2 %:**	**21.4**
Sample Collection Point	**bore**	**Sample Method**		**bailer**		**Purge Volume**		**2**	
Electrical Conductivity (µS/cm)	**1236**	**Temp**	**27.1**	**pH**	**6.95**	**ORP**	**9.1**	**DO (%)**	**31.1**

COMMENTS

-

GROUNDWATER BORE REPORT CARD

Additional Notes

MW35 written on inside of cap

SUPPORTING INFORMATION	**Drillers Log**	**yes**	**Meeting With Land Representative**	**yes**	**Photo**	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Lake Vermont - 158010**

Photograph 2 **Lake Vermont - 158010**

BORE REPORT

REG NUMBER 158010

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-25-15	**MAP-SCALE**	
OFFICE	Emerald	**SUB-AREA**		**LONGITUDE**	148-23-05	**MAP-SERIES**	
DATE LOG RECD	20-JUL-12	**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	642528	**MAP-NO**	
D/O FILE NO.		**LOT**	4	**NORTHING**	7519939	**MAP NAME**	
R/O FILE NO.		**PLAN**	CNS382	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**		**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.42079367	**PARISH NAME**	4814-VERMONT			**ORIGINAL BORE NO**	MW35
GIS LNG	148.3848372	**COUNTY**	CAIRNS			**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	08/07/2012			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**	NEIVANDT, ROSS				
ROLES	MM	**DRILL COMPANY**	PIONEER DRILLING				
		METHOD OF CONST.	ROTARY AIR				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	08/07/2012	1	Polyvinyl Chloride	6.000	WT	140	0.00	12.00
A	08/07/2012	2	Polyvinyl Chloride	5.000	WT	60	0.00	34.50
A	08/07/2012	3	Perforated or Slotted Casing	0.400	AP		27.00	33.00
X	08/07/2012	4	Grout			190	0.00	12.00
X	08/07/2012	5	Grout			120	0.00	24.00
X	08/07/2012	6	Bentonite Seal			120	24.00	26.00
X	08/07/2012	7	Gravel Pack			120	26.00	34.50

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	1.50	BLACK SOIL, CLAY, STIFF
2	1.50	6.00	CLAY: YELLOWY BROWN, SILTY, STIFF

BORE REPORT

REG NUMBER 158010

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
3	6.00	8.50	CLAY: YELLOWY BROWN, SANDY
4	8.50	11.00	SAND: REDDISH BROWN, CLAYEY, WEAK
5	11.00	12.50	GRAVELLY COBBLE, COLLUVIAL, DRY
6	12.50	14.00	CLAYSTONE: GREY, WEAK
7	14.00	15.70	CLAYSTONE: YELLOWY BROWN, WEAK
8	15.70	16.00	CLAY: GREY
9	16.00	24.50	CLAY: YELLOWY BROWN, SILTY
10	24.50	27.00	CLAY: REDDISH BROWN, SILTY, MOIST, PLASTIC
11	27.00	31.50	SHALE: REDDISH DARK GREY, WEATHERED, WET *
12	31.50	34.50	SILTSTONE: GREY, FRESH *

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	30.00	33.00	SHLE SSTO			N	POTABLE	0.09	Y	PS	FAIR HILL FORMATION

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

****** NO RECORDS FOUND ******

BORE REPORT

REG NUMBER 158010

WATER ANALYSIS PART1

**** NO RECORDS FOUND ****

WATER ANALYSIS PART 2

**** NO RECORDS FOUND ****

WATER LEVEL DETAILS

**** NO RECORDS FOUND ****

WIRE LINE LOG DETAILS

**** NO RECORDS FOUND ****

FIELD MEASUREMENTS

PIPE	DATE	DEPTH (m)	COND (uS/cm)	pH	TEMP (C)	NO3 (mg/L)	DO (mg/L)	Eh (mV)	ALK (mEq)	METH	SOURCE
A	08/07/2012		1240	8.1						AI	GB

SPECIAL WATER ANALYSIS

**** NO RECORDS FOUND ****

BORE REPORT

**** End of Report. Produced:** 30/01/2018 06:59:03 AM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**11/11/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Lake Vermont - River Bore**

PART A: PROPERTY DETAILS

Property Name:	Lake Vermont		
Local Bore Name:	River Bore	**Ref No/GW Number:**	-
Easting (GDA94):	654027	**GPS Elevation:**	166
Northing:	7526947		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**39**	**Year Drilled:**	-
Casing Stick Up (SU):	**0.55**	**Drilled By**	**-**
Casing Material	**PVC**	**Internal Diameter**	125
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**-**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**no**	**Condition**	**Good**	**Pump Type**	no
Power Source	**no**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	no
Headworks	**no**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**stock**	**Pumping Regime**	no
Storage Type	**no**	**Approximate Volume**	no

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**14.614**	**Date / Time of Measurement:**	10:00:00 AM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**0**	**O_2 %:**	**19**
Sample Collection Point	**bore**	**Sample Method**	**bailer**			**Purge Volume**	**2**		
Electrical Conductivity (µS/cm)	**616**	**Temp**	**26.1**	**pH**	**6.5**	**ORP**	**43**	**DO (%)**	**37**

COMMENTS

-

GROUNDWATER BORE REPORT CARD

Additional Notes

Bore unused since installation. Structure erected ready to house bore equipment

SUPPORTING INFORMATION	Drillers Log	no	Meeting With Land Representative	yes	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Lake Vermont - River Bore**

Photograph 2 **Lake Vermont - River Bore**

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	11/11/2017	**SURVEY PERSONNEL:**	ML + TF	**BORE ID:**	**Lake Vermont - 158480 (VWP)**

PART A: PROPERTY DETAILS

Property Name:	Lake Vermont		
Local Bore Name:	-	**Ref No/GW Number:**	158480
Easting (GDA94):	649913	**GPS Elevation:**	166
Northing:	7522233		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	-	**Year Drilled:**	2013
Casing Stick Up (SU):	-	**Drilled By**	**Hodge Drilling**
Casing Material	**Grouted VWP**	**Internal Diameter**	-
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**VWP 1 - 94.0** **VWP 2 - 74.0** **VWP 3 - 56.0** **VWP 4 - 38.0**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**yes**	**Condition**	**Good**	**Pump Type**	N/A
Power Source	**N/A**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	N/A
Headworks	**no**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Monitoring**	**Pumping Regime**	N/A
Storage Type	**N/A**	**Approximate Volume**	N/A

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	-	**Date / Time of Measurement:**	12:00:00 AM
Pumping History	N/A		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**-**	**H_2S ppm:**	**-**	**CO ppm:**	**-**	**O_2 %:**	**-**
Sample Collection Point	**VWP Cable**	**Sample Method**		**VWP Reader**		**Purge Volume**	**-**		
Electrical Conductivity (µS/cm)	**-**	**Temp**	**-**	**pH**	**-**	**ORP**	**-**	**DO (%)**	**-**

COMMENTS

VWP - Readings taken but calibration information required to process

GROUNDWATER BORE REPORT CARD

Additional Notes

VWP Red - HZ 7007 / Temp 26.3

VWP Black - HZ 7509 / Temp 26.0

VWP Yellow - HZ 7208 - Temp 27.9

VWP Blue - HZ 7207 / Temp 27.3

SUPPORTING INFORMATION	**Drillers Log**	**yes**	**Meeting With Land Representative**	**yes**	**Photo**	yes

PHOTOGRAPHIC RECORD

Photograph 1	**Lake Vermont - 158480 (VWP)**

Photograph 2	**Lake Vermont - 158480 (VWP)**

BORE REPORT

REG NUMBER 158480

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-24-04	**MAP-SCALE**	
OFFICE	Emerald	**SUB-AREA**		**LONGITUDE**	148-27-19	**MAP-SERIES**	
DATE LOG RECD	06-AUG-13	**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	649801	**MAP-NO**	
D/O FILE NO.	50-0699	**LOT**	4	**NORTHING**	7522051	**MAP NAME**	
R/O FILE NO.		**PLAN**	CNS382	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**		**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.40110024	**PARISH NAME**	4814-VERMONT			**ORIGINAL BORE NO**	LV1235C
GIS LNG	148.4552793	**COUNTY**	CAIRNS			**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	09/07/2013			**DATA OWNER**	DNR
STATUS	Existing	**DRILLERS NAME**	DITCHMEN, RAY				
ROLES	MM	**DRILL COMPANY**	HODGE DRILLING				
		METHOD OF CONST.	ROTARY AIR				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	09/07/2013	1	Vibrating Wire Piezometer					94.00
B	09/07/2013	2	Vibrating Wire Piezometer					74.00
C	09/07/2013	3	Vibrating Wire Piezometer					56.00
D	09/07/2013	4	Vibrating Wire Piezometer					38.00
X	09/07/2013	5	Grout				0.00	94.00
X	09/07/2013	6	Polyvinyl Chloride	5.900	WT	125	0.00	57.00

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	1.00	SOIL
2	1.00	18.00	CLAY
3	18.00	38.00	SAND AND GRAVEL

BORE REPORT

REG NUMBER 158480

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
4	38.00	45.00	LOAM
5	45.00	57.00	CLAY
6	57.00	74.00	SANDSTONE
7	74.00	80.00	COAL
8	80.00	94.00	SANDSTONE

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	38.00		SAND GRAV	09/07/2013	-99.99	N			Y	UC	TERTIARY - UNDEFINED
2	56.00		CLAY	09/07/2013	-99.99	N			Y	UC	TERTIARY - UNDEFINED
3	74.00		COAL	09/07/2013	-99.99	N			Y	PS	RANGAL COAL MEASURES
4	94.00		SDST	09/07/2013	-99.99	N			Y	PS	RANGAL COAL MEASURES

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

PIPE	DATE	ELEVATION	PRECISION	DATUM	MEASUREMENT POINT	SURVEY SOURCE
A	29/05/2013	170.81	EST	AHD	R	

WATER ANALYSIS PART1

REG NUMBER **158480**

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

****** NO RECORDS FOUND ******

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

FIELD MEASUREMENTS

****** NO RECORDS FOUND ******

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

BORE REPORT

**** End of Report. Produced:** 30/01/2018 06:51:58 AM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	11/11/2017	**SURVEY PERSONNEL:**	ML + TF	**BORE ID:**	**Lake Vermont - Unknown 1**

PART A: PROPERTY DETAILS

Property Name:	Lake Vermont		
Local Bore Name:	-	**Ref No/GW Number:**	
Easting (GDA94):	650783	**GPS Elevation:**	160
Northing:	7522929		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**131**	**Year Drilled:**	-
Casing Stick Up (SU):	**0.16**	**Drilled By**	**-**
Casing Material	**PVC**	**Internal Diameter**	125
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**-**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**no**	**Condition**	**good**	**Pump Type**	no
Power Source	**no**	**Bore Capped**	**no**	**Bore Equipped With Meter**	no
Headworks	**no**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**exploration**	**Pumping Regime**	no
Storage Type	**no**	**Approximate Volume**	no

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**30.965**	**Date / Time of Measurement:**	1:28:00 PM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**1**	**O_2 %:**	**19.8**
Sample Collection Point	**bore**	**Sample Method**	**bailer**			**Purge Volume**	**2**		
Electrical Conductivity (µS/cm)	**16610**	**Temp**	**27.9**	**pH**	**6.56**	**ORP**	**49.9**	**DO (%)**	**30.6**

COMMENTS

-

GROUNDWATER BORE REPORT CARD

Additional Notes

Likely exploration hole. Looks to have been recently drilled

SUPPORTING INFORMATION	**Drillers Log**	**no**	**Meeting With Land Representative**	**yes**	**Photo**	yes

PHOTOGRAPHIC RECORD

Photograph 1	**Lake Vermont - Unknown 1**

Photograph 2	**Lake Vermont - Unknown 1**

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	11/11/2017	SURVEY PERSONNEL:	ML + TF	BORE ID:	Lake Vermont - 158484

PART A: PROPERTY DETAILS

Property Name:	Lake Vermont		
Local Bore Name:	-	**Ref No/GW Number:**	158484
Easting (GDA94):	648152	**GPS Elevation:**	163
Northing:	7524058		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**19.45**	**Year Drilled:**	2013
Casing Stick Up (SU):	**0.85**	**Drilled By**	**Hodge Drilling**
Casing Material	**PVC**	**Internal Diameter**	50
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**PVC 0-19.0** **Slotted 13.0-19.0**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**Yes**	**Condition**	**Good**	**Pump Type**	N/A
Power Source	**N/A**	**Bore Capped**	**Yes**	**Bore Equipped With Meter**	N/A
Headworks	**Gal steel monument - no cap**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Monitoring**	**Pumping Regime**	N/A
Storage Type	**N/A**	**Approximate Volume**	N/A

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**18.116**	**Date / Time of Measurement:**	3:00:00 PM
Pumping History	N/A		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**1**	**O_2 %:**	**13.5**
Sample Collection Point	**bore**	**Sample Method**	**bailer**			**Purge Volume**	**2**		
Electrical Conductivity (µS/cm)	**1401**	**Temp**	**26.8**	**pH**	**7.18**	**ORP**	**112.8**	**DO (%)**	**62.8**

COMMENTS

-

GROUNDWATER BORE REPORT CARD

Additional Notes Plinth damaged					
SUPPORTING INFORMATION	**Drillers Log**	**yes**	**Meeting With Land Representative**	**yes**	**Photo** yes

PHOTOGRAPHIC RECORD

Photograph 1 — **Lake Vermont - 158484**

Photograph 2 — **Lake Vermont - 158484**

BORE REPORT

REG NUMBER 158484

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-23-05	**MAP-SCALE**	
OFFICE	Emerald	**SUB-AREA**		**LONGITUDE**	148-26-17	**MAP-SERIES**	
DATE LOG RECD	06-AUG-13	**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	648038	**MAP-NO**	
D/O FILE NO.	50-0699	**LOT**	4	**NORTHING**	7523875	**MAP NAME**	
R/O FILE NO.		**PLAN**	CNS382	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**		**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.38477405	**PARISH NAME**	4814-VERMONT			**ORIGINAL BORE NO**	LV2370
GIS LNG	148.4379885	**COUNTY**	CAIRNS			**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	27/06/2013			**DATA OWNER**	DNR
STATUS	Existing	**DRILLERS NAME**	DITCHMEN, RAY				
ROLES	MM	**DRILL COMPANY**	HODGE DRILLING				
		METHOD OF CONST.	ROTARY AIR				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	27/06/2013	1	Polyvinyl Chloride			50	0.00	19.00
A	27/06/2013	2	Perforated or Slotted Casing			50	13.00	19.00
A	27/06/2013	3	Gravel Pack	3.000	GR		12.00	19.00
A	27/06/2013	4	Grout			165	0.00	12.00

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	1.00	SOIL
2	1.00	3.00	SAND
3	3.00	11.00	LOAM
4	11.00	14.00	CLAY
5	14.00	19.00	SAND

BORE REPORT

REG NUMBER 158484

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	14.00	19.00	SAND						Y	UC	QUATERNARY - UNDEFINED

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

PIPE	DATE	ELEVATION	PRECISION	DATUM	MEASUREMENT POINT	SURVEY SOURCE
A	29/04/2013	168.30	SVY	AHD	R	

WATER ANALYSIS PART1

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

****** NO RECORDS FOUND ******

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

FIELD MEASUREMENTS

****** NO RECORDS FOUND ******

BORE REPORT

REG NUMBER 158484

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

**** End of Report. Produced:** 30/01/2018 06:52:59 AM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**11/11/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Lake Vermont - 165124 (VWP)**

PART A: PROPERTY DETAILS

Property Name:	Lake Vermont		
Local Bore Name:	-	**Ref No/GW Number:**	165124
Easting (GDA94):	648156	**GPS Elevation:**	163
Northing:	7524044		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**-**	**Year Drilled:**	2013
Casing Stick Up (SU):	**0.49**	**Drilled By**	**Hodge Drilling**
Casing Material	**Grouted VWP**	**Internal Diameter**	-
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**VWP 1 - 78.0** **VWP 2 - 67.50** **VWP 3 - 50.0**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**yes**	**Condition**	**Good**	**Pump Type**	N/A
Power Source	**N/A**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	N/A
Headworks	**No**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Monitoring**	**Pumping Regime**	N/A
Storage Type	**N/A**	**Approximate Volume**	N/A

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**-**	**Date / Time of Measurement:**	12:00:00 AM
Pumping History	N/A		

PART F: WATER QUALITY

Well Head Gas Screening:	**CH_4 ppm:**	**-**	**H_2S ppm:**	**-**	**CO ppm:**	**-**	**O_2 %:**	**-**	
Sample Collection Point	**VWP Cable**	**Sample Method**	**VWP Reader**		**Purge Volume**	**-**			
Electrical Conductivity (µS/cm)	**-**	**Temp**	**-**	**pH**	**-**	**ORP**	**-**	**DO (%)**	**-**

COMMENTS

VWP - Readings taken but calibration information required to process

GROUNDWATER BORE REPORT CARD

Additional Notes

VWP Red - HZ 7049 / Temp 27.3

VWP Yellow - HZ 7725 - Temp 26.4

VWP Blue - HZ 6606 / Temp 26.8

SUPPORTING INFORMATION	Drillers Log	yes	Meeting With Land Representative	yes	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Lake Vermont - 165124 (VWP)**

Photograph 2 **Lake Vermont - 165124 (VWP)**

GROUNDWATER DATABASE

BORE REPORT

REG NUMBER 165124

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-23-06	**MAP-SCALE**	
OFFICE	Emerald	**SUB-AREA**		**LONGITUDE**	148-26-17	**MAP-SERIES**	
DATE LOG RECD		**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	648038	**MAP-NO**	
D/O FILE NO.		**LOT**	H	**NORTHING**	7523864	**MAP NAME**	
R/O FILE NO.		**PLAN**	SP260662	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**		**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.3848740787	**PARISH NAME**	4814-VERMONT			**ORIGINAL BORE NO**	LV2375W
GIS LNG	148.4379948207	**COUNTY**				**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	27/05/2013			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**					
ROLES	MM	**DRILL COMPANY**	HODGE DRILLING				
		METHOD OF CONST.					

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	27/05/2013	1	Vibrating Wire Piezometer					78.00
B	27/05/2013	2	Vibrating Wire Piezometer					67.50
C	27/05/2013	3	Vibrating Wire Piezometer					50.00
C	27/05/2013	4	Polyvinyl Chloride			100	0.00	82.00

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	7.00	SAND, LIGHT BROWN, FINE TO MEDIUM GRAINED
2	7.00	8.00	SAND, LIGHT BROWN, CONTAINS GRANULAR CONCRETIONS
3	8.00	10.80	CLAY, LIGHT BROWN
4	10.80	15.00	SANDY CLAY, LIGHT BROWN
5	15.00	20.00	SAND, LIGHT BROWN, COARSEMING TO GRAVEL AT BASE. BASE TERTIARY AT 20 MBGL

BORE REPORT

REG NUMBER 165124

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
6	20.00	22.50	SILTSTONE, LIGHT PINKISH-BROWN
7	22.50	60.00	SANDSTONE, LIGHT BROWISH GREY, VERY FINE GRAINED GRADING TO MEDIUM TOWARDS BASE
8	60.00	64.50	SILTSTONE, MEDIUM BROWNISH GREY, ALTERNATING BANDS OF VERY FINE SANDSTONE
9	64.50	69.00	COAL, VERMONT SEAM, BASE OF WEATHERING 68.7M
10	69.00	71.00	SILTSTONE, MEDIUM GREY
11	71.00	82.00	SANDSTONE, LIGHT GREY, VERY FINE GRAINED

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	50.00		SDST			N			Y	PS	RANGAL COAL MEASURES
2	67.50		COAL			N			Y	PS	RANGAL COAL MEASURES
3	78.00		SDST			N			Y	PS	RANGAL COAL MEASURES

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

PIPE	DATE	ELEVATION	PRECISION	DATUM	MEASUREMENT POINT	SURVEY SOURCE
C	27/05/2013	168.36	EST	AHD	R	BOWEN COAL PTY LTD

WATER ANALYSIS PART1

BORE REPORT

REG NUMBER 165124

PIPE	DATE	RD ANALYST	QAN	DEPTH (m)	RMK	SRC	COND (uS/cm)	pH	Si (mg/L)	TOTAL IONS (mg/L)	TOTAL SOLIDS (mg/L)	HARD	ALK	FIG. OF MERIT	SAR	RAH
D	28/05/2013	1 ALS	13721				10600			7559.98	7559.98	2305	1	0.5	17.9	

WATER ANALYSIS PART 2

PIPE	DATE	RD	Na	K	Ca	Mg	Mn	HCO3	Fe	CO3	Cl	F	NO3	SO4	Zn	Al	B	Cu
D	28/05/2013	1	1970.0	8.0	275.0	393.0	0.52		< 0.05		4660.0			253.0	< 0.01	< 0.01	0.38	< 0.01

WATER LEVEL DETAILS

**** NO RECORDS FOUND ****

WIRE LINE LOG DETAILS

**** NO RECORDS FOUND ****

FIELD MEASUREMENTS

**** NO RECORDS FOUND ****

SPECIAL WATER ANALYSIS

**** NO RECORDS FOUND ****

BORE REPORT

**** End of Report. Produced:** 30/01/2018 06:52:32 AM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**11/11/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Lake Vermont - 165123 (VWP)**

PART A: PROPERTY DETAILS

Property Name:	Lake Vermont		
Local Bore Name:	-	**Ref No/GW Number:**	165123
Easting (GDA94):	647629	**GPS Elevation:**	164
Northing:	7526188		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	-	**Year Drilled:**	2013
Casing Stick Up (SU):	**0.74**	**Drilled By**	**Hodge Drilling**
Casing Material	**Grouted VWP**	**Internal Diameter**	-
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**VWP 1 - 125.0** **VWP 2 - 108.0** **VWP 3 - 93.50** **VWP 4 - 73.0**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**yes**	**Condition**	**Good**	**Pump Type**	N/A
Power Source	**N/A**	**Bore Capped**	**Yes**	**Bore Equipped With Meter**	N/A
Headworks	**No**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Monitoring**	**Pumping Regime**	N/A
Storage Type	**N/A**	**Approximate Volume**	N/A

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	-	**Date / Time of Measurement:**	12:00:00 AM
Pumping History	N/A		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**-**	**H_2S ppm:**	**-**	**CO ppm:**	**-**	**O_2 %:**	**-**
Sample Collection Point	**VWP Cable**	**Sample Method**		**VWP Reader**		**Purge Volume**	**-**		
Electrical Conductivity (µS/cm)	**-**	**Temp**	**-**	**pH**	**-**	**ORP**	**-**	**DO (%)**	**-**

COMMENTS

VWP - Readings taken but calibration information required to process

GROUNDWATER BORE REPORT CARD

Additional Notes

VWP Red - HZ 6004 / Temp 25.6

VWP Black - HZ 6270 / Temp 26.2

VWP Yellow - HZ 7334 - Temp 27.0

VWP Blue - HZ 7163 / Temp 28.1

SUPPORTING INFORMATION	Drillers Log	yes	Meeting With Land Representative	yes	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Lake Vermont - 165123 (VWP)**

Photograph 2 **Lake Vermont - 165123 (VWP)**

BORE REPORT

REG NUMBER 165123

REGISTRATION DETAILS

OFFICE Emerald
DATE LOG RECD
D/O FILE NO.
R/O FILE NO.
H/O FILE NO.

BASIN 1304
SUB-AREA
SHIRE 3980-ISAAC REGIONAL
LOT 2
PLAN SP260662
ORIGINAL DESCRIPTION

LATITUDE 22-21-56
LONGITUDE 148-25-58
EASTING 647515
NORTHING 7526007
ZONE 55
ACCURACY
GPS ACC

MAP-SCALE
MAP-SERIES
MAP-NO
MAP NAME
PROG SECTION
PRES EQUIPMENT

GIS LAT -22.3655688112
GIS LNG 148.432719338
CHECKED Y

PARISH NAME 4814-VERMONT
COUNTY

ORIGINAL BORE NO LV2372R
BORE LINE -

POLYGON
RN OF BORE REPLACED
DATA OWNER

FACILITY TYPE Sub-Artesian Facility
STATUS Existing
ROLES MM

DATE DRILLED 20/08/2013
DRILLERS NAME
DRILL COMPANY HODGE DRILLING
METHOD OF CONST.

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	20/08/2013	1	Vibrating Wire Piezometer					125.00
B	20/08/2013	2	Vibrating Wire Piezometer					108.00
C	20/08/2013	3	Vibrating Wire Piezometer					93.50
D	20/08/2013	4	Vibrating Wire Piezometer					73.00
D	20/08/2013	5	Polyvinyl Chloride			100	0.00	136.00

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	1.00	SOIL, BROWN, CLAYEY
2	1.00	3.00	CLAYEY SAND, ORANGE-BROWN
3	3.00	6.00	CLAY, REDDISH GREY, LATERITIC IN PLACES
4	6.00	8.00	SAND, BROWN

BORE REPORT

REG NUMBER 165123

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
5	8.00	10.00	CLAYEY SAND, CREAM BROWN, COARSE GRAINED
6	10.00	11.00	SAND, BROWN
7	11.00	22.00	SANDY CLAY, BROWN, BASE OF TERTIARY AT 22 M BGL
8	22.00	26.00	SANDSTONE, VERY FINE GRAINED, ORANGE WHITE
9	26.00	28.00	CLAY, CREAMY WHITE, SANDY IN PLACES
10	28.00	46.00	SANDSTONE, BROWNISH GREY, FINE GRAINED
11	46.00	48.00	MUDSTONE, DARK BROWNISH-GREY, COALY. BASE OF WEATHERING AT 48 MBGL
12	48.00	49.00	SILTSTONE, MEDIUM GREY, SANDY IN PLACES
13	49.00	50.00	CARBONACEOUS MUDSTONE, DARK GREY
14	50.00	52.00	MUDSTONE, DARK GREY
15	52.00	54.00	SANDSTONE, GREY
16	54.00	55.00	COAL, BLACK
17	55.00	57.00	SILTSTONE, MEDIUM GREY, SANDY IN PLACES
18	57.00	76.00	SANDSTONE, BROWNISH GREY, VERY FINE RAINED BECOMING LIGHT WHITISH GREY, FINE TO MEDIUM GRAINED TOWARDS BASE
19	76.00	78.00	SILTSTONE, MEDIUM GREY, MUDSTONE BANDS
20	78.00	93.00	SANDSTONE, MEDUIM GREY, VERY FINE TO FINE RAINED, WITH ALTERNATING BANDS OF SILTSTONE
21	93.00	94.00	COAL, VERMONT UPPER SEAM
22	94.00	95.00	SANDSTONE, GREY, VERY FINE TO FINE GRAINED
23	95.00	97.00	CARBONACEOUS MUDSTONE, DARK GREY, MUDSTONE BANDS, COALY IN PLACES
24	97.00	102.00	SILTSTONE, MEDIUM GREY
25	102.00	119.00	SANDSTONE, LIGHT GREY, VERY FINE TO FINE GRAINED, SIDERITIC IN PLACES BETWEEN 105 AND 109M
26	119.00	122.50	SILTSTONE, MEDIUM GREY
27	122.50	129.00	COAL, VERMONT LOWER SEAM
28	129.00	136.00	SILTSTONE, MEDIUM GREY

STRATIGRAPHY DETAILS

**** NO RECORDS FOUND ****

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME

BORE REPORT

REG NUMBER 165123

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	73.00		SDST			N			Y	PS	RANGAL COAL MEASURES
2	93.50		COAL			N			Y	PS	RANGAL COAL MEASURES
3	108.00		SDST			N			Y	PS	RANGAL COAL MEASURES
4	125.00		COAL			N			Y	PS	RANGAL COAL MEASURES

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

PIPE	DATE	ELEVATION	PRECISION	DATUM	MEASUREMENT POINT	SURVEY SOURCE
D	20/08/2013	166.91	EST	AHD	R	BOWEN BASIN COAL PTY LTD

WATER ANALYSIS PART1

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

****** NO RECORDS FOUND ******

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

FIELD MEASUREMENTS

****** NO RECORDS FOUND ******

BORE REPORT

REG NUMBER 165123

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

**** End of Report. Produced:** 30/01/2018 06:50:48 AM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE: 11/11/2017	SURVEY PERSONNEL: ML + TF	BORE ID:	Lake Vermont - 158483

PART A: PROPERTY DETAILS

Property Name:	Lake Vermont		
Local Bore Name:	-	**Ref No/GW Number:**	158483
Easting (GDA94):	645638	**GPS Elevation:**	171
Northing:	7522932		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**20.71**	**Year Drilled:**	2013
Casing Stick Up (SU):	**0.74**	**Drilled By**	**Hodge Drilling**
Casing Material	**PVC**	**Internal Diameter**	50
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**PVC 0-20.0** **Slotted 14.0-20.0**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**yes**	**Condition**	**Good**	**Pump Type**	N/A
Power Source	**N/A**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	N/A
Headworks	**Gal steel monument - no cap**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Monitoring**	**Pumping Regime**	N/A
Storage Type	**N/A**	**Approximate Volume**	N/A

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**DRY**	**Date / Time of Measurement:**	4:49:00 PM
Pumping History	N/A		

PART F: WATER QUALITY

Well Head Gas Screening:	**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**1**	**O_2 %:**	**16.1**	
Sample Collection Point	**bore**	**Sample Method**	**-**		**Purge Volume**	**-**			
Electrical Conductivity (µS/cm)	**-**	**Temp**	**-**	**pH**	**-**	**ORP**	**-**	**DO (%)**	**-**

COMMENTS

-

TOC

GROUNDWATER BORE REPORT CARD

Additional Notes

-

SUPPORTING INFORMATION	Drillers Log	yes	Meeting With Land Representative	yes	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1	Lake Vermont - 158483

Photograph 2	Lake Vermont - 158483

BORE REPORT

REG NUMBER 158483

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-23-43	**MAP-SCALE**	
OFFICE	Emerald	**SUB-AREA**		**LONGITUDE**	148-24-49	**MAP-SERIES**	
DATE LOG RECD	06-AUG-13	**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	645525	**MAP-NO**	
D/O FILE NO.	50-0699	**LOT**	4	**NORTHING**	7522751	**MAP NAME**	
R/O FILE NO.		**PLAN**	CNS382	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**		**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.39514335	**PARISH NAME**	4814-VERMONT			**ORIGINAL BORE NO**	LV2369
GIS LNG	148.4136916	**COUNTY**	CAIRNS			**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	25/06/2013			**DATA OWNER**	DNR
STATUS	Existing	**DRILLERS NAME**	DITCHMEN, RAY				
ROLES	MM	**DRILL COMPANY**	HODGE DRILLING				
		METHOD OF CONST.	ROTARY AIR				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	25/06/2013	1	Polyvinyl Chloride			50	0.00	20.00
A	25/06/2013	2	Perforated or Slotted Casing			50	14.00	20.00
A	25/06/2013	3	Gravel Pack	3.000	GR		12.00	20.00
A	25/06/2013	4	Grout			165	0.00	12.00

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	1.00	TOPSOIL
2	1.00	4.00	CLAY
3	4.00	10.00	LOAM
4	10.00	15.00	RED CLAY
5	15.00	20.00	CLAY (DRY)

BORE REPORT

REG NUMBER 158483

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	14.00	20.00	CLAY						Y	UC	QUATERNARY - UNDEFINED

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

PIPE	DATE	ELEVATION	PRECISION	DATUM	MEASUREMENT POINT	SURVEY SOURCE
A	28/04/2013	173.40	SVY	AHD	R	

WATER ANALYSIS PART1

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

****** NO RECORDS FOUND ******

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

FIELD MEASUREMENTS

****** NO RECORDS FOUND ******

REG NUMBER **158483**

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

BORE REPORT

**** End of Report. Produced:** 30/01/2018 06:54:10 AM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	11/11/2017	**SURVEY PERSONNEL:**	ML + TF	**BORE ID:**	Lake Vermont - 158482(VWP)

PART A: PROPERTY DETAILS

Property Name:	Lake Vermont		
Local Bore Name:	-	**Ref No/GW Number:**	158482
Easting (GDA94):	645638	**GPS Elevation:**	174
Northing:	7522933		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	-	**Year Drilled:**	2013
Casing Stick Up (SU):	0.8	**Drilled By**	**Hodge Drilling**
Casing Material	**Grouted VWP**	**Internal Diameter**	-
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**VWP 1 - 137.0** **VWP 2 - 116.0** **VWP 3 - 86.0** **VWP 4 - 65.0**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**yes**	**Condition**	**Good**	**Pump Type**	N/A
Power Source	**N/A**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	N/A
Headworks	**No**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Monitoring**	**Pumping Regime**	N/A
Storage Type	**N/A**	**Approximate Volume**	N/A

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	-	**Date / Time of Measurement:**	12:00:00 AM
Pumping History	N/A		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**-**	**H_2S ppm:**	**-**	**CO ppm:**	**-**	**O_2 %:**	**-**
Sample Collection Point	**VWP Cable**	**Sample Method**		**VWP Reader**		**Purge Volume**	**-**		
Electrical Conductivity (µS/cm)	**-**	**Temp**	**-**	**pH**	**-**	**ORP**	**-**	**DO (%)**	**-**

COMMENTS

VWP - Readings taken but calibration information required to process

GROUNDWATER BORE REPORT CARD

Additional Notes

VWP Red - HZ 6552 / Temp 26.6

VWP Black - HZ 7247 / Temp 27.8

VWP Yellow - HZ 5563 - Temp no response

VWP Blue - HZ 6959 / Temp 28.5

SUPPORTING INFORMATION	Drillers Log	yes	Meeting With Land Representative	yes	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Lake Vermont - 158482(VWP)**

Photograph 2 **Lake Vermont - 158482(VWP)**

BORE REPORT

REG NUMBER 158482

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-23-42	**MAP-SCALE**	
OFFICE	Emerald	**SUB-AREA**		**LONGITUDE**	148-24-49	**MAP-SERIES**	
DATE LOG RECD	06-AUG-13	**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	645525	**MAP-NO**	
D/O FILE NO.	50-0699	**LOT**	4	**NORTHING**	7522752	**MAP NAME**	
R/O FILE NO.		**PLAN**	CNS382	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**		**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.39513789	**PARISH NAME**	4814-VERMONT			**ORIGINAL BORE NO**	LV2218
GIS LNG	148.4136909	**COUNTY**	CAIRNS			**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	16/07/2013			**DATA OWNER**	DNR
STATUS	Existing	**DRILLERS NAME**	DITCHMEN, RAY				
ROLES	MM	**DRILL COMPANY**	HODGE DRILLING				
		METHOD OF CONST.	ROTARY AIR				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	16/07/2013	1	Vibrating Wire Piezometer					137.00
B	16/07/2013	2	Vibrating Wire Piezometer					116.00
C	16/07/2013	3	Vibrating Wire Piezometer					86.00
D	16/07/2013	4	Vibrating Wire Piezometer					65.00
D	16/07/2013	5	Polyvinyl Chloride	5.900	WT	140	0.00	36.00
D	16/07/2013	6	Grout			140	0.00	137.00

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	1.00	SOIL
2	1.00	10.00	CLAY
3	10.00	20.00	LOAM

BORE REPORT

REG NUMBER 158482

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
4	20.00	34.00	SAND AND GRAVEL
5	34.00	36.00	CLAY
6	36.00	85.00	SANDSTONE
7	85.00	88.00	COAL
8	88.00	135.00	SANDSTONE
9	135.00	140.00	COAL
10	140.00	147.00	SANDSTONE

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	65.00		SDST						Y	PS	RANGAL COAL MEASURES
2	86.00		COAL						Y	PS	RANGAL COAL MEASURES
3	116.00		SDST						Y	PS	RANGAL COAL MEASURES
4	137.00		COAL						Y	PS	RANGAL COAL MEASURES

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

PIPE	DATE	ELEVATION	PRECISION	DATUM	MEASUREMENT POINT	SURVEY SOURCE
A	06/06/2013	173.29	SVY	AHD	R	

BORE REPORT

REG NUMBER 158482

WATER ANALYSIS PART1

**** NO RECORDS FOUND ****

WATER ANALYSIS PART 2

**** NO RECORDS FOUND ****

WATER LEVEL DETAILS

**** NO RECORDS FOUND ****

WIRE LINE LOG DETAILS

**** NO RECORDS FOUND ****

FIELD MEASUREMENTS

**** NO RECORDS FOUND ****

SPECIAL WATER ANALYSIS

**** NO RECORDS FOUND ****

BORE REPORT

**** End of Report. Produced:** 30/01/2018 06:54:28 AM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**14/11/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Leichardt - Unknown 1**

PART A: PROPERTY DETAILS

Property Name:	Leichardt		
Local Bore Name:	Yard Bore Large	**Ref No/GW Number:**	-
Easting (GDA94):	656849	**GPS Elevation:**	149
Northing:	7515959		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**74**	**Year Drilled:**	-
Casing Stick Up (SU):	**0.27**	**Drilled By**	**-**
Casing Material	**PVC**	**Internal Diameter**	125
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**-**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**No**	**Condition**	**Good**	**Pump Type**	no
Power Source	**no**	**Bore Capped**	**Yes**	**Bore Equipped With Meter**	no
Headworks	**no**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Stock**	**Pumping Regime**	no
Storage Type	**no**	**Approximate Volume**	no

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**11.705**	**Date / Time of Measurement:**	8:05:00 AM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**2**	**O_2 %:**	**19.8**
Sample Collection Point	**bore**	**Sample Method**	**bailer**			**Purge Volume**	**2**		
Electrical Conductivity (µS/cm)	**1324**	**Temp**	**26.6**	**pH**	**6.95**	**ORP**	**99.2**	**DO (%)**	**46**

COMMENTS

GROUNDWATER BORE REPORT CARD

Additional Notes

Bore drilled by McCarther Coal during exploration. Hole left open as water quality was not to be 'good'. Never Used

SUPPORTING INFORMATION	Drillers Log	no	Meeting With Land Representative	yes	Photo	Yes

PHOTOGRAPHIC RECORD

Photograph 1	Leichardt - Unknown 1

Photograph 2	Leichardt - Unknown 1

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**14/11/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Leichardt - Unknown 2**

PART A: PROPERTY DETAILS

Property Name:	Leichardt		
Local Bore Name:	Yard Bore Small	**Ref No/GW Number:**	-
Easting (GDA94):	656850	**GPS Elevation:**	149
Northing:	7515962		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**178**	**Year Drilled:**	-
Casing Stick Up (SU):	**0.13**	**Drilled By**	**-**
Casing Material	**PVC**	**Internal Diameter**	102
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**-**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**No**	**Condition**	**Good**	**Pump Type**	no
Power Source	**no**	**Bore Capped**	**Yes**	**Bore Equipped With Meter**	no
Headworks	**no**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Stock**	**Pumping Regime**	no
Storage Type	**no**	**Approximate Volume**	no

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**11.26**	**Date / Time of Measurement:**	8:44:00 AM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**1**		**O_2 %:**	**19**	
Sample Collection Point	**bore**	**Sample Method**		**bailer**		**Purge Volume**		**2**			
Electrical Conductivity (µS/cm)	**140**	**Temp**	**26.2**	**pH**	**6.85**	**ORP**	**106.8**		**DO (%)**	**37.1**	

COMMENTS

Casing to 60m

GROUNDWATER BORE REPORT CARD

Additional Notes

Info from Cap, 'Bore ID BB1333'. Strong rotten egg odour. Low EC, possiably heavily stratified

SUPPORTING INFORMATION	Drillers Log	no	Meeting With Land Representative	yes	Photo	Yes

PHOTOGRAPHIC RECORD

Photograph 1 **Leichardt - Unknown 2**

Photograph 2 **Leichardt - Unknown 2**

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**14/11/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Leichardt - 136091/1**

PART A: PROPERTY DETAILS

Property Name:	Leichardt		
Local Bore Name:	-	**Ref No/GW Number:**	136091
Easting (GDA94):	650061	**GPS Elevation:**	174
Northing:	7508592		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**77**	**Year Drilled:**	-
Casing Stick Up (SU):	**0.18**	**Drilled By**	**-**
Casing Material	**PVC**	**Internal Diameter**	141
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**-**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**No**	**Condition**	**Good**	**Pump Type**	no
Power Source	**mains**	**Bore Capped**	**Yes**	**Bore Equipped With Meter**	no
Headworks	**no**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Stock**	**Pumping Regime**	no
Storage Type	**tank**	**Approximate Volume**	80000

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**45.087**	**Date / Time of Measurement:**	10:04:00 AM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**1**	**O_2 %:**	**20.2**
Sample Collection Point	**bore**	**Sample Method**		**bailer**		**Purge Volume**			**2**
Electrical Conductivity (µS/cm)	**1662**	**Temp**	**27.3**	**pH**	**6.79**	**ORP**	**-84.9**	**DO (%)**	**30.6**

COMMENTS

GROUNDWATER BORE REPORT CARD

Additional Notes

*Multiple bores present. No filed measurements directly correlate to bore report

SUPPORTING INFORMATION	Drillers Log	yes*	Meeting With Land Representative	yes	Photo	Yes

PHOTOGRAPHIC RECORD

Photograph 1 **Leichardt - 136091/1**

Photograph 2 **Leichardt - 136091/1**

BORE REPORT

REG NUMBER 136091

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-31-21	**MAP-SCALE**	
OFFICE	Rockhampton	**SUB-AREA**		**LONGITUDE**	148-27-34	**MAP-SERIES**	
DATE LOG RECD		**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	650099	**MAP-NO**	
D/O FILE NO.	520/001/0105	**LOT**	7	**NORTHING**	7508605	**MAP NAME**	
R/O FILE NO.		**PLAN**	CNS53	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**	GPS	**PRES EQUIPMENT**	
				GPS ACC	20		
GIS LAT	-22.5225036	**PARISH NAME**	969-CARFAX			**ORIGINAL BORE NO**	
GIS LNG	148.4594489	**COUNTY**	CAIRNS			**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	16/12/2002			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**	MCCARTHY, DAVID IAN FREDERICK				
ROLES	WS	**DRILL COMPANY**	MCCARTHY DRILLING				
		METHOD OF CONST.					

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	16/12/2002	1	Polyvinyl Chloride		WT		0.00	66.00
A	16/12/2002	2	Perforated or Slotted Casing	6.000	AP		58.00	62.00
A	16/12/2002	3						

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	0.50	TOPSOIL
2	0.50	11.00	DARK BROWN CLAY
3	11.00	18.00	RED CLAY
4	18.00	25.00	LIGHT BROWN CLAY
5	25.00	42.00	BROWN SILTSTONE
6	42.00	45.00	GREY BROWN SILTSTONE

BORE REPORT

REG NUMBER 136091

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
7	45.00	51.00	GREY SILTSTONE
8	51.00	55.00	CARBINACIOUS SILTSTONE
9	55.00	69.00	LIGHT GREY SILTSTONE
10	69.00	70.00	GREY SILTSTONE

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	60.50		SSTO	17/02/2002	-99.99	N		0.40	Y	PS	BLACKWATER GROUP

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

****** NO RECORDS FOUND ******

WATER ANALYSIS PART1

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

****** NO RECORDS FOUND ******

REG NUMBER 136091

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

FIELD MEASUREMENTS

****** NO RECORDS FOUND ******

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

**** End of Report. Produced:** 13/11/2017 08:10:42 PM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**14/11/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Leichardt - 136091/2**

PART A: PROPERTY DETAILS

Property Name:	Leichardt		
Local Bore Name:	-	**Ref No/GW Number:**	136091
Easting (GDA94):	650091	**GPS Elevation:**	171
Northing:	7508608		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**-**	**Year Drilled:**	-
Casing Stick Up (SU):	**0.32**	**Drilled By**	**-**
Casing Material	**PVC**	**Internal Diameter**	Unknown
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**-**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**Yes**	**Condition**	**Good**	**Pump Type**	Submersible
Power Source	**mains**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	flow gauge
Headworks	**2" OD HDPE**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Stock**	**Pumping Regime**	no
Storage Type	**tank**	**Approximate Volume**	80000

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**-**	**Date / Time of Measurement:**	10:15:00 AM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:	**CH_4 ppm:**	**-**	**H_2S ppm:**	**-**	**CO ppm:**	**-**	**O_2 %:**	**-**	
Sample Collection Point	**-**	**Sample Method**	**-**		**Purge Volume**	**-**			
Electrical Conductivity (µS/cm)	**-**	**Temp**	**-**	**pH**	**-**	**ORP**	**-**	**DO (%)**	**-**

COMMENTS

Pump deployed

GROUNDWATER BORE REPORT CARD

Additional Notes

*Multiple bores present. No filed measurements directly correlate to bore report

SUPPORTING INFORMATION	Drillers Log	yes*	Meeting With Land Representative	yes	Photo	Yes

PHOTOGRAPHIC RECORD

Photograph 1 **Leichardt - 136091/2**

Photograph 2 **Leichardt - 136091/2**

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	14/11/2017	**SURVEY PERSONNEL:**	ML + TF	**BORE ID:**	**Leichardt - 136091/3**

PART A: PROPERTY DETAILS

Property Name:	Leichardt		
Local Bore Name:	-	**Ref No/GW Number:**	136091
Easting (GDA94):	650116	**GPS Elevation:**	186
Northing:	7508649		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**85**	**Year Drilled:**	-
Casing Stick Up (SU):	**0.47**	**Drilled By**	**-**
Casing Material	**PVC**	**Internal Diameter**	127
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**-**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**No**	**Condition**	**Good**	**Pump Type**	no
Power Source	**mains**	**Bore Capped**	**Yes**	**Bore Equipped With Meter**	no
Headworks	**no**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Stock**	**Pumping Regime**	no
Storage Type	**tank**	**Approximate Volume**	80000

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**46.65**	**Date / Time of Measurement:**	10:30:00 AM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**1**	**O_2 %:**	**19.1**
Sample Collection Point	**bore**	**Sample Method**		**bailer**		**Purge Volume**		**2**	
Electrical Conductivity (µS/cm)	**4750**	**Temp**	**27.6**	**pH**	**6.85**	**ORP**	**-119.4**	**DO (%)**	**30.1**

COMMENTS

GROUNDWATER BORE REPORT CARD

Additional Notes

*Multiple bores present. No filed measurements directly correlate to bore report

SUPPORTING INFORMATION	Drillers Log	yes*	Meeting With Land Representative	yes	Photo	Yes

PHOTOGRAPHIC RECORD

Photograph 1 **Leichardt - 136091/3**

Photograph 2 **Leichardt - 136091/3**

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**14/11/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Leichardt - 136091/4**

PART A: PROPERTY DETAILS

Property Name:	Leichardt		
Local Bore Name:	-	**Ref No/GW Number:**	136091
Easting (GDA94):	650106	**GPS Elevation:**	168
Northing:	7508653		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**56**	**Year Drilled:**	-
Casing Stick Up (SU):	**0.34**	**Drilled By**	**-**
Casing Material	**Steel**	**Internal Diameter**	115
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**-**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**No**	**Condition**	**Poor**	**Pump Type**	no
Power Source	**no**	**Bore Capped**	**No**	**Bore Equipped With Meter**	no
Headworks	**no**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Stock**	**Pumping Regime**	no
Storage Type	**tank**	**Approximate Volume**	80000

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**45.407**	**Date / Time of Measurement:**	10:40:00 AM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**1**	**O_2 %:**	**19.4**
Sample Collection Point	**bore**	**Sample Method**		**bailer**		**Purge Volume**		**2**	
Electrical Conductivity (µS/cm)	**4419**	**Temp**	**27.2**	**pH**	**7.06**	**ORP**	**58.4**	**DO (%)**	**15.6**

COMMENTS

GROUNDWATER BORE REPORT CARD

Additional Notes

*Multiple bores present. No filed measurements directly correlate to bore report

SUPPORTING INFORMATION	Drillers Log	yes*	Meeting With Land Representative	yes	Photo	Yes

PHOTOGRAPHIC RECORD

Photograph 1 **Leichardt - 136091/4**

Photograph 2 **Leichardt - 136091/4**

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	18/11/2017	**SURVEY PERSONNEL:**	ML + TF	**BORE ID:**	**Meadowbrook - 132631**

PART A: PROPERTY DETAILS

Property Name:	Meadowbrook		
Local Bore Name:	Iffley	**Ref No/GW Number:**	132631
Easting (GDA94):	635452	**GPS Elevation:**	200
Northing:	7528174		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	***328**	**Year Drilled:**	2007
Casing Stick Up (SU):	**0.59**	**Drilled By**	**Phoenix Drilling**
Casing Material	**Unknown**	**Internal Diameter**	unknown
Initial Water Quality Measurement (Driller Log)	7290 µS/cm		
Construction Summary (Driller Log)	**Steel Casing 0-328.0** **Screened 316.0-325.0**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**no**	**Condition**	**needs maintenance**	**Pump Type**	Belt driven rotary pump
Power Source	**Diesel Motor**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	flow gauge
Headworks	**3" Steel into 3" HDPE**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**stock**	**Pumping Regime**	no
Storage Type	**no**	**Approximate Volume**	no

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	-	**Date / Time of Measurement:**	10:55:00 AM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:	**CH_4 ppm:** -	**H_2S ppm:** -	**CO ppm:** -	**O_2 %:** -
Sample Collection Point -	**Sample Method** -		**Purge Volume** -	
Electrical Conductivity (µS/cm) -	**Temp** -	**pH** -	**ORP** -	**DO (%)** -

COMMENTS

Pump deployed. TD from landowner

GROUNDWATER BORE REPORT CARD

Additional Notes						
Max bore output 15,000 GPH. SWL ~40mbGL according to land owner						
SUPPORTING INFORMATION	Drillers Log	yes	Meeting With Land Representative	yes	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Meadowbrook - 132631**

Photograph 2 **Meadowbrook - 132631**

BORE REPORT

REG NUMBER 132631

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-20-49	**MAP-SCALE**	
OFFICE	Emerald	**SUB-AREA**		**LONGITUDE**	148-18-55	**MAP-SERIES**	
DATE LOG RECD	26-NOV-07	**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	635440	**MAP-NO**	8553
D/O FILE NO.	520/001/100	**LOT**	10	**NORTHING**	7528179	**MAP NAME**	GROSVENOR DOWNS
R/O FILE NO.		**PLAN**	CNS93	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**	GPS	**PRES EQUIPMENT**	
				GPS ACC	5		
GIS LAT	-22.3469444	**PARISH NAME**	4814-VERMONT			**ORIGINAL BORE NO**	
GIS LNG	148.3152778	**COUNTY**	CAIRNS			**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	18/01/2007			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**	HARRIS, JOHN CLARKE				
ROLES	WS	**DRILL COMPANY**	PHOENIX DRILLING CAPALLA SHED				
		METHOD OF CONST.	ROTARY AIR				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	18/01/2007	1	Steel Casing	4.800	WT	223	0.00	48.00
A	18/01/2007	2	Steel Casing	6.400		168	0.00	328.00
A	18/01/2007	3	Perforated or Slotted Casing				316.00	325.00
A	18/01/2007	4	Gravel Pack				298.00	328.00
A	18/01/2007	5	Cuttings or other fill between casing and hc				295.00	298.00
A	18/01/2007	6	Grout				0.00	48.00
A	18/01/2007	7	Grout				0.00	295.00

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	1.00	TOP SANDY SOIL
2	1.00	16.00	YELLOW SANDY CLAY

BORE REPORT

REG NUMBER 132631

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
3	16.00	20.00	M/C SAND AND GRAVEL CLAYED
4	20.00	45.00	CLAY AND MUDSTONE
5	45.00	48.00	FINE GREY SANDSTONE
6	48.00	316.00	INTERBADED FINE GREY SANDSTONE/MUDSTONE AND SHALE
7	316.00	321.00	SLIGHTLY FRACTURED FINE GREY SANDSTONE
8	321.00	321.30	LARGE FRACTURE IN GREY SANDSTONE
9	321.30	328.00	FINE GREY SANDSTONE

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	321.00	328.00	SDST	18/01/2007	-31.00	N	7290 US/CM	15.00	Y	FR	BACK CREEK GROUP

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

****** NO RECORDS FOUND ******

WATER ANALYSIS PART1

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

BORE REPORT

REG NUMBER 132631

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

****** NO RECORDS FOUND ******

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

FIELD MEASUREMENTS

****** NO RECORDS FOUND ******

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

BORE REPORT

**** End of Report. Produced:** 30/01/2018 07:09:23 AM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**18/11/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Meadowbrook - Bullock Paddock**

PART A: PROPERTY DETAILS

Property Name:	Meadowbrook		
Local Bore Name:	Bullock Paddock	**Ref No/GW Number:**	-
Easting (GDA94):	636052	**GPS Elevation:**	185
Northing:	7528117		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**50.2**	**Year Drilled:**	-
Casing Stick Up (SU):	**0.3**	**Drilled By**	**-**
Casing Material	**PVC**	**Internal Diameter**	125
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**-**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**no**	**Condition**	**good**	**Pump Type**	no
Power Source	**no**	**Bore Capped**	**no**	**Bore Equipped With Meter**	no
Headworks	**no**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**stock**	**Pumping Regime**	no
Storage Type	**Tank**	**Approximate Volume**	80000

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**21.625**	**Date / Time of Measurement:**	11:40:00 AM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**1**	**CO ppm:**	**0**	**O_2 %:**	**20.2**
Sample Collection Point	**bore**	**Sample Method**	**bailer**			**Purge Volume**	**2.00**		
Electrical Conductivity (µS/cm)	**6212**	**Temp**	**28.5**	**pH**	**7.39**	**ORP**	**-320**	**DO (%)**	**1.4**

COMMENTS

Land owner recalls bore was ~90m depth but dip line unable to pass 50.2mbTOC

GROUNDWATER BORE REPORT CARD

Additional Notes

Strong rotten egg odour

SUPPORTING INFORMATION	Drillers Log	no	Meeting With Land Representative	yes	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Meadowbrook - Bullock Paddock**

Photograph 2 **Meadowbrook - Bullock Paddock**

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	18/11/2017	SURVEY PERSONNEL:	ML + TF	BORE ID:	Meadowbrook - Swamp Bore

PART A: PROPERTY DETAILS

Property Name:	Meadowbrook		
Local Bore Name:	Swamp Bore	**Ref No/GW Number:**	-
Easting (GDA94):	645595	**GPS Elevation:**	171
Northing:	7528661		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**85**	**Year Drilled:**	-
Casing Stick Up (SU):	**0.25**	**Drilled By**	**-**
Casing Material	**PVC**	**Internal Diameter**	125
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**-**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**no**	**Condition**	**good**	**Pump Type**	no
Power Source	**no**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	no
Headworks	**no**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**stock**	**Pumping Regime**	no
Storage Type	**Tank**	**Approximate Volume**	40000

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**17.523**	**Date / Time of Measurement:**	1:05:00 PM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**1**	**CO ppm:**	**0**	**O_2 %:**	**20.1**
Sample Collection Point	**bore**	**Sample Method**		**bailer**		**Purge Volume**		**2.00**	
Electrical Conductivity (µS/cm)	**1078**	**Temp**	**27.7**	**pH**	**7**	**ORP**	**-62**	**DO (%)**	**34**

COMMENTS

-

GROUNDWATER BORE REPORT CARD

Additional Notes

Land owner claims output to be 1500 GPH

SUPPORTING INFORMATION	Drillers Log	no	Meeting With Land Representative	yes	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Meadowbrook - Swamp Bore**

Photograph 2 **Meadowbrook - Swamp Bore**

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	18/11/2017	SURVEY PERSONNEL:	ML + TF	BORE ID:	Meadowbrook - 122458/1

PART A: PROPERTY DETAILS

Property Name:	Meadowbrook		
Local Bore Name:	Rolfies #1	**Ref No/GW Number:**	122458
Easting (GDA94):	644973	**GPS Elevation:**	172
Northing:	7526776		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**52.2**	**Year Drilled:**	2006
Casing Stick Up (SU):	**0.72**	**Drilled By**	**Depco**
Casing Material	**PVC**	**Internal Diameter**	125
Initial Water Quality Measurement (Driller Log)	COND 4000		
Construction Summary (Driller Log)	**PVC 0-50.5** **Slotted 38.5-50.5**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**no**	**Condition**	**good**	**Pump Type**	no
Power Source	**no**	**Bore Capped**	**no**	**Bore Equipped With Meter**	no
Headworks	**no**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**stock**	**Pumping Regime**	no
Storage Type	**no**	**Approximate Volume**	no

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**22.335**	**Date / Time of Measurement:**	2:15:00 PM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**26**	**CO ppm:**	**0**	**O_2 %:**	**19.7**
Sample Collection Point	**bore**	**Sample Method**	**bailer**			**Purge Volume**	**2.00**		
Electrical Conductivity (µS/cm)	**5098**	**Temp**	**28.2**	**pH**	**7.29**	**ORP**	**-290**	**DO (%)**	**30.7**

COMMENTS

-

GROUNDWATER BORE REPORT CARD

Additional Notes

Land owner claims output to be 2000 GPH. Rotten egg odour

SUPPORTING INFORMATION	Drillers Log	yes	Meeting With Land Representative	yes	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Meadowbrook - 122458/1**

Photograph 2 **Meadowbrook - 122458/1**

BORE REPORT

REG NUMBER 122458

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-21-32	**MAP-SCALE**	104
OFFICE	Rockhampton	**SUB-AREA**		**LONGITUDE**	148-24-29	**MAP-SERIES**	M
DATE LOG RECD	07-APR-06	**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	644983	**MAP-NO**	8553
D/O FILE NO.	520/001/100	**LOT**	10	**NORTHING**	7526770	**MAP NAME**	GROSVENOR DOWNS
R/O FILE NO.		**PLAN**	CNS93	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**	GPS	**PRES EQUIPMENT**	
				GPS ACC	30		
GIS LAT	-22.3588889	**PARISH NAME**	4814-VERMONT			**ORIGINAL BORE NO**	
GIS LNG	148.4080556	**COUNTY**	CAIRNS			**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	21/03/2006			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**	BOURNE, KEVIN JOHN				
ROLES	WS	**DRILL COMPANY**	DEPCO DRILLING				
		METHOD OF CONST.	ROTARY AIR				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
X	21/03/2005	1	Polyvinyl Chloride	5.900	WT	141	0.00	50.50
X	21/03/2005	2	Perforated or Slotted Casing	4.000	AP	141	38.50	50.50
X	21/03/2005	3	Gravel Pack	5.000	GR	177	31.00	50.50
X	21/03/2005	4	Cuttings or other fill between casing and hc			177	7.00	31.00
X	21/03/2005	5	Grout			177	0.00	7.00

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	5.00	WEATHERING
2	5.00	6.50	SAND AND GRAVEL
3	6.50	14.00	WEATHERED SHALES
4	14.00	17.00	WEATHERED SANDSTONE

BORE REPORT

REG NUMBER 122458

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
5	17.00	35.00	WEATHERED SHALE
6	35.00	50.50	FRACTURED SHALE *

STRATIGRAPHY DETAILS
**** NO RECORDS FOUND ****

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	35.00	50.50	SHLE	21/03/2005	-26.00	N	COND 4000	1.88	Y	FR	BACK CREEK GROUP

PUMP TEST DETAILS PART 1
**** NO RECORDS FOUND ****

PUMP TEST DETAILS PART 2
**** NO RECORDS FOUND ****

BORE CONDITION
**** NO RECORDS FOUND ****

ELEVATION DETAILS
**** NO RECORDS FOUND ****

WATER ANALYSIS PART1
**** NO RECORDS FOUND ****

WATER ANALYSIS PART 2
**** NO RECORDS FOUND ****

WATER LEVEL DETAILS
**** NO RECORDS FOUND ****

WIRE LINE LOG DETAILS

BORE REPORT

REG NUMBER 122458

**** NO RECORDS FOUND ****

FIELD MEASUREMENTS

**** NO RECORDS FOUND ****

SPECIAL WATER ANALYSIS

**** NO RECORDS FOUND ****

BORE REPORT

**** End of Report. Produced:** 30/01/2018 07:07:53 AM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**18/11/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Meadowbrook - 122458/2**

PART A: PROPERTY DETAILS

Property Name:	Meadowbrook		
Local Bore Name:	Rolfies #2	**Ref No/GW Number:**	122458
Easting (GDA94):	644971	**GPS Elevation:**	174
Northing:	7526779		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**103**	**Year Drilled:**	-
Casing Stick Up (SU):	**0.15**	**Drilled By**	**-**
Casing Material	**PVC**	**Internal Diameter**	125
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**-**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**no**	**Condition**	**good**	**Pump Type**	no
Power Source	**no**	**Bore Capped**	**no**	**Bore Equipped With Meter**	no
Headworks	**no**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**stock**	**Pumping Regime**	no
Storage Type	**no**	**Approximate Volume**	no

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**21.74**	**Date / Time of Measurement:**	2:30:00 PM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**1**	**CO ppm:**	**1**	**O_2 %:**	**18.8**
Sample Collection Point	**bore**	**Sample Method**		**bailer**		**Purge Volume**			**2.00**
Electrical Conductivity (µS/cm)	**8666**	**Temp**	**28.2**	**pH**	**7.32**	**ORP**	**-267.7**	**DO (%)**	**2.5**

COMMENTS

-

GROUNDWATER BORE REPORT CARD

Additional Notes

Exploration hole

SUPPORTING INFORMATION	Drillers Log	no	Meeting With Land Representative	yes	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Meadowbrook - 122458/2**

Photograph 2 **Meadowbrook - 122458/2**

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**18/11/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Meadowbrook - Black Tank**

PART A: PROPERTY DETAILS

Property Name:	Meadowbrook		
Local Bore Name:	Black Tank	**Ref No/GW Number:**	-
Easting (GDA94):	642742	**GPS Elevation:**	173
Northing:	7521198		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**-**	**Year Drilled:**	-
Casing Stick Up (SU):	**0.385**	**Drilled By**	**-**
Casing Material	**PVC**	**Internal Diameter**	125
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**-**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**yes**	**Condition**	**poor**	**Pump Type**	Submersible
Power Source	**Genset**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	no
Headworks	**2" HDPE pump output line**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**stock**	**Pumping Regime**	no
Storage Type	**no**	**Approximate Volume**	no

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**-**	**Date / Time of Measurement:**	3:33:00 PM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**1**	**O_2 %:**	**19.2**
Sample Collection Point	**bore**	**Sample Method**	**-**			**Purge Volume**	**-**		
Electrical Conductivity (µS/cm)	**-**	**Temp**	**-**	**pH**	**-**	**ORP**	**-**	**DO (%)**	**-**

COMMENTS

Pump deployed. TD from landowner

GROUNDWATER BORE REPORT CARD

Additional Notes

Land owner claims output to be 1000 GPH

Shelter and headworks damaged in storm ~7 years ago

SUPPORTING INFORMATION	Drillers Log	no	Meeting With Land Representative	Yes	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Meadowbrook - Black Tank**

Photograph 2 **Meadowbrook - Black Tank**

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**18/11/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Meadowbrook - Power Bore**

PART A: PROPERTY DETAILS

Property Name:	Meadowbrook		
Local Bore Name:	Power Bore	**Ref No/GW Number:**	-
Easting (GDA94):	641260	**GPS Elevation:**	186
Northing:	7520977		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	-	**Year Drilled:**	-
Casing Stick Up (SU):	**0.46**	**Drilled By**	**-**
Casing Material	**Unknown**	**Internal Diameter**	unknown
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**-**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**yes**	**Condition**	**good**	**Pump Type**	Submersible
Power Source	**mains**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	no
Headworks	**3" HDPE pump outlet line**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**stock**	**Pumping Regime**	no
Storage Type	**no**	**Approximate Volume**	no

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**16.5**	**Date / Time of Measurement:**	3:50:00 PM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:	**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**0**	**O_2 %:**	**19.9**	
Sample Collection Point	**pump output line**	**Sample Method**	**-**		**Purge Volume**	**-**			
Electrical Conductivity (µS/cm)	**-**	**Temp**	**-**	**pH**	**-**	**ORP**	**-**	**DO (%)**	**-**

COMMENTS

Pump deployed, dip measured through poly. TD from landowner

GROUNDWATER BORE REPORT CARD

Additional Notes

Land owner claims output to be 1000 GPH

SUPPORTING INFORMATION	**Drillers Log**	**no**	**Meeting With Land Representative**	**yes**	**Photo**	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Meadowbrook - Power Bore**

Photograph 2 **Meadowbrook - Power Bore**

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**13/11/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Olive Downs - Bore 8**

PART A: PROPERTY DETAILS

Property Name:	Olive Downs		
Local Bore Name:	5 Mile Bore	**Ref No/GW Number:**	-
Easting (GDA94):	640186	**GPS Elevation:**	188
Northing:	7547990		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**-**	**Year Drilled:**	-
Casing Stick Up (SU):	**0.1**	**Drilled By**	**-**
Casing Material	**PVC**	**Internal Diameter**	Unknown
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**No details Available**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**Yes**	**Condition**	**Good**	**Pump Type**	Submersible
Power Source	**Genset**	**Bore Capped**	**Yes**	**Bore Equipped With Meter**	Flow meter
Headworks	**Steel taps with 32mm HDPE output**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Stock**	**Pumping Regime**	no
Storage Type	**Tank**	**Approximate Volume**	25000

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**-**	**Date / Time of Measurement:**	9:15:00 AM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**-**	**H_2S ppm:**	**-**	**CO ppm:**	**-**	**O_2 %:**	**-**
Sample Collection Point	**-**	**Sample Method**	**-**			**Purge Volume**	**-**		
Electrical Conductivity (µS/cm)	**-**	**Temp**	**-**	**pH**	**-**	**ORP**	**-**	**DO (%)**	**-**

COMMENTS

Pump deployed

GROUNDWATER BORE REPORT CARD

Additional Notes

-

SUPPORTING INFORMATION	Drillers Log	no	Meeting With Land Representative	yes	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Olive Downs - Bore 8**

Photograph 2 **Olive Downs - Bore 8**

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	13/11/2017	SURVEY PERSONNEL:	ML + TF	BORE ID:	Olive Downs - Bore 7

PART A: PROPERTY DETAILS

Property Name:	Olive Downs		
Local Bore Name:	Saltwater Bore	**Ref No/GW Number:**	-
Easting (GDA94):	637518	**GPS Elevation:**	192
Northing:	7552628		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**16.75**	**Year Drilled:**	-
Casing Stick Up (SU):	**0.39**	**Drilled By**	**-**
Casing Material	**Steel**	**Internal Diameter**	120
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**No details Available**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**no**	**Condition**	**Poor**	**Pump Type**	no
Power Source	**Powerline**	**Bore Capped**	**No**	**Bore Equipped With Meter**	Flow meter
Headworks	**Steel taps with 2" HDPE output**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Stock**	**Pumping Regime**	no
Storage Type	**no**	**Approximate Volume**	no

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**15.695**	**Date / Time of Measurement:**	10:05:00 AM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:	**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**0**	**O_2 %:**	**20.2**	
Sample Collection Point	**bore**	**Sample Method**	**bailer**		**Purge Volume**	**2**			
Electrical Conductivity (µS/cm)	**994**	**Temp**	**25.3**	**pH**	**6.75**	**ORP**	**-109.9**	**DO (%)**	**24**

COMMENTS

-

GROUNDWATER BORE REPORT CARD

Additional Notes

Bore not in use. No pump present. Casing heavily corroded

SUPPORTING INFORMATION	**Drillers Log**	**no**	**Meeting With Land Representative**	**yes**	**Photo**	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Olive Downs - Bore 7**

Photograph 2 **Olive Downs - Bore 7**

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	13/11/2017	**SURVEY PERSONNEL:**	ML + TF	**BORE ID:**	**Olive Downs - 162472**

PART A: PROPERTY DETAILS

Property Name:	Olive Downs		
Local Bore Name:	-	**Ref No/GW Number:**	162472
Easting (GDA94):	635533	**GPS Elevation:**	193
Northing:	7554547		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**91.2**	**Year Drilled:**	2009
Casing Stick Up (SU):	**0.9**	**Drilled By**	**Pioneer Drilling**
Casing Material	**PVC**	**Internal Diameter**	50
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**PVC 0-81.0** **Slotted 81.0-90.0**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**Yes**	**Condition**	**poor**	**Pump Type**	N/A
Power Source	**N/A**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	N/A
Headworks	**50mm Standpipe Piezometer**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Monitoring**	**Pumping Regime**	N/A
Storage Type	**N/A**	**Approximate Volume**	N/A

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**23.33**	**Date / Time of Measurement:**	11:25:00 AM
Pumping History	N/A		

PART F: WATER QUALITY

Well Head Gas Screening:	**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**1**	**O_2 %:**	**20.7**	
Sample Collection Point	**-**	**Sample Method**	**-**		**Purge Volume**	**2**			
Electrical Conductivity (µS/cm)	**-**	**Temp**	**-**	**pH**	**-**	**ORP**	**-**	**DO (%)**	**-**

COMMENTS

Standpipe damaged, bailer couldn't pass

GROUNDWATER BORE REPORT CARD

Additional Notes

Monument damaged, supported by starposts

SUPPORTING INFORMATION	Drillers Log	yes	Meeting With Land Representative	yes	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Olive Downs - 162472**

Photograph 2 **Olive Downs - 162472**

BORE REPORT

REG NUMBER 162472

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-06-31	**MAP-SCALE**	
OFFICE	Mackay	**SUB-AREA**		**LONGITUDE**	148-18-50	**MAP-SERIES**	
DATE LOG RECD		**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	635531	**MAP-NO**	
D/O FILE NO.		**LOT**	3	**NORTHING**	7554554	**MAP NAME**	
R/O FILE NO.		**PLAN**	GV90	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**		**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.10872204	**PARISH NAME**	2420-ILSINGTON			**ORIGINAL BORE NO**	PZ4
GIS LNG	148.31394053	**COUNTY**				**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	27/03/2009			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**					
ROLES	MM	**DRILL COMPANY**	PIONEER DRILLING				
		METHOD OF CONST.					

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	27/03/2009	1	Polyvinyl Chloride				0.00	81.00
A	27/03/2009	2	Perforated or Slotted Casing	1.000	AP		81.00	90.00
X	27/03/2009	3	Grout			114	0.00	73.00
X	27/03/2009	4	Bentonite Seal			114	73.00	75.00
X	27/03/2009	5	Gravel Pack			114	75.00	90.00

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	2.00	TOPSOIL: SILTY CLAY, BROWN, TRACE GRAVEL, ORGANIC MATTER PRESENT
2	2.00	4.00	SILTY CLAY: BROWN/ORANGE-BROWN, TRACE FINE SAND AND GRAVEL
3	4.00	7.00	SANDY CLAY: GREY-BROWN, MINOR FINE SAND AND GRAVEL
4	7.00	15.00	CLAYSTONE: GREY-BROWN, TRACE MEDIUM TO FINE GRAVEL, WELL CEMENTED

BORE REPORT

REG NUMBER 162472

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
5	15.00	27.00	SILTSTONE: BROWN/GREY BROWN, INTERBEDDED WITH FINE SANDSTONE, MODERATELY SOFT, IRON STAINING PRESENT
6	27.00	44.00	SILTSTONE: GREY-BROWN, MINOR FINE SANDSTONE, IRON STAINING, MODERATELY HARD, NON CARBONACEOUS
7	44.00	49.00	SILTSTONE: GREY, MINOR MUDSTONE AND FINE SANDSTONE, NON CARBONACEOUS, MODERATELY HARD
8	49.00	50.00	SANDSTONE: GREY, INTERBEDDED WITH SILTSTONE AND MUDSTONE, MODERATELY HARD
9	50.00	51.00	SILTSTONE: GREY, ONLY MINOR SANDSTONE, MODERATELY HARD
10	51.00	62.00	MUDSTONE: GREY, MINOR SILTSTONE, TRACE FINE SANDSTONE, INTERBEDDED WITH TUFF LAYER WHICH IS MOSTLY WEATHERED TO BROWN CLAY, MODERATELY HARD
11	62.00	72.00	SANDSTONE: GREY, INTERBEDDED WITH SOME SILTSTONE, TRACE MUDSTONE, TUFF LAYER PRESENT, MODERATELY HARD, NON CARBONACEOUS
12	72.00	82.00	MUDSTONE: GREY, MINOR SILTSTONE, TUFF LAYER STILL PRESENT, MODERATELY HARD
13	82.00	89.00	SILTSTONE: GREY, MINOR MUDSTONE, TUFF LAYER STILL PRESENT
14	89.00	90.00	SANDSTONE: BLUE-GREY, MINOR SILTSTONE AND MUDSTONE, NON CARBONACEOUS, TUFF LAYER PRESENT, QUARTZ PRESENT, MODERATELY HARD

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	81.00	90.00	SSTO SDST			N			Y	PS	

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

BORE REPORT

REG NUMBER 162472

PIPE	DATE	ELEVATION	PRECISION	DATUM	MEASUREMENT POINT	SURVEY SOURCE
A	27/03/2009	193.94	SVY	AHD	R	

WATER ANALYSIS PART1

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE
A	06/05/2009	-23.96	R		ACT	A	10/06/2009	-23.87	R		ACT	A	08/07/2009	-23.92	R		ACT
A	19/08/2009	-23.95	R		ACT	A	14/09/2009	-23.94	R		ACT	A	15/10/2009	-23.94	R		ACT
A	17/11/2009	-23.94	R		ACT	A	16/12/2009	-23.95	R		ACT	A	12/01/2010	-23.96	R		ACT
A	18/03/2010	-23.91	R		ACT	A	22/04/2010	-23.91	R		ACT	A	16/02/2011	-23.73	R		ACT
A	14/04/2011	-23.77	R		ACT	A	03/06/2011	-23.78	R		ACT	A	30/06/2011	-23.70	R		ACT
A	21/07/2011	-23.72	R		ACT	A	17/08/2011	-23.71	R		ACT	A	07/09/2011	-23.74	R		ACT
A	25/10/2011	-23.22	R		ACT	A	11/11/2011	-23.77	R		ACT	A	23/08/2012	-24.03	R		ACT
A	20/09/2012	-23.66	R		ACT	A	23/10/2012	-23.68	R		ACT	A	21/11/2012	-23.68	R		ACT
A	19/12/2012	-23.68	R		ACT	A	16/01/2013	-23.69	R		ACT	A	21/02/2013	-23.63	R		ACT
A	13/03/2013	-23.64	R		ACT	A	18/04/2013	-23.60	R		ACT	A	09/05/2013	-23.65	R		ACT
A	18/06/2013	-23.60	R		ACT	A	08/07/2013	-23.63	R		ACT	A	07/08/2013	-23.66	R		ACT
A	02/09/2013	-23.64	R		ACT	A	03/10/2013	-23.65	R		ACT	A	04/11/2013	-23.63	R		ACT
A	05/12/2013	-23.64	R		ACT	A	06/01/2014	-23.65	R		ACT	A	06/03/2014	-23.64	R		ACT
A	07/04/2014	-23.64	R		ACT	A	05/05/2014	-23.66	R		ACT	A	05/06/2014	-23.00	R		ACT
A	03/07/2014	-23.70	R		ACT	A	19/08/2014	-23.66	R		ACT	A	17/09/2014	-23.68	R		ACT
A	23/10/2014	-23.70	R		ACT	A	20/11/2014	-23.72	R		ACT	A	30/12/2014	-23.72	R		ACT
A	24/02/2015	-23.70	R		ACT	A	25/03/2015	-23.69	R		ACT	A	14/04/2015	-23.72	R		ACT
A	27/05/2015	-23.73	R		ACT	A	29/06/2015	-23.74	R		ACT	A	22/07/2015	-23.75	R		ACT
A	11/08/2015	-23.74	R		ACT	A	03/09/2015	-23.75	R		ACT	A	21/10/2015	-23.77	R		ACT
A	24/11/2015	-23.77	R		ACT	A	23/02/2016	-23.70	R		ACT	A	12/04/2016	-23.69	R		ACT
A	24/08/2016	-23.63	R		ACT	A	16/11/2016	-23.83	R		ACT	A	06/02/2017	-23.50	R		ACT
A	05/06/2017	-23.40	R		ACT												

BORE REPORT

REG NUMBER 162472

WIRE LINE LOG DETAILS

**** NO RECORDS FOUND ****

FIELD MEASUREMENTS

**** NO RECORDS FOUND ****

SPECIAL WATER ANALYSIS

**** NO RECORDS FOUND ****

BORE REPORT

**** End of Report. Produced:** 29/01/2018 07:37:26 PM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**13/11/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Olive Downs - Bore 9**

PART A: PROPERTY DETAILS

Property Name:	Olive Downs		
Local Bore Name:	House Bore	**Ref No/GW Number:**	162439
Easting (GDA94):	633886	**GPS Elevation:**	189
Northing:	7553064		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**-**	**Year Drilled:**	-
Casing Stick Up (SU):	**0.19**	**Drilled By**	**-**
Casing Material	**Unknown**	**Internal Diameter**	Unknown
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**No details Available**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**Yes**	**Condition**	**good**	**Pump Type**	screw
Power Source	**mains**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	no
Headworks	**2' Steel outlet** **Samples hose and 32mm H.D.**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Domestic**	**Pumping Regime**	no
Storage Type	**Tank**	**Approximate Volume**	40000

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**-**	**Date / Time of Measurement:**	12:22:00 PM
Pumping History	Pumping at time of inspection		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**-**	**H_2S ppm:**	**-**	**CO ppm:**	**-**	**O_2 %:**	**-**
Sample Collection Point	**Sample Tap**	**Sample Method**		**Bucket**		**Purge Volume**		**20**	
Electrical Conductivity (µS/cm)	**935.8**	**Temp**	**32**	**pH**	**7.01**	**ORP**	**39.1**	**DO (%)**	**24.5**

COMMENTS

Pump deployed

GROUNDWATER BORE REPORT CARD

Additional Notes

SUPPORTING INFORMATION	**Drillers Log**	**no**	**Meeting With Land Representative**	**yes**	**Photo**	yes

PHOTOGRAPHIC RECORD

Photograph 1 — **Olive Downs - Bore 9**

Photograph 2 — **Olive Downs - Bore 9**

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	13/11/2017	**SURVEY PERSONNEL:**	ML + TF	**BORE ID:**	**Olive Downs - 162439**

PART A: PROPERTY DETAILS

Property Name:	Olive Downs		
Local Bore Name:	MB8	**Ref No/GW Number:**	-
Easting (GDA94):	631866	**GPS Elevation:**	196
Northing:	7553657		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**12.578**	**Year Drilled:**	2015
Casing Stick Up (SU):	**0.7**	**Drilled By**	**Barnes Drilling**
Casing Material	**PVC**	**Internal Diameter**	50
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**PVC 0-11.90** **Slotted 8.9-11.9**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**Yes**	**Condition**	**good**	**Pump Type**	N/A
Power Source	**N/A**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	N/A
Headworks	**Gal Steel Monument**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Monitoring**	**Pumping Regime**	N/A
Storage Type	**N/A**	**Approximate Volume**	no

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**12.517**	**Date / Time of Measurement:**	1:00:00 PM
Pumping History	N/A		

PART F: WATER QUALITY

Well Head Gas Screening:	**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**1**	**O_2 %:**	**10.7**	
Sample Collection Point	**bore**	**Sample Method**	**-**		**Purge Volume**	**-**			
Electrical Conductivity (µS/cm)	**-**	**Temp**	**-**	**pH**	**-**	**ORP**	**-**	**DO (%)**	**-**

COMMENTS

insufficient volume for grab sample

GROUNDWATER BORE REPORT CARD

Additional Notes

SUPPORTING INFORMATION	Drilllers Log	yes	Meeting With Land Representative	Yes	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Olive Downs - 162439**

Photograph 2 **Olive Downs - 162439**

BORE REPORT

REG NUMBER 162439

REGISTRATION DETAILS

		BASIN	1304	LATITUDE	22-07-02	MAP-SCALE	
OFFICE	Mackay	SUB-AREA		LONGITUDE	148-16-43	MAP-SERIES	
DATE LOG RECD	27-JUL-15	SHIRE	3980-ISAAC REGIONAL	EASTING	631867	MAP-NO	
D/O FILE NO.		LOT	3	NORTHING	7553655	MAP NAME	
R/O FILE NO.		PLAN	GV90	ZONE	55	PROG SECTION	
H/O FILE NO.		ORIGINAL DESCRIPTION		ACCURACY		PRES EQUIPMENT	
				GPS ACC			
GIS LAT	-22.1171238	PARISH NAME	2420-ILSINGTON			ORIGINAL BORE NO	MB08
GIS LNG	148.27849899	COUNTY				BORE LINE	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	DATE DRILLED	16/07/2015			DATA OWNER	
STATUS	Existing	DRILLERS NAME	WESTON, CLAY DEAN				
ROLES	MM	DRILL COMPANY	BARNES DRILLING				
		METHOD OF CONST.	ROTARY MUD				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	16/07/2015	1	Polyvinyl Chloride	5.000	WT	60	0.00	8.90
A	16/07/2015	2	Perforated or Slotted Casing	0.400	AP	60	8.90	11.90
X	16/07/2015	3	Grout			171	0.00	5.50
X	16/07/2015	4	Cuttings or other fill between casing and hc			171	5.50	7.60
X	16/07/2015	5	Bentonite Seal			171	7.60	8.40
X	16/07/2015	6	Gravel Pack			171	8.40	11.90
X	16/07/2015	7	Bentonite Seal			171	11.90	13.00
X	16/07/2015	8	Gravel Pack			171	13.00	20.50

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	2.00	SOIL: MEDIUM REDDIISH BROWN, VERY SOFT SOIL (X1), EXTREMELY WEATHERED

BORE REPORT

REG NUMBER 162439

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
2	2.00	7.00	CLAY: MEDIUM REDDISH BROWN, VERY SOFT SOIL (X1), EXTREMELY WEATHERED
3	7.00	9.00	SANDY CLAY: MEDIUM REDDISH BROWN, FIRM SOIL (X3), EXTREMELY WEATHERED
4	9.00	12.00	SAND: MEDIUM ORANGY BROWN, VERY SOFT SOIL (X1), EXTREMELY WEATHERED
5	12.00	17.00	CLAY: LIGHT ORANGY GREY, SOFT SOIL (X2), EXTREMELY WEATHERED
6	17.00	20.50	SILTSTONE: LIGHT ORANGY GREY, EXTREMELY LOW STRENGTH ROCK (H1), DISTINCTLY WEATHERED

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	8.90	11.90	SAND			N			N	WZ	ISAAC RIVER ALLUVIUM

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

****** NO RECORDS FOUND ******

WATER ANALYSIS PART1

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

BORE REPORT

REG NUMBER 162439

****** NO RECORDS FOUND ******

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

FIELD MEASUREMENTS

****** NO RECORDS FOUND ******

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

BORE REPORT

**** End of Report. Produced:** 29/01/2018 07:42:59 PM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	13/09/2017	**SURVEY PERSONNEL:**	ML + AF	**BORE ID:**	**Willunga - 97181**

PART A: PROPERTY DETAILS

Property Name:	Willunga		
Local Bore Name:	Pisscutter	**Ref No/GW Number:**	97181
Easting (GDA94):	656325	**GPS Elevation:**	167
Northing:	7523641		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**19.77**	**Year Drilled:**	1996
Casing Stick Up (SU):	**0.8**	**Drilled By**	**Water Drill**
Casing Material	**PVC**	**Internal Diameter**	125
Initial Water Quality Measurement (Driller Log)	Good		
Construction Summary (Driller Log)	**PVC 0-19.51** **Screen 17.37-18.29**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**yes**	**Condition**	**good**	**Pump Type**	Submersible
Power Source	**powerline**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	flow meter
Headworks	**2" Steel manifold to 2" Poly. Bore standpipe encased in concrete**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**stock**	**Pumping Regime**	no
Storage Type	**no**	**Approximate Volume**	no

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**12.69**	**Date / Time of Measurement:**	4:10:00 PM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**1**	**O_2 %:**	**19.9**
Sample Collection Point	**bore**	**Sample Method**	**bailer**			**Purge Volume**	**2**		
Electrical Conductivity (µS/cm)	**298**	**Temp**	**26.31**	**pH**	**6.93**	**ORP**	**90.1**	**DO (%)**	**30.96**

COMMENTS

-

GROUNDWATER BORE REPORT CARD

Additional Notes

Two wells, one open and one with pump deployed. Sample taken from open bore. Land owner claims max yield of 1500 GPH

SUPPORTING INFORMATION	**Drillers Log**	**yes**	**Meeting With Land Representative**	**yes**	**Photo**	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Willunga - 97181**

Photograph 2 **Willunga - 97181**

BORE REPORT

REG NUMBER 97181

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-22-58	**MAP-SCALE**	104
OFFICE	Rockhampton	**SUB-AREA**		**LONGITUDE**	148-31-10	**MAP-SERIES**	M
DATE LOG RECD		**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	656434	**MAP-NO**	8653
D/O FILE NO.	515/030/0016	**LOT**	8	**NORTHING**	7523988	**MAP NAME**	BOMBANDY
R/O FILE NO.		**PLAN**	KL95	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**	P8	**ACCURACY**	SKET	**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.383010352	**PARISH NAME**	1312-COXENDEAN			**ORIGINAL BORE NO**	CUTTER BORE
GIS LNG	148.519511432	**COUNTY**	KILLARNEY			**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	22/06/1996			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**	W BEALE				
ROLES	WS	**DRILL COMPANY**	WATER DRILL				
		METHOD OF CONST.	ROTARY				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	22/06/1996	1	Polyvinyl Chloride	5.900	WT	140	0.00	17.37
A	22/06/1996	2	Screen	0.750	AP	140	17.37	18.29
A	22/06/1996	3	Polyvinyl Chloride	5.900	WT	140	18.29	19.51
A	22/06/1996	4	Gravel Pack	10.000	GR		0.00	18.29

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	10.67	LOAM
2	10.67	14.33	SILTY LOAM
3	14.33	17.07	FINE TO COARSE SAND
4	17.07	18.29	DIRTY FINE TO COARSE SAND
5	18.29	20.42	YELLOW CLAY

BORE REPORT

REG NUMBER 97181

STRATIGRAPHY DETAILS
**** NO RECORDS FOUND ****

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	14.33	18.29	SAND	22/06/1996	-13.41	N	GOOD	12.00	Y	UC	ISAAC RIVER ALLUVIUM

PUMP TEST DETAILS PART 1
**** NO RECORDS FOUND ****

PUMP TEST DETAILS PART 2
**** NO RECORDS FOUND ****

BORE CONDITION
**** NO RECORDS FOUND ****

ELEVATION DETAILS
**** NO RECORDS FOUND ****

WATER ANALYSIS PART1
**** NO RECORDS FOUND ****

WATER ANALYSIS PART 2
**** NO RECORDS FOUND ****

WATER LEVEL DETAILS
**** NO RECORDS FOUND ****

WIRE LINE LOG DETAILS
**** NO RECORDS FOUND ****

FIELD MEASUREMENTS
**** NO RECORDS FOUND ****

BORE REPORT

REG NUMBER 97181

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

BORE REPORT

**** End of Report. Produced:** 30/01/2018 03:36:08 PM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	17/09/2017	SURVEY PERSONNEL:	ML + AF	BORE ID:	Willunga - 97185

PART A: PROPERTY DETAILS

Property Name:	Willunga		
Local Bore Name:	Bottom Bore	**Ref No/GW Number:**	97185
Easting (GDA94):	659239	**GPS Elevation:**	164
Northing:	7519220		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**19.53**	**Year Drilled:**	1996
Casing Stick Up (SU):	**0.73**	**Drilled By**	**Water Drill**
Casing Material	**PVC**	**Internal Diameter**	125
Initial Water Quality Measurement (Driller Log)	Good		
Construction Summary (Driller Log)	**PVC 0-18.9** **Screened 16.76-17.68**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**no**	**Condition**	**good**	**Pump Type**	no
Power Source	**powerline**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	flow meter
Headworks	**3" Steel manifold to 3" HDPE. Standpipe concrete encased**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**stock**	**Pumping Regime**	no
Storage Type	**no**	**Approximate Volume**	no

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**14.25**	**Date / Time of Measurement:**	11:50:00 AM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**1**	**O_2 %:**	**20.1**
Sample Collection Point	**bore**	**Sample Method**	**bailer**			**Purge Volume**	**2**		
Electrical Conductivity (µS/cm)	**442.8**	**Temp**	**26.23**	**pH**	**7.12**	**ORP**	**-95.6**	**DO (%)**	**24.4**

COMMENTS

-

GROUNDWATER BORE REPORT CARD

Additional Notes

Land owner claims max yield of 1200 GPH

SUPPORTING INFORMATION	Drillers Log	yes	Meeting With Land Representative	yes	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1	**Willunga - 97185**

Photograph 2	**Willunga - 97185**

BORE REPORT

REG NUMBER 97185

REGISTRATION DETAILS

BASIN 1304
LATITUDE 22-25-09
MAP-SCALE 104
OFFICE Rockhampton
SUB-AREA
LONGITUDE 148-32-38
MAP-SERIES M
DATE LOG RECD
SHIRE 3980-ISAAC REGIONAL
EASTING 658897
MAP-NO 8653
D/O FILE NO. 515/030/0016
LOT 8
NORTHING 7519944
MAP NAME BOMBANDY
R/O FILE NO.
PLAN KL95
ZONE 55
PROG SECTION
H/O FILE NO.
ORIGINAL DESCRIPTION P8
ACCURACY SKET
PRES EQUIPMENT
GPS ACC

GIS LAT -22.41930535
PARISH NAME 1312-COXENDEAN
ORIGINAL BORE NO BOTTOM BORE
GIS LNG 148.54383265
COUNTY KILLARNEY
BORE LINE -
CHECKED Y

POLYGON
RN OF BORE REPLACED
DATA OWNER

FACILITY TYPE Sub-Artesian Facility
DATE DRILLED 12/06/1996
STATUS Existing
DRILLERS NAME W BEALE
ROLES WS
DRILL COMPANY WATER DRILL
METHOD OF CONST. ROTARY

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	12/06/1996	1	Polyvinyl Chloride	5.900	WT	140	0.00	16.76
A	12/06/1996	2	Screen	0.750	AP	140	16.76	17.68
A	12/06/1996	3	Polyvinyl Chloride	5.900	WT	140	17.68	18.90
A	12/06/1996	4	Gravel Pack	10.000	GR	140	0.00	18.29

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	0.61	SANDY LOAM
2	0.61	6.10	LOAM
3	6.10	7.32	VERY FINE SAND
4	7.32	9.75	SILTY CLAY
5	9.75	10.67	BROWN CLAY

BORE REPORT

REG NUMBER 97185

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
6	10.67	12.80	BROWN & RED CLAY
7	12.80	14.63	BLUE & BROWN CLAY
8	17.68	17.68	FINE TO VERY COARSE SAND
9	17.68	20.42	WHITE CLAY

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	14.63	17.68	SAND	12/06/1996	-14.33	N	GOOD	2.53	Y	UC	ISAAC RIVER ALLUVIUM

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

****** NO RECORDS FOUND ******

WATER ANALYSIS PART1

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

****** NO RECORDS FOUND ******

BORE REPORT

REG NUMBER 97185

WIRE LINE LOG DETAILS

**** NO RECORDS FOUND ****

FIELD MEASUREMENTS

**** NO RECORDS FOUND ****

SPECIAL WATER ANALYSIS

**** NO RECORDS FOUND ****

BORE REPORT

**** End of Report. Produced:** 30/01/2018 03:41:12 PM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	17/09/2017	SURVEY PERSONNEL:	ML + AF	BORE ID:	Willunga - 97184

PART A: PROPERTY DETAILS

Property Name:	Willunga		
Local Bore Name:	Leichardt Bore	**Ref No/GW Number:**	97184
Easting (GDA94):	659014	**GPS Elevation:**	163
Northing:	7519480		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**20.63**	**Year Drilled:**	1996
Casing Stick Up (SU):	**0.78**	**Drilled By**	**Water Drill**
Casing Material	**PVC**	**Internal Diameter**	125
Initial Water Quality Measurement (Driller Log)	Good		
Construction Summary (Driller Log)	**PVC 0-18.59** **Screened 16.46-17.37**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**yes**	**Condition**	**good**	**Pump Type**	Submersible
Power Source	**powerline**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	power meter
Headworks	**3" Steel manifold to 3" HDPE. Standpipe concrete encased**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**stock**	**Pumping Regime**	no
Storage Type	**no**	**Approximate Volume**	no

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**14.615**	**Date / Time of Measurement:**	12:25:00 PM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**1**	**O_2 %:**	**19.6**
Sample Collection Point	**bore**	**Sample Method**	**bailer**			**Purge Volume**	**2**		
Electrical Conductivity (μS/cm)	**598.5**	**Temp**	**25.68**	**pH**	**6.79**	**ORP**	**45.9**	**DO (%)**	**32.51**

COMMENTS

-

GROUNDWATER BORE REPORT CARD

Additional Notes

Two wells, one open and one with pump deployed. Sample taken from open bore.

SUPPORTING INFORMATION	**Drillers Log**	**yes**	**Meeting With Land Representative**	**yes**	**Photo**	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Willunga - 97184**

Photograph 2 **Willunga - 97184**

BORE REPORT

REG NUMBER 97184

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-24-53	**MAP-SCALE**	104
OFFICE	Rockhampton	**SUB-AREA**		**LONGITUDE**	148-32-31	**MAP-SERIES**	M
DATE LOG RECD		**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	658710	**MAP-NO**	8653
D/O FILE NO.	515/030/0016	**LOT**	8	**NORTHING**	7520443	**MAP NAME**	BOMBANDY
R/O FILE NO.		**PLAN**	KL95	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**	P8	**ACCURACY**	SKET	**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.414815254	**PARISH NAME**	1312-COXENDEAN			**ORIGINAL BORE NO**	LEICHARDT BORE
GIS LNG	148.541961757	**COUNTY**	KILLARNEY			**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	25/06/1996			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**	W BEALE				
ROLES	WS	**DRILL COMPANY**	WATER DRILL				
		METHOD OF CONST.	ROTARY				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	25/06/1996	1	Polyvinyl Chloride	5.900	WT	140	0.00	16.46
A	25/06/1996	2	Screen	0.750	AP	140	16.46	17.37
A	25/06/1996	3	Polyvinyl Chloride	5.900	WT	140	17.37	18.59
A	25/06/1996	4	Gravel Pack	10.000			0.00	18.29

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	5.18	LOAM
2	5.18	8.23	LOAMY CLAY
3	8.23	10.67	BROWN CLAY
4	10.67	12.19	SILTY CLAY
5	12.19	13.41	WHITE CLAY

BORE REPORT

REG NUMBER 97184

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
6	13.41	15.24	FINE TO COARSE SAND
7	15.24	18.29	FINE TO VERY COARSE SAND
8	18.29	20.42	YELLOW & GRAY CLAY

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	13.41	18.29	SAND	25/06/1996	-13.79	N	GOOD	2.60	Y	UC	ISAAC RIVER ALLUVIUM

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

****** NO RECORDS FOUND ******

WATER ANALYSIS PART1

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

****** NO RECORDS FOUND ******

BORE REPORT

REG NUMBER 97184

WIRE LINE LOG DETAILS

**** NO RECORDS FOUND ****

FIELD MEASUREMENTS

**** NO RECORDS FOUND ****

SPECIAL WATER ANALYSIS

**** NO RECORDS FOUND ****

BORE REPORT

**** End of Report. Produced:** 30/01/2018 03:40:31 PM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**17/09/2017**	**SURVEY PERSONNEL:**	**ML + AF**	**BORE ID:**	**Willunga - 97182**

PART A: PROPERTY DETAILS

Property Name:	Willunga		
Local Bore Name:	Blue Pump 5"	**Ref No/GW Number:**	97182
Easting (GDA94):	657944	**GPS Elevation:**	165
Northing:	7521843		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**20.92**	**Year Drilled:**	1996
Casing Stick Up (SU):	**0.65**	**Drilled By**	**Water Drill**
Casing Material	**PVC**	**Internal Diameter**	125
Initial Water Quality Measurement (Driller Log)	Good		
Construction Summary (Driller Log)	**PVC 0-19.35** **Screened 17.37-18.29**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**yes**	**Condition**	**good**	**Pump Type**	no
Power Source	**powerline**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	no
Headworks	**Standpipe concrete encased**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**stock**	**Pumping Regime**	no
Storage Type	**no**	**Approximate Volume**	no

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**13.13**	**Date / Time of Measurement:**	1:07:00 PM
Pumping History	adjacent pump operating		

PART F: WATER QUALITY

Well Head Gas Screening:	**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**0**	**O_2 %:**	**19.9**	
Sample Collection Point	**bore**	**Sample Method**	**bailer**		**Purge Volume**	**2**			
Electrical Conductivity (µS/cm)	**472.5**	**Temp**	**26.26**	**pH**	**7.24**	**ORP**	**-142.1**	**DO (%)**	**26.53**

COMMENTS

-

GROUNDWATER BORE REPORT CARD

Additional Notes

adjacent pump operating at time of measurements

SUPPORTING INFORMATION	**Drillers Log**	**yes**	**Meeting With Land Representative**	**yes**	**Photo**	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Willunga - 97182**

Photograph 2 **Willunga - 97182**

BORE REPORT

REG NUMBER 97182

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-23-48	**MAP-SCALE**	104
OFFICE	Rockhampton	**SUB-AREA**		**LONGITUDE**	148-31-36	**MAP-SERIES**	M
DATE LOG RECD		**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	657151	**MAP-NO**	8653
D/O FILE NO.	515/030/0016	**LOT**	8	**NORTHING**	7522448	**MAP NAME**	BOMBANDY
R/O FILE NO.		**PLAN**	KL95	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**	P8	**ACCURACY**	SKET	**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.396854844	**PARISH NAME**	1312-COXENDEAN			**ORIGINAL BORE NO**	5 BLUE PUMP
GIS LNG	148.526620689	**COUNTY**	KILLARNEY			**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	14/06/1996			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**	W BEALE				
ROLES	WS	**DRILL COMPANY**	WATER DRILL				
		METHOD OF CONST.	ROTARY				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	14/06/1996	1	Polyvinyl Chloride	5.900	WT	140	0.00	17.37
A	14/06/1996	2	Screen	0.750	AP	140	17.37	18.29
A	14/06/1996	3	Polyvinyl Chloride	5.900	WT	140	18.29	19.35
A	14/06/1996	4	Gravel Pack	10.000	GR		0.00	18.29

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	9.14	LOAM
2	9.14	12.19	DRY FINE TO MEDIUM SAND
3	12.19	12.80	CLAY
4	12.80	14.02	FINE SAND
5	14.02	15.24	DIRTY FINE TO MEDIUM SAND

BORE REPORT

REG NUMBER 97182

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
6	15.24	16.46	CLAYBOUND SAND
7	16.46	18.29	FINE TO COARSE WHITE SAND
8	18.29	20.42	CLAY

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	14.02	18.29	SAND	14/06/1996	-14.78	N	GOOD	0.51	Y	UC	ISAAC RIVER ALLUVIUM

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

****** NO RECORDS FOUND ******

WATER ANALYSIS PART1

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

****** NO RECORDS FOUND ******

BORE REPORT

REG NUMBER 97182

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

FIELD MEASUREMENTS

****** NO RECORDS FOUND ******

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

BORE REPORT

**** End of Report. Produced:** 30/01/2018 03:37:37 PM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	17/09/2017	SURVEY PERSONNEL:	ML + AF	BORE ID:	Willunga - 97183

PART A: PROPERTY DETAILS

Property Name:	Willunga		
Local Bore Name:	Blue Pump 8"	**Ref No/GW Number:**	97183
Easting (GDA94):	657950	**GPS Elevation:**	165
Northing:	7521838		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	-	**Year Drilled:**	1996
Casing Stick Up (SU):	**0.7**	**Drilled By**	**Water Drill**
Casing Material	**PVC**	**Internal Diameter**	~220 (OD)
Initial Water Quality Measurement (Driller Log)	Good		
Construction Summary (Driller Log)	**PVC 0-18.29** **Screened 17.68-18.29**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**yes**	**Condition**	**good**	**Pump Type**	Submersible
Power Source	**powerline**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	flow meter
Headworks	**3" Steel manifold to 3" HDPE. Standpipe concrete encased**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**stock**	**Pumping Regime**	no
Storage Type	**no**	**Approximate Volume**	no

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	-	**Date / Time of Measurement:**	1:15:00 PM
Pumping History	Pumping at time of inspection		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**0**	**O_2 %:**	**19.2**
Sample Collection Point	**bore**	**Sample Method**	**-**			**Purge Volume**	**-**		
Electrical Conductivity (µS/cm)	**-**	**Temp**	**-**	**pH**	**-**	**ORP**	**-**	**DO (%)**	**-**

COMMENTS

-

GROUNDWATER BORE REPORT CARD

Additional Notes

pumping at time of inspection

SUPPORTING INFORMATION	Drillers Log	yes	Meeting With Land Representative	yes	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Willunga - 97183**

Photograph 2 **Willunga - 97183**

BORE REPORT

REG NUMBER 97183

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-23-54	**MAP-SCALE**	104
OFFICE	Rockhampton	**SUB-AREA**		**LONGITUDE**	148-31-45	**MAP-SERIES**	M
DATE LOG RECD		**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	657419	**MAP-NO**	8653
D/O FILE NO.	515/030/0016	**LOT**	8	**NORTHING**	7522279	**MAP NAME**	BOMBANDY
R/O FILE NO.		**PLAN**	KL95	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**	P8	**ACCURACY**	SKET	**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.39835155	**PARISH NAME**	1312-COXENDEAN			**ORIGINAL BORE NO**	8 BLUE PUMP
GIS LNG	148.529239859	**COUNTY**	KILLARNEY			**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	15/06/1996			**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**	W BEALE				
ROLES	WS	**DRILL COMPANY**	WATER DRILL				
		METHOD OF CONST.	ROTARY				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	01/06/1996	3	Gravel Pack	10.000	GR		0.00	18.29
A	15/06/1996	1	Polyvinyl Chloride	10.000	WT	220	0.00	17.68
A	15/06/1996	2	Screen	1.100	AP	220	17.68	18.29

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	9.14	LOAM
2	9.14	12.19	FINE TO MEDIUM DRY SAND
3	12.19	12.80	CLAY
4	12.80	14.02	FINE SAND
5	14.02	15.24	DIRTY FINE TO MEDIUM SAND
6	15.24	16.46	CLAYBOUND SAND

BORE REPORT

REG NUMBER 97183

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
7	16.46	18.29	WHITE FINE TO COARSE SAND
8	18.29	20.42	CLAY

STRATIGRAPHY DETAILS
**** NO RECORDS FOUND ****

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	14.02	18.29	SAND	15/06/1996	-14.78	N	GOOD	0.51	Y	UC	ISAAC RIVER ALLUVIUM

PUMP TEST DETAILS PART 1
**** NO RECORDS FOUND ****

PUMP TEST DETAILS PART 2
**** NO RECORDS FOUND ****

BORE CONDITION
**** NO RECORDS FOUND ****

ELEVATION DETAILS
**** NO RECORDS FOUND ****

WATER ANALYSIS PART1
**** NO RECORDS FOUND ****

WATER ANALYSIS PART 2
**** NO RECORDS FOUND ****

WATER LEVEL DETAILS
**** NO RECORDS FOUND ****

WIRE LINE LOG DETAILS

REG NUMBER **97183**

****** NO RECORDS FOUND ******

FIELD MEASUREMENTS

****** NO RECORDS FOUND ******

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

**** End of Report. Produced:** 30/01/2018 03:38:40 PM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**10/11/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Winchester Downs - White Tank**

PART A: PROPERTY DETAILS

Property Name:	Winchester Downs		
Local Bore Name:	White Tank	**Ref No/GW Number:**	-
Easting (GDA94):	629347	**GPS Elevation:**	212
Northing:	7542483		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**53**	**Year Drilled:**	-
Casing Stick Up (SU):	**0.48**	**Drilled By**	**-**
Casing Material	**PVC**	**Internal Diameter**	127
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**-**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**no**	**Condition**	**good**	**Pump Type**	no
Power Source	**no**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	no
Headworks	**no**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Stock**	**Pumping Regime**	no
Storage Type	**tank**	**Approximate Volume**	35000

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**17.133**	**Date / Time of Measurement:**	9:17:00 AM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:	**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**0**	**O_2 %:**	**18.8**	
Sample Collection Point	**bore**	**Sample Method**	**bailer**		**Purge Volume**	**2**			
Electrical Conductivity (µS/cm)	**1721**	**Temp**	**26.1**	**pH**	**6.66**	**ORP**	**174.5**	**DO (%)**	**32.9**

COMMENTS

-

TOC

GROUNDWATER BORE REPORT CARD

Additional Notes

No pump deployed. Near to watering trough

SUPPORTING INFORMATION	Drillers Log	no	Meeting With Land Representative	yes	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Winchester Downs - White Tank**

Photograph 2 **Winchester Downs - White Tank**

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**10/11/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Winchester Downs - 141382**

PART A: PROPERTY DETAILS

Property Name:	Winchester Downs		
Local Bore Name:	-	**Ref No/GW Number:**	141382
Easting (GDA94):	628494	**GPS Elevation:**	205
Northing:	7542693		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**51.3**	**Year Drilled:**	2008
Casing Stick Up (SU):	**0.5**	**Drilled By**	**IESA**
Casing Material	**PVC**	**Internal Diameter**	50
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**PVC 0-51.5** **Screened 48.5-51.5**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**yes**	**Condition**	**Good**	**Pump Type**	N/A
Power Source	**N/A**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	N/A
Headworks	**Steel Monument**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Monitoring**	**Pumping Regime**	N/A
Storage Type	**N/A**	**Approximate Volume**	N/A

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**14.929**	**Date / Time of Measurement:**	10:55:00 AM
Pumping History	N/A		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**1**	**O_2 %:**	**18.3**
Sample Collection Point	**bore**	**Sample Method**		**bailer**		**Purge Volume**	**2**		
Electrical Conductivity (µS/cm)	**2281**	**Temp**	**27**	**pH**	**5.98**	**ORP**	**-176.8**	**DO (%)**	**35.7**

COMMENTS

-

GROUNDWATER BORE REPORT CARD

Additional Notes

No logger deployed. Monument cap broken at hinge

SUPPORTING INFORMATION	**Drillers Log**	**yes**	**Meeting With Land Representative**	**yes**	**Photo**	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Winchester Downs - 141382**

Photograph 2 **Winchester Downs - 141382**

GROUNDWATER DATABASE

BORE REPORT

REG NUMBER 141382

REGISTRATION DETAILS

BASIN 1304
LATITUDE 22-12-59
MAP-SCALE 254
OFFICE Mackay
SUB-AREA
LONGITUDE 148-14-48
MAP-SERIES
DATE LOG RECD 01-MAY-08
SHIRE 3980-ISAAC REGIONAL
EASTING 628490
MAP-NO SF55-11
D/O FILE NO. 520/000/0072
LOT 5
NORTHING 7542693
MAP NAME CLERMONT
R/O FILE NO.
PLAN CNS90
ZONE 55
PROG SECTION
H/O FILE NO.
ORIGINAL DESCRIPTION
ACCURACY
PRES EQUIPMENT
GPS ACC
GIS LAT -22.21638819
PARISH NAME 5065-WINCHESTER
ORIGINAL BORE NO MB5
GIS LNG 148.24663621
COUNTY
BORE LINE -
CHECKED Y
POLYGON
RN OF BORE REPLACED
FACILITY TYPE Sub-Artesian Facility
DATE DRILLED 09/04/2008
DATA OWNER DNR
STATUS Existing
DRILLERS NAME MCLEAN, WAYNE ROBERT
ROLES SM
DRILL COMPANY IESA
METHOD OF CONST. ROTARY AIR - HAMMER

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	09/04/2008	1	Polyvinyl Chloride	5.500	WT	60	0.00	48.50
A	09/04/2008	2	Centraliser				3.00	48.00
A	09/04/2008	3	Screen	0.500	AP		48.50	51.50
A	09/04/2008	4	Gravel Pack	7.000	GR	164	18.00	52.00
A	09/04/2008	5	Bentonite Seal			164	17.00	18.00
A	09/04/2008	6	Grout			164	0.00	17.00

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	0.70	"TOP SOIL CLAY BROWN"
2	0.70	3.00	CLAY, SILTY, ORANGE
3	3.00	11.00	CLAY, SILTY, OCHRE; SOME SILCRETE

BORE REPORT

REG NUMBER 141382

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
4	11.00	12.00	SHALE, LIGHT OCHRE
5	12.00	13.00	SHALE, SILTY, VERY FINE, SOFT; SOME IRON STAINING
6	13.00	16.00	SHALE, LIGHT OCHRE; SOME SILCRETE
7	16.00	33.00	SHALE, "SANDY/SILTY", LIGHT GREY; TRACE WATER 25 M
8	33.00	37.00	CARBONACEOUS MATERIAL, DARK GREY BLACK
9	37.00	40.00	SHALE, DARK GREY
10	40.00	52.00	"SHALE HARD/SOFT BANDS GREY"

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	25.00		SHLE	09/04/2008	-18.36	N		0.02	Y	PS	

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

PIPE	DATE	ELEVATION	PRECISION	DATUM	MEASUREMENT POINT	SURVEY SOURCE
A	09/04/2008	209.33	SVY	AHD	R	
X	09/04/2008	208.83	SVY	AHD	N	

WATER ANALYSIS PART1

****** NO RECORDS FOUND ******

BORE REPORT

REG NUMBER 141382

WATER ANALYSIS PART 2

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE
A	09/04/2008	-18.36	N		NR	A	19/04/2008	-15.95	R		ACT	A	11/06/2008	-15.46	R		ACT
A	13/10/2011	-15.12	R		ACT	A	10/11/2011	-15.09	R		ACT	A	11/01/2012	-15.04	R		ACT
A	12/06/2012	-14.87	R		ACT	A	09/08/2012	-15.08	R		ACT	A	11/09/2012	-14.86	R		ACT
A	10/10/2012	-14.81	R		ACT	A	05/11/2012	-14.80	R		ACT	A	05/12/2012	-14.78	R		ACT
A	08/01/2013	-14.34	R		ACT	A	11/02/2013	-14.75	R		ACT	A	18/03/2013	-14.33	R		ACT
A	08/04/2013	-14.35	R		ACT	A	08/05/2013	-14.29	R		ACT	A	11/06/2013	-14.40	R		ACT
A	08/07/2013	-14.15	R		ACT	A	06/08/2013	-14.40	R		ACT	A	09/09/2013	-14.40	R		ACT
A	08/10/2013	-14.33	R		ACT	A	06/11/2013	-14.27	R		ACT	A	04/12/2013	-14.31	R		ACT
A	07/01/2014	-14.32	R		ACT												

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

FIELD MEASUREMENTS

PIPE	DATE	DEPTH (m)	COND (uS/cm)	pH	TEMP (C)	NO3 (mg/L)	DO (mg/L)	Eh (mV)	ALK (mEq)	METH	SOURCE
A	09/04/2008		6120	7.7						PU	GB
A	13/10/2011		3918	7.2			0.16			PU	GB
A	10/11/2011		3918	7.2			0.16			PU	GB
A	12/12/2011		3565	7.3			0.23			PU	GB
A	11/01/2012		4207	7.6	28.9		1.56			PU	GB
A	12/06/2012		4078	7.0	26.8		0.52			PU	GB
A	09/08/2012		3948	8.4	26.5		2.64			PU	GB
A	11/09/2012		4324	7.5	26.8		0.28			PU	GB
A	10/10/2012		4126	7.9	27.7		1.06			PU	GB
A	05/11/2012		5029	7.2	27.7					PU	GB
A	05/12/2012		4080	7.8	27.5					PU	GB
A	08/01/2013		4807	7.1	28.3		4.87			PU	GB
A	11/02/2013		3678	7.4	28.2					PU	GB

GROUNDWATER DATABASE

BORE REPORT

REG NUMBER **141382**

PIPE	DATE	DEPTH (m)	COND (uS/cm)	pH	TEMP (C)	NO3 (mg/L)	DO (mg/L)	Eh (mV)	ALK (mEq)	METH	SOURCE
A	18/03/2013		4126	7.8	26.9		1.00			PU	GB
A	08/04/2013		5365	7.6	26.4					PU	GB
A	08/05/2013		4733	7.2	26.3		1.67			PU	GB
A	11/06/2013		5210	7.8	26.0		3.64			PU	GB
A	08/07/2013		4637	7.0	26.5		5.26			PU	GB
A	06/08/2013		4631	7.4	27.3					PU	GB
A	09/09/2013		5476	7.3	26.4					PU	GB
A	08/10/2013		5702	6.2	29.3		0.25			PU	GB
A	06/11/2013			6.3	27.3		0.36			PU	GB
A	04/12/2013		5785	6.9	29.4		1.98			PU	GB
A	07/01/2014		5330	7.4	28.2					PU	GB

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

BORE REPORT

**** End of Report. Produced:** 29/01/2018 07:48:56 PM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**10/11/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Winchester Downs - 14**

PART A: PROPERTY DETAILS

Property Name:	Winchester Downs		
Local Bore Name:	-	**Ref No/GW Number:**	-
Easting (GDA94):	628742	**GPS Elevation:**	202
Northing:	7546690		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**14.4**	**Year Drilled:**	-
Casing Stick Up (SU):	**0.27**	**Drilled By**	**-**
Casing Material	**Steel**	**Internal Diameter**	144
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**-**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**no**	**Condition**	**Poor**	**Pump Type**	no
Power Source	**windmill**	**Bore Capped**	**no**	**Bore Equipped With Meter**	no
Headworks	**no**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**Stock**	**Pumping Regime**	no
Storage Type	**Tank**	**Approximate Volume**	ruptured

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**3.59**	**Date / Time of Measurement:**	12:53:00 PM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**0**	**O_2 %:**	**19.4**
Sample Collection Point	**bore**	**Sample Method**	**bailer**			**Purge Volume**	**2**		
Electrical Conductivity (µS/cm)	**3003**	**Temp**	**25.3**	**pH**	**7.17**	**ORP**	**-135**	**DO (%)**	**34.5**

COMMENTS

-

GROUNDWATER BORE REPORT CARD

Additional Notes

Windmill blades on ground

SUPPORTING INFORMATION	**Drillers Log**	**no**	**Meeting With Land Representative**	**yes**	**Photo**	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Winchester Downs - 14**

Photograph 2 **Winchester Downs - 14**

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**10/11/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Winchester Downs - 162460**

PART A: PROPERTY DETAILS

Property Name:	Winchester Downs		
Local Bore Name:	Number One	**Ref No/GW Number:**	162460
Easting (GDA94):	627204	**GPS Elevation:**	215
Northing:	7546953		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**11.23**	**Year Drilled:**	-
Casing Stick Up (SU):	**0.36**	**Drilled By**	**-**
Casing Material	**PVC**	**Internal Diameter**	125
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**-**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**yes**	**Condition**	**Good**	**Pump Type**	Submersible
Power Source	**Genset**	**Bore Capped**	**no**	**Bore Equipped With Meter**	Flow meter
Headworks	**2" HDPE outlet off steel manifold**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**stock**	**Pumping Regime**	no
Storage Type	**tank**	**Approximate Volume**	20000

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**dry**	**Date / Time of Measurement:**	1:40:00 PM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**2**	**O_2 %:**	**10.5**
Sample Collection Point	**bore**	**Sample Method**	**-**			**Purge Volume**	**-**		
Electrical Conductivity (µS/cm)	**-**	**Temp**	**-**	**pH**	**-**	**ORP**	**-**	**DO (%)**	**-**

COMMENTS

-

TOC

GROUNDWATER BORE REPORT CARD

Additional Notes

Insufficient water to take sample. Appears to be a duplicate bore as adjacent bore appears to have a similar construction.

Submersible pump deployed down adjacent bore. Windmill positioned over bore

SUPPORTING INFORMATION	Drillers Log	yes	Meeting With Land Representative	yes	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Winchester Downs - 162460**

Photograph 2 **Winchester Downs - 162460**

BORE REPORT

REG NUMBER 162460

REGISTRATION DETAILS

		BASIN	1304	**LATITUDE**	22-10-41	**MAP-SCALE**	
OFFICE	Mackay	**SUB-AREA**		**LONGITUDE**	148-14-02	**MAP-SERIES**	
DATE LOG RECD		**SHIRE**	3980-ISAAC REGIONAL	**EASTING**	627200	**MAP-NO**	
D/O FILE NO.		**LOT**	8	**NORTHING**	7546952	**MAP NAME**	
R/O FILE NO.		**PLAN**	SP277384	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**		**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-22.17801525	**PARISH NAME**	5065-WINCHESTER			**ORIGINAL BORE NO**	NO. 1 BORE
GIS LNG	148.23378644	**COUNTY**				**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**				**DATA OWNER**	
STATUS	Existing	**DRILLERS NAME**					
ROLES	WS	**DRILL COMPANY**					
		METHOD OF CONST.					

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	01/01/1900	1	Polyvinyl Chloride			140		

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	30.00	NO DETAILS. DEPTH APPROX.

STRATIGRAPHY DETAILS

****** NO RECORDS FOUND ******

AQUIFER DETAILS

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 1

BORE REPORT

REG NUMBER 162460

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

PIPE	DATE	ELEVATION	PRECISION	DATUM	MEASUREMENT POINT	SURVEY SOURCE
A	09/02/2006	217.90	GPS	AHD	R	ISAAC PLAINS BORE CENSUS

WATER ANALYSIS PART1

****** NO RECORDS FOUND ******

WATER ANALYSIS PART 2

****** NO RECORDS FOUND ******

WATER LEVEL DETAILS

PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE
A	09/02/2006	-14.78	R		ACT												

WIRE LINE LOG DETAILS

****** NO RECORDS FOUND ******

FIELD MEASUREMENTS

****** NO RECORDS FOUND ******

SPECIAL WATER ANALYSIS

****** NO RECORDS FOUND ******

BORE REPORT

**** End of Report. Produced:** 29/01/2018 08:02:59 PM ******

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	10/11/2017	SURVEY PERSONNEL:	ML + TF	BORE ID:	Winchester Downs - 15

PART A: PROPERTY DETAILS

Property Name:	Winchester Downs		
Local Bore Name:	-	**Ref No/GW Number:**	-
Easting (GDA94):	629039	**GPS Elevation:**	204
Northing:	7546882		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**23.4**	**Year Drilled:**	-
Casing Stick Up (SU):	**0.2**	**Drilled By**	**-**
Casing Material	**PVC**	**Internal Diameter**	135
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**-**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**no**	**Condition**	**Poor**	**Pump Type**	no
Power Source	**no**	**Bore Capped**	**no**	**Bore Equipped With Meter**	no
Headworks	**no**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**stock**	**Pumping Regime**	no
Storage Type	**no**	**Approximate Volume**	no

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**9.67**	**Date / Time of Measurement:**	2:44:00 PM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:	**CH_4 ppm:**	**2.4**	**H_2S ppm:**	**0**	**CO ppm:**	**1**	**O_2 %:**	**11.3**	
Sample Collection Point	**bore**	**Sample Method**	**bailer**		**Purge Volume**	**2**			
Electrical Conductivity (µS/cm)	**2063**	**Temp**	**25.4**	**pH**	**7.5**	**ORP**	**-178.4**	**DO (%)**	**28**

COMMENTS

methane present at 2.4%

TOC

GROUNDWATER BORE REPORT CARD

Additional Notes

Appears to previously have had piston pump installed

SUPPORTING INFORMATION	Drillers Log	no	Meeting With Land Representative	yes	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1	**Winchester Downs - 15**

Photograph 2	**Winchester Downs - 15**

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**10/11/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Winchester Downs - Lemon Tree**

PART A: PROPERTY DETAILS

Property Name:	Winchester Downs		
Local Bore Name:	Lemon Tree	**Ref No/GW Number:**	-
Easting (GDA94):	630655	**GPS Elevation:**	195
Northing:	7551954		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	-	**Year Drilled:**	-
Casing Stick Up (SU):	**0.51**	**Drilled By**	**-**
Casing Material	**PVC**	**Internal Diameter**	125
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**-**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**yes**	**Condition**	**good**	**Pump Type**	Submersible
Power Source	**Genset**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	Flow meter
Headworks	**2" Steel manifold to 2" Poly**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**stock**	**Pumping Regime**	no
Storage Type	**no**	**Approximate Volume**	no

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**-**	**Date / Time of Measurement:**	4:18:00 PM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:	**CH_4 ppm:**	**-**	**H_2S ppm:**	**-**	**CO ppm:**	**-**	**O_2 %:**	**-**	
Sample Collection Point	**-**	**Sample Method**	**-**		**Purge Volume**	**-**			
Electrical Conductivity (µS/cm)	**-**	**Temp**	**-**	**pH**	**-**	**ORP**	**-**	**DO (%)**	**-**

COMMENTS

Pump deployed

GROUNDWATER BORE REPORT CARD

Additional Notes

-

SUPPORTING INFORMATION	Drillers Log	no	Meeting With Land Representative	yes	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Winchester Downs - Lemon Tree**

Photograph 2 **Winchester Downs - Lemon Tree**

TOC

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	29/09/2017	SURVEY PERSONNEL:	ML + TF	BORE ID:	Wynette - Bore 1

PART A: PROPERTY DETAILS

Property Name:	Wynette		
Local Bore Name:	Bore 1	**Ref No/GW Number:**	-
Easting (GDA94):	634791	**GPS Elevation:**	189
Northing:	7550019		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	-	**Year Drilled:**	-
Casing Stick Up (SU):	0.5	**Drilled By**	-
Casing Material	PVC	**Internal Diameter**	unknown
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	-		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	no	**Condition**	good	**Pump Type**	Submersible
Power Source	Genset	**Bore Capped**	yes	**Bore Equipped With Meter**	no
Headworks	3" Steel with sample tap				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	stock	**Pumping Regime**	-
Storage Type	Tank	**Approximate Volume**	40000

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	-	**Date / Time of Measurement:**	2:40:00 PM
Pumping History	Bore hasn't been successfully pumped for +15 years		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	-	**H_2S ppm:**	-	**CO ppm:**	-	**O_2 %:**	-
Sample Collection Point	-	**Sample Method**	-			**Purge Volume**	-		
Electrical Conductivity (µS/cm)	-	**Temp**	-	**pH**	-	**ORP**	-	**DO (%)**	-

COMMENTS

Pump deployed

GROUNDWATER BORE REPORT CARD

Additional Notes

No sample or gas measurements taken due to headworks

SUPPORTING INFORMATION	Drillers Log	no	Meeting With Land Representative	yes	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1	**Wynette - Bore 1**

Photograph 2	**Wynette - Bore 1**

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	**29/09/2017**	**SURVEY PERSONNEL:**	**ML + TF**	**BORE ID:**	**Wynette - Bore 2**

PART A: PROPERTY DETAILS

Property Name:	Wynette		
Local Bore Name:	Bore 2	**Ref No/GW Number:**	-
Easting (GDA94):	634788	**GPS Elevation:**	191
Northing:	7550024		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**19.85**	**Year Drilled:**	-
Casing Stick Up (SU):	**0.61**	**Drilled By**	**-**
Casing Material	**PVC**	**Internal Diameter**	125
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**-**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**no**	**Condition**	**good**	**Pump Type**	no
Power Source	**no**	**Bore Capped**	**yes**	**Bore Equipped With Meter**	no
Headworks	**no**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**stock/monitoring**	**Pumping Regime**	-
Storage Type	**Tank**	**Approximate Volume**	40000

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**15.97**	**Date / Time of Measurement:**	2:10:00 PM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0**	**H_2S ppm:**	**0**	**CO ppm:**	**1**	**O_2 %:**	**11.9**
Sample Collection Point	**bore**	**Sample Method**	**bailer**			**Purge Volume**	**2**		
Electrical Conductivity (µS/cm)	**2903**	**Temp**	**30.9**	**pH**	**6.69**	**ORP**	**124**	**DO (%)**	**27.13**

COMMENTS

Water level logger present in bore

GROUNDWATER BORE REPORT CARD

Additional Notes

Bore was drilled when Bore 1 became dry 15 years ago. Bore doesn't yield sufficient volumes to warrant the permanent deployment of a pump

SUPPORTING INFORMATION	Drillers Log	no	Meeting With Land Representative	yes	Photo	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Wynette - Bore 2**

Photograph 2 **Wynette - Bore 2**

GROUNDWATER BORE REPORT CARD

SURVEY DATE:	29/09/2017	SURVEY PERSONNEL:	ML + TF	BORE ID:	Wynette - Bore 3

PART A: PROPERTY DETAILS

Property Name:	Wynette		
Local Bore Name:	Bore 3	**Ref No/GW Number:**	-
Easting (GDA94):	634785	**GPS Elevation:**	187
Northing:	7550009		

PART B: BORE CONSTRUCTION DETAILS

Bore Depth (mBTOC):	**94**	**Year Drilled:**	-
Casing Stick Up (SU):	**0.6**	**Drilled By**	**-**
Casing Material	**PVC**	**Internal Diameter**	125
Initial Water Quality Measurement (Driller Log)	-		
Construction Summary (Driller Log)	**-**		

PART C: BORE EQUIPMENT AND CONDITION DETAILS

Bore In Use	**no**	**Condition**	**good**	**Pump Type**	no
Power Source	**no**	**Bore Capped**	**no**	**Bore Equipped With Meter**	no
Headworks	**no**				

PART D: BORE WATER SUPPLY INFORMATION

Observed Purpose	**stock**	**Pumping Regime**	-
Storage Type	**Tank**	**Approximate Volume**	40000

PART E: WATER LEVEL INFORMATION

Depth to Water (mBTOC):	**15.91**	**Date / Time of Measurement:**	1:40:00 PM
Pumping History	no		

PART F: WATER QUALITY

Well Head Gas Screening:		**CH_4 ppm:**	**0.6**	**H_2S ppm:**	**0**	**CO ppm:**	**0**	**O_2 %:**	**19.8**
Sample Collection Point	**bore**	**Sample Method**	**bailer**			**Purge Volume**	**2**		
Electrical Conductivity (µS/cm)	**6677**	**Temp**	**26.79**	**pH**	**7.44**	**ORP**	**43.5**	**DO (%)**	**28.3**

COMMENTS

methane present at 0.6%. Likely penetrating coal measures

GROUNDWATER BORE REPORT CARD

Additional Notes

Drilled at same time as bore 2 but to an increased depth looking for an alternate aquifer

SUPPORTING INFORMATION	**Drillers Log**	**no**	**Meeting With Land Representative**	**yes**	**Photo**	yes

PHOTOGRAPHIC RECORD

Photograph 1 **Wynette - Bore 3**

Photograph 2 **Wynette - Bore 3**

Appendix B Modelling Appendix

HYDRO SIMULATIONS

Olive Downs South and Willunga

Appendix B

Modelling Appendix

FOR

Pembroke Olive Downs Pty Ltd

BY

NPM Technical Pty Ltd

trading as

HydroSimulations

1 INTRODUCTION

Numerical modelling was undertaken to assess the impact of the project on the groundwater regime. The objectives of the predictive modelling were to:

- assess the groundwater inflow to the mine workings as a function of mine position and timing;
- simulate and predict the extent and area of influence of dewatering and the level and rate of drawdown at specific locations; and
- identify areas of potential risk, where groundwater impact mitigation/control measures may be necessary.

The key to numerical modelling is the adequate conceptualisation of the groundwater regime, and calibration of the model against observed data. The conceptual model represents how the groundwater regime operates based on available data and experience. The main report details the conceptual understanding of the hydrogeological regime at the project site. **Section** 2 of this modelling appendix presents how the conceptualisation has been developed as a numerical groundwater model, and **Section 2.5** presents how well the model replicates observed data (calibration). Details on how the model represents the proposed Project and other future approved and foreseeable activities within the region (including the Bowen Gas Project) is outlined within **Section** 3.

2 MODEL DESIGN

2.1 MODEL COMPLEXITY AND SOFTWARE

Numerical modelling has been undertaken using Geographic Information Systems (GIS) in conjunction with MODFLOW-USG, which is distributed by the United States Geological Survey (USGS). MODFLOW-USG is a relatively new version of the popular MODFL OW code (McDonald and Harbaugh, 1988) developed by the United States Geological Survey (USGS). MODFLOW is the most widely used code for groundwater modelling and has long been considered an industry standard.

MODFLOW-USG represents a major revision of the MODFLOW code, in that it uses a different underlying numerical scheme: control volume finite difference (CVFD), rather than traditional MODFLOW's finite difference (FD) scheme. 'USG' is an acronym for Un-Structured Grid, meaning that MODFLOW-USG supports a variety of structured and unstructured model grids, including those based on cell shapes including prismatic triangles, rectangles, hexagons, and other cell shapes (Panday *et al*., 2013). The CVFD method allows a model cell to be connected to an arbitrary number of adjacent cells, which is not the case with a standard FD scheme.

In contrast with structured rectangular finite-difference grids, flexible meshes have a number of advantages. Firstly, they allow finer grid resolution to be focused solely in areas of a model that require it (e.g. along mining trenches), as opposed to refinement over the entire grid, significantly decreasing cell count and consequently model runtimes. Secondly, spatial areas not required in the model may be omitted rather than deactivating cells or retaining "dummy" layers (e.g. for layer pinch-outs). Thirdly, flexible meshes allow cell boundaries to follow important geographical or geological features, such as watercourses and faults, more accurately modelling the physical system. Finally, the orientation of the flow interfaces between cells may vary, allowing preferential flow directions to be modelled with higher accuracy.

Additionally, MODFLOW-USG is able to simulate variably saturated flow and can handle desaturation and re-saturation of multiple hydrogeological layers without the “dry cell” problems of traditional MODFLOW. This is pertinent to models which simulate layers, such as surficial regolith, which frequently alternate between unsaturated and saturated, as well as the depressurisation and desaturation that occur due to mine excavation. Traditional versions of MODFLOW can handle depressurisation and desaturation to some extent, but model cells that are dewatered (water level reduced below cell bottom) are replaced by “dry” cells, which can interfere with the simulation of various processes and also cause model instability

2.2 MODEL EXTENT AND MESH DESIGN

The model is centred over the Project and is elongated in the north-west to south-east direction to follow geological strike. The model is roughly 55 km x 70 km at its widest extents. The model domain was selected based on the following considerations:

- The south-west and north-east boundaries are represented by the outcrop of the Back Creek Group, which is considered to be the regional low permeability basement for the purpose of this modelling.
- The north-west and south-east boundaries are approximately 15 km from the edge of the proposed pits and include the surrounding mines listed in **Section 2.4.6** for cumulative impact assessment.

The large spatial area of the model extent resulted in the need for an unstructured grid with varying cell sizes, and refinement in the areas of interest, in order to reduce the total cell count to a manageable size. The model mesh is shown in **Figure B2-1**.

The following features have been included in the mesh design:

- Rivers in the immediate vicinity of Olive Downs (Isaac River and Ripstone Creek) have a 50 m Voronoi cell size constraint. All other rivers/creeks have a maximum cell size of 100 m.
- Open cut mine areas at Olive Downs South and Willunga have a 100 m Voronoi cell size constraint.
- Open cut mining at Olive Downs North, Lake Vermont, Poitrel, Daunia, Peak Downs and Saraji have a maximum cell size of 200 m.
- Longwall mining at Eagle Downs has an oriented regular grid of 375 m width squares to represent longwalls. Proposed mining at Saraji East is represented similarly by 400 m squares.
- Faults are represented using a 100 m Voronoi cell constraint.

The cell count for one layer is 91,806. Over the 14 model layers, with pinch-out areas (where a layer is not present) in layers 2 to 14, the total cell count for the model is 966,821.

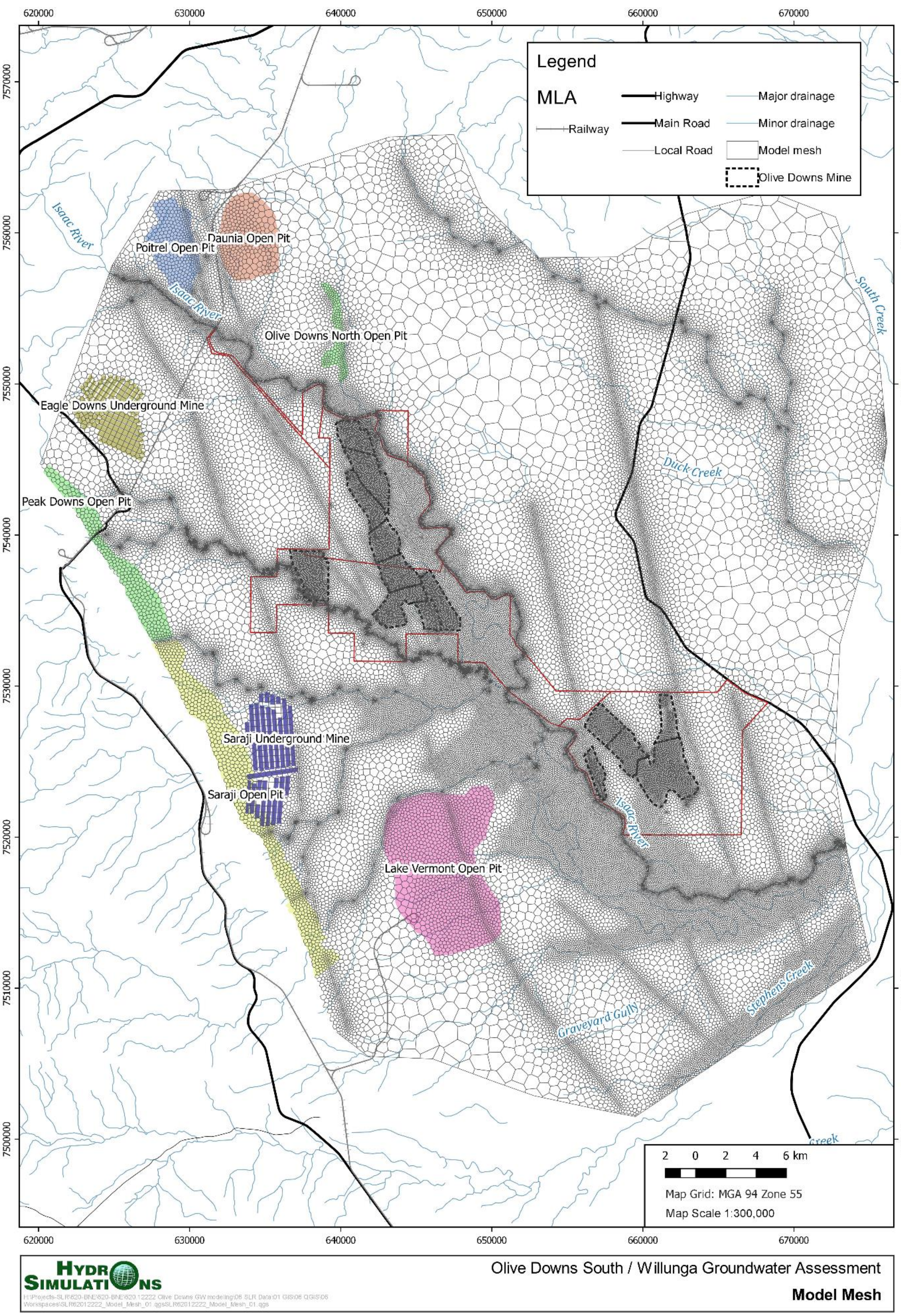


Figure B2-1 Model Mesh

2.3 MODEL LAYERS

The topography of the model relies on LiDAR data provided by Pembroke, the extent of which is shown in **Figure B2-2**. The remaining model extent has topography defined by the Australia Wide 1 Sec DEM-H (Geoscience Australia, 2011). There was a correction of +3 m applied to the Geoscience Australia data to maintain consistency between the two data sets.

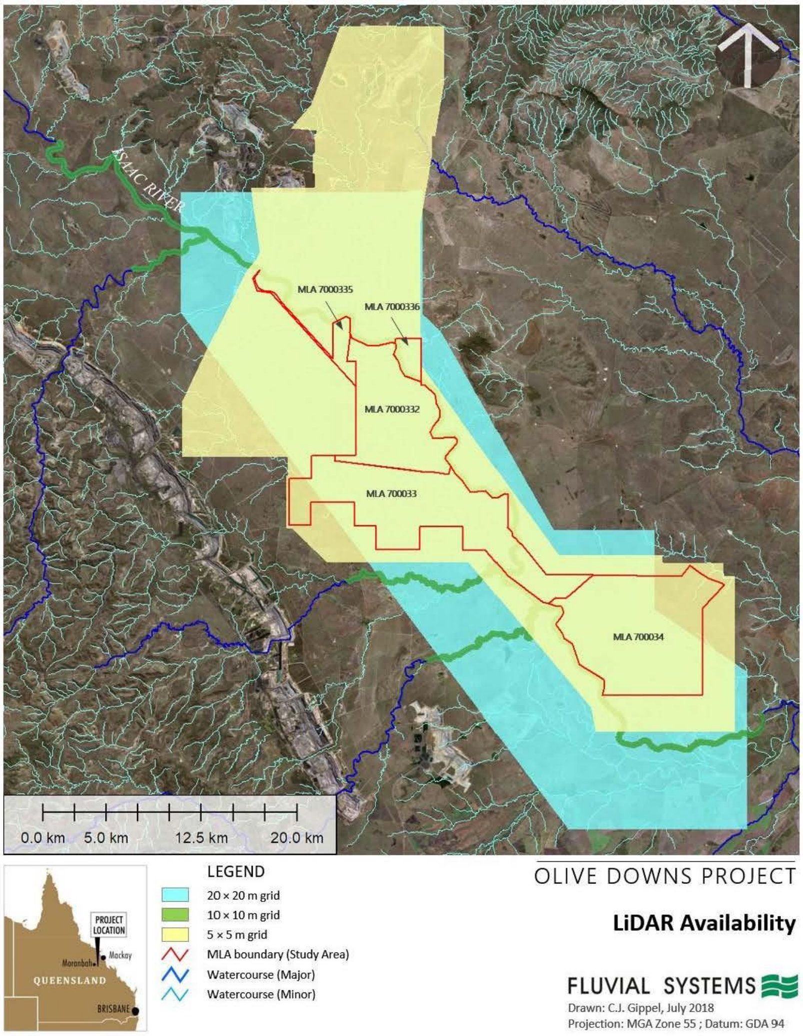


Figure 3. LiDAR data availability for the Study Area.

The Atlas of Australian Soils was compiled by H. Northcote and others of CSIRO in the 1960s to provide a consistent national description of Australia's soils. The maps were published at a scale of 1:2,000,000 but the original compilation was at scales from 1:250,000 to 1:500,000. The Digital Atlas of Australian Soils was created by the National Resource Information Centre (NRIC) in 1991 from scanned tracings of the published hardcopy

Figure B2-2 Extent of Project LiDAR Data

The model domain is discretised into 14 layers, as listed in **Table B2-1**. Model layers (lateral and vertical extents) have been defined using data available from the following sources:

- Pembroke site geological model (as at May 2017)
- Site TEM alluvial survey
- NGIS/DNRM groundwater bore database
- Queensland Petroleum Exploration Database (QPED)
- Reported bore details and cross-sections, particularly from URS (2012)
- Outcrop geology maps where the basal contact of a unit is intercepted with topography to provide a series of layer bottom elevation points at the outcrop extents.

Model layer 1 is fully extensive across the model with an assumed minimum depth of 3 m for colluvium. All other layers are only present to the limit of their outcrop extent, with some inference made for the presence of older units beneath the surface outcrop due to folding and faulting. The Back Creek Group is considered the regional low-permeability basement for the purpose of this modelling and defines the western, eastern and bottom edges of the model.

It is not possible to represent every individual coal seam (typically <1 m thickness) in a regional groundwater model, therefore a “combined thickness” totalling the individual seam thicknesses for each relevant seam has been simulated. Site specific information regarding the Rangal Coal Measures is available from the site geological model and exploration database (provided to HS in June 2017). Limited regional information regarding layer thicknesses away from the site as well as thickness of units older than Rangal Coal Measures at site is available, therefore where information was lacking the following layer thicknesses have been assigned based on the average of available data:

- Rangal Coal Measures:
    - Total Thickness: 150 m
    - Leichhardt Seam: 5.5 m
    - Vermont Upper Seam: 4 m
- Fort Cooper Coal Measures:
    - Total thickness 200 m
    - Combined seam thickness 80 m
- Moranbah Coal Measures
    - Total Thickness: 110 m
    - Combined seam thickness 20 - 40 m

With the exception of Layer 1, the minimum thickness for all model layers is 0.1 m, with any model cell below this thickness pinched out of the model. The minimum thickness of Layer 1 is 3 m. Average and maximum thicknesses for each model layer are shown in **Table B2-1**.

Table B2-1 Model Layers and Thicknesses

Model Layer	Formation	Unit	Average Thickness (m)	Max Thickness (m)
1	Alluvium, colluvium	Surface cover	8	46
2	Tertiary sediments	Tertiary and minor Triassic Clematis	26	167
3	Rewan	Triassic	111	662
4	Rangal Coal Measures	Leichhardt overburden	51	390
5		Leichhardt seam	5	6
6		Interburden	39	53
7		Vermont seam	4	4
8		Vermont underburden	26	33
9	Fort Cooper Coal Measures	Fort Cooper overburden	76	186
10		Fort Cooper seams (combined)	74	180
11		Fort Cooper underburden	74	179
12	Moranbah Coal Measures	Moranbah Overburden	51	219
13		Moranbah seams (combined)	49	210
14		Moranbah Underburden	49	209

2.3.1 GEOLOGICAL FAULTS

The Project is located with the highly faulted Jellinbah Fault Zone, in which several easterly dipping thrust faults are present. Major regional faults identified have been included in the model, as well as smaller local faults identified in the site geological model. Most of the local faults occur in the ODS domain, whereas Willunga appears to be more affected by open folding. Mesh refinement (100 m) along the faults has been included in the model build in order to allow the change of hydraulic properties along the fault zones during calibration and sensitivity analysis. The model fault zones are shown in **Figure B2-3**.

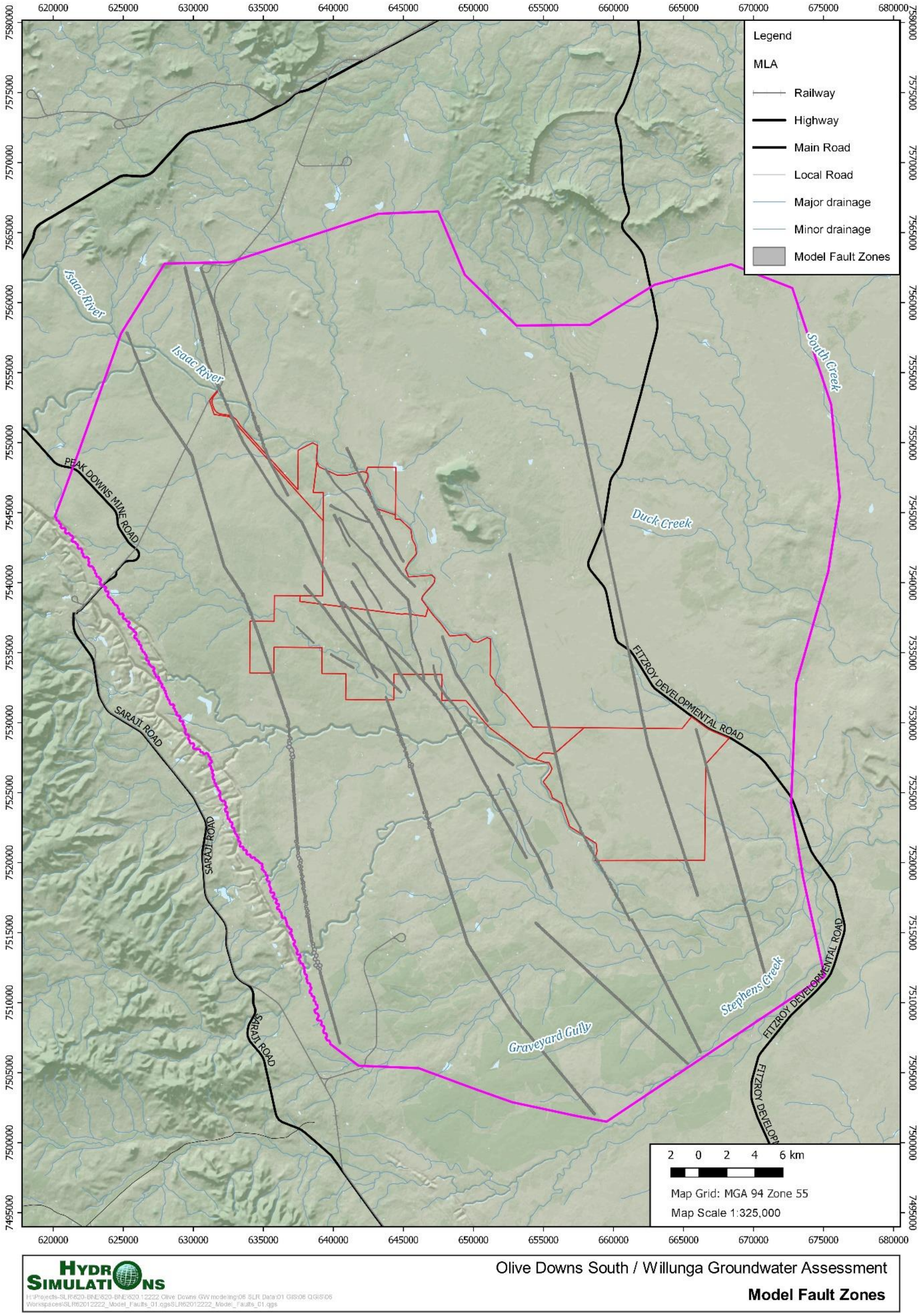


Figure B2-3 Model Fault Zones

2.4 MODEL STRESSES AND BOUNDARY CONDITIONS

2.4.1 REGIONAL GROUNDWATER FLOW

The model perimeter is set as a 'no-flow' boundary by default, except where regional groundwater flow is likely to enter or leave the active model area in which case a general head boundary (GHB) is specified. The GHB boundary condition is used to represent the regional flow into and out of the model area and has been assigned using GHBs in Layers 1, 2, 5, 7, 10 and 13 using pre-mining head elevation. Groundwater will enter the model where the head set in the GHB is higher than the modelled head in the adjacent cell, and leave the model when the water level is lower in the GHB. Conductance is calculated using the modelled hydraulic conductivity of the layer in which the GHB sits divided by the cell area, and is therefore variable in this model due to variable cell-size.

2.4.2 WATERCOURSES

The Isaac River is represented in the model using the Stream Flow Routing (SFR) package. All other watercourses as shown in **Figure B2-4** are represented using the MODFLOW River (RIV) package. The rivers are set with the river bed 2 to 6 m below the surrounding topography to represent the steep-banked incised channels.

Surveyed river stage data was available at several locations along the Isaac River. The closest gauging station to the site, located at Deverill, records average monthly water levels as shown in **Table B2-2**. This data was extrapolated to provide contiguous stage elevations. Similarly a decommissioned gauge located at Phillips Creek at Tayglen was used to provide a seasonal estimate of stage for tributary rivers to the Isaac.

Table B2-2 Average Stage Heights (m) Used to Develop Transient Sequence

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL AVERAGE
Isaac at Deveril	2.24	2.39	1.78	1.30	1.34	0.83	0.93	1.05	0.77	0.89	1.32	1.97	1.40
Phillips at Tayglen	0.52	0.58	0.64	0.50	0.59	0.46	0.47	0.43	0.40	0.22	0.45	0.50	0.48

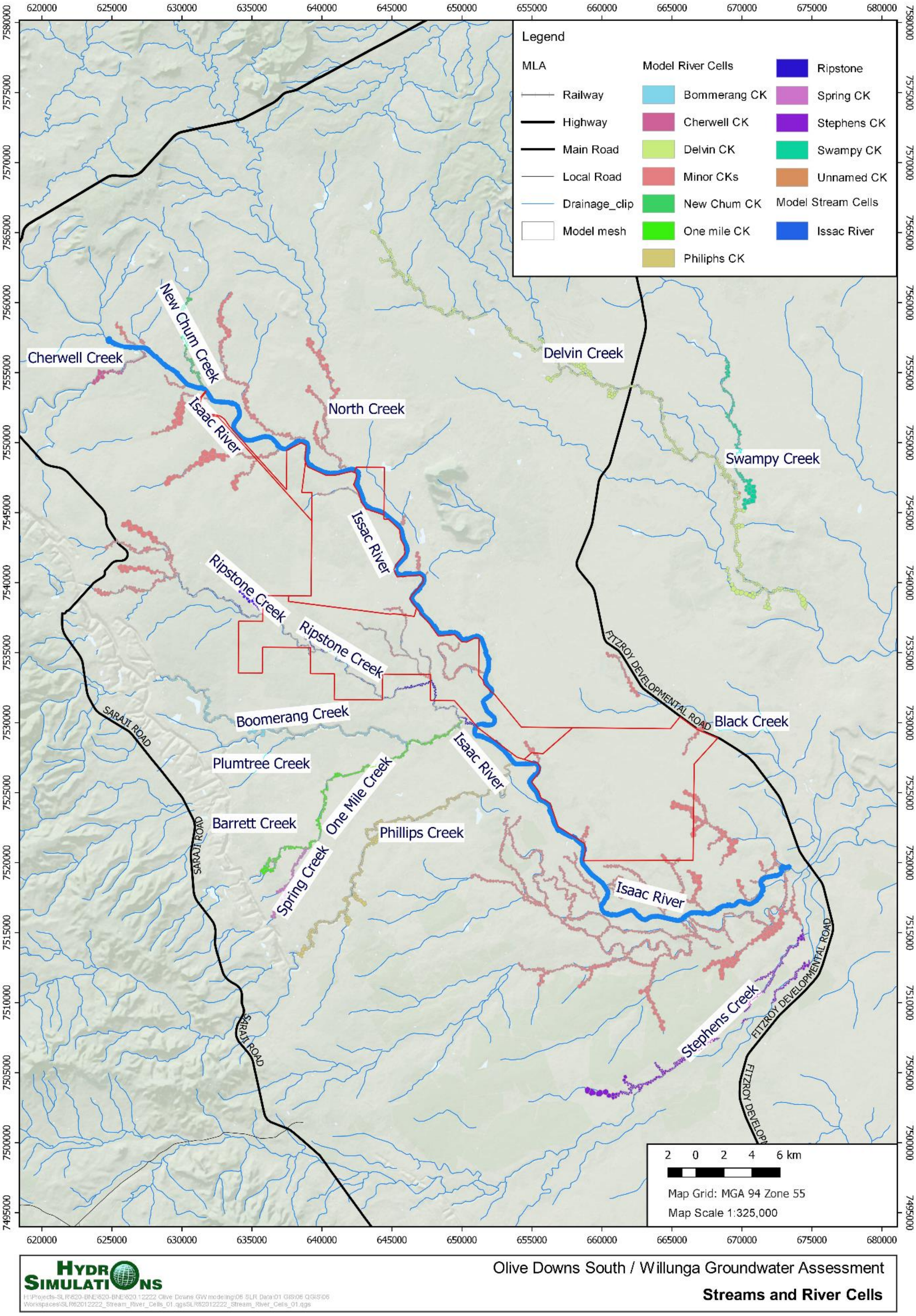


Figure B2-4 Streams and River Cells

2.4.3 RAINFALL RECHARGE

Rainfall recharge was applied to the model using the MODFLOW-USG recharge (RCH) package. The model distributed the recharge in zones across the model domain according to outcropping geology. The model assigned a proportion of annual rainfall to each of these zones. The proportion of rainfall entering the model as recharge varied through the calibration process.

The calibrated recharge rates are discussed in **Section 2.10**.

2.4.4 EVAPOTRANSPIRATION

The MODFLOW Evapotranspiration (EVT) package was used to simulate evapotranspiration from the groundwater system. Extinction depths were set to 2 m below ground across the model domain. Maximum potential rates were set using actual evapotranspiration values (from the Bureau of Meteorology), with the average value (600 mm/yr) used as the transient calibration evapotranspiration rate.

2.4.5 GROUNDWATER USE

Private groundwater pumping bores have not been included in the model due to lack of information regarding abstraction rates. Due to low groundwater abstraction across the model area, it is likely that the bores have very localised drawdowns and will not significantly impact model results.

2.4.6 MINING

The MODFLOW Drain (DRN) package is used to simulate mine dewatering in the model for the Project and the surrounding mines. Drain boundary conditions allow a one-way flow of water out of the model. When the computed head drops below the stage of the drain, the drain cells become inactive. This is an effective way of theoretically representing removal of water seeping into a mine over time, with the actual removal of water being via pumping and evaporation.

The open cut mining at the Project and surrounding mines is simulated in the model as MODFLOW Drain (DRN) cells, with drain cells applied in all layers from surface to the base of the lowest mined seam. The longwall extraction at Eagle Downs and Saraji East is represented as drain cells in model layer 13 only (combined Moranbah Coal Measures) and the fracture zone extended up to layer 8. The drain cells applied for the surrounding mines were interpolated from mine schedule information available from EIS documentation and aerial photography.

Variation in Hydraulic Properties due to mining

For open cut mining, Hawkins (1998) and Mackie (2009) indicate that spoil and waste rock are more permeable than the undisturbed strata. Completed open cut mining areas will be backfilled with waste overburden as the extraction proceeds. Backfill was given uniform hydraulic conductivity of 0.2 m/day, specific yield of 0.05 and rainfall recharge set to 1 % of average rainfall. In the transient calibration and prediction model, backfill properties are applied two years behind the mine face.

The hydraulic properties were varied with time using the TVM package of MODFLOW-USG Beta. For the underground mines, the hydraulic properties were changed with time in the goaf and overlying fractured zone directly above each longwall panel.

2.5 CALIBRATION MODEL SIMULATION PERIOD AND TEMPORAL DISCRETISATION

Both steady-state and transient calibration models have been developed:

- Steady-state model of average pre-2006 conditions.
- Transient model calibration based on temporal pre-mining data at quarterly time intervals from January 2006 to December 2017. **Table B2-3** summarises the calibration model simulation periods and mining.

Table B2-3 Calibration Model Stress-Period Setup

Model Period	Interval	SP	Date from	Date to	ODS/WIL (OC)	ODN (OC)	Peak Downs (OC)	Saraji (OC)	Saraji East (UG)	Lake Vermont (OC)	Eagle Downs (UG)	Poitrel (OC)	Daunia (OC)
Initial		1	Steady-state				x	x		x		x	x
Calibration	Quarterly	2	01/01/2006	02/04/2006			x	x		x		x	x
	Quarterly	3	02/04/2006	02/07/2006			x	x		x		x	x
	Quarterly	4	02/07/2006	01/10/2006			x	x		x		x	x
	Quarterly	5	01/10/2006	31/12/2006			x	x		x		x	x
	Quarterly	6	01/01/2007	02/04/2007			x	x		x		x	x
	Quarterly	7	02/04/2007	02/07/2007			x	x		x		x	x
	Quarterly	8	02/07/2007	01/10/2007			x	x		x		x	x
	Quarterly	9	02/10/2007	01/01/2008			x	x		x		x	x
	Quarterly	10	01/01/2008	01/04/2008			x	x		x		x	x
	Quarterly	11	01/04/2008	01/07/2008			x	x		x		x	x
	Quarterly	12	02/07/2008	01/10/2008			x	x		x		x	x
	Quarterly	13	01/10/2008	31/12/2008			x	x		x		x	x
	Quarterly	14	31/12/2008	01/04/2009			x	x		x		x	x
	Quarterly	15	02/04/2009	02/07/2009			x	x		x		x	x
	Quarterly	16	02/07/2009	01/10/2009			x	x		x		x	x
	Quarterly	17	01/10/2009	31/12/2009			x	x		x		x	x
	Quarterly	18	01/01/2010	02/04/2010			x	x		x		x	x
	Quarterly	19	02/04/2010	02/07/2010			x	x		x		x	x
	Quarterly	20	02/07/2010	01/10/2010			x	x		x		x	x
	Quarterly	21	01/10/2010	31/12/2010			x	x		x		x	x
	Quarterly	22	01/01/2011	02/04/2011			x	x		x		x	x
	Quarterly	23	02/04/2011	02/07/2011			x	x		x		x	x
	Quarterly	24	02/07/2011	01/10/2011			x	x		x		x	x
	Quarterly	25	02/10/2011	01/01/2012			x	x		x		x	x
	Quarterly	26	01/01/2012	01/04/2012			x	x		x		x	x
	Quarterly	27	01/04/2012	01/07/2012			x	x		x		x	x

	Quarterly	28	02/07/2012	01/10/2012			x	x		x		x	x
	Quarterly	29	01/10/2012	31/12/2012			x	x		x		x	x
	Quarterly	30	31/12/2012	01/04/2013			x	x		x		x	x
	Quarterly	31	02/04/2013	02/07/2013			x	x		x		x	x
	Quarterly	32	02/07/2013	01/10/2013			x	x		x		x	x
	Quarterly	33	01/10/2013	31/12/2013			x	x		x		x	x
	Quarterly	34	01/01/2014	02/04/2014			x	x		x		x	x
	Quarterly	35	02/04/2014	02/07/2014			x	x		x		x	x
	Quarterly	36	02/07/2014	01/10/2014			x	x		x		x	x
	Quarterly	37	01/10/2014	31/12/2014			x	x		x		x	x
	Quarterly	38	01/01/2015	02/04/2015			x	x		x		x	x
	Quarterly	39	02/04/2015	02/07/2015			x	x		x		x	x
	Quarterly	40	02/07/2015	01/10/2015			x	x		x		x	x
	Quarterly	41	02/10/2015	01/01/2016			x	x		x		x	x
	Quarterly	42	01/01/2016	01/04/2016			x	x		x		x	x
	Quarterly	43	01/04/2016	01/07/2016			x	x		x		x	x
	Quarterly	44	02/07/2016	01/10/2016			x	x		x		x	x
	Quarterly	45	01/10/2016	31/12/2016			x	x		x		x	x
	Quarterly	46	31/12/2016	01/04/2017			x	x		x		x	x
	Quarterly	47	02/04/2017	02/07/2017			x	x		x		x	x
	Quarterly	48	02/07/2017	01/10/2017			x	x		x		x	x
	Quarterly	49	01/10/2017	31/12/2017			x	x		x		x	x

2.6 STEADY STATE

Steady-state calibration was undertaken using the automated calibration utility PEST (Doherty, 2010) with 118 groundwater targets. Manual parameter adjustment was then undertaken to ensure the calibrated parameters were consistent with the conceptual understanding of the hydrogeological system. Steady-state calibration focused on both hydraulic conductivity and recharge. Vertical hydraulic conductivity was calibrated as a factor of horizontal conductivity (K_V/K_H). Reduced vertical hydraulic conductivity is typically observed due to sedimentary layering throughout the sequence, and by aggregation of strata in a numerical model.

2.6.1 STATISTICS

Figure B2-5 presents the observed and simulated groundwater levels graphically as a scattergram for the steady-state calibration.

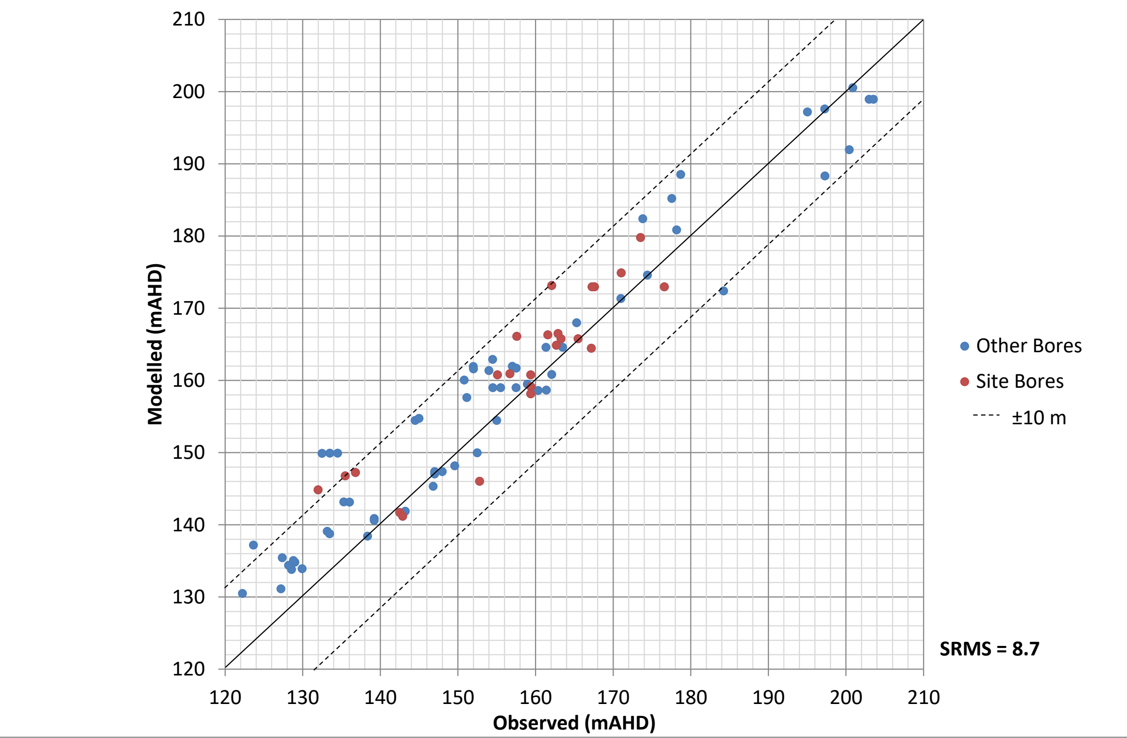


Figure B2-5 Steady-State Calibration – Modelled vs Observed Groundwater Levels

The industry standard method to evaluate the calibration of the model is to examine the statistical parameters associated with the calibration. This is done by assessing the error between the modelled and observed (measured) water levels in terms of the root mean square (RMS). A root mean square (RMS) is expressed as:

$$RMS = \left[1/n \sum (h_o - h_m)_i^{\,2}\right]^{0.5}$$

where: n = number of measurements

h_o = observed water level

h_m = simulated water level

RMS is considered to be the best measure of error, if errors are normally distributed. The RMS error calculated for the calibrated model is 7.1 m.

The acceptable value for the calibration criterion depends on the magnitude of the change in heads over the model domain. If the ratio of the RMS error to the total head change in the system is small, the errors are only a small part of the overall model response. The total measured head change across the model domain is 81.3 m; therefore, the ratio of RMS to the total head loss (SMRS) is 8.7%. This indicates a good calibration and is within the Australian guidelines indicator of 10% Scaled RMS (MDBC, 2001; Barnett *et al*., 2012).

2.6.2 WATER BALANCE

The water balance for the steady-state simulation is presented in **Table B2-4**.

Table B2-4 Steady-State Model Mass Balance

	INFLOW (ML/DAY)	OUTFLOW (ML/DAY)
RECHARGE (RCH)	4.58	0.00
ET (FROM GW) (EVT)	0.00	1.18
SW-GW INTERACTION ISAAC RIVER (STR)	2.09	4.26
SW-GW INTERACTION MINOR RIVERS (RIV)	0.00	0.04
REGIONAL GW FLOW (GHB)	2.23	1.82
MINES (DRN)	0.00	1.39
STORAGE	-	
TOTAL	8.90	8.69
% ERROR		0.02%

2.7 TRANSIENT CALIBRATION

Automated calibration utility PEST and manual calibration were used to match the available transient water level data. In all, 1001 target heads were established for 55 sites. Due to limited data for transient calibration, hydraulic conductivity parameters and recharge calibrated in the steady-state model were held constant for transient calibration, while calibration was refined using only changes to specific storage (Ss) and specific yield (Sy).

The hydraulic heads, strata hydraulic properties and recharge from the steady-state calibration provided the starting values for the transient calibration of the model. To begin each transient model calibration run, a steady-state simulation was undertaken and the storage parameters were then calibrated. The steady-state heads for each calibration scenario were transferred into the transient calibration model as initial groundwater levels. This approach ensured that initial conditions (steady-state groundwater levels) for the transient run were derived from the corresponding parameter set being applied in the transient simulation. Discrepancies between these two parameter sets would disrupt groundwater flow budgets as the transient version of the model settles to pseudo steady-state conditions outside the mining areas throughout the simulation.

2.7.1 STATISTICS

Figure B2-6 presents the observed and simulated groundwater levels graphically as a scattergram for the initial and historical transient calibration (2006 to 2016). Calibration hydrographs, showing the fit between modelled and observed groundwater levels are presented as **Attachment B1**.

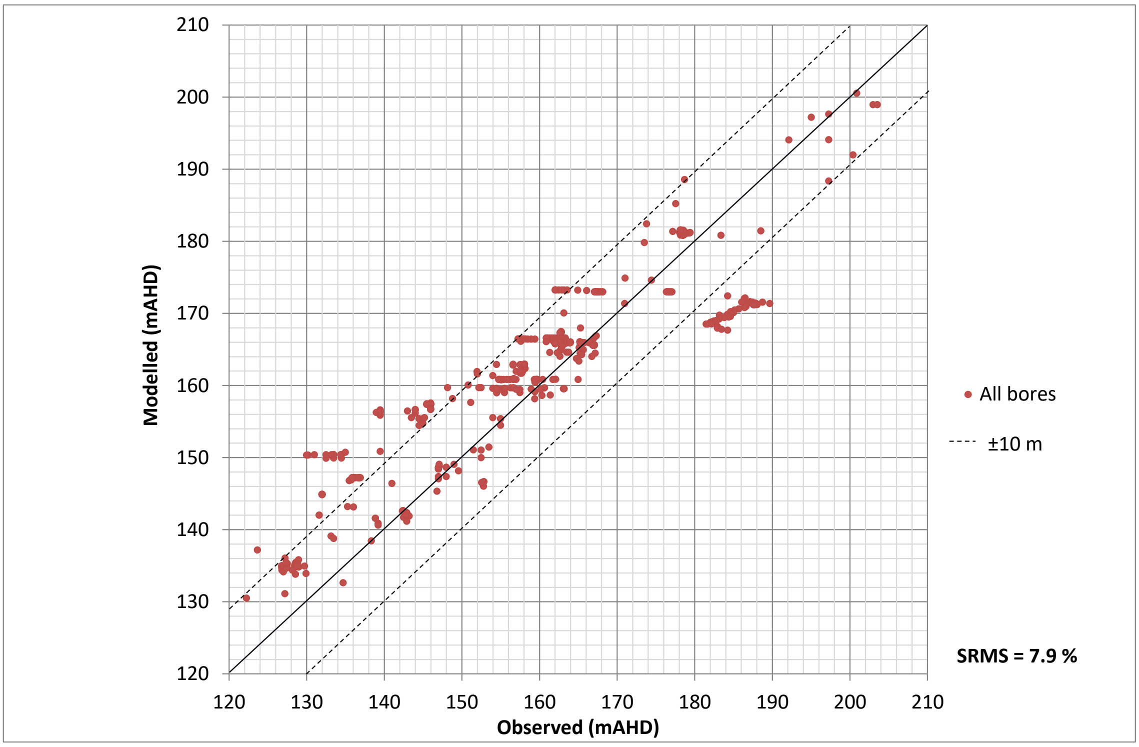


Figure B2-6 Transient Calibration – Modelled vs Observed Groundwater Levels

Resulting calibration statistics for the transient simulation are shown in **Table B2-5** and average residuals in each layer are shown in **Table B2-6**. The model scaled RMS is 7.9 %, again considered a good fit using statistical targets suggested by MDBC (2001) and Barnett *et al.* (2012). The spatial distribution of residuals is shown in **Figure B2-7**. **Attachment B2** shows the average, maximum and minimum residuals for each bore in the transient calibration.

The hydrographs and the residual map show that there was no consistent over or under prediction of groundwater elevation. **Attachment B2** shows that the model generally matches well the water levels in the alluvium bores (including S bores). The hydrographs for bores such as RN13040180 or 13040287 show the model captures the response to weather variation well. At Bore 162470, which is impacted by mining activities at Daunia Mine, the hydrographs show a decline in simulated water levels.

HYDRO SIMULATIONS

Table B2-5 Transient Calibration Statistics

Statistic	Value
Residual Mean (m)	-1.3
RMS Error (m)	6.4
Minimum Residual (m)	-20.3
Maximum Residual (m)	18.3
Scaled RMS Error	7.9
% Targets within ±2m	42.2
% Targets within ±5m	71.5

Table B2-6 Average Residual by Model Layer

Model Layer	Formation	Average Residual (m)	Number of Observation targets
1	Alluvium, colluvium	-0.9	410
2	Regolith	-3.8	300
3	Rewan Group	-4.4	39
4	Rangal Coal Measures	-2.0	4
5		-5.9	41
6		-	0
7		-3.2	24
8		-2.1	2
9	Fort Cooper Coal Measures	6.9	132
10		-7.2	26
11		3.7	10
12	Moranbah Coal Measures	-5.8	8
13		1.4	2
14		-5.9	3

Negative residuals indicate modelled heads too high, positive indicates modelled heads too low.

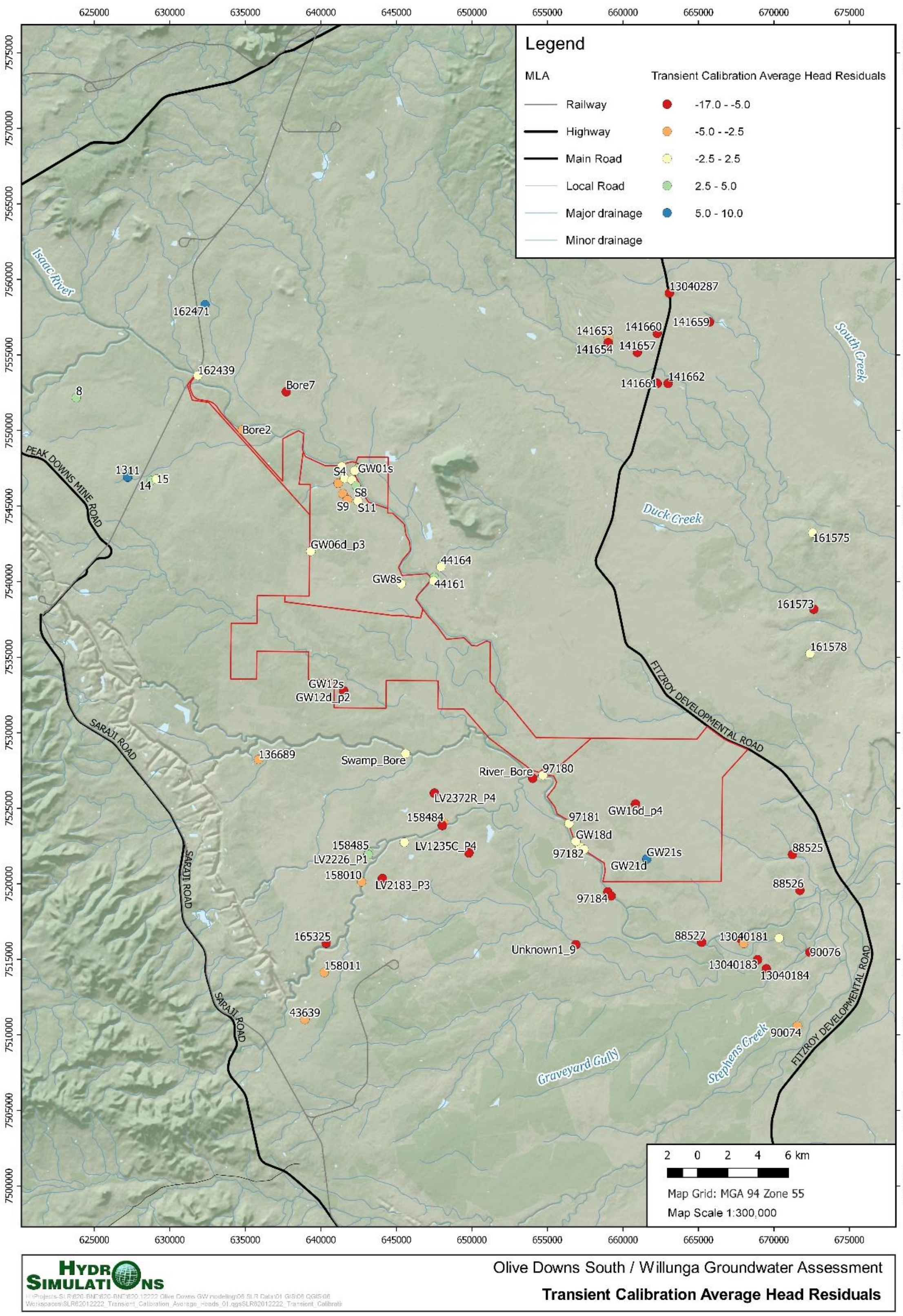


Figure B2-7 Transient Calibration Average Head Residuals (m)

2.7.2 WATER BALANCE

The water balance for the transient simulation is presented in **Table B2-7**. The mass balance error, that is, the difference between calculated model inflows and outflows at the completion of the transient calibration was 0.01%. This value indicates that the model is stable and achieves an accurate numerical solution.

Table B2-7 Transient Model Mass Balance

	INFLOW (ML/DAY)	OUTFLOW (ML/DAY)
RECHARGE (RCH)	6.14	0.00
ET (FROM GW) (EVT)	0.00	1.23
SW-GW INTERACTION ISAAC RIVER (STR)	13.10	11.58
SW-GW INTERACTION MINOR RIVERS (RIV)	0.00	0.04
REGIONAL GW FLOW (GHB)	2.22	2.94
MINES (DRN)	0.00	0.39
STORAGE	6.08	11.32
TOTAL	27.54	27.50
% ERROR		0.01%

The water budget indicates that recharge to the groundwater system within the model averages 6.14 ML/day, with approximately 0.04 ML/day being discharged via surface drainage other than net leakage of 1.52 ML/day from the Isaac River, and 1.23 ML/day lost to evapotranspiration in areas where the water table is within 2 m of the land surface. Surrounding mines capture 0.39 ML/day of groundwater. Over the period of calibration, there was a simulated gain in storage of about 5 ML/day.

2.8 CALIBRATED HYDRAULIC PARAMETERS

Table B2-8 summarises the calibrated values for horizontal and vertical hydraulic conductivity.

Table B2-8 Calibrated Hydraulic Parameters

Model Layer	Formation	Unit	Horizontal Hydraulic Conductivity (m/day)*	Anisotropy Kz/Kx
1	Alluvium	Surface cover	5.0	1.3×10^{-2}
1	Colluvium	Surface cover	9.5×10^{-1}	1.0×10^{-2}
2	Tertiary sediments	Tertiary and minor Triassic Clematis	0.23	1.8×10^{-2}
3	Rewan	Triassic	5×10^{-4}	1.8×10^{-2}
4	Rangal Coal Measures	Leichhardt overburden	1.0×10^{-5} to 2.0×10^{-2}	2.3×10^{-2}
5		Leichhardt seam	1.0×10^{-4} to 1.3×10^{-1}	1.7×10^{-2}
6		Interburden	1.0×10^{-5} to 8.0×10^{-2}	0.6×10^{-2}
7		Vermont seam	1.0×10^{-4} to 1.1	1.5×10^{-2}
8		Vermont underburden	5.0×10^{-5} to 9.0×10^{-2}	0.7×10^{-2}
9	Fort Cooper Coal Measures	Fort Cooper overburden	1.0×10^{-5} to 1.0×10^{-2}	1.3×10^{-2}
10		Fort Cooper seam	1.0×10^{-5} to 1.0×10^{-3}	0.8×10^{-2}
11		Fort Cooper underburden	1.0×10^{-5} to 1.0×10^{-3}	0.6×10^{-2}
12	Moranbah Coal Measures	Moranbah Overburden	1.0×10^{-5} to 1.0×10^{-4}	0.6×10^{-2}
13		Moranbah (Goonyella) seam	1.0×10^{-5} to 1.0×10^{-3}	1.8×10^{-2}
14		Moranbah Underburden	1.0×10^{-5} to 2.0×10^{-4}	0.9×10^{-2}
	Faults		1.0×10^{-5} to 1.0×10^{-1}	0.6×10^{-2} to 1.2×10^{-1}
-	Spoil		2.0×10^{-1}	2.0×10^{-2}

Note: ** upper hydraulic conductivity derived from depth of 20 m below surface and using depth formula*

The hydraulic conductivity of the Permian interburden material in the model reduces with depth in order to reflect field observations. Because the decrease of Kx within the interburden rock units is driven by an increase in overburden pressure, the relationship between Kx and depth is different from that of coal seams. The hydraulic conductivity for the interburden material is capped at a minimum of 1.0×10^{-5} m/day and the hydraulic conductivity of the coal seams is capped at a minimum of 1.0×10^{-4} m/day. The hydraulic conductivity of the interburden/overburden and coal seam layers decreases with depth according to Equations 1 and 2 (exponential):

Coal: $HC = HC_0 \times e(-0.015 \times depth)$ (Eq. 1)

Interburden: $HC = HC_0 \times e(-0.018 \times depth)$ (Eq. 2)

Where: HC is horizontal hydraulic conductivity at specific depth;
HC_0 is horizontal hydraulic conductivity at depth of 0 m (intercept of the curve);
depth is depth of the floor of the layer (thickness of the cover material);
slope is a term representing slope of the formula (steepness of the curve).

HC$_0$ was estimated in the calibration. It varies for the coal seams and for the interburden and overburden units in the model. The slope function and coefficient of the coal and interburden depth dependence equations were calibrated. The Kx vs. depth relationships for the interburden/overburden are presented in **Figure B2-8**, while the calibrated relationships for coal units are presented in **Figure B2-9**. The figure also presents the Coffey (2014) Bowen Basin data trends and the Isaac Plains groundwater calibrated model parameters (Hansen Bailey, 2016).

Figure 2-9 shows lower hydraulic conductivities in Fort Cooper and Moranbah coal measures. It was not possible to represent every individual coal seam in Fort Cooper and Moranbah coal measures in the model. Therefore, a "combined thickness" totalling the individual seam thicknesses for each relevant seam has been simulated.

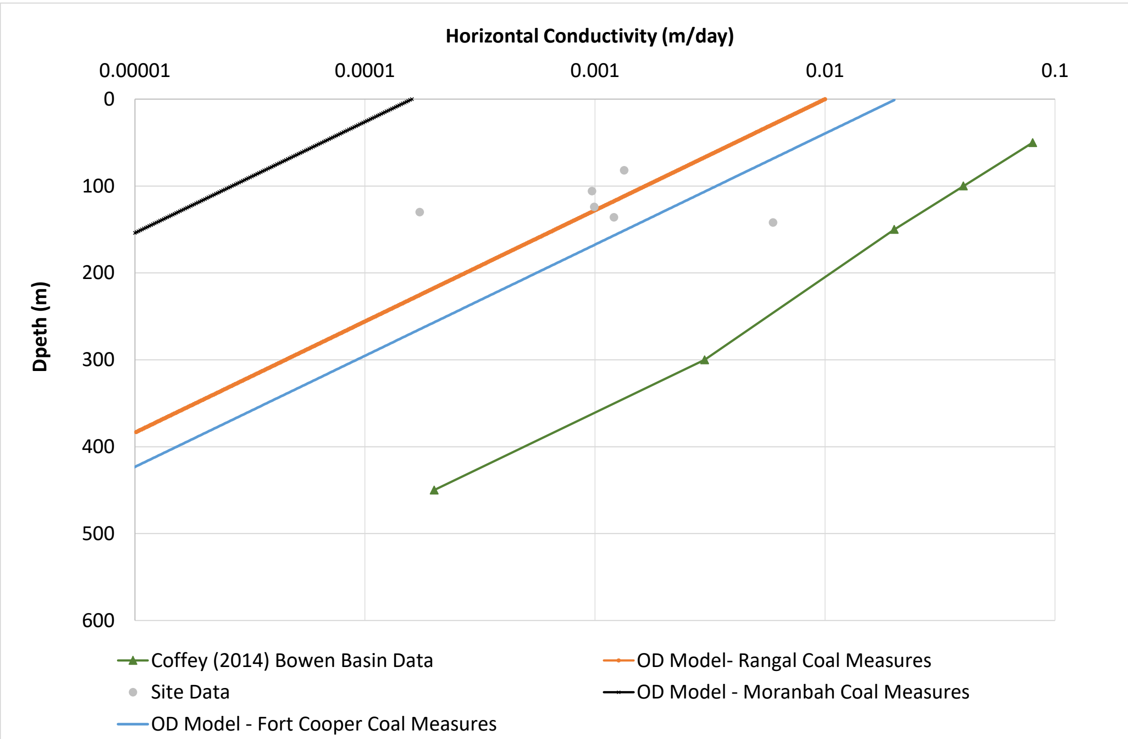


Figure B2-8 Hydraulic Conductivity vs Depth – Interburden/Overburden

Figure B2-10 illustrates the range in horizontal hydraulic conductivity obtained from site testing and publicly available data. The data are focused on the key site units, being the alluvium, regolith, Rewan Group and the coal and interburden sequences of the Rangal Coal Measures (RCM).The data are compared to the horizontal hydraulic conductivity values used in the model. Due to the use o f the depth dependence equation for the RCM in the numerical groundwater model, the average value at the mine site is displayed. As shown in **Figure B2-10**, the modelled horizontal hydraulic conductivity values are all within the range of field data.

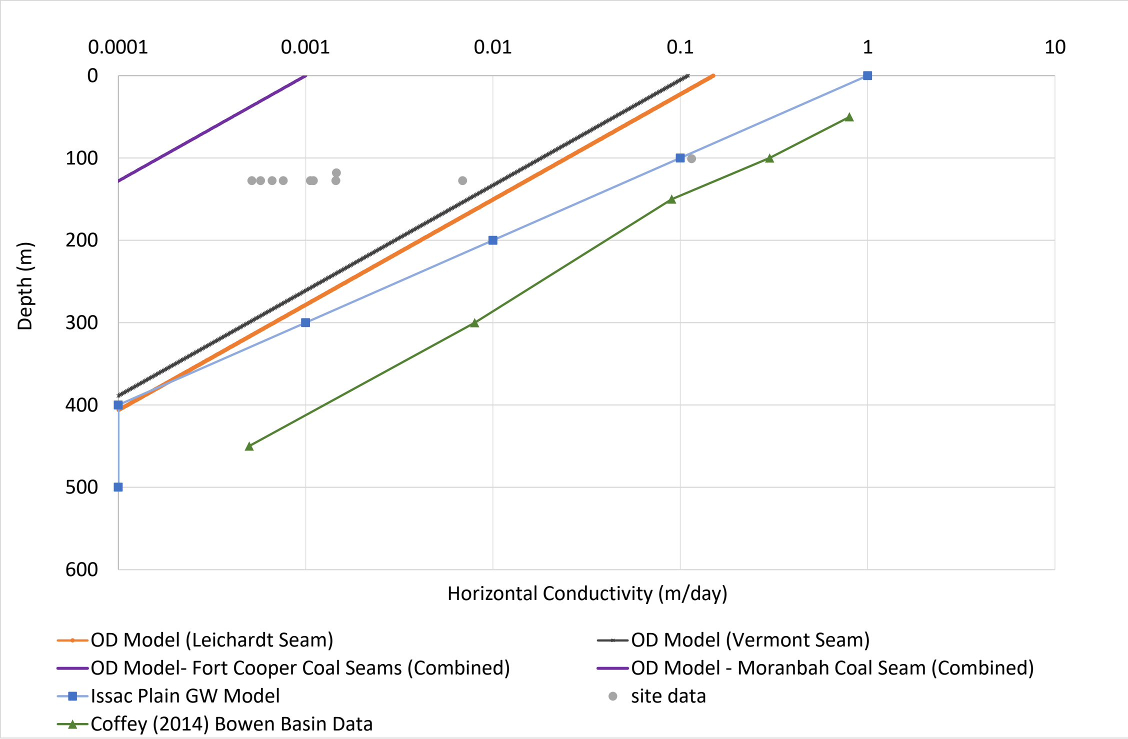


Figure B2-9 Hydraulic Conductivity vs Depth – Coal

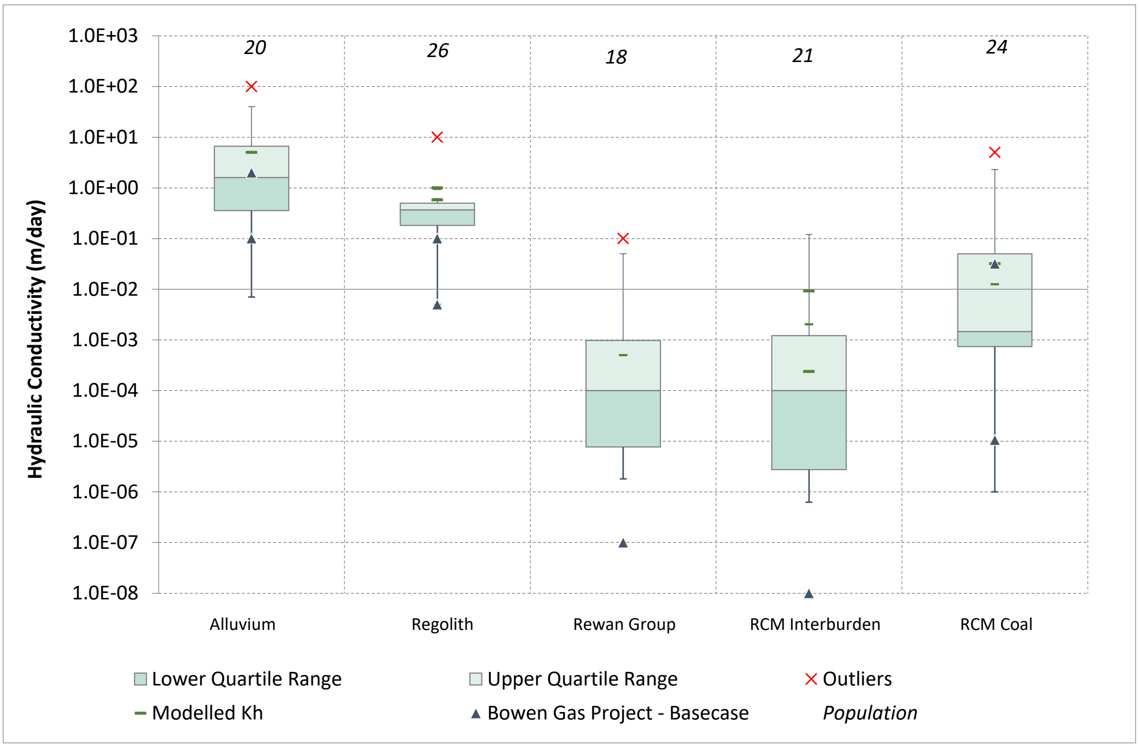


Figure B2-10 Site Hydraulic Parameters Estimates vs Calibrated Hydraulic Parameters

2.9 CALIBRATED STORAGE PROPERTIES

Table B2-9 summarises the calibrated values for specific storage and specific yield.

Table B2-9 Calibrated Storage Parameters

Model layer	Formation	unit	Specific Yield Sy	Specific Storage Ss (m^{-1})
1	Alluvium	Surface cover	5.0%	1.0×10^{-4}
1	Colluvium	Surface cover	0.10%	1.0×10^{-5}
2	Tertiary sediments	Tertiary and minor Triassic Clematis	0.10%	1.0×10^{-5}
3	Rewan	Triassic	0.01%	1.0×10^{-5}
4	Rangal Coal Measures	Leichhardt overburden	0.01%	1.0×10^{-6}
5		Leichhardt Seam	0.10%	5.0×10^{-6}
6		Interburden	0.01%	1.0×10^{-6}
7		Vermont Seam	0.10%	5.0×10^{-6}
8		Vermont underburden	0.01%	1.0×10^{-6}
9	Fort Cooper Coal Measures	Fort Cooper overburden	0.01%	1.0×10^{-6}
10		Fort Cooper seam	0.10%	5.0×10^{-6}
11		Fort Cooper underburden	0.01%	1.0×10^{-6}
12	Moranbah Coal Measures	Moranbah overburden	0.01%	1.0×10^{-6}
13		Moranbah (Goonyella) Seam	0.10%	5.0×10^{-6}
14		Moranbah underburden	0.01%	1.0×10^{-6}
	Fault		0.10%	1.0×10^{-3}
	Spoil		5.0%	1.0×10^{-5}

2.10 CALIBRATED RECHARGE

Table B2-10 presents the calibrated (Base Case) recharge rates to each geological unit in the model, compared to the Bowen Gas Project (BGP) recharge rate range.

The predictive model adopted the Olive Downs (OD) Base Case recharge rates from **Table B2-10**.

Figure B2-11 illustrates the range in recharge values for the model domain, as a percentage of annual rainfall. The recharge rates were calculated using the chloride mass balance (CMB) method for the various units. The CMB calculations were based on available water quality results (chloride concentrations) collected from site monitoring bores and landholder bores. The CMB calculation assumed average annual rainfall of 620 mm as modelled. The calculations also assumed a mean annual rainfall chloride flux of 3 mg/L. No site data is available for the low permeability Rewan Group. Outliers were excluded from the calculations, and were identified as readings more than four standard deviations above the mean (U.S. EPA 2009).

Table B2-10 Rainfall Recharge Ranges

Surface Geology	BGP Low		OD Base Case		BGP High	
	(mm/yr)	% rain	(mm/yr)	% rain	(mm/yr)	% rain
Stream Channel	3	0.48	2.8	0.45	27	4.35
Flood Plain Alluvium	2	0.32	5.1	0.82	18	2.90
Other Alluvium	1	0.16	3.1	0.49	9	1.45
Tertiary sediments	0.3	0.05	0.15	0.02	3	0.48
Rewan	0	0.00	0.01	<0.01	0	0.00
Outcropping Coal Measures	0.33	0.05	0.06	0.01	3	0.48

BGP – Arrow Energy Bowen Gas Project

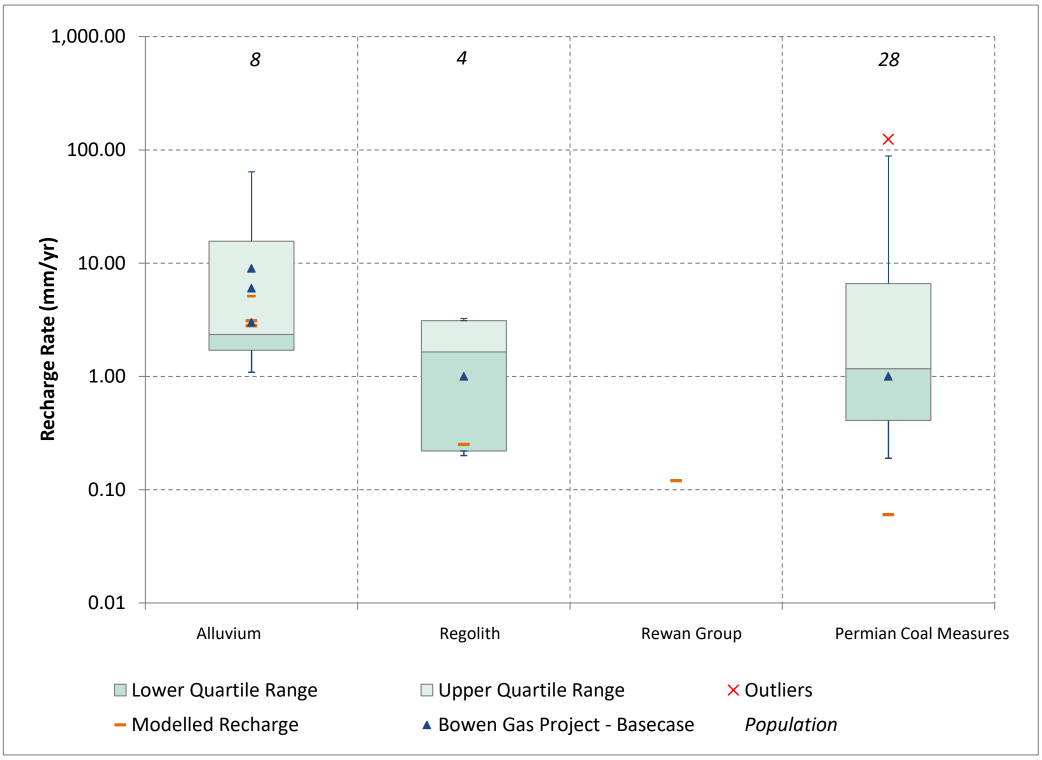


Figure B2-11 Site Recharge Estimates vs Modelled Recharge

This is consistent with the recharge applied in the Bowen Gas Project modelling and has been used as a guide to applicable recharge ranges for each outcropping geological unit. As per the conceptual model, higher recharge occurs through the alluvium and lower recharge in regolith and Permian outcrops. Increased recharge through the alluvium of the Isaac river channel has been used to simulate the potential for the Isaac River to provide rapid recharge to the alluvial groundwater system during rainfall events. For comparison, other nearby projects have used modelled recharge as a default value across the domain, with Lake Vermont simulating recharge equivalent of 2% mean annual rainfall, and Isaac Plains simulating 0.5% to alluvium and 0.25% elsewhere. These values indicate overall rainfall recharge to the groundwater system is limited.

2.11 MODEL CONFIDENCE LEVEL CLASSIFICATION

Under the earlier MDBC (2001) modelling guideline, the model is best categorised as an Impact Assessment Model of medium complexity. That earlier guide (MDBC, 2001) describes this model type as follows:

> *"Impact Assessment model - a moderate complexity model, requiring more data and a better understanding of the groundwater system dynamics, and suitable for predicting the impacts of proposed developments or management policies."*

Barnett *et al.* (2012) developed a system within the modelling guidelines to classify the confidence level for groundwater models. Models are classified as Class 1, Class 2 or Class 3 in order of increasing confidence based on key indicators such as available data, calibration procedures, consistency between calibration and predictive analysis and level of stresses.

Table B2-11 presents a summary of the ODS model compared to the Barnett *et al.* (2012) model classifications. Overall, the model dominantly meets Class 2 requirements, with 1 element of Class 1 and some elements of Class 3.

Table B2-11 Groundwater Models Classification Table

CLASS	DATA	CALIBRATION	PREDICTION	INDICATORS	TOTAL
1	Not much. Spares. **Not metered usage.** Remote climate data.	Not Possible. Large error statistics. Inadequate data spread. Targets incompatible with model purpose.	Timeframe>>calibration. Long stress periods. Transient prediction but steady state calibration. Bad verification.	Timeframe>10x. Stresses>5x. Mass balance>1% (or single 5%). Properties<>Field Bad discretisation No review.	
COUNT	1	0	0	0	1
2	**Some.** **Poor coverage.** Some usage info. **Baseflow estimates.**	**Partial performance.** Long-term trends wrong. **Short time record.** **Weak seasonal replication.** No use of targets compatible with model purpose.	**Timeframe>calibration.** **Long stress periods.** New stresses not in calibration. Poor verification.	**Timeframe=3-10x.** **Stresses=2-5x.** **Mass balance<1%.** **Properties<>Field measurements.** **Some key coarse discretisation.** Reviewed by hydrogeo	.
COUNT	**3**	**3**	**2**	**5**	**13**
3	Lots. Good aquifer geometry. Good usage info. Local climate info. **K measurements** **Hi –res DEM.**	Good performance stats. Long-term trends replicated. Seasonal fluctuations OK. **Present day data targets.** Head and flux targets.	Timeframe~calibration. Similar stress periods. Similar stresses to those in calibration. Steady state prediction consistent with steady state calibration. Good verification.	Timeframe<3x. Stresses<2x. **Mass balance<0.5%** Properties~Field measurements. Some key coarse discretisation. **Reviewed by modeller.**	
COUNT	2	1	0	2	5

3 PREDICTIVE MODELLING

3.1 TIMING AND MINING

Transient predictive modelling simulating both the proposed mining at the Project and surrounding mines has been undertaken. The predictive transient model ran for 78 years from 1/11/2017 to 31/12/2095. The model simulates mining cells which progress monthly, annually or five yearly, dependent on the stress period duration (see **Table B3-1**).

The model represented mining using the drain (DRN) package. During the predictive run, drain cells were used to simulate the effect of the proposed mine and other mines in the area. A nominally high drain conductance of 100 m^2/day was applied to the drain cells and the elevation of the base of the modelled layer was used as the drain invert level.

For the Project, the mine area was pre-stripped a year in advance of mining, with the pre-strip extended down to the bottom of layer 3. During the predicted mine year, the drain cells were extended to the base of the target coal seam. For the Project, this was down to the base of layer 7. It was assumed that the mining will have a two year operational window, and when an area has reached this, the drains undertaking the dewatering are removed and spoil parameters are assigned to these model cells. Details on the timing of mining in the predictive model are presented in **Table B3-1**.

Table B3-1 Predictive Model Stress-Period Setup and Mining

Model Period	Interval	SP	Date from	Date to	ODS/WIL (OC)	ODN (OC)	Peak Downs (OC)	Saraji (OC)	Saraji East (UG)	Lake Vermont (OC)	Eagle Downs (UG)	Poitrel (OC)	Daunia (OC)
Prediction	monthly	50	1/11/2017	30/11/2017			x	x		x	x	x	x
	monthly	51	1/12/2017	31/12/2017			x	x		x	x	x	x
	monthly	52	1/1/2018	30/01/2018			x	x		x	x	x	x
	monthly	53	30/01/2018	01/03/2018			x	x		x	x	x	x
	monthly	54	01/03/2018	01/04/2018			x	x		x	x	x	x
	monthly	55	01/04/2018	01/05/2018			x	x		x	x	x	x
	monthly	56	01/05/2018	01/06/2018			x	x		x	x	x	x
	monthly	57	01/06/2018	01/07/2018			x	x		x	x	x	x
	monthly	58	01/07/2018	31/07/2018			x	x		x	x	x	x
	monthly	59	31/07/2018	31/08/2018			x	x		x	x	x	x
	monthly	60	31/08/2018	30/09/2018			x	x		x	x	x	x
	monthly	61	30/09/2018	31/10/2018			x	x		x	x	x	x
	monthly	62	31/10/2018	30/11/2018			x	x		x	x	x	x
	monthly	63	30/11/2018	31/12/2018		x	x	x		x	x	x	x
	monthly	64	31/12/2018	30/01/2019		x	x	x		x	x	x	x
	monthly	65	30/01/2019	02/03/2019		x	x	x		x	x	x	x
	monthly	66	02/03/2019	01/04/2019		x	x	x		x	x	x	x
	monthly	67	01/04/2019	01/05/2019		x	x	x		x	x	x	x

	monthly	68	01/05/2019	01/06/2019		x	x	x		x	x	x	x
	monthly	69	01/06/2019	01/07/2019		x	x	x		x	x	x	x
	monthly	70	01/07/2019	01/08/2019		x	x	x		x	x	x	x
	monthly	71	01/08/2019	31/08/2019		x	x	x		x	x	x	x
	monthly	72	31/08/2019	01/10/2019		x	x	x		x	x	x	x
	monthly	73	01/10/2019	31/10/2019		x	x	x		x	x	x	x
	monthly	74	31/10/2019	30/11/2019		x	x	x		x	x	x	x
	monthly	75	30/11/2019	31/12/2019		x	x	x		x	x	x	x
	monthly	76	31/12/2019	30/01/2020		x	x	x		x	x	x	x
	monthly	77	30/01/2020	01/03/2020		x	x	x		x	x	x	x
	monthly	78	01/03/2020	31/03/2020		x	x	x		x	x	x	x
	monthly	79	31/03/2020	01/05/2020		x	x	x		x	x	x	x
	monthly	80	01/05/2020	31/05/2020	Pit 1 and 2	x	x	x		x	x	x	x
	monthly	81	31/05/2020	01/07/2020	x	x	x	x		x	x	x	x
	monthly	82	01/07/2020	31/07/2020	x	x	x	x		x	x	x	x
	monthly	83	31/07/2020	30/08/2020	x	x	x	x		x	x	x	x
	monthly	84	30/08/2020	30/09/2020	x	x	x	x		x	x	x	x
	monthly	85	30/09/2020	30/10/2020	x	x	x	x		x	x	x	x
	monthly	86	30/10/2020	30/11/2020	x	x	x	x		x	x	x	x
	annual	87	30/11/2020	30/12/2020	x	x	x	x		x	x	x	x
	annual	88	30/12/2020	30/12/2021	x	x	x	x		x	x	x	x
	annual	89	30/12/2021	31/12/2022	x	x	x	x		x	x	x	x
	annual	90	31/12/2022	31/12/2023	x	x	x	x	x	x	x	x	x
	annual	91	31/12/2023	30/12/2024	x	x	x	x	x	x	x	x	x
	annual	92	30/12/2024	30/12/2025	x	x	x	x	x	x	x	x	x
	annual	93	30/12/2025	31/12/2026	x	x	x	x	x	x	x		x
	annual	94	31/12/2026	31/12/2027	Pit 3	x	x	x	x	x	x		x
	annual	95	31/12/2027	30/12/2028	x	x	x	x	x	x	x		x
	annual	96	30/12/2028	30/12/2029		x	x	x	x	x	x		x
	annual	97	30/12/2029	31/12/2030	x	x	x	x	x	x	x		x
	annual	98	31/12/2030	31/12/2031	x		x	x	x	x	x		x
	annual	99	31/12/2031	30/12/2032	x Willunga and ODS Pits 4,6 and 9		x	x	x	x	x		x
	annual	100	30/12/2032	30/12/2033	x		x	x	x	x	x		x
	annual	101	30/12/2033	31/12/2034	x		x	x	x	x	x		x
	annual	102	31/12/2034	31/12/2035	x		x	x	x	x	x		x
	annual	103	31/12/2035	30/12/2036	Pit 5		x	x	x	x	x		x
	annual	104	30/12/2036	30/12/2037	x		x	x	x	x	x		x
	annual	105	30/12/2037	31/12/2038	x		x	x	x	x	x		x
	annual	106	31/12/2038	31/12/2039	x		x	x	x	x	x		x
	annual	107	31/12/2039	30/12/2040	x		x	x	x	x	x		x
	annual	108	30/12/2040	30/12/2041	x		x	x	x	x	x		x
	annual	109	30/12/2041	31/12/2042	x		x	x	x	x	x		x

	annual	110	31/12/2042	31/12/2043	x		x	x	x	x	x		x
	annual	111	31/12/2043	30/12/2044	x		x	x	x	x	x		x
	annual	112	30/12/2044	30/12/2045	x		x	x	x	x	x		x
	annual	113	30/12/2045	31/12/2046	x		x	x	x	x	x		x
	annual	114	31/12/2046	31/12/2047	x		x	x	x	x	x		x
	annual	115	31/12/2047	30/12/2048	x		x	x	x	x	x		x
	annual	116	30/12/2048	30/12/2049	x		x	x	x	x	x		x
	annual	117	30/12/2049	31/12/2050	x		x	x	x	x	x		x
	annual	118	31/12/2050	31/12/2051	x		x	x	x	x	x		x
	annual	119	31/12/2051	30/12/2052			x	x	x	x	x		x
	annual	120	30/12/2052	30/12/2053	Pit 8		x	x		x	x		x
	annual	121	30/12/2053	31/12/2054	x		x	x		x	x		x
	5 year	122	31/12/2054	31/12/2055	x		x				x		
	5 year	123	31/12/2055	30/12/2060	Pit 7		x				x		
	5 year	124	30/12/2060	30/12/2065	x		x						
	5 year	125	30/12/2065	31/12/2070	x		x						
	5 year	126	31/12/2070	31/12/2075	x								
	5 year	127	31/12/2075	30/12/2080	x								
	5 year	128	30/12/2080	30/12/2085	x								
	5 year	129	30/12/2085	31/12/2090	x								
	5 year	130	31/12/2090	31/12/2095	x								
Recovery	200 year	131	1/1/2096	01/01/2295									

The approximate model timing for the Project is presented in **Figure B3-1** for the ODS domain, and **Figure B3-2** for the Willunga domain. The BGP was modelled to capture cumulative groundwater impacts by applying drain cells to zones around the proposed gas production wells. It was assumed each proposed well has a 15 year production life. These locations were based on the mapped extent of wells within the Ausenco-Norwest (2012) report for the Arrow Energy Bowen Gas Project EIS. The locations of these drain zones are presented in **Figure B3-3.**

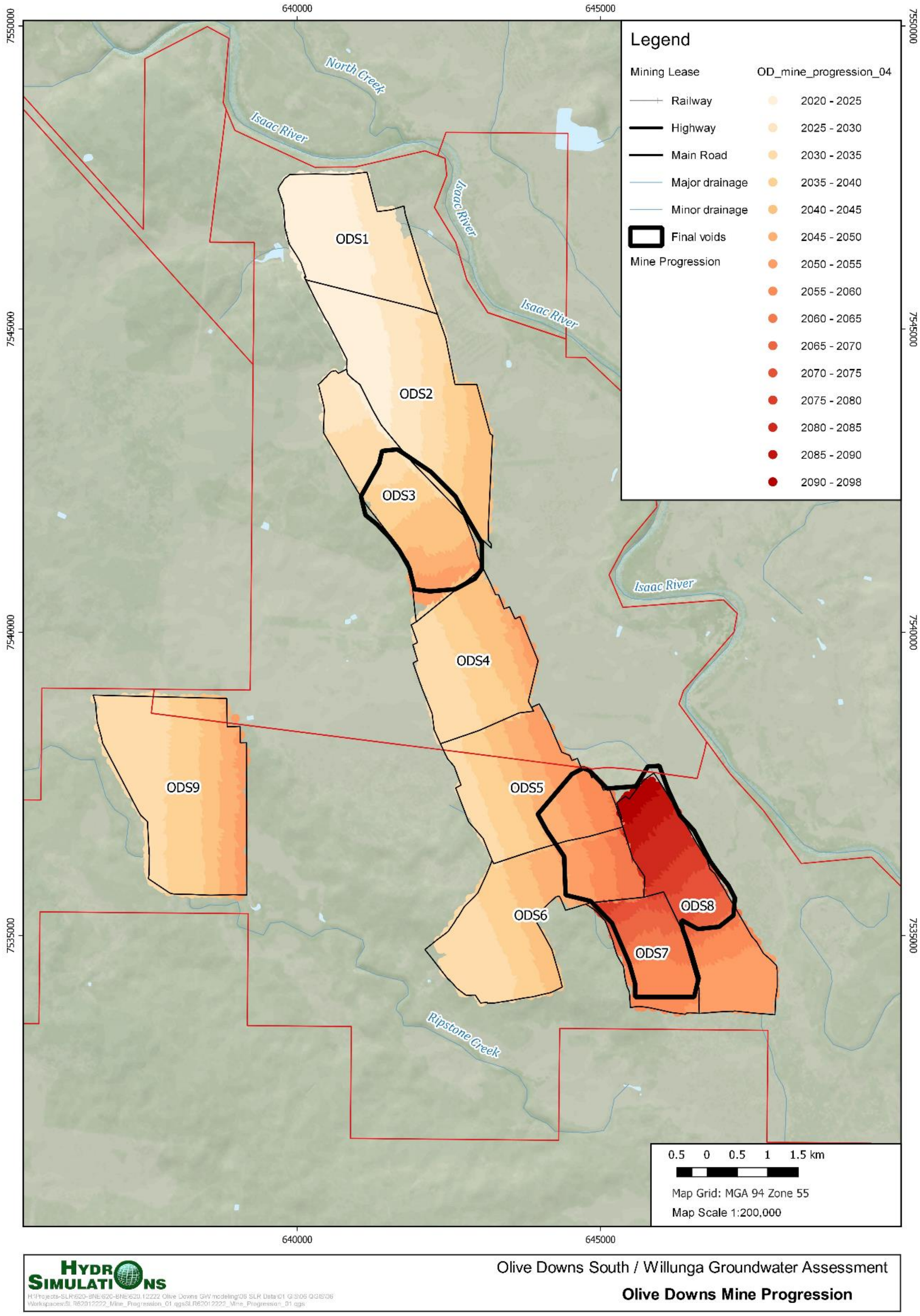


Figure B3-1 Olive Downs South Domain Mine Progression

HYDROSIMULATIONS

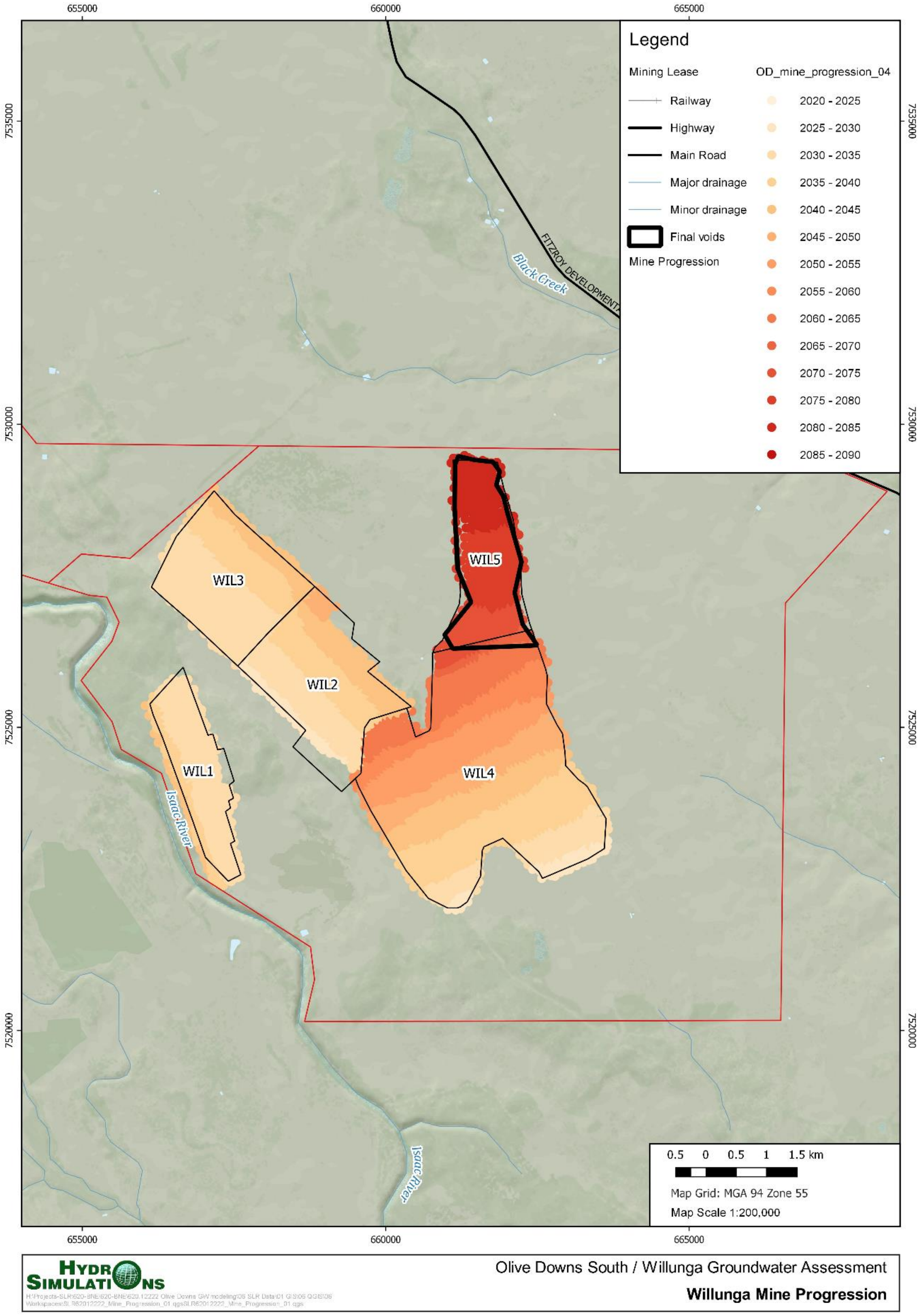


Figure B3-2 Willunga Domain Mine Progression

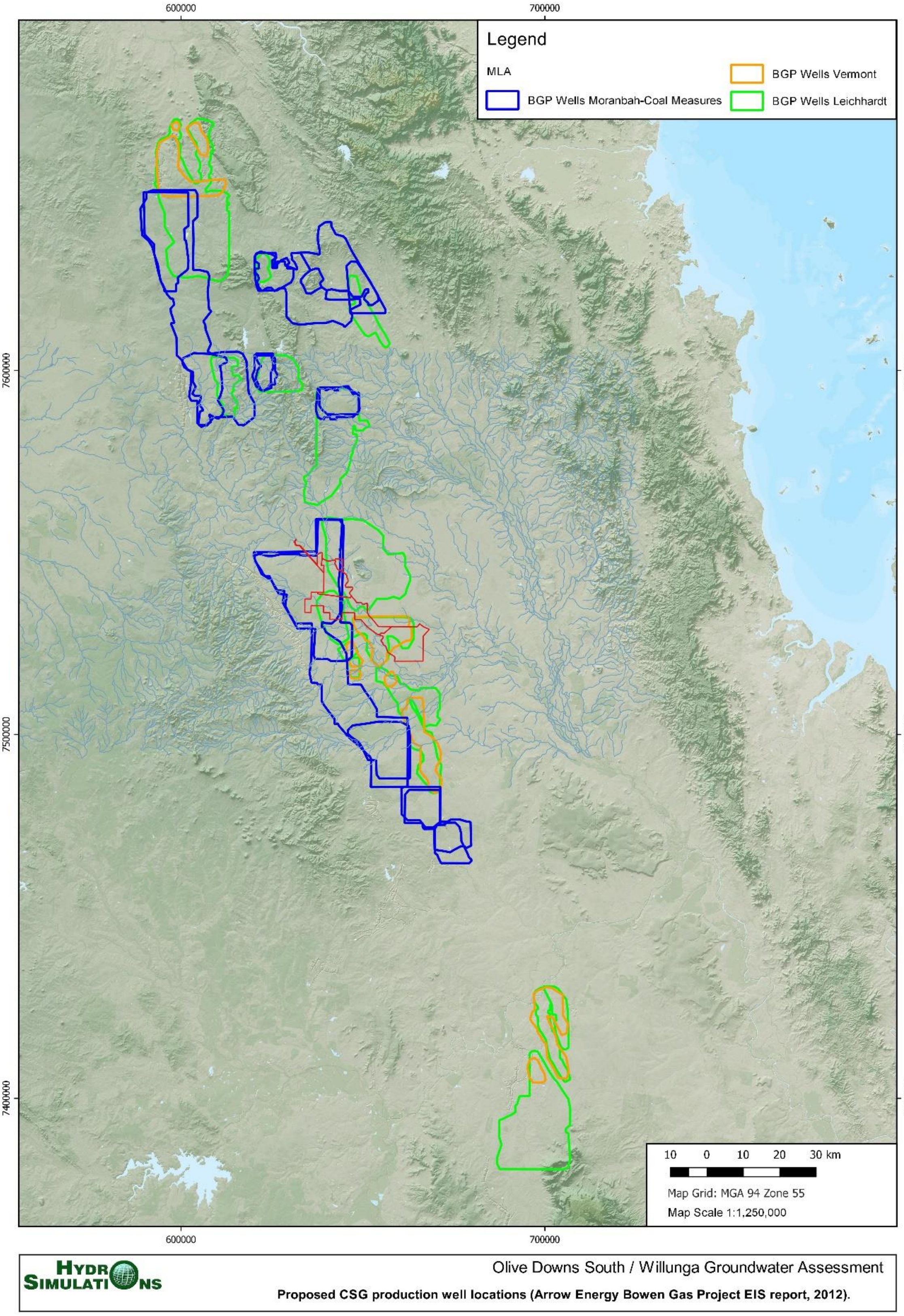


Figure B3-3 Proposed CSG Production Well Locations (Ausenco-Norwest, 2012).

3.2 WATER BALANCE

Table B3-2 shows the average rates of water transfer into and out of the model over the period of the predictive model (January 2018 to December 2095) for two scenarios:

- Scenario A (Approved Mine Plan) which includes the surrounding mines; and
- Scenario B (Cumulative) which includes the surrounding mines, Olive Downs South and Willunga.

Table B3-2 shows the Approved mining scenario rainfall recharge to the groundwater system is 6.27 ML/day, with a larger volume of 14.46 ML/day entering the model through the streams. Evapotranspiration for the predictive model is at 1.19 ML/day where the water table is within 2 m of the land surface. 14.63 ML/day of water leaves the model through stream baseflow and 0.06 ML/day through the minor drainages.

For the Cumulative scenario, the rainfall recharge is 6.53 ML/day while the streams are contributing a 14.64 ML/day to the groundwater system. For this scenario stream baseflow and evapotranspiration are removing 13.15 ML/day and 1.18 ML/day from the groundwater system, respectively. It is noted that the outflow from the stream package (Isaac River) is, on average, lower with the Project (by 10%).

As other mines are unchanged for the two scenarios, the difference is the incremental effect of the Project. The average mine inflow for Scenario B is 1.62 ML/day which is 1.15 ML/day higher that 0.47 ML/day simulated in Scenario A. Detailed discussion of predicted inflows is provided in the main report.

The mass balance discrepancy for both predictive models was less than 0.01% indicating that the model achieved an accurate numerical solution.

Table B3-2 Average Simulated Water Balance at the End of Project

COMPONENT	SCENARIO A APPROVED MINING		SCENARIO B CUMULATIVE	
	Inflow (ML/d)	Outflow (ML/d)	Inflow (ML/d)	Outflow (ML/d)
Drains (Mine inflow)	/	0.47	/	1.62
Recharge (direct rainfall)	6.27	/	6.53	/
Evapotranspiration (ET)	/	1.19	/	1.18
SW/GW Interaction Isaac River (STR)	14.46	14.63	14.64	13.15
SW/GW Interaction Minor Rivers (RIV)	0.00	0.06	0.00	0.05
Regional GW flow (GHB)	2.84	3.14	2.85	3.14
Storage	2.24	6.33	3.36	8.25
Total	25.81	25.82	27.39	27.39
Mass Balance	0.01%		0.00%	

3.3 PREDICTED GROUNDWATER LEVELS

Predicted groundwater levels at the end of mining operations for the two scenarios are shown in **Figure B3-4** to **Figure B3-7**.

Figure B3-4 and **Figure B3-6** show predicted groundwater levels in the unconsolidated lithologies at the end of mining for the two scenarios (Approved Mine Plan and Cumulative). The figures show groundwater levels for the unconsolidated strata remain relatively unchanged with only localised changes in groundwater levels around the open cut mine areas. **Figure B3-6** shows that due to mining at Olive Downs South and Willunga, the extent of the unsaturated zone in Layer 1 and Layer 2 has increased. The gaps in the simulated water levels in **Figure B3-4** and **Figure B3-6** indicate where the water level is below the base of cell and the layer is dry.

Figure B3-5 and **Figure B3-7** show the predicted water levels at the base of the Rangal coal measures (Layer 9) at the end of mining for the Approved Mine Plan and Cumulative scenarios. This Permian coal measure unit is presented due to its regional extent. The water levels in the Permian coal measures follow the downstream flow gradient of the Isaac River, and maintain southeasterly hydraulic gradients. However, due to mining at surrounding operations and the Project site, a zone of depressurisation has developed around the open pits. Further discussion on groundwater drawdown within the Permian coal measures is included within the main report.

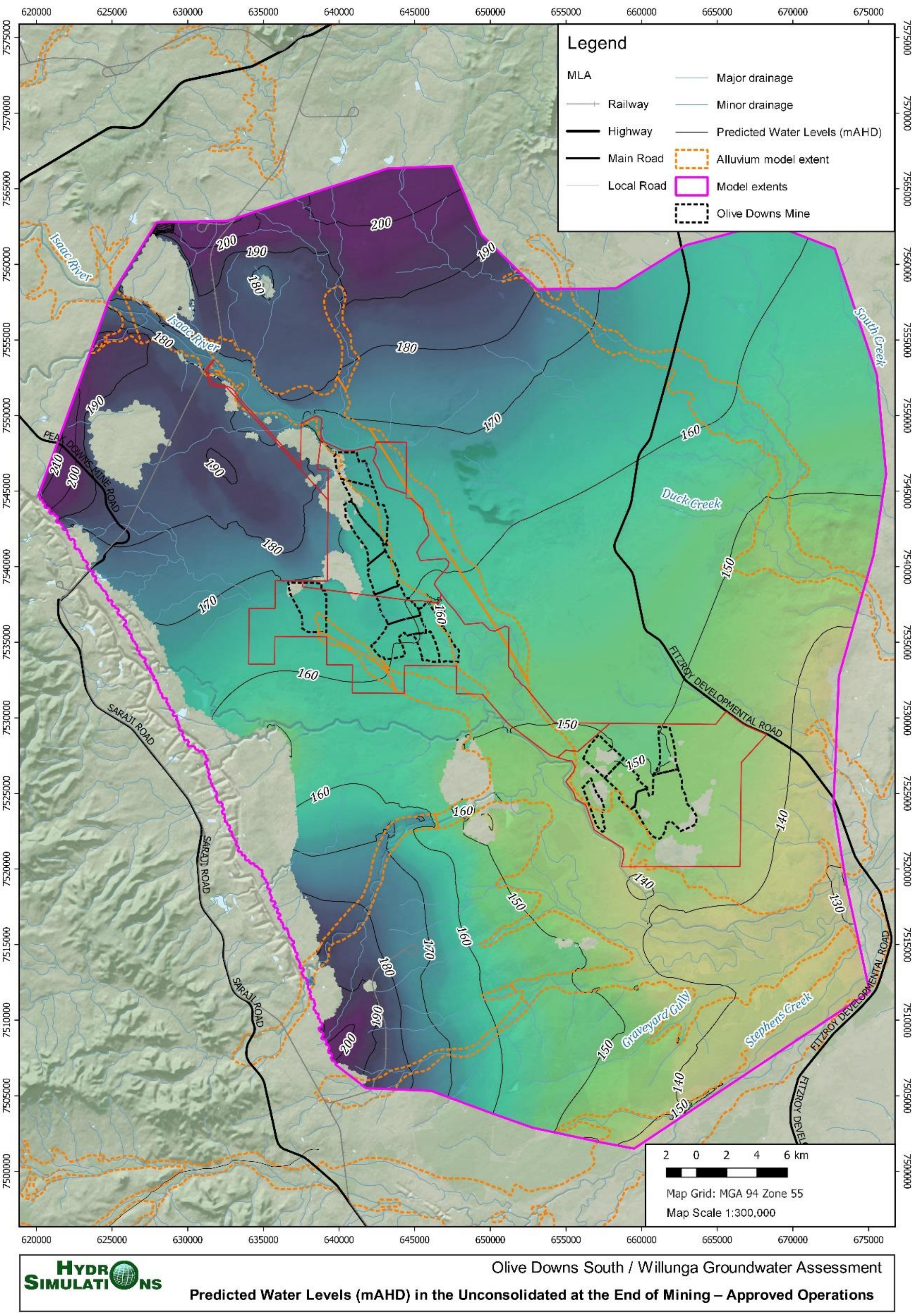


Figure B3-4 Predicted Water Level within Unconsolidated (Layer 1 and Layer 2) at End of Mining – Approved Operations Only

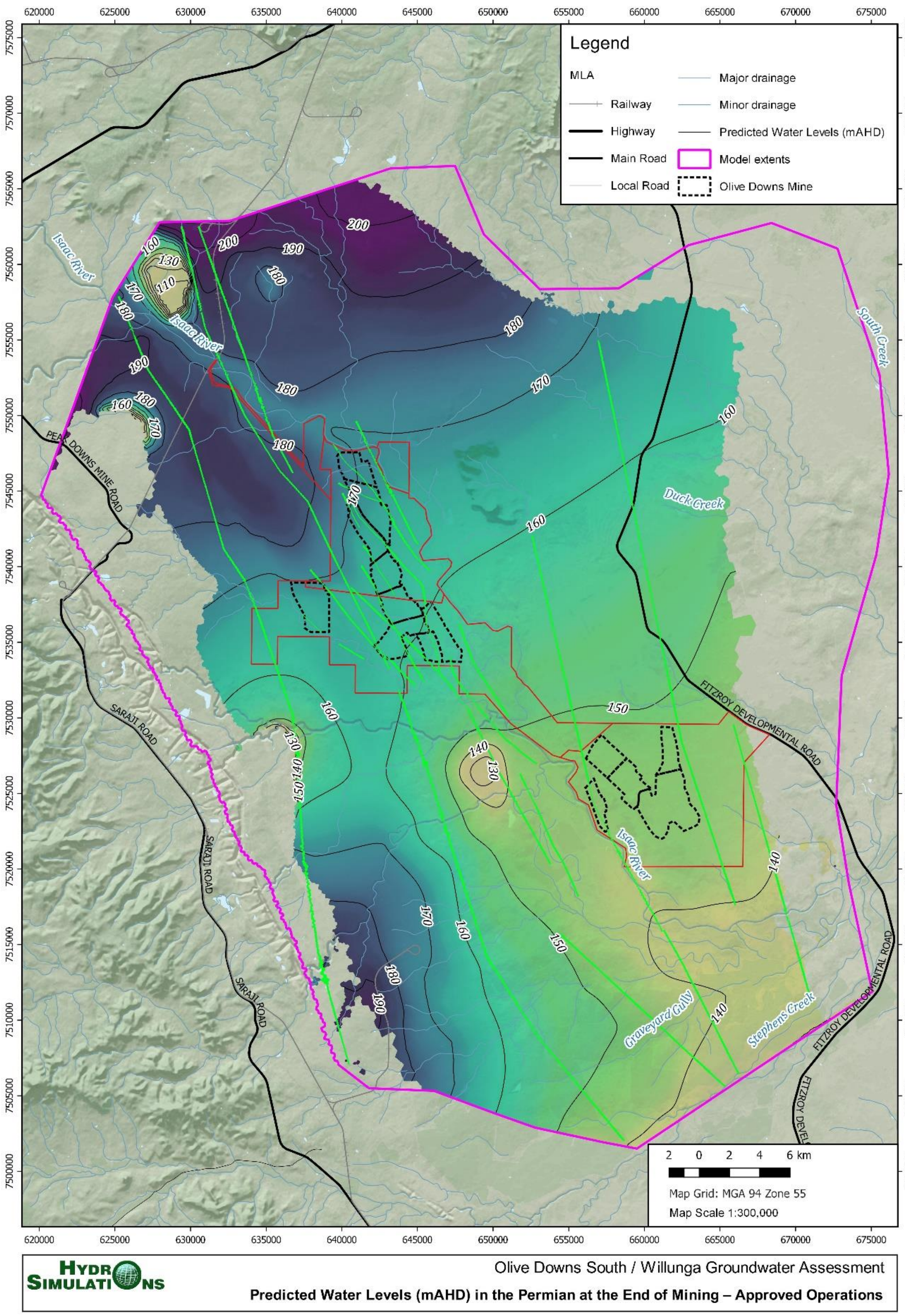


Figure B3-5 Predicted Water Level within Permian Coal Measures (Layer 9) at End of Mining – Approved Operations Only

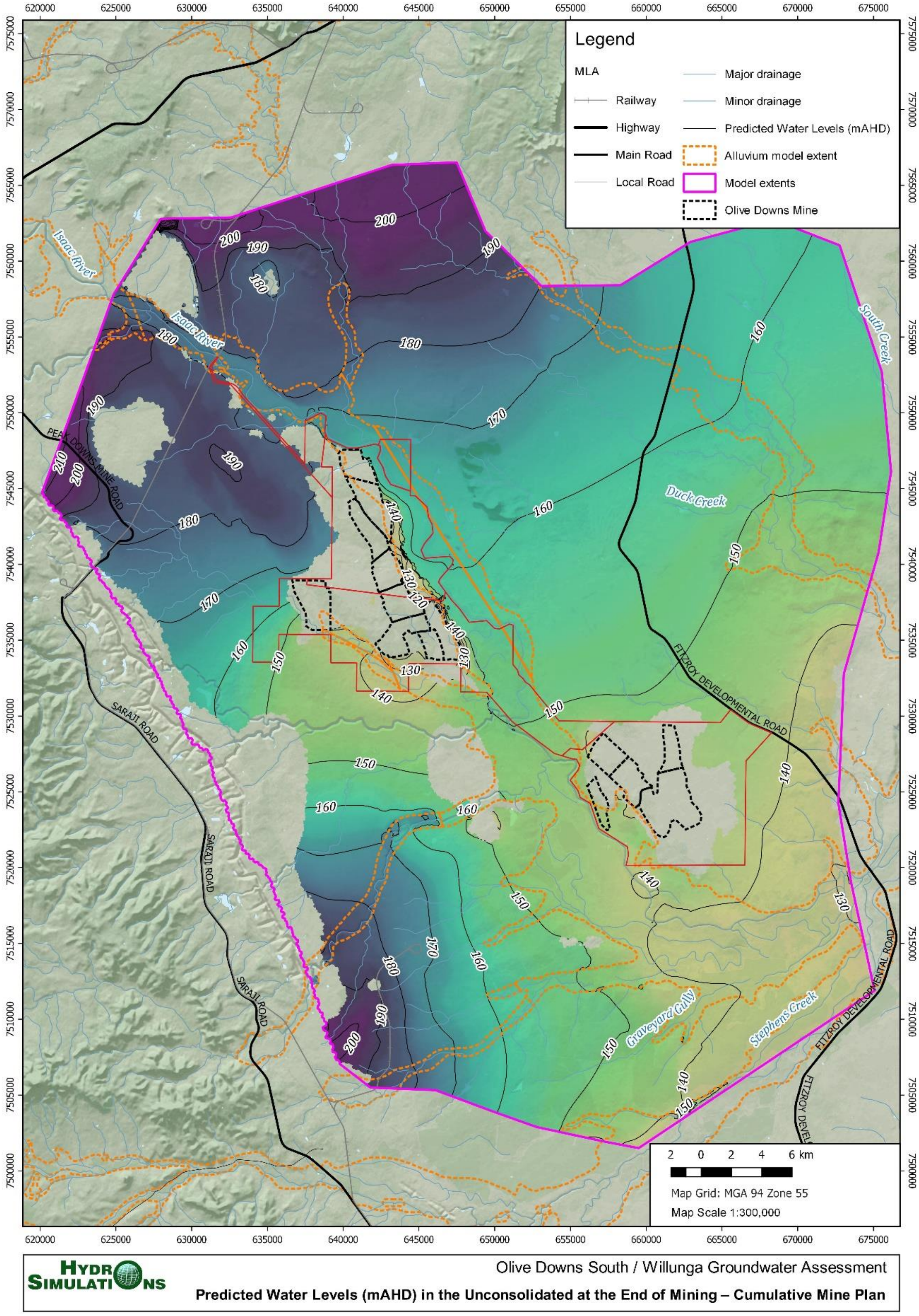


Figure B3-6 Predicted Water Level within Unconsolidated (Layer 1 and Layer 2) at End of Mining – Cumulative Mine Plan

HYDRO SIMULATIONS

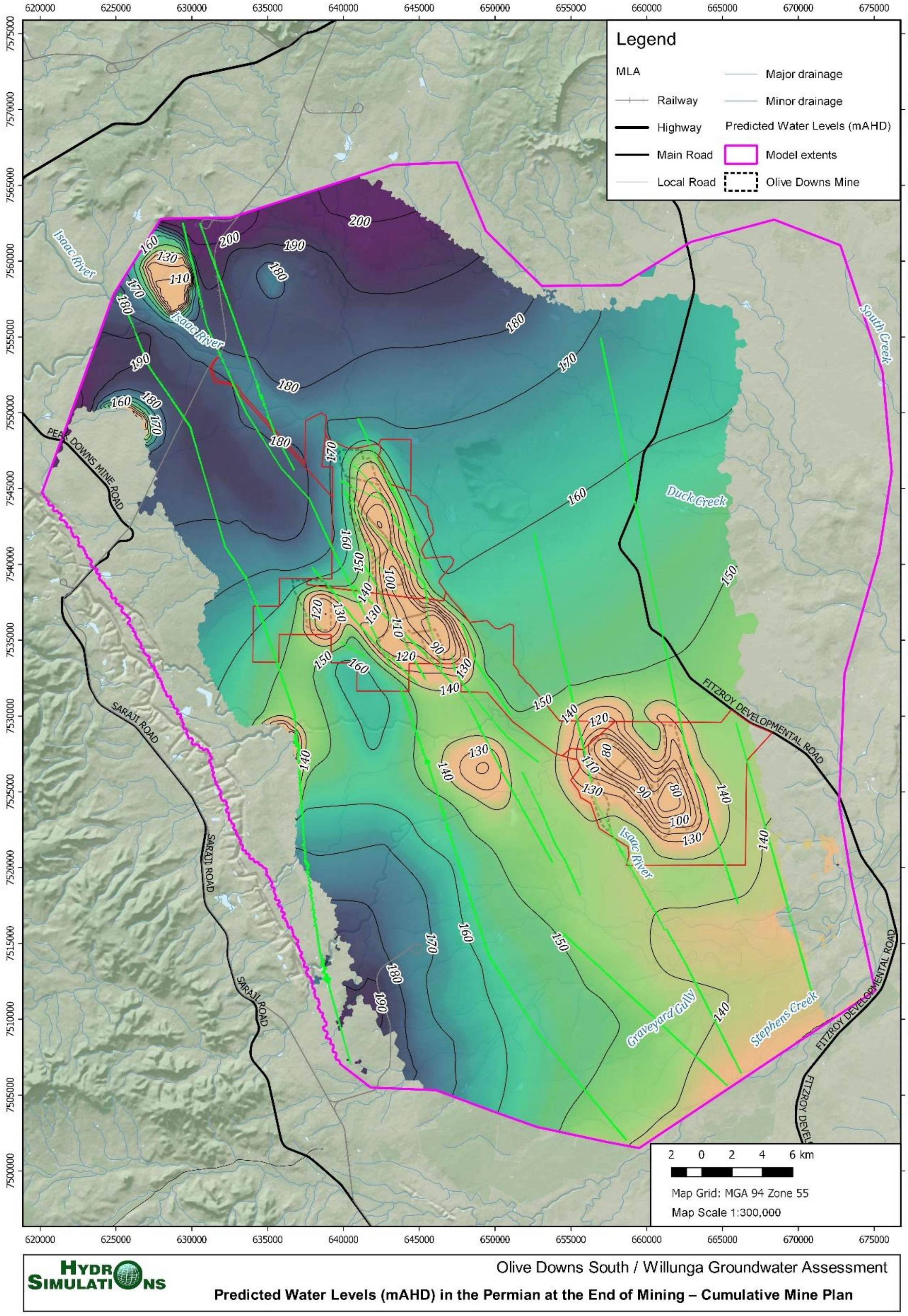


Figure B3-7 Predicted Water Level within Permian Coal Measures (Layer 9) at End of Mining – Cumulative Mine Plan

4 RECOVERY MODELLING

Post mining impacts were investigated with a recovery model, commencing from the end of mining and run for 200 years. A transient model was created to ascertain post-mining inflows, with all predictive model drain cells removed. The model used the end of mining groundwater levels as the starting heads, and removed all drain cells simulating the proposed mining areas to allow groundwater levels to equilibrate. At the end of mining, the properties of the final voids cells were converted to values representative of voids. The voids were assigned a high horizontal and vertical hydraulic conductivity (1000 m/day) and storage parameters (specific yield of 1.0, storage coefficient of 5.0 x 10^{-5} m^{-1} based on the compressibility of water), to simulate free water movement within the void. This approach is often referred to as a 'high-K' lake.

Groundwater inflows to the void during recovery were provided to the surface water consultants, and the results were incorporated in a high-resolution surface water model. The pit lake recovery levels and timing were predicted by the surface water consultants. The predicted final void water levels (at equilibrium) were:

- 80 mAHD within ODS3 void;
- 25 mAHD within ODS7/ODS8 void; and
- 63 mAHD within WIL5 void.

These elevations and recovery timing derived from the surface water modelling were replicated within the numerical groundwater model using the time variant constant head boundary condition. This recovery model was then re-run for 200 years to ensure consistency with the surface water assessment. Predictions from the re-run recovery model are presented within the main report.

5 SENSITIVITY ANALYSIS

Sensitivity analysis was conducted to understand how changes to a range of model assumptions and variables might influence the model predictions. This included assessment of the influence of selected physical properties (specific yield and spoil properties), fault structures and the approved Bowen Gas Project.

A more complex Monte Carlo style uncertainty analysis was also undertaken where numerous model inputs were changed at the same time. **Section** 6 discusses and presents the results of the uncertainty analyses.

5.1 PHYSICAL PARAMETERS

5.1.1 SPECIFIC YIELD

Previous studies in the area have suggested a wide range of values for specific yield (see **Appendix A**). The values for specific yield derived from model calibration (**Section 2.9**) are generally at or below publicly reported values. There are no specific yield measurments avaible for the site; therefore, specific yield is considered a poorly known model property. Sensitivity analysis was undertaken on specific yield, with modelled values for all geological units increased by a multiplier ranging from 5 to 100. **Table B5-1** shows the specific yield values adopted in the sensitivity run.

Table B5-1 Predicted Drawdown at Private Bores Due to Project

Model layer	Formation	Unit	Specific Yield Sy
1	Alluvium	Surface cover	5.0 x10$^{/2}$
1	Colluvium	Surface cover	1.0 x10$^{/2}$
2	Tertiary sediments	Tertiary and minor Triassic Clematis	1.0 x10$^{/2}$
3	Rewan	Triassic	5.0 x 10$^{/3}$
4	Rangal Coal Measures	Leichhardt overburden	5.0 x 10$^{/3}$
5		Leichhardt Seam	1.0 x10/2
6		Interburden	5.0 10$^{/3}$
7		Vermont Seam	1.0 x10$^{/2}$
8		Vermont underburden	5.0 x10$^{/3}$
9	Fort Cooper Coal Measures	Fort Cooper overburden	5.0 x 10$^{/3}$
10		Fort Cooper seam	1.0 x10$^{/2}$
11		Fort Cooper underburden	5.0 x 10$^{/3}$
12	Moranbah Coal Measures	Moranbah overburden	1.0 x10$^{/2}$
13		Moranbah (Goonyella) Seam	5.0 x10$^{/3}$
14		Moranbah underburden	5.0 x10$^{/3}$
	Fault		5.0 x10$^{/3}$
	Spoil		5.0 x10$^{/2}$

Figure B5-1 compares the Project only maximum 1m drawdown extent at the base of the Rangal Coal Measures. The maximum drawdown is a combination of the maximum values recorded at each cell at any time over the predictive model. This gives an indication of where groundwater related impacts may occur at a point in time during the Project; however, the timing and duration of the maximum drawdown can vary. **Figure B5-1** shows that the increase in specific yield reduced the extent of drawdowns. Therefore, the specific yield used for the impact assessment is considered conservative with respect to spatial drawdown extent.

5.1.2 SPOIL PROPERTIES

There is limited information on the properties of spoil material within the region. Therefore, sensitivity analysis was conducted in order to better understand the influence of these parameters on the predictions. The sensitivity analysis included three scenarios with the following changes made to the spoil properties:

- Specific yield increased to 0.2;.
- Recharge increased to 5%.
- Horizontal conductivity increased to 1 m/day and vertical conductivity increased to 0.1 m/day,.

Figure B5-2 compares the Project only maximum 1m drawdown extent at the base of the Rangal Coal Measures for each of the scenarios. The figure shows minimal change in the drawdown extent with change in spoil properties (specific yield, recharge and hydraulic conductivity).

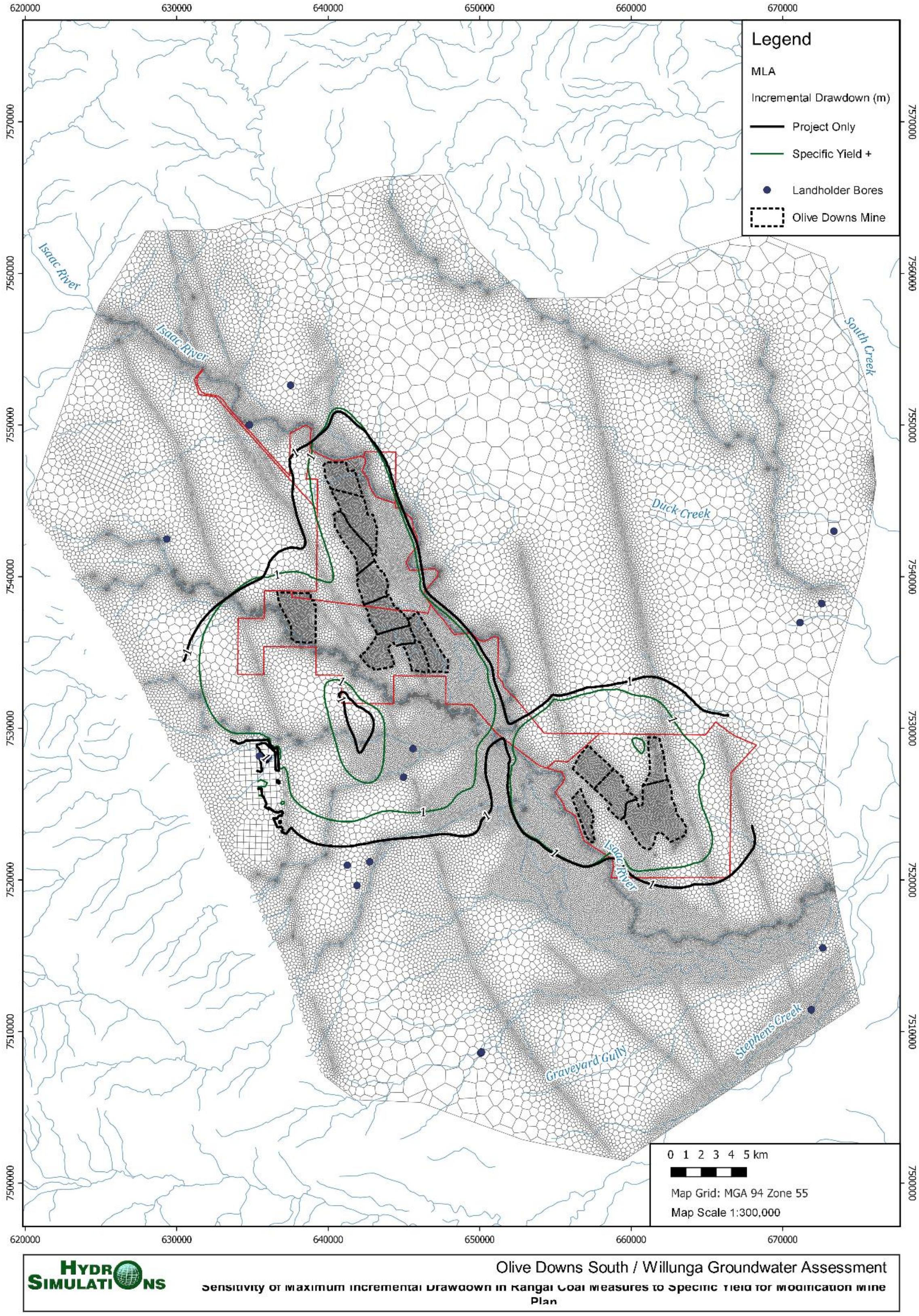


Figure B5-1 Sensitivity of Maximum Incremental Drawdown in Rangal Coal Measures to Specific Yield

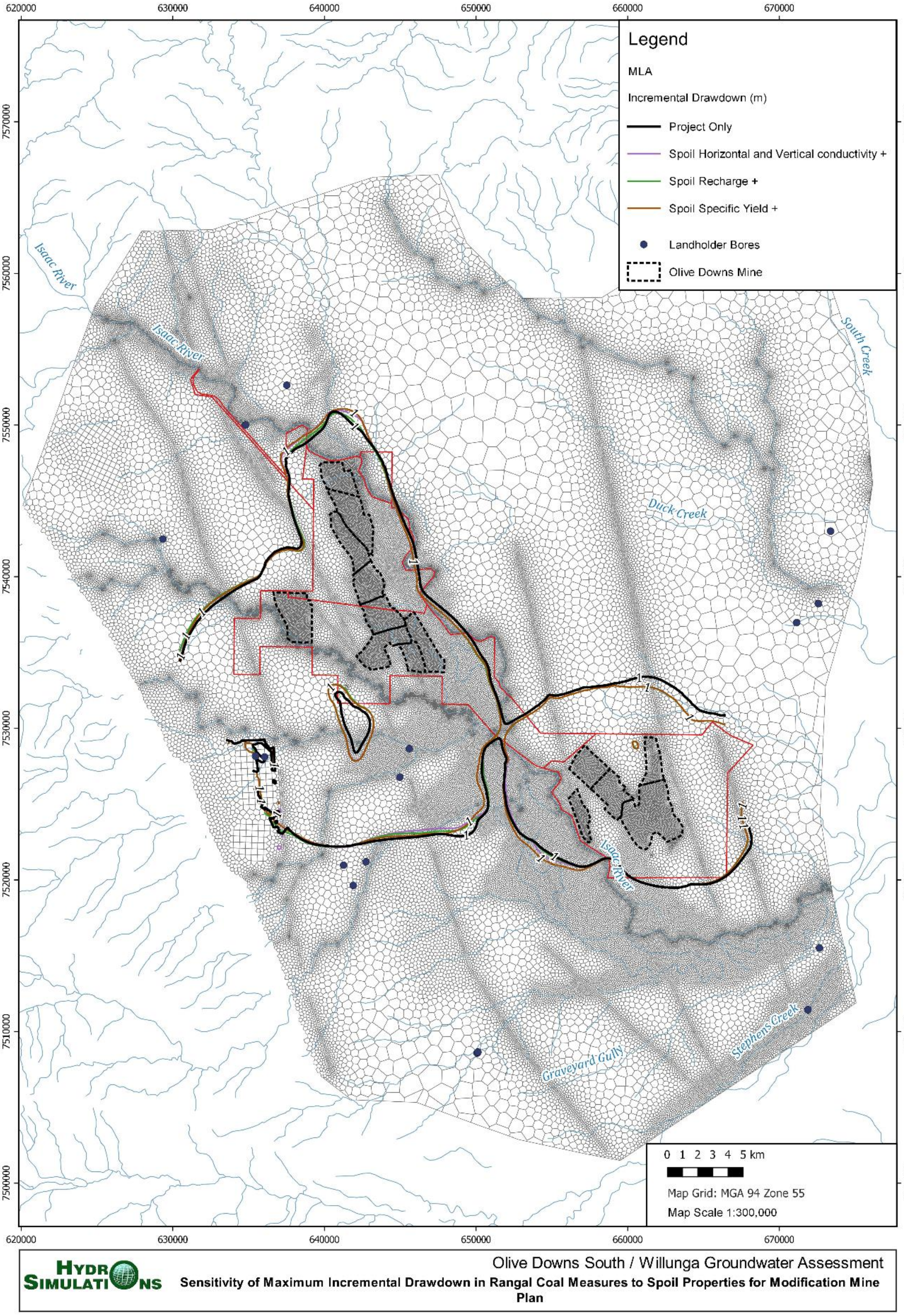


Figure B5-2 Sensitivity of Maximum Incremental Drawdown in Rangal Coal Measures to Spoil Properties

5.2 FAULTS

Available site data indicates that vertical hydraulic conductivity can vary within fault zones by around 50 percent to 160 percent of horizontal conductivity. This indicates that faulting could provide both conduits and barriers to vertical flow at the Project Site. The numerical model was designed with zones aligned with mapped faults, as discussed in **Section 2.3.1**.

Sensitivity analysis was undertaken of the fault zones in order to understand the sensitivity of the model predictions to the faults being either conduits or barriers to flow. The sensitivity analysis included two scenarios with the following changes made to the fault zones:

- Horizontal and vertical hydraulic conductivity increased by an order of magnitude.
- Horizontal and vertical hydraulic conductivity decreased by an order of magnitude.

Figure B5-3 compares the Project only maximum 1m drawdown extent at the base of the Rangal Coal Measures for each of the scenarios. The figure shows minimal change in the drawdown extent with change in the fault properties.

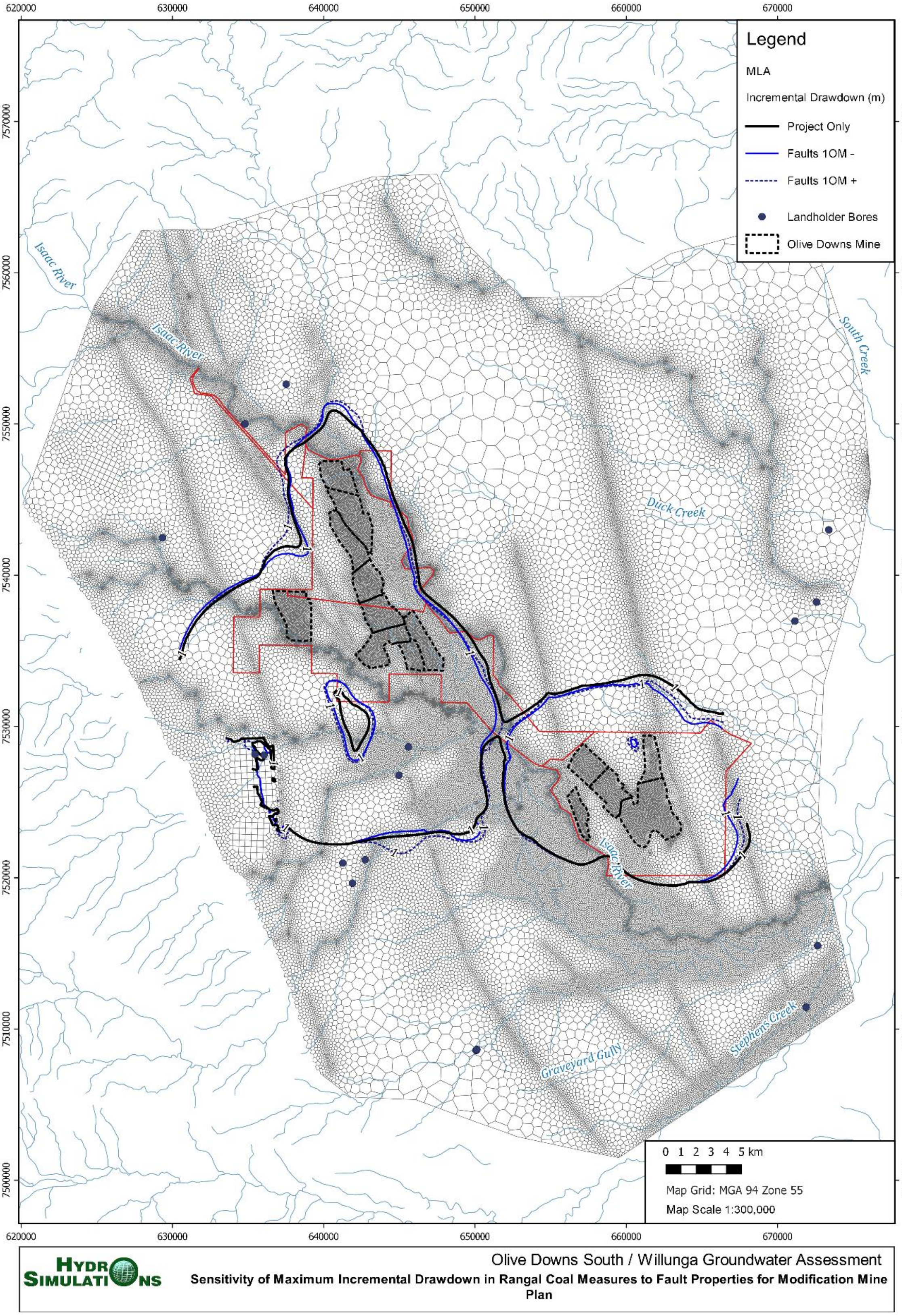


Figure B5-3 Sensitivity of Maximum Incremental Drawdown in Rangal Coal Measures to Fault Properties

5.3 COAL SEAM GAS PRODUCTION

Numerous coal seam gas production wells have been proposed within the model area as part of the Bowen Gas Project. Simulation of coal seam gas extraction is complex, as it involves separate gas and water phases. This study simulated only the water phase, but used surrogate relative permeabilities to approximate the influence of the gas phase. Water extraction was automated by applying drain cells to zones around the proposed gas production wells (40 m above the target coal seam). The drain schedule was simulated using reported timings as per the Bowen Gas Project EIS (Ausenco-Norwest, 2012).

In order to ensure the impacts of gas extraction were adequately represented in the model and consistent with modelling by Ausenco-Norwest (2012), an iterative model “validation” process was undertaken. This involved modifying the drain conductance to match drawdowns and extraction volumes as reported within Ausenco-Norwest (2012). During this “validation” process, cumulative impacts from approved operations were excluded, consistent with the modeling study undertaken by Ausenco-Norwest (2012).

From the “validation” process , abstraction rates from the CSG wells were predicted to be 7 ML/day on average. These results are slightly lower than findings by OGIA (Ausenco-Norwest, 2012), who predicted an average take of 10 ML/day from CSG production. However, this difference may relate to the more regional extent covered and a different method used in simulating CSG extraction by OGIA.

Once the drain conductance was derived, the drain cells were applied to the predictive model. Predictive model scenarios included:

- CSG Production – Bowen Gas Project only.
- Cumulative – Approved and foreseeable mining plus the Project and plus the Bowen Gas Project.

Figure B5-4 compares the maximum 1m drawdown extent at the base of the Rangal Coal Measures for the Project only, the Bowen Gas Project only, and for the Project plus the Bowen Gas Project. **Figure B5-4** shows the Bowen Gas Project would increase the drawdown extent by 15 km to the east of the Olive Downs Domain, and by 10 km south of the Willunga Domain.

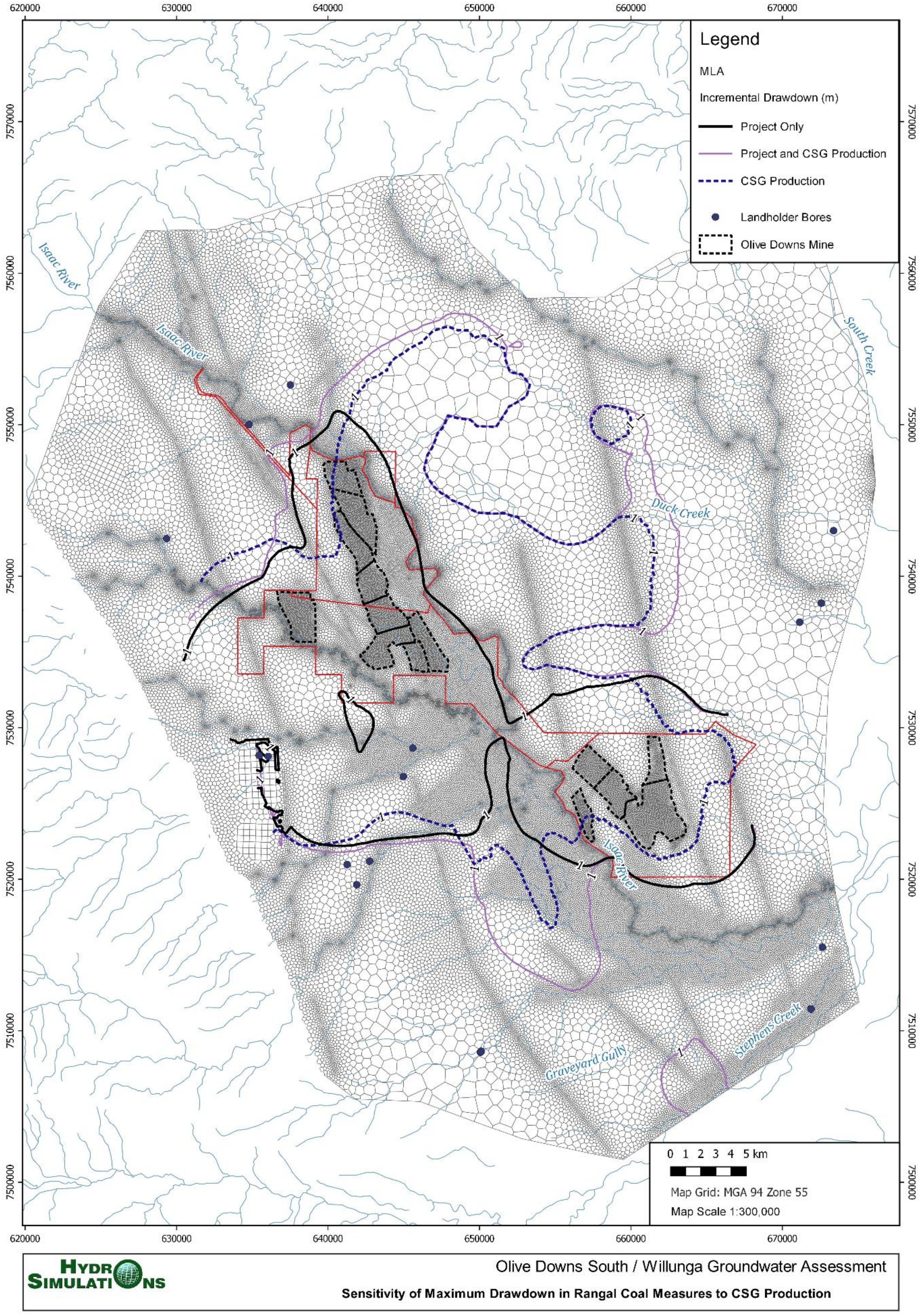


Figure B5-4 Sensitivity of Maximum Incremental Drawdown in Rangal Coal Measures to CSG Production

6 UNCERTAINTY ANALYSIS

6.1 METHODOLOGY

This study addresses parameter uncertainty by stochastic modelling using the Monte Carlo method. This method operates by generating numerous alternative sets of input parameters to the deterministic groundwater flow model (realisations), executing the model independently for each realisation, and then aggregating the results for statistical analysis.

A traditional drawback to the Monte Carlo method is that its successful application often necessitates many hundreds or thousands of model runs, each of which may take several hours of run time on a modern computer. More complex variants of Monte Carlo exist which aim to explore the parameter space more efficiently than the basic Monte Carlo approach, such as Null Space Monte Carlo (NSMC) (Doherty, 2015) and Markov Chain Monte Carlo (MCMC) approaches (e.g. Vrugt *et al.*, 2009).

However, recent offerings in the field of cloud computing have greatly increased the availability and accessibility of computing resources, allowing hundreds of model runs to be evaluated simultaneously. Owing to this, we have elected to use the more basic Monte Carlo approach, which places no reliance on a linearisation of the model, allows for each individual model run to be kept relatively simple and with predictable run time (no additional calibration steps), and is free from the problem of autocorrelated samples that may occur with MCMC approaches.

AlgoCompute software (HydroAlgorithmics, 2018; Merrick, 2017) was used as the platform for executing the model runs in parallel; up to 255 realisations were evaluated simultaneously, each being allocated to a single CPU core of a virtual machine in the cloud. The model-independent uncertainty quantification software **HGSUQ** (Miller *et al*., 2018) was used to generate the Monte Carlo parameter realisations and orchestrate the model runs within the AlgoCompute environment.

6.1.1 PILOT POINTS

To assess the uncertainty in the hydraulic conductivity and storage parameters in the model, *a pilot point* approach was applied. Lateral hydraulic conductivity (Kx), vertical hydraulic conductivity (Kz), and specific yield (Sy) values were permitted to vary spatially throughout the model domain, by taking representative values at 200 locations (pilot points) in each of the model's 14 layers.

The locations of the pilot points were distributed approximately equidistantly throughout the model domain. This was accomplished by starting with points placed in initially random locations within the model extents, and then using the optimisation algorithm for mesh generation in the **AlgoMesh** software tool (Merrick and Merrick, 2015) to distribute the points according to a uniform distance function.

Three parallel, closely-spaced strips of pilot points were used in layers 3 to 14 to allow for sharp variations in hydraulic conductivity across the Isaac Fault, running approximately north-northwest to south-southeast through the model. In layers 1 and 2, above the faulted zone, the two "side strips" of pilot points along the fault were deactivated, leaving only the central strip, such that the sharp variations in properties would not occur in these surface layers, where faulting is not present. The outer strips represent the conceptual fault damage zone, while the inner strip represents the conceptual fault core. As the penetrated layers adopt independent hydraulic conductivities, the full range of barrier or conduit or mixed characteristics of the fault zone is explored.

Figure B6-1 shows the resulting pilot point locations. The 200 pilot points shown were duplicated in each of layers 3 to 14, and 164 of the pilot points were placed in layers 1 and 2 (after removal of the Isaac Fault "side strips").

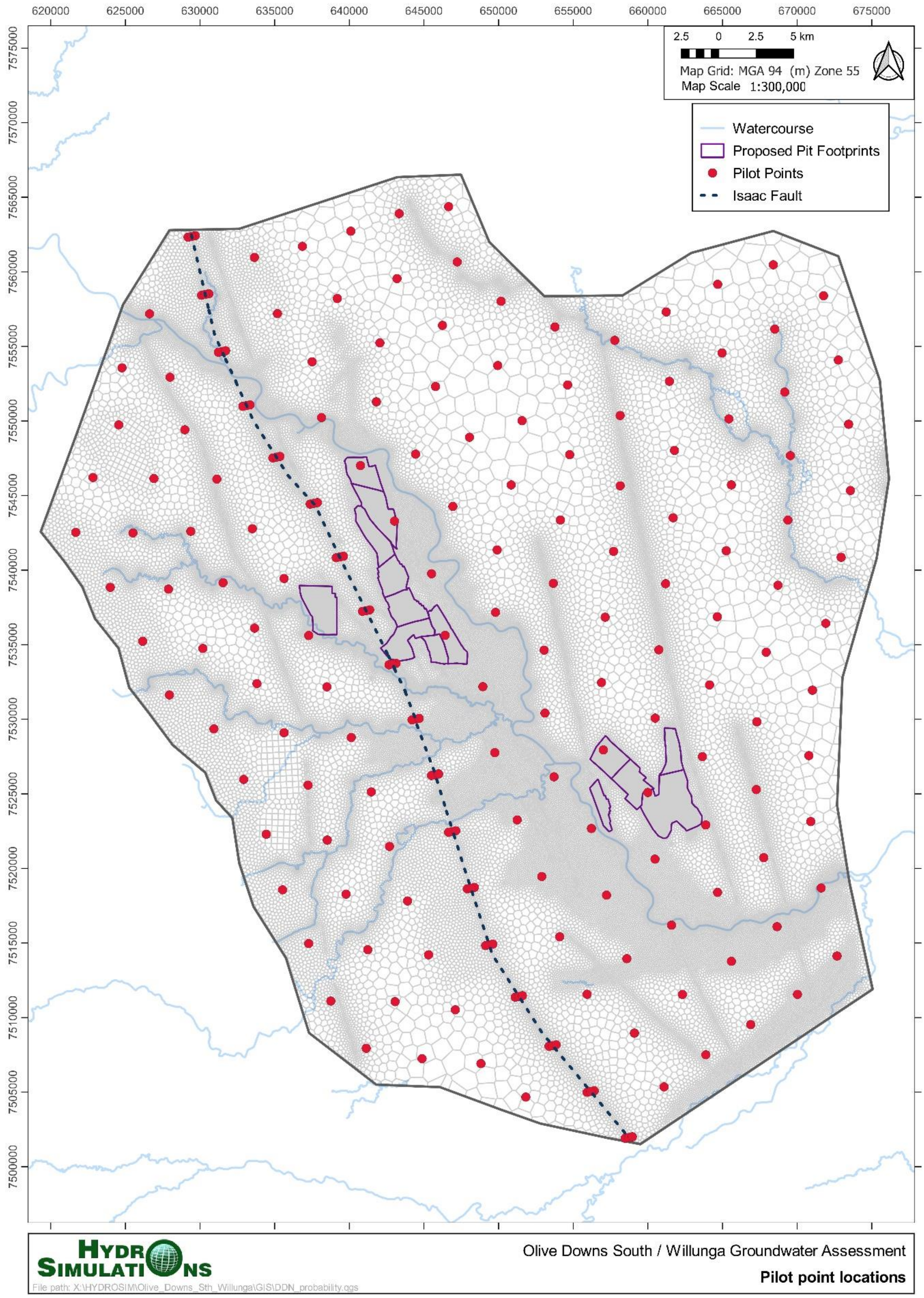


Figure B6-1 The 200 Pilot Point Locations used to Represent Spatially-Varying Material Parameters

For each realisation generated by the Monte Carlo process, every pilot point was assigned a Kx value, a Kx/Kz ratio, and an Sy value. In layer 1, two additional parameters were applied to the pilot points to allow better parameterisation of the alluvium: an alluvium conductivity multiplier and an alluvium Sy value. In total, 8,512 parameters were used (200 points * 12 layers * 3 parameters + 164 points * 1 layer * 3 parameters + 164 points * 1 layer * 5 parameters).

Each model cell was assigned Kx, Kz and Sy values through interpolation from surrounding pilot point values by kriging. Along the Isaac Fault, additional points were placed using a linear interpolation process prior to kriging, to ensure that the linear feature was retained in the interpolated value fields; this was necessary to spread the parameter values along the length of the fault in a linear fashion and avoid radial effects at each of the fault pilot points, allowing the cells along the fault to form either a conduit or a barrier to flow (or a combination of both, at different locations).

In cells identified as lying within alluvium in layer 1, the Kx and Kz values were obtained by multiplying the interpolated “alluvium conductivity multiplier” with the interpolated base Kx and Kz values, and Sy values were taken from the interpolated alluvium Sy field.

Lateral hydraulic conductivity (Kx) values at each pilot point were sampled from a log-normal distribution with a mean based on the depth of the pilot point below ground – using identical depth functions to those applied in the base model on a cell-by-cell basis – and with a standard deviation of one order of magnitude (i.e. a standard deviation of 1 for log10(Kx)). Pilot points along the Isaac Fault were assigned values from independent distributions; these are detailed in the **Input Parameter Distributions** section.

Vertical hydraulic conductivity (Kz) values were generated by dividing the sampled Kx values by a vertical anisotropy factor (Kx/Kz). Vertical anisotropy values at each pilot point were sampled from a uniform distribution between 30 and 300.

Specific yield values were sampled from a uniform distribution in each layer ranging from the base model value (fractional Sy of 0.001 or 0.0001) to a fractional Sy of 0.05.

Alluvium conductivity multipliers were sampled from a uniform distribution between 1.5 and 10 – meaning that alluvium K values were between 1.5 and 10 times the outlying K values. Alluvium fractional Sy values were sampled from a uniform distribution between 0.02 and 0.1.

6.1.2 BASELINE MEAN PROPERTIES RUN

Prior to execution of the suite of Monte Carlo runs, a representative run was undertaken locally to provide a baseline for calibration checks. For this run, the mean values of Kx, Kz and Sy were used at all pilot points. The calibration fit of this realisation was computed to be 8.1% scaled root mean square (SRMS). These figures were used in determining appropriate cut-off limits for further runs in the Monte Carlo suite, as detailed below in the individual run procedure.

6.1.3 RUN PROCEDURE

For each Monte Carlo realisation, the following procedure was executed on a virtual machine in the cloud, initiated by a HGSUQ “slave” worker process:

1. Interpolate Kx, Kx/Kz and Sy values linearly between subsequent pilot points along segments of the Isaac Fault, creating 10 additional “virtual” pilot points between each parameterised pair of fault pilot points.

2. Convert Kx value and Kx/Kz ratio to a Kx and a Kz value at each pilot point.

3. Convert Kx, Kz, alluvium conductivity multiplier and alluvium Sy values to alluvium-specific Kx, Kz and Sy values at each layer 1 pilot point.

4. Interpolate Kx, Kz, and Sy values to model cells by kriging with **PLPROC** (Doherty, 2016). In cells zoned as alluvium, apply the alluvium values; elsewhere, apply the base values.

5. Run transient calibration model. This model includes an initial steady-state stress period to calculate appropriate initial conditions.

6. Compute SRMS error of the outputs of the calibration model at a set of observation locations with respect to observed values at those locations.

7. If the global SRMS error exceeds 9.32%, stop processing and reject the run. The 9.32% figure represents a 15% allowed deviation from the baseline Mean Properties run's figure of 8.1%.

8. Run prediction model with existing approved mining operations only, i.e. with Olive Downs South and Willunga mines inactive (the null model).

9. Run prediction model with approved operations plus Olive Downs South and Willunga mining (the mining model).

10. Aggregate drawdown (null - mining), number of bores affected by 1m+ drawdown, mine inflow, alluvium take and stream flow results from the null and mining models and return these to the HGSUQ "master" process for amalgamation with other run results.

6.1.4 ASSUMPTIONS OF NOTE

The following assumptions should be noted in assessing the information presented in this report.

- The stochastic modelling performed was limited to hydraulic conductivity and specific yield values.

- The zonation of model cells considered to represent alluvium was fixed, i.e. uncertainty was not assessed on where the alluvial boundaries lie.

- Mean Kx values are assumed to decrease logarithmically with increasing depth below ground surface, as per the depth functions used in the base model.

- Kz values are assumed to correlate to Kx according to a spatially-varying linear ratio. See the **Input Parameter Distributions** section for details on the distributions used.

- Each calibrated realisation was assumed to be equally likely in the analysis of the model outputs, i.e. apart from rejecting particularly poorly-calibrated runs, no weighting was applied to distinguish models based on how well they fit the observed data.

6.2 INPUT PARAMETER DISTRIBUTIONS

Two sets of parameter distributions are presented in this section: *prior* and *posterior* distributions. The prior distributions are those from which the Monte Carlo process builds random samples for evaluation. This process produces a finite number of sample sets. Additionally, some of these sample sets are rejected during evaluation due to failing calibration checks. The posterior distributions model the actual parameter distributions evaluated after sampling and rejection are taken into account.

In total, 463 realisations were evaluated as part of the Monte Carlo process. Of these, 312 (67.4%) were accepted and 151 (32.6%) were rejected by the prescribed calibration criteria.

6.2.1 PRIOR DISTRIBUTIONS

The prior distribution of lateral hydraulic conductivity (Kx) at each pilot point was log-normal with mean calculated according to the groundwater unit of the model cell containing the pilot point, and standard deviation of log10(Kx) of 1.0. Prior values for vertical anisotropy (Kx/Kz), specific yield (Sy), the alluvium conductivity multiplier (AlluvMult) and alluvium specific yield (AlluvSy) were all taken from uniform distributions (equal probability of any value within the specified range). **Table B6-1** summarises the prior mean values of Kx, and prior ranges for the other property values, by geological unit.

Table B6-1 Prior Property Value Distributions.

[Kx distribution is log-normal with mean value at each pilot point calculated based on depth below ground surface; other property distributions are uniform within the given ranges at each pilot point.]

MODEL LAYER	UNIT	MEAN HYDRAULIC CONDUCTIVITY (Kx) [m/day]	VERTICAL ANISOTROPY (Kx/Kz)	SPECIFIC YIELD (SY) [FRACTIONAL]	Alluvium Conductivity Multiplier (AlluvMult)	Alluvium Specific Yield (AlluvSy)
1	Surface cover (non-alluvium)	9.5×10^{-1}	30.0 to 300.0	1.0×10^{-3} to 5.0×10^{-2}	1.5 to 10.0	2.0×10^{-2} to 1.0×10^{-1}
2	Tertiary and minor Triassic Clematis	5.0×10^{-4} to 9.6×10^{-1}		1.0×10^{-3} (Tertiary) / 1.0×10^{-4} (Rewan) to 5.0×10^{-2}	*N/A (Alluvium only in layer 1)*	
3	Triassic and Isaac Fault	5.0×10^{-4}		1.0×10^{-4} to 5.0×10^{-2}		
4	Leichhardt overburden	1.0×10^{-5} to 2.4×10^{-2}		1.0×10^{-4} to 5.0×10^{-2}		
4	Isaac Fault	9.2×10^{-4} to 2.4×10^{-2}		1.0×10^{-3} to 5.0×10^{-2}		
5	Leichhardt seam	1.0×10^{-4} to 1.3×10^{-1}		1.0×10^{-3} to 5.0×10^{-2}		
5	Isaac Fault	3.8×10^{-4} to 1.3×10^{-1}		1.0×10^{-3} to 5.0×10^{-2}		
6	Interburden	1.0×10^{-5} to 8.7×10^{-3}		1.0×10^{-4} to 5.0×10^{-2}		
6	Isaac Fault	5.0×10^{-5} to 8.6×10^{-3}		1.0×10^{-3} to 5.0×10^{-2}		
7	Vermont seam	1.0×10^{-4} to 8.9×10^{-2}		1.0×10^{-3} to 5.0×10^{-2}		
7	Isaac Fault	1.2×10^{-4} to 9.1×10^{-2}		1.0×10^{-3} to 5.0×10^{-2}		
8	Vermont underburden	1.0×10^{-5} to 1.6×10^{-3}		1.0×10^{-4} to 5.0×10^{-2}		
8	Isaac Fault	5.0×10^{-5} to 1.8×10^{-3}		1.0×10^{-3} to 5.0×10^{-2}		
9	Fort Cooper overburden	1.0×10^{-5} to 1.9×10^{-3}		1.0×10^{-4} to 5.0×10^{-2}		
9	Isaac Fault	5.0×10^{-5} to 1.5×10^{-3}		1.0×10^{-3} to 5.0×10^{-2}		
10	Fort Cooper seam	1.0×10^{-4} to 8.5×10^{-4}		1.0×10^{-3} to 5.0×10^{-2}		
10	Isaac Fault	5.0×10^{-5} to 5.3×10^{-4}		1.0×10^{-3} to 5.0×10^{-2}		
11	Fort Cooper underburden	1.0×10^{-5} to 9.9×10^{-4}		1.0×10^{-4} to 5.0×10^{-2}		
11	Isaac Fault	5.0×10^{-5} to 4.2×10^{-4}		1.0×10^{-3} to 5.0×10^{-2}		
12	Moranbah overburden	1.0×10^{-5} to 1.3×10^{-4}		1.0×10^{-4} to 5.0×10^{-2}		
12	Isaac Fault	5.0×10^{-5}		1.0×10^{-3} to 5.0×10^{-2}		
13	Moranbah (Goonyella) seam	1.0×10^{-4} to 1.2×10^{-3}		1.0×10^{-3} to 5.0×10^{-2}		
13	Isaac Fault	5.0×10^{-5} to 1.5×10^{-4}		1.0×10^{-3} to 5.0×10^{-2}		
14	Moranbah underburden	1.0×10^{-5} to 2.0×10^{-4}		1.0×10^{-4} to 5.0×10^{-2}		
14	Isaac Fault	5.0×10^{-5}		1.0×10^{-4} to 5.0×10^{-2}		

6.2.2 POSTERIOR DISTRIBUTIONS: KX

Table B6-2 summarises the posterior distributions of (non-alluvium) Kx, organised by geological unit and compared to the prior distribution statistics. Substantial differences between the posterior and prior mean values may indicate that part of the prior distribution resulted in poorly-calibrated models. Those units for which the posterior mean Kx is more than 3x the prior Kx, or vice versa, are noted in the table.

Note that the posterior standard deviation values differ from the per-pilot point standard deviation of 1.0 used for the prior distributions, as each of the reported values include multiple pilot points at different depths.

Table B6-2 Posterior vs Prior Lateral Hydraulic Conductivity (Kx) Distributions

MODEL LAYER	UNIT	# PILOT POINTS	POSTERIOR STDEV LOG10(Kx)	POSTERIOR MEAN Kx	PRIOR MEAN Kx	NOTES ON POSTERIOR vs PRIOR
1	Surface cover (non-alluvium)	128	1.00	9.5×10^{-1}	9.5×10^{-1}	
2	Tertiary and minor Triassic Clematis	128	1.38	4.8×10^{-1}	5.2×10^{-1}	
3	Triassic	182	1.85	6.4×10^{-3}	5.0×10^{-4}	Posterior mean Kx is 13x prior
3	Isaac Fault	18	1.90	1.5×10^{-2}	5.0×10^{-4}	Posterior mean Kx is 29x prior
4	Leichhardt overburden	182	1.31	3.4×10^{-3}	7.5×10^{-3}	
4	Isaac Fault	18	1.27	2.8×10^{-3}	1.4×10^{-2}	Prior mean Kx is 5x posterior
5	Leichhardt seam	182	1.37	1.9×10^{-2}	3.1×10^{-2}	
5	Isaac Fault	18	1.41	1.8×10^{-2}	6.4×10^{-2}	Prior mean Kx is 3.6x posterior
6	Interburden	182	1.39	6.0×10^{-3}	2.3×10^{-3}	
6	Isaac Fault	18	1.29	9.6×10^{-3}	4.4×10^{-3}	
7	Vermont seam	182	1.41	9.5×10^{-3}	1.8×10^{-2}	
7	Isaac Fault	18	1.44	8.1×10^{-3}	4.1×10^{-2}	Prior mean Kx is 5.1x posterior
8	Vermont underburden	182	1.46	1.7×10^{-3}	4.3×10^{-4}	Posterior mean Kx is 3.8x prior
8	Isaac Fault	18	1.41	3.1×10^{-3}	9.2×10^{-4}	Posterior mean Kx is 3.4x prior
9	Fort Cooper overburden	182	1.24	3.8×10^{-4}	3.6×10^{-4}	
9	Isaac Fault	18	1.23	4.6×10^{-4}	6.4×10^{-4}	
10	Fort Cooper seam	182	1.14	2.2×10^{-4}	2.0×10^{-4}	
10	Isaac Fault	18	1.18	2.5×10^{-4}	1.7×10^{-4}	
11	Fort Cooper underburden	182	1.18	1.1×10^{-4}	8.7×10^{-5}	
11	Isaac Fault	18	1.16	1.5×10^{-4}	9.6×10^{-5}	
12	Moranbah overburden	182	1.20	3.6×10^{-5}	1.9×10^{-5}	
12	Isaac Fault	18	1.16	4.7×10^{-5}	5.0×10^{-5}	
13	Moranbah (Goonyella) seam	182	1.09	6.8×10^{-5}	1.4×10^{-4}	
13	Isaac Fault	18	1.12	4.8×10^{-5}	6.4×10^{-5}	
14	Moranbah underburden	182	1.15	3.5×10^{-5}	1.5×10^{-5}	
14	Isaac Fault	18	1.14	5.2×10^{-5}	5.0×10^{-5}	

The following charts present further detail on the posterior distributions of Kx in those geological units noted as having a substantial difference between posterior and prior Kx: layer 3 (Triassic and Isaac Fault), layer 4 (Isaac Fault), layer 5 (Isaac Fault), layer 7 (Isaac Fault) and layer 8 (Vermont underburden and Isaac Fault). These exhibit a slight tendency in accepted (well-calibrated) models towards higher conductivity in the Vermont underburden (layer 8), and a slight tendency towards lower conductivity values along the Isaac Fault in layers 4, 5 and 7 (Leichhardt overburden and seam, and Vermont seam) – though all prior mean values are still well within one standard deviation of the posterior mean, and the distributions appear close to log-normal in shape.

In layer 3 (Triassic Rewan Formation), the posterior distributions appear almost bimodal, suggesting the possibility of contrasting high and low conductivity values through this geological unit in reality – particularly along the Isaac Fault.

The Isaac Fault distributions suggest that the fault behaves variously as a conduit or a barrier, both laterally and vertically.

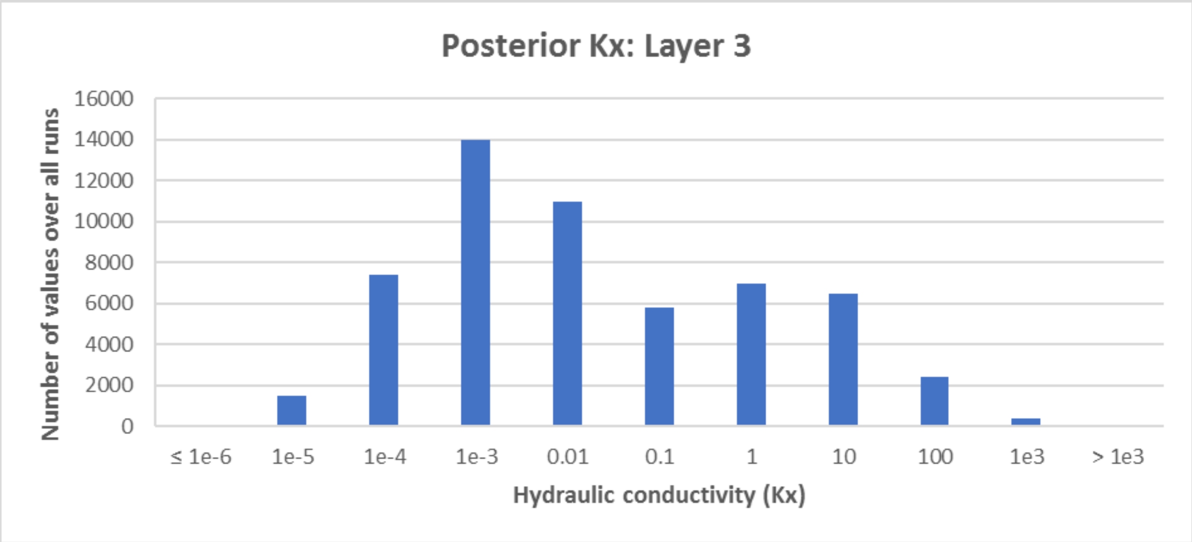


Figure B6-2 Posterior Distribution Hydraulic Conductivity (Kx) - Layer 3 Triassic (Rewan Formation)

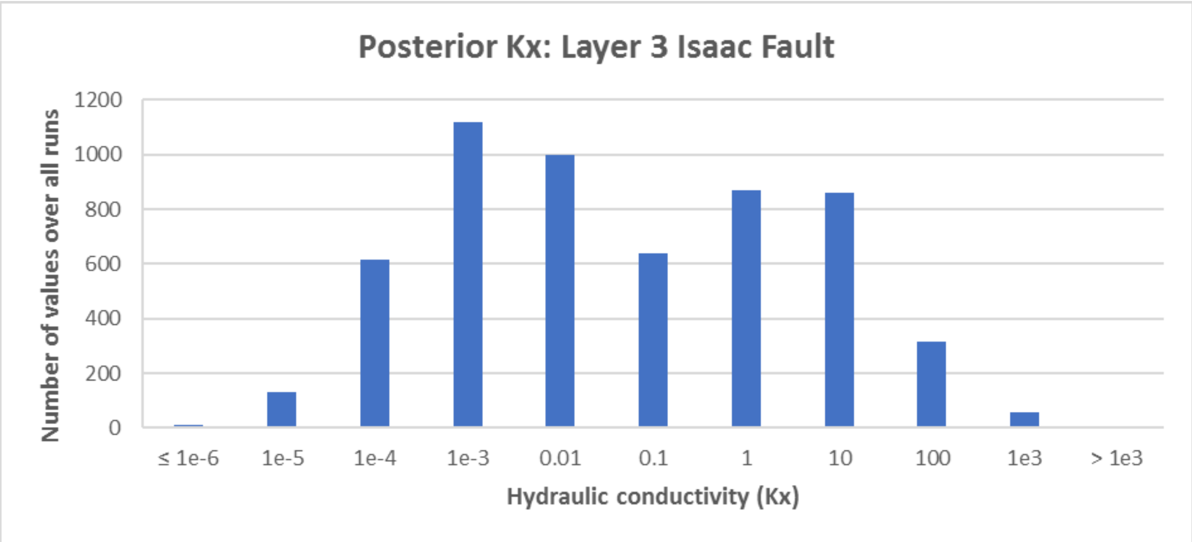


Figure B6-3 Posterior Distribution Hydraulic Conductivity (Kx) - Layer 3 Isaac Fault

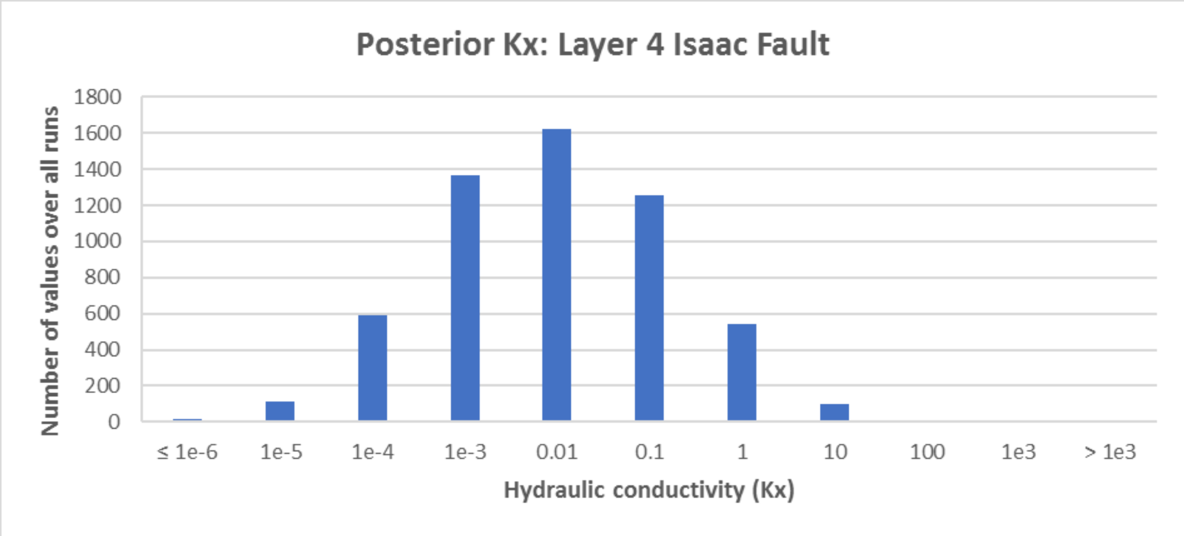


Figure B6-4 Posterior Distribution Hydraulic Conductivity (Kx) - Layer 4 Isaac Fault

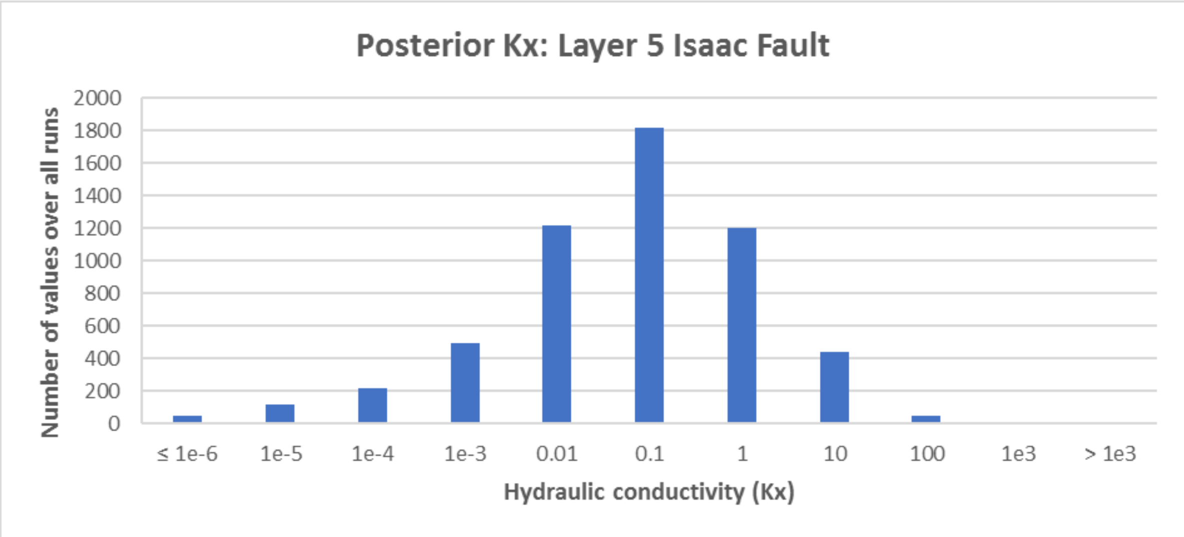


Figure B6-5 Posterior Distribution Hydraulic Conductivity (Kx) - Layer 5 Isaac Fault

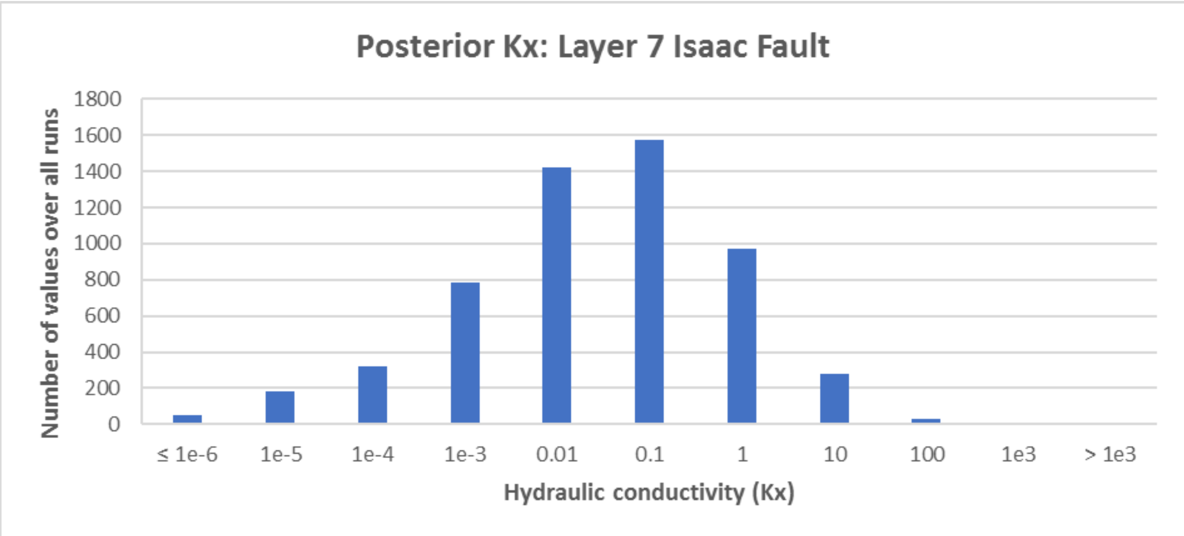


Figure B6-6 Posterior Distribution Hydraulic Conductivity (Kx) - Layer 7 Isaac Fault

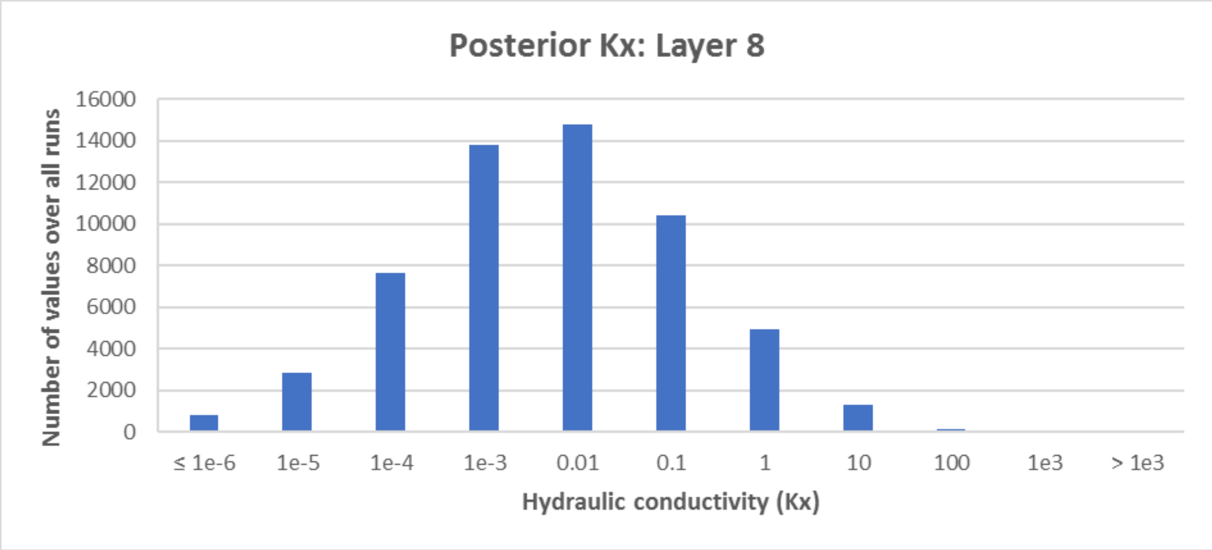


Figure B6-7 Posterior Distribution Hydraulic Conductivity (Kx) - Layer 8

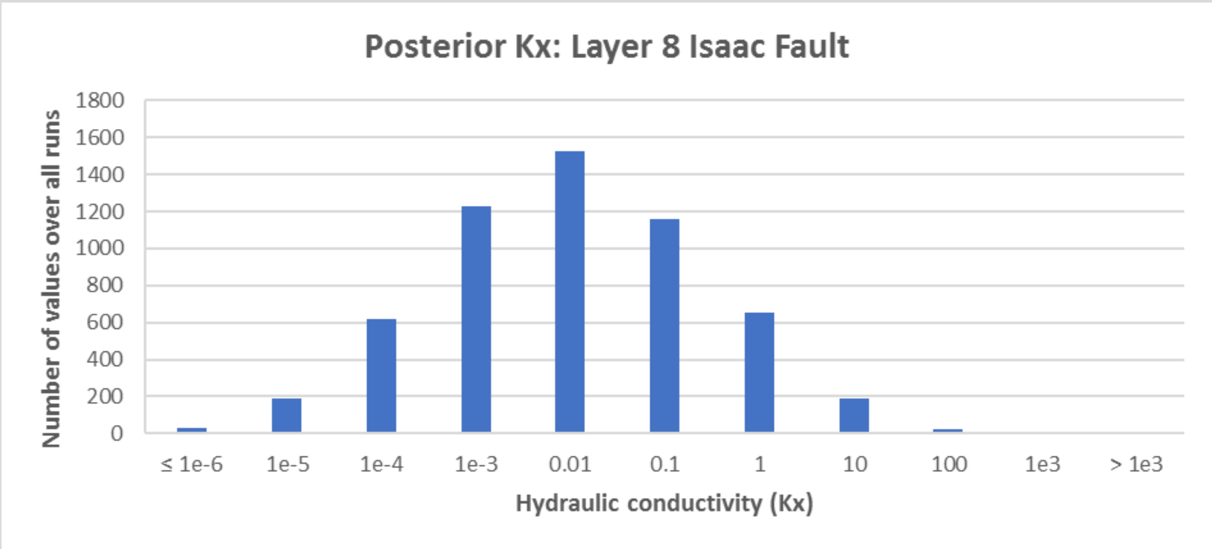


Figure B6-8 Posterior Distribution Hydraulic Conductivity (Kx) - Layer 8 Isaac Fault

6.2.3 POSTERIOR DISTRIBUTIONS: Kx/Kz, Sy, ALLUVIUM CONDUCTIVITY MULTIPLIER, ALLUVIUM Sy

The posterior mean and standard deviation of the vertical anisotropy ratio (Kx/Kz), specific yield and alluvium properties are reported in **Table B6-3**. The comparative prior distributions of these are uniform, as reported in **Table B6-1.** No substantial differences between the posterior and prior were noted.

Table B6-3: Posterior vs Prior Mean Values of Kx/Kz, Sy, Alluvium Conductivity Multiplier and Alluvium Sy.

Model Layer	Unit	Mean Kx/Kz		Mean Sy		Mean Alluvium Conductivity Multiplier		Mean Alluvium Sy	
		Post.	Prior	Post.	Prior	Post.	Prior	Post.	Prior
1	Surface cover (non-alluvium)	164.93	165	2.55×10^{-2}	2.55×10^{-2}	5.76	5.75	5.99×10^{-2}	6×10^{-2}
2	Tertiary and minor Triassic Clematis	164.87		2.55×10^{-2}	2.55×10^{-2}	*N/A (Alluvium only in layer 1)*			
3	Triassic	164.84		2.52×10^{-2}	2.51×10^{-2}				
3	Isaac Fault	166.38		2.53×10^{-2}	2.51×10^{-2}				
4	Leichhardt overburden	165.24		2.51×10^{-2}	2.51×10^{-2}				
4	Isaac Fault	165.03		2.50×10^{-2}	2.55×10^{-2}				
5	Leichhardt seam	165.38		2.54×10^{-2}	2.55×10^{-2}				
5	Isaac Fault	165.72		2.49×10^{-2}	2.55×10^{-2}				
6	Interburden	164.80		2.52×10^{-2}	2.51×10^{-2}				
6	Isaac Fault	165.74		2.53×10^{-2}	2.55×10^{-2}				
7	Vermont seam	165.01		2.54×10^{-2}	2.55×10^{-2}				
7	Isaac Fault	165.15		2.54×10^{-2}	2.55×10^{-2}				
8	Vermont underburden	164.76		2.52×10^{-2}	2.51×10^{-2}				
8	Isaac Fault	164.38		2.53×10^{-2}	2.55×10^{-2}				
9	Fort Cooper overburden	164.55		2.51×10^{-2}	2.51×10^{-2}				
9	Isaac Fault	163.52		2.52×10^{-2}	2.55×10^{-2}				
10	Fort Cooper seam	165.19		2.53×10^{-2}	2.55×10^{-2}				
10	Isaac Fault	164.79		2.53×10^{-2}	2.55×10^{-2}				
11	Fort Cooper underburden	165.44		2.51×10^{-2}	2.51×10^{-2}				
11	Isaac Fault	163.86		2.54×10^{-2}	2.55×10^{-2}				
12	Moranbah overburden	164.58		2.51×10^{-2}	2.51×10^{-2}				
12	Isaac Fault	165.80		2.52×10^{-2}	2.55×10^{-2}				
13	Moranbah (Goonyella) seam	165.14		2.55×10^{-2}	2.55×10^{-2}				
13	Isaac Fault	163.24		2.53×10^{-2}	2.55×10^{-2}				
14	Moranbah underburden	164.59		2.52×10^{-2}	2.51×10^{-2}				
14	Isaac Fault	165.23		2.53×10^{-2}	2.51×10^{-2}				

6.3 RESULTS

Statistics on several key metrics were computed from the results of the 312 accepted model runs and are presented in this section. Percentile results were calculated from the Monte Carlo outputs strictly on a conservative “round to higher value” basis, and are represented as “probabilities of exceedance” in five categories: “very likely (90%) - **green**, “likely (67%)” - **light yellow-green**, “about as likely as not (50%)” - **black**, “unlikely (33%)” - **orange**, and “very unlikely (10%)” - **red**.

To clarify, a “very unlikely (10%)” probability of exceedance value of X for a metric should be interpreted to mean “10% of realisations from the set of accepted realisations resulted in a value for this metric larger than X”.

6.3.1 SUMMARY OF AGGREGATE METRICS

Key aggregate metrics, stream flow impacts and water takes from the Monte Carlo runs are summarised in **Error! Reference source not found.** for project-only infuence.

Table B6-4 Probability of Exceedance Values of Aggregate Metrics, Stream Flow Impacts and Water Takes

	Very Likely (90%)		Likely (67%)		About As Likely As Not (50%)		Unlikely (33%)		Very Unlikely (90%)	
KEY AGGREGATE METRIC										
Number of bores affected by 1m drawdown or more	5		6		7		8		10	
Calibration error **(%SRMS)**	7.36%		7.84%		8.09%		8.42%		8.92%	
AVERAGE ENHANCED LEAKAGE (ML/DAY | ML/YEAR)										
Isaac River	3.22	1174	4.60	1680	5.59	2041	6.58	2404	8.82	3220
Other streams	0.001	0	0.012	4	0.021	8	0.033	12	0.072	26
PEAK ENHANCED LEAKAGE (ML/DAY | ML/YEAR)										
Isaac River	4.98	1818	6.65	2429	7.99	2919	9.34	3413	12.24	4471
Other Streams	0.004	1	0.024	9	0.038	14	0.057	21	0.117	43
PEAK DIRECT WATER TAKE (ML/DAY | ML/YEAR)										
Alluvium	0.60	221	1.25	458	2.05	750	2.75	1004	4.94	1805
Alluvium - ODS only	0.16	57	0.36	132	0.57	209	0.90	328	2.34	853
Alluvium - Wil only	0.38	139	0.92	337	1.71	624	2.59	945	4.85	1770
PEAK INDIRECT ALLUVIUM WATER TAKE (ML/DAY | ML/YEAR)										
Total	1.23	449	1.70	622	2.08	759	2.68	977	3.97	1450
ODS only	0.83	302	1.15	422	1.44	527	1.88	688	2.86	1046
Wil only	0.47	171	0.66	239	0.79	289	1.01	373	2.33	849

6.3.2 SPATIAL DRAWDOWN EXTENT

Spatial drawdown statistics computed on a cell-by-cell basis are contoured in **Figure B6-9** (for the water table) and **Figure B6-10** (for Layer 9 beneath the Rangal Coal Measures). The value of each contour represents the probability of drawdown exceeding 1m inside the area of the contour.

The water table drawdown is calculated as the difference between the simulated heads for the null and mining models, in the highest saturated layer in the null model. Note that the water table is in different model layers in different model cells.

In each figure, there is an indication of numerical artefacts associated with Eagle Downs Mine (to the north-west) and Saraji East Mine (to the south-west). These mines are active in model layer 13. The project-only drawdowns should be zero or close to zero. The artefacts seem to occur with Monte Carlo realisations having extreme parameter combinations.

TOC

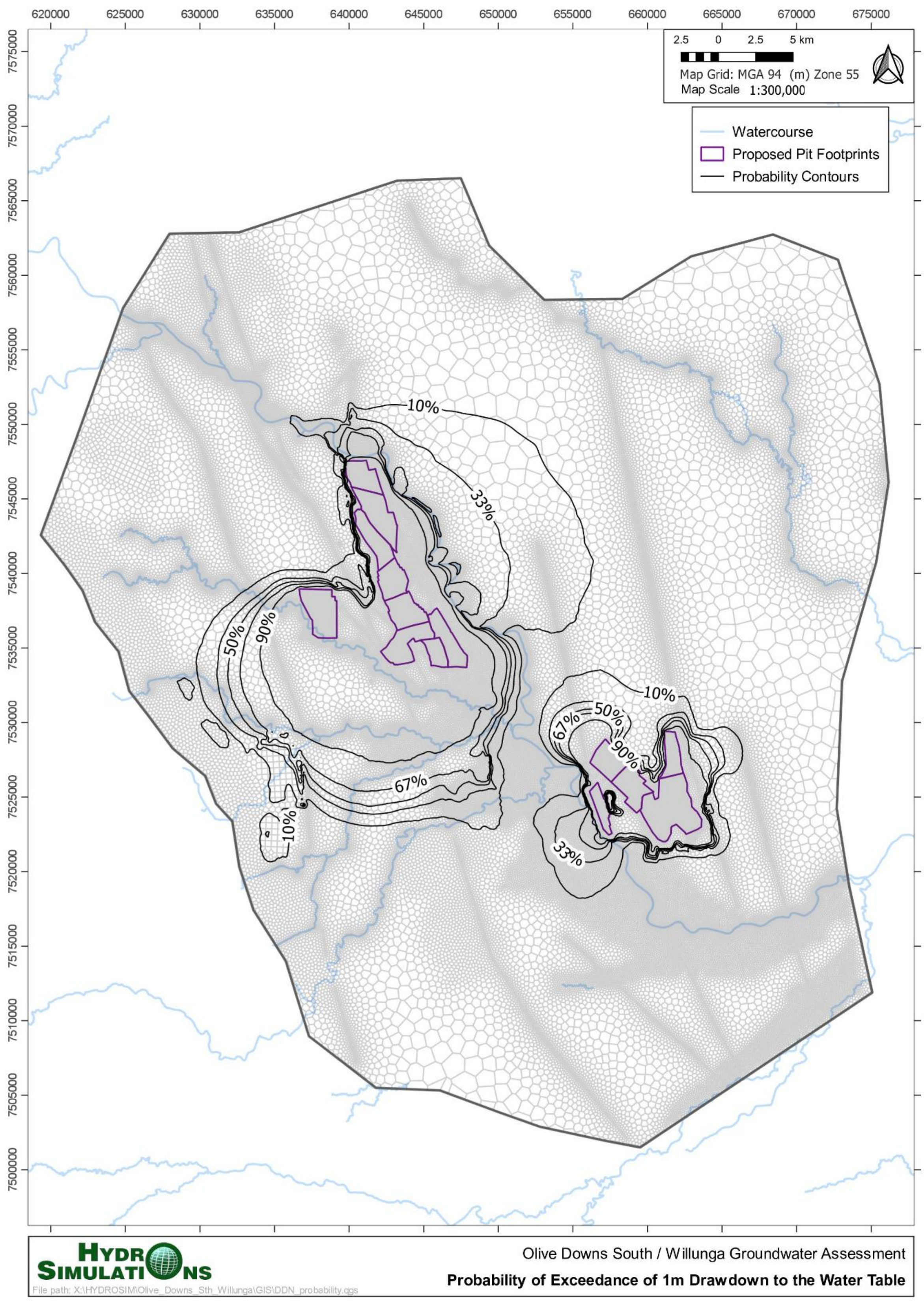


Figure B6-9 Probability of Exceedance of 1m Drawdown to the Watertable.

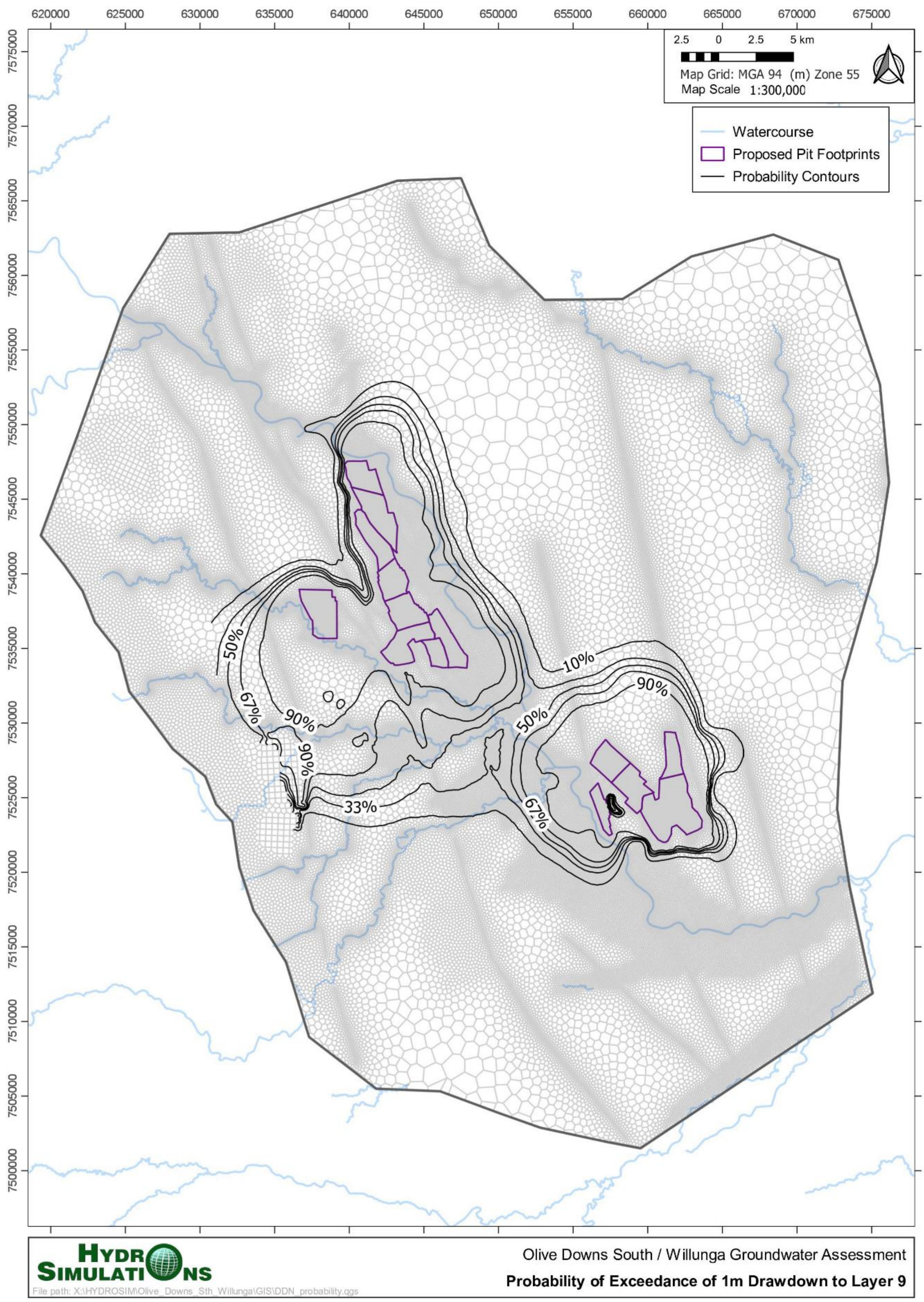


Figure B6-10 Probability of Exceedance of 1m Drawdown to Layer 9.

6.3.3 TRANSIENT STREAM IMPACTS

The following time-series charts show predicted flows over time as a “probability of exceedance”, i.e. 10%/33%/50%/67%/90% curves show the values at each point in time at which the respective percentage of Monte Carlo runs exceeded the given value.

Figure B6-11 and **Figure B6-12** show increased flows induced by ODS/WIL mining from streams to groundwater, as probabilities of exceedance. These may take the form of enhanced leakage, or in some cases, reduced baseflow. The impact to the Isaac River is shown independently, while other streams are lumped into one aggregate chart.

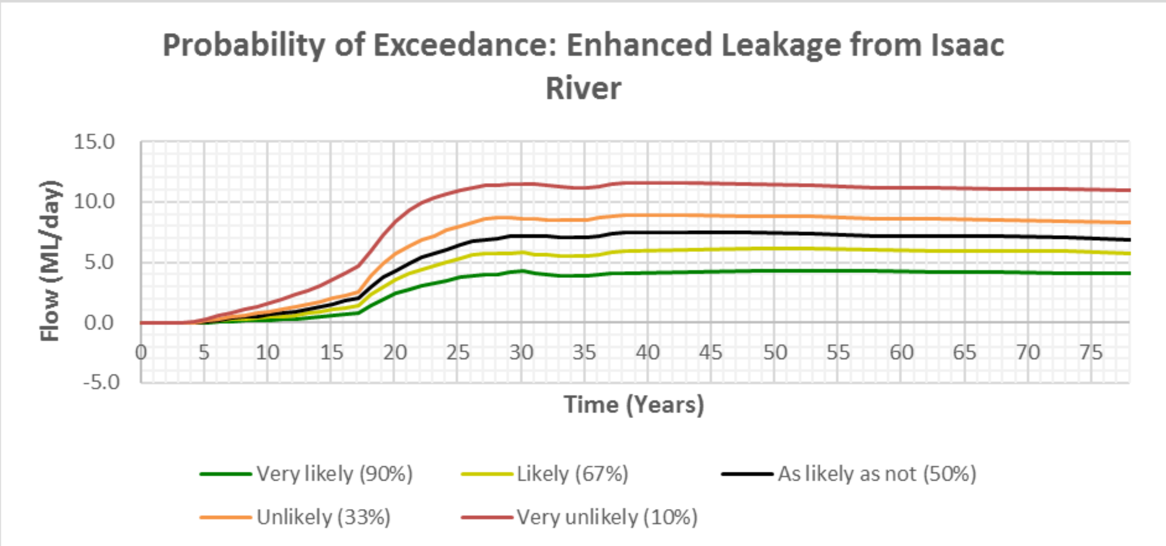


Figure B6-11 Probability of Exceedance: Enhanced Leakage from Isaac River

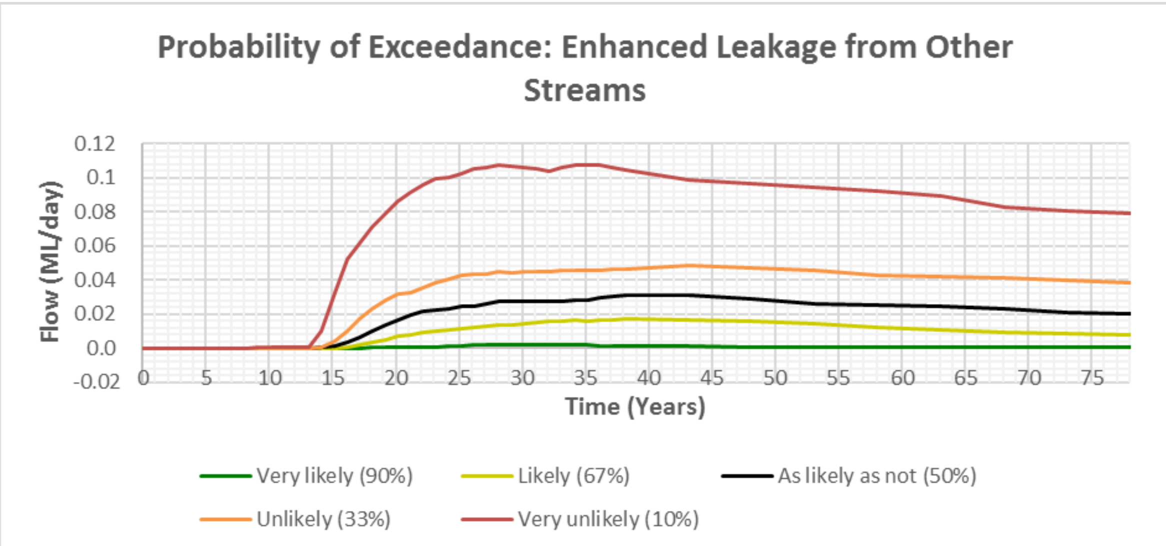


Figure B6-12 Probability of Exceedance: Enhanced Leakage from Other Streams

6.3.4 DIRECT ALLUVIUM WATER TAKE

The following charts show net take of water from storage in alluvium over time induced by ODS/WIL mining, as probabilities of exceedance. The total take is shown, followed by ODS and WIL portions separately. A positive “take” indicates that more water has been withdrawn from alluvium storage with ODS/WIL mining active, and a negative “take” indicates more water being drawn back into alluvium storage.

The boundary between ODS alluvium and WIL alluvium is defined arbitrarily by a line at bearing 70N through the confluence of Ripstone Creek and Isaac River. This definition allocates Phillips Creek to Willunga.

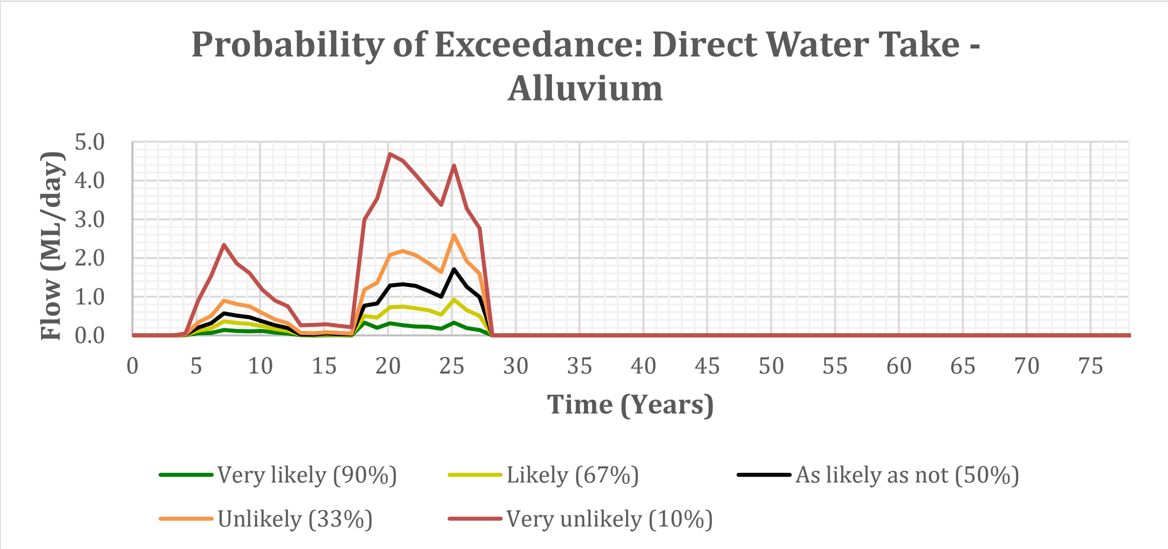


Figure B6-13 Probability of Exceedance: Direct Alluvium Water Take – Total

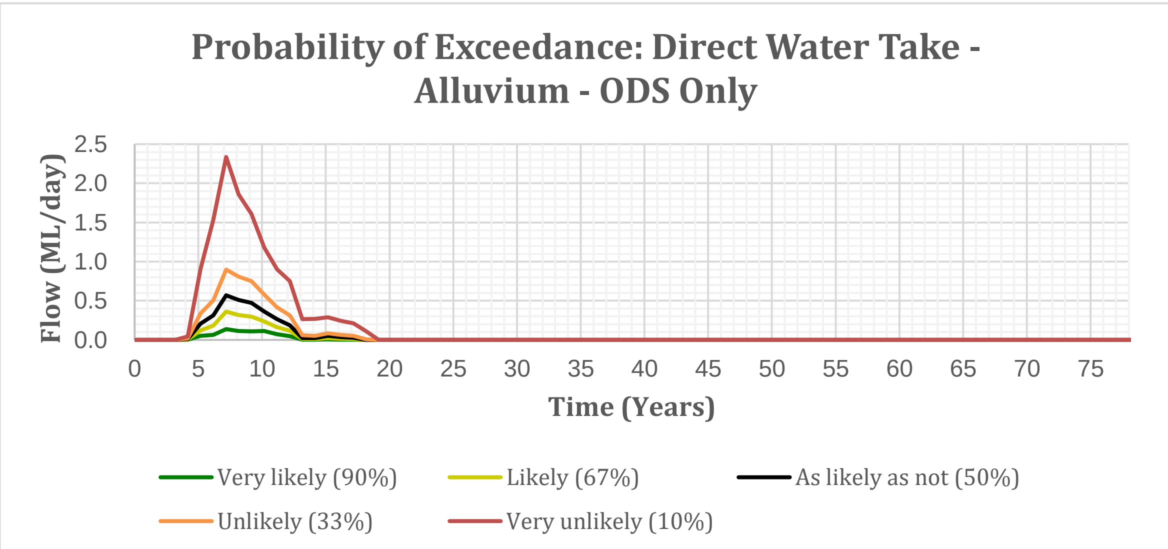


Figure B6-14 Probability of Exceedance: Direct Alluvium Water Take - Olive Downs South only

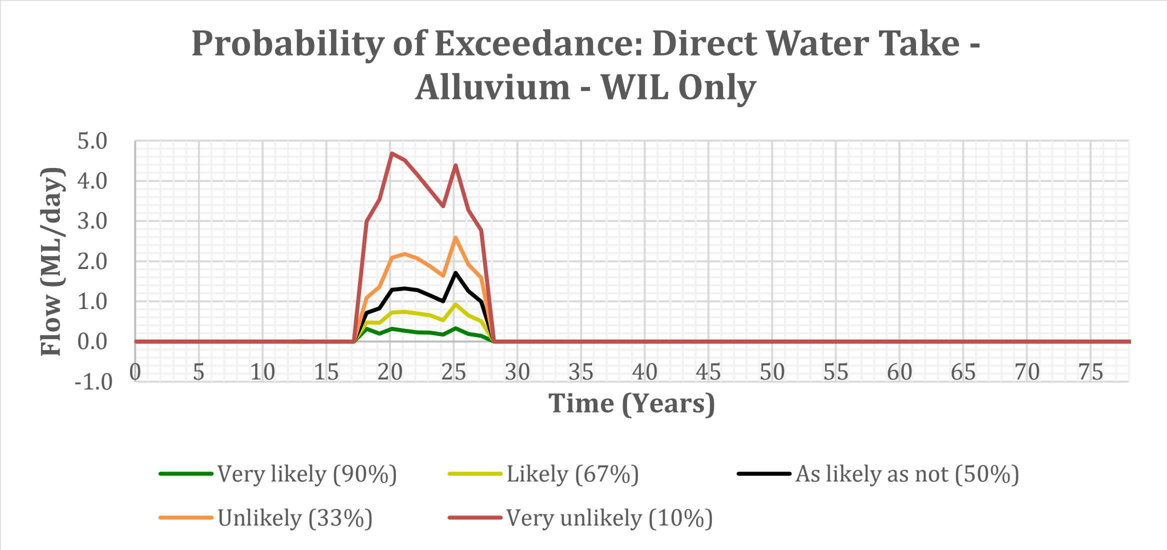


Figure B6-15 Probability of Exceedance: Direct Alluvium Water Take - Willunga only

6.3.5 INDIRECT ALLUVIUM WATER TAKE

The following charts show net take of water from storage in alluvium over time induced by ODS/WIL mining, as probabilities of exceedance. The total take is shown, followed by ODS and WIL portions separately. A positive “take” indicates that more water has been withdrawn from alluvium storage with ODS/WIL mining active, and a negative “take” indicates more water being drawn back into alluvium storage.

Due to way in which the *indirect* take is calculated, inclusive of all alluvium cells, the value incorporates the *direct* take as well. The indirect takes are calculated as the difference in net storage flux between mining (approved+project) and null (approved only) cases, so they are reporting the actions of all boundary conditions. That is, the reported take is the difference between (drain outflow+stream baseflow if any+flow to hard rock+ET) and (recharge+stream leakage+flow from hard rock) for the entire alluvium zone.

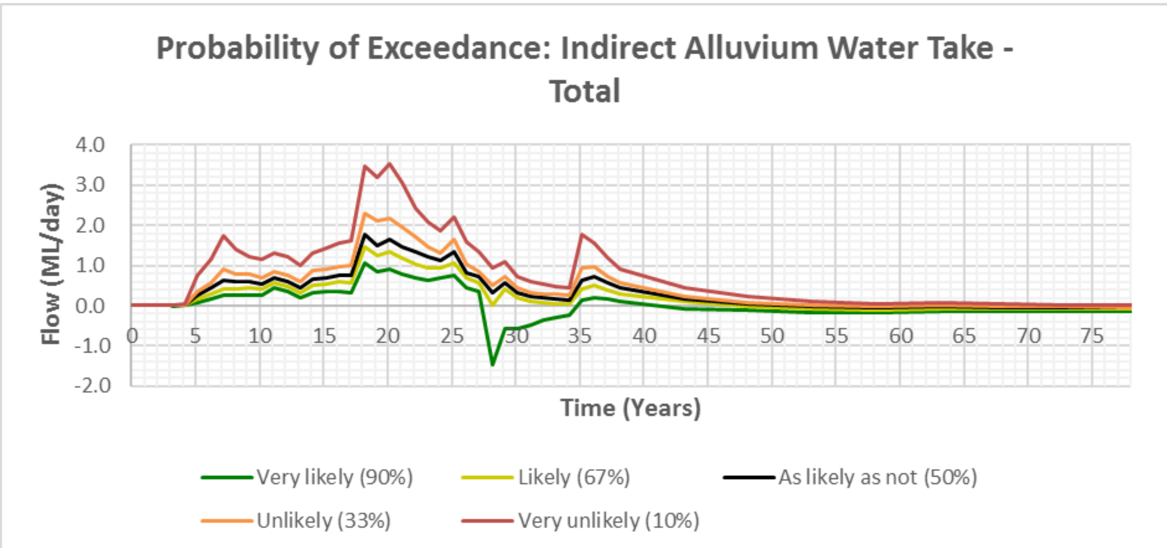


Figure B6-16 Probability of Exceedance: Indirect Alluvium Water Take - Total

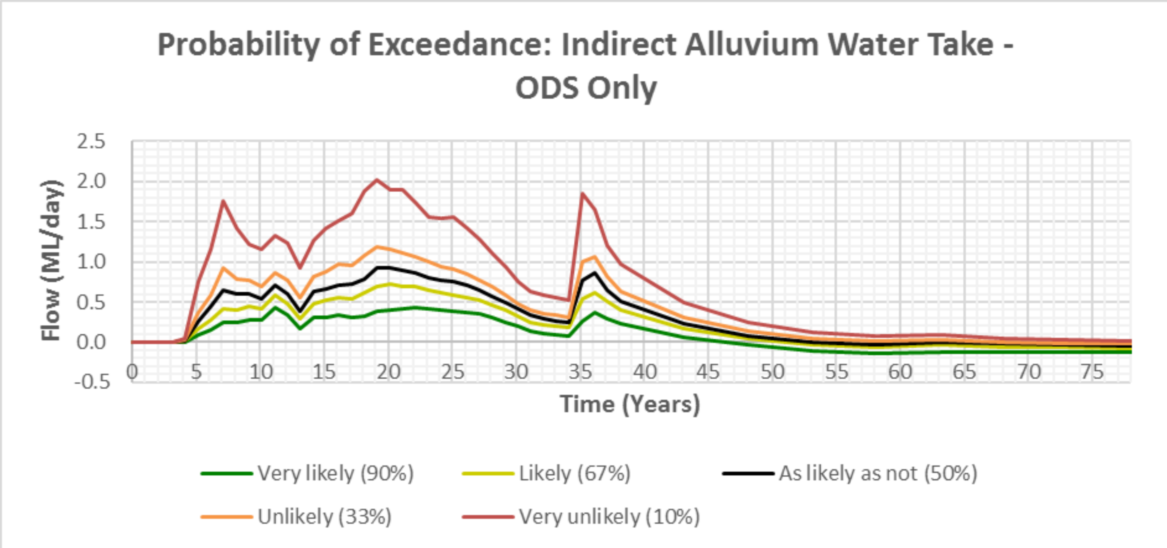


Figure B6-17 Probability of Exceedance: Indirect Alluvium Water Take - Olive Downs South only

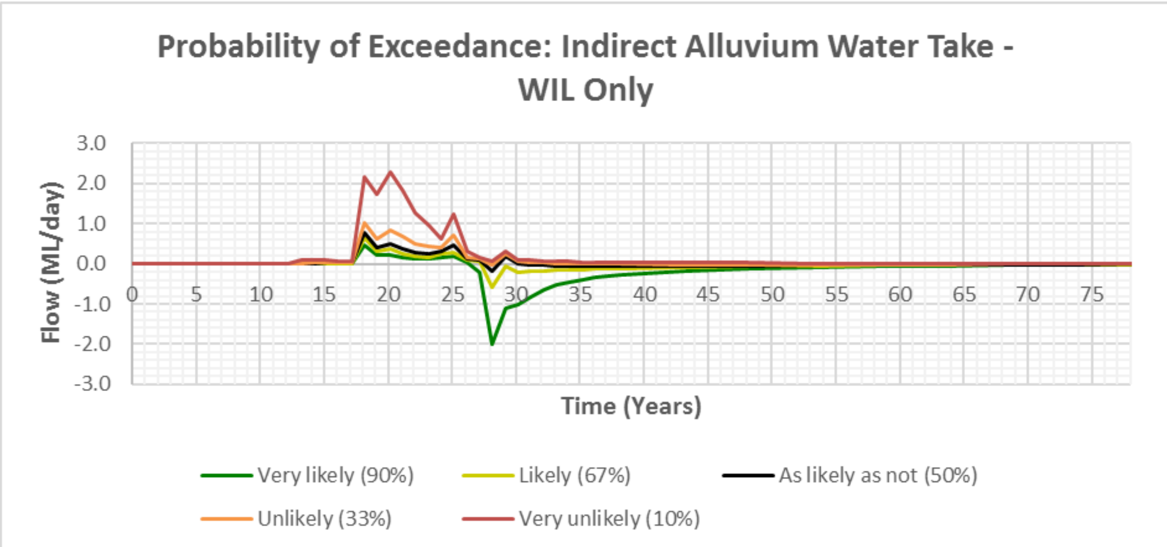


Figure B6-18 Probability of Exceedance: Indirect Alluvium Water Take - Willunga only

6.3.6 MONTE CARLO CONVERGENCE

When conducting stochastic modelling such as that performed here, it is important that a sufficient quantity of realisations have been evaluated to ensure that the results reported are accurate – that is, that the stochastic process has *converged*.

To gain confidence that the reported results were sufficiently close to their correct values, 99.7% confidence intervals were computed for the 10%, 33%, 50%, 67% and 90% probabilities of exceedance of key aggregate metrics.

Confidence interval bounds for the $(100 \times p)^{\text{th}}$ percentile may be approximated by the formula $p \pm \sqrt{p(1-p)c^2/n}$, where c is the desired confidence in standard deviations of the normal distribution – $c = 3$ for 99.7% confidence – and n is the number of runs (see e.g. Mood *et al.*, 1974 for derivations of confidence interval bounds). For example, it may be said with 99.7%

confidence after 312 successful runs that the true 90th percentile value lies between the 84.9th and 95.1st percentile estimates ($= 100 \times \left(0.9 \pm \sqrt{0.9 \times 0.1 \text{ x } 9/312}\right)$).

In this section, charts are presented illustrating the convergence of key metrics. Two types of chart are presented. The first shows the values of the 10th, 33rd, 50th, 67th and 90th percentiles as they evolve with the number of runs evaluated. The second shows the 10th, 50th and 90th percentile values surrounded by their computed 99.7% confidence intervals, also as they evolve with respect to the number of runs evaluated. Note that 33rd and 67th percentile confidence intervals have been omitted from these charts to ease readability; the intervals in these cases were similar or narrower in width than those of the 10th, 50th and 90th percentiles shown.

The colour coding of the convergence charts follows the same categorisation as in the other charts presented: "very likely (90%)" - **green**, "likely (67%)" - **light yellow-green**, "about as likely as not (50%)" - **black**, "unlikely (33%)" - **orange**, and "very unlikely (10%)" - **red**. Solid lines in the convergence charts represent the actual sampled percentile values, and dashed lines represent the 99.7% confidence intervals of the percentile corresponding to their colour.

6.3.6.1 Number of bores affected by 1m drawdown or more

The 99.7% confidence intervals indicate that the reported numbers of affected bores are within a single bore of the true values with high probability (**Figure B6-19** and **Figure B6-20**).

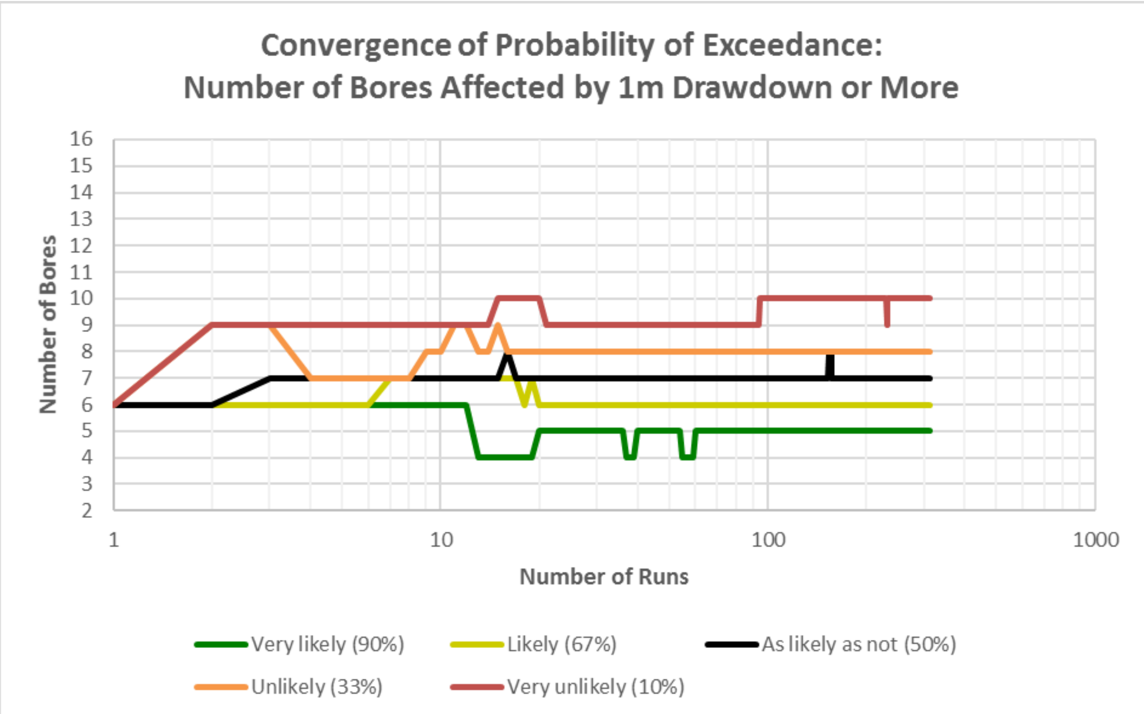


Figure B6-19 Convergence of Probability of Exceedance: Number of Bores Affected by 1m Drawdown or More

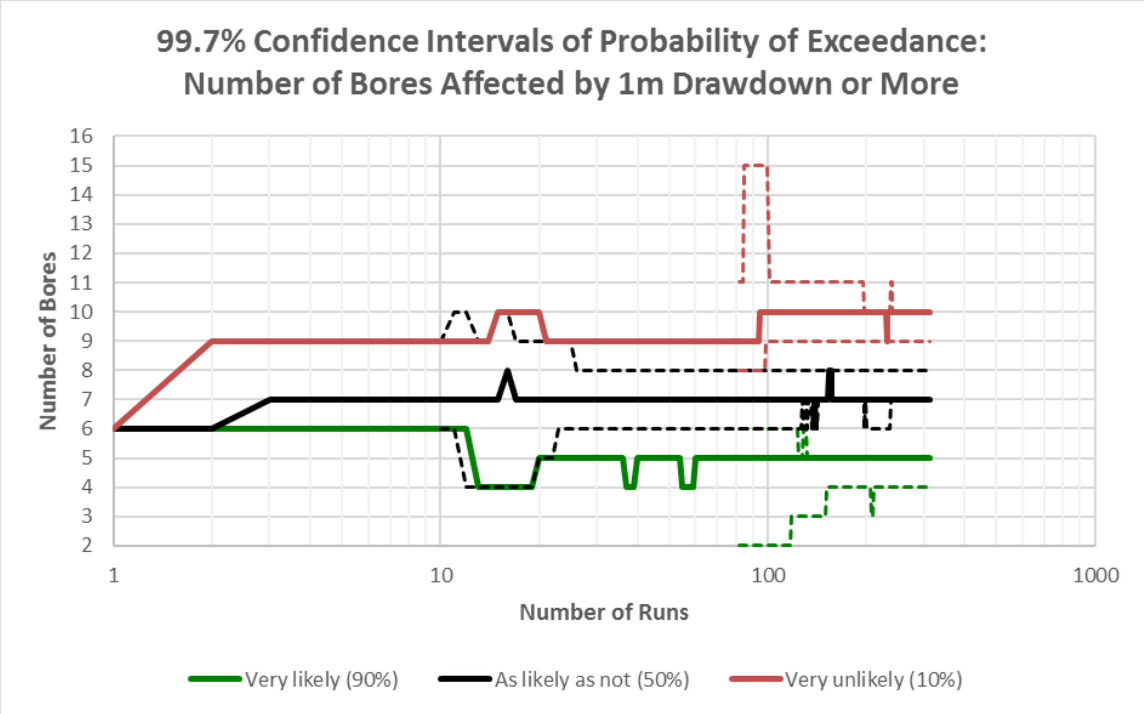


Figure B6-20 99.7% Confidence Intervals of Probability of Exceedance: Number of Bores Affected by 1m Drawdown or More

6.3.6.2 Enhanced leakage: Isaac River

The reported values for average enhanced leakage to the Isaac River are within 0.46 ML/day (14.3%) of the true averages with high probability (**Figure B6-21** and **Figure B6-22**).

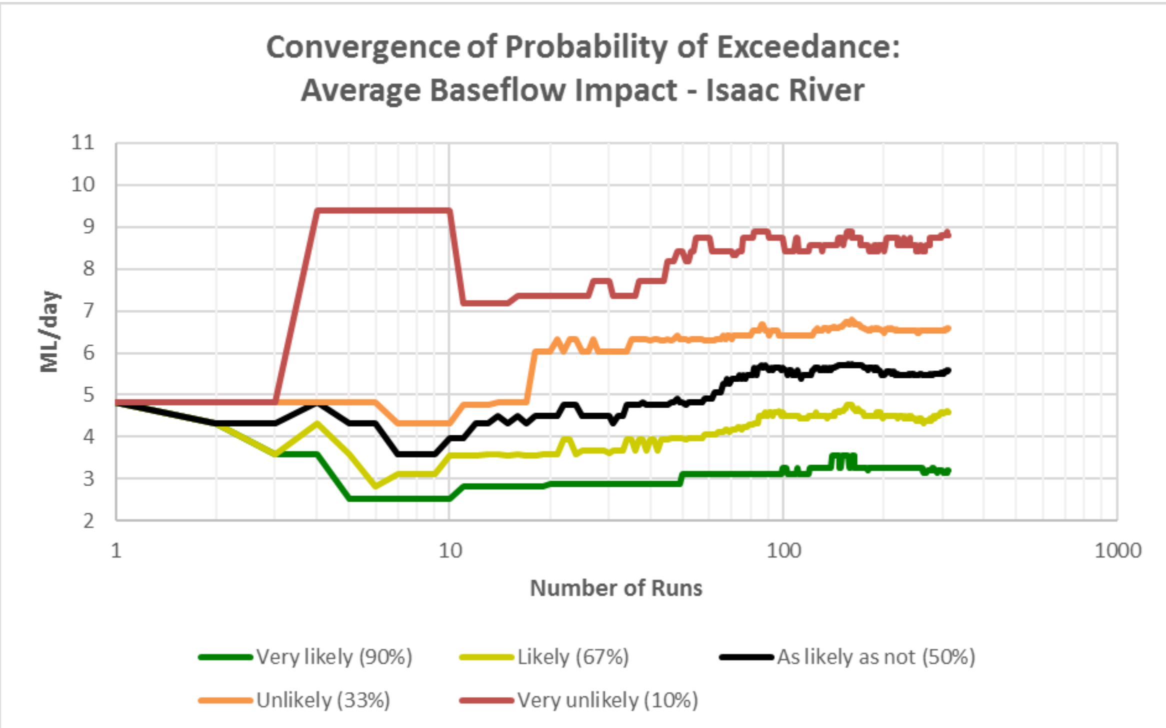


Figure B6-21 Convergence of Probability of Exceedance: Average Baseflow Impact – Isaac River

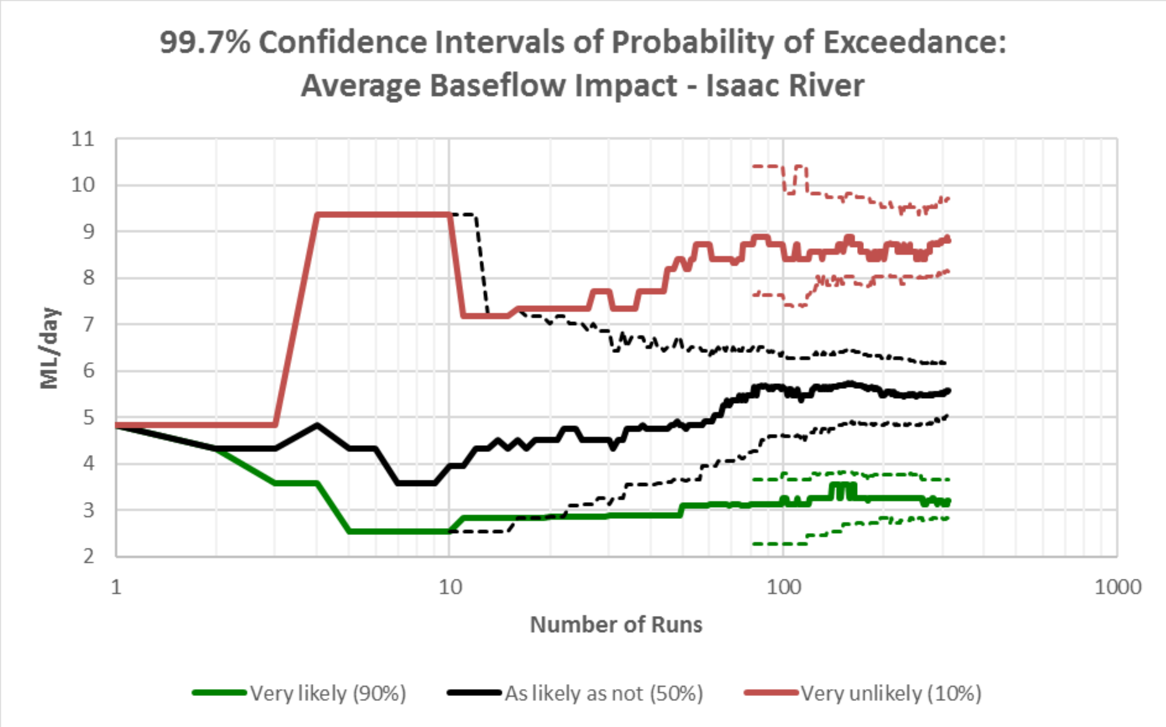


Figure 6-22 99.7% Confidence Intervals of Probability of Exceedance: Average Baseflow Impact – Isaac River

6.3.6.3 Peak indirect alluvium take

The reported values for peak indirect water take from alluvium are within 0.97 ML/day (24.4%) of the true averages with high probability in the "very unlikely (10%)" exceedance case, and within 12.9% of the true averages in other cases (**Figure B6-23** and **Figure B6-24**).

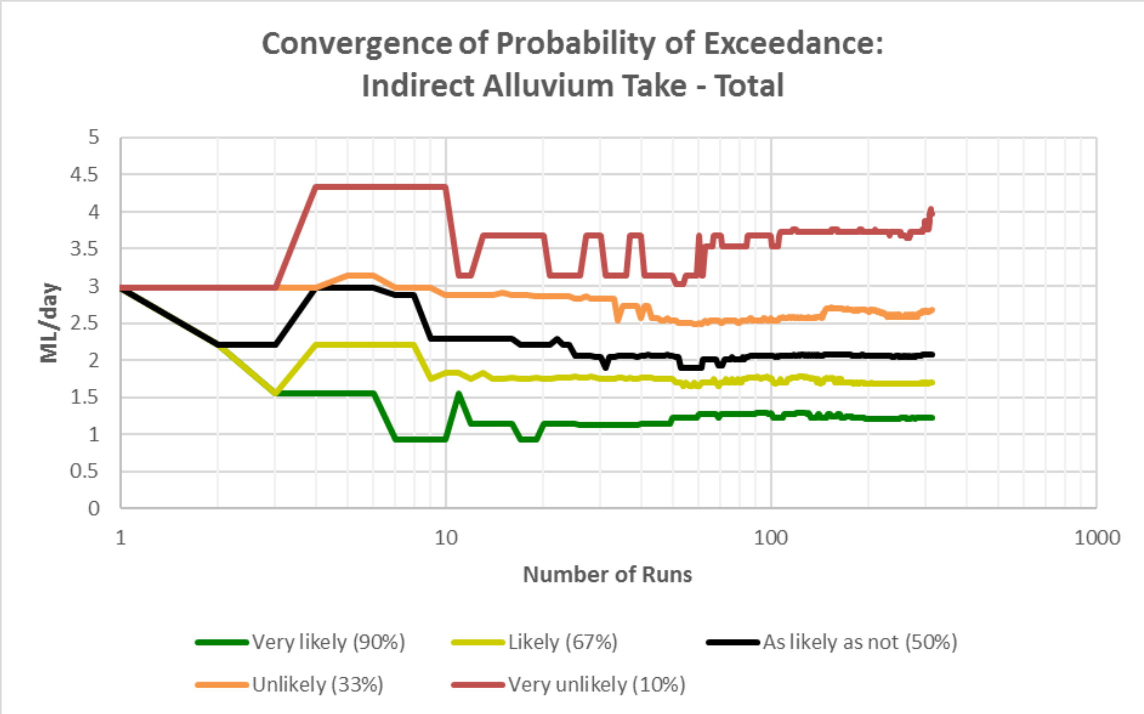


Figure 6-23 Convergence of Probability of Exceedance: Indirect Alluvium Take – Total

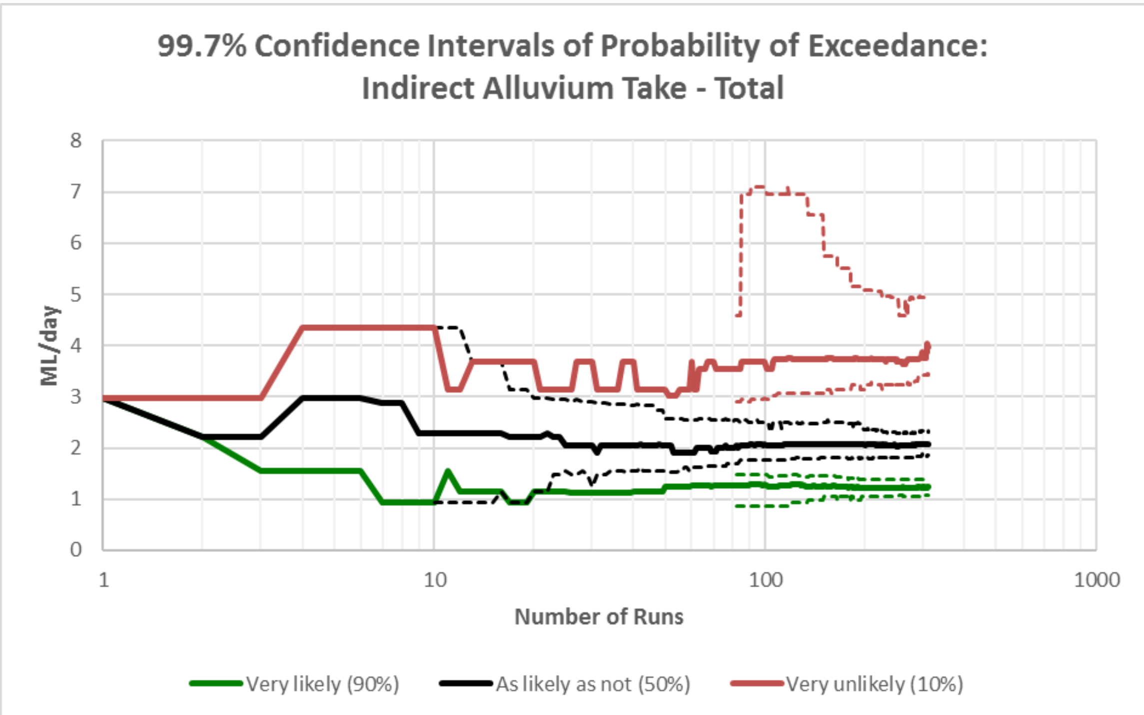


Figure B6-24 99.7% Confidence Intervals of Probability of Exceedance: Indirect Alluvium Take – Total

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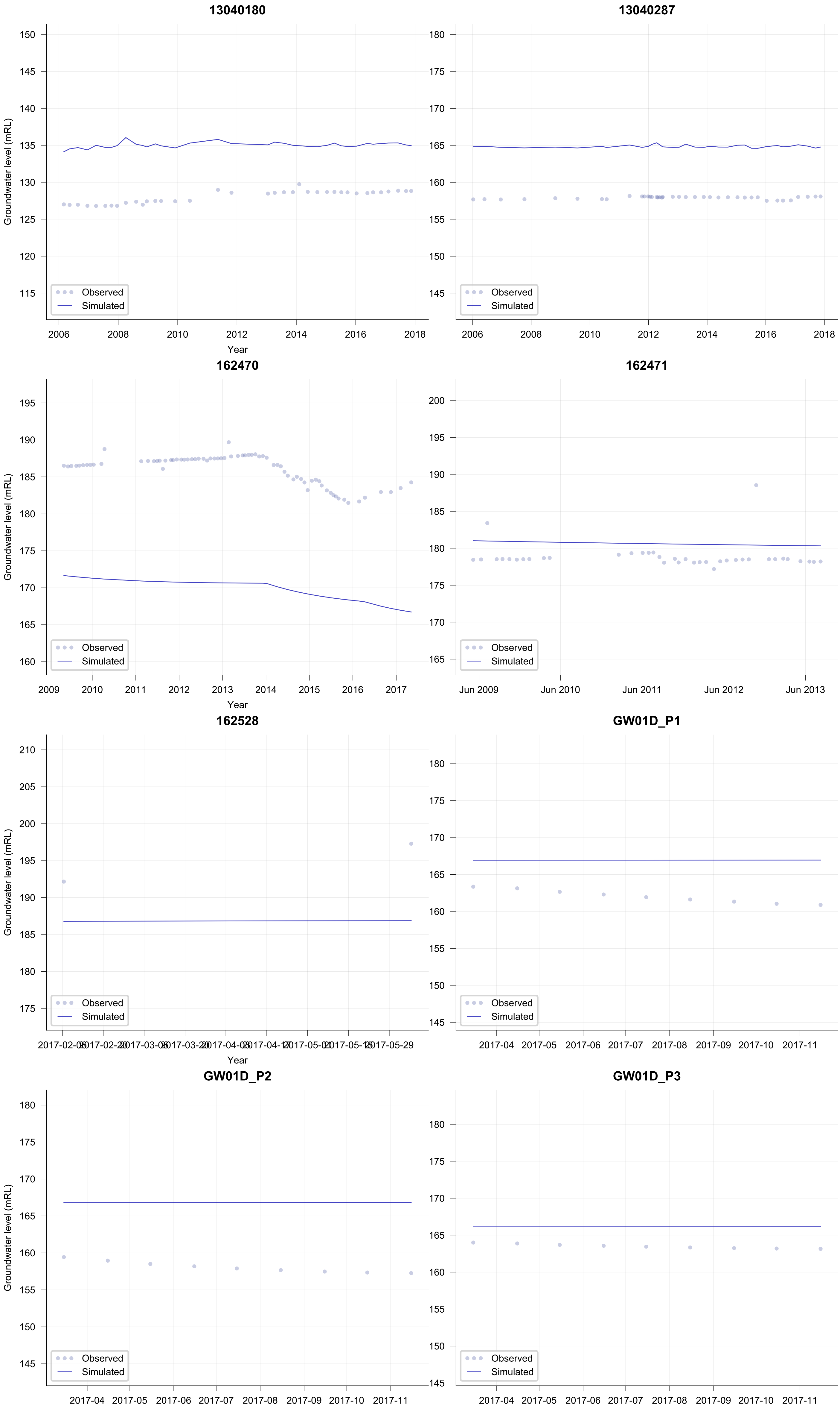
Attachments

B1 – Calibration Hydrographs

B2 – Residuals

Attachment B1 – Calibration Hydrographs

TOC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162470
162471
162528
GW01D_P1
GW01D_P2
GW01D_P3
Groundwater level (mRL)
Year
Observed
Simulated
2006
2008
2010
2012
2014
2016
2018
2009
2011
2013
2015
2017
Jun 2009
Jun 2010
Jun 2011
Jun 2012
Jun 2013
2017-04
2017-05
2017-06
2017-07
2017-08
2017-09
2017-10
2017-11
2017-05-29

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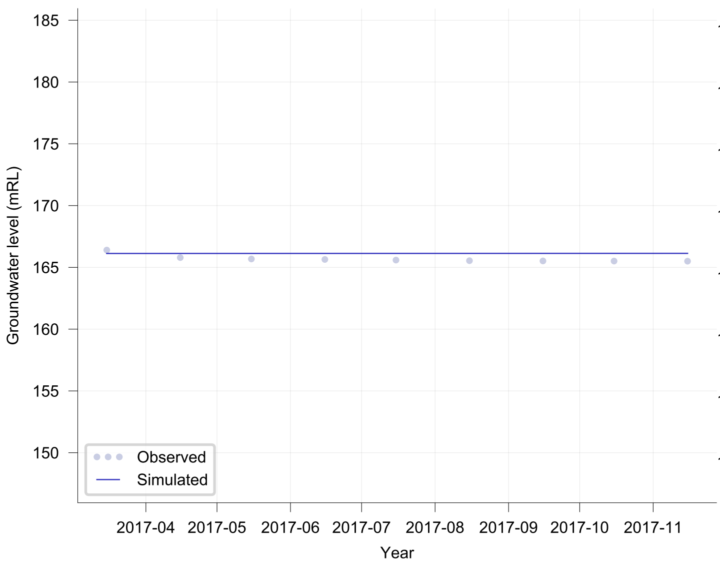

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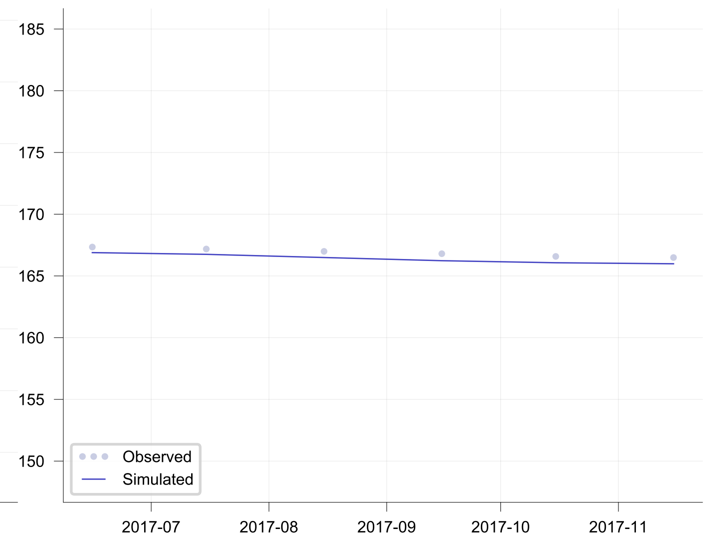

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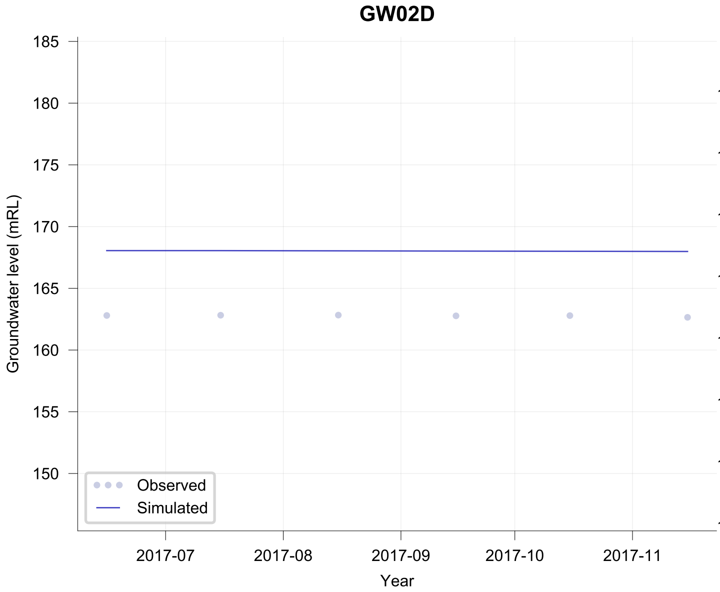

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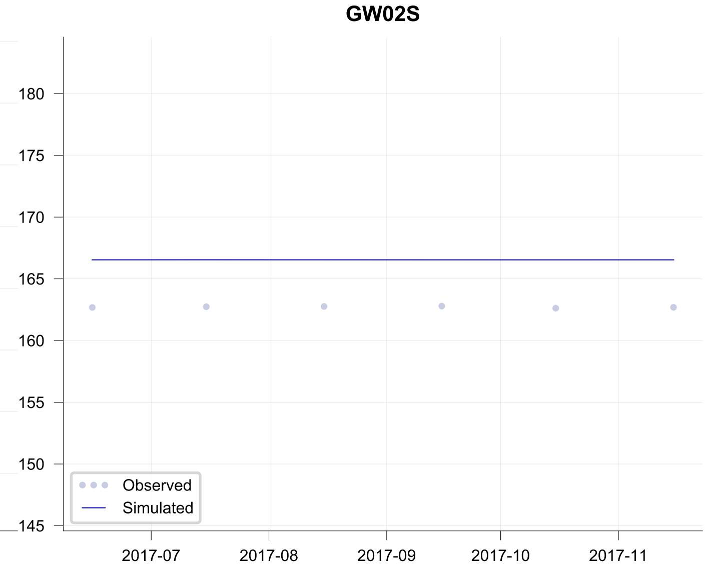

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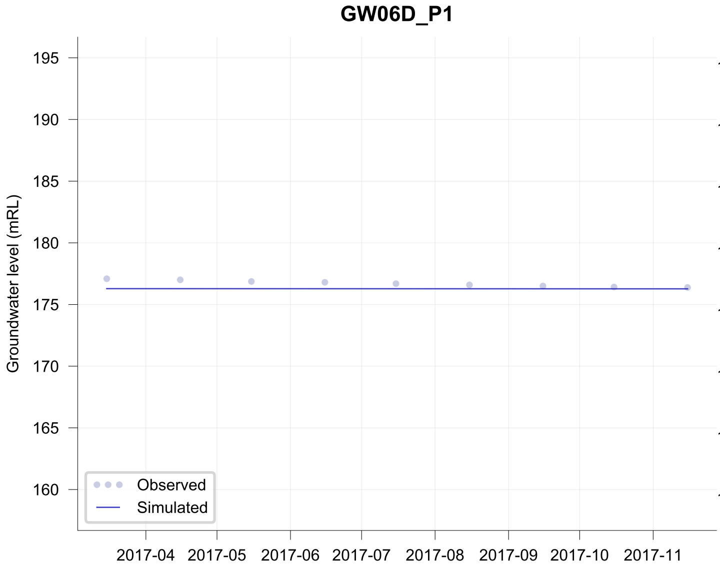

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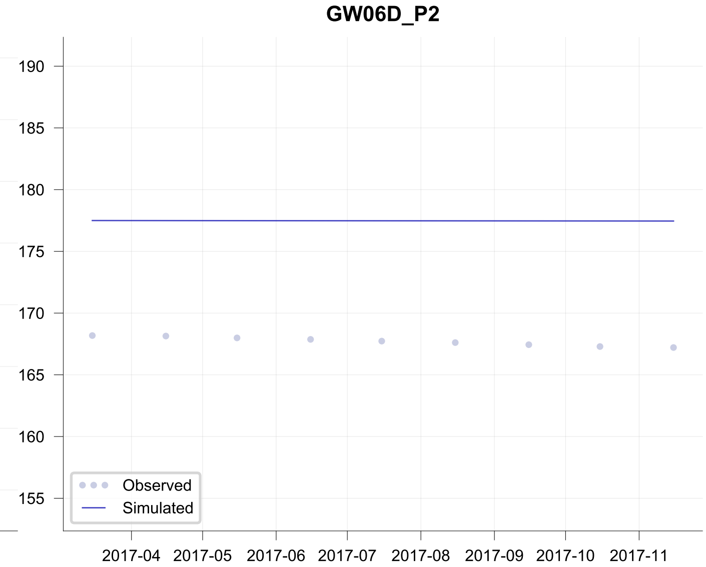

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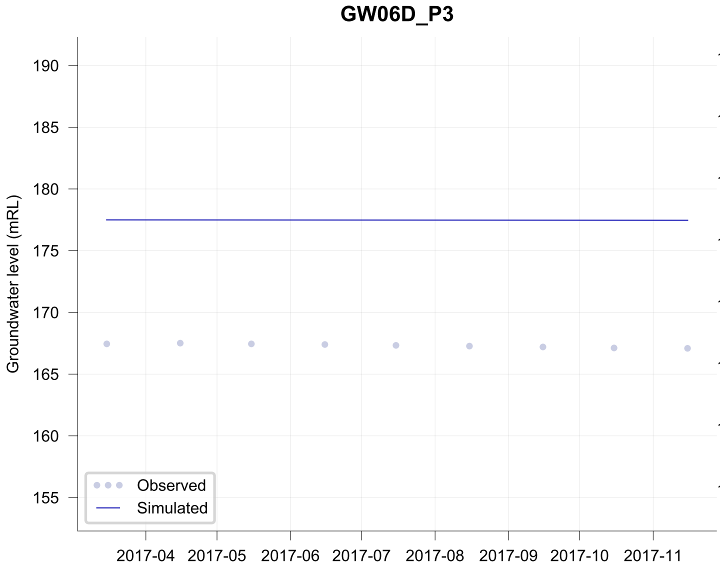

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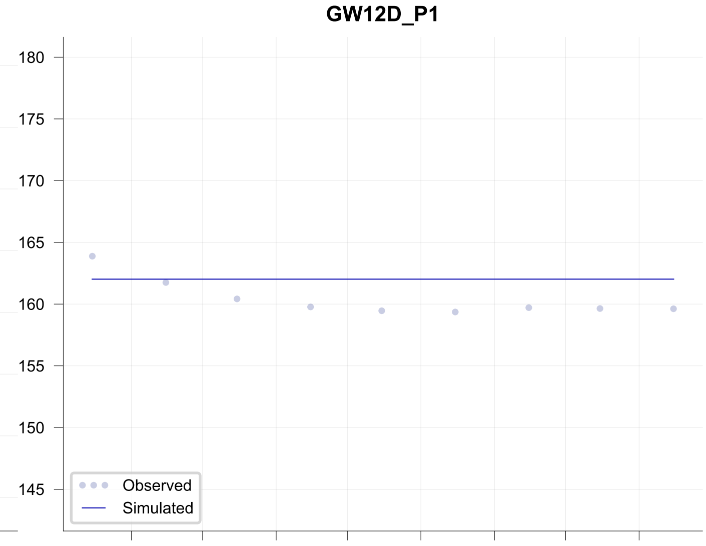

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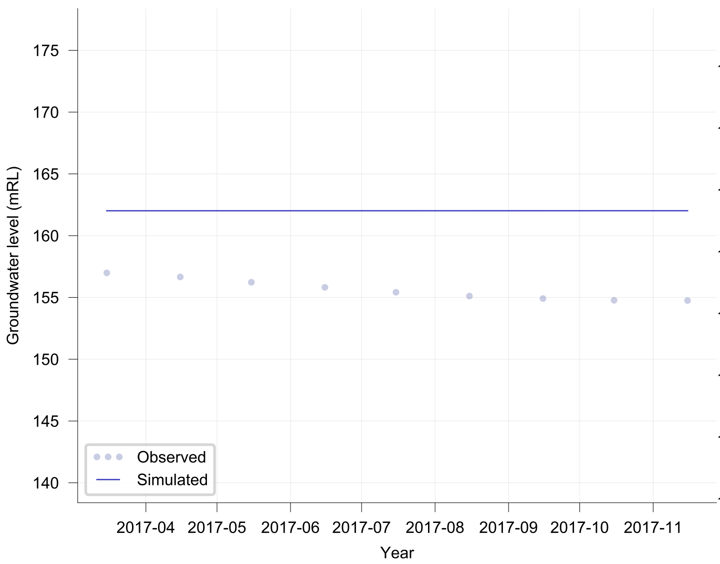

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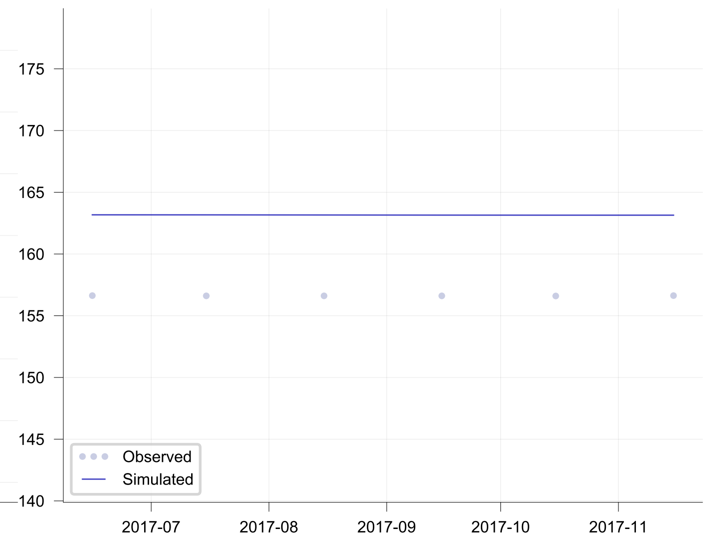

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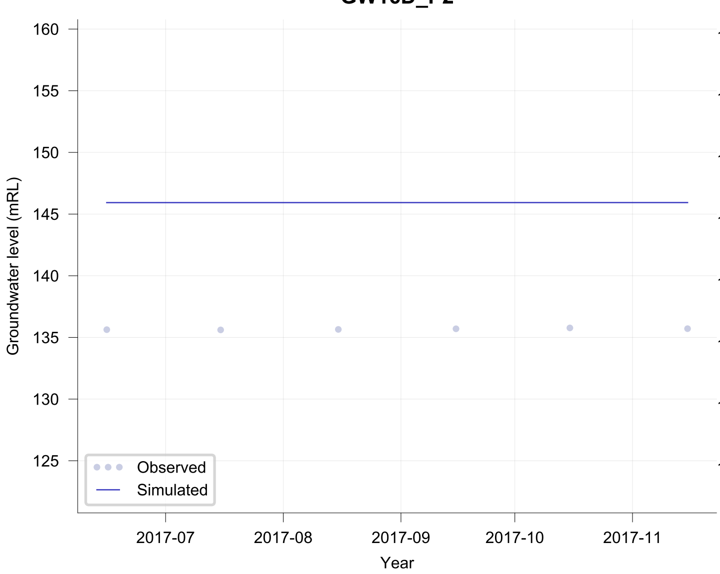

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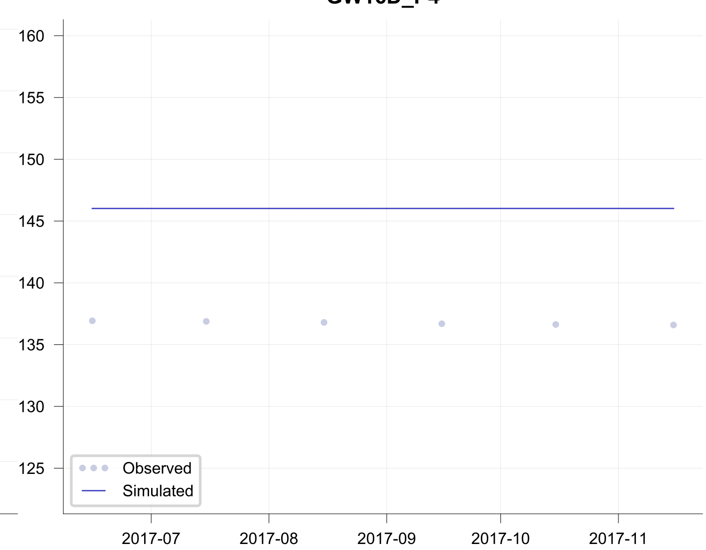

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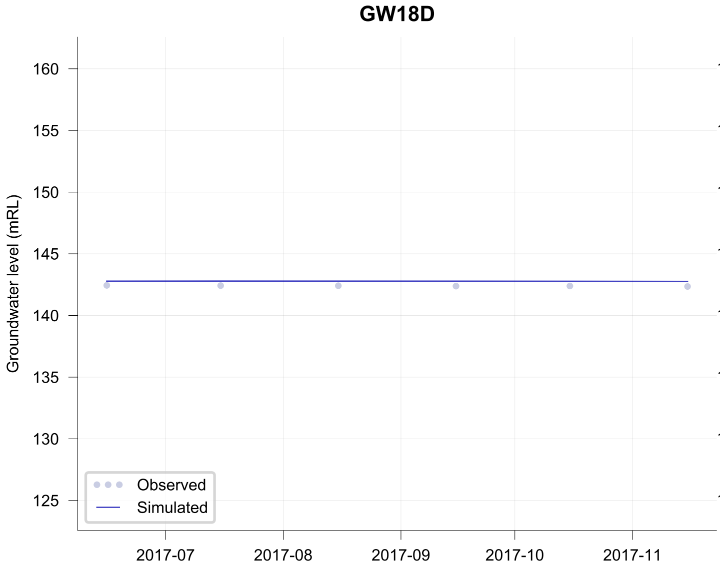

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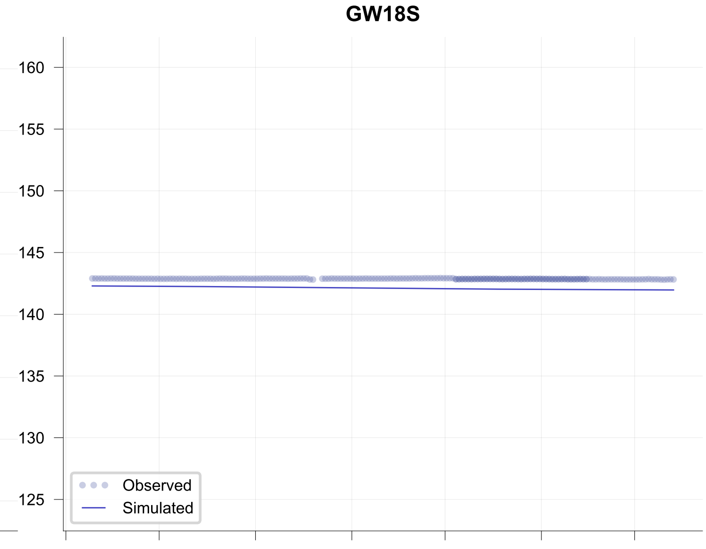

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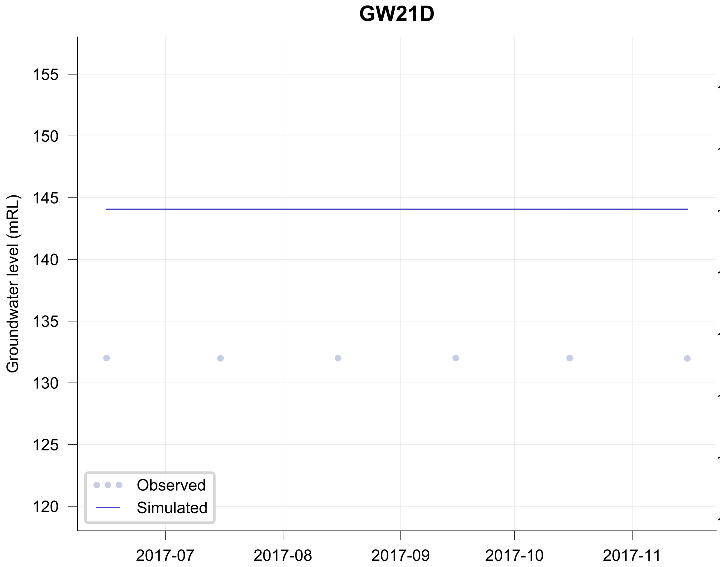

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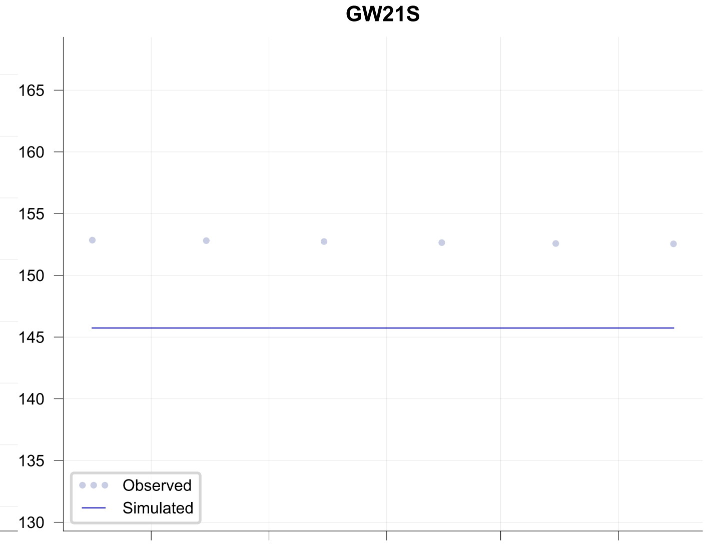

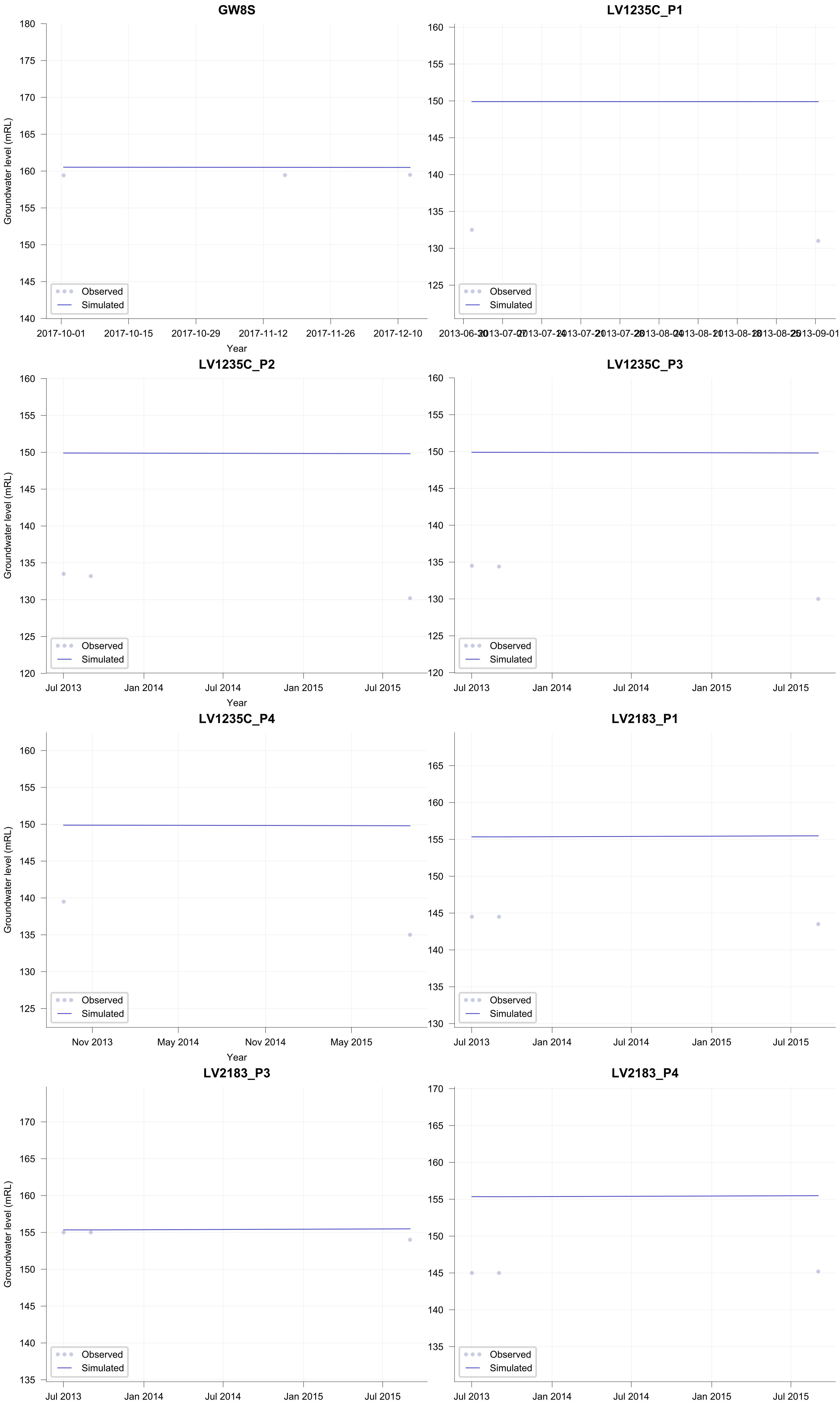
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170
165
160
155
150
145
140
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2017-10-15
2017-10-29
2017-11-12
2017-11-26
2017-12-10
Year
Observed
Simulated
LV1235C_P1
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155
150
145
140
135
130
125
2013-06-30
2013-07-07
2013-07-14
2013-07-21
2013-07-28
2013-08-04
2013-08-11
2013-08-18
2013-08-25
2013-09-01
Observed
Simulated
LV1235C_P2
Groundwater level (mRL)
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155
150
145
140
135
130
125
120
Jul 2013
Jan 2014
Jul 2014
Jan 2015
Jul 2015
Year
Observed
Simulated
LV1235C_P3
160
155
150
145
140
135
130
125
120
Jul 2013
Jan 2014
Jul 2014
Jan 2015
Jul 2015
Observed
Simulated
LV1235C_P4
Groundwater level (mRL)
160
155
150
145
140
135
130
125
Nov 2013
May 2014
Nov 2014
May 2015
Year
Observed
Simulated
LV2183_P1
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160
155
150
145
140
135
130
Jul 2013
Jan 2014
Jul 2014
Jan 2015
Jul 2015
Observed
Simulated
LV2183_P3
Groundwater level (mRL)
170
165
160
155
150
145
140
135
Jul 2013
Jan 2014
Jul 2014
Jan 2015
Jul 2015
Year
Observed
Simulated
LV2183_P4
170
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TOC

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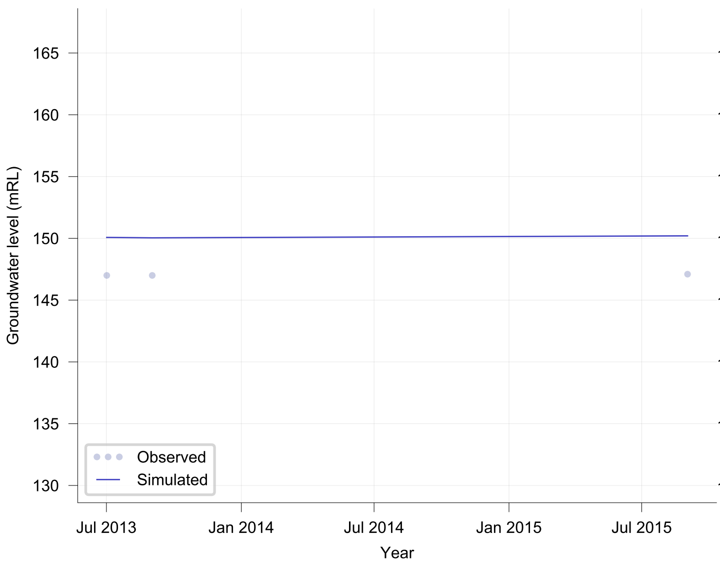

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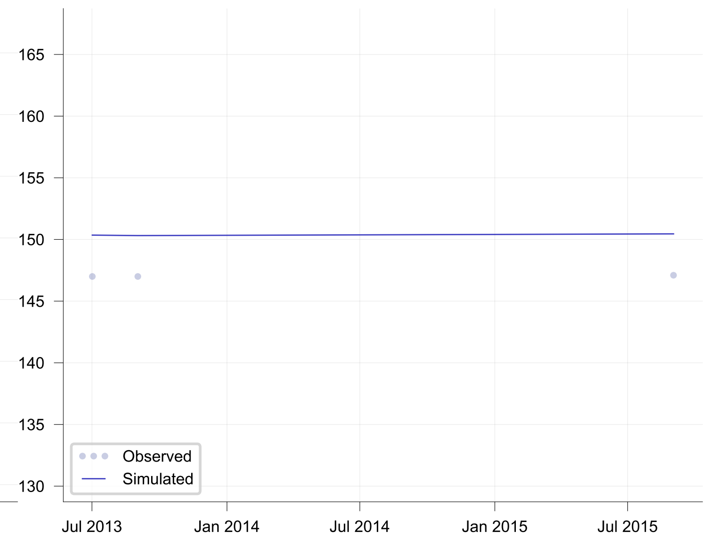

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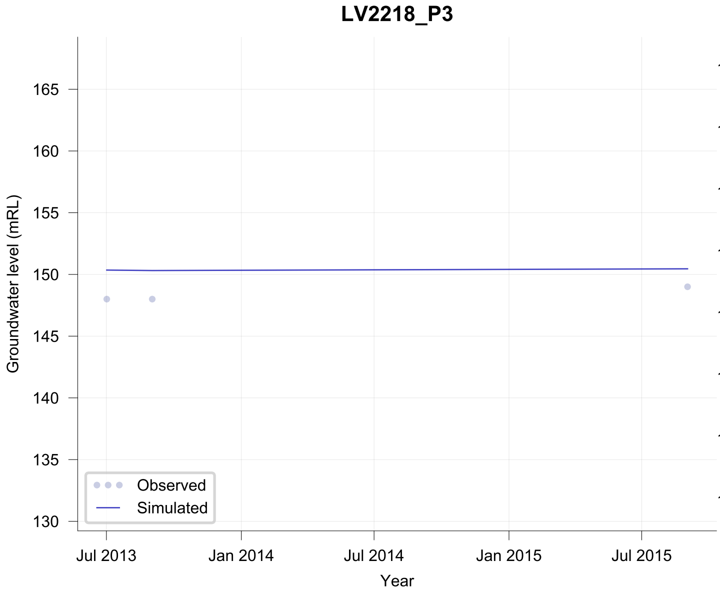

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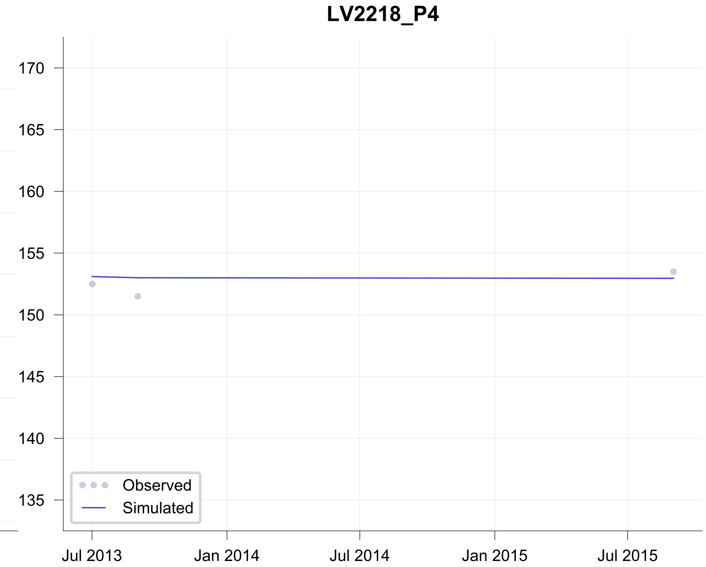

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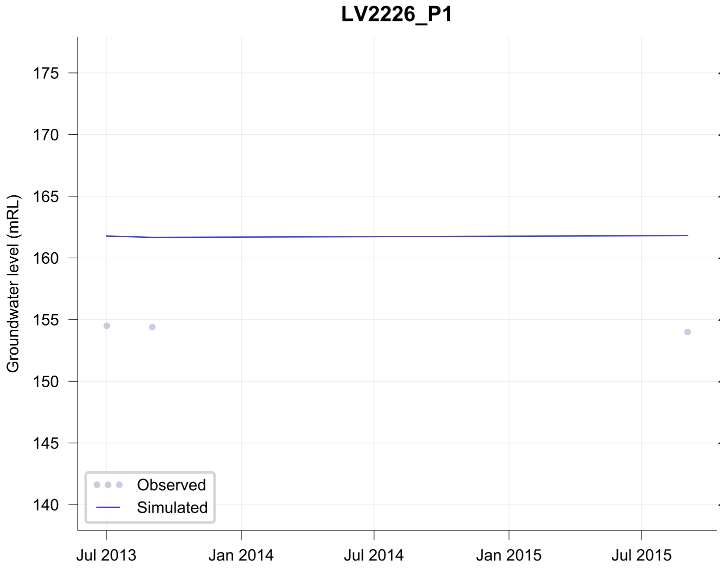

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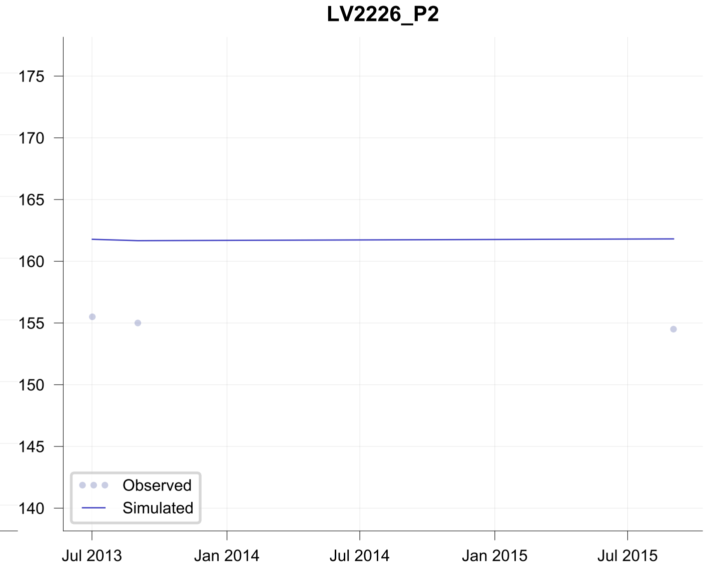

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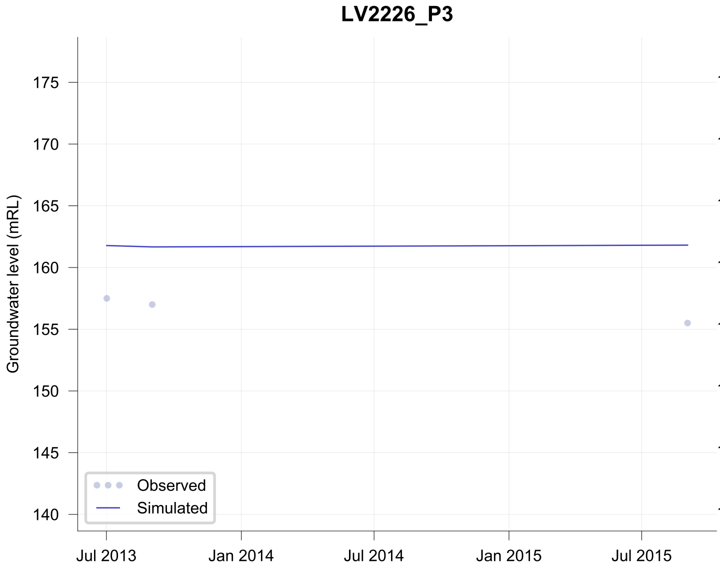

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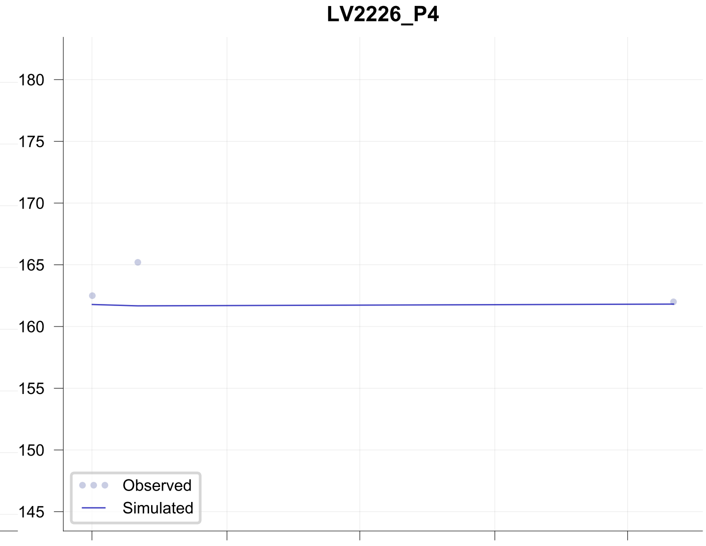
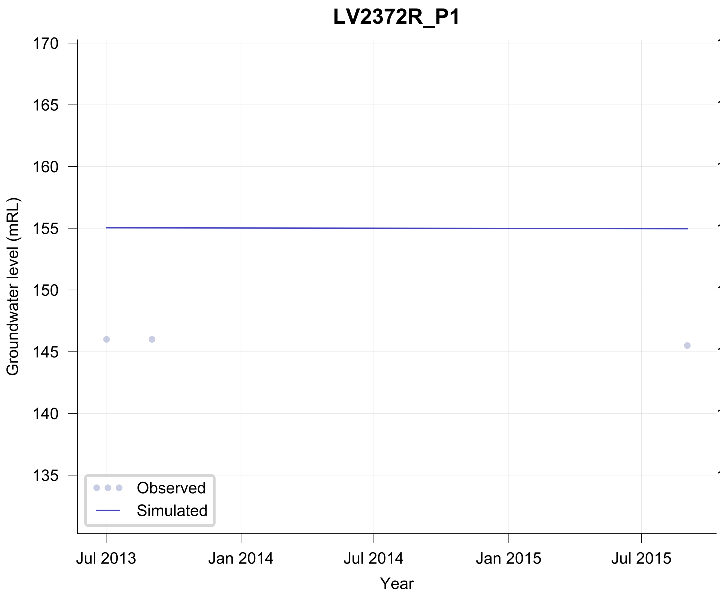
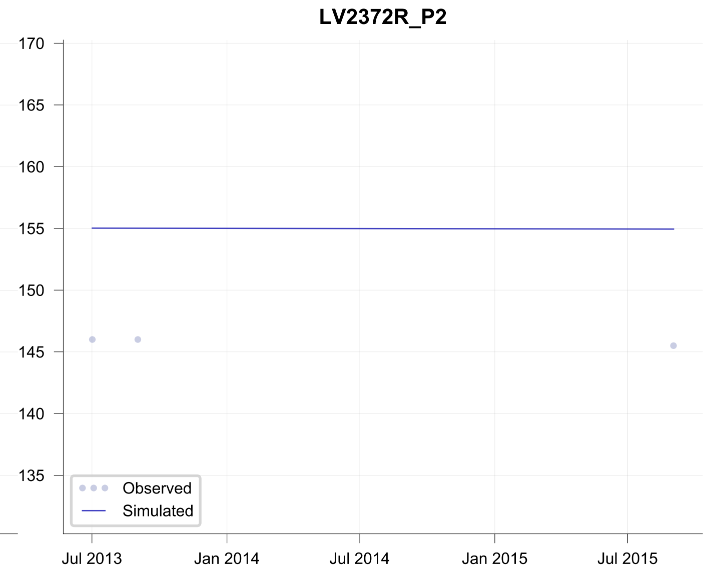
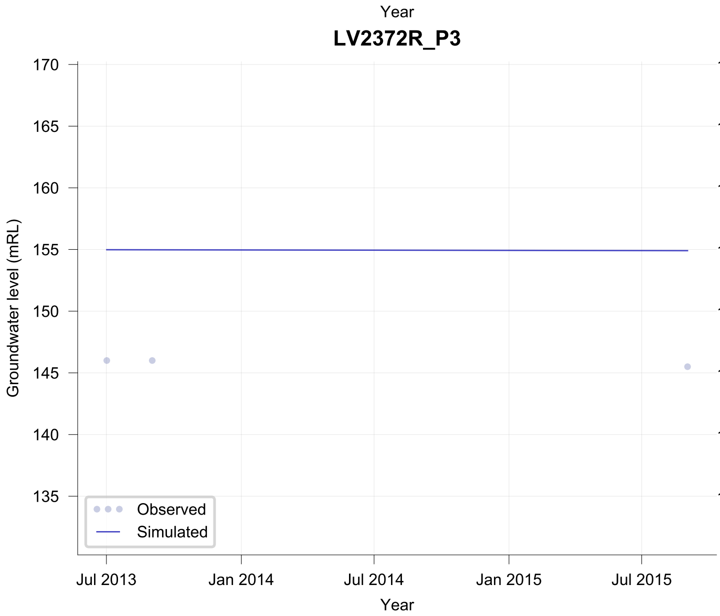
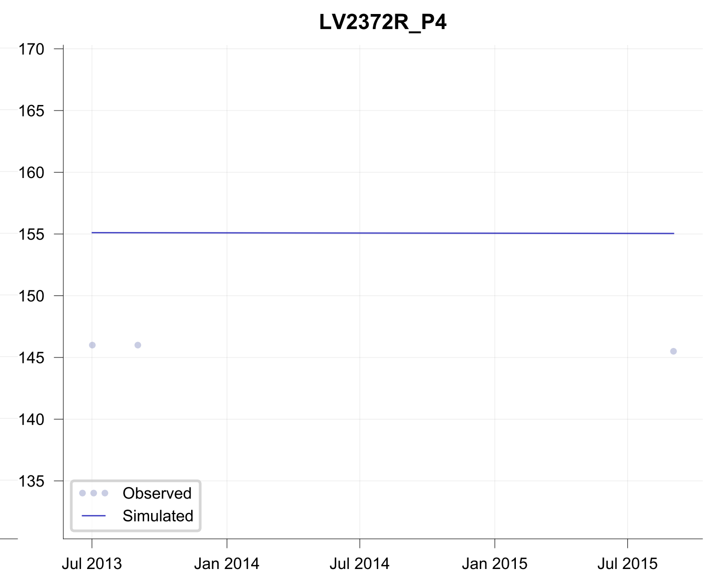
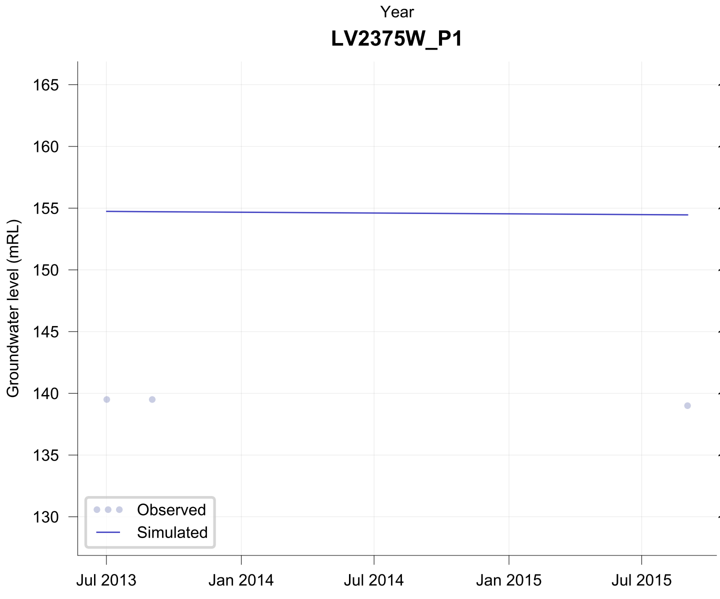


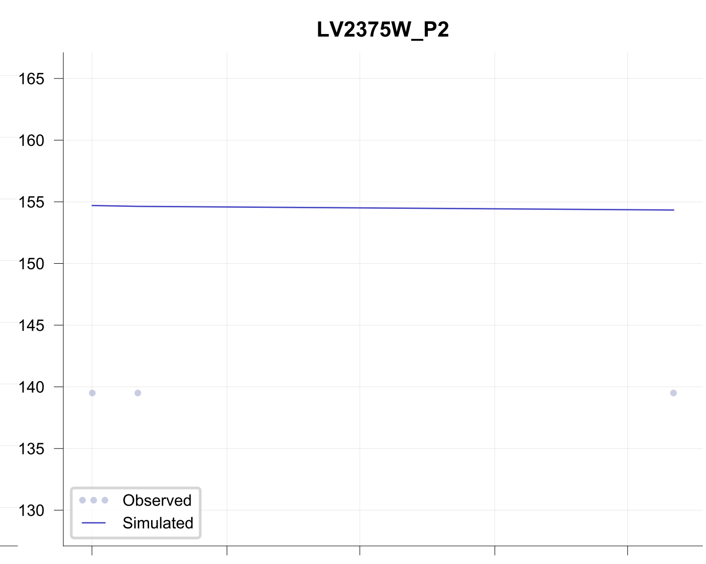

LV2372R_P1
Groundwater level (mRL)
170
165
160
155
150
145
140
135
Observed
Simulated
Jul 2013
Jan 2014
Jul 2014
Jan 2015
Jul 2015
Year

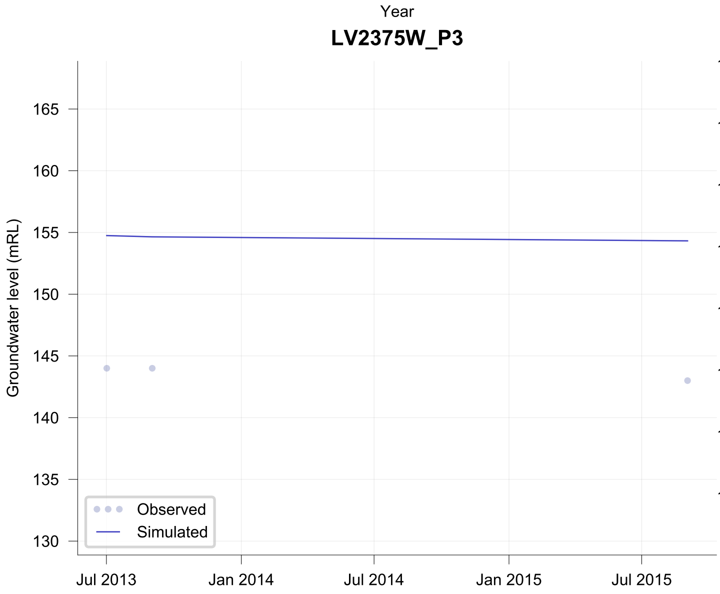

LV2372R_P2
170
165
160
155
150
145
140
135
Observed
Simulated
Jul 2013
Jan 2014
Jul 2014
Jan 2015
Jul 2015

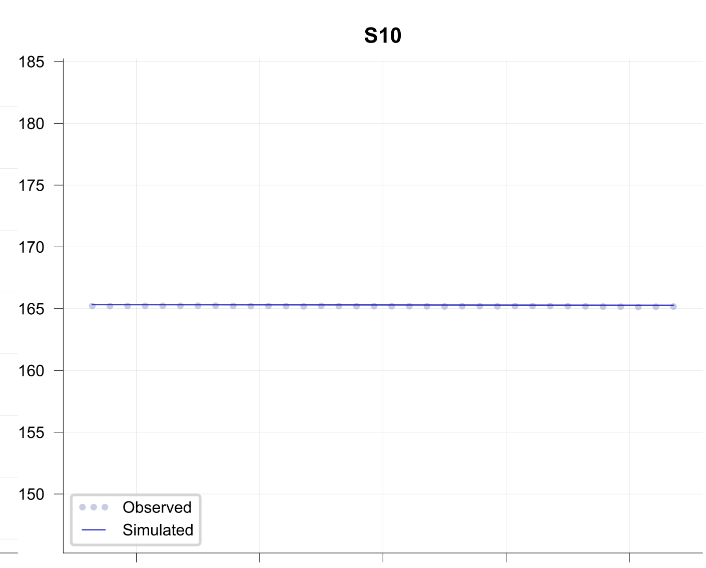

LV2372R_P3
Groundwater level (mRL)
170
165
160
155
150
145
140
135
Observed
Simulated
Jul 2013
Jan 2014
Jul 2014
Jan 2015
Jul 2015
Year

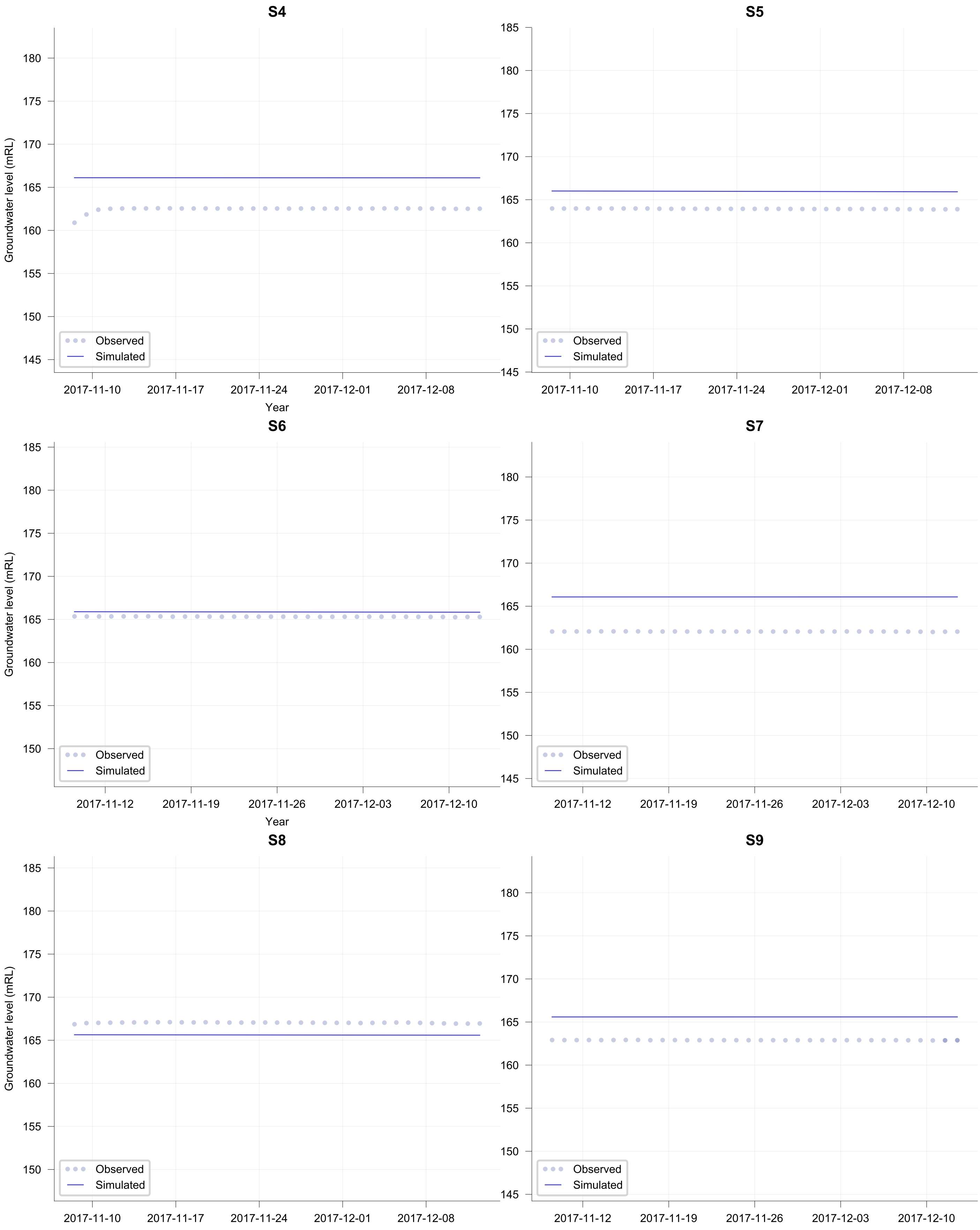

LV2372R_P4
170
165
160
155
150
145
140
135
Observed
Simulated
Jul 2013
Jan 2014
Jul 2014
Jan 2015
Jul 2015


LV2375W_P1
Groundwater level (mRL)
165
160
155
150
145
140
135
130
Observed
Simulated
Jul 2013
Jan 2014
Jul 2014
Jan 2015
Jul 2015
Year


LV2375W_P2
165
160
155
150
145
140
135
130
Observed
Simulated
Jul 2013
Jan 2014
Jul 2014
Jan 2015
Jul 2015


LV2375W_P3
Groundwater level (mRL)
165
160
155
150
145
140
135
130
Observed
Simulated
Jul 2013
Jan 2014
Jul 2014
Jan 2015
Jul 2015
Year


S10
185
180
175
170
165
160
155
150
Observed
Simulated
2017-11-12
2017-11-19
2017-11-26
2017-12-03
2017-12-10


S4
S5
S6
S7
S8
S9
Groundwater level (mRL)
Year
Observed
Simulated
2017-11-10
2017-11-17
2017-11-24
2017-12-01
2017-12-08
2017-11-12
2017-11-19
2017-11-26
2017-12-03
2017-12-10
145
150
155
160
165
170
175
180
185

Attachment B2 – Residuals

ID	Easting	Northing	Layer	Average Residual	Min	Max
8	623797	7552173	9	0.4	0.4	0.4
11	627210	7546907	2	4.1	4.1	4.1
13	627200	7546952	2	4.6	4.6	4.6
14	628767	7546686	2	-0.3	-0.3	-0.3
15	629120	7546795	8	-2.1	-2.1	-2.1
16	628258	7544098	12	8.5	8.5	8.5
43639	638939	7511033	14	-9.8	-9.8	-9.8
44161	647509	7540289	1	2.8	2.8	2.8
44164	647938	7540971	2	-0.5	-0.5	-0.5
88525	671221	7521945	12	-13.5	-13.5	-13.5
88526	671710	7519574	12	-8.2	-8.2	-8.2
88527	665212	7516134	1	-5.8	-5.8	-5.8
90074	671554	7510596	12	-3.9	-3.9	-3.9
90076	672380	7515478	12	-6.2	-6.2	-6.2
97180	654694	7527196	1	1.5	1.5	1.5
97181	656434	7523988	1	1.3	1.3	1.3
97182	657151	7522448	1	-1.7	-1.7	-1.7
97183	657419	7522279	1	-1.4	-1.4	-1.4
97184	658993	7519473	1	-5.9	-5.9	-5.9
97185	659218	7519203	1	-5.3	-5.3	-5.3
136090	647465	7540053	2	1.7	1.7	1.7
136689	635868	7528234	2	-7.4	-7.4	-7.4
141653	659045	7556157	2	-1.1	-1.1	-1.1
141654	659021	7555813	2	-3.2	-3.2	-3.2
141657	660949	7555175	2	-8.4	-8.4	-8.4
141659	665723	7557183	2	-9.2	-9.2	-9.2
141660	662270	7556435	2	-4.9	-4.9	-4.9
141661	662270	7553121	2	-9.9	-9.9	-9.9
141662	662988	7553121	2	-9.6	-9.6	-9.6
158010	642695	7520136	9	-2.7	-2.7	-2.7
158011	640219	7514147	12	-7.6	-7.6	-7.6
158484	648127	7524068	2	-6.5	-6.5	-6.5
158485	643179	7522108	9	1.3	1.3	1.3
161572	672635	7538180	14	-7.9	-7.9	-7.9
161573	672635	7538180	12	-7.1	-7.1	-7.1
161575	672566	7543230	13	1.4	1.4	1.4
161578	672387	7535241	14	-0.1	-0.1	-0.1
162439	631855	7553648	1	-0.1	-0.1	-0.1
162470	635300	7560237	9	15.3	11.9	18.3
162471	632332	7558326	9	-2.3	-4.2	7.1
162528	631660	7561036	9	3.4	-1.9	9.0
165325	640350	7516070	12	-8.6	-8.6	-8.6

ID	Easting	Northing	Layer	Average Residual	Min	Max
13040180	667824	7516333	1	-6.9	-8.8	-5.2
13040181	667995	7516067	1	-4.0	-4.0	-4.0
13040183	668911	7514985	9	-6.2	-6.2	-6.2
13040184	669488	7514387	9	-8.0	-8.0	-8.0
13040287	663069	7559093	1	-4.6	-5.3	-4.0
Bore2	634799	7550042	1	-0.3	-0.3	-0.3
Bore3	634799	7550042	10	-3.8	-3.8	-3.8
Bore7	637704	7552565	9	-6.3	-6.3	-6.3
GW01d p1	642475	7547489	7	-4.6	-5.7	-3.2
GW01d p2	642475	7547489	5	-8.4	-9.2	-7.0
GW01d p3	642475	7547489	3	-2.4	-2.8	-1.9
GW01d p4	642475	7547489	3	-0.2	-0.4	0.5
GW01s	642471	7547492	1	0.8	0.4	2.7
GW02d	641148	7546512	7	-4.4	-4.7	-3.6
GW02s	641152	7546517	1	-3.2	-3.5	-2.2
GW06d p1	639334	7542009	11	3.7	3.4	4.1
GW06d p2	639334	7542009	10	-5.3	-5.8	-4.8
GW06d p3	639334	7542009	10	-5.7	-5.9	-5.5
GW06d p4	639334	7542009	9	-10.1	-11.2	-7.0
GW08d p1	645312	7539846	5	-6.3	-11.5	1.0
GW08d p2	645312	7539846	4	-2.1	-3.4	1.0
GW08d p3	645312	7539846	3	2.9	0.7	3.7
GW12d p1	641492	7532790	5	-0.4	-1.5	4.2
GW12d p2	641492	7532790	5	-5.2	-6.1	-3.8
GW12s	641498	7532791	2	-6.0	-6.3	-4.2
GW16d p2	660834	7525288	5	-11.2	-11.3	-11.1
GW16d p3	660834	7525288	3	-11.1	-11.3	-10.9
GW16d p4	660834	7525288	3	-10.4	-10.6	-10.3
GW18d	656891	7522809	7	-0.1	-0.2	0.8
GW18s	656885	7522810	1	0.8	0.6	1.7
GW21d	661580	7521648	8	-12.9	-12.9	-12.8
GW21s	661580	7521653	2	6.2	6.0	6.8
GW8s	645323	7539847	1	-0.7	-1.0	0.3
LakeV3	648037	7523878	2	1.3	1.3	1.3
LV1235C P1	649799	7522054	2	-18.2	-19.4	-17.4
LV1235C P2	649799	7522054	2	-17.7	-20.1	-16.4
LV1235C P3	649799	7522054	2	-16.9	-20.3	-15.4
LV1235C P4	649799	7522054	2	-13.5	-15.7	-11.3
LV2183 P1	644068	7520358	2	-10.9	-12.0	-10.0
LV2183 P3	644068	7520358	2	-0.4	-1.5	0.5
LV2183 P4	644068	7520358	2	-10.2	-10.4	-9.7
LV2218 P1	645526	7522753	2	-1.1	-1.7	0.0
LV2218 P2	645526	7522753	2	-1.4	-1.9	-0.4
LV2218 P3	645526	7522753	2	-0.2	-0.6	0.6
LV2218 P4	645526	7522753	2	1.6	0.5	2.5

ID	Easting	Northing	Layer	Average Residual	Min	Max
LV2226 P1	643129	7521950	2	-5.0	-5.6	-4.5
LV2226 P2	643129	7521950	2	-4.2	-5.1	-3.5
LV2226 P3	643129	7521950	2	-2.5	-4.1	-1.5
LV2226 P4	643129	7521950	2	-3.0	-4.1	-0.8
LV2372R P1	647515	7526007	2	-11.3	-11.9	-10.7
LV2372R P2	647515	7526007	2	-11.3	-11.9	-10.7
LV2372R P3	647515	7526007	2	-11.3	-11.9	-10.7
LV2372R P4	647515	7526007	2	-11.4	-11.9	-10.8
LV2375W P1	648040	7523865	2	-16.8	-17.2	-16.3
LV2375W P2	648040	7523865	2	-16.9	-17.1	-16.5
LV2375W P3	648040	7523865	2	-12.7	-13.4	-12.1
River Bore	654027	7526987	3	-5.4	-5.4	-5.4
S10	642552	7546035	1	0.0	-0.1	1.1
S11	642455	7545332	1	1.7	1.7	1.7
S2	641386	7547617	1	0.7	0.7	0.7
S4	641567	7546845	1	-3.5	-5.2	-0.8
S5	642239	7547332	1	-1.9	-2.0	0.8
S6	642054	7546721	1	-0.5	-0.5	1.2
S7	641443	7545828	1	-3.7	-3.8	-2.2
S8	642340	7546343	1	1.5	1.3	2.8
S9	641767	7545426	1	-2.5	-2.5	-1.4
Swamp Bore	645609	7528626	2	-9.3	-9.3	-9.3
Unknown1	670340	7516415	2	2.1	2.1	2.1
Unknown1 9	656877	7515985	2	-2.7	-2.7	-2.7
Unknown2	656877	7515985	2	-10.4	-10.4	-10.4
Yard Bore1	642577	7519344	2	-6.9	-6.9	-6.9